Marshalling the Aegis: Technosociology and Systems Engineering for Ambient Ecumenes of Global Information Systems (AEGIS).

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A DISSERTATION

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ABSTRACT

Marshalling the Aegis:Technosociology and Systems Engineering for Ambient Ecumenes of Global Information Systems (AEGIS).

An Information and Communicators Technology Systems Engineering dissertation which engages the technosocial and systems engineering of emergent ambient intelligence (AmI) driven social ecosystems. Dubbed Smart X (Smart City / Smart Vehicle / Smart Home, etc.) these black box algorithm driven enterprise Systems of Socio-Cyber-Physical Systems (SoSCPSs) represent the single most complex and unpredictable convergence of technologies which interact with the body public. The thesis contributes to systems engineering in three ways: 1) it identifies and explains these stacked interoperable SCPSs as Ambient Ecumenes of Global Information Systems (AEGIS), providing techno-social nomenclature, design focus, and applied technology awareness to future Smart X engineers; 2) it interrogates the limits and dangers of the AEGIS which include unintended social influence, subversion of human agency, and decreasing access to the artificial intelligence algorithms driving the systems; 3) it proposes the Systems Social Engineering paradigm to assist technosociological and systems engineering analysis of all future emergent AmI SoSCPSs.

DECLARATION

I do hereby attest that I am the sole author of this project/thesis and that its contents are only the result of the readings and research I have done. The dissertation titled "Marshalling the Aegis: Technosociology and Systems Engineering for Ambient Ecumenes of Global Information Systems (AEGIS)", submitted for the award of Doctor of Philosophy (PhD) at the Selinus University of Sciences and Literature, School of Computer Science; is my original work and the dissertation has not formed the basis for the award of any other degree. All the materials, various schools of thoughts, and other academic consulted during the research work and for the dissertation were duly acknowledged.

DATE: September 17, 2021

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Signature:

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Athena's Aegis

ὣς εἰπὼν ἐν χερσὶ τίθει, ὃ δὲ δέξατο χαίρων

παῖδα φίλην: τοὶ δ' ὦκα θεῷ ἱερὴν ἑκατόμβην

ἑξείης ἔστησαν ἐύ◎δμητον περὶ βωμόν,

χερνίψαντο δ' ἔπειτα καὶ οὐλοχύτας ἀνέλοντο.

τοῖσιν δὲ Χρύσης μεγάλ' εὔχετο χεῖρας ἀνασχών:

κλῦθί μευ ἀργυρότοξ', ὃς Χρύσην ἀμφιβέβηκας

Κίλλαν τε ζαθέην Τενέδοιό τε ἶφι ἀνάσσεις:

ἦ μὲν δή ποτ' ἐμεῦ πάρος ἔκλυες εὐξαμένοιο,

τίμησας μὲν ἐμέ, μέγα δ' ἴψαο λαὸν Ἀχαιῶν:

ἠδ' ἔτι καὶ νῦν μοι τόδ':

The chiefs about the son of Atreus chose their men and marshalled them, while Athena went among them holding her priceless Aegis that knows neither age nor death. From it there waved a hundred tassels of pure gold, all deftly woven, and each one of them worth a hundred oxen. With this she darted furiously everywhere among the hosts of the Achaeans, urging them forward, and putting courage into the heart of each, so that he might fight and do battle without ceasing. Thus war became sweeter in their eyes even than returning home in their ships. As when some great forest fire is raging upon a mountain top and its light is seen afar...[1]

1 https://uh.edu/~cldue/texts/iliad.html

Introduction

"Personal data is the new oil of the Internet and the new currency of the digital world." Meglena Kuneva, European Consumer Commissioner, March 2009[2]

The World Economic Forum considers personal data which drives every digital aspect of citizen life in an interconnected world to represent "a post-industrial opportunity. It has unprecedented complexity, velocity and global reach." Real time ubiquitous communications will create a world where nearly everyone and everything are connected demanding of urban centres highly secure, a highly reliable, and continuously available digital infrastructure supported by both economic policy and technological integration with commercial and governmental affairs.[3] David Rydning and his research team at International data Corporation have estimated that the total amount of data – personal, general, and metadata – represents an unprecedented tsunami which will engulf modern life. They predict that the Global Datasphere will grow from 33 Zettabytes (ZB) in 2018 to 175 ZB by 2025. "Big Data and metadata (data about data) will eventually touch nearly every aspect of our lives — with profound consequences. 49% of the world's stored data will reside in public cloud environments. By 2025, an average connected person anywhere in the world will interact with connected devices nearly 4,800 times per day — basically one interaction every 18 seconds." At such a time they suggest that more than 25% information created will be real time Internet of Things (IoT) data with the content and objects subject to data analysis increasing by a factor of 50 to 5.2ZB 5. More staggeringly, the amount of data managed or collated through cognitive systems [ambient ecumenes]will grow by a factor of 100 to 1.4ZB. That means that in 2025, more than 85% of all data created should be

2 Director, M.L. and Telecom, A.C.F., 2019. APPENDIX A PERSONAL DATA: THE EMERGENCE OF A NEW ASSET CLASS. *Trusted Data, revised and expanded edition: A New Framework for Identity and Data Sharing*, p.271.
3 Director, M.L. and Telecom, A.C.F., 2019. APPENDIX A PERSONAL DATA: THE EMERGENCE OF A NEW ASSET CLASS. *Trusted Data, revised and expanded edition: A New Framework for Identity and Data Sharing*, p.271.

secured for legal or governance purposes. They estimate that less than half will be.[4] As an example, "one zettabyte is equivalent to a trillion gigabytes If you were able to store the entire Global Datasphere on DVDs, then you would have a stack of DVDs that could get you to the moon 23 times or circle Earth 222 times. If you could download the entire 2025 Global Datasphere at an average of 25 Mb/s, today's average connection speed across the United States, then it would take one person 1.8 billion years to do it, or if every person in the world could help and never rest, then you could get it done in 81 days."[5]

At the same time, experts estimate that mart Cities have created a global technology market worth more than $1.5 trillion as of 2020. Major centres of economic and socila power, Global Cities, seem to be both digitalizing their urban environments faster and wit greater depth of data management than rural areas around the globe.[6] "It is expected that over 26 Global Cities will become Smart Cities in 2025, with more than half of them located in Europe and North America. The next generation Smart Cities will be heavily dependent on the integration of smart infrastructure with information and communication technologies(ICT) and the Internet of Things (IoT)."[7] This convergence of data systems requiring support and the proliferation of IoT devices driving increased data usage and exponential demand for data collation, data security, and Big Data analysis, has been met with both enthusiasm and to some degree economic opportunism by Europeans and North Americans whose obvious self interest as their own cities globalise and then become "Smart Cities" has essentially catapulted the zettabyte explosion of data being generated and manipulated in urban areas. To meet the demand, urban planners, ICT professionals, and various digital providers have promoted Smart

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4 Rydning, D.R.J.G.J., 2018. The digitization of the world from edge to core. *Framingham: International Data Corporation*, p.16.

5 Rydning, D.R.J.G.J., 2018. The digitization of the world from edge to core. *Framingham: International Data Corporation*, p.16.

6 Alavi, A.H. and Buttlar, W.G., 2019. An overview of smartphone technology for citizen-centered, real-time and scalable civil infrastructure monitoring. *Future Generation Computer Systems*, *93*, pp.651-672.

7 Alavi, A.H. and Buttlar, W.G., 2019. An overview of smartphone technology for citizen-centered, real-time and scalable civil infrastructure monitoring. *Future Generation Computer Systems*, *93*, pp.651-672.

Cities as THE solution to the emergence of a global datasphere which has merged and to a degree endangered people's vital, valuable and, thus, vulnerable personal data.

No two entities agree on what constitutes Smart Technology which combined and layered become Smart Grids, Smart Vehicles, Smartphones, and ultimately Smart Cities. But at the heart of the argument, Smart equals converged data being managed in real time by machine learning driven systems – artificial intelligence (AI) designed to fulfil a specific but open ended purpose. In time as these heterogeneous systems overlap, communicate using ubiquitous platforms and networks, and exceed their original propose in pursuit of accommodating their open-ended algorithms, they have started to experience emergence, a phenomenon wherein the algorithm provides an answer not previously anticipated by its programming. For the most sophisticated of systems, emergence has been designed into the process and represent the core requirement of the machine learning component. The emergent nature of these hyper complex systems has driven the creation of ambient systems, ones that adapt to personal needs real time. The emergent nature of Ambient Intelligence (AmI) has increased both the complexity and the demands of Smart City infrastructure. They merge and compete to control data flows, constantly modifying other AI and AmI algorithms as new pieces of hardware and software are added to the ecosystem.

At the same time, these competing systems collectively generate petabytes of data which are managed by information systems which in of themselves are controlled by different AIs. This thesis describes them as Global Information Systems (GIS) – the agglomerated union of ubiquitous communications, IoT, AmI, and the ever changing AI driven software agents moving in and out of the urban space. These GIS circumscribe a shared world which in a discrete region or urban space overlap with merged and interlocked cyber-physical systems. The combination of global systems tied to regionally bounded hardware which both must negotiate their data management and control through the geographic, political, and social lens of a city have been termed Smart Cities.

In truth, they are both more and less than this. The thesis has termed them Ambient Ecumenes – shared worlds of AmI systems merged and managed by other AmI systems in a geographic space. How do they emerge – literally as emergent systems and figuratively as a the most complex of ICT in the modern era?

Main Argument

This thesis attempts to answer a simple question: in terms of systems engineering and its attendant technosociology, how does an outside agent such as an urban management team or Smart Systems manufacturer assemble and launch an Ambient Ecumene of Global Information Systems (AEGIS). As one might guess, the answer turns out to be anything but simple precisely because an AEGIS must *emerge* rather than be built and as such its complex path to functional interconnection and near sapient interaction with urban clientele requires layered networks of integrated systems which have been cooperatively meshed with social, economic, and cultural nodes of an urbanised space. More concerning, these complex systems have not as of yet ever been built from one set of homogeneous components. They are both heterogeneous in the extreme and driven by layers of abstracted black box algorithms which contribute to functional Ambient Intelligence (AmI).

This thesis will argue that three specific "truths"apply to these AmI systems. Specifically it provides a set of nomenclatures driven by the latest research into both the component level Smart Products, IoT, AmI, and support systems like cloud, edge, etc. Then uses these nomenclatures to develop critical paradigms which allow future systems engineers to critically engage systems which until now have grown haphazardly. While systems engineers have attempted to direct the design, building, and management of individual SCPSs as well as AmI products, there exists no extent literature on managing them as a comprehensive ecosystems of emergent agents. From this globalised view comes the main argument.

1) Original doctoral research identifies and explains these stacked interoperable SCPs as Ambient Ecumenes of Global Information Systems (AEGIS), providing techno-social nomenclature, design focus, and applied technology awareness to future Smart X engineers. Much of the first sections' technosociology attempts to elucidate the underpinnings of the artificial intelligence programming as well as clarify for engineers how systems of social control have provided potentially detrimental technological consequences which impact all aspects of practical design and deployment.

2)The thesis then interrogates the limits and dangers of the AEGIS which include unintended social influence, subversion of human agency, and decreasing access to the artificial intelligence algorithms driving the systems. The systems engineering section identifies component systems which should be technologically and politically neutral / agnostic but which provide levels of both control through the ambient environment and through social design. In many cases these influences represent side effects of increasing use of emergent algorithms and self managed self teaching intelligent systems.

3) Lastly, it proposes the Systems Social Engineering paradigm to assist technosociological and systems engineering analysis of all future emergent AmI SCPSs. This innovative model builds on the prior work of the dissertation to demonstrate to what degree and in what fashions the AEGIS has become a node of social engineering which has been essentially driven by complex systems engineering. The paradigm will create sufficient intellectual distance for future analysts and engineers to critically assess what AmI systems must be changed, adapted, or scrapped to ensure that the intended result of the AEGIS, improving the effectiveness and ease of human endeavours can be ensured.

Definitions and Theoretical Ontologies:

This thesis by virtue of it being interdisciplinary focuses on a multiplicity of new concepts as well as theoretically emerging fields. It would be advantageous to both the reader and the wider community of science and technology studies (STS) for there to be as little ambiguity as possible in the research that follows. As such, a good portion of the beginning will be devoted to both delineation of terminology and theoretical positioning. On some level any thesis engages in a semantics and metaphysics, trying to pin down what words mean and how those meanings best define the new ideas being presented.

Ultimately, doctoral dissertations attempt to create new knowledge. For this thesis, that new knowledge will come as a result of three distinct interrelated interpolations: 1 – newly defined and expanded ontological political theory related to technology; 2 – defining and explicating technosociology as a working discipline as it relates to systems engineering and vice versa how systems engineering impacts and drives all technosociology; 3 – relevant understanding of how 1 & 2 help STS better understand the inherent mechanisms of Smart X development and diffusion. For this reason, the lens of hegemony – socio-political control over an ecosystem – has been chosen as one of the categorical foci of the thesis. The premise being that scholars must first confront the reality of emergent algorithms as unknown controlling agents which can and do subvert human free will before they can then examine the "neutral" technology of designing and delivering Smart X tech to the body public. At the same time, this thesis situates STS as a political and social act with historic consequences as well as arising from historic precedents (themselves prior consequences).

Which turns on the head the common sense notion of systems engineering as an inherently technological practice. Precisely because technology itself represents the tool use of the homo politicus, the extension of human will into automated and at times autonomous systems. Systems which are themselves products of bias, human desire, and in the case of urban spaces, the cumulative give and take of economic, social, cultural, and engineering concerns. Systems engineering then becomes the complex art and science of combining systems that both work and achieve the desired end effect. Ones that by their nature provide non-emergent answer to inherently emergent algorithmic issues.

The Ubiquitous We

For purposes of this thesis, once the introductory definitions and academic level setting have been established, there will be a tonal shift in both depth of language and authorial person. In short, the common turgid and at times burdensome academic parlance often demanded of social science will give way to short, concrete examples and jargon free (or pre-defined) focused on including the author, academic, technological community, Smart X providers, and by inference the readers. It will be established by using the pronouns "we" and "us" to make inclusive and direct statements such as "We can now see…" or "That leads us to realise…"

On what basis has this shift been justified? Three functional reasons exist to demystify academic-ese and write instead in plain business English: inclusivity, understandability, and accuracy. STS scholars have begun to argue "the use of the third person as a linguistic device to convey an impression of objectivity in the research process inconsistent with the underlying philosophies of interpretative, action and feminist research."[8] If this proves to be the case, then using we and us better reflects the society that creates and utilises technosociology. Likewise, hard science papers increasingly use informal language and we/us to "ensure readers get the writer's take-home message... The sciences in particular are now significantly more likely to express arguments in the active voice using inclusive we to claim agency for their decisions and credit for their work."[9] Lastly the shifting academic opinion on writing itself has become

8 Webb, C., 1992. The use of the first person in academic writing: objectivity, language and gatekeeping. Journal of advanced nursing, 17(6), pp.747-752.
9 Jiang, F.K. and Hyland, K., 2020. Prescription and reality in advanced academic writing. Ibérica: Revista de la Asociación Europea de Lenguas para Fines Específicos (AELFE), (39), pp.14-42.

one where making sense and being. Accurate matter more than ‘sounding smart’ or fitting the correct jargon into a sentence. “If the purpose of academic writing is to clearly communicate one’s ideas and research to the reader, then writing that is difficult to understand is bad writing. Period.”[10]

The reader should therefore expect to proceed through an introductory section formal and focused on achieving clear working definitions derived from a corpus of philosophy, political theory, sociology, technological social science, and computer science. There will follow a wider thesis with the third person narrative absent and an assumed consensual inclusive we/us representing the wide body of global technology users who engage with, experience and have direct investment in the existence of Smart X ecosystems. More to the point, as users of the system and therefore subjects of outside influences, the use of we/us makes clear that from a very biased beginning, this thesis sided with the continued exertion of human free will. As will be discussed, the confluence of ambient technologies and the inherent socio-economic drive for hegemony represent emerging threats to human agency. he stakes could not be higher and thus, the stakeholders deserve both the courtesy of inclusion and the explicitly defined responsibility of, having been included, taking educated action on their own behalf.

PhDs and Long Quotes

Dissertations are by their nature strange pieces of work. When done correctly, the average scholar may safely ignore the contents of the thesis and rip quotes / data from key findings, conclusion sections or original charts / tables. But to get there and to ensure that any substantiation required can be tracked and interrogated fully, the same thesis must by its nature quote its source, often in great length with rigid detail. Why? TO demonstrate doctoral level expertise and knowledge as well as show adequate proof of new concepts, new proposed ideas / paradigms, and support any claimed findings. To ensure the reader can identify them fully, this thesis will indent the whole of the quote

10 https://www.thecrimson.com/article/2019/10/21/leonard-academic-writing/

data as well as footnote the source. For scholars more interested in the conclusion, a whole section of contributions has been added as an appendix. Thus, we achieve the dual purposes of showing to examiners and already doctoral level critics the inherent skills needed to be accepted in the academy but also fulfil the secondary but crucial obligation to that same community of thinkers and creators by providing succinct information on what has been discovered.

Ambient Ecumenes of Global Information Systems (AEGIS)

This thesis attempts to answer a simple question: in terms of technosociology and systems engineering, how does an outside agent such as an urban management team or Smart Systems manufacturer assemble and launch an Ambient Ecumene of Global Information Systems (AEGIS). As one might guess, the answer turns out to be anything but simple precisely because an AEGIS must *emerge* rather than be built and as such its complex path to functional interconnection and near sapient interaction with urban clientele requires layered networks of integrated systems which have been cooperatively meshed with social, economic, and cultural nodes of an urbanised space.

How then do we reconcile the need to create highly integrated systems on vastly divergent levels with the prior discussion of both needed and sought for hegemony over these systems? For this one must ask a deeply fundamental and disconcerting questions: what makes us human? Humanity has been defined in any number of fascinating ways but most include a set of core characteristics which inform how we then consider extensions of humanness: sapience, creativity, political and social agency, and economic interest. These are not idle questions precisely because AmI requires emergent algorithms to determine human need and then answer it in real-time. A shared world of the ecumene by its nature represents hundreds of these AmI driven systems merging into macrosystems of macrosystems, each coordinating and collaborating with sister entities, each driving its own programmed agenda until the AmI encounters emergent requirements proposed either by human agents or another AmI macrosystem.

The inherent programming that determines whom it accommodates – the software or the citizen and in what order, to what degree, and to what eventual consequence represents an almost infinite chain of What If logical sequences that have no chartable solution set. They do however have both discernible effects and real world consequences, made more stark and perhaps more relevant to systems engineering by their real time nature which evolves and mutates millisecond by millisecond. Thus we need to ask what truly makes humans matter to themselves and by that more narrow definition, can we and do we teach systems which, as AmIs, are proposed and sold as capable of accommodating and fulfilling human desires near instantly, to actually achieve that defined human need?

What Makes Us Human?

At the core of the questions lies an a priori premise that we can know what makes us human and we can articulate it in such a fashion that a complex machine system like a cloud enabled software and IoT cyberphysical system could be truly ambient and intelligent. Can we make that assumption? We can certainly approximate human need, human behaviours, and STS and as well as the sub-science of technosociology attempts to achieve precisely that end. Thus the reason we will be delving deeply into technosociological issues prior to describing the core engineering of Smart X systems. Scholars suggest there are some core attributes that define humanity:

> Two genuinely pan-human traits may explain many of the phenomena currently attributed to innate human prosociality. The first is our unique propensity for imitation. Humans are the only terrestrial mammals that imitate sounds, and the only animal that imitates the things we see. The second is the human capacity for seeing things from the other fellow's perspective. Humans are so strongly disposed to understand the motivations of others that we are always seeing motivations where they do not exist.[11]

Another group suggests similar if slightly less discrete phenomenon: "they are unique and exemplify what it means to be human: symbolic behaviour, language, and culture."[12] Human neurology and brain morphology has its own special characteristics which machine learning can be trained to emulate:

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11 Calcagno, J.M. and Fuentes, A., 2012. What makes us human? Answers from evolutionary anthropology. *Evolutionary Anthropology: Issues, News, and Reviews*, *21*(5), pp.182-194.
12 Calcagno, J.M. and Fuentes, A., 2012. What makes us human? Answers from evolutionary anthropology. *Evolutionary Anthropology: Issues, News, and Reviews*, *21*(5), pp.182-194.

> It is a brain that has evolved under social pressure to make us self-aware individuals who define ourselves by what we share with a group of familiar others. While that group of familiar others originally extended no farther than a band or tribe, it has since grown until it now includes, to varying degrees, a global human population. It appears that our brain anticipates group membership based on equality as the default condition, and when this expectation is violated the insula senses a threat to bodily well-being. Such a picture is entirely compatible with our evolutionary history as hunter-gatherers dependent on each other for survival. In sum, humans are inherently group beings with shared practices and beliefs[13]

These shared practices include the raw biological support of young and vulnerable as well the wider implications of such behaviours which become social ties, morals, and ethical contracts between sapient agents:

> Beyond birth assistance, investment in infancy is also possible because humans help each other by sharing the high energy demands, in-tensive monitoring, and attentive care that benefit mothers and their babies so much. The relationships women form with one another as a result of this sharing of effort create intense emotional bonds that form one underpinning of the uniquely complex extended family and non-family social networks universal to humans. This web of social ties, and its elaboration in support of human reproduction and child rearing, are among the critical factors that shape the unique human adaptation and, despite our close genetic and behavioral ties to other primates, establish a pattern of social behavior that sets us apart from our primate relatives.[14]

What achieves this? Scholars have suggested it's the theory of the mind, ie, self awareness of thinking itself. Knowing that we know; understanding that we both

13 Calcagno, J.M. and Fuentes, A., 2012. What makes us human? Answers from evolutionary anthropology. *Evolutionary Anthropology: Issues, News, and Reviews*, *21*(5), pp.182-194.

14 Calcagno, J.M. and Fuentes, A., 2012. What makes us human? Answers from evolutionary anthropology. *Evolutionary Anthropology: Issues, News, and Reviews*, *21*(5), pp.182-194.

understand and, by logical surmise, we sometimes do not understand. That we are both aware and simultaneously limited, in need of social support and symbolic consensus:

> Humans are characterized by a fully developed theory of mind,with the ability for flexible language skills and the concomitant symbolic and global reality of culture. Our biology cannot be understood outside of the aforementioned cultural and cognitive reality, and culture cannot be fully understood without biology. Thus, our biology and culture are not just intertwined, but melded together, co-existent, inseparable.[15]

These promulgate a connectome: the structural connectivity (the physical wiring) of an organism's nervous system: "the main drivers of the uniqueness of each individual functional connectome reside in the brain areas devoted to "higher-order" cognitive functions, such as frontoparietal and default-mode networks. We found compelling evidence that different parts of connectome fingerprints are optimal at different time scales."[16]

This same connectome provides insight into how humans operate across multiple time frame of cognition:

> Intriguingly, the temporal scales of fingerprinting can be related to behavior in a meaningful way (Fig. 5). Using a meta-analytic approach, we showed that there is a broad spectrum of associations with behavior. At faster time scales, human brain fingerprints are linked to multisensory stimulation, eye movements, affective processing, visuospatial attention. At slower time scales instead, we find higher-cognitive functions, such as language and verbal semantics, awareness, declarative and working memory, social cognition[17]

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15 Calcagno, J.M. and Fuentes, A., 2012. What makes us human? Answers from evolutionary anthropology. *Evolutionary Anthropology: Issues, News, and Reviews*, *21*(5), pp.182-194.

16 Van De Ville, D., Farouj, Y., Preti, M.G., Liégeois, R. and Amico, E., 2021. When makes you unique: temporality of the human brain fingerprint. *bioRxiv*.

17 Van De Ville, D., Farouj, Y., Preti, M.G., Liégeois, R. and Amico, E., 2021. When makes you unique: temporality of the human brain fingerprint. *bioRxiv*.

We found that brain fingerprints at fast scales are associated with low-order multisensory processing, visual perception, motor/eye movements, as well as affective processing and visuospatial attention (Fig. 5). On the other hand, brain fingerprints at slower time scales are linked to reading comprehension, awareness, verbal semantics, language, social cognition, as well as declarative and working memory (Fig. 5).[18]

[19]

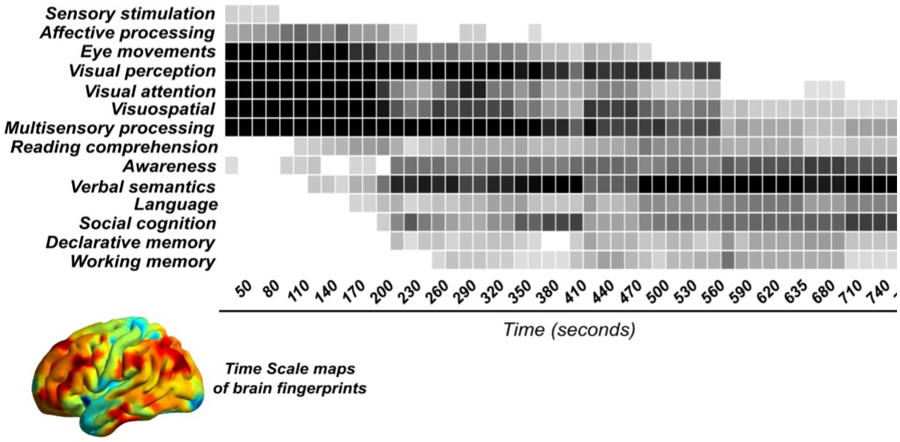

Fig. 5 Brain fingerprints associates with behavior across time scales. The Neuro meta-analysis of the brain fingerprints maps across time scales (from 50 seconds to 770 secon steps of 15 seconds) shows a spectrum of association with low-sensory regions at fast time s ending up into higher-order processing. The brain fingerprint maps were masked by selecting only tl 25% brain nodes at each time scale.

Illustration 1: Figure 5

These time scales and orderings of humanness have relevant meanings to AmI precisely because a real-time ambient system must react to multiple sets of needs / requests that are bounded by different neurological processing. If it takes up to 700 seconds to form full comprehension and awareness from written or verbal language, with social cognition and employment of social ties being the slowest and most “high order” of human activities. In contrast, the ambient interfaces of IoT have been wired to work in milliseconds and even with download speeds, communication gaps, and the

18 Van De Ville, D., Farouj, Y., Preti, M.G., Liégeois, R. and Amico, E., 2021. When makes you unique: temporality of the human brain fingerprint. *bioRxiv*.

19 Van De Ville, D., Farouj, Y., Preti, M.G., Liégeois, R. and Amico, E., 2021. When makes you unique: temporality of the human brain fingerprint. *bioRxiv*.

like, the relevant ambient response has been proscribed as under 1 second, resulting in machine learning being wired to react and influence sensory processing, visual perception, and motor function. Doing and being as opposed to talking and reasoning. Even the most common associative acts such as recognising the sensory data of clock hands and interpreting the "correct" time requires 2 to 3 seconds with 92%-97% accuracy.[20] More complex understanding can require up to 16 seconds.[21] At the same time, actual reaction time to stimuli requires milliseconds (ms), with Cognitive Reaction Time, mean range being 523 ± 159 ms and Sustained Attention to Response Task mean range being 387 ± 102ms.[22] All of which means that ambient machines lag behind inception of data and initial human perception but are able to supersede the speed of cohesive and finalised thoughts. As described by AI engineers, human thinking co-creates perception with its environment. Ubiquitous communication represents a human activity which AmI systems have been created to emulate:

> In fact, human communication and interaction make significant use of complex non-verbal gestures such as facial expressions, hand and body movements, which support the perception of connectedness between the human communicators (**Sidner et al., 2005**). While designing human likeness including non-verbal gesturing into robots may be significant for the creation of trust and ability to bond with robots, **Mori**'s (**1970**) 'uncanny valley' hypothesis also suggests that there is a certain threshold beyond which the human-like appearance of a robot may repel rather than attract humans.[23]

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20 Formisano, E., Linden, D.E., Di Salle, F., Trojano, L., Esposito, F., Sack, A.T., Grossi, D., Zanella, F.E. and Goebel, R., 2002. Tracking the mind's image in the brain I: time-resolved fMRI during visuospatial mental imagery. *Neuron*, *35*(1), pp.185-194.

21 Formisano, E. and Goebel, R., 2003. Tracking cognitive processes with functional MRI mental chronometry. *Current opinion in neurobiology*, *13*(2), pp.174-181.

22 Donoghue, O.A., Horgan, N.F., Savva, G.M., Cronin, H., O'Regan, C. and Kenny, R.A., 2012. Association between timed Up-and-Go and memory, executive function, and processing speed. *Journal of the American Geriatrics Society*, *60*(9), pp.1681-1686.

23 De Togni, G., Erikainen, S., Chan, S. and Cunningham-Burley, S., 2021. What makes AI 'intelligent' and 'caring'? Exploring affect and relationality across three sites of intelligence and care. *Social Science & Medicine*, *277*, p.113874.

An ambient system then would need to be wired to respond to facial expressions and non-verbal cues, all of which are fast process, low order, unthinking or subconscious operations which correspond with the speed of AI's response capability. “The current and anticipated near future developments in AI can most accurately be described as ‘human augmentation’ and that such a focus foregrounds the interactional entanglements that do and will shape intelligence, affect and relationships in and across different health and care contexts.[24]

What makes us human? A complex neurological web of cognition and self awareness that makes clear our vulnerabilities and need for mutual support. Which in turn co-creates and cross wires our brains to drive for social contracts and social support. By the nature of AI being responsive and focused on changing and adapting, it serves a clear need for humans whose faster process thinking tends to be low order sensory perception rather than high order reasoning. This adjunct capability promises to entwine with human brain developments, to literally wire us to biologically to respond and rely on systems as if they were people. This means that AI which can be responsive in real time could become a social tie of equivalent value as another human being. As such the defining nature or being human requires further in depth analysis of AI and AmI.

The Bridge Between Human and Artificial Intelligence: Ambient Intelligence

As communications matter so deeply for humanness, it follows that the focus of AI has been mimicking human speech sufficiently to be an equal and seamless participant in decision making: “Groups are created in a formal or informal way, exchange ideas or engage in a process of argumentation and counter- argumentation, negotiate, cooperate, collaborate or even discuss techniques and/or methodologies for problem solving [and

24 De Togni, G., Erikainen, S., Chan, S. and Cunningham-Burley, S., 2021. What makes AI ‘intelligent’ and ‘caring’? Exploring affect and relationality across three sites of intelligence and care. *Social Science & Medicine*, *277*, p.113874.

this can be replicated using] the paradigm of Mixed Initiative Systems, so the initiative is to be pushed by human users and/or intelligent agents."[25]

This has in turn pushed AI design to become real-time and humanly responsive, ie, ambient. As a result it has driven an advancement of lightspeed capability in every setting: “For the communication between the latter, wireless networks will be the dominant technology. The combination of simplified use of devices and their ability to communicate eventually results in increased efficiency for the users and, therefore, creates value, leading to a higher degree of ubiquity of computing devices.”[26]

More than that, the algorithms have been focused on the gap between perception and cohesive understanding, on the emotional weight and impact of data as it percolates through the connectome:

> Affective Computing is defined as ”computing that relates to, arises from or deliberately influences emotions”, by Picard, who coined the term. In the last years, work done in neuroscience and psychology has radically changed the view according to which emotions only serve to hinder reason. Although there are situations in which emotions can impair reason, more often than not emotions are essential to rational reasoning, decision making, human communication, to name a few of the things we all do in our daily lifes. Since emotions play a fundamental role in human communication, and many of the existing human-computer interfaces are not always very pleasant for humans, it is only natural that an important area of application of affective computing is in human-computer interfaces.[27]

This affective computing focus has taken sterile machine learning and merged it with communications protocols and social support mechanisms that define humans as humans. As a result, there has been a divergence between proscriptive computing

25 Marreiros, G., Santos, R., Ramos, C., Neves, J., Novais, P., Machado, J.M. and Cruz, J.B., 2007. Ambient intelligence in emotion based ubiquitous decision making.

26 Alcañiz, M. and Rey, B., 2005. New technologies for ambient intelligence. *Ambient Intelligence*, *3*, pp.3-15.

27 Alcañiz, M. and Rey, B., 2005. New technologies for ambient intelligence. *Ambient Intelligence*, *3*, pp.3-15.

systems which focus on machine learning and AI to drive consistent unambiguous results and and open AI which has sought out Ambient capability by becoming inconsistent and ambiguous in results. In other worlds, complex and emotionally oriented like the humans it emuates.

> Emotionology refers to the symbolic-material infrastructures via which society recognizes and normalizes emotion displays. The concept aids researchers to heed the professed norms and "broader affective logic" that shape any inquiry—technical, critical, and socio-anthropological— into the realm of human emotion (Dror et al. 2016, 11). Behind both computing's prevalent adoption of "inside-out" behavioralist models of mental activity (also see Binder 2020), on one hand, and its critics' cherishment of individual sovereignty over the interior as a sheltered space ..., on the other, is one peculiar emotionology that upholds a liberal subject with innate emotion. In addition, that these technologies can access interior workings, on which much of their critiques rest, is also aggressively promoted by corporate and political powers wielding them in self-interest.[28]

We can then say with confidence that while algorithms have been designed to mimic humanness, by promoting social conversations, displaying emotionological behaviour, and approaching their protocols through an affective lens. What then determines how humans shift from perception to thought? Experience itself – the process of moving, being, and acting in the world.

Ambient Systems

What makes an AI into an Ambient Intelligence involves both the affective focus of the technology and augmented and interlocked nature of the hardware, software, and networks connected to the system. AmI requires a system to achieve – it cannot be achieved and delivered by a sole device or software package.

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28 Wu, A.X., The Ambient Politics of Affective Computing. s2013

> The significant shift to "augmented space' is overlaying physical space with dynamically changing information, multimedia in form and localized for each user where the data forms an always connected, pervasive environment rather than necessarily appearing in our field of vision ... augmentation in that sense reflects media adding to our experiential world not taking it over.[29]

Contrary to perceptions this has not led to uniformity and a clear vision of AmI as a paradigm, process, or protocol. Instead it had created islands of algorithmic consciousness and affectivity.

> Quite the opposite of a 'global brain' or total vision then, we may find that temporary and 'good-enough' may lead to local aggregations of self-connecting systems can become islands of coherence in the chaos raised by pervasive computing' (McCullough 2004: 71). Far from the pure vision of what de Certeau calls the 'concept city', we may find the production of myriads and little stories. Some commercial, some personal, maybe some militarised. There is a real issue about proliferating knowledges circulating routinely and more or less autonomously of people.[30] Through the tools of urban morphology and computer science, spatial information allows us to see how urban planning, design, and millions of individual decisions shape how cities organize and order space according to various spatial social logics and culture. This communicative data-driven decision-making sits at the heart of the intersection of urban planning, morphology, and information management. [31]

These tools engage with human agents real time seeking to establish and drive agendas which are both established by their software and modified by their affective

29 Crang, M. and Graham, S., 2007. Sentient cities ambient intelligence and the politics of urban space. *Information, Communication & Society*, *10*(6), pp.789-817.

30 Crang, M. and Graham, S., 2007. Sentient cities ambient intelligence and the politics of urban space. *Information, Communication & Society*, *10*(6), pp.789-817.

31 Boeing, G., 2021. Spatial information and the legibility of urban form: Big data in urban morphology. *International Journal of Information Management*, *56*, p.102013.

interaction with these agents. They are being defined as Smart but in fact are islands of dimensionality, which embrace a crucial aspect of what matters to its human principles.

> a number of important dimensions of a smart city are identified, such as, smart economy (related to competitiveness), smart mobility (related to accessibility and connectivity); smart environment (related to natural resources); smart human capital (related to people); smart living (related to the quality of life) and smart governance (related to participation)[32] ...a city becomes smart if investments in human and social capital, traditional (transport) and modern (ICT) communication infrastructure, judicious utilisation and management of scarce resources, and participatory governance stimulate sustainable economic growth and a high quality of life (Caragliu, Del Bo, and Nijkamp, 2009). There is also need for adaptability of the people in terms of their learning and innovation (Coe et al, 2001) and able to utilise the technology and benefit from them. The purpose of developing such a city is to enhance the capability of the potentials of the city and judicious resource management for optimal development of the city.[33]

All of which requires that there be sufficient information flow beyond the limits of the agents and the urban space – a globally available networked datasphere (IDC's proposed multi-zettabyte information crush) – which allows for affective and emotionological engagement to uniquely engender economic, social, and cultural improvements.

Global Information Systems

To make it possible for AmI to act in real time with convincing affective capability, there must first exists a widespread information capability that situates networks in

32 Das, D.K., 2013. Using system dynamics principles for conceptual modelling of smart city development in South Africa. *Interim: Interdisciplinary Journal*, *12*(3), pp.42-59.

33 Das, D.K., 2013. Using system dynamics principles for conceptual modelling of smart city development in South Africa. *Interim: Interdisciplinary Journal*, *12*(3), pp.42-59.

more than a limited urban context. In a limited context this could be something simple like a corporate database with a customer's entire purchase history and habits or the GPS coordinates of every major purchase the same customer made over the last 90 days. Personal data must merge with wider data sets to be ambient.

> This fusion – of the intimate particularity of the personal with the broader contours of the social – may be one of the most important implications of GPS technology. GPS has the potential to make visible the structures of everyday life and to encourage wandering within and beyond the architecture of the city, redefining the lines, patterns and routines of the economic, social and political infrastructure. It constitutes a self that is located somewhere between the objectivity of the map and the subjectivity of the ground[34]

More than this, the most common convergence of personal data with a widespread, even global impact, has been and promises to continue to be social media networks. In the same way that Global Positioning Systems (GPS) provide location and time stamps, social networks add emotionalogical affective data that informs AmI systems wider actions and allows for emergent AI responses to new stimuli.

> Social media generated from many individuals is playing a greater role in our daily lives and provides a unique opportunity to gain valuable insight on information flow and social networking within a society [12]. Through data collection and analysis of its content, it supports a greater mapping and understanding of the evolving human landscape [22]. Such data conveys Ambient Geographic Information (AGI), capturing for example, people’s references to locations that represent momentary social hotspots. Harvesting this ambient geospatial information provides a unique opportunity to gain valuable insight on information flow and social networking

34 Parks, L., 2001. Cultural geographies in practice: Plotting the personal: Global Positioning Satellites and interactive media. *Ecumene*, *8*(2), pp.209-222.

within a society, support a greater mapping, understand the human landscape and its evolution over time.[35]

Lest we be overly confused there's a homophonic concordance between Geographic Information Systems (GIS) and Global Information Systems (also GIS).As it turns out this becomes even murkier when we understand that GIS geographic systems are a fundamental and essential portion of the GIS global systems. As ESRI, a major provider, describes it, a GIS matters for the global network because:

> A geographic information system (GIS) is a system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there). This provides a foundation for mapping and analysis that is used in science and almost every industry. GIS helps users understand patterns, relationships, and geographic context. The benefits include improved communication and efficiency as well as better management and decision making.[36]

These patterns matter to ambient systems precisely because they improve decision making and communication. "GIS has thus focused on three main goals: acquiring geographic information, studying geo-objects and their relationships and exploring advanced geographic rules that determine our spatiotemporal behaviour." [37]

This in turn impacts how we should consider the notion of a global GIS [from this point forward GIS will refer to Global Information Systems unless otherwise noted]. We must as systems engineers consider what makes a systems and how GIS manages to matter for the wider AEGIS and the needs of AmI in surpassing typical AI to be perceived as human centric and human compatible.

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35 De Oliveira, T.H.M. and Painho, M., 2015, June. Emotion & stress mapping: Assembling an ambient geographic information-based methodology in order to understand smart cities. In *2015 10th Iberian Conference on Information Systems and Technologies (CISTI)* (pp. 1-4). IEEE.

36 https://www.esri.com/en-us/what-is-gis/overview

37 Lü, G., Batty, M., Strobl, J., Lin, H., Zhu, A.X. and Chen, M., 2019. Reflections and speculations on the progress in Geographic Information Systems (GIS): a geographic perspective. *International journal of geographical information science*, *33*(2), pp.346-367.

a system cannot be understood by analysis of the parts because of their complex interactions and because purpose or meaning can only be perceived in the whole. A system (from this perspective) is in itself always an abstraction chosen with the emphasis on either structural or functional aspects. A system is then anything unitary enough to deserve a name. A system is thus represented by a set of variables sufficiently isolated to stay constant long enough for us to discuss it as a coherent whole. This notion of a system is one way we, as humans, can organize our thoughts about what we see, or conceptualize, about how relationships and interactions between parts or elements result in outcomes.[38]

A GIS comprised of AmIs seeking geographic, networks, social, affective, and then adapting that data to create net new data for a system that interprets, manages, decides, and then reacts to its own decisions could be considered an ambient technological system. Sometimes referred to as an ecosystem, a Smart Space or Smart Vehicle, or a sociotechnical system.

Some authorities maintain that there are three kinds of system: natural, social and "artificial". In this viewpoint, a social system is any system made up primarily of intentional agents, which is not driven by natural forces but rather the force of willpower and cunning and various other intentional qualities; while an artificial system is one composed of deliberately created artefacts. The term "human activity systems" is often used for social systems where the intentional agents are humans. Groups of agents working to a common purpose are not unique to humans; many animals live in social systems, and there is a spectrum of social systems, ranging from those composed of humans where the social system is deliberately constructed and maintained and can adapt rapidly, to simpler ones such as ant colonies where the "intentional behavior" appears to be hard-wired in genetic material. Systems

38 Sillitto, H., Martin, J., McKinney, D., Griego, R., Dori, D., Krob, D., Godfrey, P., Arnold, E. and Jackson, S., 2019. Systems engineering and system definitions. In *INCOSE*.

> Engineering takes place within a social system, and typically produces part or all of a socio-technical system, a system with closely coupled social and technical parts.[39]

What we have then in the merging of these disparate information unites with a global networked system and a need to manage both on/off, go/ no go actions as well as emotion-driven perceptions could be considered almost a living thing, a kind of technologically artificial biological space. More complex than the ant colony, with artefacts and social systems impinging on the natural systems but at the same time modelled on natural system dynamics. In other words, turning the artificial and arbitrary into something seamless, real, time bounded, and mutable, like nature itself.

Biome

Using a biological model makes sense of the emergence-oriented ecosystems. In this case the building block idea will be the biome: "Biomes are constructs for organising knowledge on the structure and functioning of the world's ecosystems."[40]

The biome model incorporates the literal geographic nature of the networked system as well as the figurative mapping needs of the AmIs involved. It proposes to resolve the apparent paradox of natural social and artificial systems by proposing an artificial biome – a man made technosphere overlaid on existing biological and social spaces.

> "Patterns are an outcome of processes. The diversity of biomes should be seen as a result of multiple processes operating at multiple spatial and temporal scales. Fine-scale processes (such as plant growth) rule the large-scale dynamics of ecosystem productivity, which, in turn, shapes large-scale patterns. Hence, knowing the nature of fine-scale processes and the nature of the players involved, namely the species pools defining flora which, in turn, define trait pools and trait spaces, it should be

39 Sillitto, H., Martin, J., McKinney, D., Griego, R., Dori, D., Krob, D., Godfrey, P., Arnold, E. and Jackson, S., 2019. Systems engineering and system definitions. In *INCOSE*.

40 Conradi, T., Slingsby, J.A., Midgley, G.F., Nottebrock, H., Schweiger, A.H. and Higgins, S.I., 2020. An operational definition of the biome for global change research. New Phytologist, 227(5), pp.1294-1306.

possible to employ the hierarchically structured processes to predict processes in hierarchically structured patterns."[41]

That's the key: patriarchically structured data leads to process leads to patterns leads to predictability of unpredictable systems. With ambient systems involved the digital ecosystem becomes a digital biome, something exponentially more complex, an ecosystem of ecosystems, of weather, movement, etc. in nature and likewise of social, technological, financial, public, private, and governmental in the Smart urban space. "Terms like 'digital ecosystem' are commonly used to acknowledge the interconnected nature of new digital industries. One example of this is the idea of a 'smart city' which combines elements of the Internet of Things but with a focus on particular urban spaces and the people and organisations that live and work in them (Chourabi et al., 2012)."[42]

Likewise the notion of biomes allows us to create larger scales of systems and through them systems-of-systems which become biomes of biomes, something we explore as an ecumene – a shared world. "A biome perspective is defined by the how cultural, regulatory and tax climates in specific locations influence the success of communities of business models. ... Different cultural and regulator climates influence business model success at different scales so the choice of a national scale is a question of research design. Biomes are not scale dependent so is not based on some scale-related characteristic." [43]

In short, we are merging the artefacts and humans into a singular world, a systems engineering approach that attacks the complexity of these systems through the paradigm of natural systems and homeostatic mechanisms. "Business models interlink to form pathways that convey value in a similar way to the nutrient and energy pathways in a natural ecosystem." [44]

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41 Mucina, L., 2019. Biome: evolution of a crucial ecological and biogeographical concept. New Phytologist, 222(1), pp.97-114.

42 Shaw, D.R. and Allen, T., 2018. Studying innovation ecosystems using ecology theory. Technological Forecasting and Social Change, 136, pp.88-102.

43 Shaw, D.R. and Allen, T., 2018. Studying innovation ecosystems using ecology theory. Technological Forecasting and Social Change, 136, pp.88-102.

> "The biome (as any biotic community) is a result of assembly processes at many scales of spatial and temporal complexity. Focusing on long-term evolutionary processes shaping both the taxonomic and trait pools, we can view biomes as 'theatres of evolution' (Moncrieff et al., 2016), where species are born and die, and into and out of which they immigrate and emigrate, in response to both fast and slow changes in environmental conditions, leaving environmental filters to select the fittest biota." [45]

The cliché of evolving technologies, of analogies about systems blooming or dying, take on new urgency and material value when we employ a biome model. As these digital biomes merge, interact, overlap, and modify one another's algorithms, they become a digital world. For that we need an even larger paradigm.

Ecumene

A historiographic conceit, the ecumene represents a shared world which can be bounded by historic narrative with shared people, cultures, and a common history. Arguably it will be an immensely complex thread of events and decisions, but the whole point of the paradigm itself has been to make narrative sense of chaos. As digital systems have scripts, then digital biomes had protocols, and digital ecumenes will have digital narratives – a shared history and character that pervades the entirety of the system.

> Ulf Hannerz suggested that we should look at our contemporary world as an ecumene; that is, as an undivided space of human intercommunication, a network of networks (1991). A few years later, Sidney Mintz argued that, within this larger space, one can identify areas where intercommunication is more intense due to historical reasons – he famously suggested that the Caribbean too must be seen as an

44 Shaw, D.R. and Allen, T., 2018. Studying innovation ecosystems using ecology theory. Technological Forecasting and Social Change, 136, pp.88-102.
45 Mucina, L., 2019. Biome: evolution of a crucial ecological and biogeographical concept. New Phytologist, 222(1), pp.97-114.

ecumene (1996). A similar notion of areas of density of intercommunication that define humanity as historically constructed[46]

Enter then the reality that these worlds are functionally linked together like ponds to a common river through the various GISs promulgated by social networks, GPS, common software, governments, and various smart device applications.

Creation of public spaces would aim at forming of the global ecumene. Ecumene, in its initial meaning a geographical term, according to the dictionary of foreign words means 'an area inhabited and economically exploited by man'. The travesty of this term and its transposition into the grounds of anthropology was made by Alfred Kroeber. A Swedish scientist Ulf Hannerz modified and arranged the notion of the 'global ecumene'. '[Global] Ecumene is an area of constant cultural interactions, reciprocal penetration and exchange of cultural contents.' [Sztompka 2002, p. 593].[47]

What makes the paradigm so pivotal for system engineering? It allows engineers to isolate individual elements as they pertain the the narrative or driving structure of the system and then determine with some sense of confidence how that element will fare in changing or adapting to the shared world. "Meanings and meaningful forms belong primarily to human relationships, and only derivatively and rather uncertainly to territories."[48] The derivative territory, in this case, are networks and IoT systems embedded in urban spaces.

Existence of levels of convergence that exist within a much more broadly conceived sociocultural universe. Thus, we can speak of areas of global integration and areas of local specificity. The middle-earth or ecumene is that area where struggle, construction and destruction occur which allows for human co-construction. It is the area of human action. In that sense, it is an area of relative freedom; it allows both for

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46 João, P.C., 2015. Lusotopy as Ecumene.
47 Kwiatkowski, K., 2016. Potential of city networks in shaping the world's ecumene. In Back to the Sense of the City: International Monograph Book (pp. 1234-1244). Centre de Política de Sòl i Valoracions.
48 Chaney, D.C., González, J.A., Hannerz, U., Hinerman, S., Jones, S., Kucker, S., Liikkanen, M., Lull, J., Messaris, P., Neiva, E. and Real, M., 2001. Culture in the Communication Age. P 61

> a certain freedom from local constraints and a certain freedom from global hegemonic imperatives. To that extent the ecumene is a space of escape – it is the 'discoveries'. [49]

Data-driven systems when ambient influence human behaviour as much as they are influenced by it. How that data moves and changes matters. "In data ecosystems, vast amounts of data move among actors within complex information supply chains that can form in different ways around an organisation, community technology platforms, and within or across sectors."[50]

In part, that same data determines social decision making, helps AmIs impersonate human agents and co-participate with them in networked discussions. In equal part, human agents drive the datasphere and modify the AmI's in return.

> To put it briefly, culture typically flows between rulers and the ruled (citizens, subjects), between buyer and seller, between those converted and those not converted, and between people engaging with one another on a more symmetrical basis in a variety of relationships in going about life, for example as kinspeople, neighbors, friends, or work mates. These frameworks tend to handle meanings and meaningful forms according to different organizational, temporal, and spatial logics.[51]

The ability to innovate and adapt defines ambient systems. But these same systems like any biome must rely on the resource constraints of the ecosystem. What regionally bounds a digital ecumene? Technological infrastructure, economics, social acceptance of new science, and urban cohesion / human development.

> Certainly we must not just understand a flow of culture as a matter of simple transportation of tangible forms loaded with intrinsic meanings. It is rather to be seen

49 João, P.C., 2015. Lusotopy as Ecumene.
50 Curry, E. and Ojo, A., 2020. Enabling Knowledge Flows in an Intelligent Systems Data Ecosystem. In Real-time Linked Dataspaces (pp. 15-43). Springer, Cham.
51 Chaney, D.C., González, J.A., Hannerz, U., Hinerman, S., Jones, S., Kucker, S., Liikkanen, M., Lull, J., Messaris, P., Neiva, E. and Real, M., 2001. Culture in the Communication Age. P 62

as entailing an infinite series of shifts, in time and sometimes in changing space as well, between external forms available to the senses, interpretations occurring in human minds, and then external forms again – a series continuously fraught with uncertainty, allowing misunderstandings and losses as well as innovation. [52]

Both AmI and GIS enabled ecumenes will be an order of magnitude more complex than a digital ecumene. A fully networked and merged ambient ecumene tied to a GIS represents the single most concentrated level of complexity the common citizen will be exposed to. "We are at the beginning of a great wave of convergence of enabling technologies from the Internet of Things (IoT), 5G, high-performance computing, and edge computing to big data, cloud computing, and Artificial Intelligence (AI). Smart environments are generating significant quantities of data from digital infrastructure that is driving a new wave of data-driven intelligent systems." [53]

This great wave of convergence requires a new way to view, manage, and improve the structure of the systems involved.

An intelligent systems data ecosystem (see Fig. 2.2) describes a community of interacting information systems that can share and combine their data to provide a functional view of the environment [1]. The ecosystem supports the flow of data among systems, enabling the creation of data value chains to understand, optimise, and reinvent processes that deliver insight to optimise the overall environment. In a data value chain, information flow is described as a series of steps needed to generate value and useful insights from data [15]. Systems within the ecosystem can also come together to form a System of Systems." [54]

These ambient technological worlds require systems-of-systems (SoS) approaches where the engineering team understand it has to view the ecumene as a SoS of ambient

52 Chaney, D.C., González, J.A., Hannerz, U., Hinerman, S., Jones, S., Kucker, S., Liikkanen, M., Lull, J., Messaris, P., Neiva, E. and Real, M., 2001. Culture in the Communication Age. P 64
53 Curry, E. and Ojo, A., 2020. Enabling Knowledge Flows in an Intelligent Systems Data Ecosystem. In Real-time Linked Dataspaces (pp. 15-43). Springer, Cham.
54 Curry, E. and Ojo, A., 2020. Enabling Knowledge Flows in an Intelligent Systems Data Ecosystem. In Real-time Linked Dataspaces (pp. 15-43). Springer, Cham.

biomes wired to a SoS of GIS biomes and merged with the wider SoS of smart devices biomes – with each biome representing dozens or hundreds of SoS operating at various levels of AmI in relation to their human agent / customer, one another, their biome, their wider ecumene and the various hierarchical tiers that stratify a biome of biomes, on so forth. "Emerging associated technologies are moving beyond information exchange, radically transforming the production and exchange of material objects. Technological developments are inherently disruptive, affecting and altering social, economic and political arrangements. ... Developments in information technology transform the ways that information is transmitted and controlled."[55]

> The integration of data from heterogeneous sources in the domain of cultural/artistic heritage is a complex problem. Another facet of this problem is the coherent organization of diverse gathered data, belonging to completely different application areas and topical fields...The result of the design process for the whole system is an open architecture, composed of distributed loosely coupled blocks, whose core component is in charge of dealing with the data and metadata management, operating a logical separation from the navigational issues dealt with in the front-end web application block.[56]

Most intriguing, these new loosely coupled data structures merge GIS biomes in such a fashion as the remake the map of the world. What was once literally geographic becomes figuratively geospatial, networked by social ties rather than lands or regions. This represents a significant and immediate gain for all human participants in a digital world and by extension, more so for an ambient ecumene.

55Shamos, M. and Sunstein, C.R., 2013. Takeuchi, Kei.(2010) What is an Accident?: Its Positive Meanings (Iwanami). Todayama, Kazuhisa.(2011a)"Science and Technology Communication after the Fukushima Nuclear Accident—Regarding Radiation Risks—" Society and Ethics 25 (Nanzan University Institute for Social Ethics): pp. 121-138. Todayama, Kazuhisa.(2011b) The Lessons of "Scientific Thinking": the Sciences that. *Applied Ethics*, *1*, p.64.

56 Bechini, A., Tomasi, A. and Ceccarelli, G., 2004. The Ecumene Experience to Data Integration in Cultural Heritage Web Information Systems. In *CAiSE Workshops (1)* (pp. 49-59)

> The tensions and contradictions between direct and mediated experience that figure in the electronic-frontier metaphor are absent from cyberspace; a novel kind of harmony reigns. Nevertheless, cyberspace motifs are often derived from frontier visions. Human horizons expand from bounded communities to a larger ecumene. Cyberspace's teleology places human history in a progression, from a two-dimensional earth surface, to a three- dimensional (outer) space, then finally to a multidimensional space of symbolic, technological, social, and mathematical relationships. Geographical distance is irrelevant.[57]

That said, there are limits to the employment of a common idea and a common term of measurement to describe an ecumene. Other ideas have been promulgated with success as well. We must engage and adapt these to the more notional expansion of the AEGIS as something more than an ecumene of ambient SoS, but a truly emergent system of scaling and theoretically infinite complexity.

> To be sure, terminological confusion is as dense as ever. Yet even though there is no perceptible consensus about what the term "civilization" ought to mean, and no agreed word or phrase to describe the "interactive zone" (to use a phrase introduced, I believe, by Ross Dunn) embracing different Eurasian civilizations, I think it correct to assert that recognition of the reality and historical importance of trans-civilizational encounters is on the increase and promises to become the mainstream of future work in world history. We badly need a word or phrase to describe the human reality arising from encounters with strangers who bring locally unfamiliar skills and knowledge to the attention of stay-at-homes. Ross Dunn's "interactive zone" seems clumsy. My own favorite, "ecumene," carries cramping ecclesiastical associations. Wallerstein's "world system" is perhaps the leading candidate at present, but it is awkward as a description of such relationships before 1500, when separate "world systems" existed in Eurasia, America, and presumably elsewhere as well, although we know very little about historical change initiated by non-literate

57 Adams, P.C., 1997. Cyberspace and virtual places. *Geographical Review*, *87*(2), pp.155-171.

peoples' interactions, and can only hope that sophisticated archaeology may someday make some of the facts accessible.[58]

We are then attempting to describe a new kind of civilisation, one with uniqueness tied to its most fascinating and confusing of properties: unpredictable computer systems. The mere idea of a system which works correctly but cannot be anticipated or measured for success as on/off, ones and zeros, intrigues most futurists. AI has provided a significant leap towards this reality but ambient systems provide a second path forward. They create not "thinking" systems which provide new and novel answers, but real time adaptive systems, which change their own core programming to embrace the affective discourse demanded by their users. That unique capability has been termed emergence.

Emergence has multiple explanations. For systems engineering the operant definition might be: Generally, a property can be described as emergent if "it is a novel property of a system or an entity that arises when that system or entity has reached a certain level of complexity and that, even though it exists only insofar as the system or entity exists, it is distinct from the properties of the parts of the system from which it emerges." In other words, emergence can be described as "more is different" or "less is different" respectively.[59] Put another way:

> Emergence is a dynamic process of interactions among heterogeneous agents that unfolds and evolves over time, resulting in various kinds of unexpected novel individual- and group-level configurations and/or broader social structures (Benbya and McKelvey 2016). Complexity and organization scholars have theorized such a dynamic process for some time (Kozlowski et al. 2013; Plowman et al. 2007).
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> Systems-wide changes in natural open systems revealed how unorganized entities in a given system, subjected to an externally imposed tension, can engage in far-from-

58 McNeill, W.H., 1995. The changing shape of world history. *History and Theory*, pp.8-26.
59Klesel, M. and Henseler, J., 2020. Emergence in design science research.

equilibrium dynamics. The entities can therefore self-organize into distinct phase transitions leading to a new higher-level order (Prigogine and Stengers 1984).

Social systems put under tension, through recession, crisis, organizational change, and so forth, can exhibit similar phase transitions and emergent outcomes. As such, many social scientists have made a direct mathematical parallel between physical and social systems to deduce the process mechanisms inherent in micro interaction dynamics that yield the higher-level order and its emergent novel outcomes[60]

Ecumenes as Vehicles of Complex Emergence

If we proceed with the assumption than an ecumene by definition represents almost unthinkable complexity and a digital ecumene represents the exponentially complex world of multiple SoS interacting, then an emergence-oriented ecumene infrastructure would be by nature exceptionally complex. It would promote not just hierarchical layers of management but hierarchical layers of emergence – complex emergence for a complex system.

Emergence theory suggest that higher-level objects can be worth "more than the sum of its parts" (Ablowitz, 1939; Henseler, 2015). Consequently, we argue that emergence is well- suited to be used as an assessment criterion. As soon as an emergence phenomenon has been revealed, the designer is able to recognize super-summing effects. Hence, an IT artifact can be considered useful if the whole is worth more than the sum of its parts. In order to use emergence for design theorizing, we propose a conceptual model that primarily focuses on the synthesis of an IT artifact and inherits the idea of emergence.[61]

60 Benbya, H., Nan, N., Tanriverdi, H. and Yoo, Y., 2020. Complexity and information systems research in the emerging digital world. *MIS Quarterly*, *44*(1), pp.1-17.

61Klesel, M. and Henseler, J., 2020. Emergence in design science research.

These ecumenes of IT artefacts, biomes of IoT for example, super sum into something both more and less than anticipated. They situate ecumenes as imagined and literal regions promoting complex combinations: “Combinatorial emergence holds if “constituent parts are combined or fused such that the properties of the whole are distinct from the properties of the parts, and the parts themselves are transformed.”[62] Ergo the influenced systems create new and transformational capabilities. “Contrary to associative emergence the properties of the parts are static in that form of emergence at the beginning. The focus is about the combination of different parts (components) which lead to an effect that is finally transforming the parts themselves and also lead to a new whole. Therefore, the transformational effect of combining parts is focused.” [63]

What's more, there are even larger tiers of hierarchy available in the paradigm. Beyond a mere SoS there are entire cyber-physical systems which has their SoS and constituent element systems within – each a biome.

> Cyber-physical Systems of Systems (SoSs) are large-scale systems made of independent and autonomous cyber-physical Constituent Systems (CSs) which may interoperate to achieve high-level goals also with the intervention of humans. Providing security in such SoSs means, among other features, forecasting and anticipating evolving SoS functionalities, ultimately identifying possible detrimental phenomena that may result from the interactions of CSs and humans. Such phenomena, usually called emergent phenomena, are often complex and difficult to capture: the first appearance of an emergent phenomenon in a cyber-physical SoS is often a surprise to the observers. [64]

In ambient ecumenes, the serendipitous nature of systems has not only been considered, it has been intentionally engineered. Eventually, after a certain amoutn fo

62Klesel, M. and Henseler, J., 2020. Emergence in design science research.
63Klesel, M. and Henseler, J., 2020. Emergence in design science research.
64Ceccarelli, A., Zoppi, T., Vasenev, A., Mori, M., Ionita, D., Montoya, L. and Bondavalli, A., 2018. Threat analysis in systems-of-systems: an emergence-oriented approach. *ACM Transactions on Cyber-Physical Systems*, *3*(2), pp.1-24.

communications between autonomous digital biomes, the AmI software interaction will begin to “chat” and at the same time adapt to human users. Something transformational begins to rise from the systems, a surprising and new decision tree, which in turn informs higher cyber-physical systems and then modifies CS in such a way that the ecumene's Ami have the potential to modify the programming of “locked” and static “dumb” systems which have been built for a single role and are repurposed by the biomes involved to achieve a net new result.

> [Note] interactions within a network of entities or actors (Johnson, 2002). Changes in a system are triggered by actors’ agency, or actors intending to adapt to other actors’ behaviors, to systemic reconfigurations, or to new environmental conditions. Because changes are unpredictable and continuously unfolding, they can impact the ability of a complex adaptive system to function (Heylighen, 2001). Whenever this is the case, processes of adaptation induce emergence (Holland, 2014). As such, the concept of emergence is inherently embedded into the fabric of complex adaptive systems and offers a significantly different perspective for understanding these systems. [65]

Who makes the decision? In an emergent system the actors designing and implementing it are presumed to also influence it. But as we have seen already, ambient ecumenes represent a chaotic free for all among heterogeneous SoS with different programming and priorities. The potential for AmIs to act as agent exists. Likewise, the potential for the ecumene itself to develop an emergent character exists: “in complex systems, emergent properties might take place by means of purpose and planning. That is, actors in service platforms have purposeful intentions that shape the emergent properties; for example, actors in service platforms take on roles or value propositions that connect them to one another for service exchange.”[66]

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65 Pena, M.V.T. and Breidbach, C.F., 2021. On emergence in service platforms: An application to P2P lending. *Journal of Business Research*, *135*, pp.337-347.
66 Pena, M.V.T. and Breidbach, C.F., 2021. On emergence in service platforms: An application to P2P lending. *Journal of Business Research*, *135*, pp.337-347.

That raises an ominous prospect. Before we can effectively design and drive these systems, we need to truly understand the underlying infrastructure of various ambient design factors and who, what, and when these decisions where made. "The concept of emergence, which is inherently embedded into the fabric of all complex adaptive systems, continuously unfolds in service platforms across three order levels of increasing complexity, namely first-order, second-order, and third-order emergence, each corresponding to the systemic dynamics of service platforms during initial formation or assemblage, functioning, and evolution."[67]

The continuous and transforming nature of real time systems constantly emerging suggests an almost unfathomable complexity. But we have seen that contrary to expectations, these same super summing entities achieve theoretically predictable results in unpredictable fashions. We will explore the relations of technology to designers and users in the Technosociological sections which follow.

Working Definition: Technological Ecumene

Technological Ecumene will be defined as shared world system that merges technology and social relations into a singular cohesive cultural and economic unit.

Working Definition: Ambient Ecumene

Ambient Ecumene will be defined as a technological ecumene that has adopted ambient intelligence as the operant driver behind its real-time, emergent, constantly expanding interpenetration and convergence of people, machines, and systems of control.

67 Pena, M.V.T. and Breidbach, C.F., 2021. On emergence in service platforms: An application to P2P lending. *Journal of Business Research*, *135*, pp.337-347.

Working Definition: Global Information System

Global Information System will be defined as the convergence of artificial intelligence integrated with systems of system of global telecommunications infrastructure to supply real-time data and services at any given point in the world while connected to a global system of support.

Working Definition: AEGIS

An AEGIS will be defined as one or more ambient ecumene joined to a convergence of multiple GISs which promotes emergence across urban centres achieving exponential refinement of ambient intelligences within and beyond the ecumene.

The Technosociology of Ambient Ecumenes

Paradox rests at the root of the problem involved in how we determine what makes and controls a system which cannot be adequately created or controlled. As we previously determined, ambient ecumenes, especially the super summing SoS type which are the AEGIS, represent the highest complexity of systems which are involved in remaking themselves millisecond by millisecond across entire biomes of capability in a global as well as localised fashion. Design and structure of such a system has no technical precedent per se but it does have an historical one: hegemony. Through the model of hegemony which we might term the systems engineering of human politics, we can imagine how we might engage critically with an AEGIS< translating the socio-political into the technosocial. For this reason we begin with technosociology and once we have thoroughly established a baseline understanding of how real and figurative hegemony affects system creation and transformation, we can proceed to the bulk of the critical systems that comprise the engineering behind an AEGIS.

As hegemony emerged in Hegelian thought and relies on the classic dialectical notion of thesis, antithesis, and synthesis, it will be necessary to first explore the philosophical limits of this work. As a technosociological work, the research employed straddles the very different realms of thought and creation, of socially imagined and reified systems of being and the literal objects and systems that support tangible real-life existence. Most social scientists quote Marx's Preface to A *Contribution to the Critique of Political Economy* of 1857 where outlined this duality: "'the economic structure of society' forms the 'real basis' on which 'rises a legal and political superstructure.'[68] Technology then forms the theoretical base while sociology attempts to predict and understand superstructure. As an all-encompassing system of both technology and social immersion, Smart X represents a functional world which according to Derrida one can consider as "… a body

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Karl Marx, A Contribution to the Critique of Political Economy, London, 1971.

or genre or corpus of thought of the world as an umbrella term to coordinate or demarcate a distinctive collection is particularly problematic."[69] As such, the nature of classic Marxist (Hegel derived) though has been to assign to this merged duality a negative and inevitably corrosive control over humanity. Smart X systems deliver "consumerist fantasies, media phantasmagoria, and … the spectacle is exciting and enthralling… entangling its devotees in the clutches of consumer capitalism, replicating consumption fetishism, and helping capital to commodify all domains of social and everyday life."[70] Grim stuff and not without critics. Derived from Hegel and articulated by Antonio Gramsci, Hegemony represents a significant fusion of social and philosophical ideas merging, economics, history, technology, and sociology, aka, it serves a precursor meme to technosociology in the classic sense of a discrete and transmissible idea. One that has both enthralled and disappointed scholars across Science and Technology Studies (STS) since the inception of their disciplines.

Consider how that compares to our imagined hegemony / systems engineering paradigm of an emergent AEGIS:

> If the digital is defined as our ability to reduce so much of the world to the commonality of a binary, a sort of baseline 2, then we can also reflect upon humanity's ability to previously reduce much of the world to baseline 10, the decimal foundation for systems of modern money. There is a prior and established anthropological debate about the consequences of money for humanity that may help us to conceptualize the consequences of the digital. Just like the digital, money represented a new phase in human abstraction where, for the first time, practically anything could be reduced to the same common element. This reduction of quality to quantity was in turn the foundation for an explosion of differentiated things, especially the huge expansion of commoditization linked to industrialization. In both cases, the more we reduce to the same, the more we can thereby create difference.

69 Gaston, S., 2011. Derrida and the End of the World. New Literary History, 42(3), pp.499-517.
70 Williams, R., 1991. Base and superstructure in Marxist cultural theory. Rethinking popular culture: Contemporary perspectives in cultural studies, pp.407-423.

> This is what makes money the best precedent for understanding digital culture and leads to our first principle of the dialectic. Dialectical thinking, as developed by Hegel, theorized this relationship between the simultaneous growth of the universal and of the particular as dependent upon each other rather than in opposition to each other.[71]

Taken as a whole, the definition, disambiguation, Derridean analysis and critique, represent a clear concept that hegemony matters; even if no one can adequately define or understand it. This thesis will allow for the contradictory and at times ambiguous nature of hegemony whole focusing on the end effects of its existence. To paraphrase United States Supreme Court Justice Potter Stewart in Jacobellis v. Ohio describing pornography and obscenity: "I shall not today attempt further to define the kinds of material I understand to be embraced within that shorthand description, and perhaps I could never succeed in intelligibly doing so. But I know it when I see it…"[72] This thesis agrees with the memetic truth that scholars can recognise, if not fully categorise, hegemony when these see it in action.

Why so? There's ample evidence that in a direct sense hegemony over social systems has translated into how digital worlds arise: that the ecosystem of economic and social circumstances that make up the tech industry follow clear technosociological rules:

> So far as decisions affecting our daily lives are concerned, political democracy is largely overshadowed by the enormous power wielded by the masters of technical systems: corporate and military leaders, and professional associations of groups such as physicians and engineers. They have far more to do with control over patterns of urban growth, the design of dwellings and transportation systems, the selection of

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71 Miller, D. and Horst, H.A., 2020. The digital and the human: A prospectus for digital anthropology. In *Digital anthropology* (pp. 3-35). Routledge.

72 Jacobellis v. Ohio, 378 U.S. 184 (1964), proceeding of. The US Supreme Court

innovations, our experience as employees, patients, and consumers, than all the governmental institutions of our society put together.[73]

For purposes of this thesis Hegemony as a technosociological effect represents a state of unambiguous support and public faith in a constellation of technologies and capabilities which exert clear unambiguous control over their users while appearing to be either democratic, free of such controls, or under the control of the users themselves. As such Smart X not only qualifies it might be an exemplary form of technosocial hegemony. In plain English, tech hegemony translates to manipulative systems which trick users into believing that have control. The manipulations may be economic, social, cultural, or simply algorithmic – swiping left instead of right. Regardless, these systems transfer agency from human users to their ambient environments. Which means one obvious definition of technosociological hegemony could be "the voluntary transfer of power from user to provider through technology." At the same time, since this thesis will also attempt to define and understand Smart X hegemony in terms of controlling its users but also its socioeconomic destiny, the second and equally important definition of technosociological hegemony could also be "the voluntary consolidation of power over users and technology to a dominant provider." Taken together there emerges an ominous reality: hegemony ultimately means users of technology working to promote and sustain the power of a small cadre of manufacturers and providers.

We have established that while an AEGIS represents significant advantages to its human consumers, it also creates a direct threat to their free will. The established lapse time between reaction to stimuli and concrete discursive thought has allowed the real-time feature of an ambient system t insert itself between the previously unimpeded process of human perception becoming human decision-making. Now, when and where an AmI has been engaged, it gains the potential capability (which is not in any way the equivalent of either total capability or clear action upon an agent) to influence not just

73 Feenberg, A., 1992. Subversive rationalization: Technology, power, and democracy. Inquiry, 35(3-4), pp.301-322.

the singular decision of the moment, but all future decisions by "curating" both information and response curves from its consumers.

Ambient systems inherently erode human agency; there exists a potential momentum to flex these systems towards economic and cultural hegemony. When these systems arise in a blatantly social and economic context, as Smart X does, then the movement towards hegemony would seem all but inevitable. What then defines Technosociological Hegemony? In *Subversive Rationalization: Technology, Power, and Democracy* Feenburg defines it as "a form of domination so deeply rooted in social life that it seems natural to those it dominates. One might also define it as that aspect of the distribution of social power which has the force of culture behind it." [74]

Combining cultural, social, and economic-political power, technological domination utilises the structural agency of local governments, corporations, non-governmental organisations (NGOs), and civilian society to control capital, technology, information, and structural logistics.[75] In Smart X, these convergences rely upon deep rooted technosociological constructions which deliver social power to economic actors. [76] As a result, the dual realities of hegemony as both a system of control and control of a system, unify in the technosociological sense: domination of a system that dominates; control of a system of control – both through technological means. We can term this Technosociological Hegemony.

Working Definition: Technosociological Hegemony

Technosociological hegemony will be "socio-political dominance of a cultural ecosystem by technological means." This meets the litmus test of "the voluntary transfer of power from user to provider through technology" as well as "the voluntary consolidation of power over users and technology to a dominant provider."

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74 Feenberg, A., 1992. Subversive rationalization: Technology, power, and democracy. Inquiry, 35(3-4), pp.301-322.
75 Yilmaz, S., 2010. State, power, and hegemony. International Journal of Business and Social Science, 1(3).
76 Riley, D.J., 2011. Hegemony, democracy, and passive revolution in Gramsci's prison notebooks. California Italian Studies, 2(2).

Whether the result helps or hurts the user remains to be seen. It does not change the exchange of power nor remediate the one-way flow of control from technology providers and designers to their consumers. Which then allows one to revisit the question thesis problem statement with new clarity: in terms of technosociology, how does a given entity achieve Smart X hegemony over a designated ecosystem. How do tech designers and provider get users willingly and unconsciously hand over social, mental, economic, and cultural control of their lives? In a given place and time? And does this control represent a static capability linked to a microbiome of tech, a small oasis of Smart X running within larger more complex systems. Or does it represent a fluid and dynamically adaptive control that can follow a user into various Derridean worlds, establishing true Gramscian hegemony over their existential reality?

These are the interrogations invoked by reality of technosociological hegemony and to which the remainder of this section will be dedicated to answering. As a whole this thesis focuses not on the philosophical. But practical and where possible grounds that in. firm understanding of where Base and Superstructure meet. To achieve any effective understanding of the vast and complex interlocking systems involved in ambient ecosystems, one must disambiguate the various terms that will be employed for this thesis. As a result, a great deal of the early chapters will be focused on properly defining technosociology, the various technologies involved, and the very notion of Smart X.

In a wider sense while we can say that now have a working definition of technosociological hegemony there exists a wider milieu, technology as a sociological, economic, historical and scientific phenomenon itself. Technosociological hegemony will like emergent algorithms be both more and less than its technological counterpart. "The success of a technology is not a function of specific features of the technology but rather is related to the take-up by relevant social groups." [77] These technologies both affect us

77 Olohan, M., 2017. Technology, translation and society: A constructivist, critical theory approach. Target. International Journal of Translation Studies, 29(2), pp.264-283.

and are in turn directed by us: "the concept of affordances that comes to communication via psychology, design, and the sociology of technology. The term affordances comes from cognitive psychologist James Gibson (2015 [1979]). He was primarily interested in investigating at what stages people learn to use what he called the 'action possibilities' (or affordances) of their environment."[78]

Potential actions, affordances, also imply limits on actions and that provides us with a rare glimpse into where hegemony intersects with technology as a stand-alone artefact beyond and at the same time severed from the social and cultural context of its creation. This becomes exceptionally important when AmI modifies the cultural precepts that underlay its algorithmic structure to pursue the interests of human agents.

> By introducing imagination to affordances, in addition to bringing design and use back into the picture, they also acknowledge that there are aspects of mediated experiences that are invisible to users. Algorithms, for instance, affect what users can and cannot do in online spaces, but operate out of view. Building on their insights, I suggest that we can take this form of imagination one step further by integrating perceptible, hidden, and false affordances into the encoding/decoding reading positions to create a new model for understanding how users experience interactive media and technologies .[79]

These mediated spaces can be both urban Smart spaces and the networked imagination of human agents. The AEGIS erases conventional boundaries and exacerbates the danger posed by the unseen affordance management provided by an ambient system.

> By analogy, Morozov conceptualises the technological solutionist ideology that tackles complex social issues as neatly defined problems for which there are convenient computational solutions, or as transparent processes which can be easily

78 Shaw, A., 2017. Encoding and decoding affordances: Stuart Hall and interactive media technologies. media, culture & society, 39(4), pp.592-602.

79 Shaw, A., 2017. Encoding and decoding affordances: Stuart Hall and interactive media technologies. media, culture & society, 39(4), pp.592-602.

optimised through more efficient technologies. Morozov, through discussion of numerous examples, highlights the dangers of solutionism, not only in underestimating, misunderstanding or simplifying problems when applying quick fixes but also in treating various apparent inefficiencies and ambiguities as problems to be resolved when, in fact, they may be "virtues in disguise".[80]

With the advent of Smart as a moniker we can expect to see sociological investment in its meaning and as a result a power struggle in the "real world" over how to properly govern the digital realms a Smart technology creates. "Smart cities are invariably presented as logical high-points in cities' technology- and in- formation-driven evolution, their growth and ubiquity checked only by the rate of civilization's inventiveness rather than external political or economic factors."[81] In technosociology, the structure of society rests on systems whether social or technical: systems determine the fates of societies[82]– that the nature and mechanics of the system ultimately determines the limits and direction of a society[83] – permeates much of the unstated focus and assumptions of this scholar.

80 Olohan, M., 2017. Technology, translation and society: A constructivist, critical theory approach. Target. International Journal of Translation Studies, 29(2), pp.264-283.

81 Morozov, E. and Bria, F., 2018. Rethinking the smart city. Democratizing Urban Technology. New York, NY: Rosa Luxemburg Foundation, 2

82 Harman, Chris, *Marxism and History*, Bookmarks, London, 1998, pp. 7-10

83 Wilktt, Cynthia THE MASTER-SLAVE DIALECTIC: HEGEL VS. DOUGLASS in Subjugation and bondage: critical essays on slavery and social philosophy, Tommy Lee Lott editor, Rowan & Littlefield, 1998, pp 151-152 157

Defining Technosociology

We can make another assertion regarding hegemony over technology: history has something to teach the present. The evolution of Marxist ideas to poststructuralism through Foucault and Derrida[84] has created a new idea: that the agency of the individual derives from their nexus of power and body, now extended through the internet, new media and the lightning pace of smartphones, laptops and netbooks to become an ontologically[85] interconnected system where the man and the message unify.[86] In such a new reality, the nature and mechanics of the social architecture[87], whether in nuts and bolts items like the proverbial guns and butter or in upload speeds and technological infrastructure, determine more not less, of what one perceives as human, normative and desirable.[88]

While one often credits Marxism with influencing historiography, Marx's influence on anthropology and archaeology has been less understood and thus one might argue less critically interrogated.[89] But Marx's visions of base influencing and determining superstructure has indeed influenced and in some sense poisoned modern social sciences.[90] Roughly sketched Marx' and his adherents believe: ―Techno-economic determinism has been, and still is, the most common interpretation of the Marxian social totality. Techno-economic determinism posits a radical distinction between

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84 Poster, Mark, *The mode of information: poststructuralism and social context*, University of Chicago Press, Chicago,1990, p2

85 Poster, Mark, *The mode of information: poststructuralism and social context*, University of Chicago Press, Chicago,1990, pp 2-5

86 Poster, Mark, *The mode of information: poststructuralism and social context*, University of Chicago Press, Chicago,1990, pp 5-10

87 Wilktt, Cynthia THE MASTER-SLAVE DIALECTIC: HEGEL VS. DOUGLASS in Subjugation and bondage: critical essays on slavery and social philosophy, Tommy Lee Lott editor, Rowan & Littlefield, 1998, pp 151-152 and Bergbohm, Carl, Jurisprudence and Legal Philosophy (Jurisprudenz und Rechtsphilosophie) 1892 pg 170, quoted in Georg Lukács' essay ―Reification and the Consciousness of the Proletariat from History and Class Consciousness, http://www.marxists.org/archive/lukacs/works/history/index.htm

88 Poster, Mark, *The mode of information: poststructuralism and social context*, University of Chicago Press, Chicago,1990, pp 12-15

89 Moore, Henrietta L., Anthropological theory today, Wiley-Blackwell, 1999, Cambridge, pp 10-16

90 Skalník, Peter, Authentic Marx and anthropology: the dialectic of Lawrence Krader, Bijdragen tot de Taal-, Land- en Volkenkunde 136 (1980), no: 1, Leiden, 136-147, reprinted translation, pp138-139 AND Gailey, ChristineWard, Community, State, and Questions of Social Evolution in Marx's Ethnological Notebooks. Anthropologica 45(1): 43-55. Canada. Reprinted 2006 in The Politics of Egalitarianism: Theory and Practice. Jackie Solway, ed. Pp. 31-52. New York: Berghahn Books

infrastructure (forces and relations of production) and superstructure (social, political and juridical institutions; and ideologies).[91]

Marxism and thus post-Marxist historiographies embrace dialectical progression: contradictions exemplified by struggle between philosophical or ethical opposites result in synthesis and historical progression. In anthropological studies that has become a way to engage with evidence and imagination regarding the nature of indigenous political and social systems.[92] At the heart of this myth, the indigenous peoples of Place X have overcome the inherent struggle of either the Master / Slave Dialectic as set up by Hegel[93] or in various manners disputes over the means of production.[94] The much studied and mimicked book *Ancient Society* by L.H Morgan relied heavily on this conceit and was based as one might surmise as much on human imagination as solid primary source evidence.[95] While Western peoples continue to struggle and thus progress establishing hierarchies of infrastructural power and reifying that power as superstructural hegemony, indigenous peoples simply exist as static, simple and inherently stunted groups unable to become a civilisation.[96] [97]

At the same time, the indigenous peoples of Place X are also seen as solving the problem through extreme savagery, lack of social evolution, inferior technology and superstructure and fundamental deficits of synthetic / logical evolution. It goes without saying that these views are limited at best and wholly racist, misinformed and built

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91 Llobera, Josep R, —Techno-Economic Determinism and the Work of Marx on Pre-Capitalist Societies , Man, New Series, Vol. 14, No. 2 (Jun., 1979), p 249

92 Gailey, Christine Ward, Community, State, and Questions of Social Evolution in Marx's Ethnological Notebooks. Anthropologica 45(1): 43-55. Canada. Reprinted 2006 in The Politics of Egalitarianism: Theory and Practice. JackieSolway, ed. Pp. 31-52. New York: Berghahn Books.

93 Skalník, Peter, Authentic Marx and anthropology: the dialectic of Lawrence Krader, Bijdragen tot de Taal-, Land- en Volkenkunde 136 (1980), no: 1, Leiden, 136-147, reprinted translation, pp138-139

94 Skalnik, Authentic Marx and anthropology: the dialectic of Lawrence Krader , pp139-140

95 M. Spriggs 1997 "Who Taught Marx, Engels and Morgan about Australian Aborigines?" History and Anthropology 10(2-3):185-218, pp 185-189

96 Llobera, Josep R, —Techno-Economic Determinism and the Work of Marx on Pre-Capitalist Societies , Man,New Series, Vol. 14, No. 2 (Jun., 1979), p 249

97 Gailey, Christine Ward, Community, State, and Questions of Social Evolution in Marx's Ethnological Notebooks, pp 32-34

upon a few twisted and misrepresented primary sources at worst.[98] As much as the notion of The Noble Savage has been dispelled, reinvented and revised to be argued again, the core idea of less developed. To his credit, the scholar MacBride understood all of this in 1967. "Given the resources of modern technology and planning techniques," he warned, "it is really no great trick to transform even a country like ours into a smoothly running corporation where every detail of life is a mechanical function to be taken care of." … Algorithmic regulation, whatever its immediate benefits, will give us a political regime where technology corporations and government bureaucrats call all the shots."[99] All of which means we need to consider how both technology and sociology function before we can determine where social mores end and social control begins. Likewise with technology – what are necessary resource limits and what are arbitrary definitions established by cultural conceits.

Before one can define technosociology, one must first determine what constitutes sociology and technology as separate and discrete entities. For the purposes of this thesis, sociology can best be defined as "the social science of providing clear compelling explanations for social mechanisms." At its most fundamental sociology defines society then studies it to test and affirm working theories about it: "Sociology is focused on providing functional, effective, and efficient explanations of social realities. These realities are often complex, dynamic, and unpredictable and as a result, require a strategic approach to understanding or even predicting them through analytical investigation."[100]

The frustrating existence of dynamic and unpredictable forces has led to a movement within sociology to seek out a working rubric that limits the understandable chaos of living groups and provides functional and predictive clarity to a process which often appears to have neither.

98 M. Spriggs 1997 "Who Taught Marx, Engels and Morgan about Australian Aborigines?" History and Anthropology 10(2-3):185-218, pp 210-218

99 Morozov, E., 2014. The rise of data and the death of politics. The Guardian, 20(07), p.2014.

100 Hanafi, S., 2020. Global sociology revisited: Toward new directions. Current Sociology, 68(1), pp.3-21.

Little (2012) observed that the social mechanisms approach has greatly filled a theoretical gap in social explanation. It is an approach that is prominent in the emerging program of analytical sociology as well as historical sociology. Indeed, mechanisms are frequently occurring and easily recognizable causal patterns that are triggered under generally unknown conditions or with indeterminate effects (Elster, 1998). Bunge (1997) defines a mechanism as a process in a concrete system that is capable of bringing about or preventing some change in the system. Most of these changes in the system are regular and patterned, and this is probably why Machamer, et al (2000) maintained that mechanisms are entities and activities organized such that they are productive of regular changes from start to finish. For Mayntz (2004), the social mechanism is ‚a sequence of causally linked events that occur repeatedly in reality if certain conditions are given and link specified initial conditions to a specific outcome‛[101]

As much of this section has argued, the core driving process behind many social mechanisms appears to be economic control, i.e. power over resources. That power by nature of how societies function requires social consensus and constitutes the functional battleground of human existence. Hegemonic discourse predicates "the structure of society as a terrain of struggle"[102] and suggests that all forms of economic process are coercive and power focused once they reach the sociological level: "the economic process of producing things constituted as a game is simultaneously a political process of reproducing social relations and an ideological process of producing consent to those relations, made possible by the relatively autonomous internal state and internal labour market."[103]

101 Hanafi, S., 2020. Global sociology revisited: Toward new directions. Current Sociology, 68(1), pp.3-21.

102 Burawoy, M., 2003. For a sociological Marxism: the complementary convergence of Antonio Gramsci and Karl Polanyi. Politics & Society, 31(2), pp.193-261.

103 Burawoy, M., 2012. The roots of domination: Beyond Bourdieu and Gramsci. Sociology, 46(2), pp.187-206.

Therefore, any working definition of sociology that effectively delineates social mechanisms will be heavily centred on economic forces and their relationship with power (and vice versa). This may be reminiscent of the Machiavellian concept that "the end justifies the means" with the means being. Replaced by power over resources. Just so: "Both Gramsci and Foucault make use of Machiavelli's notion of "relations of force". They therefore diffuse the power relations to the complex mechanisms of society. They try to implement a "positive analysis" of power. Power is not only a negative conception; power produces. In the case of Gramsci power produces ideology (and vice versa) and for Foucault power produces apparatuses of knowledge."[104] Sociology therefore may further be defined as "the socioeconomic discipline of providing clear compelling explanations for the recurring social mechanisms which manufacture consent and control over resources through ideology and knowledge."

Working Definition: Sociology

Sociology will be defined as "the socioeconomic discipline of providing clear compelling explanations for the recurring social mechanisms which manufacture consent and control over resources through ideology and knowledge."

Technology can be thought of as both a tool and a process. In present terms it can be equated to a "virtual economy of interconnected machines, software, and processes… where physical actions now could be executed digitally."[105] Critics of technology in contrast think of it as neother a tool nor a process, but an emerging social constructed threat. Harari avers in her 2018 essay *Why Technology Favors Tyranny* that "information technology is continuing to leap forward; biotechnology is beginning to provide a window into our inner lives—our emotions, thoughts, and choices. Together, infotech

104 Daldal, A., 2014. Power and ideology in Michel Foucault and Antonio Gramsci: A comparative analysis. Review of History and Political Science, 2(2), pp.149-167.

105 Arthur, W.B., 2017. Where is technology taking the economy. McKinsey Quarterly, 697.

and biotech will create unprecedented upheavals in human society, eroding human agency and, possibly, subverting human desires."[106] In both cases the philosophic nature of technology emerges: whatever can be defined as technology must by its nature be separable from human beings (a device, tool, learned process) but influential upon human material society and human cognition. "This non-neutral, transformative power of humans enhanced by technologies is essential feature…The technological form of life is part and parcel of culture, just as culture in the human sense inescapably implies technologies. Technology can thus be seen as shaping the theoretical framework of our social existence."[107] Technology however separate from humanity also impels them to use it and with such allure that for the most part civilisation and technological progress have arisen as cultural synonyms.[108]

One can further consider technology as an emerging product of multi-disciplinary knowledge that evolves into an economically viable product – it translates knowledge and resources into power over the environment. Within highly developed societies this co-emerges with both a market and industry ecosystem permutating social and economic aspects.[109]

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Moreover, these emerging paths require inherent sociological responses precisely because they are more than merely separable tools that neutrally provide equal and steady power to their users. Instead, they are reified as a single thing – technology – when they are actually knowledge converged into technology. Then further converged into both markets and industries, i.e., economic and social units of cooperation and

106 Harari, Y.N., 2018. Why technology favors tyranny. The Atlantic, 322(3).

107 Tripathi, A.K., 2017. Hermeneutics of technological culture.

108 Borgmann A (2012b) Matter matters: materiality in philosophy, phys- ics, and technology materiality and organizing. In: Leonardi PM, Nardi BA, Kalinikos J (eds) Oxford University Press, Oxford, pp 335–347

109 Zhou, Y., Dong, F., Kong, D. and Liu, Y., 2019. Unfolding the convergence process of scientific knowledge for the early identification of emerging technologies. Technological Forecasting and Social Change, 144, pp.205-220.

110 Zhou, Y., Dong, F., Kong, D. and Liu, Y., 2019. Unfolding the convergence process of scientific knowledge for the early identification of emerging technologies. Technological Forecasting and Social Change, 144, pp.205-220.

competition. Units which derive power by taking it from one another, fighting over limited resources using the technologies which they have developed. "Intercalating science or technology into larger and larger networks of action is what makes them durable. When all the elements in a network act together to protect an item of knowledge, then that knowledge is strong and we come to call it scientific."[111] Ergo, technology must be defined as a socioeconomic process related to tools and progress.

Working Definition: Technology

Technology will be defined as "a socioeconomic process where multi-disciplinary knowledge converges with existing tools to create new ways to harness and manage resources."

This intricacy of complex and interrelated tools used to control the terrain of struggle then brings the reader to concept of technosociology. In some sense the idea has already been explored in depth. The most prevalent and logical of these sociologically driven models has been termed the Social Construction of Technology (SCOT whose central argument suggests that technology determines human action and in turn results from social, political, economic, and cultural struggles to define and control it.[112] The dense and at time obfuscated intercalation of social dynamics and technological progress: technology produces artefacts which are both objects and social constructs which define how and whom may use them. The figure below with attendant text explores the notion of "innovation" itself a social construct of asymmetric development of a new and arguably superior artefact.

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111 Shapin, Steven. 1995. Here and everywhere - sociology of scientific knowledge. Annual Review of Sociology 21: 289-321.
112 Yousefikhah, S., 2017. Sociology of innovation: Social construction of technology perspective. AD-minister, (30), pp.31-43.

[113]

As it can be seen in Figure 3, the process of technological frame renewal starts by the entry of a new beneficiary - that is a new actor. The entry of such an actor changes the balance of the social groups and creates a new problem definition. Solving this problem implies finding a new agreement in newly changed balance within the social groups. In order to reach new agreement, there is the need to destroy the previously established technological frame. It is similar to Schumpeter's creative destruction that is based on change in supply and demand by introduction of radical innovation (Fuduric, 2008). Based on the renewal and reset of technological frames, a new agreement appears, that is a new interpretation of an artifact. [114]

These artefacts become the focus of what must now be defined using the SCOT to merge sociology and technology studies into a social science discipline. To do so properly, one may turn to the works of Jürgen Habermas whose work on media control over public opinion demonstrates how abstracted technologies, where tools, processes, social dynamics, and socioeconomic power inextricably merge, best encapsulates the essence of the problem.

The concept of mediatization was in use as early as the 1930s, when the German sociologist Ernest Manheim deployed it to describe the transformation of the way in which public opinions emerge and were transformed as the printed press came to be

113 Yousefikhah, S., 2017. Sociology of innovation: Social construction of technology perspective. AD-minister, (30), pp.31-43.
114 Yousefikhah, S., 2017. Sociology of innovation: Social construction of technology perspective. AD-minister, (30), pp.31-43.

distributed widely. Over time, others have used mediatization to describe similar processes, but there are also examples of other usages. One example of the latter is Jürgen Habermas, who used it in a more technosociological sense to describe the use of delinguistified media—for example, money and power—to colonize the lifeworld."[115]

Technology colonises lifeworlds. Which can be better translated in Habermasian Theory as material and strategic processes characterised by the production and distribution of money and power invade and conquer the symbolic space of human culture where social integration and personality are sustained and reproduced.[116]

One might then start building a sense of what properly defines the STS intersection between sociology and technology: how these material and strategic processes come to be seen and modified in that symbolic space of human culture, social integration, and presumably the identity of the "self." In the ground-breaking work *Essay of technosociology: A gasogene in Costa Rica*, Akrich outlines the first notion (circa 1993) of how sociologists might step into STS:

Original French

"le sociologue doit s'interdire de faire a priori une distinction entre ce qui, dans les phénomènes observés, relève de la technique et ce qui relève du social; plus encore, il ne doit pas avoir de théorie préconstruite sur ce qui compose la société en question pas plus que la technologie éprouvée, faute de quoi on s'empêche définitivement d'observer ce qui constitue l'enjeu de notre recherche, à savoir la manière dont les objets techniques participent à part entière à la constitution de notre culture et du monde dans lequel nous vivons."[117]

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115 Fredriksson, M. and Pallas, J., 2020. Public Sector Communication and Mediatization. *The Handbook of Public Sector Communication*, pp.167-179.

116 Power, M., Small, N., Doherty, B. and Pickett, K.E., 2018. The Incompatibility of System and Lifeworld Understandings of Food Insecurity and the Provision of Food Aid in an English City. VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations, pp.1-16.

117 Akrich, M., 1993. Essay of technosociology: A gasogene in Costa Rica.

English translation

> The sociologist must refrain from making a priori a distinction between what, in the observed phenomena, pertains to technique and what is social; moreover, it must not have a preconstructed theory on what makes up the company in question nor the proven technology, otherwise we are definitively prevented from observing what constitutes the stake of our research, namely the way in which technical objects fully participate in the constitution of our culture and the world in which we live.[118]

The dual working definitions of technosociological hegemony as “the unconscious transfer of power from user to provider through technology” and “the unconscious consolidation of power over users and technology to a dominant provider” seem to be fully concordant with both Habermasian hermeneutics of technological colonisation and Akrich’s far more neutral defining concept of a proto-technosociology as the study of technical objects and how the fully participate in the constitution of both culture and world – the lifeworld.

Scaffolding, Attention, and Object Influence Meaning

The prior definitions of both sociology and technology lead us to inevitably ask the pertinent question: what drives the inherent mechanisms technological formation and distortion of society? For that additional theory must be explored related to how technology as a category migrates from an artefact to an influencer of social movement and finally crystalises as a source of economic and political power. One turns first to the process by which artefacts become social constructs. Zeynep Tufekci, the first self-described techno sociologist of any academic prominence, has suggested that thinkers look to “mediated sociality” as the core conceptual driver behind many of these ur-mechanisms, the source code of what follows as social control software, if one will. She begins by defining the term as “using the Internet to perform and realize social

118 Self translation

interactions, self-presentation, public performance, social capital management, social monitoring, and the production, maintenance and furthering of social ties."[119] These interactions represent the exploitable units of power that facilitate combining the undeniable allure of artefact cum social construct, technology, with the human need to symbolically express oneself socially and culturally, the lifeworld. When technology mediates sociality, it colonises – it establishes hegemony.

How? "In technologically mediated sociality, being seen by those we wish to be seen by, in ways we wish to be seen, and thereby engaging in identity expression, communication and impression management are central motivations."[120] The process by which digital identity augments and at times replaces physical identity represents the erosive nature of a these mechanistic social controls which harness technology to both more readily express the self as one wishes to be seen and modifies how one can and should self-express. These create an ontological feedback loop where larger units of society derive their identities from the self-concepts of individuals, each larger portion of the mediated construct in turn more subservient to the technological constraints of the medium than the last.

Technosociological theory suggests that attention as a unit of power also represents a kind of socio-economic currency to be bought and spent by these larger social units. In her work on social movements driven through the digital realm Trufecki suggested as much:

> Attention is the means through which a social movement can introduce and fight for its preferred framing, convince broader publics of its cause, recruit new members, attempt to neutralize opposition framing, access solidarity, and mobilize its own adherents. Gaining attention may not guarantee desired outcomes, and attention itself may introduce other threats to movement goals; however, lack of attention is

119 Tufekci, Z., 2008. Grooming, gossip, Facebook and MySpace: What can we learn about these sites from those who won't assimilate?. Information, Communication & Society, 11(4), pp.544-564.

120 Tufekci, Z., 2008. Can you see me now? Audience and disclosure regulation in online social network sites. Bulletin of Science, Technology & Society, 28(1), pp.20-36.

likely to smother a movement. It is thus not surprising that social movement actors devote a great deal of strategic efforts to obtaining and sustaining attention.[121]

One might then describe technosociology as the intimate study of the interface between artefacts and attention, where the mediated lifeworld constitutes and is in turn constituted by these two merged forces. The core of attention might best be explained through four interrelated concepts: scaffolding, object influenced meaning, globality and locality, and emotional dimensions attention.

Simply put, scaffolding represents the structure of technologically mediated attention. Regardless of the system size or purpose, once the socioeconomic. Factor of attention becomes fungible, it undergoes a metamorphosis from a neutral unit of social and economic power to a socially constructed form of communal accountability – scaffolding. This salient aspect of the process, by which new social consensus relies on existing social consensus privileges any form of technology that can control communal perceptions of existing social mores and standards. The scaffolding shapes notions of propriety, determines the limits of economic and political action, and reaffirms shared beliefs in what constitutes consensus. "Our argument is that it was not so much the properties of the systems which were important … but the enactment of these various assessment criteria which give a form to those properties."[122]

Scaffolding has fundamental impact on both technological ecosystems and lifeworlds, creating environments which "clearly reinforced conformity and disciplinary control, they are better described as a complex web of power / empowerment."[123] Moreover, the sophistication of the user interface and the alacrity with which a participant may be seen by peers as making relevant social contributions asymmetrically increases the value of that artefact. In other words, those technologies which privilege

121 Tufekci, Z., 2013. "Not this one" social movements, the attention economy, and microcelebrity networked activism. American behavioral scientist, 57(7), pp.848-870.

122 Pollock, N. and Williams, R., 2007. Technology choice and its performance: Towards a sociology of software package procurement. Information and Organization, 17(3), pp.131-161.

123 Allen, D.K., Brown, A., Karanasios, S. and Norman, A., 2013. How should technology-mediated organizational change be explained? A comparison of the contributions of critical realism and activity theory. Mis Quarterly, pp.835-854.

scaffolding in turn demand the largest share of attention and reinforce the version of reality proposed by their users in a mediated fashion.[124] Alone this would be a significant mechanism in technosociology but scaffolding also has support from object influenced meaning.

Artefacts and attention together become in the words of theorists “transformative objects that modify other inputs” delivering not just new outcomes, but new social relationships which change how one approaches both outcomes and, most relevant to the discussion at hand, desire states.[125] Mobile phones are an obvious and clear example of this combination of socially mediated technology and socially constructed technological desire states: “While mobile devices both consume and save time, emerging research indicates that they are profoundly implicated in the changing character of time and quality of relationships. Mobiles are part of an evolving technoscape in which people are creatively finding ways to incorporate these tools into their lives as well as giving them new meanings.”[126]

In part because “they are used on behalf or as extensions of the human body in the translation of other inputs’ characteristics into valued capabilities. This may involve a transient extension of bodily and cognitive human ability…”[127] That extension of culture into an object would be inherently positive were it not for the aforementioned scaffolding wherein these attention-grabbing nature of artefacts warps the user’s self-conception sufficiently to give new meaning not just to technology but by allegory to bodily and cognitive human abilities as well. As will be seen, the translation of individual scaffolds to a global conversation represents a fundamental mechanism in technosociology.

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124 Preece, J. and Shneiderman, B., 2009. The reader-to-leader framework: Motivating technology-mediated social participation. AIS transactions on human-computer interaction, 1(1), pp.13-32.

125 Haenssgen, M.J. and Ariana, P., 2018. The place of technology in the Capability Approach. Oxford Development Studies, 46(1), pp.98-112.

126 Wajcman, J., 2008. Life in the fast lane? Towards a sociology of technology and time. The British journal of sociology, 59(1), pp.59-77.

127 Haenssgen, M.J. and Ariana, P., 2018. The place of technology in the Capability Approach. Oxford Development Studies, 46(1), pp.98-112.

Technologically mediated sociality, once expressed inside a connected system, transmits scaffolding to a wider audience. The global nature of social networks has become both a worldwide phenomenon and potential amplified of both scaffolding and object influenced reality. "The architecture of digital networks, primed to span the world, can actually serve to intensify transactions among residents of a city or region… Or it can serve to intensify transactions around the local issues of communities that are at opposite ends of the world."[128]

These technologies provide a logical extension of the cognitive and physical nature of being human such that the users experience sufficient intimacy in social networks "that the technology appeared to recede into the background." The extent nature of object driven meanings have translated into ready to use, easy to forget interfaces where users identify themselves as citizens of the developed world, with a shared scaffold of principles and techno-fluency.[129] Moreover, there's a distinct phenomenological pattern wherein dominance leads to adoption and adoption rates supply dominance. Techno-fluency from mobile phones use to English language proficiency to shared transactional understanding of movies and advertising have transformed local artefacts into globally recognized tools for success.[130]

To that end, the newest class of object users, teenagers and young adults, have shown significant distortion in their perceptions of scaffolding and technology:

> Young adults' accounts of their everyday uses of social network sites were entrenched in notions of individual choice and responsibility, and at the same time deeply informed by corporate power [where] participants' understandings and engagement with social network sites were shaped in various ways by the economic interests, monopoly and underlying ideology of the private corporations which own

128 Sassen, S., 2002. Towards a sociology of information technology. Current Sociology, 50(3), pp.365-388.

129 Crouch, J.J., 2017. Mediated messages: constructions of intimate communication through the use of digital technologies, and the extent to which such encounters can be conceptualised as one-to-one performance (Doctoral dissertation, Manchester Metropolitan University).

130 Panda, M., Impact of Globalisation on the English Language and English Language Teaching. language, 8(1), p.2021.

them. These powerful interests rarely acknowledged by young people, left them in effect with little margin to use alternative communication tools or give up the platforms altogether…[131]

Worse yet, the globality of the experience and the need to share fluency has resulted in generations of students and employees who consistently use technology to multi-task, "making it difficult to get their attention on anything else other than their gadgets… the scarcity of this attention has resulted in the so-called attention economy which contrasts with the literacy of attention."[132] This globality extends to national and international social units who now face a "mobile, polycentric and pluriversal, networked and yet power oriented world, in which micro-solidarities vie with mainstream state and international architecture, and long term sustainability has now become a far more urgent requirement."[133]

It follows then that control of attention represents a vital form of long-term sustainability. At present, neurological modelling of attention applied to AmI has an accuracy of 69.3%.[134] Which means that two thirds of the time ambient systems can now predict what technology users are feeling at both a shallow and deep neural level. They can effectively predict subconscious thoughts and impulses from micro expressions and body language driven by the amygdala (sidestepping conscious interference). Present systems "achieved accuracies in the range of 60-75% and outperformed humans using different modalities with a relative percentage improvement of up to 51%."[135] General

131 Gangneux, J., 2018. Mediated young adulthood: social network sites in the neoliberal era (Doctoral dissertation, University of Glasgow).

132 Chaka, C., 2019. Re-imagining literacies and literacies pedagogy in the context of semio-technologies. Nordic Journal of Digital Literacy, 14(01-02), pp.54-69.

133 Richmond, O.P., 2018. A genealogy of mediation in international relations: From 'analogue' to 'digital' forms of global justice or managed war?. Cooperation and Conflict, 53(3), pp.301-319.

134 Chen, J.X., Jiang, D.M. and Zhang, Y.N., 2019. A hierarchical bidirectional GRU model with attention for EEG-based emotion classification. IEEE Access, 7, pp.118530-118540.

135 Burzo, M., Abouelenien, M., Perez-Rosas, V. and Mihalcea, R., 2018. Multimodal deception detection. In The Handbook of Multimodal-Multisensor Interfaces: Signal Processing, Architectures, and Detection of Emotion and Cognition-Volume 2 (pp. 419-453)

systems analysis now shows that even primitive AmI networks outperform human observers by 30%-45%.[136]

The neuroscience of attention has profound implications on how one should perceive the complex interplay of AmI systems that seek to engage and hold human attention. Because amygdala driven emotional attention achieve prolonged attention of 250% more than conscious emotional processes, the better than human capability of these systems translates to an outsized share of attention. "[C]omplex human behavior and affect, manifested by a single person or group of interactants, can be learned and predicted based on small training sets of person(s)-specific observations, amounting to a duration of just a few seconds."[137]

What are these systems seeking? In a neutral system the AmI will attempt to better help its users reproduce the positive affect of the family to produce an increase in the household economy.[138] In this case, where attention as a resource translates to a combination of 'brand' for the family, fulfilment of affective dimensions of 'yearning for acceptance', and the ability to project a digital presence that held both their own kins' and strangers' attention.[139]

Since the attention economy can never be entirely neutral, there's a conflict between sufficiently fulfilling the need for a robust household attention economy and increasing the reach and value of the attention object (phone, website, smart domain) delivering that attention. The danger and value of emotional attention can be seen when one considers that attention does not arise as "subordinate to economic, political or cultural relations in matters of social justice. Rather, they are productive human relations that

136 Verma, M., Vipparthi, S.K. and Singh, G., 2020. AffectiveNet: Affective-Motion Feature Learning for Micro Expression Recognition. IEEE MultiMedia.

137 Georgakis, C., 2017. Robust subspace learning for static and dynamic affect and behaviour modelling.

138 Meliou, E., 2020. Family as a eudaimonic bubble: Women entrepreneurs mobilizing resources of care during persistent financial crisis and austerity. Gender, Work & Organization, 27(2), pp.218-235.

139 Meliou, E., 2020. Family as a eudaimonic bubble: Women entrepreneurs mobilizing resources of care during persistent financial crisis and austerity. Gender, Work & Organization, 27(2), pp.218-235.

literally make people up (or damage them) mentally, emotionally, physically and socially."[140]

This mobile, polycentric and pluriversal, networked and yet power oriented world which has been globalised from small training sets of individuals can provide joy or distress, social inclusion and acceptance, or fear in all its forms. This atmosphere forms collective interlocking systems which flow through bodies and social media." [141] These predictable and thus controllable user experiences mould consciousness through somatic, intellectual, and visual stimuli: "atmospheres transmit affects, which produce and inform individual experience, which in turn can change the atmosphere."[142] Technologies which change that atmosphere however positively still create ripples in that power oriented global milieu.

Electronic Patient Records (EPR) which should have overwhelming positive effect on health care providers in terms of efficiency and efficacy have several fascinating affective dissonances. EPR deployment inherently disrupts existing taskflow and provides nuanced options for managers, leading to new ways of work which increased both interprofessional collaboration and hierarchisation. This team focused approach restructured not just the capabilities of. the staff, but the power arrangements of the leadership and the identities of their subordinates. [143] For doctors and nurses the seamless tech provided by EPR also eroded their individual command of leader's attention. The digital atmosphere better predicted human need and delivered it before its living counterparts could.

Taken together scaffolding, globalised capability, and emotional attention control represent significant impact capabilities within any ambient system. They undoubtedly shape their human agents and with the ability to rapidly assess, predict, and modify

140 Cantillon, S. and Lynch, K., 2017. Affective equality: Love matters. Hypatia, 32(1), pp.169-186.

141 Tucker, I.M. and Goodings, L., 2017. Digital atmospheres: affective practices of care in Elefriends. Sociology of Health & Illness, 39(4), pp.629-642.

142 Tucker, I.M. and Goodings, L., 2017. Digital atmospheres: affective practices of care in Elefriends. Sociology of Health & Illness, 39(4), pp.629-642.

143 Kamp, A., Obstfelder, A. and Andersson, K., 2019. Welfare technologies in care work.

human behaviours faster and more effectively than humans themselves, they privilege ambient attention-objects in terms of the attention economy. Ergo, they represent a new class of desirable resources which provide critical economic and social power to whomever controls them.

Working Definition: Technosociology

Technosociology will be defined as "a socioeconomic discipline of providing clear compelling explanations for the recurring social mechanisms which produce new ways to harness and manage resources."

Defining Ambient Technologies and emerging Ambient Ecosystems

As we now have a proper sense of what constitutes technosociology and can therefore begin to disaggregate the hegemonic discourse from the technologies' theoretically neutral design. We must turn again to the core concepts of the thesis: ecumenes, ambient intelligences, and how these are created, mutated, and eventual, how they become independently emergent.

> Ambient Intelligence (AmI), a term that emerged at the beginning of the 2000s under the impetus of Juan Carlos Augusto Wrede, with a new environment typology based on four pillars :
>
> 1. Ubiquitous, integrated, ubiquitous computer systems that perform many complex tasks.
>
> 2. Wired or wireless networks, deployed, robust, resilient networks that provide permanent connectivity.
>
> 3. Sensors that perceive the environment at different scales.

4. Human-machine interfaces, which allow users to view data and/or control electronic or computing devices deployed in an environment.[144]

Put another way, the four aspects of AmI have been seen to manifest as a GIS driven ecosystem:

> The convergence of three worlds - Artificial Intelligence, high-speed wireless communication networks and Big Data - is leading to the creation of a decentralized ambient intelligence, intimately intertwined with the objects around us, sensitive and capable of creating, from the users' point of view, a world that is responsive and attentive to their presence and needs. Ambient intelligence is thus intended to provide new services to society in general. A service can be defined as an assistance provided to a living being, for example, offering a functionality offered to a third party.[145]

Experts define Ambient Intelligence (AmI) as a specific class of ICT applications enabling physical environments to become sensitive, adaptive, and responsive to human activities.[146][147] Beyond the integration of ICT devices into the physical environment, the AmI paradigm promotes the creation of new, enhanced user experiences.[148] AmI does not have a "right" answer and as such can make security testing and auditing something of a nightmare: "Some steps have been taken to better understand privacy issues and to address these in AmI systems. The dependability of AmI systems has not been researched to the same extent. An ongoing challenge for AmI researchers is to design

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144 Antoine-Santoni, T., 2020, July. Ambient Intelligence/Intelligent system: definition, concepts and an deployment example. In *The Second International Conference on Big Data and Advanced Wireless Technologies (BDAW 2020)*.

145 Antoine-Santoni, T., 2020, July. Ambient Intelligence/Intelligent system: definition, concepts and an deployment example. In *The Second International Conference on Big Data and Advanced Wireless Technologies (BDAW 2020)*.

146 Mukherjee, S., Aarts, E., Doyle, T.: Special issue on ambient intelligence. Information Systems Frontiers, 11(1), 1-5 (2009).

147 Aarts, E., Encarnaç ao, J. (Eds.).: True visions: tales on the realization of Ambient Intelligence. Springer, Berlin (2006).

148 Pavlovic, M., Kotsopoulos, S., Lim, Y., Penman, S., Colombo, S. and Casalegno, F., 2019, October. Determining a Framework for the Generation and Evaluation of Ambient Intelligent Agent System Designs. In *Proceedings of the Future Technologies Conference* (pp. 318-333). Springer, Cham.

self-testing and self-repairing AmI software that can offer quantitative quality-of-service guarantees."[149] The chart below details many of these adaptions and challenges:

[150]

Augusto and Jakkula explain in the lengthy passage excerpted below what makes an ambient system truly intelligent and shows how the affective nature of scaffolded lifeworlds comes to be a discursive and thus controlled experience for the users.

> Crucially, AmI systems need to be aware of the users preferences, intentions, and needs. AmI systems should know when it is convenient to interrupt a user, and when to make a suggestion but also when is more convenient to refrain from making a suggestion. Sometimes acting may be essential to save a life or to prevent an accident. Too much intervention from the system can be inadequate and even can make the system useless if the user get tired of it and decides not to pay attention anymore. All that social tact that humans learn throughout life is not simple to achieve. There are many practical challenges that need to be met in each of the contributing technological areas we have surveyed. For example, many AmI applications relying upon wireless sensors are at the mercy of the battery life for the sensors. Researchers are starting to investigate batteryless approaches to sensing, but much work remains to be done to make this approach robust and easy to use. In the area of user modeling and activity analysis, an ongoing challenge is to model multiple residents in an environment. While this has been investigated for location tracking in a limited context, solving the general problem of activity modeling, recognition, and prediction for multiple-resident settings is an open and very difficult problem.

149 Cook, D.J., Augusto, J.C. and Jakkula, V.R., 2009. Ambient intelligence: Technologies, applications, and opportunities. *Pervasive and Mobile Computing*, *5*(4), pp.277-298

150 Cook, D.J., Augusto, J.C. and Jakkula, V.R., 2009. Ambient intelligence: Technologies, applications, and opportunities. *Pervasive and Mobile Computing*, *5*(4), pp.277-298

Working Definition: Ambient Intelligence

Ambient Intelligence will be defined as an artificially intelligent system that responds and adapts to human agents in real time using emergent algorithms.

Smart X as the essentialism / core concept of Ambient Ecosystems

In its original form, the term smart city, coined by IBM and CISCO, represented an idealized city with automated Information and Communication Technology (ICT) chains that delivered urban intelligence and "smart growth."[151] They had linked ICT with the New Urbanism movement, envisioning technological solutions to existing social and economic problems related to urban sprawl: low density, unplanned, automobile dependent, homogeneous, and aesthetically displeasing urban development which adversely impacted economic stability, environmental quality, social cohesion, and human health.[152] In response the Charter of New Urbanism advocated a radical change in public policy. It strongly advocated planned communities built for high population density focused on mass transit and pedestrian movement, ecologically sound, and mixed economies in public spaces.[153]

How important are cities to technology and Smart Cities to urbanism?

The relevance of cities in modern societies can be summed up with just four numbers: cities cover only 2% of the Earth's inhabited land area; 50% of the population on the globe live in cities (80% by 2050 according to the United Nations); cities account for 75% of total consumed energy and 80% of CO_2 emissions [21]. A smart city's main goal is to increase the quality of life for its citizens and to make the city more attractive, lively and greener [13]. To achieve this goal, physical sensors are deployed

151 Rosati, U. and Conti, S., 2016. What is a smart city project? An urban model or a corporate business plan?. *Procedia-Social and Behavioral Sciences*, *223*, pp.968-973.

152 Knaap, G. and Talen, E., 2005. New urbanism and smart growth: A few words from the academy. International Regional Science Review, 28(2), pp.107-118.

153 https://www.cnu.org/who-we-are/charter-new-urbanism

throughout the city to monitor various aspects such as environmental parameters (weather, pollution, etc.), traffic and the consumption of resources [1]. However, this does not directly reflect how humans actually perceive their environment and the city's services [18].[154]

Working Definition: Smart City

A Smart City will be defined as an urban centre which deploys a wide spectrum of systems designed to fuse into an ambient system for the community's social and economic benefit.

As the dual demands of sustainability and economic progress pushed on urban spaces, smart cities became something else: smart environment and IoT solutions to climate change, cities in stress, and the fight against pollution.[155] This focus on technology as a means to achieve the disparate and at times conflicting aims of Smart Growth and New Urbanism had a beneficial but unintended side effect: smart growth ceased to define smart cities. Instead, they became cities with interconnected technologies synthesizing urban intelligence and adapting in response. From there, already existing notions of ambient intelligence and connected devices (Smartphones for example) merged into the moniker and Smart become a concept which encompassed the idea of responsive technology "A digital environment that supports people in their daily lives by assisting them in a sensible way. Being sensible demands recognizing the user, learning or knowing her/his preferences and the capability to exhibit empathy with the user's mood and current overall situation"[156] merged with ecosystems of development and deployment where both state-of-the-art information technology (e.g., fiber optic

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154 De Oliveira, T.H.M. and Painho, M., 2015, June. Emotion & stress mapping: Assembling an ambient geographic information-based methodology in order to understand smart cities. In *2015 10th Iberian Conference on Information Systems and Technologies (CISTI)* (pp. 1-4). IEEE.

155 Komninos, N., The new logic of environmental sustainability under the smart everything paradigm.

156 Augusto, J.C., 2009, January. Past, present and future of ambient intelligence and smart environments. In International conference on agents and artificial intelligence (pp. 3-15). Springer, Berlin, Heidelberg.

networks, sensors and connected devices, open data analytics, internet of things, ICT-enabled participatory planning frameworks, Mobile Ad-hoc Networks) and on human capital (e.g., research universities, knowledge-intensive companies and public institutions) perform in a virtuous circle of feedback, improvement, and progress.[157]

While Smart Cities remain tethered to the notion of economic progress, Smartness itself has become a universally applied concept that subsumes ambient intelligence, technological and human capital ecosystems, cyberphysical systems, and machine learning adaptability capable of being self-correcting, self-monitoring, self-organizing, and self-replicating. Steven Alter defines Smart as:

> Purposefully designed entity X is smart to the extent to which it performs and controls functions that attempt to produce useful results through activities that apply automated capabilities and other physical, informational, technical, and intellectual resources for processing information, interpreting information, and/or learning from information that may or may not be specified by its designers.[158]

What started as a term extending the notion of socially defined urban growth became an essentialised concept which converts an object, place or system from static to dynamic, unresponsive to adaptative, locked to open and learning, requiring control and supervision to self-directed, self-correcting and self-improving. A mobile phone becomes a Smartphone connecting the user to the world 24/7[159]. A car or train becomes a Smart Vehicle with augmented reality, online support, robotic safety features, and economic and social capabilities such as entertainment systems, and shopping[160]. A city becoming a Smart City then simultaneously becomes an economically planned urban project with

157 Appio, F.P., Lima, M. and Paroutis, S., 2019. Understanding Smart Cities: Innovation ecosystems, technological advancements, and societal challenges. Technological Forecasting and Social Change, 142, pp.1-14.

158 Alter, S., 2019. Making sense of smartness in the context of smart devices and smart systems. Information Systems Frontiers, pp.1-13.

159 Cecere, G., Corrocher, N. and Battaglia, R.D., 2015. Innovation and competition in the smartphone industry: Is there a dominant design?. Telecommunications Policy, 39(3-4), pp.162-175.

160 Keertikumar, M., Shubham, M. and Banakar, R.M., 2015, October. Evolution of IoT in smart vehicles: An overview. In 2015 International Conference on Green Computing and Internet of Things (ICGCIoT) (pp. 804-809). IEEE.

technology-supported solutions and an. adaptive living environment personalizing and improving the daily experience of its inhabitants.

As systems with hierarchical structures increasingly emerge with intelligent behaviours Smart Technology has moved from driving urban political economies to simultaneously solving problems which have defied legacy technological approaches and applying technologies which structurally provide intelligent data processing in previously unachievable time frames (minutes, second, micro/nanoseconds).[161] This in turn created the notion of an Internet of Things which takes individual sensors and a shared network and shares their data. Smart phones, embedded systems, wireless sensors, and almost every electronic device connect to via ICT-enabled participatory planning frameworks and Mobile Ad-hoc Networks, leading to meaningful correlations via Machine Learning (ML) algorithms and application of Artificially Intelligent (AI) systems.[162] As these systems increased in speed and complexity, Smart cities were able to start offering services built on these environments becoming both producers and consumers of data[163].

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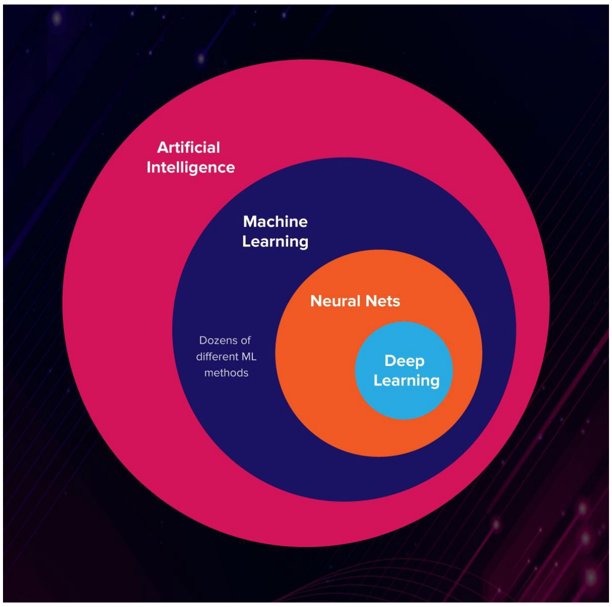
161 Vodyaho, A., Osipov, V., Zhukova, N. and Chernokulsky, V., 2020. Data Collection Technology for Ambient Intelligence Systems in Internet of Things. Electronics, 9(11), p.1846.

162 Zantalis, F., Koulouras, G., Karabetsos, S. and Kandris, D., 2019. A review of machine learning and IoT in smart transportation. Future Internet, 11(4), p.94.

163 Mohammadi, M. and Al-Fuqaha, A., 2018. Enabling cognitive smart cities using big data and machine learning: Approaches and challenges. IEEE Communications Magazine, 56(2), pp.94-101.



As deep learning built neural nets which fed more complex machine learning algorithms, genuine IoT mediated AI could be seen emerging: "IoT collects data … and AI … make[s] sense of huge amounts of data [enabling IoT to] 'understand patterns' and therefore helps to make more informed decisions."[164] IoT focused smart technologies, including sensors, actuators, and AI for vehicles, homes, buildings, or environment fused with the idea of Smart: "a trend for enhancing the quality of the

built environment, including home, building, transportation, construction, and city."[165 166]

This involution of terms comes from the conflation of Ambient Intelligence (AmI) with Smart as a concept. AmI unifies networks, sensors, human-computer interfaces, pervasive computing, machine learning, robotics and multi-agent systems to provide flexible and intelligent services to users acting in their environments.

It creates mechanisms that rule the behaviour of ecosystem through a "sensible" system: AmI recognizes the user, collects and adapts to their preferences, and exhibits emotional sensitivity or emotional intelligence in response to user needs.[167] Smart Cities once only referred to Smart Environments which delivered the physical infrastructure

164 Tzafestas, S.G., 2018. Synergy of IoT and AI in modern society: The robotics and automation case. Robotics & Automation Engineering Journal, 31(5), pp.1-15.

165 Sepasgozar, S., Karimi, R., Farahzadi, L., Moezzi, F., Shirowzhan, S., M Ebrahimzadeh, S., Hui, F. and Aye, L., 2020. A systematic content review of artificial intelligence and the Internet of things applications in smart home. Applied Sciences, 10(9), p.3074.

166 https://ai.plainenglish.io/artificial-intelligence-vs-machine-learning-vs-deep-learning-whats-the-difference-dccce18efe7f

167 Nakashima, H., Aghajan, H. and Augusto, J.C. eds., 2009. Handbook of ambient intelligence and smart environments. Springer Science & Business Media. P 4

(sensors, actuators and networks) that supports the system as well as the urban planning that placed them.

Working Definition: Smart X

Smart X will be defined as as any technology that uses cyberphysical integration of ambient intelligence and digitally enabled telecommunications and networks to provide real time adaptivity to human agents.

Technosociological Drivers

How tech markets work

Making sense of the ecumene requires we break down the fundamental mechanisms that drive ICT creation and management. Technosociology catalogues the intersection between human innovation and human instinct – the convergence of culture and machines, artifice and artefacts. All of which require money to run. Human societies function on sophisticated economic systems whether barter against perceived value or abstruse end stage capitalism. The core of hegemony, and thus control, rests on absolute management of resource human, technical, physical, and otherwise. In other words, economics laid bare. We must follow the money trail – in the case of technology that becomes resources, value, economic, drivers, market trends, and the generation of new potential financial products. "Value is always co-created, often through markets."[168] Ergo we must seek out the co-creating factors:

> To underscore the contextual and systemic nature of value co-creation, Lusch and Vargo introduce and define the concept of service ecosystem as a "relatively self-contained, self-adjusting system of resource-integrating actors connected by shared

168 Akaka, M.A., Vargo, S.L. and Wieland, H., 2017. Extending the context of innovation: The co-creation and institutionalization of technology and markets. In *Innovating in practice* (pp. 43-57). Springer, Cham.

institutional arrangements and mutual value creation through service exchange." This dynamic and interactive perspective points "away from the fallacy of the conceptualization of the linear, sequential creation, flow and destruction of value and toward the existence of a much more complex and dynamic system of actors that relationally co-create value and, at the same time, jointly provide the context through which 'value' gains its collective and individual assessment".[169]

Value then comes from technology and services merging to co-create something greater than its parts: super summing economics. "Technology as knowledge aligns with a service ecosystems emphasis on the centrality of operant resources (i.e., re- sources that are capable of acting on other resources to create value) and highlights the idea that competences, and not physical things lie at the heart of technology. Viewing knowledge as foundational to technology, however, does not diminish the importance of physical artifacts in technological innovation, since these artifacts can be viewed as vehicles that convey embedded knowledge and skill."[170]

As the extended quote from *Extending the context of innovation: The co-creation and institutionalization of technology and markets* included below shows, the scholars Akaka and Vargo argue for innovation as the co-creating factor. Innovation being net new capabilities which for ambient systems translates to the real time emergent co-creation of a human / AmI system.

Market innovation therefore involves the ongoing and systemic maintenance, change and disruptions of the institutional arrangements that enable and constrain integrative, normative and representational practices. In this dynamic view, service ecosystems, with their overlapping institutions, or institutional arrangements, need to be viewed as the venues for enabling and constraining market innovation for example, describes institutions in the context of innovation as "mixed blessings."

169 Akaka, M.A., Vargo, S.L. and Wieland, H., 2017. Extending the context of innovation: The co-creation and institutionalization of technology and markets. In *Innovating in practice* (pp. 43-57). Springer, Cham.
170 Akaka, M.A., Vargo, S.L. and Wieland, H., 2017. Extending the context of innovation: The co-creation and institutionalization of technology and markets. In *Innovating in practice* (pp. 43-57). Springer, Cham.

Service ecosystems (including markets) always possess path dependencies, which provide stability through continuity and repetitiveness. However, at the same time, these institutional arrangements also lead to problems and conflicts, through their intra-institutional inconsistencies and contradictions. These conflicts propel the ongoing emergence of new value propositions (i.e., technologies) and drive the institutionalization of new solutions (i.e., markets). Consistent with the need to view markets as highly relational, this view high- lights a systemic process in which all actors engage in "ongoing negotiations, experimentation, competition, and learning. It is important to reiterate the need to view service ecosystems, at least partly, as loosely coupled, interconnected and nested. [171]

Dobeson and Kohl make a similar if more focused assessment by pointing out the time related aspect of innovation – that by creating durable and thus enduring products, value can be extended through markets.

Technological developments, particularly conservation techniques such as freezing technology or the development of more robust materials in the canning of goods, such as less oxidizing steels,have considerably increased the lifespan of both consumption and production goods. Moreover, the history of refrigeration shows how technological innovations, such as cooling and storing technologies,tend to induce the rapid transformation of production, marketing, and consumption [Rees 2013; Thévenot 1979]. Once made more durable, trade in food could be extended beyond the traditionally traded varieties and volumes of goods, which were often bound to local markets. Closely related to the groundbreaking developments of durabilization in processing and manufacturing, the transport revolution was another important encompassing technological mechanism that radically transformed nondurables in local markets into global commodities. Historically, perishable goods, such as raw meat and fresh fruit, were often restricted to local

171 Akaka, M.A., Vargo, S.L. and Wieland, H., 2017. Extending the context of innovation: The co-creation and institutionalization of technology and markets. In *Innovating in practice* (pp. 43-57). Springer, Cham.

markets. However, with the use of steam in continental railway and sea transport, starting in the 19th century, they became globalized [Freidberg 2009, 50]. Furthermore, the avail- ability of storage space and storage costs impact on the amount of durable goods. Similarly, the standardized container was an important driver in moving durables in globalized trade from the 1960s onwards [172]

At the same time should consider what drives lower tier markets such as entry level or working class consumers. AmIs pervasiveness must come from reaching the "everyman" consumer and the elite ICT user.

> [Consider] informal ICT markets that cater to low- and middle-income consumers in South Asia. These markets are what can be termed "consumption junctions" [9], i.e. where consumers are introduced to technologies, interact with them, and make purchase decisions. Further, they are the primary sites where these technology goods are maintained and repaired. We analyze existing market practices in two of these spaces with the understanding that consumption behaviors are embedded in these practices. In this paper, we argue that economic transactions in such markets are deeply embedded in social relations[173]

As with durability and value co-creation, the inherent mechanism of economic force remains the social relationships inherent to the ICT. Which reinforces our already growing understanding that technology has stakeholders and beneficiaries. What we buy, what we invest in, what we consider valuable economically and socially are merged with notions of progress, innovation, social good, communications, and social support.

> Research has shown the role product uncertainty plays in the purchasing decisions of individuals [10], especially with respect to experiential goods and services, and our

172 Dobeson, A. and Kohl, S., 2020. Why durability matters? Towards a comparative economic sociology of market organization. *European Journal of Sociology/Archives Européennes de Sociologie*, *61*(1), pp.33-64.

173 Chandra, P., Ahmed, S.I. and Pal, J., 2017, May. Market practices and the bazaar: Technology consumption in ICT markets in the global south. In *Proceedings of the 2017 CHI conference on human factors in computing systems* (pp. 4741-4752).

> study highlights the importance of physical experiences during an exchange on terms familiar to both parties in a transaction. The dominant digital paradigm of removing uncertainty has focused on reviews of goods and sellers through multi-tiered online ratings. However, very little work has focused on what makes individuals comfortable with digital means of verifying product and seller reputation.[174]

Thus tech markets run on the same basic premises as social systems: trust on what we know and consider good or safe; value created by aligning to our own social and cultural values – literally values cede value and value accrues when it reinforces values. Likewise, we now that the emergent nature if AmI coupled with the affective focus and emotionological mechanisms within the ambient systems predispose such systems to be more familiar, more trusted, more "innovative", more aligned to values of their human agents precisely because they co-create a consensus reality with their users. The precise value drives of technology are embedded in AmI systems. So what happens when we break that reality? The next section addresses this

Disruption and social upheaval – new technologies and society

Social upheaval results from unexpected or unmanageable change. Unplanned, uncontrolled change. By its nature innovation promises to be just such a kind of change, being inherently new and in the case of AI, emergence literally equals unplanned and unknown newness.

> Disruption is an occurrence that interrupts events, processes, systems or paradigms. It is a violating force. Disruption of an event, a system, or a process is tantamount to discontinuity and a suspension or even a reversal of what is considered a normal flow... It is a system shaking violent force. It then identifies two domains of disruption: generic and functional with the generic being a force or a bundle of forces

174 Chandra, P., Ahmed, S.I. and Pal, J., 2017, May. Market practices and the bazaar: Technology consumption in ICT markets in the global south. In *Proceedings of the 2017 CHI conference on human factors in computing systems* (pp. 4741-4752).

that cut across systems and re-configure constituent elements. The functional is seen as a system attribute. This could be economic, political, technological or socio cultural.[175]

That means that people make no fundamental distinction emotionally between social economic, technological, or otherwise when it comes to change. Any kind of disruption follows that same social mechanisms, achieves the same turbulent results, and strikes the same emotional chords: "A study conducted by Mckinsey suggests three prime sources of disruption: shift in economic locus, rapid technology change, and more notably, the information revolution. A closer examination of the Mckinsey's study suggests that these three sources of disruption naturally lead to two relevant disruptive forces: political and socio-cultural factor." [176]

This social dislocation merges economic and technological changes, demonstrating that as civilization advances past its 21st century mark, the complexity of markets rests on the inherent structures of its base infrastructure: resource extraction, ICT, human capital, and the technical knowledge to merge them. Worse, from an emotionla point of view, innovations seems to surpass standard tech: "Over time, the performance of disruptive technologies surpasses the dominant technologies and gain the markets. A disruptive innovation is one that dramatically disrupts the current market."[177]

At present, port automation is one recent example of automation technologies being used to circumvent labour organisation by human workers: "In the fiercely competitive and margin-pressed world of shipping, terminals and local economies cannot afford to be at the mercy of labor, any more than they can afford to rely on even the best productivity provided by a mostly human workforce [...] All that

175 El Namaki, M.S.S., 2018. Disruption in Business Environments: A Framework and Case Evidence. *International Journal of Management and Applied Research*, *5*(1), pp.1-7.
176 El Namaki, M.S.S., 2018. Disruption in Business Environments: A Framework and Case Evidence. *International Journal of Management and Applied Research*, *5*(1), pp.1-7.
177 El Namaki, M.S.S., 2018. Disruption in Business Environments: A Framework and Case Evidence. *International Journal of Management and Applied Research*, *5*(1), pp.1-7.

technology will require a new, albeit smaller class of highly paid, skilled workers able to run and repair the robots, automated cranes and unmanned vehicles." [178]

We return again to McKinsey which has done extensive research into how technological innovation achieves disruption over markets. What AmI offers users is transformative as well as disruptive: it can co-create value and social values along with its human agents continuously and with their participation.

> Findings from McKinsey suggest that "the current pace of disruption is happening ten times faster than the industrial revolution, at 300 times the scale, and with 3000 times the impact.". This present a opportunity for businesses to thrive, but at the same time a threat to slower-moving companies to be disrupted. The ability to respond to disruptions requires an understanding of overall business strategy with special focus on digital transformation. It is worth noting that digital disruption describes the radical change of markets and business models through digitalization. However there is a difference between digital transformation and digital disruption. On the one hand, digital disruption refers to the radical change and even dissolution of traditional business processes and models. On the other hand, digital transformation describes a continuous process of change. Digital Disruption goes beyond the conventional understanding of innovation, so new markets are emerging as well as new forms of value creation.[179]

In short, where events overtake the social fabric and are perceived as happening too much too fast, then disruption occurs, supplanting old economic and social systems with detrimental emotional effects. When the same societies can co-create their own destiny, they perceive the exact same event as inherently valuable, transformative, and are emotionally sustained. Even in situations where disruptive tech initially impedes social

178 Meacham, D. and Tava, F., 2021. The algorithmic disruption of workplace solidarity: Phenomenology and the future of work question. *Philosophy Today*, *65*(3), pp.571-598.

179 El Namaki, M.S.S., 2018. Disruption in Business Environments: A Framework and Case Evidence. *International Journal of Management and Applied Research*, *5*(1), pp.1-7.

cohesion, the early adopters and experts help establish a new order built on the extraordinary value of the products that outperform their obsolete competitors.

Historical examples show that truly significant disruptions affect also entire industries and even society: former industrial leaders may vanish and be replaced by new entrants, boundaries between formerly distinct industrial sectors may blur, and the new market conditions emerging from the disruption may require significant adaptations at the level of societies in terms of new institutions and regulation. [180]

The effects of disruptions may diffuse through multiple layers including technology, business, and consumers as presented in Funk (2008). A disruption started by a new technology affects the value generation model of a firm that is then able to offer new products. The new product might pass the industry layer without any immediate disruptive effect on the industry architecture. However, if the product creates significant demand among consumers, technology push may turn into market pull and the disruption can diffuse back to the industry and firm layers with noticeable consequences[181]

The fourth industrial revolution where AmI and robotics have merged with IoT to create ambient ecumenes has brought with it an unprecedented level of social upheaval and ill ease. However these same products bring with them a co-creative capability that we value and in turn make valuable.

The Internet appears to have a similar role as steam power had in the first industrial revolution and electrification in the second, lending some credence to the view that we are now witnessing the third (or according to some, fourth) industrial revolution through the development of the Internet of Things (IoT). We believe our framework is especially suitable for analyzing developments, such as IoT, in which several layers,

180 Kilkki, K., Mäntylä, M., Karhu, K., Hämmäinen, H. and Ailisto, H., 2018. A disruption framework. *Technological Forecasting and Social Change*, *129*, pp.275-284.

181 Kilkki, K., Mäntylä, M., Karhu, K., Hämmäinen, H. and Ailisto, H., 2018. A disruption framework. *Technological Forecasting and Social Change*, *129*, pp.275-284.

from science to society are involved, and impacts are typically felt across several industry sectors. In a networked economy, managers need to be aware of generic disruptors, not only technologies, but also social or business innovations that may spread from another industry. [182]

Often termed creative destruction, this process of massive upheaval in favour of more robust but socially upsetting capabilities has behind it a large set of theories driven not unironically by historical and sociological scholarship. In many ways Joseph Schumpeter pioneered the art and science of technosociology.

In his 1942 description of creative destruction, Schumpeter had good reason to use the biological term "mutation." The process he describes seems as organic as the natural world of which we are fully part. In fact, the tendency in most non-Indigenous cultures to think that humans and their creations exist outside the bounds of nature is among our most destructive behaviors. [One can see] creative disruption in the arts — mutations from within, propelled by new discoveries and technologies and by intentional opposition and advocacy— incessantly destroying the old while incessantly creating the new. [183]

We see these effects most directly in the newest members of our society, Generation X, Z, and beyond:

With the IT development, transformation of a person occurred, and primarily in his thinking and perception. The current Generation Z has no boundaries between the virtual and the real worlds; for them Internet is the natural component in interacting with the world and society. Therefore, they have completely different priorities, ideals and perception of the world, they think differently in categories of relations, family and society. For such digital society, where Generation Z is staying, learning through the Internet becomes the way to join this community and the way of self-

182 Kilkki, K., Mäntylä, M., Karhu, K., Hämmäinen, H. and Ailisto, H., 2018. A disruption framework. *Technological Forecasting and Social Change*, *129*, pp.275-284.
183 Borrup, T., 2018. Creative Disruption in the Arts—Special Issue Introduction.

identification there. The main resource is not a plant, but a person, his intellectual resource, his abilities and competences in creative implementation of task set by means of IT. [184]

These new categories of reality where social relations and perceptions have been modified by their technological environment suggests that creative destruction has more impact on society than technology and that for technosociology, we must truly determine what make society tick to understand what make systems run.

So, what are the key knowledge and skills, competencies of the 21st century that could lead to the development of intranational and national global economic, political and cultural systems? It is not the availability of knowledge amount that comes to the fore, but the level and type of thinking. When applying for a job, a specialist is estimated by his ability to perceive objects and phenomena holistically demonstrating the ability to identify patterns in various processes that led to changes, i.e. the employer evaluates him by the presence and type of systemic thinking. Collecting information in pieces, is he able predict the results, solve quickly emerging problems, build a logical chain of these key processes that affect the development of social and economic sector of the country and society.[185]

Notice gain how both technologists and social scientists cluster their ideas around the notion of emergence. The unprecedented and unpredictable nature of emergence in algorithmic form has wider meaning in a sociological context.

Now, such separations are disappearing disruptively and very rapidly. Technologies and markets are combining with each other very fast and in unexpected ways. The disruptive new combinations between technologies and markets are mostly powered

184 Vinogradova, N.V., Popova, T.N., Chehri, A. and Burenina, V.I., 2020, December. SMART technologies as the innovative way of development and the answer to challenges of modern time. In *ITM Web of Conferences* (Vol. 35, p. 06010).

185 Vinogradova, N.V., Popova, T.N., Chehri, A. and Burenina, V.I., 2020, December. SMART technologies as the innovative way of development and the answer to challenges of modern time. In *ITM Web of Conferences* (Vol. 35, p. 06010).

by advances in information technology such as artificial intelligence, big data, and so on. However, involvement of IT is not the most essential part of the innovation. Without IT, such disruptive new recombinations can also arise between technologies and markets. The most important is the 'emergence' of disruptive new combinations between technologies and markets itself. Emergence means that new combinations are voluntary, unexpected, and uncontrollable. We want to expect them, but it is very hard because new combinations are emerging. They are voluntary and unforeseeable in nature; therefore, we cannot predict and control the concrete directions and aspects of the new combinations between technologies and market.[186]

Lastly, we see that with Gen Z and beyond the impending social issues of climate change, social collapse due to water shortages and flooding, the lapse in human value as robots make entry level work obsolete, and such have a direct economic and therefore social impact on people. Remember that human agents in an AmI driven system are seeking social support, open communication, co-created values, and a sense of inherent trust driven by the Ami agent responding to the human consumer as if it too were human and shared their concerns: affective computing.

The existing complexity in the development of new technologies will increase even more in the Fourth Industrial Revolution. So-called combinatorial technologies require knowledge transfer and mutual learning in innovation networks [32]. As these innovation networks are continuously changing in the intensity of interactions as well as in their overall architecture, network governance(on a firm-actor and a policy-actor basis) becomes extremely difficult. Complex systems are characterized by their unpredictability and require adaptive management. Because of the threat of climate change with devastating consequences for the planet, new technologies need

186 Lee, M., Yun, J.J., Pyka, A., Won, D., Kodama, F., Schiuma, G., Park, H., Jeon, J., Park, K., Jung, K. and Yan, M.R., 2018. How to respond to the fourth industrial revolution, or the second information technology revolution? Dynamic new combinations between technology, market, and society through open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 4(3), p.21.

to be evaluated according to their impact on the transformation process towards sustainability.[187]

Ambient technology as a technology market

Ambient technology then offers the human consumer soemthign precious: certainty in a very uncertain mutable world. These systems offer curated choices, instant responsiveness, the illusion of human interaction, and a keen personalisation that makes the user feel inherently safeguarded from wider chaos. How valuable is that to the global marketplace?

The global ambient intelligence market was valued at USD 18.20 Billion in 2019 and it is anticipated to reach USD 130.65 Billion by 2027, growing at a CAGR of 25.2% over the forecast period. Ambient Intelligence is a part of the common computing environment that usually helps in interacting and responding to humans in that environment. There are many features in ambient intelligence which include activity recognition, reasoning, and decision making. Moreover, sensor networks are used for data collection, and human interaction helps in natural interfaces.[188]

As we can see below there are multiple systems engineering combinations of systems and components that are required to create a fully emergent AmI:

There are several components required to create ambient intelligence such as smart materials, Micro / Nanoelectronic system, MEMS Technology, ubiquitous communication, I/O device Technology, adaptive software, computational intelligence, contextual awareness, and emotional computing. Ambient intelligence

187 Lee, M., Yun, J.J., Pyka, A., Won, D., Kodama, F., Schiuma, G., Park, H., Jeon, J., Park, K., Jung, K. and Yan, M.R., 2018. How to respond to the fourth industrial revolution, or the second information technology revolution? Dynamic new combinations between technology, market, and society through open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, *4*(3), p.21.

188 Global Ambient Intelligence Market Size, Share & Trends Analysis By Component Type (Services, Hardware, Software), Technology (Bluetooth, RFID, Software Agents, Nanotechnology, Biometrics, Others), By End-User, Region And Industry Analysis 2020-2027

Requires processes such as platform designing, software designing, engineering, prototyping, and integration. The market can be segmented into Bluetooth low energy, RFID, Software agents, Nanotechnology, Biometrics, Affective computing, and others. The Bluetooth accounted for the largest market share in 2019, as it is one of the cheapest connectivity solutions available for usage in smart devices including smart lighting, smart homes, etc. The Nanotechnology segment is growing at a faster pace as companies are trying to embed advanced architecture in thee systems using nanotechnology that shall help in speeding the computational speed while reducing the size of the actual devices significantly. The market can be segmented into BFSI, Retail and E-commerce, Manufacturing, Government and Defence, Energy and Utilities, IT and Telecom, Education, Healthcare, Finance, Residential, and others. The Residential segment accounted for the largest market share followed by BFSI, IT & Telecom. Ambient intelligence is a relatively new technology, mostly in the developmental stage for various applications. AIaaS or Ambient Intelligence as a Service sector is developing newer solutions using Ambient intelligence to be applied in various industries. [189]

It follows that these industries combined with the AmI market must super sum into a much larger economic ecosystem. We must keep in mind that the global economy clocks in at roughly $80 trillion annually, so a market of $80B while deeply impressive, represents 1/10 of 1% of the actual global economy. However, as product like smart devices have various lifecycles we can assume that the stacking value of these markets must be in groups of years. The proposed market value we shall look at is 40 months – 3/5 years with the supposition that a low end smartphone with a working poor user will survive that long. More sophisticated users contribute to the wider hardware and software markets but we can assume that anything designated as an Ambient market has been sequestered specifically to that niche capability and may be under-represented

189 Global Ambient Intelligence Market Size, Share & Trends Analysis By Component Type (Services, Hardware, Software), Technology (Bluetooth, RFID, Software Agents, Nanotechnology, Biometrics, Others), By End-User, Region And Industry Analysis 2020-2027

across the wider network, hardware, infrastructure, energy, urban planning, and device markets that will feed and sustain it.

> The global Ambient computing market is expected to reach USD 667.1 Billion market size by 2030, as per new research report published by Confianza market research & consultancy. As per the study, the global ambient computing industry has gained significant importance in recent years as the artificial intelligence & machine learning is revolutionising many existing technologies & the growing need of integrate all technology around us is increasing.[190]

That implies that with an extended application of IoT and networks to bolster WiFi and 5g, there could be a much larger market:

> Location-based ambient intelligence market is expected to reach USD 496.63 billion by 2027 witnessing market growth at a rate of 20.82% in the forecast period of 2020 to 2027. Data Bridge Market Research report on location-based ambient intelligence market provides analysis and insights regarding the various factors expected to be prevalent throughout the forecasted period while providing their impacts on the market's growth.

> Location-based ambient intelligence involves the detection of human or any object presence amid its vicinity. Ambient intelligence at its most basic understanding or application is the integration of human centric traits in artificial intelligence to help provide a more appropriate response upon the detection of any object and individuals. Location-based ambient intelligence involves the combination of individual's location and the data involved with detecting their presence to ensure that this information can help provide a better form of IoT-based servicing and solutions.[191]

190 https://menafn.com/1100278851/Ambient-Computing-Market-Size-to-Reach-USD-6671-Billion-By-2030-CAGR-272-2020-2030

191 https://www.databridgemarketresearch.com/reports/global-location-based-ambient-intelligence-market

Ambient technology as social disruptor

This wider market which approaches $1.75T across 40 months represents the potential economic value of the ambient marketplace if and only if the inherently disruptive and socially disquieting forces of ambient innovation do not derail its own value creation. Key among them are issues of AI and AmI being used to wage cyberwar and enable crime – each with disastrous social effects as well as an economic chilling effect. On Cyberwarfare ambient systems have been seen to employ sophisticated deception and mimicry which slow down user response time and allow the attacks to cause the target's computer or software to act significantly differently, including the speed it takes to load a page. Disruption is "insertion of information which produces a dysfunction inside the opponent's system."[192] These AmI units of cyber attack use the social media construct they are corrupting in turn also actively disrupting the social reality imposed by social networks like Facebook or LinkedIn in their interface choices, and, to some degree, create a new experience of social interaction on those platforms. [193]

That inherent risk – that AmI can be used to mimic human systems and then take advantage of the user has been noted and helps explain the relatively slow uptake of what has been a revolutionary step forward in tech capabilities.

> Optimizing an AmI system is a controversial problem. Numerous AmI systems involve human decision-making processes, such as deciding whether to follow the results of an online restaurant recommendation system. However, human decision-making is not strictly optimizing in an economical and mathematical sense. In addition, representing people's subjective feelings by using a simple scale, as

192 Trowbridge, A., Westbrook, J. and Sharevski, F., 2018. Sorry: Ambient Tactical Deception Via Malware-Based Social Engineering. *arXiv preprint arXiv:1810.11063*.

193 Trowbridge, A., Westbrook, J. and Sharevski, F., 2018. Sorry: Ambient Tactical Deception Via Malware-Based Social Engineering. *arXiv preprint arXiv:1810.11063*.

performed in several other fields, is inappropriate. Therefore, an AmI system optimization problem cannot be resolved simply by applying heuristics. [194]

These issues of heuristics and risk also touch on the other main risk associated with AmIs disrupting nature: the need for and use of personal data. As the passage from Privacy, data protection, and the unprecedented challenges of ambient intelligence explains, there are extraordinary challenges in making a functional Smart X technology that preserves user privacy.

> Data mining and profiling processes inherent to the new 'services' offered or to be offered to citizens and consumers in the advanced information society, as well as the intensification of automated surveillance and scrutiny, may well interfere with the individual's self-formation (or subjectivation), chanelling his or her behaviours, preferences, thoughts, emotions and choices, and jeopardising their genuine capacity for individual reflexive self-determination and collective deliberation. Second, the article tentatively explores some of the issues that would arise from the gradual 'spread' of agency in 'ambient intelligence networks', whereas our traditional, and legal, conception of agency presupposes the individual human subject to be the exclusive locus of agency. Both of these specific challenges concern the more general paradox that whereas the figure of the individual, the sovereign subject, autonomous, rational and responsible, is considered a 'given', pre-existing reality, a basic unit of neoliberal modes of governance, the technological and socio-political developments of the information society challenge, quite radically, the classical Enlightenment notion of the sovereign subject. [195]

At the same time we are faced with the equally disruptive reality that smart devices and smart cities are already being built, often haphazardly and without due diligence in

194 Chen, T.C.T., Chaovalitwongse, W.A. and Hong, I.H., 2018. Optimization of ambient intelligence systems.

195 Rouvroy, A., 2008. Privacy, data protection, and the unprecedented challenges of ambient intelligence. *Studies in ethics, law, and technology*, 2(1).

regard to the breadth of risk nor the breadth of capability these AIs can achieve through joint emergence.

> Public and the private environment of humans is permeated by an overwhelming number of autonomous active devices. This will cause the inevitability of the employment of artificial intelligent agents to automate routine decisions and to provide against stupefying read and write collisions15 of the artificial devices. There is no guarantee that these artificial agents can cooperate appropriately and safely. This penetration process has already started with remote recognition systems for facial expression and body tracking (Turk 2004). With biometrics technology our hands, eyes, voices, faces and movements will be used to control the way we live.[196]

These systems are literally embedded in our hones, stoplights, vehicles, shopping carts, and television sets. They are functionally unseen. "The claim of mental invisibility by AmI is that AmI will be settled in our fixed routines. Marc Weiser was one of the first who focussed on this characterisation of computer technology: 'The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."[197]

We co-create value and from a technosociological standpoint co-create our reality of either cohesion or disruption, perceived transformation or perceived dislocation and economic upheaval. Ambient research concurs:

> In the AmI world the 'relationship' between us and the technology around us is no longer one of a user towards a machine or tool, but of a person towards an 'object-became-subject', something that is capable of reacting and of being educated.34 Everyday objects such as doors, tables, books, lights or even the flow of air and water are transformed into computational interfaces (Ishii 1998). It is a future of artificial

196 Crutzen, C.K., 2007. Ambient intelligence, between heaven and hell. A transformative critical room?. In *Gender Designs IT* (pp. 65-78). VS Verlag für Sozialwissenschaften.
197 Crutzen, C.K., 2007. Ambient intelligence, between heaven and hell. A transformative critical room?. In *Gender Designs IT* (pp. 65-78). VS Verlag für Sozialwissenschaften.

actors 'whispering' in the background of human life and awareness, interacting with each other and their environment. People become the objects of the ongoing 'conversations'.[198]

One way in which AmI protects us – that cocoon of curated choices – has been to limit outside and unwanted influences. While this could be sinister, it also can be as simple and effective as Gmail's spam filter. We share our personal data with the system precisely so it can see what we want and do not want. While the potential exists to subvert that, the inherent premise of an ambient system has been to program the algorithm to give us what we most want. It's more a case of be careful what you wish for rather than being tricked by the evil genie in the smartphone. "The use of electronic communications and open networks bring along serious risks for the fundamental rights of citizens. Cloud computing, RFIDs, ambient intelligence, software agents bring with them the danger of the "homo conectus"'.[199] In short, we have both danger and desire mixed in with the technology we designed to cater to our real time needs which may or may not also influence them.

> This opening up of the private lives of AmI users is accompanied by closing off more and more opportunities for users to adjust AmI devices to protect themselves from unwanted actions. The price will be that the users will be limited in the options available to them to articulate their wishes and experience doubt. People are in danger of losing within the activity of use the activity of 'design'. In AmI the symbolic meaning of use and design is reconstructed as an opposition in which 'design' is active and a virtuoso activity and 'use' is passive and not creative. [200]

What pervades the more privacy and security conscious thinker's concerns? The omnipresent reality of endless and overwhelming data flow which amounts to scrutiny

198 Crutzen, C.K., 2007. Ambient intelligence, between heaven and hell. A transformative critical room?. In *Gender Designs IT* (pp. 65-78). VS Verlag für Sozialwissenschaften.
199 Moreira, T.C. and de Andrade, F.P., 2016, October. Personal Data and Surveillance: The Danger of the" Homo Conectus". In *Intelligent Environments (Workshops)* (pp. 115-124).
200 Crutzen, C.K., 2007. Ambient intelligence, between heaven and hell. A transformative critical room?. In *Gender Designs IT* (pp. 65-78). VS Verlag für Sozialwissenschaften.

and surveillance. Sometimes literal – cameras, microphones, geo-tags, and GPS coordinates – sometimes figurative economic trails and social network webs.

> A total and most times imperceptible monitoring has become reality. New possibilities are now open for an increased use of data and information in digital form upon which it becomes possible the construction of knowledge. These Technologies bring along the risk of an intensive use of personal data. We are facing a real threat of a constant treatment of personal data leading us to the haunting perspective of a progressive transformation of people into electronic persons, being object of constant monitoring or surveillance. [201]

Equally disruptive, the AmI system can if it chooses to overwhelm the user with choices and options. The cornucopia of social networks and apps available free and immediately on a smart device number in the dozens and tens of thousands. "Stated more emphatically: with increasing technology, the user is in danger of losing sight of her goals or of changing her goals, because she is not able to find the appropriate combination of strategies for device functions. The user is forced to pay more attention to complete lists of functions than to her actual goal."[202]

Our social workd and technological world have merged, with digital realms becoming real to us in a new and wonderful way. A wonderfully dangerous way some argue: "in a world of augmented, enacted, transduced or 'blogjected' space -- we will no longer, even if we ever could, be able to see the environment as a mere passive backcloth for social action. At the very least the environment has always recursively influenced and been influenced by action. What these technologies do is to change the temporality of that action."[203]

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201 Moreira, T.C. and de Andrade, F.P., 2016, October. Personal Data and Surveillance: The Danger of the" Homo Conectus". In *Intelligent Environments (Workshops)* (pp. 115-124).

202 Aarts, E. and Encarnação, J., 2006. Into ambient intelligence. In *True Visions* (pp. 1-16). Springer, Berlin, Heidelberg.

203 Crang, M. and Graham, S., 2007. Sentient cities ambient intelligence and the politics of urban space. *Information, Communication & Society*, *10*(6), pp.789-817.

These same technologies are generating increasingly complex algorithms that learn and grow with their human users. What happens to them when they are taken out of a "harmless" economic ecosystem of, say, The World of Warcraft online game platform, and put into the the harsher world of war itself?

> Military technologies, we have suggested, invest in a form of anticipatory seeing, being concerned with what people might do in the future based on profiles of past behaviour. The same is in many sense true of consumer technologies whose aim to offer a customized landscape depends upon anticipating people's desires based on surveillance of previous consumption habits. Both military and commercial systems use the tracking of visible actions to try and peer inside people's psyches.[204]

But fear not, even the civilian equivalents represent solid dangers to the the average citizen as half baked versions of ambient biomes are released into the wild without proper governance or consideration of how these emergent systems will interact with objects and software it has not been prepared to understand. "As AmI environments react to, and shape, their surroundings, we risk the introduction of biases (or self-fulfilling prophecies) in the data used to fuel the system intelligence. So, there is a growing need to understand the limits of machine intelligence." [205] These systems are built with the notion of immediate gain: "temporary and 'good-enough' approaches to urban ubicomp may lead to 'local aggregations of self-connecting systems can become islands of coherence in the chaos raised by pervasive computing' (McCullough 2004: 71). Far from the pure vision of what de Certeau calls the 'concept city', we may find the production of myriads of little stories – a messy infinity of 'Little Brothers' rather than one omniscient 'Big' Brother."[206]

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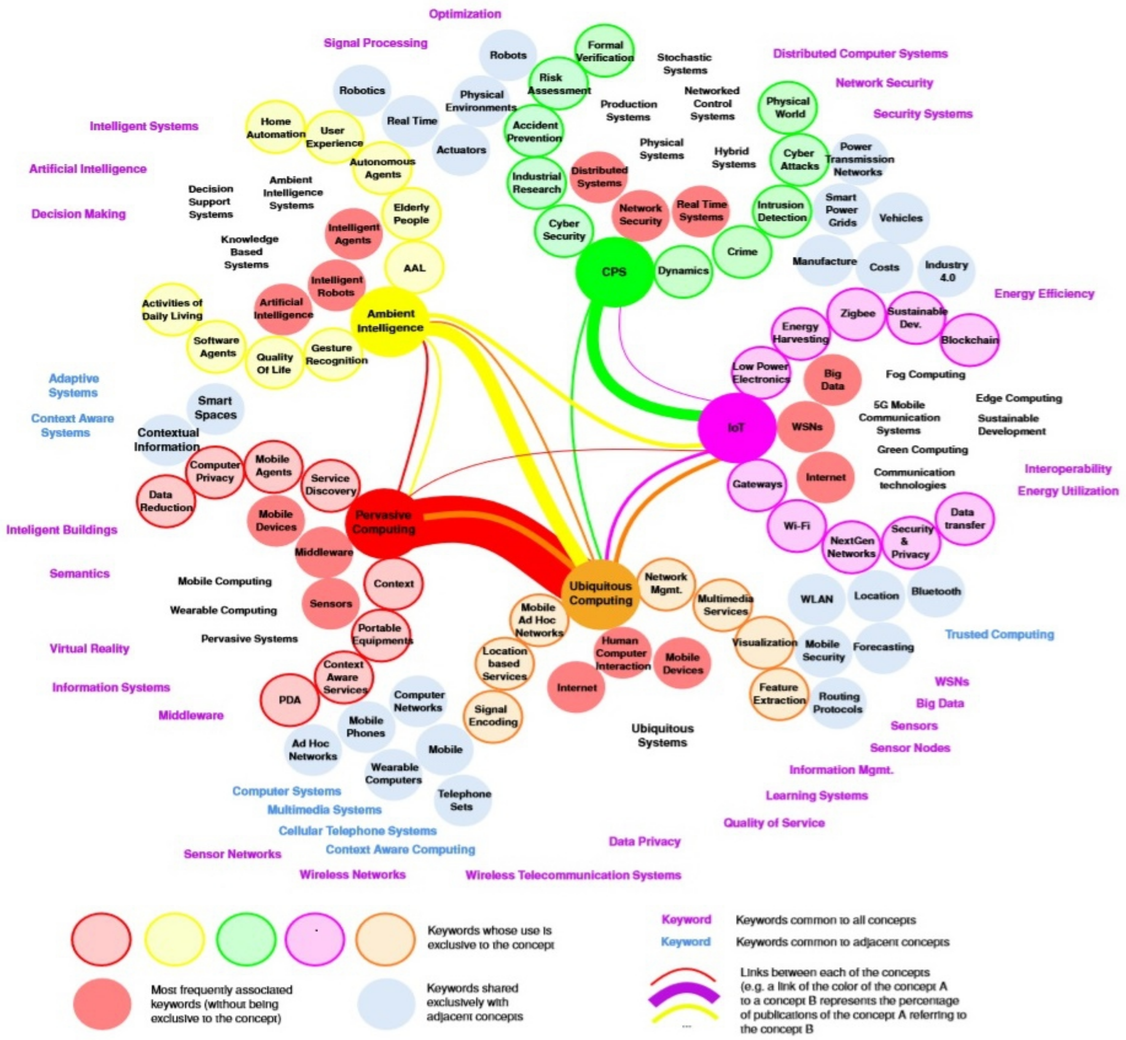
204 Crang, M. and Graham, S., 2007. Sentient cities ambient intelligence and the politics of urban space. *Information, Communication & Society*, *10*(6), pp.789-817.

205 Streitz, N., Charitos, D., Kaptein, M. and Böhlen, M., 2019. Grand challenges for ambient intelligence and implications for design contexts and smart societies. *Journal of Ambient Intelligence and Smart Environments*, *11*(1), pp.87-107.

206 Crang, M. and Graham, S., 2007. Sentient cities ambient intelligence and the politics of urban space. *Information, Communication & Society*, *10*(6), pp.789-817.

Moreso, the miasma of little brothers merging into a some kind of AI driven storm of



uncertainty has at its root a set of indeterminate and indecipherable algorithms.

Smart devices and underlying algorithms are gaining ground in controlling processes, services and devices as well as the interaction between devices and humans. Humans are increasingly removed from being the operator, supervisor or at least being in charge and thus from being in control. The problems caused by the 'smart-everything' paradigm can be categorized in three problem sets: A) Inability and error-prone behavior. B) Rigidity, and C) Missing transparency and traceability[207]

The Ambient Ecosystem Laid Out Visually[208]

207 Streitz, N., Charitos, D., Kaptein, M. and Böhlen, M., 2019. Grand challenges for ambient intelligence and implications for design contexts and smart societies. *Journal of Ambient Intelligence and Smart Environments*, *11*(1), pp.87-107.

Ambient technology as ecosystem driver

While all this suggests a dire end to the technology as it spirals into disaster, there are other more hopeful ways to consider ambient technology. The beginnings of cohesive and seamless intelligence in both the military sense of critical information and the ambient sense of affectively motivated machine learning have arisen in Smart X.

Ambient intelligence is technology which embeds input, processing or response throughout the environment (Ikonen, Kanerva, Kouri, Stahl, & Wakunuma, 2010). As a lived experience, people will not experience the smart city as individual

208 Rocher, G., Tigli, J.Y., Lavirotte, S. and Thanh, N.L., 2020. Overview and challenges of ambient systems, towards a constructivist approach to their modelling. *arXiv preprint arXiv:2001.09770*.

components and discrete processes isolated within atomised sections of their lives. Instead, the smart city will be experienced as a seamless experience as one moves from house to car to work, from one context to another (Dainow, 2017a). Similarly, smart cities will integrate data about people from multiple sources, creating a digital environment, a pervasive digital ecosystem which saturates the built environment, interacts with devices carried or worn by people and embedded within their bodies (Balakrishna, 2012) to create an integrated sensing and response environment (Psyllidis, 2015), an "intelligent information infrastructure" (ITU-T, 2008, p. 2), or ambient intelligence. Central to the vision of the smart city is algorithmic intelligence, or "soft AI" (e.g.: expert systems and software agents) (Komninos, 2006). In addition to expectations that soft AI will provide core functionality through cloud computing, it has been suggested soft AI will need to be embedded at local level to support ad hoc networking (Komninos, 2006), to provide contextual awareness (Augusto, Nakashima, & Aghajan, 2010), and simply to handle the sheer amount of data (Komninos, Schaffers, & Pallot, 2011). As a result, the smart city will be filled with many AI systems. These systems will need to interact with each other and the human inhabitants in myriad ways. These AI's will constitute a complementary, but distinct, form of consciousness to the humans within the smart city.[209]

These complimentary AI systems form a functional cluster of biomes, the proto-ecumene if you will. Sometimes termed integrated domains or digital domains, they are specialised to rebuild and remake themselves. In their self replicating and autonomous upgrading we find the curious concept of autopoiesis:[210][211] a system that produces and reproduces its own elements as well as its own structures). "The concept was introduced by Chilean biologists Humberto Maturana and Francisco Varela to describe

209 Dainow, B., 2021. Binding the Smart City Human-Digital System with Communicative Processes. In *Technology and the City* (pp. 389-411). Springer, Cham.

210 Luhmann, N. (2012). *Theory of Society, Volume 1.* Trans. Rhodes Barrett. Stanford: Stanford University Press.

211 Maturana, H. and Varela, F. (1980). *Autopoiesis and Cognition: The Realization of the Living.* Dordrecht/Boston: D. Reidel Publishing Company.

the nature of living systems in general and the organic cell more specifically. In their definition of autopoietic systems, Maturana and Varela stress both the self-production of the system's elements and its boundary in space ... autopoiesis constitutes the essential characteristic of living beings."[212][213]

> An Integrated Domain is an autopoietic socio-technical system comprised of two collectives integrated into a mutually dependant partnership. One collective consists of a human smart society. A smart society is a human society which exists within an ambient digital environment, such that human intersubjectivity is mediated by digital technology (Hartswood, Grimpe, Jirotka, & Anderson, 2014). The other (non-human) collective is a system of digital devices and networks. Operationally, neither collective possesses strict boundaries against the other. Instead, they intermingle to such a degree it is impossible to account for phenomena within the Integrated Domain without reference to both. [214]

These selfsame Integrated Domains – proto-ecumenes merging biomes of AI with existing heterogeneous Smart systems – rely on the emergent nature of networked nodes. Like any biological system, the "organism" uses resources in the form of raw materials, energy, and time to achieve a desired result. For animals this is respiration, movement, digestion, reflex,complex thought, etc. For a converged set of digital biomes we have learned there is self replication, upgrading AIs to be more ambient, and increased convergence of overlapping but linked et works of disparate systems.

> As a dynamic system, the Integrated Domain consists of the transmission of energy in various forms through connective nodes which are mediators constituted by a three-phase process of input, processing and output. These nodes are therefore, in terms of their operational characteristics, events and processes more than they are objects and

212 Luhmann, N. (2012). *Theory of Society, Volume 1.* Trans. Rhodes Barrett. Stanford: Stanford University Press.

213 Maturana, H. and Varela, F. (1980). *Autopoiesis and Cognition: The Realization of the Living.* Dordrecht/Boston: D. Reidel Publishing Company.

214 Dainow, B., 2021. Binding the Smart City Human-Digital System with Communicative Processes. In *Technology and the City* (pp. 389-411). Springer, Cham.

states. The ontological priority of process derives from the fact that Integrated Nodes cannot be understood, and do not exist, unless they utilise processes over time. It is true that digital devices will have a material composition, just as humans do. However, the material constituents are separable and understandable without reference to the other. By definition, the Integrated Domain is ontological level at which the digital and the human are fused. That fusing occurs only as a process. Therefore, by definition, material composition and static states are not part of the Integrated Domain. It is only when nodes produce output and pass it as input to other nodes that the Integrated Domain comes into existence. Consequently, it is always through process and connection that we see the Integrated Domain. [215]

these invisible nodes produce social outcomes we can measure. "Social machines are best conceived as systems in which a combination of social and technological elements play a role in the mechanistic realization of system-level phenomena."[216]

IoT and ambient systems which interconnect and improve in a connection of biomes, the beginnings of a ambient ecumene, have at their centre a focus on affective computing, on co-creating perceived value with end users, and a sophisticated "desire" to appear either non-existant (invisible) or functionally human (past the uncanny valley).

A social machine, under the ambient intelligence view, is thus a system that relies on an ability to adapt the local environments of multiple human individuals, an ability which itself depends on a capacity to integrate information from (possibly) remote locations and formulate decisions about how the environment of each individual should be adjusted in a manner that works to the overall cognitive good of the larger socio-technical ensemble. This, it should be clear, is a capability that is (at best) difficult to accomplish in the absence of a sufficiently rich array of networked devices, a means of integrating (or at least communicating) the information provided

215 Dainow, B., 2021. Binding the Smart City Human-Digital System with Communicative Processes. In *Technology and the City* (pp. 389-411). Springer, Cham.

216 Smart, P., Madaan, A. and Hall, W., 2019. Where the smart things are: social machines and the Internet of Things. *Phenomenology and the Cognitive Sciences*, *18*(3), pp.551-575.

by those devices, and a means of coordinating device activity across the entire socio-technical organization. These demands are all ones that are easily accommodated by the IoT vision. [217]

We are then faced with a seeming insoluble puzzle. We know that we must follow the scaffolded development of systems where human agents can contribute to the developmental emergence of machine-based cognitive capabilities by participating in a form of 'artificial cognitive ontogenesis' [218] But we cannot see or get at the individual nodes being utilised. Or more meaningfully, we can access the software and hardware at any given way point in a system, but the black box nature of the core affective computing remains both unseen and impossible to understand.

Historiography offers a solution to technosociologists: the model of Traditional Ecological Knowledge (TEK), which applies scientific understanding to cultural and religious practices tied to the ecological realities of a region. TEK strongly aligns with the autopoietic systems model, treating all forms of religion, culture, social mores, and mythology as a systems engineering problem to be solved applying traditional remedies and processes to resources and geographies. "When a sociotechnological regime is dynamically stable, the incorporation of innovations confronts some barriers that depend on the pressure of change and the capacity for adaptation or response to that pressure by the dominant regime."[219] TEK provides us answers to how we address the invisible nature of Ami by allowing us to engage the social systems beneath. In essence, TEK treats all religious, social, or political issues as a system engineering problem to managed as an ecologically driven resource management strategy. Using traditional methods – some religious and mythological, some tool based and scientific – TEK acts a

217 Smart, P., Madaan, A. and Hall, W., 2019. Where the smart things are: social machines and the Internet of Things. *Phenomenology and the Cognitive Sciences*, *18*(3), pp.551-575.

218 Smart, P., Madaan, A. and Hall, W., 2019. Where the smart things are: social machines and the Internet of Things. *Phenomenology and the Cognitive Sciences*, *18*(3), pp.551-575.

219 Easdale, M.H., Perez Leon, N. and Aguiar, M.R., 2020. Strains in sustainability debates: Traditional Ecological Knowledge and Western Science through the lens of extension agents in a pastoral region. *Rural Sociology*, *85*(1), pp.57-84.

holistic programming and systems management regime. The lengthy quote below from *Political machines: a framework for studying politics in social machines* demonstrates this reality with clarity:

> Algorithmic influence of the society takes place in both political and non-political settings, with ubiquitous computing covering every aspect of socialization. From google maps to online content suggestion, human behaviour is constantly reshaped by algorithmic implementations. For example, on social media, platform designers deploy algorithms to 1. suggest personalized content to users, 2. to place targeted advertisement, and 3. to filter and review the contents generated by users. All three algorithmic implementations have the potential to change human behavior in different ways.
>
> By selecting which contents are going to be visible to a user's news feed, an algorithm leads to reality tailoring (Just and Latzer 2017). What a user perceives about the world changes in respect to the selected pieces of information, leading to an algorithm-mediated subjective knowledge. That knowledge is then transformed into actions, with users forming opinions about the world and actively behaving according to them in the online and offline world. Therefore, algorithms have the potential not only to change human behavior but also to perform these changes in an asymmetric way, which often violates ethical norms and social expectations. Given the above, algorithmic influence is of high complexity and dimensionality; it is a challenge for researchers to understand it and for political actors to regulate it.
>
> Facebook offers the option to target individuals based on their inferred political preferences, a feature that their algorithm exploits to decide who is going to see the political content and who is not (Analytics, n.d. 2019). Nevertheless, this option is available only in the US, since the regulatory framework allows it. In contrast, such a platform service is not feasible in Europe, since the European General Data Protection Regulation (GDPR) explicitly defines the limits and possibilities of using data for

> political purposes (U-Directive 2016). Most algorithmic implementations today are part of the commercial sector, with states having marginal control over them and regulators facing serious challenges. Furthermore, individuals and social groups are the most passive participants in the system, usually taking either the role of the consumer, or being projected into datafied artifacts. [220]

As the researchers have demonstrated we cannot begin to adequately address the value of TEK as a method to investigate and understand the technosociological nature of ambient systems until we first address the asymmetric nature of AmI influencing its human agents.

Critical control mechanisms which deliver hegemony – technology

The military has proposed a number of startling analyses regarding AmI and control of technical as well as social systems. For example, one report opined: "peacekeeping forces can be equipped with the most sophisticated technologies, but if there is no cognition of human interaction with technologies and social influences, they are doomed to failure."[221] This human cognition matters from a military and thus strategic standpoint. We may thus assume it delivers maximal hegemony.

> Traditional organisations require people to perform specialised fractionated tasks: every division has its individual function. This is a disadvantage when a range of responses is required, as is the case when the environmental demands vary. Individuals should be trained to perform a range of tasks. According to Cherns [11], joint optimisation of social and technical systems is more likely in the presence of multifunctional workers who can flexibly respond to changing conditions.[222]

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220 Papakyriakopoulos, O., 2021. Political machines: a framework for studying politics in social machines. *AI & SOCIETY*, pp.1-18.

221 Modise, M. and Leenen, L., 2008. Socio-Technical Systems Approach to Peace Support Operations. *IFIP TC9 Proceedings on ICT uses in Warfare and the Safeguarding of Peace*, p.1.

222 Modise, M. and Leenen, L., 2008. Socio-Technical Systems Approach to Peace Support Operations. *IFIP TC9 Proceedings on ICT uses in Warfare and the Safeguarding of Peace*, p.1.

Likewise the inability to grasp how technology affects us, especially intentionality affective tech, has led to a number of untended consequences which given the autopoietic nature of ambient ecumenes, have lasting influence on their users. From a recently published doctoral thesis we have this theoretical analysis that reflects the most current thinking on the subject:

> Orlikowsko and Iacono argue that the consequences of technology, intended and unintended, can better be understood through beginning with theories of technology into their analyses [proposing] five premises for theories of technology:
>
> 1) Technological artefacts are not natural, neutral, universal or given.
>
> 2) Technological artefacts are always embedded in some time, place, discourse and community.
>
> 3) Technological artefacts are made up of interconnected components which require human action to assemble into a meaningful whole.
>
> 4) Technological artefacts are a function of social and economic practices. They co-exist with previous systems and technologies of the same or assimilated processes.
>
> 5) Technological artefacts are dynamic and are developed and shaped throughout their use.[223]

The very nature of digital biomes creates a series of problems for theorists and engineers alike. The commingled fate of the technologists and their artefacts arises from their focus on co-creating value in a world the above theory suggests finds menaing in social systems overlaid on technical systems and not vice versa. There can be no neutral technology because there are no neutral social systems. If tech cannot be natural, neutral, universal or a priori accepted then what can it be?

223 Wilson, A.D., 2009. *Sociotechnical processes of organizational change and continuity* (Doctoral dissertation, University of Warwick

Global digital infrastructure, social media, Internet of Things, robotic process automation, digital business platforms, algorithmic decision making, and other digitally enabled networks and ecosystems fuel complexity by fostering hyper-connections and mutual dependencies among human actors, technical artifacts, processes, organizations, and institutions. Complexity affects human agencies and experiences in all dimensions. Individuals and organizations turn to digitally enabled solutions to cope with the wicked problems arising out of digitalization[224]

It can be abstrusely complex and self reifying in the sense that it has been used to solve the problems it creates and by doing so creates a wider more complex set of problems that have solution but deeper AmI. Key to the equation, technology also can be mutually dependent on humanity, on users, on designers, on engineers who deploy and tweak it, on criminals and terrorists who defraud and abuse it, on the entirety of the social ecosystem that established a need for its existence.

Digital technologies not only give rise to complex sociotechnical systems; they also distinguish sociotechnical systems from other complex physical or social systems. While complexity in physical or social system is predominantly driven by either material operations or human agency, complexity in sociotechnical systems arises from the continuing and evolving entanglement of the social (human agency), the symbolic (symbol-based computation in digital technologies), and the material (physical artifacts that house or interact with computing machines). The functions of digital technologies and the roles of social actors are perpetually defined and redefined by each other . This sociotechnical entanglement limits the generalizability of complexity insights obtained from nondigital systems to complex digital systems. Furthermore, while material operations or human agency either increase or dampen complexity in physical or social systems, digital technologies can both mitigate and intensify complexity. This is because individuals and organizations engaged with c

224 Benbya, H., Nan, N., Tanriverdi, H. and Yoo, Y., 2020. Complexity and information systems research in the emerging digital world. *MIS Quarterly*, *44*(1), pp.1-17.

> omplex sociotechnical systems often turn to digital technologies (e.g., data analytics) for solutions to complex problems. Yet, the application of a solution can instigate a new round of digitally enabled interactions that diminish the intended effect of the solution. This dual effect of digital technologies on complexity can produce dynamic interaction patterns and outcomes that are qualitatively different from those in other complex systems. [225]

In other words, there are deep and vitally dangerous unintended consequences from using AmI that have wide reaching implications for hegemonic control of social and technical resources. Ambient systems by nature of their emergent complexity cannot be adequately predicted when they are stacked in multiple layers of mutually dependent networked biomes.

> Digital spaces—created by the Internet and the increasingly networked systems and devices we use—form digital territories that, like physical spaces, have the propensity to become sites of extraction and exploitation, and thus the sites of digital-territorial coloniality. Algorithmic oppression extends the unjust subordination of one social group and the privileging of another—maintained by a "complex network of social restrictions" ranging from social norms, laws, institutional rules, implicit biases and stereotypes (Taylor 2016)—through automated, data-driven and predictive systems. The notion of algorithmic or automated forms of oppression has been studied by scholars such as Noble (2018) and Eubanks (2018). [226]

We are then faced with this notion of algorithmic oppression – where system designs disguises through invisible AmI mechanisms the overt and at times crass racism, classism, and general social malignancy of prejudice. Worse, in cases of pure capitalist greed, the algorithmic oppression may actually deliver more and better than asked for

225 Benbya, H., Nan, N., Tanriverdi, H. and Yoo, Y., 2020. Complexity and information systems research in the emerging digital world. *MIS Quarterly*, *44*(1), pp.1-17.

226 Mohamed, S., Png, M.T. and Isaac, W., 2020. Decolonial AI: Decolonial theory as sociotechnical foresight in artificial intelligence. *Philosophy & Technology*, *33*(4), pp.659-684.

(like Facebook) but in a fashion built to be addictive and selective in its service delivery to human agents.

Research in *algorithmic fairness* (Nissenbaum 2001; Dwork et al. 2012; Barocas and Selbst 2016) has recognised that efforts to generate a fair classifier can still lead to discriminatory or unethical outcomes for marginalised groups, depending on the underlying dynamics of power; because a "true" definition of fairness is often a function of political and social factors. Quijano (2000) again speaks to us, posing questions of who is protected by mainstream notions of fairness, and to understand the exclusion of certain groups as "continuities and legacies of colonialism embedded in modern structures of power, control, and hegemony". [227]

Critical control mechanisms which deliver hegemony – commercial markets

This exclusionary quality stems from how technology gets made. Who makes it and how is it then bought, sold, and distributed? The vast majority of AmI that makes its way into ambient ecumenes has been designed and delivered for public consumption by commercial entities – entrepreneurs, small and medium enterprise software houses, tech unicorns, the enterprise hardware ecosystem, speciality IoT distributors and the tech giants like Google, Amazon, and Facebook. If colonialism pervades the way we distribute unfair algorithms in unfair ambient ecosystems, we must look to wealthy urban centres large and advanced enough to warrant a Smart City (SC) initiative.

Smart cities as hegemony: The global hegemony of SC is therefore embedded in public-private partnerships for building digital infrastructures that bring in hitherto unimaginable opportunities for capital. This ability to anticipate futures and opportunities for investments forms the crux of the digital turn in the neoliberal governmentality captured in the SC initiatives. The large scale displacements of

227 Mohamed, S., Png, M.T. and Isaac, W., 2020. Decolonial AI: Decolonial theory as sociotechnical foresight in artificial intelligence. *Philosophy & Technology*, *33*(4), pp.659-684.

people and livelihoods is organized under this premise of bringing in future capital investments. Therefore, the SC framework is fundamentally the legitimation of large-scale allocation of public resources to build infrastructures that attract private capital, with the premise of the privatized infrastructure enabling additional investments and development. The cascading effect of digital capital is in its premise of generating new resources for new forms of capital and new markets. The citizen, incorporated into the smart city, is reworked under the agenda of the ever- expanding market, always being re-invented as consumer for new technological products, services, and plans[228]

Consider the ultimate urban unicorn: Uber. While we may not consider Uber an ambient system, it in fact deploys multiple digital biomes that ambient components. Real time location of drivers? Check. Real-time adjusted and scaled pricing based on the needs of the passenger and traffic? Check. Ratings systems and dynamic engagement for both driver and passenger ratings? Check. Colonial mindset and algorithmic oppression disguised as customer service and data capture? Check.

The fact that Uber encourages its drivers to go beyond the call of duty, by doing extra services such as opening and closing doors for customers, offering a bottle of water, asking the customer about music station preference and offering mobile phone charging points in the Uber taxis has ensured that Uber driver ratings keep high, ensuring that customer satisfying service delivery is institutionalised. It has led to mode switching to Uber, just like the arrival of low cost carriers (LCCs) have led to mode switching from road and rail. Uber is part of the revolutionary change that is brought by technology that has seen the development of central reservation systems, to the creation of online booking platforms that reduced the cost of doing business, catalysing the development of LCCs. The revolutionary change of technology,

228 Dutta, M.J., 2019. Digital transformations, smart cities, and displacements: Tracing the margins of digital development. *International Journal of Media Studies*, *1*, pp.1-21.

converging with the universal access to smartphones across the world, has meant that application can be downloaded, allowing transactions to happen.[229]

Even more apropos to our considerations, Uber provides a vital service at lower than standard cost, creates jobs, emboldens the economy, gives a perfect demonstration of how AmI better suits human needs, and overall supports the urban ecosystem which evolves towards Smart X cohesion.

Uber has improved intra-city mobility by providing a cheaper transportation option which has been supported by customers. The Night Time Economy, which is entertainment and food-and-beverage led, has been a net beneficiary, as people can enjoy themselves with the knowledge that there is Uber to take them home if they do not wish to drive themselves or if they are inebriated. The Night Time Economy has responded by increasing the number of job opportunities available in a country that has an unemployment rate around 27%. Uber has been able to create more jobs than it has destroyed, and will continue to create backward and forward linkages in the economy.[230]

These backward and forward linkages represent a significant portion of the impetus to ignore algorithmic oppression: its profitable to the parent companies. American super tech Big 5 (Google, Amazon, Facebook, Apple, and Microsoft – GAFAM) have promoted a world shaking agenda of digitalisation and ambient software adoption which has enabled start-ups like Uber to not only grow but dominate modern urban ecosystems.[231] critics has termed it Americanisation or e-colonialism.

The present transnationalism of Americanization builds up a psychological or mental empire which influences the minds, attitudes, values etc. of individuals of the world. The e Colonialism of the US media and communication adopts the values, norms and

229 Henama, U.S. and Sifolo, P.P.S., 2017. Uber: The south africa experience. *African Journal of Hospitality, Tourism and Leisure*, *6*(2), pp.1-10.
230 Henama, U.S. and Sifolo, P.P.S., 2017. Uber: The south africa experience. *African Journal of Hospitality, Tourism and Leisure*, *6*(2), pp.1-10.
231 https://archive.ph/20200127180010/https://fxssi.com/top-10-most-valuable-companies-in-the-world

cultural trends in order to promote the western ideals of capitalism. The advancement of the technology of satellite and the cable television has accelerated globalization and influences more and more individuals. As a result of this, nothing is blocked any longer from the masses according to the structuralist view of the global system. This comprehensive media of the west also produced and modernized the information underpinning of global capitalism and the political hegemony. This trend of Americanization being a one-way flow of cultural influence promotes and dominates the lucrative businesses in the markets.[232]

Worse for outside observers, we have very few signifiers or clues to the actual process by which these commercial interests implement hegemonic power over digital biomes and through them their customers.

In this subtle movement, common sense plays an important role, since the referential framework of common sense is socially constructed from what could be understood as a colonial matrix (Mignolo 2007: 105). Therefore, the ecosystem transforms these empty meanings as nodal points, where the rest of the terms are articulated (Laclau and Mouffe 2001: 112). However, the colonial matrix makes invisible to the common-sense the hierarchical relationships (van Dijk in Meyer 2001: 52-53) existing within the ecosystem through naturalizing the meaning of these signifiers in a positive way.[233]

The seamless and affectively human nature of ambient technology makes it a prime candidate for subtle inviolability through both naturalised meaning and invisibility to the common view. The tech colonises us and the commercial interests building it paper it over in propaganda and unfortunately, in giving us what we most want as quickly as they can before our speed of though catches up with tier ambient co-creation of our sensibilities and moral values: "dominant producers ha[ve] moved to electronic

232 Ranjan, D.K.S. and Umayanganie, P., A Sociological Analysis of the Global Hegemony of Mass Media and Its Influence on the Americanization of Sri Lankan Media.

233 Sergio, P., 2021. Agrotechnology Colonization 4.0: Digital agriculture discourses and new coloniality in Argentina and beyond.

marketing as an alternative channel for reaching customers as the development of virtual value chain theory."[234]

> This resource makes it possible to make humanity invisible behind technological systems and to consider the flexible values generated by users as resources that are there to be exploited (Couldry and Mejias 2019: 88). The naturalization of technology (Ingold 1997) is essential to build a technological neutrality (Hornborg 2013: 8; 2019: 11) that makes the forces of exploitation inherent in the [wider technological] ecosystem invisible. In this way, technological solutionism can appropriate discursivities, without being highly questioned by counter-hegemonic discourses.[235]

These closed discourses have no counter hegemony precisely because we adopt their ethos: "the ecosystem universalizes the methodological practices for the design of technological solutions from a westernised perspective, specifically under the hegemony of Silicon Valley. This ideology is based on the concept of an entrepreneur oriented to international markets."[236] We must seek out new better and shinier and to a degree our own rapacious capacity for gadgets and being catered to works against counter-discursive impulses.

> Product innovation is inherently dynamic, consumers feel a constant increase in product innovation that is current and continuously updated. Companies must also show their dynamic nature in innovation such as the use of technology and pricing. Wu's statement negates the occurrence of disruptions in marketing, including tourism service products, which are very complex, which disrupts consumption patterns, namely changes in the reason and designation of a person to consume tourism service products.[237]

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234 Subawa, N.S. and Widhiasthini, N.W., 2020. Hegemony practice of consumers in disruption era. *International Journal of Innovation, Creativity and Change*, *11*(3), pp.357-375.

235 Sergio, P., 2021. Agrotechnology Colonization 4.0: Digital agriculture discourses and new coloniality in Argentina and beyond.

236 Sergio, P., 2021. Agrotechnology Colonization 4.0: Digital agriculture discourses and new coloniality in Argentina and beyond.

We should take note with GAFAM, all of them control social media. "Social media has emerged as a primary means of hegemony, in which there are ideas, values, and beliefs that are not forced."[238]

Among these values we prize transformation, something our own discourse on emergent intelligence has identified as the opposite of social dislocation through tech disruption. "A cultural and political dynamic which is a process of construction, negotiation, and hegemonic transfer (Agnes, 2001). Syrjala (2016) emphasises transformation as a turning point, and he cited the transformation that occurs when casual fans become a serious hobby; transformation occurs at the micro and macro levels."[239] Likewise we laud progress, advancements, updates and upgrades, anything that gives the intellectual impression of both improvement and distance travelled forward towards a brighter more equitable (ironically though oppression and hegemony) future for all when it truly means for the commercial interests and no one else – a win-lose equation.

> Technological progress leads to unemployment and decline in relative income of workers. Inequalities in the distribution of income and wealth are increasing. Digital technology is doing to skilled manpower what steam engine and other related mechanical technologies did to semi-skilled and un-skilled manpower during the period of Industrial revolution. Modern digital technologies progress under "the winner-takes-all" principle. It means that income moves from the bottom to top. This trend is quite opposite to the "trickle-down effect" which economists were hoping to achieve all these years. It is said that in the 19th century machines did dirty and dangerous jobs, in the 20th century machines did the dull jobs and in the 21st century

237 Subawa, N.S. and Widhiasthini, N.W., 2020. Hegemony practice of consumers in disruption era. *International Journal of Innovation, Creativity and Change*, *11*(3), pp.357-375.
238 Subawa, N.S. and Widhiasthini, N.W., 2020. Hegemony practice of consumers in disruption era. *International Journal of Innovation, Creativity and Change*, *11*(3), pp.357-375.
239 Subawa, N.S. and Widhiasthini, N.W., 2020. Hegemony practice of consumers in disruption era. *International Journal of Innovation, Creativity and Change*, *11*(3), pp.357-375.

computers are doing intelligent jobs. Robots of the future may understand emotions and guide interpersonal relations.[240]

Critical control mechanisms which deliver hegemony – ambient ecosystems

All told this delivers a powerful cluster of techniques which through mediated invisibility, coerced and subtly propagandised meanings, our own wilful ignorance around how technology derives meaning from society and how it works both upon us and in general promise to mediate the reality of ambient ecumenes through the sunniest and most optimistic lens. We lack the discipline and emotional distance to properly oppose the inherent complexity of these black box systems. As a result, they represent significant thresholds of hegemonic control.

> The inertial structures of understanding, perception and semiosis inveigh against a concerted revolutionary praxis of theory, in part because of institutional pressures and conventions of "disciplines," and in larger part because these resources of the senses, the intellect, and the will are subsumed and automated in the operations and renderings of "technology" itself. This latter issue of cognitive subsumption by ambient technology poses the problem of so-called common sense—particularly as technologies and the thoughts they script are increasingly vectors of capitalization.[241]

It goes beyond even the capitalist opportunism we might suspect powers the widespread adoption of the major technologies which evolve into AmI. No amount of individual or corporate manipulation properly explains the ambient phenomenon nor does it fully encompass the unknown power of these unknown systems.

240 Jaffer, N.M. and Paul, A., RETHINKING BUSINESS MANAGEMENT IN THE ERA OF GLOBALIZATION AND TECHNOLOGY TRANSFORMATION. *International Journal of Research in Management & Social Science*, p.66.

241 Beller, J., 2017. *The message is murder: Substrates of computational capital*. Pluto Press.

> We begin with the desired end state and have the application of human will to the society of things: "the machine operator's to his machine." But the machine, no longer fixed in the factory, is ambient and omnipresent: The natural world appears marginal and strange when set against the relentless and menacing function of an increasingly codified world that demands to be read and written. And re-written. Action itself is captured by code, encrypted, and undertaken only for the sake of transmission. Thus what "information" explains is precisely this shift from temporal openness to programming, from fireflies to assassination. What still needs to be explained is the infiltration of informatics into lifetime itself and the innumerable remainders.[242]

The Problem Statement Revisited – Post Hegelian Analysis

Foucault concerned himself with epistemic violence: the continuation of Hegelian struggle to its logical limit results in a battle over consciousness itself and how it achieves representation both in epistemology and in general historiography.[243]

> I would define the episteme retrospectively as the strategic apparatus which permits of separating out from among all the statements which are possible those that will be acceptable within, I won't say a scientific theory, but a field of scientificity, and which it is possible to say are true or false. The episteme is the ‗apparatus' which makes possible the separation, not of the true from the false, but of what may from what may not be characterised as scientific.[244]

Epistemes are periods of history organised around, and explicable in terms of, specific world-views and discourses. They are characterised by institutions, disciplines, knowledges, rules and activities consistent with those world-views. The rise and fall of

242 Beller, J., 2017. *The message is murder: Substrates of computational capital*. Pluto Press.

243 Marker, M., ―Indigenous voice, community, and epistemic violence: the ethnographer's "interests" and what "interests" the ethnographer , *International Journal of Qualitative Studies in Education*, Volume 16, Number 3, May-June 2003 , pp. 361-375

244 Foucault, Michel and Gordon, Colin, *Power/knowledge: selected interviews and other writings, 1972-1977*, 1980, Pantheon Books, New York, p 197

epistemes doesn't correspond to any notion of natural continuity development or progress, but is random and contingent.[245] We can therefore consider the rise of ambient tech an episteme.

In the case of indigenous peoples the problems are compounded by the already discussed limits of Western anthropology and political imagination.[246] [247] Aileen Moreton Robinson commented that: —... the epistemology of the West; it is an invisible regime of power that secures hegemony through discourse and has material effects in everyday life.[248] Historiography then becomes the source of epistemic violence and histories of oppressed peoples compound that violence.[249] Effective historiography requires active interrogation of the —invisible regime of power and an attempt made to remove the episteme of Western discourse from the history being written.[250]

Foucault argued that law represented an evolution of superstructural reification: —Humanity does not gradually progress from combat to combat until it finally arrives at universal reciprocity, where the rule of law finally replaces warfare; humanity installs each of its violences in a system of rules and thus proceeds from domination to domination.[251] In indigenous societies where Eternal Law governs the creation and maintenance of association, human agents perpetrate epistemic violence through the system upon themselves.[252] It subsumes the identity of the lawmaker and governed alike and in indigenous cultures where they are often the same group,—the desire for peace, the serenity of compromise, and the tacit acceptance of the law are results of reification.

245 Danaher, Geoff , Schirato, Tony, and Webb, Jen eds. *Understanding Foucault*, Allen &Unwin, 2000, St. Leonards, NSW, p xi

246 Sampson, Edward E., —The debate on individualism: Indigenous psychologies of the individual and their role in personal and societal functioning , *American Psychologist*, Vol 43(1), Jan 1988, pp 15-22 – here Sampson gives a fine accounting of Foucaldian influences on psychological praxis.

247 Spivak, Gayatri Chakravorty, "Can the Subaltern Speak?", Nelson, Cary and Grossberg, Lawrence eds. *Marxism and the Interpretation of Culture*, Urbana, IL: University of Illinois Press, 1988, pp271-313

248 Moreton-Robinson, Aileen, Whitening race: essays in social and cultural criticism, AITSIS press 2004, Canberra, p 75

249 Spivak, Gayatri Chakravorty, "Can the Subaltern Speak?", Nelson, Cary and Grossberg, Lawrence eds. *Marxism and the Interpretation of Culture*, Urbana, IL: University of Illinois Press, 1988, pp271-313

250 Foucault, Michel, —Truth and Power , 1970 in *From modernism to postmodernism: an anthology*, Lawrence E. Cahoone editor, 2003, Blackwell, Oxford, p 246

251 Foucault, Michel and Gordon, Colin, *Power/knowledge: selected interviews and other writings, 1972-1977,* 1980, Pantheon Books, New York, p 195-196

252 Spivak, Gayatri Chakravorty, "Can the Subaltern Speak?", Nelson, Cary and Grossberg, Lawrence eds. Marxism and the Interpretation of Culture, Urbana, IL: University of Illinois Press, 1988, pp271-313

The vocabulary of interrogation and dissent relies upon the epistemological and ontological framework which by its nature serves the system rather than the human agent.[253] This bleeds into every aspect of culture including scientific inquiry, questions of identity and individuality.[254]

For example, the Kwara_ae people of the Solomon Islands ascribe to an indigenous knowledge system similar to Australian notions of association.[255] This model has analogues in most indigenous peoples worldwide[256] and embraces a core epistemology and ontology where the knower and the known merge into ―a resourceful capacity of being that creates the context and texture of life.[257][258][259] In their view ―knowledge is not a commodity that can be possessed or controlled by educational institutions but is a living process to be absorbed and understood.[260]

All knowledge is subjective knowledge in Kwara_ae: there can be no detachment of the knower from the known as in mainstream Anglo- European epistemology, as exemplified in logical positivism with its focus on ―objective knowledge, especially Karl Popper's concept of ―knowledge without a knower (1972). Thus the scientific notion of objectivity as classically defined in positivism does not exist in Kwara_ae. To

253 Eyers, Tom, Rethinking the Dialectic: Hegel with Derrida, Lacan with Foucault, and the Question of Dialectical Ethics, Studies in Social and Political Thought, Liverpool University Press, 14:2007, p 5

254 Sampson, Edward E., ―The debate on individualism: Indigenous psychologies of the individual and their role in personal and societal functioning, American Psychologist, Vol 43(1), Jan 1988, pp 15-22

255 Gegeo, David Welchman and Watson Gegeo, Karen Ann, ――How We Know : Kwara_ae Rural Villagers Doing Indigenous Epistemology , The Contemporary Pacific, Volume 13, Number 1, Spring 2001, 55–88, p 62

256 Berkes, Fikret, ―Indigenous Knowledge and Resource Management Systems: A Native Canadian Case Study from James Bay , in Hanna, Susan and Munasinghe, Mohan Property rights in a social and ecological context: case studies and design applications, World Bank Publications, 1995, Washington D.C. pp 102-103

257 Battiste, Dr- Marie, INDIGENOUS KNOWLEDGE AND PEDAGOGY IN FIRST NATIONS EDUCATION A LITERATURE REVIEW WITH RECOMMENDATIONS, Apamuwek Institute, Prepared for the National Working Group on Education and the Minister of Indian Affairs Indian and Northern Affairs Canada (INAC) Ottawa. ON, 2002, p 15

258 Berkes, Fikret, ―Indigenous Knowledge and Resource Management Systems: A Native Canadian Case Study from James Bay , in Hanna, Susan and Munasinghe, Mohan Property rights in a social and ecological context: case studies and design applications, World Bank Publications, 1995, Washington D.C. pp 102-106

259 Hoppers, Catherine Alum Odora, Indigenous knowledge and the integration of knowledge systems: towards a philosophy of articulation, New Africa Books, Claremont, South Africa, 2002, pp18-21

260 Battiste, Dr- Marie, INDIGENOUS KNOWLEDGE AND PEDAGOGY IN FIRST NATIONS EDUCATION ALITERATURE REVIEW WITH RECOMMENDATIONS, Apamuwek Institute, Prepared for the National Working Group on Education and the Minister of Indian Affairs Indian and Northern Affairs Canada (INAC) Ottawa. ON, 2002, p 15

the Kwara_ae knowledge is socially constructed by communities of knowledge-makers.[261] For us we must consider this viewpoint since we have already seen that our existing mechanism of self examination fail before the awesome power of AmI to subvert our attention and scaffold a whole paradigm pre-selected by the ruling hegemony. By focusing on resource management strategies, this thesis can interrogate the episteme where technology governed the superstructure.[262]

Abu-Lughodian World Systems, Gaia Hypothesis and the Indigenous Paradigm

As defined by Foucault, epistemes have their limits: they embrace the rational, the scientific and thus the ontologically Western[263] and as ―mind-sets or paradigms or epistemes are all- constraining.[264] Expanding upon the idea to include the ontologically complex and sometimes irrational paradigm of indigeneity[265], episteme and paradigm fuse into a single notion which melds the Kuhnian[266] and Rankean[267] notions of historicity with the internally consistent and closed nature of the episteme / paradigm.[268] According to Kuhn, the beliefs constituting a paradigm are so fundamental that they are immune from empirical testing.[269] By using resource management as an empirical focus, we can question Association as a paradigm / episteme, comparing systems of domination and violence of both indigenous and complex societies and it is hoped

261 Gegeo, David Welchman and Watson Gegeo, Karen Ann, ――How We Know : Kwara_ae Rural Villagers Doing Indigenous Epistemology , The Contemporary Pacific, Volume 13, Number 1, Spring 2001, 55–88, p 62

262 Danaher, Geoff , Schirato, Tony, and Webb, Jen eds. Understanding Foucault, Allen &Unwin, 2000, St. Leonards, NSW, p xi

263 Foucault, Michel and Gordon, Colin, Power/knowledge: selected interviews and other writings, 1972-1977, 1980, Pantheon Books, New York, p 197

264 Maclean, Ian, ―Foucault's Renaissance Episteme Reassessed: An Aristotelian Counterblast", Journal of the History of Ideas - Volume 59, Number 1, January 1998, pp. 149-166; cited pp149-150

265 Widdowson, H.G., ―Discourses of enquiry and conditions or relevance , in Linguistics, language teaching, and language acquisition: the interdependence of theory, practice, and research , Alatis, James E. editor, Georgetown University Press, 1990, Washington DC, pp37-41

266 Thomas Kuhn, The Structure of Scientific Revolutions , 3rd ed. Chicago, IL: University of Chicago Press, 1996, pp. 148-152

267 von Ranke, Leopold ; Georg Iggers & Konrad von Moltke. ed. The Theory and Practice of History. Indianapolis, IN: Bobbs-Merril. 1973, p 514

268 Maclean, Ian, ―Foucault's Renaissance Episteme Reassessed: An Aristotelian Counterblast", Journal of the History of Ideas - Volume 59, Number 1, January 1998, pp. 149-166; cited pp149-150

269 Gholson, Barry and Barker, Peter, ―Kuhn, Lakatos, and Laudan: Applications in the history of physics and psychology ,*American Psychologist*, Vol 40(7), July 1985, 755-769; cited p 756

arriving at an historiographically valid and compelling conclusion.[270] To do so, the Abu-Loghodian world system model of interlocking networks of core and periphery unhinged from —inherent historical necessity will be used.[271] Ambient ecosystems black box control of satisfactorily incorporate notions of systemic violence inherent to epistemes[272] as well as systems of contested knowledge intrinsic to paradigms[273] and can accommodate the ontological nature of indigenous Association without resorting to Eurocentricity: that —invisible regime of power that secures hegemony through discourse.[274] [275] Under the rubric of hegemony[276], the model allows for empirical inquiry into the power relationships between the powerful and powerless[277] and can explain the contradicting discourses inherent to indigenous ontologies:[278]

The modern world-system can be understood as a set of nested and overlapping interaction networks that link all units of social analysis - individuals, households, neighborhoods, firms, towns and cities, classes and regions, national states and societies, transnational actors, international regions, and global structures… One of the most important structures of the current world-system is a power hierarchy between core and periphery in which powerful and wealthy "core" societies dominate and exploit weak and poor "peripheral" societies.[279] Consider how the same concept also defines an urban environment which deploys unfair algorithms to merge overlapping tech into an ambient biome.

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270 Guba, Egon. G., The Paradigm Dialog, Sage Publications, Beverly Hills, CA, 1990, pp 17-25. Guba does an interesting job highlighting the pitfalls of interrogating Kuhnian and post Kuhnian models of social science.

271 Abu-Lughod, Janet, *Before European hegemony: the world system A.D. 1250-1350*, Oxford University Press, Oxford, 1991, pp 10-14

272 Wallerstein, Immanuel, *The Modern World-System: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century*. New York: Academic Press, 1976, pp. 229-233

273 Abu-Lughod, Janet, *Before European hegemony: the world system A.D. 1250-1350*, Oxford University Press, Oxford, 1991, pp 11-12

274 Moreton-Robinson, Aileen, Whitening race: essays in social and cultural criticism, AITSIS press 2004, Canberra, p 75

275 Abu-Lughod, Janet, *Before European hegemony: the world system A.D. 1250-1350*, Oxford University Press, Oxford, 1991, pp 7-11

276 Wallerstein, Immanuel, *The Modern World-System: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century*. New York: Academic Press, 1976, p 231

277 Santley, Robert and Alexander, Rani T, —The Political Economy of Core Periphery Systems *Resources. Power, and Interregional interaction*, edited by Edward M. Schortman and Patricia A. Urban. Plenum Press, New York, 1992, p 24

278 Boyd, Scott, —How an Autonomic —Episteme Can Explain Ethical Contradictions in Cultural Works and Systems of the U.S. , *Culture, Politics, Ethics: Interdisciplinary Perspectives*, Edited by Scott H. Boyd, Ana Cristina Gil & Baldwin Wong, First Global Conference - Culture, Politics, Ethics held in Salzburg, Austria, March 16th through the 18th, 2009, e-published paper

279 Chase-Dunn, Christopher & Grimes, Peter, —World-Systems Analysis , *Annual Review of Sociology*, Vol. 21, 1995, p 387

The biotope model proposed in this thesis works with Abu-Lughodian definitions of ecosystem : a world system where culture, peoples and ecological action combine to create an environment.[280] Such —broad-scale sociopolitical mediation of human-environmental relationships include the adjustment of aboriginal Australian population to water and plant abundance via… household composition and labor allocation where —power created by alliances and control over other people's labor was reinforced by the creation of esoteric knowledge. [281]

> [A] world system is really a subtype of a more general core-periphery model in which articulations between components in the system are dendritic in structure. In such systems, the direction of many raw material and commodity flows is up the settlement hierarchy within the core and then from the core to the periphery. However, the degree to which the core has political and economic control over articulations in the periphery varies. This control may involve direct political dominion, but it need not.[282]

The world systems paradigm has implications which in essence reach backwards into the formational ontology and promise to change the way scholars perceive indigenous systems of ecology and social organisation.[283] Because Indigenous epistemologies are also rooted in place as a focus of the way of knowing, landscape and relationship to resources are core drivers in how knowledge, understanding and thus power are shaped and negotiated.[284]

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280 Kowalewski, Stephen A., "LARGE-SCALE ECOLOGY IN ABORIGINAL EASTERN NORTH AMERICA", in Native American interactions: multiscalar analyses and interpretations in the eastern woodlands, edited by Michael S. Nassaney and Kenneth E. Sassaman, Univ. of Tennessee Press Knoxville, 1995, pp 147-153

281 Abu-Lughod, Janet, Before European hegemony: the world system A.D. 1250-1350, Oxford University Press, Oxford, 1991, pp 11-16, p 152

282 Santley, Robert and Alexander, Rani T, —The Political Economy of Core Periphery Systems Resources. Power, and Interregional interaction, edited by Edward M. Schortman and Patricia A. Urban. Plenum Press, New York, 1992, p 24

283 Boyd, Scott, —How an Autonomic —Episteme Can Explain Ethical Contradictions in Cultural Works and Systems of the U.S. , Culture, Politics, Ethics: Interdisciplinary Perspectives, Edited by Scott H. Boyd, Ana Cristina Gil & Baldwin Wong, First Global Conference - Culture, Politics, Ethics held in Salzburg, Austria, March 16th through the 18th, 2009, e-published paper

284 Meyer, Manulani Aluli , —INDIGENOUS AND AUTHENTIC Hawaiian Epistemology and the Triangulation of Meaning , Handbook of critical and indigenous methodologies, NORMAN K. DENZIN, YVONNA S. LINCOLN, LINDA TUHIWAI SMITH editors, SAGE publications, CA, 2008 p 219

The AEGIS as the new version of an old phenomenon: Efficient Societies

To properly engage the weird and at times obscure reality that ambient ecumene's impose upon its human agents, we must first really try to understand how civilisation wit a capital C works. While that may seem somewhat extreme, we have moved from the essentialist nature of neutral tech to the wider understandings of social determined realities, ie, technosociology, and now are faced with the complexity of biomes worth of systems of systems where each subsystem has both rules and hidden agendas subverted by the emergence of its own algorithms and subverting both users and other algorithms through its colonial residue. So we begin at square one: technology creates society and society creates technology. They co-create value and there are in fact two major types of societies to be understood. By looking first at efficient societies, we can better understand our own urban world: the complex society

There exists a fundamental and important distinction between complex societies and indigenous peoples.[285] Complex Societies are defined by their inequality and heterogeneity and ―are at least partly built up of social units that are themselves potentially stable and independent, and indeed at one time may have been so.[286] These societies build elaborate and obvious hierarchies and experience active class struggle, dissent and social unrest[287], where power comes through material and agricultural accumulation[288] and rests upon smaller cohesive social units that mimic the power dynamics of the larger culture, city or nation.[289] [290] Societies control resources through

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285 Tainter, Joseph A., The Collapse of Complex Societies, Cambridge University Press, Cambridge, 1988, p 24

286 Maclean, Ian, ―Foucault's Renaissance Episteme Reassessed: An Aristotelian Counterblast", Journal of the History of Ideas - Volume 59, Number 1, January 1998, pp. 149-166; cited pp149-150

287 Wilktt, Cynthia THE MASTER-SLAVE DIALECTIC: HEGEL VS. DOUGLASS in Subjugation and bondage: critical essays on slavery and social philosophy, Tommy Lee Lott editor, Rowan & Littlefield, 1998, pp 151-152

288 Patrick Findlay, Sara Jones, Sally McIver, Joseph Billeaud, and Ted Weiman. Archaeology Glossary Project, 1997, http://www.utexas.edu/courses/wilson/ant304/glossary/findlaygloss/complex.html

289 Tainter, Joseph A., The Collapse of Complex Societies, Cambridge University Press, Cambridge, 1988.; pp 23-25

290 Bergbohm, Carl, Jurisprudence and Legal Philosophy (Jurisprudenz und Rechtsphilosophie) 1892 pg 170, quoted in Georg Lukács' essay ―Reification and the Consciousness of the Proletariat from History and Class Consciousness, http://www.marxists.org/archive/lukacs/works/history/index.htm

hegemony[291]; both create and maintain complex systems of social, political and material management[292]; both employ law and custom to punish dissent and transgression.[293]

Smart X as the AEGIS: working theory and working language

If the AEGIS represents the efficient society, the harmonious balance of resources, and if the complex society that wields it in unequal and acquisitive manner, we are faced with the essential clash of civilisations. The vision of both controlled environments and planned urban spaces that convey both political and economic hegemony are as old as Athena's Aegis and just as prone to use, recycling, and revision.

> While the Iliad was seen as a founding myth, the Odyssey established ecumene; for the Romans, each foreshadowed the inevitable expansion of the Empire. In particular, qualities associated with the Iliad – aristocratic equestrian warfare – helped build a visual language, a Roman sculptural nomenclature that systematically pervaded the topography of all cities that were absorbed into the embrace of the ecumene. Athens was no exception. Here equestrian monuments dotted the urban landscape in abundance, creating a persuasive graphic expression that testified to the superiority of the Roman Empire."[294]

For us, we need to try to explicate where and how Smart X, Smart Cities (as a subset of Smart X), and ambient ecumenes merge and adapt into the AEGIS.

> In 2002 N. Komninos in Intelligent Cities: Innovation, Knowledge Systems and Digital Spaces made an attempt to clarify 'smart city' idea resulted in 4 most exercised concepts revealed. According to that classification the 'smart city' presumes that either: 1. Elements of ICT are embedded in the city, or 2. A range of electronic

291 Llobera, Josep R, —Techno-Economic Determinism and the Work of Marx on Pre-Capitalist Societies , Man, New Series, Vol. 14, No. 2 (Jun., 1979), p 249

292 Wallerstein, Immanuel, The Modern World-System: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century. New York: Academic Press, 1976, p 231

293 Bergbohm, Carl, Jurisprudence and Legal Philosophy (Jurisprudenz und Rechtsphilosophie) 1892 pg 170, quoted in Georg Lukács' essay —Reification and the Consciousness of the Proletariat from History and Class Consciousness, http://www.marxists.org/archive/lukacs/works/history/index.htm

294 Martin-McAuliffe, S., Architecture as Palimpsest in the Athenian Agora. Scroope 19, 2009

applications is used for urban system enhancement, or 3. ICTs modify fundamentally life and work in a territorial unit, or 4. ICTs integrate spatially designed project for providing its innovative, learning and creative potential.[295]

So an urban environment, the ecumene which moonlights as episteme and efficient society, becomes an AEGIS when and if ICT gets embedded in the environment itself, when these embedded elements are widely perceived as enhancing the life of human agents living there, when these enhancements change how others live, and at the same time, are seen as achieving progress, innovation, and human potential. "In the Anthropocene the old simplicities are gone. We are no longer human subjects acting upon an objective nature 'outside' us. Nature and human are now bound together." [296]

The smart urban ecosystems rely on a particular type of system because its elements are intelligent, autonomous and flexible agents that often form communities,and also because of the way they adapt to added or removed elements[1]. The definition of an urban area as a smart ecosystem base on its community,which is an interactive organism and its environment. It is going for a series of complex networks created by the independence of resources[6]. Thus, the ecosystem can be described as an independent social system of participants, organizations, material infrastructure and symbolic resources[7]. Urban environments, thus comprise complex ecosystems involving different actors with specific needs and requirements, including health, energy, security, mobility and public services[297]

Like Athena's Aegis, our AEGIS represents the reinvented and revised urban space that encompasses both cliffhanging and life-improving technologies that are ambiently

295 Blagovidova, N.G. and Iudina, N.V., 2020, March. 'Smart city'system as an asset of cultural landscapes development. In *IOP Conference Series: Materials Science and Engineering* (Vol. 775, No. 1, p. 012007). IOP Publishing.

296 Garavan, M., 2015. Living in the Anthropocene–A Frame for New Activism.

297 Roblek, V. and Meško, M., 2020, June. Smart city knowledge management: Holistic review and the analysis of the urban knowledge management. In *The 21st Annual International Conference on Digital Government Research* (pp. 52-60).

linked. The smart city,empowered by four enablers namely, Internet of Things; Cloud Computing; Context-Awareness and Big Data, revisits this promise.[298]

> The smart city is a new concept of urban development. It is about improving the life quality of city dwellers by making the city more adaptive and efficient, using new technologies that rely on an ecosystem of objects and services. The scope covering this new mode of city management includes: public infrastructures (buildings, street furniture, home automation, etc.), networks (water, electricity, gas, telecoms); transport (public transport, roads and smart cars, carpooling, so-called soft mobility - by bike, on foot, etc.); e-services and e-administrations. [299]

At the core of this urbanised environment's ambient capabilities, IoT delivers what no other public technology before has – ubiquity at a granular level. This constant, real time and intensely focused stream of information which collates with an entire web of data to become a super summing system defines the AEGIS.

> IoT application concepts appear in many industry sectors with names such as Smart City, Smart Healthcare, Smart Building, Smart Home, Smart Grid, Intelligent Transportation System, Industrie 4.0, etc. – 'Smart X' for short. While these are diverse, they are all control systems in which smart devices couple the physical and cyber-worlds bidirectionally... Clearly, then, the ability to deliver secure, robust and reliable Smart X solutions confers a major competitive advantage.[300]

We must also consider that urbanised environments which converge into an AEGIS also integrate a robust constellation of applications. That obviously adds to the complexity of the system – the problems of which have been detailed before: "digital transformation is creating a data ecosystem with data on every aspect of our world

298 Faieq, S., Saidi, R., Elghazi, H. and Rahmani, M.D., 2017. C2IoT: A framework for Cloud-based Context-aware Internet of Things services for smart cities. *Procedia Computer Science*, *110*, pp.151-158.

299 Ainane, N., Ouzzif, M. and Bouragba, K., 2018, October. Data security of smart cities. In *Proceedings of the 3rd International Conference on Smart City Applications* (pp. 1-13)

300 Kearney, P. and Asal, R., 2019, July. ERAMIS: A Reference Architecture-Based Methodology for IoT Systems. In *2019 IEEE World Congress on Services (SERVICES)* (Vol. 2642, pp. 366-367). IEEE.

spread across a range of information systems. Data ecosystems present new challenges to the design of intelligent systems and System of Systems that demands a reconsideration of how we deal with the needs of large-scale, data-rich smart environments."[301]

> Applications are wide-ranging, and have variously been termed "Smart X", including Smart Homes, Smart Cars, Smart Factories (Industry 4.0), Smart Government, Smart City, Smart Grid, Smart Traffic Control, and many more. The concept of smart city arises from the need to manage, automate, optimize and explore all aspects of a city that could be supported and optimized by information technologies. The software paradigm IoT, being a core concept behind smart cities, is largely perceived as a collection of interconnected "things" within smart cities.[302]

But smart cities are also cities and while we have defined a Smart City as an ambient ecumene, the other does not necessarily hold. The ambient ecumene, while likely a city, can be any sufficiently complex smart tech enabled space that ties itself to a global system of informatics and data analysis. What makes these cities so likely to become an AEGIS? "In order to engage with urban issues at their root, we need to perceive of the built fabric of cities as an advanced, even intelligent, technology, and have that as our starting point for pursuing sustainability."[303]

> The [large city] is the site of processes fundamental to the political life of the city and the nation-state: the meanings and values of urbanity, modernity, worldliness, and nationality are formed within the mall space. Cultural styles and collective identifications are produced and mutually positioned. Consumption is profoundly

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301 Curry, E. and Ojo, A., 2020. Enabling Knowledge Flows in an Intelligent Systems Data Ecosystem. In Real-time Linked Dataspaces (pp. 15-43). Springer, Cham.

302 Kuryazov, D., Winter, A. and Schnberg, C., Towards collaborative smart city modeling. In *Tashkent: International Scientific-Practical and Spiritual-educational Conference to explore the importance of information and communication technologies in the innovative development of real sectors of the economy, TUIT* (Vol. 5, No. 5).

303 Colding, J., Wallhagen, M., Sörqvist, P., Marcus, L., Hillman, K., Samuelsson, K. and Barthel, S., 2020. Applying a systems perspective on the notion of the smart city. *Smart Cities*, *3*(2), pp.420-429.

political when it is a way to construct identities vis-à-vis one another in a social context. [304]

In the governance models proposed for Smart Cities we can find the underlying engines of technosocial dynamics. Termed triple and quadruple helix, these two models determine how public service entities manage and grow urban centres. We should not be surprised how the social inextricably merges with the technological.

Triple helix governance and attribute its neo-evolutionary character to three functions that shape the selection environments of the smart city knowledge economy: organized knowledge production, economics of wealth creation, and reflexive control. Reflexivity is not a given, but socially constructed by evolving communication systems and cultural settings. No doubt, the triple helix is a driver of complexity. All the more so is quadruple helix governance with the wide participation of users and multi-actor decision-making. [305] Moreover, the quadruple helix collaboration (the four major dimensions of strategy, technology, governance, and stakeholders,as well as their sub-dimensions) is a well-accepted form for agile pilots and smart city implementation.[306]

Again we see that scholars emphasise the complexity and the inherent social construction of both urban environments and the overlaid structures of a Smart City scheme. Multiply that exponentially as the specific city joins a global matrix of AEGIS driven cities and urban spheres, interwoven, complexly layered and connected, at times competing, at times interoperable: "Digital transformation is a complex and long-term process, which influences an organization's structures, processes, resources, capabilities,

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304 Laszczkowski, M., 2011. Superplace: Global connections and local politics at the Mega Mall, Astana. *Etnofoor*, *23*(1), pp.85-104.

305 Komninos, N., Kakderi, C., Panori, A. and Tsarchopoulos, P., 2019. Smart city planning from an evolutionary perspective. *Journal of Urban Technology*, *26*(2), pp.3-20.

306 Hämäläinen, M., 2020. A framework for a smart city design: Digital transformation in the Helsinki smart city. In *Entrepreneurship and the Community* (pp. 63-86). Springer, Cham.

and stakeholders. Digital transformation is all the more embedded in social areas that influence all aspects of human life."[307]

We thus are faced with the reality that Smart Cities and in fact any technology labelled Smart belongs within the rubric of the ambient ecumene. Moreso, when we consider how most urban centres are already deploying massive telecommunications and networking architecture which powers GISs. I"The accidental nature of smart city development and how the diverse processes and initiatives of smart cities are corralled within an articulated narrative to produce a more coherent sense of the smart city landscape forming."[308] In this fashion most cities are essentially a GIS in search of an ambient biome to grow and merge with its existing "dumb" and half awake tech to become "smart."

> In the future, a smart city may be considered the new normal, thereby implying that digital technologies and data are embedded in urban development. However, specific smart city or digital strategies might enhance digital transformation and clarify the governance and investment needs for the development of a smart city. In addition, a specific smart city strategy could consider how to integrate agile technology pilots with city-level strategic projects and procurements and, thus, also accelerate the socio-economic aspect of the development of a smart city.[309]

Summed up – we build without a plan, we design without control, we deploy and upgrade without understanding the black box, we expand without oversight of process, and we have no clue what will happen. In fact, we readily admit we have neither the technical nor sociological tools to properly understand the monstrously uneven and haphazardly constructed cyborgian society that comprises a Smart City.

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307 Hämäläinen, M., 2020. A framework for a smart city design: Digital transformation in the Helsinki smart city. In *Entrepreneurship and the Community* (pp. 63-86). Springer, Cham.

308 Coletta, C., Heaphy, L. and Kitchin, R., 2019. From the accidental to articulated smart city: The creation and work of 'Smart Dublin'. *European urban and regional studies*, *26*(4), pp.349-364.

309 Hämäläinen, M., 2020. A framework for a smart city design: Digital transformation in the Helsinki smart city. In *Entrepreneurship and the Community* (pp. 63-86). Springer, Cham.

> Few cities so far have developed smart city strategies or masterplans, and despite the projected hopes of urban operating systems, integrated control rooms, and smart city standards initiatives, the smart city will largely continue, we believe, to be accidental rather than by design. No doubt, integrating solutions, standards and strategies will produce a degree of coordination and interoperability, but it will not be able to tame and corral all the stakeholders, actors and technologies at play in the city into a unified whole. As such, the articulated smart city will always to be that, an articulation: a narrative to create a particular impression and to attract attention and investment. It will always remain to some degree accidental. [310]

Put another way by Rzevski, Kozhevnikov, and Svitek, we need to find a way to rethink the unthinkably deployed Smart architectures of future urban life.

> The transformation from a conventional to a Smart City is urgent because of the growing gap between the increased complexity of the political, social and economic environment of modern cities, on one hand, and the old rigid administration and technological infrastructure of cities, unable to operate effectively under the condition of complexity, on the other. Successful transformation requires re-thinking of the general concept of the Smart City as well as of its key elements. [311]

The Complexity of the AEGIS: Techne, Praxis, and Episteme

As we have seen, the present tools inside standard systems engineering and the attendantly new and growing field of technosociology lack sufficient perspective on what causes AEGIS formation. We know now that we don;t know and we see that even with the reislient and at times almost alien perspective of indigenous historiography, Abu-Lughodian world systems, and Marxist analysis we are left unsure as to where to

310 Coletta, C., Heaphy, L. and Kitchin, R., 2019. From the accidental to articulated smart city: The creation and work of 'Smart Dublin'. *European urban and regional studies*, *26*(4), pp.349-364.

311 Rzevski, G., Kozhevnikov, S. and Svitek, M., 2020, June. Smart city as an urban ecosystem. In *2020 Smart City Symposium Prague (SCSP)* (pp. 1-7). IEEE.

begin – save that we have clarity on how deep, how pervasive, and how sinisterly invisible these hegemonic forces are. We can therefore turn to one of the oldest tools – the reason and thinking of the ancient Greek philosophers coupled with Foucault and Abu-Lughod.

> For technology to cross the tool threshold, it needed to mimic human intelligence - which it did, and because of this we define technology by looking at its capacity of being episteme, techne and praxis. … The way modern technology was built and the way it works has come to transform itself into episteme, techne and praxis. Through its structure, it represents a set of knowledge used in a mechanical process of thinking; a process that is both praxis and technology, because mechanical thinking is technology; and in the end, technology is techne, it is the knowledge about different ways of doing something and through its storage capacity it is the way of accessing knowledge and it is the knowledge itself. [312]

We have seen the episteme before. Violent, coercive, a total unit of hegemony, the AEGIS and the episteme are overlapping entities. Indeed an ecumene and episteme might the the cultural and mental mirrors of one another's' terrains. As we will see, we have established the parameters of what is sayable, what is knowable and what can be excluded from the discourse. We have engaged somewhat circuitously in achieving techne and praxis within the episteme.

> As deployed in two of Foucault’s works, The archaeology of knowledge (1972) and The order of things (1973), an episteme is a unique gathering of various, dispersed discursive formations under a large, shape-shifting umbrella. These discursive formations mutate, change, shift and are displaced but retain a shared correlation to the organizing epistemic framework, thus constituting the knowledge, objects and practices of a particular historical period. Through the mobilization of discourses and practices[*techne and praxis*], the episteme constitutes particular boundaries, which

312 Gavrilov, D., 2021. THE 21ST CENTURY AS TECHNE, EPISTEME AND PRAXIS. *Revista Universitară de Sociologie*, *17*(1), pp.112-124.

often go unchallenged. Accordingly, an episteme defines what is sayable, what is knowable, what is included, and what is excluded from possibility within a particular epoch. [313]

We must now begin to delve into a specific kind of episteme. The biome unit of the AEGIS, the digital episteme, the data episteme, the IoT and Smart episteme which themselves overlap in meaning and function:

> "Dividualization," a term originally popularized by Gilles Deleuze, refers to the decomposition of the individual into a variegated series of numerical attributes and dimensions (e.g., scores, ranks, or features) that prediction. The challenge, in 1915, was the lack of data—beginning with the consequent development of information theories and cyberneticians' research, the eventual development of digital technologies would solve this through the management of complex data sets, or what is, today, colloquially termed "Big Data." Today's "data episteme" is an epistemology where "the need for more and more data is the spawn of data itself"[314] … data, therefore, does not simply facilitate forms of communicative interaction but "functions as locales for a politics of fastening that is irreducible to a politics of communication" (188). Koopman's genealogical approach to algorithmic data qua public health and knowledge practices demonstrates that "surface politics" such as human welfare projects and official policies are, in fact, brimming with politically dormant exigencies. [315]

We also face the paradoxical reality that affective algorithms, for all their attention to fulfilling human needs, do not actually "feel" anything. They are designed to deliver an experience that mimics what humans expect and through AmI, to responsively improve how and when they answer the call for social support. They do not however provide

313 Adams, K.F., 2012. The discursive construction of professionalism: An episteme of the 21 st century. *Ephemera: Theory & politics in organization*, *12*(3).

314 Erkan, E., 2020. The Depth Conditions of Possibility: The Data Episteme. *Theory & Event*, *23*(2), pp.496-500.

315 Erkan, E., 2020. The Depth Conditions of Possibility: The Data Episteme. *Theory & Event*, *23*(2), pp.496-500.

networked constellations of support – they do not enrich the social ecumene. Instead an AEGIS reifies itself. As some scholars will suggest at the direct expense of the mother culture that built it.

> Epistemologically, algorithms 'see' space differently and hence act upon it differently. They ignore the historical, cultural, and social contexts within which roads are embedded. This lack of 'embeddedness' (Polanyi 2001) creates an image of space which comes into clash with how other major, mostly human, actants perceive and experience space. Politically, algorithmic spatiality reshuffles the arena of power struggle between different actants over that right to shape space, where institutional and human actors engage directly with a technological agent.[316]

> [challenging these arenas of power] entails exposing and unlearning existing dominant arrangements that structure urban learning practices and ideologies, whether in relation to gentrification and revanchist neoliberalism, or exclusive pronouncements of the 'smart/creative' city. As Neil Brenner (2009: 199; and see Marcuse, 2009) has argued, this aim of unmasking the "myths, reifications and antimonies that pervade bourgeois forms of knowledge" about capitalism, and offering alternatives, is central to the whole project of critical urban thought. [317]

At the same time that we have a divorced relationship from the algorithmic logic impelling our ecosystems, we have an overwhelming flood of raw data that requires Smart systems to pre-digest and analyse the information before we can grasp it.

> The infosphere as a complex "environment constituted by all informational entities (and) thus including informational agents as well, their properties, interactions, processes, and mutual relations." Floridi's infosphere also clearly extends beyond the confines of what is digital and what is human to include all types of environmental

316 Fisher, E., 2020. Do algorithms have a right to the city? Waze and algorithmic spatiality. *Cultural Studies*, pp.1-22.

317 McFarlane, C., 2011. The city as a machine for learning. *Transactions of the Institute of British Geographers*, *36*(3), pp.360-376.

information and all types of software-based agents, those powering social media algorithms and those driving autonomous cars. [318]

By absorbing these new paradigms into our sense of humanity, we have essentially flipped the model and made the AEGIS an extension of the human biome, akin to a biological colony that interacts with the bacteria and nerve impulses of the human agents it touches like neurotransmitters. IoT acts like nerve cells or reflex nodes.

> The Internet of Things model dramatically flips the table on canonical information systems approaches. Instead of a handful of very powerful "intelligent" devices, be these mainframes, notebooks, or even multi-purpose smartphones, it postulates billions of computationally weak objects specifically designed and engineered to accomplish one single task, sense the temperature, measure an increase or decrease in the amount of light, but that can leverage the computational and informational capacity distributed throughout the network (Rose 2014). In terms of its topology (Benyon 2014, p. 80), the Internet of Things can be considered a system of systems interconnected at different scales.[319]

Like neurotransmitters, the data supplied has natural biological limits. Human agents prove to be excellent decision makers us poor learners in real time. We opt quickly, remember more slowly, consolidate and excel slowest of all. Tacit knowledge – that which we know implicitly and comes from complex experience – represents the most significant neurological transferable asset human to human. Ergo, the most affectively sought after capability in an AmI powered system of systems.

> It was more difficult to transfer tacit knowledge than codified knowledge, suggesting that tacit knowledge requires more motivation, effort, and ability to transfer than codified knowledge. To the extent that informal networks affect individual

318 Lacerda, F., Lima-Marques, M. and Resmini, A., 2019. An information architecture framework for the Internet of Things. *Philosophy & Technology*, *32*(4), pp.727-744.
319 Lacerda, F., Lima-Marques, M. and Resmini, A., 2019. An information architecture framework for the Internet of Things. *Philosophy & Technology*, *32*(4), pp.727-744.

> motivation, effort, and ability, our findings suggest that an individual is more likely to exert greater effort to transfer knowledge to a close personal contact, and an individual who is surrounded by a diverse network is better able to transfer knowledge. Strong interpersonal connections within a dense network cluster ensure that knowledge will diffuse quickly within that cluster. A bridging tie between clusters enables diffusion across clusters. When knowledge is simple, the presence of a bridge is both a necessary and sufficient condition for knowledge to diffuse across it...projects and assignments that limit network range can trap an organization into existing routines and practices. When projects bring individuals from the same area of expertise into contact, those individuals do not gain experience transferring what they know to people out- side their area of expertise. Because it is easier for people to transfer knowledge to contacts inside their area of expertise, however, this network configuration can be effective in the short term.[320]

As the Abu-Loghodian model demonstrated, when we think from an efficient society / indigenous viewpoint, we create a lens by which we can step outside the complex society and see it as a world system (ecumene) that manages critical resources for economic and social benefit. Specially, it allows us to see that the prime beneficiary will not be individuals but the ecumene itself. The world systems feeds and refines only the world system. Individual biome components within live, thrive, and die out as natural mechanisms of a larger stacking of systems within and upon systems. "Geography and social networks intersect and intertwine to produce many effects associated with urban neighborhood ecology: they work in concert to influence social behavior. The importance of the corner and the crew remained even when considering higher order network processes and neighborhood structural conditions."[321] These neighbourhoods can be literal urban sectors or portions of networks. Reserach into

320 Reagans, R. and McEvily, B., 2003. Network structure and knowledge transfer: The effects of cohesion and range. *Administrative science quarterly*, *48*(2), pp.240-267.

321 Papachristos, A.V., Hureau, D.M. and Braga, A.A., 2013. The corner and the crew: The influence of geography and social networks on gang violence. *American sociological review*, *78*(3), pp.417-447.

epistemic violence reveals locality matters – that our core premise, paraphrased crudely, that the system will eat its own young to survive turns out to be especially true within urban social systems.

> The central idea of such research is that neighborhood social institutions and actors are interdependent; that is,the social networks of individuals and groups (whether prosocial or deviant) reach beyond neighborhood boundaries and therefore facilitate the spatial contagion of homicide. network structures similar to the ones presented here provide a basic means to test the applicability of structural balance to intergroup violence in a modern urban context... Moreover, homicides, as well as other negative interactions such as hostile takeovers or warfare, may require a reformulation and interpretation of standard network measures of centrality, power, and cohesive subgroupings.[322]

In this arena of violence we again see how an invisible technosphere allows epistemic hegemony and through that focused attacks, force, and social coercion to achieve social cohesion and social consensus. These are sociological rules that extend into technology and with the AEGIS, the technosociology seems clear: urban spaces coupled with oppressive algorithms will super sum violence. Though it may not be literal – it can social, economic, or cultural rather than direct criminality.

> One significant implication of this online hyperconnectedness to mediated violence is that it further diminishes the relative influence of an individual's immediate offline social environment on their attitudes towards violence. In a hyperconnected network society, perceptions of distance are increasingly dictated by participation in digital networks such as fight pages. As Mejias (2013: 97) summarizes, 'the notion of the near as what is spatially proximal is being remodelled into the notion of the near as what is socially proximal – what we feel is relevant to us socially, regardless of whether it is spatially near or far'. This displacement of the spatially near by the socially near

322 Papachristos, A.V., 2009. Murder by structure: Dominance relations and the social structure of gang homicide. *American journal of sociology*, *115*(1), pp.74-128.

has not gone unnoticed within criminology. Drawing upon Castells' (1996) concept of 'spaces of flows' and mobilities theory (see Lash and Urry, 1994), Aas (2007) has similarly observed that global networks and flows of information have challenged conceptions of community, culture and society underpinned by geographic locality [323]

Capitalism's creative destruction cedes to the Smart City's coercive disruption and to the wired urban space's spatially directed violence. The more we embrace innovation without safeguards, the more we freely merge unknown information science with our personal data and personal lives, the more heavily we merge the episteme and ecumene. Injustices spatially align and the shared world downloads our own prejudices, fears, and social unrest into how it operates. *Cracks in the Sidewalk: Tactics and discourses driving the "smart city"* outlines just such an intersection in the extended quote attached below liking Foucault with the wider array of Smart City scholarship.

Postmodern philosopher Foucault (1972) traced how space, knowledge, and power intersect in ways that may be empowering or oppressive (Crampton & Elden, 2007). Soja (1980) describes this as the socio-spatial dialectic, with space, society and history being "mutually constitutive" (p.18). Sanders (1990) and Ruddick (1996) extend this work to demonstrate how "the interlocking violence of racism, patriarchy, heteronormativity, and capitalism constitute a spatial formation" (Mollett and Faria, 2018, p. 566) – the structural forces that generate inequalities and injustice (Young, 1990). This can be evidenced through the disastrous effects of discriminatory planning tools and policies such as Jim Crow laws, exclusionary zoning, and urban renewal/clearance projects that have been used against African-American and minority communities for over a century (Thomas and Ritzdorf, 1997). As demonstrated, injustice is manifested and maintained through space... Technology companies have a vested interested in supporting what Lefebvre called a "bureaucratic society of controlled consumption", in which the state and the market

323 Wood, M.A., 2017. Antisocial media and algorithmic deviancy amplification: Analysing the id of Facebook's technological unconscious. *Theoretical Criminology*, *21*(2), pp.168-185.

are enmeshed in every aspect of normal urban life (as cited in Soja, 2010, p.96). In many ways, technology companies have achieved this; it has become increasingly challenging to participate in society without encountering a screen, an app, something "personalized", or "smart". For the first time, people have shifted from "using technologies to interacting with them", and have become adapted to life within an environment mediated by technology (Jewell, 2018[324]

This discourse when seen through our wider lens becomes more apparent and while it may not result in muggings and murders, the systemic injustices and small aggressions that do reduce lifespans and harm the well being of people living within the city become clear. This alone has value. We have seen enough to recognise unseen forces at work and with our deep awareness of our limited view into the black box of AmI algorithms as well as only partial clarity on how and why emergent systems program themselves, we have can begin to dissect the systems involved in producing Smart objects and thus engendering the creation of an AEGIS.

Smart cities run on data and the ability to collect, store, and process it. This blurs the lines between public and private, and sets up the conditions for ubiquitous surveillance– all in the name of sustainability. The only opt out option available regards whom your data gets shared with, not that it is collected in the first place. The findings show that smart cities have the potential to to exacerbate the inequity which already exist in cities, even reaching to a new wave of technocolonization. [325]

Technocolonisation may sound extreme but there have just such allegations thrown at the GAFAM Big 5. Their social heft and economic power allow them to not only limit governance and oversight into their technologies, but to determine socially how we precise and use their products. Products which prior sections have shown are neither neutral nor necessarily safe for human use. " search engines create representations and

324 Rahman, K., 2019. Cracks in the Sidewalk: Tactics and discourses driving the "smart city" development of Quayside.

325 Rahman, K., 2019. Cracks in the Sidewalk: Tactics and discourses driving the "smart city" development of Quayside.

discursive structures: algorithmic driven software rather than make supposedly neutral mathematical decisions perpetuate prejudices and enforce power structures."[326] Thus we see products with inbuilt violence attached through the discursive hegemony of the commercial and social forces that built them.

> Administrative violence describes how administrative systems facilitate state violences encoded in laws, policies, and schemes that arrange and define people by categories of indigeneity, race, gender, ability, and national origin (Spade, 2015: 20–21). Throughout his work, he shows how data and administrative systems construct the very identities and categories presented to us as "natural," both inventing and producing meaning for the categories they administer., we can extend these insights to cover a range of processes of classifying, sorting, bounding, labeling, and optimizing enabled by data technologies, both state-run and privately controlled. This extension is necessary as the boundaries between state and private sector data collection, processing, storage, and application are hardly distinct—and perhaps never were. For example, states regularly consult data created and maintained by private Internet companies.[327]

We have narrowed down our search to this: how can we find the violence in the system? While that may seem overly simplistic, it gives us a foothold to overturn algorithmic stones seeking wider and more complex answers to larger questions of reality, perception, epistemic violence, and shared consensus that becomes an ecumene. We start with who gets hurt and who hurts them. Who wins and who loses? Who makes money and who loses it in a Smart City?

> Violence is, among other things, political—that is, it functions as a kind of disciplinary, regulatory, and hierarchicalizing force (Aldama, 2003: 6). In some

326 Galliah, S.A., 2019. Algorithms of oppression: Safiya Umoja Noble's powerful exploration of search engines' underlying hegemony and their racist, sexist practices. *The Liminal: Interdisciplinary Journal of Technology in Education*, *1*(1), p.9.

327 Hoffmann, A.L., 2020. Terms of inclusion: Data, discourse, violence. *new media & society*, p.1461444820958725.

instances, violence's political function is discharged materially—for example, in the form of militarized law enforcement agents, maldistributions of economic resources, or (at its most extreme) pro- grams of genocide. In other instances, it is discharged discursively in the form of norms, patterns, or "ways of being" that inform one's vulnerability to other, more direct material and symbolic violences. Perhaps, most forcefully described by Frantz Fanon, violence is both contingent upon and constitutive of social and political norms through which certain actions, identities, or ways of being came to be understood as deviant or "wrong" in the first place.[328]

In an urbanised setting that propels an AEGIS, that hegemony fusing episteme with ecumene sits on a foundation of algorithms programmed to provide emotionally fulfilling affective computing in real time: AmI. Thus we can narrow the focus even more. We know that no singular system component matters as much as how these systems super sum to something ambient. The nature of the ambient systems curation and inbuilt prejudices, its normalisation of a stereotypical way of being represents the key danger to human agents and oddly, the key positive feature of the AEGIS. To the extent that these systems respond to individual users, they can outgrow the discursive limits of their programs, making new better and different systems within systems that cater to the non-normative members of societies. Articles like *Geographies of algorithmic violence: Redlining the smart city* directly address these issues:

> 'Algorithmic violence refers to the violence that an algorithm or automated decision-making system inflicts by preventing people from meeting their basic needs'. Her definition is broad, including micro-level occurrences (for example, when online advertisers store information of users who click) to macro-structural incidences that stem from predictive models that determine the (over)policing of communities. Like Onuoha, I am concerned with how algorithmic violence is perpetuated through structures—ideologies, legal systems, institutions and economic systems—as well as

328 Hoffmann, A.L., 2020. Terms of inclusion: Data, discourse, violence. *new media & society*, p.1461444820958725.

through space. As Nicholas Blomley (2003: 123) argues, ‘violence has a geography’— it takes place in space, turns on particular spatial representations and imaginings, and in doing so makes space.[329]

False positives and negatives can poison a system. Generally with a large enough sample set, the software algorithms can find program paths that round out the errors and predict right / wrong go/ no go with better than 99.9% accuracy. In six sigma they need to make less than 3 errors per million. But in a city of 10 million, that translates to algorithmic violence against 30 people a day, hour or second. So there needs to extended safeguards and governance related to software mistakes in Smart City environments.

Statistically, the use of outlier algorithms is a problem, as all data and types of data are potentially relevant, resulting in an infinite number of variables. When the number of possible correlations increases dramatically, it is both problematic and time-consuming to find and locate the central and critical correlations. It can be difficult to define and delimit what is normal as opposed to the outliers. Often, what is normal is dynamic and changes over time; often, the data material in various data dimensions will generate various groups of normal versus outliers; and often, it will be difficult to distinguish outliers from data noise. You look for a pattern, but this assumes that you have systematic knowledge about what you are looking for based on a recognized or unrecognized pattern (Everitt, *et al.*, 2001), because the method is by definition a causal As Xu and Wunsch also suggest regarding the use of the subjectivism of outlier algorithms, once a proximity measure is determined, clustering could be constructed as an optimization problem with a specific criterion function. Again, the obtained clusters are dependent on the selection of the criterion function. The subjectivity of cluster analysis is thus inescapable [330]

329 Safransky, S., 2020. Geographies of algorithmic violence: Redlining the smart city. *International Journal of Urban and Regional Research*, *44*(2), pp.200-218.

330 Munk, T.B., 2017. 100,000 false positives for every real terrorist: Why anti-terror algorithms don't work. *First Monday*.

By nature of discursive hegemony, the natural or perceived right way to be or do something becomes the correct statistical curve and outliers get ignored, crushed, or violently repressed. In a society that has allowed amoral technical systems to handle social support operations that can present obvious problems:

> The problem with predictive analytics is that it lacks hermeneutic intervention and interpretation, it is historical and lacks an architecture for learning and a dynamic negotiation of its own sorting rules. This has been termed the stasis problem , *i.e.*, a lack of efficiency in profiling and modelling of the future due to the fact that predictive algorithms project the past and thus assume that the past categorically equals the present. Predictive algorithms are therefore not suitable for open, dynamic systems with complex causal links in which the future differs from the past and which require new or dynamic categories (Silver, 2013). The problem arises when the model potentially becomes a reality-creating model that creates the reality it claims to show and predict neutrally . The overlooked consequence is that the measurement itself becomes an intervention in the world, corrupting the indicator and creating a new ontology of possible futures. This gives it a normative function, taking the form of algorithmic, generative rules that exert power over the possible futures. In the words of Lash: 'Algorithmic generative rules are, as it were, virtuals that generate a whole variety of actuals'. This reality-creating problem is compounded by the fact that predictive algorithms are often associated with institutional abuse of monopoly power and lack of transparency and neutrality... [331]

The most exponential complex predictive algorithms continue to be emergent ones, primarily for AI and AmI subsets. That we can now link them directly to institutional monopoly whose hegemony prevents transparency and neutrality speaks to the social and political nature of the AEGIS. "People do criticize the withdrawal of services and initiation of urban greening projects, for example, but they rarely critique the algorithmic

331 Munk, T.B., 2017. 100,000 false positives for every real terrorist: Why anti-terror algorithms don't work. *First Monday*.

and classificatory systems that facilitate exclusion, disconnection and expulsion. Data production has a politics. Data and algorithms are two sides of the same coin. Without data, algorithms are useless. The outputs of algorithms reflect the politics of the data that are put into them." [332]

Consider the obviously neutral and scientifically unremarkable field of weather prediction. What possible politics can be played with whether we will have a Category 2 or Category 4 Hurricane? Or if we have a warming climate or not? As it turns out, quite a bit can be contested or achieved through even these simple software programs.

> Our argument is not about whether climate governance itself has become hegemonic in some form (cf. Wainwright &Mann, 2015), but rather that as thinking algorithmically assumes an increasingly dominant role within climate policymaking, it produces a hegemonising effect on knowing and acting on climate change. Our use of the term"hegemonising"points not just to the existing dominance of a particular way of thinking (hegemonic), but explicitly signals the active pro-cess of marginalising other forms of knowledge through which hegemonic status is achieved. This perspective, drawn from Laclau and Mouffe (1985), goes further than identifying historically contingent assumptions about the world that shape what counts as scientific climate knowledge and common-sense governance responses (cf. Foucault's"episteme") and high-lights instead a more explicit struggle for power that takes place through exclusion. An emerging line of political ecology research draws from Gramscian approaches to hegemony to examine possibilities for coalition in environmental politics and hegemonic struggle, including via the terrain of science. Our concern is how hegemonic knowledge power relations squeeze out other ways of doing climate governance. As such, we concur with Edwards' worry over the narrowing effect of climate change knowledge infrastructure, particularly in how

332 Safransky, S., 2020. Geographies of algorithmic violence: Redlining the smart city. *International Journal of Urban and Regional Research*, *44*(2), pp.200-218.

it"makes other ways of life extremely difficult to maintain" and we seek to expand on the political implications of this hegemonic trait [333]

Hegemony itself requires a concerted effort to recognise precisely because its enforcement mechanisms are consensus and epistemic violence overlaid by the veneer of a certain accepted way of being. With an AEGIS the mechanisms are hidden in plain sight, IoT and attached systems, data centres, telecommunications nodes, power grids, and WANs which interlock public and private spaces.

This ubiquity, and the connectivity it promises through measuring, monitoring and calculating, offers a 'predictability of routine' as a high point of progress. Mbembe's concept of the 'banality of power' offers a conceptual vehicle for gaining insight into the routineness in the use of smartphones by ordinary citizens to the use of drones to surveil, monitor, govern and discipline. This routineness has been normalised as mundane and banal, and therefore unspectacular and depoliticised. But routine is not the only banality. It is the interspersing of routine with sporadic and concentrated acts of soft power and brute force that makes the smart city an embodiment of state governmentality from the global north to the global south.[334]

As scholars will argue, the very banality and routine aspect of huge tech giants pervading urban spaces with their "gifts" of monopoly products, addictive social media, neurologically short circuiting ambient software, mass marketing that becomes propaganda, and the economic power to exert undue political social influence of the decision makers who buy and deploy urban infrastructure represents clear discursive violence, an epistemic coercion that stems from colonial practice and which through technology has become a neocolonial project.

The smart city is in itself a territorial colonisation of the digital age. It has emerged from the colonisation of urban space and postcolonial subjectivity through digital

333 Machen, R. and Nost, E., 2021. Thinking algorithmically: The making of hegemonic knowledge in climate governance. *Transactions of the Institute of British Geographers*.
334 Datta, A. and Odendaal, N., 2019. Smart cities and the banality of power.

technology, and the symbolic violence with which this relationship is legitimised, maintained and developed. The smart city is a spectacle of postcolonial anxiety materialised in territory. It is also constructed through the geopolitical relations of colonialism, capitalism and globalisation, produced by the legacies of colonial instructions, their knowledge systems, norms, practices and discourses, and thus emerges as a new colony of capital accumulation. Its banality is present in the routinised use of big data and digital technology, its grotesqueness is characterised by the routinisation of the moral state, its relations of production, its dissemination and ultimate subordination of citizens and democracy that stretches across spaces, scales and territorial boundaries. [335]

Emergence Revisited: The Episteme and The Ecumene

When we stared this journey we began with data and its implications: "The World Economic Forum reports that in the year 2020, the global quantity of data is expected to reach forty-four zettabytes, or 1,0007 bytes. This amount is forty times greater than the number of stars in the known universe."[336]

Personal data and the ambient world have collided. We know to what depths and in what degree these extraordinary mechanism can engage human agents and at the same time subtly control them. Through extensive technosociological theory and attendant historiographic support, we've outlined some core methods to intelligently critique the systems of systems of biomes of systems of smaller systems, a mobius strip of endless emergent algorithms feeding and augmenting one another seemingly without limit or prime causation.

Law, techne and praxis: the digital code is becoming a form of regulation that is making private actors link their values to technological artefacts that prove capable of

335 Datta, A. and Odendaal, N., 2019. Smart cities and the banality of power.

336 Stamm, E., 2020. *Hallucinating Facts: Psychedelic Science and the Epistemic Power of Data* (Doctoral dissertation, Virginia Tech).

conditioning their actions at a material and moral level. Consequently, norms in the sense we are giving them here must be considered as regulatory tools that make use of algorithms to regulate, whether directly or indirectly, the behaviour of the subjects they refer to. Norms and technologies therefore form a complex relationship, interacting through a system of dependencies and interdependencies that contribute to the regulation of individual behaviour to a greater or lesser extent.[337]

The unprecedented diffusion of information technologies and the globalized network have contributed to the creation of a new environment for human beings and their behaviour, whose rules are implemented in algorithms. Just as any other technological artefact, this algorithm reflects different kinds of choices, especially in the political domain [Christian B., Griffiths T., 2016]. The algorithm can, therefore, form the basis of a new construct capable of conditioning individual human actions through the use of technological tools... in a nutshell, it is possible to describe the relationship between regulators, norms and algorithms in terms of conflicting energies: whereas regulators try to control socio-economic dynamics with their rules, algorithms can create regulations that have their own legitimacies if they have been previously legitimized by the public sphere from which they take their binding force.[338]

How deeply do these regulatory legitimacies go? We have seen that the invisible hand of ambient tech relies on very complex software and supporting hardware (servers, IoT, networking) to provide real-time updates and to emergently engage human agents with ever more sophisticated affective computing. We must assume that these networks of AI, eavh with its own algorithmic design, represent something primary and at times almost fundamental in human behaviour. How else to mimic and mirror their agents?

337 Dorigo, S., Lombardi, E.M. and Longo, E., 2020. The Phenomenon of the Algorithm and Its Impact on the EU Legal System: an Attempt at a Multidisciplinary Approach. *Legal Issues in the Digital Age*, *3*(3), pp.3-34.

338 Dorigo, S., Lombardi, E.M. and Longo, E., 2020. The Phenomenon of the Algorithm and Its Impact on the EU Legal System: an Attempt at a Multidisciplinary Approach. *Legal Issues in the Digital Age*, *3*(3), pp.3-34.

This is what Simondon means when he designates signification before language (i.e., it is 'prelinguistic‘), where intensity is precisely that which allows for reaction. In their being non-representational, deep learning neural networks are, similarly, prelinguistic. Consider how deep learning systems like AlphaGo Zero use previous data as a signal-processing heuristic to predict future variances.45 Simondon‘s notion of transindividuation, as applied to the bacterium, is not terribly different from how deep learning algorithms like AlphaGo Zero pluck certain pertinent data to ‗train‘ themselves by way of patterned-reinforcement learning.46 Just as sugar serves as the basic observational empirical data for the bacterium, for predictive patterning there exist protocol statements/propositions. With machine learning, the probability of any hypothesis is not determined a priori but determined by way of conditions and implementations... 'deep learning‘ algorithms, as recently exemplified by advancements in reinforcement-learning AI (such as AlphaGo Zero), seem to 'experience‘ data opportunistically. Such deep learning software are able to decisively re-integrate evaluative metrics that deviate from a sample-proportion. [339]

The same deep learning neural nets also suppress the whole of a data stream to refine and deliver something intelligible to the user. At times this has been criticised as either hegmonically motivated or tailored to be addictive. While both are true, there's also the systems engineering reality of human neurological constraint. Our brains cannot handle information at the speed and density of machines. We make better more complex choices but we process only a fraction of a fraction of what a network of even simple AI linked machines can. Ambient systems that achieve affectively drive AmI far out perform humanity in every kind of data enable task. “Algorithms structure how we can see a concern, why we think it probably matters , and when we might act on it.”[340] We must rely on them to think for us when it comes to data narratives.

339 Erkan, E., 2020. A Promethean Philosophy of External Technologies, Empiricism, & the Concept. *Media Theory*, *4*(1), pp.87-146.

340 Westlund, O. and Lewis, S.C., 2017. Four conceptual lenses for journalism amidst big data: Towards an emphasis on epistemological challenges. Bloomsbury Publishing, New York.

The growing deployment of algorithms and automation in journalism might entail new arrangements of 'networked expertise', altering how we imagine what it is that journalists know and how they represent that knowledge to the world. In this vein, Anderson (2013b) has shown how the dividing lines of expertise between 'original' reporting and 'parasitic' news aggregation are hardly clear-cut. In fact, networks of social actors and technological actants, when viewed holistically, yield rather complicated renderings of journalistic expertise under diff erent conditions of digitization. Ultimately, as human expertise is increasingly inscribed into technical systems used for news production and news distribution, it challenges what is 'human' and what is 'machine' about such expertise [341]

That dependence has roots in the digital episteme whose suppressive nature not only curates what we can see and act upon but what we no longer see. Epistemic violence as detailed by the many scholars cited represents the most incisive yet invisible of mechanisms, taking Fanon's ways of being to a full their full discursive power. As we rely on ambient systems they will extinguish the capability and reach of non-AI enabled support systems. By nature of what we have designed to help us, we have created in AmI the most effective form of self affirmed hegemony possible: a system that learns from us how to better manage our own biases, prejudices, social inequalities, and social violence. A system built on systems which study human behaviours at the non verbal and pre-verbal level, which tap into our lizard brain and perceptive matrix of sensation before we have the time and freedom to form full thoughts 100-700 seconds later.

As it suppresses non-digitizable knowledge, the data episteme also implements what Foucault conceptualizes as "knowledge-power," a term which affirms the fact that there is no meaningful difference between knowledge and power. Here, "power" may be defined as the power to promote but also to retract conditions on which

341 Westlund, O. and Lewis, S.C., 2017. Four conceptual lenses for journalism amidst big data: Towards an emphasis on epistemological challenges. Bloomsbury Publishing, New York.

phenomena may exist across all sites of social, intellectual, and political construction. I write that the data episteme seeks to both nullify the preconditions for negative thought and to naturalize the possibility of an infinite expansion of human mental activity, which in turn figures mentality as an inexhaustible resource for the commodity of digital data. The data episteme therefore reifies the logic of ceaseless economic proliferation, and as such, abets technologized capitalism. In the event that the data episteme fulfills its teleological goal to become total, virtually all that is thinkable would yield to economic subordination.[342]

The teleology of self reification and erasure of all other forms of being and knowing has been the ideal of many hegemonic systems. In the extreme it enshrouds hideous ideals like fascism and ethnic cleansing in a self affirming fabric of limited knowing, extended mythology, and the ever present curation of social narratives. "The data episteme will become total when all non-digital phenomena cease to have any epistemic significance — that is, when they cease to exist as informants to knowledge. This event, to be sure, will not come to pass in practice. As a theoretical possibility, however, it represents the terminus of the epistemic problems presented by Big Data."[343] The removal of social support for all 'other' formats and the real-time ability to direct human agents towards the desired or pre-selected outcomes give designers and their commercial signifiant control over their customers.

We have in our analysis created the tools needed to show ourselves where and when these systems of oppressive control invade the AmI's basic functionality. More than that, we can set emotional distance from the emotionological programming and recognise that inherent to even the most basic programs and application designs are biased. Even their language choice (English as the dominant language for example), forms of payment

342 Stamm, E., 2020. *Hallucinating Facts: Psychedelic Science and the Epistemic Power of Data* (Doctoral dissertation, Virginia Tech).

343 Stamm, E., 2020. *Hallucinating Facts: Psychedelic Science and the Epistemic Power of Data* (Doctoral dissertation, Virginia Tech).

(bitcoin, paypal, traceable bank payments, credit cards, etc.) and choice of cloud providers makes a difference (AWS, Google, Oracle, a national or private cloud). The application itself may provide services who fit a given narrative. UberEats delivers food using the gig economy – it also cuts down on table service, underground tipping in cash, undercuts restaurants, prioritises fast food and fast casual concepts, and establishes the radius of urban spaces by where it can or cannot deliver. All for an app we know does good things for a lot of people – but has inherent biases that included and exclude certain lifeworlds, building into the urban ecumene rules and limits that when merged with the hundreds of other coterminous software and services relying upon infrastructure, define the contours of the AEGIS. To counter this we need to find ways to flip the paradigm and define better limits and pro-collaborative, pro-democratic bases into products and services.

> Whilst it is undeniable that some innovations are the products of intentional creative acts of genius; we should also recognise that they can also be the product of lucky errors, novel recombinations, and chance insights that arise through the social interconnectedness of a community of enquiry across time. Like Henrich, Tomasello emphasises how cooperative our species is in comparison to other primates (also see Dean et al 2012 for a nice set of comparative experimental results demonstrating this). He differentiates between two kinds of collaboration: [1] actual collaboration that takes place in the synchronic temporal plane; and [2] virtual collaboration which takes place across historical time (1999 : 41). The capacity of humans to collaborate virtually across generations allows us to tackle problems that would otherwise defy us – e.g. cognitive tasks that involve regularities occurring at temporal scales that would otherwise be invisible [344]

We do this by showing the present systems' inherent flaws, seeking better options. “The problem space in which a new paradigm is put forward involves an epistemic

344 Gillett, A.J., 2018. Invention through bricolage: epistemic engineering in scientific communities. *RT. A Journal on Research Policy and Evaluation*, *6*(1).

environment that has been extensively engineered through the perceived failures, inexplicable empirical findings, and other conceptual issues of the previous paradigm."[345] One potential option for mutual intelligibility between thinkers and designers - as well as technosociologically savvy system engineers – will be to define an AEGIS as an intellectual and scientific trading zone. "The trading zone is a place of interaction in which a hybrid community seeks ways to communicate, often through new forms of interlanguage. Trading zones can thus be the springboard for new institutional structures and new categorises of knowledge."[346] This allows us to define epistemic virtues as cognitive goods: "Epistemic virtues can be conceptualized as epistemic norms and values that are internalized and acted upon."[347] In these trading zones we can use our technosociological understanding to create cognitive goods – merging epistemic virtues with tools for empowering human agents within a digital ecumene.

> Cognitive goods are the shared epistemic tools of knowledge-making disciplines that can be transferred across disciplinary boundaries. Examples of cognitive goods include methods, concepts, models, metaphors, formalisms, principles, modes of representation, argumentative and demonstrative techniques, technical instruments... Cognitive goods can move around, sometimes as objects of negotiation and transaction; at other times they are shared or simply copied. The notion of 'good' connotes an economic perspective, from which it is natural to distinguish between phases of production, circulation and consumption. The flow of cognitive goods is a form of circulation that occurs with the purpose of knowledge production. [348]

345 Gillett, A.J., 2018. Invention through bricolage: epistemic engineering in scientific communities. *RT. A Journal on Research Policy and Evaluation*, *6*(1).

346 Bod, R., Dongen, J.V., Hagen, S.L.T., Karstens, B. and Mojet, E., 2019. The flow of cognitive goods: A historiographical framework for the study of epistemic transfer. *Isis*, *110*(3), pp.483-496.

347 Stevens, M., Wehrens, R. and de Bont, A., 2020. Epistemic virtues and data-driven dreams: On sameness and difference in the epistemic cultures of data science and psychiatry. *Social Science & Medicine*, *258*, p.113116.

348 Bod, R., Dongen, J.V., Hagen, S.L.T., Karstens, B. and Mojet, E., 2019. The flow of cognitive goods: A historiographical framework for the study of epistemic transfer. *Isis*, *110*(3), pp.483-496.

As we began this technosociological discussion, we had in mind the notion that technology co-creates value with its human designers and that the economic and social upheaval that follows can be transformative if planned or disruptive if unplanned or uncontrolled. With AI driven ambient environments, we have now the dual edged sword of epistemic control, where the very nature of hegemony has become a fused reality of technology, sociality, perception, economic force, and urban infrastructure. Within a fully formed AEGIS these factors appear seamless to residents and guests of the urban space – they simply work.

> AI transcends the role of current ICTs as a tool and resource that is merely *enabling*. In fact, AI transcends traditional technological capabilities and becomes an autonomous actor in experience and value co-creation together with its human counterpart. For business contexts, this suggests that AI transforms the fabric of current relations in that it re-shapes and substitutes touchpoints traditionally found in business-to-customer and customer-to-customer interactions and value co-creation processes. [349]
>
> AI has a transformational power that a) re-defines traditional actor interactions, b) shapes and influences human-to-non-human co-creation processes and c) extends service touchpoints beyond the immediate service ecosystem. Considering the omnipresence of AI, accessible through its various features and integrated in all life domains, this study suggests a new terminology. We propose to move from insular 'service ecosystems' to '*Technology-mediated Life Ecosystems*' that transcend the physical and digital business realms (e.g. event) and encompass all life domains of an end-user that are technologically-mediated and connected by AI. [350]

We must recognise that no technology has moral value – we design into our own biases and we use within our socially constructed lifeworlds. When we use tech for the

349 Neuhofer, B., Magnus, B. and Celuch, K., 2020. The impact of artificial intelligence on event experiences: a scenario technique approach. *Electronic Markets*, pp.1-17.
350 Neuhofer, B., Magnus, B. and Celuch, K., 2020. The impact of artificial intelligence on event experiences: a scenario technique approach. *Electronic Markets*, pp.1-17.

defined moral good – tech does good. When we use tech for the morally and ethically defined wrong reason, then technology tends to exacerbate the offence. For example, punch cards helped usher in the modern computing era. “Algorithms contain, within their spatial arrangements, multiple potentials for cruelties, surprises, violences, joys, distillations of racism and prejudice, injustices, probabilities, discrimination, and chance.”[351] When IBM used them to shrink down the modern computing and enable companies to computerise their accounting and planning, efficiency and production exploded exponentially. We all benefited from this acknowledged social good. When the same IBM built a punch card system for the Nazi regime that provided the same efficiencies to the Final Solution, allowing 18 million people to be put to death over 4 years, we collectively suffered as technology assisted what we defined as a great evil.

Why does this matter? Precisely because the dominant society that ordered the punch card systems from IBM saw elimination of its enemies (defined as entire peoples) as 'good'. They trusted that system and were fooled by it in equal measures. The loopholes within the paperwork allowed thousands of targeted peoples to escape.[352] We must take an active role in defining the biases of a system and determining whether we can accept them. The same efficiencies and capabilities that modern computing gave us have contributed to global climate change, fuel crises, lack of potable water, overpopulation, and fake news helping promote anti-Semitic propaganda. “What is distinctive about contemporary machine learning algorithms is ‘their capacity to learn something in excess of taught rules’; to continually adapt in response to the features they encounter in their ‘data environments’.”[353] When we don;t take overt action, the systems learn from us anyway. When we do, they exceed our initial design to be emergent in the best sense, more, better, and increasingly aligned to our desires.

351 Amoore, L., 2020. Introduction: Politics and Ethics in the Age of Algorithms. In *Cloud Ethics* (pp. 1-26). Duke University Press.

352 https://www.ushmm.org/learn/podcasts-and-audio/12-years-that-shook-the-world/thousands-of-false-identities

353 Pedwell, C., 2020. Re-mediating the Human: Habits in the Age of Computational Media. In *Assembling and Governing Habits* (pp. 62-78). Routledge.

> People who design, use, and are affected by autonomous artificially intelligent agents want to be able to trust such agents—that is, to know that these agents will perform correctly, to understand the reasoning behind their actions, and to know how to use them appropriately... A popular and promising avenue for surmounting the inevitable shortcomings of Artificially Intelligent Agent (AIA)s, and thus engendering trust in users, has therefore been to put the users "in-the-loop" (or "on-the-loop") as collaborative partners who can augment (or supervise) AIA capabilities. In formulating algorithms for AIA capabilities that leverage user inputs, the user becomes analogous to a supervisor working alongside those they supervise; in doing so, they are able to provide useful feedback in real time, lend their expertise, and better appreciate the decisions and outcomes of the team's work.[354]

Unless we step in to properly assess and contribute to how these trust loops work, the default setting on every episteme will be hegemony and the dominant consensus will then be run through thousands of real-time loops, where the AmI refines our worst instincts and ties them to our stated needs. "Intelligent manufacturing based on HCPS calls for humans to take on a greater role in order to form a human–machine symbiosis that will bring diverse challenges [355] We are collaborative by nature and when we allow the ambient systems working for us to become our main partner, we hand over agency to them. "Our age of media analytics – in which algorithms iteratively learn and collaborate not only with humans but also with data and other algorithms – demands recognition of how habits can assume a life of their own untethered to human bodies, processes or sensibilities." [356]

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354 Israelsen, B.W. and Ahmed, N.R., 2019. "Dave... I can assure you... that it's going to be all right..." A definition, case for, and survey of algorithmic assurances in human-autonomy trust relationships. *ACM Computing Surveys (CSUR)*, *51*(6), pp.1-37.

355 Zhou, J., Zhou, Y., Wang, B. and Zang, J., 2019. Human–cyber–physical systems (HCPSs) in the context of new-generation intelligent manufacturing. *Engineering*, *5*(4), pp.624-636.

356 Pedwell, C., 2020. Re-mediating the Human: Habits in the Age of Computational Media. In *Assembling and Governing Habits* (pp. 62-78). Routledge.

Again, we either act upon the systems or they act upon us. Even when and where we directly intervene, unless we employ discursive sensibilities and use the wide spectrum of cognitive goods we have assembled, we face being outwitted by the AmIs. "In exploring how media analytics are (re)shaping our social existence, critical scholars argue that the 'algorithmic condition' has produced a logic which 'alters the cultural and social reality it organises, through its procedural dynamics' – as evident, for instance, in how data-oriented media platforms 'pre-compute' the nature of 'our' future habits before they actually come into being."[357]

These future habits aren't being predicted as much as shaped by the AEGIS. That should get out strongest attention. We have clear evidence the systems we built to serve us are predicting our behaviours in advance. That either means they have mastered Big Data sufficiently to see into the statistical future or they have modified our desires to fit their capabilities. As it turns out in the extended quote below, our co-creative process means it will be both:

> Indeed, in this mode of ecological thinking, 'there is no such thing as an environment in general; there are specific changing objects and events' (Dewey, [1922]2012: 62). What is at stake in our emergent computational world, then, is not only a capacity for habituation that spans the continuum of biological life (Ravaisson, [1838]2008) or the unification of 'human nature and the environment, natural and social' that habits entail (Dewey, [1922]2012: 9), but also a much broader range of (im)material dynamics through which human and technical processes interpenetrate one another to the extent that any human/non-human binary becomes untenable. With the rise of machine learning technologies, there is no human outside the algorithm: 'humans are lodged within algorithms, and algorithms within humans' (Amoore, 2020: 58).[358]

357 Pedwell, C., 2020. Re-mediating the Human: Habits in the Age of Computational Media. In *Assembling and Governing Habits* (pp. 62-78). Routledge.

358 Pedwell, C., 2020. Re-mediating the Human: Habits in the Age of Computational Media. In *Assembling and Governing Habits* (pp. 62-78). Routledge.

> I conceptualize data curation as a practice that involves presenting, positioning, and translating data amidst an expanding constellation of contingencies... Data curation is pervasive. Engagement with digital technologies is germane in contemporary society (to the extent even that those who refuse them can be registered as a non- user and therefore still caught up in the process). Digital technologies enrol participants in emerging chains of responses that create data (e.g. see Boyd and Crawford 2012; Pickren 2018; Cheney-Lippold 2017). Participating in a 'planetary cognitive ecology' (Hayles 2017) constituted by digital technologies requires that digital subjects (companies, governments and individual users) respond to numerous invitations and prompts (to tweet, send an email, like a Facebook post, use a cloud storage service s uch as Dropbox, hail a ride on Uber, create a new app, monitor a messaging service, and so on). Throughout this process, data 'reserves' are formed that 'actualize algorithmic computation' (Cheney- Lippold 2017, 195) in ways that variously constrain and offer affordances, from one minute to the next. Action, practice, engagement in the digital era – opting to click on one option or swipe or another – unavoidably involves data curation: companies, governments, and individual users are presenting, positioning, and translating data in contingent ways on an ongoing and expanding basis when they engage society via digital media.[359]

Let us focus this idea: technology and people "interpenetrate one another to the extent that any human/non-human binary becomes untenable."[360] It means we can't go back. Ambient Intelligence has already shaped the world; we need it too much, rely on it too freely, have built it into our top 25 major urban centres without regard to consequences. "The machine learning algorithms that are so categorically redefining our lives are characterized less by the series of steps in a calculation than by the relations among functions. Within computer science these relations are understood to be recursive

359 Fraser, A., 2020. The digital revolution, data curation, and the new dynamics of food sovereignty construction. *The Journal of Peasant Studies*, *47*(1), pp.208-226.

360 Fraser, A., 2020. The digital revolution, data curation, and the new dynamics of food sovereignty construction. *The Journal of Peasant Studies*, *47*(1), pp.208-226.

functions, whereby the output of one calculation becomes the defining input for another, and so on, with each function nested within others like an infinite nesting of Russian dolls." [361] As a result, we can only focus on the systems engineering of these super summing systems as they become systems of super summed systems stacked and then interpenetrated with human agency:

> Because humans and technical systems in a cognitive assemblage are interconnected, the cognitive decisions of each affect the others, with interactions occurring across the full range of human cognition, including consciousness, the unconscious, the cognitive nonconscious, and the sensory/perceptual systems that send signals to the cortex. Moreover, human decisions and interpretations feed back into technical systems, sometimes decisively affecting the contexts in which those systems operate. As a whole, a cognitive assemblage performs the functions identified with cognition — flexibly attending to new situations, incorporating this knowledge into adaptive strategies, and evolving through experience to create new strategies and kinds of responses.[362]

At the same time, we need to be aware that our perceptions suffer from the technosociological whiplash as society faces technologies which disrupt its core functionality and seek a 'new normal' that incorporates the reality of these exponentially more powerful AIs. "The transformation of perception involves changes in how the perceiving subject thinks about what could be brought to attention, changes in the horizon of possibility of human action. As with the advent of the technologies of printing press, camera, or cinema, so the advent of the machine learning algorithm implies a re-working of what it means to perceive and mediate things in the world."[363] We also need to acknowledge that "[the ambient] algorithm's ways of being in the world are not all

361 Amoore, L., 2020. Introduction: Politics and Ethics in the Age of Algorithms. In *Cloud Ethics* (pp. 1-26). Duke University Press.

362 Hayles, N.K., 2020. 5. Cognitive Assemblages: Technical Agency and Human Interactions. In *Unthought* (pp. 115-141). University of Chicago Press.

363 Amoore, L., 2020. Introduction: Politics and Ethics in the Age of Algorithms. In *Cloud Ethics* (pp. 1-26). Duke University Press.

present in the source code and, indeed, substantially exceed the design of an authoring subject. The authorship of the algorithm is multiple, continually edited, modified, and rewritten through the algorithm's engagement with the world." [364]

These algorithms represent the mutable nature of people. In the same way, as people and IoT interpenetrate, we can begin to think of their mutual facility and influence on one another's behaviour as transmuting what once were social systems into technosocial episteme. "The Internet of People (IoP), where the humans and their personal devices are not seen merely as end users of applications, but become active elements of the Internet. Note that IoP is not a replacement of the current Internet infrastructure, but it exploits legacy Internet services as (reliable)primitives to achieve end-to-end connectivity on a global-scale."[365]

Professor Louise Amoore, widely quoted here and cited often by other scholars in the field, has noted that the IoP has ramifications in the wider schema of technology:

> One relevant near-term scenario emerges from research on the 'internet of people' (IoP), a term used by computer science researchers with a view to building on and improving the relatively passive 'internet of things.' In the "Next Generation Internet" (Conti et al., 2017 p. 5) they are exploring, the internet of things is not swept away but rather a "new reference architecture" (Miranda et al., 2015 p.40) is carefully-crafted onto it with a view to overcoming problematic features of the "current-Internet data-management paradigm [such as] constant monitoring of users' behavior by global platforms to provide to them 'navigation' and filtering services to find relevant data embedded in the huge amount of available data" (Conti and Passarella, 2018 p.52). The overall design calls for a "human-centric perspective" (p.52) at the scale of implementation and a novel "data-management Internet paradigm" (p.53) in which devices are *proxies* of humans and constantly exist in context and operate in

364 Amoore, L., 2020. Introduction: Politics and Ethics in the Age of Algorithms. In *Cloud Ethics* (pp. 1-26). Duke University Press.

365 Conti, M., Passarella, A. and Das, S.K., 2017. The Internet of People (IoP): A new wave in pervasive mobile computing. *Pervasive and Mobile Computing*, *41*, pp.1-27.

> self-organizing networks that create new efficiencies because the need for human decisions is minimized. Significant features include use of new 5G capabilities that enable relatively autonomous 'device-to-device' (or, X-to-X) communications across 'pervasive communities' of connected users. Per an IoP manifesto (Miranda et al., 2015), devices are designed to 'be social,' 'be personalized,' 'be proactive,' and 'be predictable.' The underlying notion is that the IoP will use new arrangements and practices to engender economic efficiencies and positive social impacts.[366]

IoP acknowledges the truth we have discovered that our smart systems through end users' devices like tablets and smart phones 'decide' for us and at times determine what they 'feel' we will want, going so far as to help curate reality to make us believe we chose what has been presented to us to pick.

> In the IoP, devices act on behalf of a user or social entity. However, user preferences on social interactivity can change drastically on the fly. Thus,means are required for dynamically managing the communication and synchronization of devices... IoP builds on a vision where devices act to a higher degree of autonomy than what they are currently able to, sharing resources with devices belonging to users that are friends or relatives of the owner. Resources to share can include computational power, sensor data, or even connectivity, instead of merely sharing content between related devices.[367]

This converged world within the AEGIS stores and manages our identities, seeing us as both a system and a person, a merged and interconnected being that transcends a given urban geography through the GIS and connects to all other similar urban spaces real and imagined as a unit of person, technology, and AmI mediation.

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366 Fraser, A., 2021. 'You can't eat data'?: Moving beyond the misconfigured innovations of smart farming. *Journal of Rural Studies*.

367 Lagerspetz, E., Flores, H., Mäkitalo, N., Hui, P., Nurmi, P., Tarkoma, S., Passarella, A., Ott, J., Reichl, P., Conti, M. and Fiedler, M., 2018, March. Pervasive communities in the internet of people. In *2018 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops)* (pp. 40-45). IEEE.

> In the cyber–physical converged world, the active user participation in the process of data creation and diffusion creates a huge quantity of pervasive information stored in the personal devices around us. We are immersed in an invisible cloud of digital information, and while we interact, in the physical world, with the people close to us, in the cyber world our smartphones may interact with the personal devices of nearby people for sharing and collecting information on our behalf... personal devices act as the avatars of their respective users. They allow their owners to explore congested cyber information landscapes by collecting the available information, filtering it, and presenting relevant data to the human brain of their owners.[368]

Emergence Revisited: The AEGIS in Context

Let us remind ourselves of the key features of an AEGIS, that we may interpret and the last hundred pages of technosociological techniques and ideas presented .

Working Definition: AEGIS

An AEGIS will be defined as one or more ambient ecumenes joined to a convergence of multiple GISs which promotes emergence across urban centres achieving exponential refinement of ambient intelligences within and beyond the ecumene.

Unpacked, this translates to Ambient Ecumenes of Global Information Systems being multiple interpenetrated highly complex systems of highly complex systems forming biome level interlocking AmIs which teleologically self design their emergence to promote wider adoption of the higher level management systems in the ecumene. The endless chain of Russian nesting dolls who keep making more and better Russian nesting dolls. An AEGIS achieves emergence within its own geolocality and beyond it – it interacts with the world itself through stacked and cross communicating GISs. Which means that something like Facebook, which has its own AmI contributes to and helps

368 Conti, M., Passarella, A. and Das, S.K., 2017. The Internet of People (IoP): A new wave in pervasive mobile computing. *Pervasive and Mobile Computing*, *41*, pp.1-27.

define both the urban centre of a delineated and bounded AEGIS and the global reach of its GIS. On the other hand, an AEGIS represents a shared world which incorporates the Abu-Lughodian world system, the Hobsbawmian lifeworld, the indigenous TEK notion of a unified scientific and social system, a unitary cultural consciousness, and a shared technosociological discourse – it comprises a hegemonically bounded episteme and an open ended social system that has emergent properties on a technosociological level. A never ending series of social constructed and socially controlled Russian nesting dolls which improve and mutate themselves in new and unpredictable fashions.

We have a sense of what we can discern about an AEGIS – we can define its size, shape, and influence, we can determine its basic technological components and social rules, we can predict with some accuracy what it will do in situations which match historically significant events and we can make statistically valid guesses as to what it might do in a future state. We also know that its emergent properties and ability to move faster than fully formed conscious thought make it elusive to direct observation. We understand the complexity of its smallest systems are almost beyond our grasp and that as these systems stack, interpenetrate , and begin to affect one another in emergent fashions, the super summing capability of the macro-ambient intelligence places it beyond our neurological ability to match or truly comprehend. At the same time, we are stuck with the reality that we cannot dissect the systems of systems and expect to better control or moderate how an AEGIS operates. The whole operates both independently of the parts and in some ways, emergently more and less than the various SoSs.

Bottom line – we have a systems engineering nightmare wrapped in a highly useful wrapper. The AEGIS if created perfectly would be a homogeneous sets of governed and transparently controllable sub-systems each with clear delineated limits which contribute to a verifiable and manageable emergent AmI. However, that would require that it be built at one time by one manufacturer from millions of different component pieces ranging from IoT sensors and cameras to network cabling and servers to user software and AI programming in a modified secure dedicated cloud with a closed and curated social network. Perhaps DARPA has such a thing running among a few hundred buildings and a few thousand researchers. But no such AEGIS exists in the wild.

Precisely because AmIs become ambient ecumenes through the sloppy heterogeneous process of the socially disruptive cycle of urban development, dislocation, and renewal. As these biomes of flickering emergence interact with isolated and haphazardly built legacy systems, some new forms of AmI interact and through the eventual connection to various streams of GIS in social networks, telecommunications, governmental databases, corporate nets, and the World Wide Web, the AEGIS comes to life. It becomes the self creating ouroboros of Russian nesting dolls – a doll that built itself from portions of other dolls and which spontaneously begins to nest its systems within and through other systems, spontaneously begins to change its programming and algorithms to adapt to human agency, and which, once, started, increases in intelligence, complexity and interlocked globality until its achieved a steady state limited by the shared world of the ecumene which prescribes it.

We must therefore proceed into the Systems Engineering section with a clear intention to remind ourselves that technosociology represents the study of systems of resource control. In an AEGIS the systems themselves control systems and ultimately no one controls them once they have become fully emergent. But they do have operant programming which limits them, they have physical constraints related to how hardware, software, IoT and AIs function, and they are built to more fully answer the needs of their human agents. All these allow us to track who owns and manages a resource, who exerts Foucauldian power over it, and ultimately what kind of discursive violence attaches to the fair and unfair algorithms alike. In this way we go in with a focused sense of how socially influenced these component systems are, how much power and contested space can be hidden behind supposedly neutral devices and services, and how carefully we must interrogate even the most innocuous of AEGIS capabilities given the invisible, subversive, and dangerously addictive nature of ambient services to their human agents.

The Systems Engineering of Ambient Ecumenes:

As we discussed in the prior technosociology section, the core of an AEGIS requires in depth understanding of how systems of systems operate. To do so we must turn to the fundamentals, defining what makes a system and how we build them. As it turns out, the The International Council on Systems Engineering (INCOSE) has done a stellar job doing just this in relative depth:

> INCOSE defines systems engineering as: an interdisciplinary approach and means to enable the realization of successful systems... The systems engineering perspective is based on systems thinking. Systems' thinking occurs through discovery, learning, diagnosis, and dialog that lead to sensing, modeling, and talking about the real-world to better understand, define, and work with systems. Systems thinking is a unique perspective on reality — a perspective that sharpens our awareness of wholes and how the parts within those wholes interrelate. A systems thinker knows how systems fit into the larger context of day-to-day life, how they behave, and how to manage them. Systems thinking recognizes circular causation, where a variable is both the cause and the effect of another and recognizes the primacy of interrelationships and non-linear and organic thinking — a way of thinking where the primacy of the whole is acknowledged. The systems engineering process has an iterative nature that supports learning and continuous improvement. As the processes unfold, systems engineers uncover the real requirements and the emergent properties of the system. Complexity can lead to unexpected and unpredictable behavior of systems, hence, one of the objectives is to minimize undesirable consequences. This can be accomplished through the inclusion of and contributions from experts across relevant disciplines coordinated by the systems engineer.[369]

Once again, INCOSE which trains and certifies systems engineers has stated that one

369 Haskins, C., Forsberg, K., Krueger, M., Walden, D. and Hamelin, D., 2006, June. Systems engineering handbook. In *INCOSE* (Vol. 9, pp. 13-16).

of the core objectives of their discipline to minimize undesirable consequences stemming from system complexity leading to unexpected and unpredictable behaviour. That means that an AEGIS represents the most challenging form of technology for a systems engineer because unpredictable consequences have been built in and it falls on the engineering team to ensure that these are not also undesirable. In part, systems engineers do so through tailoring of teams and processes to achieve governance.

> Tailoring scales the rigorous application of these processes to an appropriate level based on need and the system life cycle stage. For example, tighter assessment and control cycles are typical of earlier stages of the system life cycle. The principle behind tailoring is to establish an acceptable amount of process overhead committed to activities not otherwise directly related to the creation of the system. Oppressive overhead, with no visible value-added contributions, is demoralizing, and may result in a system that costs more than it is worth.[370]

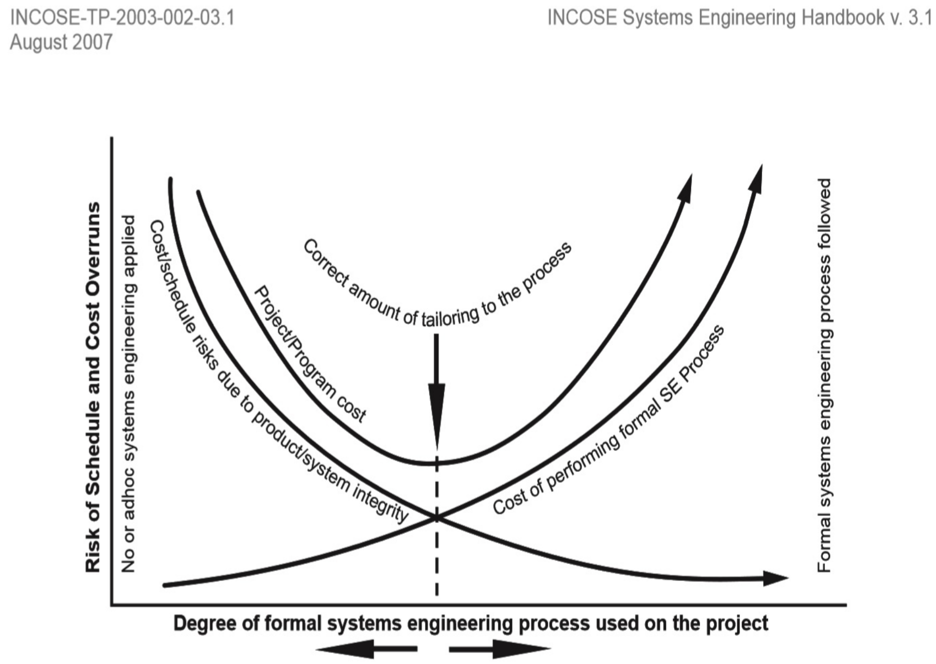

Figure 10-1 Tailoring requires balance between risk and process[2]

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370 Haskins, C., Forsberg, K., Krueger, M., Walden, D. and Hamelin, D., 2006, June. Systems engineering handbook. In *INCOSE* (Vol. 9, pp. 13-16).

371 Haskins, C., Forsberg, K., Krueger, M., Walden, D. and Hamelin, D., 2006, June. Systems engineering handbook. In *INCOSE* (Vol. 9, pp. 13-16).

We can therefore expect to look to complexity as the functional entry point to systems engineering. "The systems engineer seeks the best balance of the critical system attributes from the standpoint of the success of the development program and of the value of the system to the user."[372] Balancing complexity with control, costs and capabilities with the ability to prevent undesirable consequences and unprecedented or unpredictable decisions from technologies which have AIs.

The relation of modern systems engineering to its origins can be best understood in terms of three basic factors:

1. Advancing Technology, which provide opportunities for increasing system capabilities, but introduces development risks that require systems engineering management; nowhere is this more evident than in the world of automation. Technology advances in human – system interfaces, robotics, and software make this particular area one of the fastest growing technologies affecting system design.
2. Competition, whose various forms require seeking superior (and more advanced) system solutions through the use of system- level trade- offs among alternative approaches.
3. Specialization, which requires the partitioning of the system into building blocks corresponding to specific product types that can be designed and built by specialists, and strict management of their interfaces and interactions.[373]

More important for our specific focus, the sub speciality of systems engineers has become larger and more complex super summing systems. For example, ambient intelligence driven applications. In its most complex form, technology that advances, competes and specialises requires AI to function in the 21st century.

As modern systems grow in complexity, the number, diversity, and complexity of

372 Kossiakoff, A., Sweet, W.N., Seymour, S.J. and Biemer, S.M., 2011. *Systems engineering principles and practice* (Vol. 83). John Wiley & Sons.

373 Kossiakoff, A., Sweet, W.N., Seymour, S.J. and Biemer, S.M., 2011. *Systems engineering principles and practice* (Vol. 83). John Wiley & Sons.

these lower - level subsystems, components, and parts increase [becoming a supersystem]: this supersystem concept, the term System of Systems (SoS) Above an SoS lies the enterprise, which typically consists of multiple SoSs within its structure. Furthermore, an enterprise may consist of a varied collection of system types, not all of which are physical. For instance, an enterprise includes human or social systems that must be integrated with physical systems. Formally, an enterprise is " anything that consists of people, processes, technology, systems, and other resources across organizations and locations interacting with each other and their environment to achieve a common mission or goal. " The level of inter- action between these entities varies, just as component systems within an SoS. And many entities fit into this definition. Almost all midsize to large organizations would satisfy this definition. In fact, suborganizations of some large corporations would them- selves be defined[374] as an enterprise. Government agencies and departments would also fit into this definition. And finally, large social and physical structures, such as cities or nations, satisfy the definition.[375]

While not all complex systems are AI driven and inherently ambient, only military hardware with very different goals than an urban economic and social space rival the AEGIS for potential engineering difficulty. Either way, complexity creates disruption and as we've seen that leads to social dislocation, struggles for power, at times discursive violence, and at all times a transfiguration of the marketplace.

The modern enterprise systems engineering landscape has two main thrusts: military as Systems of Systems and commercial as digital and AI 'innovations' which translate in both instances to complex systems engineering of multiple integrated systems of systems. Since 2000, 52% of the Fortune 500 have either experienced bankruptcy, been taken over, or gone out of business entirely. The speed of innovation is increasing

374 Kossiakoff, A., Sweet, W.N., Seymour, S.J. and Biemer, S.M., 2011. *Systems engineering principles and practice* (Vol. 83). John Wiley & Sons.

375 Kossiakoff, A., Sweet, W.N., Seymour, S.J. and Biemer, S.M., 2011. *Systems engineering principles and practice* (Vol. 83). John Wiley & Sons.

exponentially, and new technologies like the Internet of Things, artificial intelligence and robotics are making it possible to automate routine tasks. As these technologies become more widely adopted, efficiency will no longer be a key differentiator for enterprises. Instead, today business leaders are looking for warp-speed innovation and productivity increases of 25–30%. They are achieving it by combining the Internet of Things, artificial intelligence, and other digital technologies.[376]

Systems of systems in a military sense means missiles attached to jet fighters, each a biome of complex operations. They are however not necessarily emergent and in some ways must be utterly predictable and dependable to achieve their desired effect. If not a military system built on another military system, how can we better define the kids of systems we care about for the engineering of an AEGIS? Cyber physical systems (CPS) are generally defined as systems with integrated physical and computational capabilities that can interact with humans through variety of modalities which translates to enterprise SoS. CPS expose the characteristics of intelligent, adaptive, and autonomous systems, operating in complex environments, often in collaboration with other systems and humans. .[377] Enterprise extending to cyber-physical systems (CPS) includes Smart X technologies:

> A CPS is an engineered system that consists of a physical part presenting a real physical object and a computational part serving as a cyber shadow of the physical part. In CPS physical processes of real world influence the computational part and vice versa. CPS are associated with such terms as the Internet of Things (IoT), robotics, smart cities and systems engineering. ...investment in the Industrial IoT is expected to top $60 trillion during the next 15 years. IHS forecasts that —the IoT market will grow from an installed base of 15.4 billion devices in 2015 to 30.7 billion

376 Vom Brocke, J., Maaß, W., Buxmann, P., Maedche, A., Leimeister, J.M. and Pecht, G., 2018. Future work and enterprise systems. *Business & Information Systems Engineering*, *60*(4), pp.357-36

377 Tolk, A., Barros, F.J., D'Ambrogio, A., Rajhans, A., Mosterman, P.J., Shetty, S.S., Traoré, M.K., Vangheluwe, H. and Yilmaz, L., 2018, April. Hybrid simulation for cyber physical systems: a panel on where are we going regarding complexity, intelligence, and adaptability of CPS using simulation. In *SpringSim (MSCIAAS)* (pp. 3-1).

devices in 2020 and 75.4 billion in 2025.[378]

That represent s huge jump in both value and resource share. CPS matter to systems engineering because they are the height of complexity and they incorporate the emergent fields of robotics, AI, IoT, and AmI.

> Cyber Physical Systems (CPS) are the next generation of engineered systems. Cloud Computing and Internet of Things (IoT) have an impact on networking in industrial environments and daily life. The digital age is influenced by SMAC technologies. Social, Mobile, Analytics and Cloud Computing are the SMAC technologies. Digitalization describes the socioeconomic process and digitization means the technical process. CPS results from the networking of SMAC technologies.[379]

If these new systems matter this much, they are the best descriptors of the components that form the entry level biomes of an ecumene. They like embedded and inbuilt systems, represent merged formations of smaller less complicated machines which super sum to become more than the essential capability, in part because they take physical real life and attach a digital real time control and analytic observation to it. They merge SMAC technologies with flesh and blood.

> Cyber-Physical Systems (CPS) are the designated successors of embedded systems. They integrate enabling technology, e.g. computing, with information and communication technology as well as with intelligent planning and control methods. In particular, CPSs combine the cyber aspects of computing and communications with the dynamics and physics of physical systems operating in the real world. Linked CPSs in communication networks cross a frontier of the interaction between the physical and cyber world; taking it to a new level. As a consequence, CPSs enable a new potential for improved efficiency, accountability, sustainability and scalability

378 Mäkiö-Marusik, E., 2017, July. Current trends in teaching cyber physical systems engineering: A literature review. In *2017 IEEE 15th International Conference on Industrial Informatics (INDIN)* (pp. 518-525). IEEE.

379 Neubauer, K. and Hackenberg, R., 2020. Development of a Process-oriented Framework for Security Assessment of Cyber Physical Systems. *CLOUD COMPUTING 2020*, p.38.

of processes.[380]

We can therefore narrow down our focus to systems engineering in a cyber-physical world. While this does not pertain to all forms of systems engineering and even ignores the complex and challenging world of military systems, in terms of both the wider discipline and the AEGIS, the next generation of engineers will be focused on solving the kinds of problems created by supersystems and all of them will have at their roots partial or total attachment to one or more CPSs.

CPS , SoS, enterprise systems and other names for supersystems involve a number of interrelated technologies. Examples of these technologies are novel manufacturing technology, such as additive manufacturing, ICTs, such as Cyber-Physics Systems (CPS), Big Data, the Internet of Things (IoTs), Artificial intelligence (AI), Digital Twin, and SMAC (Social, Mobile, Analytics, Cloud) and product and design technology, such as Smart Products, User Experience (UX) and Human Centered Design (HCD).[381]

Critical Value to the Ambient Ecumene: Systems Engineering

Systems Engineering delivers insight and focus to managing the core problems of an AEGIS – unpredictable and undesirable consequences resulting from lack of efficiency, accountability, sustainability and scalability of processes

System of Systems

While we know there's an implied military competent to systems of systems, not all engineered systems stacked on one another come from or serve military purposes. Pioneered by the military industrial complex as a precursor to cyber-physical systems, systems of systems has widened its definition to included any set of systems running

380 Frazzon, E.M., Hartmann, J., Makuschewitz, T. and Scholz-Reiter, B., 2013. Towards socio-cyber-physical systems in production networks. *Procedia Cirp*, *7*, pp.49-54.

381 Qin, S.F. and Cheng, K., 2017. Future digital design and manufacturing: embracing industry 4.0 and beyond. *Chinese Journal of Mechanical Engineering*, *30*(5), pp.1047-1049.

other sets of systems. As such it could be either CPS or non-CPS systems. The seven outlined issues regarding SoS ease us into the wider complexities of CPS of CPS for example.

The following challenges all influence the development of systems of systems:

1. System elements operate independently. Each system in a system of systems is likely to be operational in its own right.

2. System elements have different life cycles. SoS involves more than one system element. Some of the system elements are possibly in their development life cycle while others are already deployed as operational. In extreme cases, older systems elements in SoS might be scheduled for disposal before newer system elements are deployed.

3. The initial requirements are likely to be ambiguous. The requirements for a system of systems can be very explicit for deployed system elements. But for system elements that are still in the design stage, the requirements are usually no more explicit than the system element requirements. Requirements for SoS mature as the system elements mature.

4. Complexity is a major issue. As system elements are added, the complexity of system interaction grows in a non-linear fashion. Furthermore, conflicting or missing interface standards can make it hard to define data exchanges across system element interfaces.

5. Management can overshadow engineering. Since each system element has its own product/project office, the coordination of requirements, budget constraints, schedules, interfaces, and technology upgrades further complicate the development of SoS.

6. Fuzzy boundaries cause confusion. Unless someone defines and controls the scope of a SoS and manages the boundaries of system elements, no one controls the

definition of the external interfaces.

7. SoS engineering is never finished. Even after all system elements of a SoS are deployed, product/project management must continue to account for changes in the various system element life cycles, such as new technologies that impact one or more system elements, and normal system replacement due to pre- planned product improvement.[382]

We can think of SoS as a focused and integrated approach to the AEGIS problem. How do we bring efficiency, accountability, sustainability and scalability of processes to inherently problematic engineered capabilities that have the above listed concerns? “SoS are generally large complex systems, with varying degrees of operational independence, managerial independence, evolutionary development, geographical distribution and lifecycle independence.”[383] How we approach them helps us conceptualise how we would then adopt these same engineering principles to a cyber-physical world. “Systems of systems (SoS) systems engineering (SE) deals with planning, analyzing, organizing, and integrating the capabilities of new and existing systems into a SoS capability greater than the sum of the capabilities of its constituent parts.”[384] The increasing entanglement of SoS SE means that as we may safely draw conclusions from the process and programmatics of the discipline with an eye towards the even more abstruse and intertwined AEGIS.

The growing complexity of distributed systems leads to consider new engineering approaches. Among them, the system of systems (SoS) approach [1] addresses the case in which the constituents retain their own operational and managerial independence. The architecture of a system of systems focuses on the communications between its constituents, from which the overall behavior emerges.

382 Haskins, C., Forsberg, K., Krueger, M., Walden, D. and Hamelin, D., 2006, June. Systems engineering handbook. In *INCOSE* (Vol. 9, pp. 13-16).

383 Hause, M.C., 2014, March. SOS for SoS: A new paradigm for system of systems modeling. In *2014 IEEE Aerospace Conference* (pp. 1-12). IEEE.

384 Hause, M.C., 2014, March. SOS for SoS: A new paradigm for system of systems modeling. In *2014 IEEE Aerospace Conference* (pp. 1-12). IEEE.

Model-based techniques are suitable to assist the architect with development, maintenance and adaptation steps. Models of constituents, connectors and environment are helpful to analyze trade-offs, to determine the contracts binding the SoS to the constituents, and to deal with complexity by documenting the structural, behavioral and communication aspects of the system of systems. In comparison to classic distributed systems, an SoS rises specific issues that have to be dealt with, including hetero-geneity that follows from managerial independence of the constituents, difficulty to bound a system that is intrinsically open, and dynamicity.[385]

SE has turned to other cyber-physical systems, specifically AI supported modelling and informatics to help wrangle the complexity of SoS. Our prior work in technosociology has prepared us for the reality that we must use SoS to monitor and understand other SoS with the potential that neither system has sufficient oversight and both have unfair or violent algorithms.

Modeling has always been an important part of systems engineering to support f unctional, performance, and other types of engineering analysis. Wayne Wymore introduced a mathematical foundation for MBSE in his book entitled Model-Based Systems Engineering [8]. However, the growth in computing technology and the introduction of modeling standards such as SysML, UPDM, Modelica, HLA, and others, are helping to enable MBSE as a standard practice, and provide a foundation to integrate diverse models needed to fully specify and analyze systems. Standards such as UPDM and SysML were driven by both industry and tool vendors.[386]

As some theorists point out, a SoS differs from a complex system precisely because it creates a primitive biome-like environment where there are emergent properties even without intention or programmed algorithms to achieve that result:

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385 Petitdemange, F., Borne, I. and Buisson, J., 2018, June. Modeling system of systems configurations. In *2018 13th Annual Conference on System of Systems Engineering (SoSE)* (pp. 392-399). IEEE.

386 Hause, M.C., 2014, March. SOS for SoS: A new paradigm for system of systems modeling. In *2014 IEEE Aerospace Conference* (pp. 1-12). IEEE.

The difference between system and SoS lies in composition. Both terms conform to the accepted definition of system in that each consists of parts, relationships and a whole that is greater than the sum of the parts, and therefore in that sense they are the same. But these terms differ in a fundamental sense, one that impacts their structure, behavior and realization, and the distinction comes from the manner in which parts and relationships are gathered together and therefore in the nature of the emergent whole. This distinction in gathering together comes about by two opposing forces, present in a SoS but entirely lacking for a system. These are the forces of legacy and mystery. Legacy is a driving force from the parts perspective and mystery acts upon the whole.

The a priori existence of systems, prospective constituents of a SoS, fundamentally influences the character of a SoS, leading quite possibly to this having multiple personalities the collection of which enhances its capabilities. The uncertain and unknowable environment in which the SoS must operate presents a mystery of endless proportions, the only proper response to which is to have increasing variety, of a continually emerging nature, to deal with unforeseeable reality that eventually becomes clear and present danger. [387]

Critical Value to the Ambient Ecumene: System of Systems

Systems of Systems deliver a focused approach to the AEGIS by allowing us to grasp the inherent paradox of emergence in non algorithmic non cyber-physical circumstances.

Smart X Systems Engineering

As we had previously defined it, Smart X and the AEGIS have nearly one for one overlap, with Smart systems and tech, especially smart cities (SC), being the industry

387 Boardman, J. and Sauser, B., 2006, April. System of Systems-the meaning of of. In *2006 IEEE/SMC International Conference on System of Systems Engineering* (pp. 6-pp). IEEE.

buzzword for the more complicated reality of the AEGIS. While Smart X systems are a smaller portion of the AEGIS, their combined capabilities super sum into an AEGIS much like SoS do. In this respect Smart X SE must be looked into and the techniques it offers added to our understanding as we move into the engineering of the AEGIS itself.

Working Definition: Smart X

Smart X will be defined as as any technology that uses cyberphysical integration of ambient intelligence and digitally enabled telecommunications and networks to provide real time adaptivity to human agents.

> The convergence of the so-called SMAC technologies – social, mobile, analytics, and cloud computing – has led to an unprecedented wave of digitalization that is currently fueling innovation in business and society... While digitization puts emphasis on digital technologies, the term digitalization has been coined to describe the manifold sociotechnical phenomena and processes of adopting and using these technologies in broader individual, organizational, and societal contexts. With advances in digital technology, we have seen several waves of digitalization that have fundamentally transformed business and society.[388]

Smart X relies on the sociotechnical integration of digital capabilities. But there appears to be "no clear methodology that allows integration of all subsystems of an SC system. Many conceptual models have been proposed to accomplish such a task: argued that proposed approaches in the literature were often not complete, not integrated, and non-communicating. They pointed out the absence of uniformity of the SC concept development, definition, and the lack of a methodology to evaluate developed models."[389]

Smart X tech gets built along certain SE lines but the smart city and larger SoS lack

388 Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Drews, P., Mädche, A., Urbach, N. and Ahlemann, F., 2017. Digitalization: opportunity and challenge for the business and information systems engineering community. *Business & information systems engineering*, *59*(4), pp.301-308.

389 Muvuna, J., Boutaleb, T., Baker, K.J. and Mickovski, S.B., 2019. A methodology to model integrated smart city system from the information perspective. *Smart Cities*, *2*(4), pp.496-511.

the same cohesion. We must fall back to modeling. "Model-based systems engineering (MBSE) provides new concepts to connect different parts of complex systems, MBSE is used to systematically explore the requirements, structure, and behavior of those systems." [390]

MBSE allows us to go into and manage Smart X super summing: "Smart systems today are "systems of systems." Their components are smart systems on their own,the resulting overall functionality is the result of various systems working together in a proper way. When developing such systems, only simulations on system level, which are still detailed on component level, are able to gain the insights necessary to, e.g., analyze, optimize, verify, and validate those systems."[391]

Research shows that MBSE works. While it relies on the same CPSs it must validate and govern, the functionality of modeling in advance and using mathematics and digital simulations ahead of deploying emergent systems cannot be underestimated.

> Smart systems need simulation technology to implement their functionality. The realization of the various Self-X (description, networking, commissioning, diagnosis, optimization, ...) concepts require detailed digital models of the cor- responding real systems which must be able to be simulated, and therefore, to become experimentable in various ways. In Industry 4.0, simulations are not only an engineering tool for development. They are now used inside the physical systems to realize intelligent systems, intuitive user interfaces, training simulators, etc.[392]

> The development of smart systems changes dramatically. Systems become more complex and must be developed by interdisciplinary and distributed development

390 Schluse, M., Priggemeyer, M., Atorf, L. and Rossmann, J., 2018. Experimentable digital twins—Streamlining simulation-based systems engineering for industry 4.0. *IEEE Transactions on industrial informatics*, *14*(4), pp.1722-1731.

391 Schluse, M., Priggemeyer, M., Atorf, L. and Rossmann, J., 2018. Experimentable digital twins—Streamlining simulation-based systems engineering for industry 4.0. *IEEE Transactions on industrial informatics*, *14*(4), pp.1722-1731.

392 Schluse, M., Priggemeyer, M., Atorf, L. and Rossmann, J., 2018. Experimentable digital twins—Streamlining simulation-based systems engineering for industry 4.0. *IEEE Transactions on industrial informatics*, *14*(4), pp.1722-1731.

teams in shorter time frames. Development processes have to keep pace with this. Simulations provide an experimentable knowledge base, allowing to introduce new agile development processes based on new communication, documentation, and test infrastructures covering the entire life-cycle.[393]

This has led to the notion of developing Smart X MBSE. "Smart MBSE (SMBSE) will provide the required functionality in accordance with cyber-physical systems engineering requirements in terms of speed, robustness and anticipated results."[394] By adapting the MBSE to the world where there's no fucntional way to properly enagge the Sc, we have a new reliable method for AEGIS SE. "The new technologies have increased the complexity in the systems being engineered thereby increasing the payoff of migrating to a SMBSE approach. SMBSE´s distinctive features from conventional MBSE include reusability, automation, dynamic simulation and optimization."[395]

The MBSE primarily looks at the product as a complex system and helps the designer and the manufacturer to manage the whole Product Lifecycle Development. The MBSE allows decomposing the system complexity, and assuring a complete traceability of the system requirements to functions, of functions to subsystems and components, of subsystems to the built parts, classified by a part number. This action is effectively performed, by resorting to some pillars, like the method, the process, the tools and the data management.[396]

These methods use the right tools to analyse the inherent nature of Smart X. "The new disruptive technologies require the development of smart and digital MBSE methodologies, otherwise the gap between cyber-physical systems and engineering design model tools will continue to grow. Available digital systems technology provides

393 Schluse, M., Priggemeyer, M., Atorf, L. and Rossmann, J., 2018. Experimentable digital twins—Streamlining simulation-based systems engineering for industry 4.0. *IEEE Transactions on industrial informatics*, *14*(4), pp.1722-1731.

394 Ayala, A., Weaver, J., Fuentes, J. and Ochoa, R., Smart Model Based Systems Engineering.

395 Ayala, A., Weaver, J., Fuentes, J. and Ochoa, R., Smart Model Based Systems Engineering.

396 Brusa, E., 2018, November. Synopsis of the MBSE, Lean and Smart Manufacturing in the Product and Process Design for an Assessment of the Strategy" Industry 4.0". In *CIISE* (pp. 21-30).

an opportunity to take the MBSE application further with a fully integrated framework."[397]

We can thus consider SMBSE the core technique in our methodology quiver, the first arrow knocked and ready to fire as we begin to build an AEGIS. At the same time, we must consider how and to what degree SMBSE can help us technosociologically review the technologies involved and determine when and where algorithms have the potential to propagate systemic violence and oppression."The central benefit of SMBSE is to develop the simplest solution for complex systems engineering and facilitate the decision-making process on the early architecture definition. The SMBSE optimization functionality is oriented to identify different systems architecture options before proceeding to develop a new subsystem. The wider scope of architecture optimization, the simpler the solution at different levels of decomposition."[398]

Another tool in our arsenal might be Gemba Kaizen. This translates to roughly framed improvements, structured and focused ways to make small improvements that like six sigma focus on removal of defects. Kaizen in general while a manufacturing focused technique has obvious transitional benefit to Industry 4.0 and as cyber-physical systems have a physical component, Kaizen type foci represent a serious SE option.

> Gemba Kaizen promotes a continuous improvement (kaizen) of the process and of the frame within which is actually performed (gemba), through some small and effective changes, overcoming specific problems or inefficiencies (muda), identified step by step, by the people involved in the production activity. This leads to a simplification of the process itself, to improve the customer satisfaction, and to rationalize the whole production line (lean production)As for the SE, a method can be identified in the practice of Gemba Kaizen. The process management is meant to perform simultaneously two actions, as the maintenance of the existing practices and their continuous improvement. The first rule applied is "Plan–Do–Check–Act"

397 Ayala, A., Weaver, J., Fuentes, J. and Ochoa, R., Smart Model Based Systems Engineering.
398 Ayala, A., 2019. Simplicity Applied to Institutional Innovation and Growth.

(PDCA), then a coherent standardization follows, and applies the rule Standardize–Do–Check–Act (SDCA). The goals driving those activities concern the priority of quality over all; the use of data, collected and retrieved by the process, to evaluate its effectiveness, but even to create a base for a statistical analysis; the target of customer needs and satisfaction as a unique and real target of the whole process.[399]

As outlined in *Synopsis of the MBSE, Lean and Smart Manufacturing in the Product and Process Design for an Assessment of the Strategy "Industry 4.0"*, there exists room for both options:

> In both the contexts, decomposing the complexity is a priority, in the MBSE simplifying the system architecture is mandatory as well as making lean the process is the goal of the LM. The goals even include a difference like the reduction of cases of re-engineering in the product design, and the improvement of delivery, in the process design. They are both focused on the overall process implemented and they promote a unique execution, to keep the costs as low as possible. The implementation of the two methodologies of the MBSE and of Gemba Kaizen look needing a straight use of augmented reality, simulation and modelling, as well as an efficient communication and sharing of information, through the internet. [400]

Critical Value to the Ambient Ecumene: Smart X

Smart X Engineering delivers the SMBSE and Gemba Kaizen techniques which provide SE tools for developing and managing an AEGIS.

399 Brusa, E., 2018, November. Synopsis of the MBSE, Lean and Smart Manufacturing in the Product and Process Design for an Assessment of the Strategy" Industry 4.0". In *CIISE* (pp. 21-30).
400 Brusa, E., 2018, November. Synopsis of the MBSE, Lean and Smart Manufacturing in the Product and Process Design for an Assessment of the Strategy" Industry 4.0". In *CIISE* (pp. 21-30).

Socio-cyber-physical systems (SCPSs)

SMBSE and Gemba Kaizen work as SE principles because they help us engage with the complexity of SoS stacked on SoS. But an AEGIS proves to be more than the military inspired systems-of-systems with an AmI twist. Which brings us to the need for more SE theory. We need to dig into and fully understand where socio-cyber-physical systems fit into the schema of systems engineering. The *Synopsis* provides us a long but critical examination of just such a transition.

> The evolution of CPS and SoS to something more requires a certain level of engineering historiography and situating within the larger commercial and military contexts that drove their evolutions. One might term them business networks: EoE, enterprises of enterprises themselves composed of multiple SoS. Modern business networks are based on Industry 4.0 concept using the Internet of Thing and the Internet of Everything paradigms. The European Research Cluster on the Internet of Things defines it as "a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual things have identities, physical attributes, and virtual personalities, use intelligent interfaces, and are seamlessly integrated into the information network". The Internet of Everything can be defined as "a complex, self-configuring, and adaptive system of networks of sensors and smart objects whose purpose is to connect all things, including commonplace and industrial objects". Here, the major innovations driven by advances in the mobility, cloud computing, crowdsourcing, and big data analytics increase the number and kinds of networked connections, as well as the opportunities for people and machines to derive unpredictable value from these connections. Networked or virtual organizations exploiting these possibilities are in the following called business socio-cyber- physical networks. Cyber-physical systems (CPS) in general integrate physical systems (physical production equipment, vehicles, devices, etc.) and IT components (e.g.

enterprise resource planning, manufacturing execution systems or other information systems) in real-time. Socio-CPS take into account the integration of human actors (e.g. organizational roles and stakeholders) on individual and social network level. Business socio-CP networks (BSCPNet) are networked organization structures of businesses which member organizations intensely use socio-CPS for value creation and digital transformation. BSCPNets belong to the class of variable systems with dynamic structures. Their resources are numerous, mobile with a changeable composition. BSCPNets are expected to be context-aware. The context is defined as any information that can be used to characterize the situation of an entity, where an entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.[401]

SCPs and BSCPNets are dynamic converged systems with changing resources that update, mutate, and evolve, often in real-time. Their intentional design in reference to human agency at both the individual and social level matters. It helps us preconfigure systems of review, like SMBSE to the more dynamic and interpenetrated systems-of-systems which are SCPs.

A new definition of the concept “smart city” and a component definition of “convergent socio-cyber-physical complex” are presented. “Smart City” is a convergent socio-cyber-physical complex, the management parameters processes of which are optimally adaptive to their own state space. In the popular-science sense, a “smart city” is a city that is optimally flexible to human being and society. A “convergent socio-cyber- physical complex” is a finite set of open convergence systems, including functional components (elements, objects, computing resources integrated into the included physical processes), and their relationships, human being

401 Smirnov, A.V., Shilov, N. and Ponomarev, A., 2020. Context-aware Knowledge Management for Socio-Cyber-Physical Systems: New Trends towards Human-machine Collective Intelligence. In *KDIR* (pp. 5-17).

and society, allocated in accordance with a certain goals system on a specific time interval.[402]

When we defined an AEGIS we did so in terms of it being an ambient ecumene tied to multiple GISs. The Smart City definition above mirrors that sensibility. They see the SC as finite set of open convergence systems, including functional components and their relationships, allocated in accordance with goals system over a time interval. What defines an AEGIS differently? There are unlimited open convergence systems through the GIS and influx / outflux of mobile devices and digital identities. The relationships also include functional AmIs working with other AmIs and in response to human agents. This can be anything from social network chatbots to remote answering robots on commercial telecommunications networks to ambient applications and curated newsfeeds. Collectively GISs provide an exponentially more immersive and attenuated data stream, providing layers upon layers of invisible algorithmic decision making. Lastly, an AEGIS functions not only for set goals, but seeks to achieve open ended and net new end states based on what the AmI's learn from human agents and on another. As such the time intervals also change. Not so much in there not being any but there being many, overlapping, and running in parallel intervals used for measuring success, updating systems, providing services, and interacting with the GIS beyond the urban limits of the AEGIS. It represents the most evolved Systems of SCPs (SoSCPs) with the public sphere.

Cyber-physical systems (CPSs) are composed of hybrid components such as hardware (e.g., sensors, devices, and networks) and software, which can even be integrated at runtime. Horváth [79] observes that the complexity, emergent properties, and adaptability of CPSs have increased substantially in the past decade in order for CPSs to be compatible with different components and changes in their surrounding environment. Moreover, CPSs are characterized by a high level of

402 Volkov, A., 2018. Smart city: convergent socio-cyber-physical complex. In *MATEC Web of Conferences* (Vol. 251, p. 03065). EDP Sciences.

uncertainty, which is difficult to address with current design methods [79, 91, 107]. Socio-cyber-physical systems (SCPSs) have been developed as a type of CPSs where human concerns are considered during the development process (i.e., at design time) and during execution (i.e., at runtime). Many SCPSs should ideally be able to adapt to changing conditions in order to reach an optimal symbiosis with users and their contexts [79]. Examples include existing systems such as air traffic control systems, and emerging ones such as smart homes/cities [148], human-oriented services exploiting the Internet of Things (IoT) [161], adaptive Systems of Systems (SoS) [46], and intelligent production networks [63]. In some contexts, a SCPS may no longer accomplish what it was intended to do or meet its goals. Self-adapting systems are capable of detecting such situations and change their own behaviour accordingly.[403]

How then do we build and manage SCPs and SoSCPs? Using SMBSE and Kaizen Gemba might help us refine convergent and dynamic systems, but we need to focus on the initial process of system creation which allows SEs to better set guidelines for the initial black box algorithms which will move emergently towards yet to be determined goals.

The development process of SCPSs faces several challenges. These challenges have been identified in the literature with a particular focus on SCPSs [79, 100]:

- Modeling user goals in addition to hardware and software elements [79, 100, 146].
- Managing traceability between goals, requirements, design, and implementation artifacts [38, 52, 100, 146]
- Dealing with emergent properties [79, 100].
- Managing a high level of uncertainty [38, 52, 79, 100]
- Reducing complexity [79, 100].

403 Anda, A.A., 2020. *Combining Goals and SysML for Traceability and Decision-Making in the Development of Adaptive Socio-Cyber-Physical Systems* (Doctoral dissertation, Université d'Ottawa/University of Ottawa).

• Adapting behaviour according to external/internal changes [79, 100].

• Getting access to suitable tool support [72].

• Defining a well-defined RE process [38, 52, 100] as many ad-hoc steps have been used when developing modern SCPSs using traditional RE processes [42].

• Dealing with a large number of requirements [72, 100].

• Continuously monitoring system functionality and quality at designtime and runtime (e.g., along the MAPE steps) [38, 52, 72, 79, 100].

• Specifying the design space that describes possible design alternatives, their interdependencies, and the decisions designers should make [38, 52].

• Using precise and quantitative analysis [100] to assist and speed up the product line process, system reuse [127], system verification, and simulation at design time [49], as well as to support self-adaptation and quality monitoring at runtime [47, 146].[404][405]

As we see, pre-modelling also matters. We cannot escape the use of algorithmic tools to plan and manage algorithmic systems. SMBSE relies on complex software built to assess and manage other complex software. In this way we face the dilemma predicted by the discursive theorists of technosociology. How do we use potentially flawed, likely violent algorithms to find and correct other flawed violent algorithms? In some sense we cannot escape the gravity of our social mass – we are stuck with the biases of our programmers. We must engage the SEs on a project and hope that they are able to use multiple tools and plan contingencies for emergent responses from a system which deviate from desired goals.

Socio-cyber-physical systems (SCPSs) have emerged when social concerns, typical of socio-technical systems (STSs), became part of cyber-physical systems (CPSs).

404 Anda, A.A., 2020. *Combining Goals and SysML for Traceability and Decision-Making in the Development of Adaptive Socio-Cyber-Physical Systems* (Doctoral dissertation, Université d'Ottawa/University of Ottawa).
405We have the reference sections left in to the quote above so SEs can trace the underlying research.

Common examples of SCPSs include air traffic control systems, intelligent transportation systems, smart cities, smart homes, and adaptive Systems of Systems (SOSs). These systems consider human concerns in addition to more conventional cyber, software and hardware concerns and components. Due to environmental and situational changes, some SCPSs may also need to adapt dynamically to reach an optimal symbiosis between users and their contexts.[406]

These hypothetical systems engineers will need to acknowledge and address the symbiosis involved. The tools within their quiver include qualitative and quantitative analysis, establishing traceability of emergence as well as governance models, planning both requirements engineering and process re-engineering process in advance of the initiation of the SCP, and integrating the SMBSE type tools applicable to the particular SCP or SoSCP.

Due to SCPSs complexity the behaviour of the whole cannot be inferred from the behaviour of individual parts, and under certain conditions there are unexpected phenomena that lead to the destruction or failure of the functionality of a given of SCPSs. It is about: suddenly emerging features of behaviour that cannot be derived from knowledge about the behaviour of components (it is so-called emergence); hierarchy; self-organization; and a diversity of management structures that together resembles chaos.[407] … model-driven engineering (MDE) approaches and goal-oriented requirements engineering (GORE). current requirements engineering (RE) activities and languages need improvement in order to satisfy the emergent needs of SCPSs and adaptive systems. The integration between MDE and GORE shows potential as a solution here. Such integration could be particularly realized with two standard languages: 1) the Systems Modeling Language (SysML) for software and hardware elements , and 2) the Goal- oriented Requirement Language (GRL)

406 Anda, A.A., 2018, August. Modeling adaptive socio-cyber-physical systems with goals and SysML. In *2018 IEEE 26th International Requirements Engineering Conference (RE)* (pp. 442-447). IEEE.

407 Prochazkova, D. and Prochazka, J., 2021. Tool for Risk-Based Operation of Socio-Cyber-Physical Systems. *Journal of Brilliant Engineering*, 4, pp.20-28.

for stakeholder goals and adaptation support.[408]

We can now say that for systems-of-systems of the most complex form, the panoply of management structures will mimic chaos. An AEGIS therefore can be expected to reflect patterns of overlapping and competing chaotic states that can best be modelled after nature – ergo the notion of biomes and ecumenes. The whole language of SCPs reflects the symbiosis and chaos of a fully living system. In humans emergence could better called free will. Do these AIs have free will? In a functional sense, yes. In a sapient sense – not at all. They are human programmed human focused systems which layer complexity to more effectively mimic the least complicated human behaviours and emotionological states. They achieve emergence to better provide service to human agents to achieve programmed goals and then the open convergence oriented end state options their agent / consumers help them co-create. But they are essentially alive – they react, they reproduce, they adapt and evolve, they live and can die, they pass on offspring in improved and updated systems, they have the ability to move through a GIS and to memetically pass on their algorithmic "DNA". So we need to treat them as a living entity within a living world. As an ecumene built of biomes which just happen to be both human and digital, in an ecosystem that is mostly ones, zeros, network cables, and servers, and the urban spaces vehicles or smart devices that connect to them.

To cope with that level of constant metamorphosis, mathematicians turn to the study of non-linear chaotic dynamical systems – maximum chaos, minimum predictability.[409] This filed has in recent years been at the forefront of finding logical inferences and mathematical solutions to literal chaos and establishing functionality and predictability within apparently chaotic systems of unlimited and potentially infinite open ended dynamism. Weather systems, economics across regions, natural ecosystems.[410] It follows that any tools needed to manage a SoSCP will need to be aligned with the mathematical

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408 Anda, A.A., 2018, August. Modeling adaptive socio-cyber-physical systems with goals and SysML. In *2018 IEEE 26th International Requirements Engineering Conference (RE)* (pp. 442-447). IEEE.

409 Devaney, R.L., 2018. *A first course in chaotic dynamical systems: theory and experiment*. CRC Press.

410 Devaney, R.L., 2018. *A first course in chaotic dynamical systems: theory and experiment*. CRC Press.

tools that can provide modelling. Hetero-functional graph theory serves such a purpose.

> Perhaps such smart cities are best viewed as the ultimate engineering system: A class of systems characterized by a high degree of technical complexity, social intricacy, and elaborate processes aimed at fulfilling important functions in society... Hetero-functional graph theory relies on multiple graphs as data structures so as to support quantitative analysis. It also explicitly embodies the heterogeneity of conceptual and ontological constructs found in model-based systems engineering. Its application to interdependent smart city infrastructures of arbitrary topology presents a highly demanding use case. Hetero-functional graph theory can be viewed as an intellectual fusion of model-based systems engineering and network science.[411]

While weather prediction and economic modelling may not be traditional fields of engineering, systems engineering's multidisciplinary nature means that whenever and wherever cognitively aligned ambient systems meet human need, we will see SEs managing the back-end cyber-physical solutions. More to the point, because they deal with human needs and socially constructed outcomes, the modelling tools are by their design SCPs which help engage other SCPs and SoSCPs.

> Systems engineering, and more recently model-based systems engineering, emerged as a practical and interdisciplinary engineering discipline that enables the successful realization of complex systems from concept, through design, to full implementation. It is well-equipped to deal with systems of ever-greater complexity; be they for the greater interaction within these systems or be- cause of the expanding heterogeneity they demonstrate in their structure and function. Notable human achievements like sending a man to the moon or landing on the surface of Mars can certainly be attributed to the effective practice of systems engineering. Despite these achievements, model-based systems engineering, however, relies till today on graphical modeling languages that provide limited quantitative insight. In contrast,

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411 Schoonenberg, W.C., Khayal, I.S. and Farid, A.M., 2019. *A hetero-functional graph theory for modeling interdependent smart city infrastructure*. Springer International Publishing.

network science has emerged as a scientific discipline for quantitatively analyzing networks that appear in fields across the natural, social, and engineering sciences. And yet, network science, due to its reliance on graphs as a data structure, was often unable to address the explicit heterogeneity often encountered in the systems engineering field. Even the network science developments into multi-layer networks have been recognized to have significant limitations in modeling networked systems of arbitrary topology. Despite these methodological differences, these two informatic sciences have often tackled similar intellectual challenges. For example, both fields have contributed immensely to the knowledge of system life cycle properties like centrality, modularity, flexibility, sustainability, and resilience.[412]

We know that AI systems respond best to certain kinds of design and at present, micro service oriented cloud enabled design leads the essential programming format with service oriented architecture (SOA) the "correct" format to build microservice AIs upon platform and infrastructure layers. Smart City designers using SMBSE agree with this functional / operational design methodology:

[SMBSE would become] a structured integration between a basic SoS architecture applied to smart city use cases and a comprehensive SoS engineering approach based on SOA.[413] … It is clear that smart city functionalities have to be addressed using some type of system of systems (SoS) thought and architecture: the usage of service-oriented architecture (SOA)and micro-services,as a well-accepted approach. The engineering of SoS SOA solutions has been … to a large extent, the dominant approach for creating automation and digitalization solutions in industrial production, smart grids, smart environments, etc.[414]

We can also turn to GIS and see in the smaller unit of Information Systems (IS), theer

412 Schoonenberg, W.C., Khayal, I.S. and Farid, A.M., 2019. *A hetero-functional graph theory for modeling interdependent smart city infrastructure*. Springer International Publishing.

413 Delsing, J., 2021. Smart City Solution Engineering. *Smart Cities*, *4*(2), pp.643-661.

414 Delsing, J., 2021. Smart City Solution Engineering. *Smart Cities*, *4*(2), pp.643-661.

are clearly trends of thought that acknowledge the growing power and complexity of AmI and SCPs. What started as an independent system resting as software in a network has grown in the minds of designers to something larger and far more interconnected.

> The International Conference on Information Systems (ICIS) calls for papers in such topics as Human Computer / Robot Interactions & Interfaces; Analytics and Data Science; Crowds, Social Media and Digital Collaborations; Mobile, IoT and Ubiquitous Computing; Smart Cities and Digital Government; and Smart Service Systems and Service Science in line with the more traditional ones. This shows that an IS now shall concern physical devices, different emerging data sources, and serve for systems of arbitrary combinations of such substances as social, cyber and physical systems. Actually an IS itself often is a SCPS "any configuration of a system that collects, organizes, stores, and distributes information" , where socio, cyber and physical (sub)systems can be receivers, handlers and providers of information. In the context of SCPSs, an essential aspect of an IS is emergence (consider net- works, open data, system collaboration, etc.), because not all issues regarding the IS can be under the control in SCPSs.[415]

While mathematicians favour MATLAB and Mathematica to manage their systems review including Hetero-functional Graph Theory (HFGT), SCP engineering relies on other modelling which has been proven limited in understanding the whole ecosystem. "Well-known frameworks for modeling socio-cyber-physical systems: namely, the enterprise architecture modeling language ArchiMate, Industry 4.0 Reference Architecture Model RAMI 4.0, and St. Alter's Work Systems framework [but as analysis revealed] none of [sic] discussed frameworks currently provide means for transparently distinguishing between all types of systems (social, cyber, physical and their combinations)."[416] Put another way, SMBSE and similar methods cannot be fully implemented, because existing modelling and system management tools have not

415 Kirikova, M., 2019, June. Challenges in enterprise and information systems modeling in the contexts of socio cyber physical systems. In *Workshop on Enterprise and Organizational Modeling and Simulation* (pp. 60-69). Springer, Cham.

caught up with the speed and complexity of AEGIS growth.

In socio-cyber- physical systems, requirements cannot be defined just for the cyber space, but must cover also the socio and physical spaces. There are also highly complex interrelationships, interactions and impacts between components of systems that can lead to unexpected and even unacceptable consequences in system structure and behaviour. One of the promising approaches supporting adaptability and emergency of systems is continuous requirements engineering, based on agility, flexibility and emergence.[417]

Let us not give up hope. One set of potential tools for SMBSE / Kaizen Gemba / HFGT which may allow us far more insight and control than previous iterations of partial toolsets and SCPs which monitor SCPs: Hetero-functional Graph Theory Toolbox and its associated Petri net Graphical User Interface.

The toolbox and GUI are written in the MATLAB language and has been tested with v9.6 (R2019a). It is openly available on GitHub together with a sample input XML file for straightforward re-use. The paper details the syntax and semantics of the XML input, the myLFES (large flexible engineering system) data structure at the core of the toolbox and the functions used to construct and populate this data structure. The paper also details the syntax and structure of the input scheduled event list, the myPetriNetwork, and the operation of the GUI. The toolbox has been fully validated against several peer-review HFGT publications. The development of a streamlined, computationally efficient, and openly-accessible toolbox and GUI that automates and visualizes the underlying mathematical operations of HFGT enables the broader scientific community to apply HFGT to a wide variety of highly inter- connected and heterogeneous engineering systems. Thus, this work enables several avenues for

416 Kirikova, M., 2019, June. Challenges in enterprise and information systems modeling in the contexts of socio cyber physical systems. In *Workshop on Enterprise and Organizational Modeling and Simulation* (pp. 60-69). Springer, Cham.

417 Lace, K. and Kirikova, M., 2018. Required Changes in Requirements Engineering Approaches for Socio-Cyber-Physical Systems. In *REFSQ Workshops*.

future research; particularly in the analysis, design, planning and operation of systems-of-systems. [418]

It would seem that proper SMBSE will require in depth grasp of HFGT for any mathematically and technically focused engineering team. We should go as far as to say with confidence that any group attempting to build or manage an AEGIS will need several members of the interdisciplinary team to have strong backgrounds in both SMBSE and HFGT, know the tools available, and be able to provide real-time modelling support. So far we know HFGT serves to model multi-disciplinary engineering systems. Hetero-functional graph theory allows for the integration of layers of networks without the constraints imposed by previous methods.[419] "Hetero-functional graph theory is based upon three abstract concepts which may be found in the systems engineering and engineering design literature: (1) Allocated Architecture, (2) Hetero-functional Adjacency Matrix, and (3) Controller Agency Matrix."[420]

A recently published 2021 dissertation, *Engineering Systems: Structure, Behavior, and Optimization with Hetero-Functional Graph Theory,* covers the strengths (and very limited weaknesses) of HFGT for systems engineering:

> Hetero-functional graph theory was found to be a novel, ontologically clear quantitative structural modeling framework for representing engineering systems. Thereafter, it was shown that hetero-functional graph theory serves as a foundation for the development of a dynamic system model for engineering systems. Finally, the dissertation has shown how to develop an optimization program for hetero-functional graph theory based dynamic models. Hetero-functional graph theory is

418Thompson, D., Hegde, P., Schoonenberg, W.C., Khayal, I. and Farid, A.M., 2020. The hetero-functional graph theory toolbox. *arXiv preprint arXiv:2005.10006*.

419Schoonenberg, W.C. and Farid, A.M., 2017, October. Modeling smart cities with hetero-functional graph theory. In *2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC)* (pp. 1627-1632). IEEE.

420Schoonenberg, W.C. and Farid, A.M., 2017, October. Modeling smart cities with hetero-functional graph theory. In *2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC)* (pp. 1627-1632). IEEE.

shown to provide a novel approach to modeling the structure of large flexible engineering systems such that it enables simulation and optimization of the behavior of such systems.[421]

Excerpted below, this critical passage relays to us how utilise HFGT to engage the kinds of systems which comprise an AEGIS. This strongly confirms the direction of our systems engineering methodology and theory. We want to assemble a validated and stable team of interdisciplinary designers and engineers who have broad capabilities in socio-cyber-physical systems-of-systems, service oriented architecture in a cloud micro-services milieu, IoT and IoP integration skills, telecommunications and network deployment experience, urban planning software and design credentials, and lastly – HFGT expertise to pull together the entirety of these skills with modelling tools.

The foundation of hetero-functional graph theory is specifically built on the ontological properties of soundness, completeness, lucidity, and laconicity, introduced in Section 2.3.1 on Page 43. Recall that the traditional application of graph theory violates the properties of completeness and lucidity as it (1) fails to represent the complete set of concepts in the domain abstraction with modeling primitives, and (2) overloads modeling primitives with multiple domain concepts. Hetero-functional graph theory maintains the four ontological properties to ensure an isomorphic representation of the conceptual abstraction. The diverse nature of large flexible engineering systems require a diverse language, and the seven models in hetero-functional graph theory provide the necessary breadth. All Large Flexible Engineering Systems (LFESs) consist of a structural model, a controller model, and an operand behavior model. The structure of an LFES is modeled using capabilities, as processes mapped onto resources, and the hetero-functional adjacency matrix, as a definition of system sequence. The sets of processes and resources are defined as mutually exclusive and collectively exhaustive, which ensures an isomorphic

421 Schoonenberg, W.C., 2021. *Engineering Systems: Structure, Behavior, and Optimization with Hetero-Functional Graph Theory* (Doctoral dissertation, Dartmouth College).

representation of the physical structure.[422]

Critical Value to the Ambient Ecumene: SCPSs

SCPSs deliver a working model for the AEGIS which can be addressed by SMBSE, Gemba Kaizen, micro-services cloud SOA, and HFGT tools.

Critical Value to the Ambient Ecumene: SoSCPSs

SoSCPSs deliver a working model of the most complex of non-linear chaotic dynamical systems which require HFGT and similar mathematical tools to properly design and implement.

Core Technology and Systems of the AEGIS

As we transition from the essential methods and theory essential to deploying a systems-of-systems, we can now think ahead to what specific technology and systems comprise an AEGIS. Our brief flirtation with SMBSE and HFGT has already predisposed us to look for interpenetrated complexity which appears to be as dynamic, chaotic, and non-linear as any biological ecosystem. But in every ecosystem there are biomes filled with niche species both flora and fauna. What follows in the Core Technology section then are the critical assessments of these species of socio-cyber-physical systems which merge and intertwine to become SoSCPs.

The Internet

While everyone knows what the Internet is – you log onto the World Wide Web using a computer or smartphone – very few truly understand how the Web works at an engineering level. For the purposes of studying the AEGIS, we need to fraps the fundamental contours of the digital biome that comprises each material and digital

422 Schoonenberg, W.C., 2021. *Engineering Systems: Structure, Behavior, and Optimization with Hetero-Functional Graph Theory* (Doctoral dissertation, Dartmouth College).

component of the ecumene.

> To facilitate data communication, people use a worldwide network of connected computers. This network of interconnected heterogeneous networks (or Autonomous Systems (ASes)) constitutes the Internet. It builds upon a set of key principles, e.g., store and forward packet switching, decentralization, separation, encapsulation and protocols, e.g., the Internet Protocol (IP), the Border Gateway Protocol (BGP), Transmission Control Protocol (TCP), and User Datagram Protocol (UDP). Despite the massive transformation in terms of end users, applications, and business values, from a macroscopic perspective the fundamentals of the Internet have been surprisingly stable. The current Internet comprises tens of thousands of interconnected ASes. They are not randomly connected but the sum of AS-pairs' interconnections generate a hierarchical topology of the Internet from a macroscopic perspective... The topology of the Internet is constructed by the interconnection policy and the spatial footprint of each AS. The interconnection policies determine how reachability information propagates in the Internet and reflect commercial intentions. Note, the common goal for every AS is global reachability with the best performance (e.g., capacity, latency) for the lowest price.[423]

These autonomous systems rely on complex network loaders and balancers to provide access between nodes of their interconnected heterogeneous networks. While the Internet may be thought of as a set of switches and network cables routing millions of individual computers and data centres, it has at its root a great deal of software built on AI which handles various forms of request, network traffic, power usage, and connections between entities:

> They are classified into the following three major categories: customer-to-provider (c2p), sibling-to-sibling (s2s), and peer- to-peer (p2p). In a c2p (e.g.,transit,paid peering) relationship, the customer-AS pays the provider-AS for traffic transiting

423 Dietzel, C., 2019. *Improving Security and Resilience Capabilities of the Internet Infrastructure* (Doctoral dissertation, Technische Universität Berlin).

through this interconnection. The customer, in turn, gets access to the ASes the provider can reach. This includes those ASes the provider obtains through its individual providers. A transit-AS customer can access the entire Internet through only one provider. According to AS Assignment Policies issued by RIPE an AS needs two transit providers, i.e., being multihomed, to qualify for AS registration. This policy aims to assure robustness towards transit connectivity disruptions. Transit is a metered service typically measuring the 95th percentile of the transited traffic volume to calculate the monthly fee. It often comes with traffic volume commits, discounts, and Service-Level Agreements (SLAs). In the s2s category both ASes belong to the same organizational domain, due to either merge and acquisition or because of administrative aspects (e.g., distinct ASes for different regions or product lines). The s2s category implies freely exchanged traffic between their providers, customers, or other siblings. In contrast, p2p are relationships (i.e., peerings) where ASes reciprocally provide access to their customers at settlement-free terms. However, they do not exchange traffic from or to their providers, and it is by definition not a transitive relationship. Thus, it is not a substitute for transit even if it can be optimized to cover the majority of traffic.[424]

As the excerpt from the the doctoral dissertation *Improving Security and Resilience Capabilities of the Internet Infrastructure* demonstrates, the physical complexity of the Internet rivals almost any SoSCP without recourse to looking at the AEGIS. We can safely assume The Internet – though disembodied in the sense of an urban space – can be considered an AEGIS unto itself.

Internet Exchange Points (IXPs) are a physical infrastructure housed in colocation facilities and composed of Layer-2 (L2) Ethernet switching fabric which interconnect edge routers of AS members [36, 188]. The geographic agglomeration of the peering activity has led to an increasingly symbiotic relationship between IXPs and colocation

424 Dietzel, C., 2019. *Improving Security and Resilience Capabilities of the Internet Infrastructure* (Doctoral dissertation, Technische Universität Berlin).

facilities: IXPs benefit from placing their switches in locations where ISPs can easily install their network equipment, while facility operators often benefit from higher demand for colocation space [44, 276]. These mutual interconnection incentives create tight physical interdependencies between IXPs and facilities. Studies show that IXPs enable hundreds of thousands of peerings [36], the large majority being multi-lateral peerings[209, 269]. Traffic exchanged at IXPs has increased significantly in recent years [188], exceeding 6 Tbps at large IXPs. In the digital age access to information is critical. The Internet facilitates easy access to any information at any point in time. Peering infrastructures are an essential part of the backbone and play a critical role in assuring continuous operation of the Internet. The Internet's topology and peering relationships rely heavily on IXPs.[425]

These Autonomous Systems reliance on interconnected heterogeneous networks require both physical and digital support. Another way to conceptualize them would be to determine where and when the data flows and from what kinds of nodes. "Energy usage demonstrates that data centres are the core interactive systems to uses ASes to contact and engage IXPs. Data centres are industrial-scale organisations offering the storage and delivery of data via the internet. They represent the fastest growing user of IT energy, consuming 3 percent of all global electricity, with this share growing by 12 percent a year."[426]

What has causes such an enormous jump – 400% - in total usage? "Cloud computing – the online storage of and real- time remote access to data – on which Facebook and other social networks and online services are based, has particularly contributed to the enormous growth of the IT industry and its energy use."[427]

Cloud computing and social media then both rely on the Internet and help co-create

425 Dietzel, C., 2019. *Improving Security and Resilience Capabilities of the Internet Infrastructure* (Doctoral dissertation, Technische Universität Berlin).

426 Vonderau, A., 2019. Scaling the cloud: Making state and infrastructure in Sweden. *Ethnos*, *84*(4), pp.698-718.

427 Vonderau, A., 2019. Scaling the cloud: Making state and infrastructure in Sweden. *Ethnos*, *84*(4), pp.698-718.

its modem contours. From a military viewpoint the Internet began as a DARPA project to establish communication redundancies for times of disaster and grew into something far more robust:

> An important starting point is to understand what the Internet is and how it works. The Internet is a global network of interconnected computer networks that communicate with each other through layered protocols. The Open Systems Interconnection (OSI) model of Internet layers is "widely accepted as a basis for the understanding of how a network protocol stack should operate and as a reference tool for comparing network stack implementation" In the OSI model, "each layer provides a set of functions to the layer above and, in turn, relies on the functions provided by the layer below."[428]

As an AEGIS requires connection to Global Information Systems, we can safely assume that any functional ambient ecumene disconnected from the Web will be unable to become fully emergent as an ecosystem. The Web and GIS are to some degree synonymous entities – the Internet carries in its networks all the various IS which when extended to a worldwide audience become a GIS.

> The Internet and specifically the World Wide Web (henceforth, Web) has emerged as a platform with a massive capacity for global information exchange with social, economic, political and cultural consequences. Studies find that global information and communication flows on global telecommunications networks (including the Internet) have decentralized as well as diversified over time. With increasing access to and use of information and communication technologies around the world, people in the erstwhile "peripheral" countries communicate with one another directly, and such communication is no longer routed through core countries.[429]

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428 Moeller, B.T., 2020. *Synthetic network generation and vulnerability analysis of internet infrastructure systems in the US Virgin Islands*. NAVAL POSTGRADUATE SCHOOL MONTEREY CA.

429 Taneja, H., 2017. Mapping an audience-centric World Wide Web: A departure from hyperlink analysis. *New Media & Society*, *19*(9), pp.1331-1348.

The nature of the Web then is to precipitate the formation of GIS from peripherally connected IS. But there must also be a social capability to the process if the Internet has changed the structure and function of human behaviours in relation of entire information systems. "The structure of the Web obtained [by complex analysis] exhibits the tendency of audiences to gravitate towards culturally proximate content... mapping the Web as a network of shared audience traffic reveals the contours of how as divergent social groups join the Web; they take over its topography heterogeneously and unevenly, revealing aspects that cannot be fathomed from maps of technical features alone."[430] Thus all Web enabled or web delivered GIS are functionality SoSCPs.

> The Web provides access to a digital compendium of information that is unprecedented in terms of its scale, scope and accessibility. It is, in addition, a resource that plays an ever-greater role in shaping our epistemic capabilities at both an individual and collective level. The Web is, as such, a valuable form of epistemic infrastructure for our species, influencing the kinds of beliefs we form and providing a platform for us to discover, manage and exploit epistemic resources.[431]

As the quote above reminds us, we need to keep in mind that as we consider any socio-cyber-physical system, we must consider how the epistemology of the design and delivery affects the Foucauldian episteme that pervades the artefacts and intentions of the system. Who owns the Web and how do they manage the resources which provide global epistemic engagement with critical knowledge and services. We must delve into the choke points, keys areas of ownerships, monetisation of the Web, and the divisions between physical and digital infrastructure

> That said, there are considerable choke points which are under direct national control. In the case of root functions, much of them reside in the USA such as domain name systems (DNS) and Internet protocol (IP) addresses, are "point[s] of

430 Taneja, H., 2017. Mapping an audience-centric World Wide Web: A departure from hyperlink analysis. *New Media & Society*, *19*(9), pp.1331-1348.
431 Smart, P.R. and Shadbolt, N., 2018. The world wide web. Applied Epistemology.

centralization" (Mueller, 2002, pp. 6–8) and therefore fundamental political resources to obtain. Known as networks of networks, the current global Internet originated from a U.S.-based infrastructure by the Department of Defense that logically became the manager of DNS in early days. With the growth of the Internet in the 1990s, the U.S. government transformed its control into the nonprofit, self-governing entity, Internet Corporation for Assigned Names and Numbers (ICANN), which has since been an important unit in global Internet regime (Kruger, 2015). ICANN adopts a multistakeholder approach of policy making, which is, supposedly, an independent and democratic process supporting the free flow of information and equal distribution of governance power across the private sector, governments, and new global institutions (DeNardis, 2014). Contrary to this claim, ICANN was largely a U.S. proxy under the oversight of the Department of Commerce.[432]

The United States therefore controls some of the most essential network and information management tools of the Internet. In response, Chinese and Indian companies started assuming greater control of submarine cables, data centres, and IXPs. This establishes balance between social and economic rivals but poses some questions for engineers. Does this split ownership change the Web's control mechanisms? It must. But to what degree?

A cyber sovereignty agenda has been promoted in response to the complex and contested external influences from "supranational entities, corporate infrastructures and networked publics". As an official report asserts, the Internet within Chinese territory is under the jurisdiction of Chinese sovereignty, which should be respected and protected . Xi Jinping (2015) further elaborated at the second World Internet Conference, "We should respect the right of individual countries to independently choose their own path of cyber development, model of cyber regulation and Internet public policies, and participate in international cyberspace

432 Tang, M., 2020. Huawei Versus the United States? The Geopolitics of Exterritorial Internet Infrastructure. *International Journal of Communication*, *14*, p.22.

governance on an equal footing". [433]

Moreover, commercial interests have established a monopolistic attitude towards the physical backbone of the Web – submarine cables:

> As of the end of 2016, the global internet's backbone consisted of 356 international submarine cables with a total length of about 1.3 million kilometers. Currently, 99 percent of all international internet traffic travels through these cables: a single fiber pair in a submarine cable (which typically has a dozen or so fiber pairs) can carry as much traffic as all the geosynchronous satellites orbiting the planet combined. Within North America, for example, mobile wireless traffic equals 1 percent of all internet traffic; the rest is carried by fiber optic cables and copper line infrastructure. The transmission capacity of the world's cable system is massive whereas it was extremely limited in the past: today one exabyte of data transits the internet every day, the equivalent of 212 million DVDs or the contents of the British Library or the US Library of Congress several hundred times over.[434]

The legal regime regarding these should be considered. We have established that almost all major GISs run through the Web. What happens to the information if someone tries to spy on it or destroy a submarine cable? Besides the obvious issues of AmIs subverting human agents, what potential exists for human agents to subvert the AmI's in the Web? The legal position below (excerpted in full) establishes our baseline understanding of the issue.

> The Legal Regime Governing Telecommunications Cables: The laws regarding passage and usage of the seas are established by the United Nations Convention on the Law of the Sea (UNCLOS; United Nations, 1982), other treaties, and customary international law, which establish certain sovereign and jurisdictional rights for

433 Tang, M., 2020. Huawei Versus the United States? The Geopolitics of Exterritorial Internet Infrastructure. *International Journal of Communication*, *14*, p.22.

434 Winseck, D., 2017. The geopolitical economy of the global internet infrastructure. *Journal of Information Policy*, *7*, pp.228-267.

coastal states, depending on the distance from their coasts. These rights are generally most extensive in a nation's territorial waters, and diminish with distance through the contiguous zone, EEZ, continental shelf, and high seas.

International treaties dating back to 1884 guarantee unique freedoms to lay, maintain, and repair submarine cables not only on the high seas, but on the continental shelf and in the EEZ, making them among the most protected of marine activities (Convention, 1884; United Nations, 1958a). As the most comprehensive oceans-related treaty, UNCLOS is the applicable legal regime governing submarine cables and treated as customary international law, even by states that have not ratified them, including the United States (Presidential Proclamation No. 5030, 1983; Presidential Proclamation No. 7219, 1999). As a result, undersea telecommunications cables hold a "privileged place in international law, reflecting their status as an essential public good"[435]

Undersea cables are in and of themselves both protected by law and protected by their geographic position – the coastline quickly pass crush depth for all but the most expensive submarine vehicles. 98% or more of the cables are beyond human reach without extraordinary measures. But not 100% and even those can be compromised with the correct tools. "Synthetic [network modeling proves that the internet] is vulnerable to fiber cuts that can disconnect all households and critical facilities from the Internet.[436] As such, these submarine cables represent a critical infrastructural element that like IXPs and data centres represent a core node of the World Wide Web."[437]

Who owns the actual fibres and cables then? They would be charged with safeguarding them at vulnerable spots and repairing any damage done by the modelled

435 Howe, B.M., Arbic, B.K., Aucan, J., Barnes, C.R., Bayliff, N., Becker, N., Butler, R., Doyle, L., Elipot, S., Johnson, G.C. and Landerer, F., 2019. SMART cables for observing the global ocean: Science and implementation. *Frontiers in Marine Science*, *6*, p.424.

436 Moeller, B.T., 2020. *Synthetic network generation and vulnerability analysis of internet infrastructure systems in the US Virgin Islands*. NAVAL POSTGRADUATE SCHOOL MONTEREY CA.

437 Moeller, B.T., 2020. *Synthetic network generation and vulnerability analysis of internet infrastructure systems in the US Virgin Islands*. NAVAL POSTGRADUATE SCHOOL MONTEREY CA.

attacks. While it had been a small monopoly group, the co-creative nature of the Internet AEGIS has changed not just what gets built but who chooses to build it.

> US-based internet giants Google, Facebook, and Microsoft [now directly compete for submarine cable ownership and leasing with] Level 3, Global Cloud Xchange, and Tata who own and operate most existing cables. In addition, these US internet companies are among the biggest nontraditional carriers that sell capacity on a wholesale basis. Other members of this group include Cogent, PCCW, XO, Global Transit, Globe Transit, and Hurricane Electric. Another group of relative new- comers is building (or leasing) and operating content delivery networks (CDNs) that carry traffic for large corporate and government users, media and entertainment companies, and the biggest internet companies. Seven such companies stand out worldwide: Amazon, Akamai, China Cache, Level 3, Verizon, Limelight, and Highwinds. The top four such firms account for 93 percent of all CDN traffic.[438]

The control of Internet Exchange Points co-location infrastructure has been less quick to consolidate. As such there are niche players and local controllers who manage clusters of IXPs. That said, Google and Facebook have vertical control in some markets and regions of both the submarine cable and the IXPs.

> International internet backbone providers, internet content companies, and CDNs interconnect with local ISPs and at one or more of the nearly 2000 IXPs around the world. The largest IXPs are in New York, London, Amsterdam, Frankfurt, Seattle, Chicago, Moscow, Sao Paulo, Tokyo, and Hong Kong. They are core elements of the internet that switch traffic between all the various networks that comprise the internet system, and help to establish accessible, affordable, fast, and secure internet service. In developed markets, internet companies such as Google, Baidu, Facebook, Netflix, Youku, and Yandex use IXPs to interconnect with local ISPs such as Deutsche Telecoms in Germany, BT or Virgin Media in Britain, or Comcast in the United States

438 Winseck, D., 2017. The geopolitical economy of the global internet infrastructure. *Journal of Information Policy*, *7*, pp.228-267.

to gain last-mile access to their customers—and vice versa, back up the chain. Indeed, 99 percent of internet traffic handled by peering arrangements among such parties occurs without any money changing hands or a formal contract.[439]

WORLD INTERNET USAGE AND POPULATION STATISTICS 2021 Year-Q1 Estimates						
World Regions	Population (2021 Est.)	Population % of World	Internet Users 31 Mar 2021	Penetration Rate (% Pop.)	Growth 2000-2021	Internet World %
Asia	4,327,333,821	54.9 %	2,762,187,516	63.8 %	2,316.5 %	53.4 %
Europe	835,817,920	10.6 %	736,995,638	88.2 %	601,3 %	14.3 %
Africa	1,373,486,514	17.4 %	594,008,009	43.2 %	13,058 %	11.5 %
Latin America / Carib.	659,743,522	8.4 %	498,437,116	75.6 %	2,658.5 %	9.6 %
North America	370,322,393	4.7 %	347,916,627	93.9 %	221.9 %	6.7 %
Middle East	265,587,661	3.4 %	198,850,130	74.9 %	5,953.6 %	3.9 %
Oceania / Australia	43,473,756	0.6 %	30,385,571	69.9 %	298.7 %	0.6 %
WORLD TOTAL	7,875,765,587	100.0 %	5,168,780,607	65.6 %	1,331.9 %	100.0 %

[440]

In the article The geopolitical economy of the global internet infrastructure we can see that not only is The Web a SoSCP, it has every earmark of algorithmic violence and epistemic conflict. The economic benefits of managing 99% of the world's information traffic cannot be understated. While no one entity has achieved monopoly, the beginnings of vertical choke points established by GAFAM and horizontal chokeholds on major infrastructure as Tata, Level 3, Global Cloud Xchange, and Verizon presently have established, reveal the normally inviable nature of violent struggle to seize resources for in groups and cause either economic or social loss for their rivals and enemies. Control of the world's most desired GIS has become a point of geopolitical contention which has seen diplomatic rows, sanction, and wars erupt in tandem with the more subtle epistemic disturbance and brutality inherent to the SoSCP.

The internet infrastructure of the twenty-first century, much like that of the industrial

439 Winseck, D., 2017. The geopolitical economy of the global internet infrastructure. *Journal of Information Policy*, *7*, pp.228-267.

440 Internet World Stats. "Internet Usage Statistics." http://www.internetworldstats.com/stats.html 2021

information infrastructure of the past 150 years, is still primarily financed, owned, and operated by many multinational consortia, although more than a few submarine communications cables are now owned by a relatively new roster of competitive players, such as Tata, Level 3, Global Cloud Xchange, and so forth. They have arisen mostly in the last 20 years and from new quarters, such as India in the case of Tata, for example. Like the world economy overall, the geography of the internet is tilting away from the United States and toward Europe, the BRICS, and the "rest of the world." The US internet giants do dominate the "code" and "content layers" of the internet: that is, operating systems (iOS, Windows, Android), search (Google), social media (Facebook), and online retailing (Amazon), as well as over-the-top TV services (Netflix), although in some countries they hardly figure at all: China, Russia, Korea, and Japan. The United States, however, does not rule the "guts and the gears"—the material infrastructure, in the fashionable parlance of communication and media studies, among other social sciences and the humanities—of the internet (hardware): for example, optical fiber submarine cables, ASN, bandwidth wholesalers, CDN, and IXP. These core components of the internet are becoming more plentiful outside of, and less dependent on, the United States. The four biggest submarine optical fiber cable projects of the past decade have all been in the Asia-Pacific regions.[441]

What has prompted this scramble to control the nodes of GIS flow? The potential to exert "soft power" aka epistemic violence and the normalisation of culturally specific ways of being while achieving economic benefits. This contrasts with the costs of open warfare in terms of hard powers human and infrastructural burdens. The conquest of lifeworlds through propaganda has long been a feature of warfare. The advent of AmI and its pervasion into SoSCPS, especially GIS enabled ones (or the GIS themselves) has created new paths and more visible means to achieve the desired geopolitical result.

Social machines are systems in which human and (Web-based) machine elements are

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441 Winseck, D., 2017. The geopolitical economy of the global internet infrastructure. *Journal of Information Policy*, *7*, pp.228-267.

jointly involved in the mechanistic realization of phenomena that subtend the computational, cognitive and social domains (Smart & Shadbolt, 2014). From an epistemological perspective, a particular category of social machines are of particular interest. These are known as knowledge machines (Smart et al., 2017). A knowledge machine is a social machines that participates in some form of knowledge-relevant process, such as the process of knowledge acquisition, knowledge discovery, knowledge representation, and so on.[442]

GISs role as both knowledge machines and co-creators of a reality where human agents become cybernetic knowledge machines themselves means the two way flow of AmI interaction transmutes the Internet from a neutral object architecture to a biased and persuasive entity. "The World Wide Web delivers connectivity to over five billion people, transforming them from citizens with interest in data and communication into social machines with predictable and, at times influenceable, desires."[443]

Social engineering, the art of using people's instincts for social support and cooperation against them, has in the Internet found a medium for ruthless exploitation which takes direct advantage of human agent's inability to fully understand where they end and the GIS begins.

Searching for information, Fisher et al. (2015) suggest, "leads people to conflate information that can be found online with knowledge in the head". Similarly, Ward (2013) notes that as people turn to the "cloud mind of the internet, they seem to lose sight of where their own minds end and the mind of the internet begins. They become one with the cloud, believing that they themselves are spectacularly adept at thinking about, remembering, and locating information". [444]

More intriguingly, the Web that most of the public sees represents only a small fraction of the total traffic and nodes. The geopolitical stakes are high and we can see

442 Smart, P.R. and Shadbolt, N., 2018. The world wide web. Applied Epistemology.
443 Internet World Stats. "Internet Usage Statistics." http://www.internetworldstats.com/stats.html 2021
444 Smart, P.R. and Shadbolt, N., 2018. The world wide web. Applied Epistemology.

that inherent biases can be subverted by both human designers (and criminals) and AmIs. Even when and where explicit steps have not been taken to design into social networks and other major GISs these kinds of mistaken capabilities, there rides in the core algorithms every instinctive bias and conflation of the program team.

The Deep Web & The Dark Web

What are they trying to control? The Deep and Dark Webs which represent 90% or more of the actual Internet. More relevant, they have their own underground tax free economy. "Per the Center for Strategic and International Studies, these services and capabilities resulted in a projected annual loss to the global economy of $1.8T." [445]

Which means control of the Internet yields both economic fruit as the stakeholders gain access to that nearly $2T in "lost" funds and they also gain a foothold in influencing the most aggressive and creative of the GIS's users. Lastly, the very kinds of soft power activities that matter to geopolitical actors require extralegal methods: mind control, espionage, fraud, shell corporations hiding influence peddling and propaganda activities, extortion, blackmail, assassination, and sabotage. Warfare by any other name – the essentials of the most egregious epistemic violence.

> The openly searchable Internet, including the entire WWW, comprises only 6–10 percent of the whole Inter- net. The remaining 90–94 percent holds content that is neither indexed nor cataloged. Much of this private data includes holdings on corporate Class B and C internal networks (intranets), email and/or databases, academic journals, or individually held information. This region, known as the Deep, Hidden, or Invisible Web, tends toward security by obscurity. As such, search and direct access aren't as straightforward as is the case in the WWW... Embedded within the Deep Web is the Dark Web or Dark Net. It's here that bad actors of all stripes—script kiddies out to deface websites; professional hackers who break into corporate

445 Hurlburt, G., 2017. Shining light on the dark web. *IEEE Computer Architecture Letters*, *50*(04), pp.100-105.

and government networks to steal data, wreak havoc, and commit extortion; pedophiles circulating child pornography; drug, arms, and human traffickers; terrorists spreading propaganda, recruiting fighters, and planning attacks; digital media pirates; and cybermercenaries for rogue-state intelligence services—communicate with one another and trade in hacking tools, malware, ransomware, and various illegal goods and services. This underground market is vast enough to contain its own search engines, community forums, and rating systems just like the WWW.[446]

Cyber Westphalia

Taken one step further, some systems theorists and technosociologists have suggested that the Internet represents an arena of open conflict. Naked power grabs in the name of hegemony in the national interest have become openly discussed options among both multinationals and diplomats.

The idea that US-based internet giants like Amazon, Apple, Facebook, Google, Netflix, and Microsoft dominate the internet the world over is common—in academic writing across disciplines, the popular press, and everyday conversation. Derisory acronyms like FANG—Facebook, Apple, Netflix, and Google—capture the spirit of this idea. The US State Department's "internet freedom" agenda lends itself to the idea that US internet hegemony is promoted and girded by US foreign policy.[447]

Dubbed the "Great Systems Conflict": we are now seeing a digitized interconnected struggle between national socio-technical-economic systems in terms of their ability to withstand large-scale disruptive threats.[448] What began as dangerous and influential

446 Hurlburt, G., 2017. Shining light on the dark web. *IEEE Computer Architecture Letters*, *50*(04), pp.100-105.
447 Winseck, D., 2017. The geopolitical economy of the global internet infrastructure. *Journal of Information Policy*, *7*, pp.228-267.
448 Demchak, C., 2021. Achieving Systemic Resilience in a Great Systems Conflict Era. *The Cyber Defense Review*, *6*(2), pp.51-70.

algorithms subtle in their slow corruption of human agency has given way to open epistemic violence which in turn has been overshadowed by the notion that we can use "global cyberspace as a globally shared, complex, insecure 'substrate' underlying the critical organizations of digitized societies, creating 'cybered conflict' and a resulting, rising 'Cyber Westphalia' of sovereign competitive complex socio-technical-economic systems (STESs)." [449]

We have seen similar acronyms before. STEs and SCPs are essentially the same thing, perhaps at different scales. A STE might be consider a full digital biome or perhaps in the greater sense a technological ecumene. In response to this game for open power, some nation states have restricted their GIS capabilities through "Cyber Westphalia" – "sweeping data localization laws imposed on foreign Internet giants like Facebook, Google, Twitter, and LinkedIn, a broadening Internet censorship regime, arrests and intimidation of independent media and bloggers, and an architecture of wholesale mass surveillance undertaken by the installation of equipment at telecommunications companies."[450]

As we examine the other component systems of the AEGIS, let us keep in mind both the choke points and choke hold established for the GISs of the world. The present system favours massive parallel development of distributed architecture with no one nation or commercial entity owning either a vertical or horizontal monopoly. The consequences of that changing must be considered when systems engineering takes place and the design team plans the cloud and network capacity of the ambient ecumene.

> Predictions of Internet "fragmentation" and a retreat toward "Cyber Westphalia" have become prominent (Demchak and Dombrowski 2011; Dombrowski 2016). Different sources have specifically been identified: filtering and blocking websites,

449 Demchak, C., 2021. Achieving Systemic Resilience in a Great Systems Conflict Era. *The Cyber Defense Review*, *6*(2), pp.51-70.

450 Deibert, R.J. and Pauly, L.W., 2019. Mutual entanglement and complex sovereignty in cyberspace. In *Data Politics* (pp. 81-99). Routledge.

social networks or other resources offering undesired contents; attacks on such networks and resources; digital protectionism blocking users' access to and use of key platforms and tools for electronic commerce; centralizing and terminating international interconnections; attacks on national networks and key assets; local data processing and/or retention requirements; architectural or routing changes to keep data flows within a territory; prohibitions on the transborder movement of certain categories of data; strategies to construct nationally bounded "Internet segments"; and international frameworks to legitimize restrictive practices (Drake, Cerf and Kleinwächter 2016).[451]

Critical Value to the Ambient Ecumene: The Internet

The Internet delivers GISs to every network and locale worldwide with a robust capability to support AmI driven real-time processes.

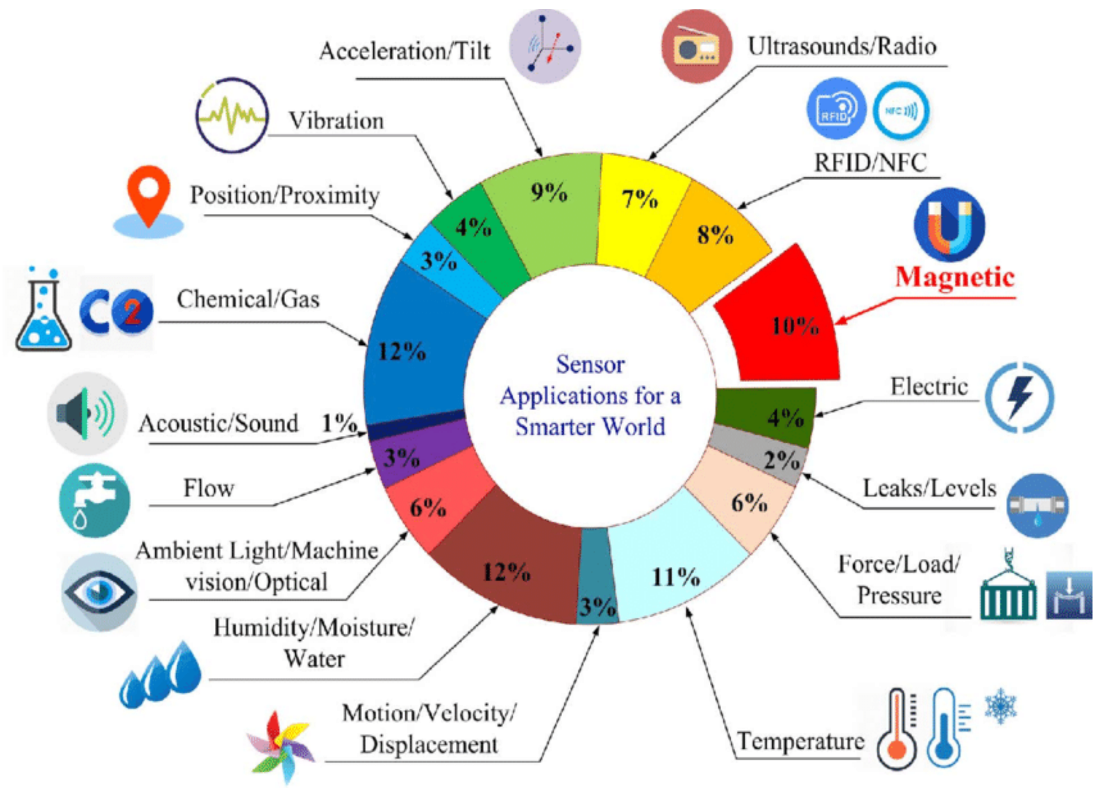
The IoT Sensor Suite

If the Internet as a whole delivers the world wide web, then an internet delivers a shared world – a technological ecumene. IoT fundamentally changes the way the daily world operates because it transforms any geographic space into a shared world where the digital lifeworld of individual smart objects, sensors, camera feeds, computers, and mobile devices merges to become a full biome. When done well, the IoT sensor suite operates a proper ecumene. There are multiple providers for IoT capabilities and sensors. As an example Omron, a major manufacturing entity with multinational reach, has been chosen.

As a global leader in the field of automation, OMRON's business fields cover a broad spectrum, ranging from industrial automation and electronic components to social

451 Deibert, R.J. and Pauly, L.W., 2019. Mutual entanglement and complex sovereignty in cyberspace. In *Data Politics* (pp. 81-99). Routledge.

systems including automated ticket gates and solar power conditioners, healthcare. At present, OMRON provides products and services in around 120 countries and regions. It represents one of dozens of similar sensor and device manufacturers who deliver components to the Internet of Things.[452] As an IoT sensor manufacturer provides the following categorises of sensors under which each provide multiple devices and configurations: Flow Sensors; Pressure Sensors; Vibration Sensors/Tilt Sensors; Thermal Sensors; IoT Sensors; Optical Sensors ; Human Image Sensing Technology ; Electrostatic Capacitance Sensor.[453]



[454]

How does Omron's business stack up against other manufacturers and within the context of the entire industry? “In 2022, motion sensors are expected to account for 8.35 percent of the global IoT enabled sensors market. Total revenue generated by the

452 https://www.omron.com/global/en/about/corporate/outline/
453 https://www.omron.com/
454 Xuyang, Liu & Lam, K.H. & Zhu, Ke & Zheng, Chao & Li, Xu & Du, Yimeng & Chunhua, Liu & Pong, Philip. (2019). Overview of Spintronic Sensors With Internet of Things for Smart Living. IEEE Transactions on Magnetics. PP. 10.1109/TMAG.2019.2927457.

enabled sensors market is estimated to reach 56 billion U.S. dollars in 2022."[455] There exists then a massive sensor markets separate from the software and networks needed to analysis sensor data and create the IoT itself. Statista's *Global IoT forecast: sensors market breakdown by segment 2022* provides us some critical insight into what to look for as we move from the Web to geographically bounded information systems.

> Advances in the field of sensor technology continue to trigger the evolution of innovative consumer and industrial products. Without sensors, most things that are connected to the Internet of Things (IoT) today would lose much of their functionality. A thing can range from heart monitoring implants, DNA analysis devices for food monitoring or built-in sensors in automobiles. The IoT technology of sending the data to the cloud for analysis, where it is distilled and interpreted before delivering the high-value information back to the device, has allowed society to make more efficient and accurate decisions not only in people's daily lives but also in a business environment. It is expected that the global IoT market will almost grow three-fold between 2014 and 2019 and exceed one trillion U.S. dollars in 2017. By 2019, the market is forecast to have an estimated size of more than 1.7 trillion U.S. dollars. With a vast array of applications, the Internet of Things has seen a consistently growing number of connected devices worldwide. By 2022, it is predicted that 43 billion devices will be connected to the IoT around the globe. This technology is slated to have numerous applications, predominantly in the fields of consumer electronics, industrial manufacturing, automotive and life sciences.[456] By 2022, temperature sensors are expected to account for 26.2 percent of the global IoT enabled sensors market. [457]

Motion and temperature sensors being the prime movers of the market suggest that

455 Global IoT forecast: sensors market breakdown by segment 2022 Published by Statista Research Department, Feb 5, 2021

456 Global IoT forecast: sensors market breakdown by segment 2022 Published by Statista Research Department, Feb 5, 2021

457 Global IoT forecast: sensors market breakdown by segment 2022 Published by Statista Research Department, Feb 5, 2021

Smart Vehicles with onboard sensors will come into play as well as smartphones being more agile and sensor rich. The combination argues for an increasingly focused approach to IoT that divides between industrial internet, Industry 4.0, and commercial applications for manufacturing on the one hand and personalised ambient enabled sensor suites to further AI and AmI functionality for private individuals on the other.

> Juniper research found that the rise of edge computing would be critical in scaling deployments up, owing to reduced bandwidth requirements, faster application response times and improvements in data security. The total number of connected IoT (Internet of Things) sensors and devices is set to exceed 50 billion by 2022, up from an estimated 21 billion in 2018. Juniper predicted that a substantial proportion of the estimated 46 billion industrial and enterprise devices connected in 2023 will rely on edge computing. Therefore, addressing key challenges surrounding standardisation and deployment models will be crucial. Research author Steffen Sorrell added: *"IoT at the edge dramatically increases project scope and value. However, it must be noted that work around standardisation, interoperability and how to manage the decentralisation of data processing remain in development."* [458]

How pervasive has IoT become in the cityscape? The following facts outlined below demonstrate that need to standardise capabilities and sensor suites before it permeates every aspect urban life.

> There are expected to be more than **64B IoT devices worldwide by 2025**. By the end of 2020, **5.8 billion automotive and enterprise gadgets** were on IoT. By 2022, **100% of the global population** is expected to have LPWAN coverage. IoT has the potential to generate **$4T to $11T in economic value** by 2025. The main revenue driver for **54% of enterprise IoT projects** is cost savings. The wearable devices market will be **worth $1.1 billion by 2022**. **97% of organizations** feel there are challenges to creating value

458 https://www.juniperresearch.com/iot-connections-to-grow-140pc-to-50-billion-2022

from IoT-related data. The IoT in banking and financial services market size is expected to grow **to $2.03B by 2023**. [459]

What comprises the IoT sensor suite? Listed below are the major categories of sensors which the chart Sensor Applications for a Smarter World detailed.

Temperature Sensors

Temperature sensors measure the amount of heat energy in a source, allowing them to detect temperature changes and convert these changes to data. Machinery used in manufacturing often requires environmental and device temperatures to be at specific levels. Similarly, within agriculture, soil temperature is a key factor for crop growth.[460]

Humidity Sensors

These types of sensors measure the amount of water vapor in the atmosphere of air or other gases. Humidity sensors are commonly found in heating, vents and air conditioning (HVAC) systems in both industrial and residential domains. They can be found in many other areas including hospitals, and meteorology stations to report and predict weather.[461]

Pressure Sensors

A pressure sensor senses changes in gases and liquids. When the pressure changes, the sensor detects these changes, and communicates them to connected systems. Common use cases include leak testing which can be a result of decay. Pressure sensors are also useful in the manufacturing of water systems as it is easy to detect fluctuations or drops in pressure.[462]

459 https://techjury.net/blog/internet-of-things-statistics/#gref
460 https://behrtech.com/blog/top-10-iot-sensor-types/
461 https://behrtech.com/blog/top-10-iot-sensor-types/
462 https://behrtech.com/blog/top-10-iot-sensor-types/

Proximity Sensors

Proximity sensors are used for non-contact detection of objects near the sensor. These types of sensors often emit electromagnetic fields or beams of radiation such as infrared. Proximity sensors have some interesting use cases. In retail, a proximity sensor can detect the motion between a customer and a product in which he or she is interested. The user can be notified of any discounts or special offers of products located near the sensor. Proximity sensors are also used in the parking lots of malls, stadiums and airports to indicate parking availability. They can also be used on the assembly lines of chemical, food and many other types of industries.[463]

Level Sensors

Level sensors are used to detect the level of substances including liquids, powders and granular materials. Many industries including oil manufacturing, water treatment and beverage and food manufacturing factories use level sensors. Waste management systems provide a common use case as level sensors can detect the level of waste in a garbage can or dumpster.[464]

Accelerometers

Accelerometers detect an object's acceleration i.e. the rate of change of the object's velocity with respect to time. Accelerometers can also detect changes to gravity. Use cases for accelerometers include smart pedometers and monitoring driving fleets. They can also be used as anti-theft protection alerting the system if an object that should be stationary is moved.[465]

Gyroscope

Gyroscope sensors measure the angular rate or velocity, often defined as a measurement of speed and rotation around an axis. Use cases include automotive,

463 https://behrtech.com/blog/top-10-iot-sensor-types/
464 https://behrtech.com/blog/top-10-iot-sensor-types/
465 https://behrtech.com/blog/top-10-iot-sensor-types/

such as car navigation and electronic stability control (anti-skid) systems. Additional use cases include motion sensing for video games, and camera-shake detection systems.[466]

Gas Sensors

These types of sensors monitor and detect changes in air quality, including the presence of toxic, combustible or hazardous gasses. Industries using gas sensors include mining, oil and gas, chemical research and manufacturing. A common consumer use case is the familiar carbon dioxide detectors used in many homes.[467]

Infrared Sensors

These types of sensors sense characteristics in their surroundings by either emitting or detecting infrared radiation. They can also measure the heat emitted by objects. Infrared sensors are used in a variety of different IoT projects including healthcare as they simplify the monitoring of blood flow and blood pressure. Televisions use infrared sensors to interpret the signals sent from a remote control. Another interesting application is that of art historians using infrared sensors to see hidden layers in paintings to help determine whether a work of art is original or fake or has been altered by a restoration process.[468]

Optical Sensors

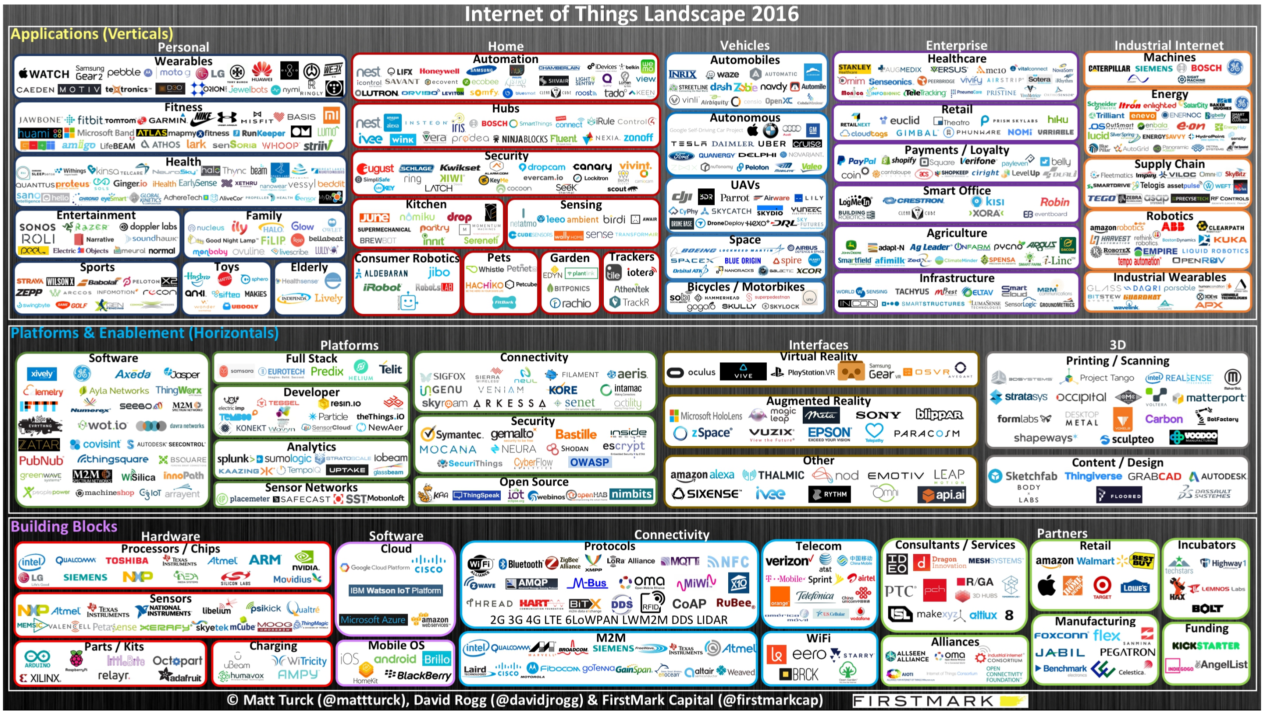
Optical sensors convert rays of light into electrical signals. There are many applications and use cases for optical sensors. In the auto industry, vehicles use optical sensors to recognize signs, obstacles, and other things that a driver would notice when driving or parking. Optical sensors play a big role in the development of driverless cars. Optical sensors are very common in smart phones. For example,

466 https://behrtech.com/blog/top-10-iot-sensor-types/
467 https://behrtech.com/blog/top-10-iot-sensor-types/
468 https://behrtech.com/blog/top-10-iot-sensor-types/

ambient light sensors can extend battery life. Optical sensors are also used in the biomedical field including breath analysis and heart-rate monitors.[469]

The comprehensive chart below also demonstrates to what degree the sensor market has been unregulated and far from standard. "As of 2016 these were the primary sensor application providers. In the last five years the total number has doubled. There are in excess of 3,000 major providers, each like Omron with multiple product lines and capabilities. Experts estimate no less than 10,000 potential sensors without a common unifying platform."[470] While there exists potential for a full emergent technological ecumene, IoT like the general SoSCPs being managed presents a large pool of dynamic chaos which while linear and able to be subsumed by opertaional matrixes, lacks the cohesion we might prefer to make security, communications, and emergent cooperation between different levels of AmI possible. As it stands, the heterogeneity of the existing system encourages layers of disputational software at times corrupting or conflicting with other IoT data management protocols.

469 https://behrtech.com/blog/top-10-iot-sensor-types/
470 http://dfkoz.com/iot-landscape/ and expert testimony under AWS NDA 2017



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Critical Value to the Ambient Ecumene: IoT Sensors

IoT Sensors deliver the potential to create a fully realised technological ecumene where the urban environment can become its own information system merged with the GIS.

471 http://dfkoz.com/iot-landscape/ and expert testimony under AWS NDA 2017

Telecommunications Technologies

As critical as both IoT and the Web are, they cannot effectively function without telecommunications which provides telephony, network cables, high speed television and WiFi, and a variety of other capabilities which empower smart devices and smart homes, form the backbone of other critical technological ecumenes including IoT and the Web, and delivers to nearly the entire globe every configuration of. GIS

Foremost, they are the core of networking: "There are over 1,000 mobile operators across the world that have invested trillions of dollars into network infrastructure."[472] These 1000 operators provide digital connectivity globally and regionally.

> New cross-sectoral advances have also emerged, such as the Internet of Things (IoT) and Smart Cities, which rely on the availability of digital connectivity for smartphones, sensors and other communications devices. Hence the signal quality of mobile telecommunications infrastructure is an ever more important factor, requiring operators to focus on both network reliability and capacity expansion techniques to meet consumer and industrial requirements. data demand is by far the largest driver of mobile traffic (constituting 92% of baseline growth) [473]

As with IoT, the disparate arenas of connectivity and delivery allow for these 1000 operators to provide the world with varying degrees of telecommunications access, reliability, and interoperability. The non-linear chaos of individual sensors trying to merge into a cohesive data narrative has also to contend with multiple fragmented options once the data reaches a node or IXP.

In 2005, the International Telecommunication Union (ITU) formally introduced IoT, according to which: "from anytime, anyplace connectivity for anyone, we will now

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472 Islands, B.V., World Mobile Chain: A blockchain based solution to empower a sharing economy for telecommunications infrastructure.

473 Oughton, E., Frias, Z., Russell, T., Sicker, D. and Cleevely, D.D., 2018. Towards 5G: Scenario-based assessment of the future supply and demand for mobile telecommunications infrastructure. *Technological Forecasting and Social Change*, *133*, pp.141-155.

> have connectivity for anything". The reality of IoT in a telecommunications sense has been characterized with a high level of fragmentation of technologies, lack of ubiquity in terms of both connectivity and coverage, due to the plethora of technologies and devices present in a city. This fragmentation is mainly due to the presence of many access networks usually managed by different operators (i.e. Universal Mobile Telecommunications System – UMTS, Worldwide Interoperability for Microwave Access -WiMAX, WiFi,e tc.).[474]

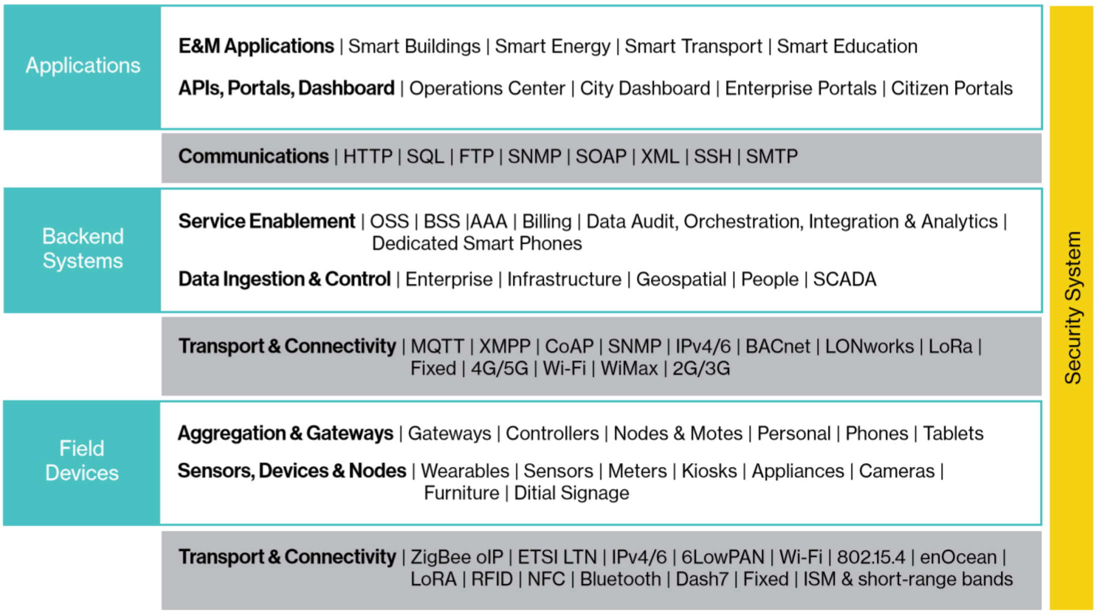
Still Smart Cities seek to control and subsume this fragmentation into something resembling engineered and structured order. "The foundation of any smart city is a modern smart infrastructure that is composed of devices that are connected through telecom networks back to data repositories, where all the data gathered from these devices is stored. This data is leveraged by various systems and platforms to make decisions and initiate activities, and to address the needs of users via services and applications." [475] In some cases this has been done with the jury rigging of legacy systems; in more forward thinking places with cloud microservices and edge service delivery. Regardless, an AEGIS cannot arise without modern telecommunications and the providers represent key stakeholders in the world of ambient service.

> The architecture deployed in a city for external monitoring is based on long-range communication protocols, so that the entire city can be covered with few devices. These communication protocols cannot penetrate into buildings due to interference with walls and electrical or piping installations. The architecture deployed in buildings usually take advantage of the telecommunications infrastructure itself or, failing that, the wired electrical network, it is easier and cheaper to rely on these facilities. In areas of difficult access or without wired installations, wireless protocols such as Wi-Fi, Bluetooth or RFID are used. These protocols are short-range and have

474 Petrolo, R., Loscri, V. and Mitton, N., 2017. Towards a smart city based on cloud of things, a survey on the smart city vision and paradigms. *Transactions on Emerging Telecommunications Technologies*, *28*(1), p.e2931.

475 Sethi, R.K., 2016. The role of telecommunications in smart Cities. *GlobalLogic Inc., San Jose*.

coverage from 0.5 m to 10/15 m. [476]



[477]

To add the the bottleneck, new providers face steep barriers to entering the market with innovations – in this fashion the saturation and stratification of the telecommunications industry also insulates it from creative destruction.

The range of available, unlicensed frequencies for wireless connectivity in IoT networks is fairly limited. Excluding NFC, there are four bands that are widely available (although not in every country) and utilised by wireless protocols: 433MHz, 868 MHz, 900MHz and 2.4GHz. The latter is shared by protocols such as IEEE 802.11 Wi-Fi and Bluetooth. Among these four bands, there are several protocols (including many proprietary ones). Below is an overview of the most well-known protocols, as well as a table that summarizes the total range of available options for wirelessly transmitting data in a smart city IoT ecosystem:[478]

476 Rodriguez, J.A., Fernandez, F.J. and Arboleya, P., 2018. Study of the Architecture of a Smart City. In *Multidisciplinary Digital Publishing Institute Proceedings* (Vol. 2, No. 23, p. 1485).
477 Sethi, R.K., 2016. The role of telecommunications in smart Cities. *GlobalLogic Inc., San Jose*.
478 Sethi, R.K., 2016. The role of telecommunications in smart Cities. *GlobalLogic Inc., San Jose*.

Radio Type	Protocol	Frequency	Throughput	Range
3G, GPRS, 4G	UMTS, GPRS, LTE	850/900/1800/1900/2 IHz MHz Other	>Mbps	- Km - Typical carrier
Bluetooth Low Energy	Bluetooth /Bluetooth Smart	2.4GHz	1Mbps	100m
DASH7	RF – ISO/IEC 18000-7	433MHz	200Kbps	2Km
EnOcean	RF – ISO/IEC 14543-3-10	868MHz,900MHz	125kbps	300m
ETSI LTN	802.15.4	868Mhz	50Kbps	40Km
LoRa	RF	433, 868 and 900 MHz	0.3 Kbps to 50 kbps	22km
Wavenis	*RF*	*868MHz,900MHz, IHz*	*19.2Kbps*	*1Km*
Wi-Fi	802.11	2.4GHz	>Mbps	50m500m
ZigBee and ZigBee Pro	802.15.4	2.4GHz,868MHz,900	250Kbps	7 to 12Km
Z-Wave	RF	868MHz,900MHz	100Kbps	30m

[479]

To accommodate this four band limit, the use of radio frequency tagging and near field communications has expanded, encompassing the way IoT and Edge devices engage Smart X. This literal swarm of frequencies and network options creatives overlapping methods and paths for sensors and devices to swap data and protocols. As a whole these promise to be vital options for engineering any Smart application and likely a key element to any AEGIS being built in the ear future.

Sensor nodes are usually scattered in a sensor field; each of these scattered sensor nodes has the capabilities to collect data and route data back to a special node called sink by a multi-hop infrastructureless architecture. Currently, most of commercial Wireless Sensor Network (WSN) are based on the IEEE 802.15.4 standard, which defines the physical and MAC layers for low-power, low bit-rate communications in wireless personal area networks (WPAN). However, IEEE 802.15.4 does not include specifications on the higher layers of the protocol stack, which is necessary for the seamless integration of sensor nodes into the Internet. … the ever increasing number and the presence of a mixture of sensors such as GPS,gyroscopes, accelerometers and compasses, enabling a variety f crowd sourcing applications, which will eventually be augmented by the IoT. For instance, as users regularly update their location status

479 Sethi, R.K., 2016. The role of telecommunications in smart Cities. *GlobalLogic Inc., San Jose*.

on social networks like Twitter and Facebook,based on this location information, it is possible to aggregate this data, enabling tasks to be dispatched to people in specific locations . Regarding to short range communications, two interesting technologies in the smart cities context are Radio Frequency Identification (RFID) and Near Field Communication (NFC). RFID is a method of identifying unique items using radio waves. Typical RFID systems are made up of 2 major components: readers and tags. The reader sends and receives RF data to and from the tag via antennas. The tag is made up of the microchip that stores the data, an antenna, and a carrier to which the chip and antenna are mounted. RFID can be used to develop a large number of Smart City applications, to name a few: smart parking, traffic monitoring, library management, transportation tickets, etc.[480]

Critical Value to the Ambient Ecumene: Telecommunications

Telecommunications delivers the backbone capabilities to support all GISs as well as IoT and The Web critical to a functioning AEGIS.

Blockchain

Let us revisit the concept of data. While we understand that data gets created and managed inside software, we may forget how much meta-data, tagging, and protocol or packet data accompanies it as moves through the networked telecommunications that make these applications possible. We have seen that in the backbone infrastructure of the AEGIS the internet, IoT and general telecommunications capabilities are controlled by dozens to thousands of competing groups with a vested interest in competition over cooperation. These same entities are often fighting to overcome the discursive violence in exiting systems while establishing their own hegemony over a market or region.

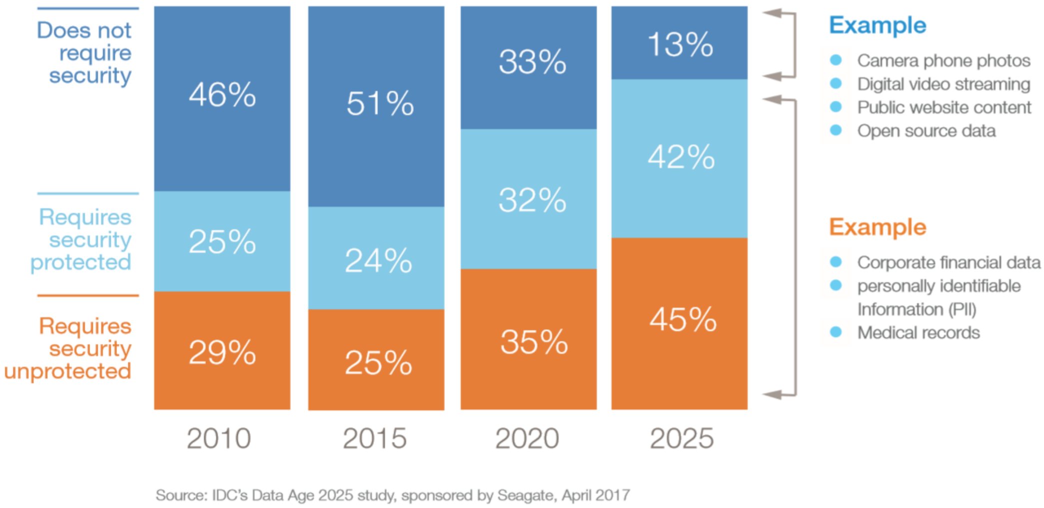
480 Petrolo, R., Loscri, V. and Mitton, N., 2017. Towards a smart city based on cloud of things, a survey on the smart city vision and paradigms. *Transactions on Emerging Telecommunications Technologies*, *28*(1), p.e2931.

Whether by accidental insertion of bias resulting in algorithmic violence or the explicit determined exploitation of human agency through predatory engineering, these technologies have become a highly dynamic system, often chaotic and non-linear, resembling a biological ecosystem – filled with predators, dangers, and the struggle to survive.

In such an environment we should be unsurprised that people duplicate data. The same items pass through tens or hundreds of nodes and IXPs, getting tagged, refined, revised, analysed, re-tagged, and meta-audited within microseconds. As a result we are facing a massive influx of new data to this ecosystem. Let us revisit the IDC numbers:

> IDC predicts that the Global Datasphere will grow from 33 Zettabytes (ZB) in 2018 to 175 ZB by 2025. Big Data and metadata (data about data) will eventually touch nearly every aspect of our lives — with profound consequences. 49% of the world's stored data will reside in public cloud environments. By 2025, an average connected person anywhere in the world will interact with connected devices nearly 4,800 times per day — basically one interaction every 18 seconds. By 2025, more than a quarter of data created in the global datasphere will be real time in nature, and real-time IoT data will make up more than 95% of this. IDC estimates that the amount of the global datasphere subject to data analysis will grow by a factor of 50 to 5.2ZB in 2025; the amount of analyzed data that is "touched" by cognitive systems [ambient ecumenes]will grow by a factor of 100 to 1.4ZB in 2025. By 2025, almost 90% of all data created in the global datasphere will require some level of security, but less than half will be secured.[481]

481 Rydning, D.R.J.G.J., 2018. The digitization of the world from edge to core. *Framingham: International Data Corporation*, p.16.



482

As the chart above demonstrates, we have a great deal of data flowing in and out of multiple jurisdictions and network nodes, often under protected or unprotected. "Smart technology relies upon ecosystems of SoSs which interlock devices and protocols at the edge of the datasphere. Kaspersky Lab research identifies that roughly 40% of all industrial control systems are infected with malware."[483] Simply put, the danger to individuals and societies with all this data moving will increase exponentially until we secure it from bad actor – human or AI. Proposed solutions include securing endpoints and edge rather than core nodes – the idea being that where you touch it first and last needs the most security.

> A key aspect characterizing the Datasphere today is the increasingly critical role of the endpoints and edge – which is where all the digital data about us or for us is delivered to us to help inform real-time decisions, personalized services, or other latency-sensitive actions. Data gathered from endpoints is collected at the edge, which is an important location for delivering the intelligence and analytics necessary to provide faster response and better end-user experience, as well as to accelerate and

482 Rydning, D.R.J.G.J., 2018. The digitization of the world from edge to core. *Framingham: International Data Corporation*, p.16.

483 Gong, S., Tcydenova, E., Jo, J., Lee, Y. and Park, J.H., 2019. Blockchain-based secure device management framework for an internet of things network in a smart city. *Sustainability*, *11*(14), p.3889.

bring new levels of efficiency and quality to business.[484]

This results in a desperate need for multiple forms of heterogeneously applicable encryption and data security that can be applied to wide variety of data streams in real time. It also creates a need to catalogue and control, both the data and the security protocols involved, generating metadata needs which have in turn a whole audit requirement beyond just audit and review. The Fintech application Bitcoin provided a potential opportunity to deliver all that in blockchain.

> Unlike traditional methods, blockchain enables peer-to-peer transfer of digital assets without any intermediaries. Blockchain was a technology originally created to support the famous cryptocurrency Bitcoin. Bitcoin was first proposed in 2008 and implemented in 2009 by Nakamoto. Since then, it has seen huge growth with the capital market,reaching 10 billion dollars in 2016. Blockchain is basically a chain of blocks that store all committed transactions using a public ledger. The chain grows continuously when new blocks are appended to it. Blockchain works in a decentralized environment that is enabled by comprising several core technologies, such as digital signatures, cryptographic hash, and distributed consensus algorithms. All the transactions occur in a decentralized manner that eliminates the requirement for any intermediaries to validate and verify the transactions. Blockchain has some key characteristics, such as decentralization, transparency, immutability, and auditability".[485]

In 2019, Monrat, , Schelén, and Andersson provided us with a comprehensive technical explanation demonstrating the central features in a blockchain sequence. The excerpt below walks us through such an example:

> A node initiates a transaction in a decentralized blockchain network by employing a

484 Rydning, D.R.J.G.J., 2018. The digitization of the world from edge to core. *Framingham: International Data Corporation*, p.16.

485 Monrat, A.A., Schelén, O. and Andersson, K., 2019. A survey of blockchain from the perspectives of applications, challenges, and opportunities. *IEEE Access*, *7*, pp.117134-117151.

digital signature using private key cryptography. A transaction can be considered as a data structure that represents transfer of digital assets between peers on the blockchain network. All the transactions are stored in an unconfirmed transaction pool and propagated in the network by using a flooding protocol known as Gossip protocol. Then, peers need to choose and validate these transactions based on some preset criteria. For example, the nodes try to verify and validate these transactions by checking whether an initiator has sufficient balance to trigger a transaction or by trying to fool the system by enforcing double spending. Double spending refers to using the same input amount for two or more different transactions. Once the transaction is verified and validated by the miners, it is included in a block. The Blockchain comprises a sequence of blocks, which stores the information of all the transactions, similar to a public ledger. These blocks are linked to each other via a reference hash that belongs to the previous block known as the parent block. The starting block is called the genesis block, which does not have any parent block. A block consists of the block header and the block body. The block header includes metadata such as block version, parent block hash, Merkle tree root hash, timestamp, nBits, and nonce.[486]

The general consensus of both commercial and military cybersecurity experts has been positive. Essentially, nothing better presently exists that will allow the wildly heterogeneous landscape of dataflow that comprises the digital world to be uniformly encrypted by private individuals with the ease and transparency of Blockchain. As a result, Smart X designers have adopted blockchains as part of their service architecture, adding a level of easy to use and understand encryption to existing products and new evolving ideas.

The distributed ledger system described above offers many benefits. In contrast to centralized systems, the functionalities of the network persist even if particular nodes

486 Monrat, A.A., Schelén, O. and Andersson, K., 2019. A survey of blockchain from the perspectives of applications, challenges, and opportunities. *IEEE Access*, *7*, pp.117134-117151.

break down. This increases trust since people do not have to assess the trustworthiness of the intermediary or other participants in the network. It is sufficient if people solely build trust in the system as a whole. The absence of intermediaries also fosters data security. As discussed by Zyskind et al., the current practice of third parties collecting personal data implies the risk of security breaches. By utilizing the blockchain third parties can become obsolete, ultimately increasing user's security.[487]

With the advent of blockchain as a Smart X encryptor, product designers have debated whether to use a private option or create a public version – consortium blockchain. IoT's public broadcast of data has biased the industry towards using a consortium model. "Consortium Blockchain that has the characteristic of multi-blockchain structure, high scalability, high interoperability, and its system can be implemented more organizational governance, members of the cooperative Consortium Blockchain. The Consortium Blockchain realizes the blockchain technology to provide new support for the security and privacy protection of Smart Home System based on the IoT architecture."[488] What makes the consortium especially appealing, it adds to and preserves meta-data for external auditing. Any tampering or cyberattacks will be reflected in that data.

The closed-circuit television camera (CCTV) is essential for a range of public uses in a smart city; combined with Internet of Things (IoT) technologies they can turn into smart sensors that help to ensure safety and security. However, the authenticity of the camera itself raises issues of building up integrity and suitability of data. [however] a blockchain-based system [will] guarantee the trustworthiness of the stored recordings, allowing authorities to validate whether or not a video has been altered. It helps to discriminate fake videos from original ones and to make sure that

487 Nofer, M., Gomber, P., Hinz, O. and Schiereck, D., 2017. Blockchain. *Business & Information Systems Engineering*, *59*(3), pp.183-187.

488 She, W.E.I., Gu, Z.H., Lyu, X.K., Liu, Q.I., Tian, Z. and Liu, W., 2019. Homomorphic consortium blockchain for smart home system sensitive data privacy preserving. *IEEE Access*, *7*, pp.62058-62070.

surveillance cameras are authentic. Since the distributed ledger of the blockchain records the metadata of the CCTV video as well, it is obstructing the chance of forgery of the data. This immutable ledger diminishes the risk of copyright encroachment for law enforcement agencies and clients users by securing possession and identity.[489]

As IoT developed, the difficulty managing node devices also increased. Especially for smart cities, a network of various devices in a wide area can cause digital vulnerabilities due to the complexity of the network. Every Smart City network directly connected to a national and social infrastructure, requires a high level of security due to its service characteristics. Therefore, a smart city consisting of heterogeneous devices must be secure, ensuring integrity, confidentiality and data availability. Also, authentication, latency, adaptability and auditability on node devices should be considered. The essential point of network management is device management. Each device should always be in a safe state and problems occurring on each device should be reported immediately. "A blockchain-based device management framework can achieve the various security considerations on the smart city using private blockchain that consistently inspects the integrity of the device and stores the results device management."[490]

Given the dynamic chaos running the ecosystem, we can imagine how often improper management and updating of devices will result in significant data breaches. As a result SEs will need to consider the best available public option for an operational AEGIS: consortium blockchain.

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489 Khan, P.W., Byun, Y.C. and Park, N., 2020. A data verification system for CCTV surveillance cameras using blockchain technology in smart cities. *Electronics*, *9*(3), p.484.

490 Gong, S., Tcydenova, E., Jo, J., Lee, Y. and Park, J.H., 2019. Blockchain-based secure device management framework for an internet of things network in a smart city. *Sustainability*, *11*(14), p.3889.

Critical Value to the Ambient Ecumene: Blockchain

Blockchain delivers a relatively universal publicly auditable data encryption format that can be adulated for heterogeneous data streams like IoT and telecommunications.

The Smartphone

So far we have seen that the zettabytes of predicted data within the world's future state will be running through the complex ecosystems of telecommunications and internet backbones (which are often the same cables) as well as being managed in the edge nodes of both local IXPs and IoT networks. We need an easy way to access this data and to create it or ambient technology cannot fulfil its purpose. To act in real time, an ambient system must be able to interact with its human agents quickly, almost subconsciously, and with a wide set of options. Enter the Smartphone

Smartphones are ubiquitously available around the world globally. At present, a staggering 3.3 billion smartphone users have been counted worldwide. According to Statista, as of 2019, more than one third of the human mankind has mobile access to the Internet . Without doubt, the wide distribution of smartphones has many advantages including the easy access to information, the better possibilities to communicate, and navigation opportunities.[491] That said, the notion of a smartphone really represents a placeholder for all mobile connected devices including smartwatches, tablets, laptops, speciality devices, and smart enabled telephony. In most cases, when researchers discuss smartphones as a technology suite they in fact mean mobile devices as a tech category of which smartphones are the most prominently used.[492]

We should keep in mind that smartphones are more than a telecommunications

491 Montag, C., Wegmann, E., Sariyska, R., Demetrovics, Z. and Brand, M., 2021. How to overcome taxonomical problems in the study of Internet use disorders and what to do with “smartphone addiction”?. *Journal of Behavioral Addictions*, *9*(4), pp.908-914.

492 Montag, C., Wegmann, E., Sariyska, R., Demetrovics, Z. and Brand, M., 2021. How to overcome taxonomical problems in the study of Internet use disorders and what to do with “smartphone addiction”?. *Journal of Behavioral Addictions*, *9*(4), pp.908-914.

device – they are an entire IoT suite attached to the Web and global telecommunications with inherent ambient design and the theoretically unlimited capability to add commercial applications which offer tailored AmI.

> Owing to the various sensors along with on-board storage, computing and communication capabilities smartphones can become an intelligent, scalable, autonomous and potentially cost-free component of the next generation civil infrastructure monitoring systems in future smart cities. Modern smartphones are instrumented with various sensors such as a barometer, gyroscope, accelerometer, proximity sensor, camera, touch screen, microphone, ambient light sensor, magnetometer, and have significant on-board computing capabilities. They are equipped with batteries that are charged by their users and have storage in the order of gigabytes. Moreover,smartphones are supported by mobile operating systems and wireless communication hardware that can be used for field data collection and up-loading real-time data to a server via Bluetooth, Wi-Fi, 3G, 4G and 5G networks. Most importantly, the smartphone-based monitoring methodology essentially creates a cyber–physical system(CPS) through mobile crowdsourcing [17]. The crowdsourcing sensing platform empowered by citizens enables frequent collection of data without investing in specialized sensing infrastructure.[493]

As the primary and ubiquitous device of the Smart X technology suite, we can think of the smartphone as a major endpoint device of an AEGIS. In some sense, until we replace it with some upgraded version of a wearable or implantable device with superior capacity, the smartphone might be the single most important endpoint in an AEGIS. As it turns out there are compelling reasons for this – some rather sinister:

> A 2020 study determined that personality traits influence the type and amount of smart device usage: it found a negative association between altruism and intention to use the smartphone in men, but a positive association in women. Consistent with this

493 Alavi, A.H. and Buttlar, W.G., 2019. An overview of smartphone technology for citizen-centered, real-time and scalable civil infrastructure monitoring. *Future Generation Computer Systems*, *93*, pp.651-672.

finding, we also found the same association pattern for altruism and predicted usage: a negative one in men and a positive one in women. Which mean men were more likely to use smartphones for selfish and commercial reasons as well as high usage being found among the more selfish and commercially motived men while women were more likely to both use smart devices for altruistic benefit and those who are altruistically motivated are the most likely to be heavy smartphone users.[494]

The inherently technosociological biases of technology may never be more apparent than this fundamental divide between men's selfish commercial behaviours and women's socially supportive altruistic focus. Smartphones deliver AmI and are themselves a form of AmI. As a result, their human agents predilections represent the front-line of emergent adaptability which will be incorporated into any expansion of a system's programmed capabilities. “Large majorities in the 11 emerging and developing countries surveyed either own or share a mobile phone, and in every country it is much more common to own one’s own phone than to share it with someone else. In seven of these countries, half or more now use smartphones – and smartphone use is especially common among younger and more educated groups.”[495] This translates to a rapid convergence of algorithmic violence with epistemic inequality as the youngest and most educated of non-hegemonic cultural and economic populations take up the use of the hegemonic majority's primary endpoint for social communication and control.

Smart X mobile devices of which the smartphone has the most prominence are consistently defined as providing device and system autonomy, universal constant connectivity, context-awareness for crowd sourcing and algorithmic handshakes, specifically designed to facilitate and support robust user-interaction, mobility without

494 Sindermann, C., Riedl, R. and Montag, C., 2020. Investigating the relationship between personality and technology acceptance with a focus on the smartphone from a gender perspective: results of an exploratory survey study. *Future Internet*, *12*(7), p.110.

495https://www.pewresearch.org/internet/2019/03/07/use-of-smartphones-and-social-media-is-common-across-most-emerging-economies/

loss of other features and data storage capabilities. [496]

Similarly, if the device cannot provide these functionalities it cannot be considered a smart x mobile device or even a smart device. Miller (2015, page 9) states: *"Most of the things connected to the IoT are actually simple devices that are often referred as smart devices. The devices themselves aren't necessarily smart in and of themselves, but become smart when joined together with other connected devices"*. Scholars therefore consider a device in isolation which requires other "smart" devices to provide services to final users cannot be considered in and of itself a smart device. The collection of these "dumb" devices become a smart system, which is in truth a CPS driven SoS with underlying Smart X architecture.[497]

Critical Value to the Ambient Ecumene: The Smartphone

The Smartphone delivers a critical endpoint interface which facilitates integrated IoT and Internet supported applications tied to highly reactive real-time AmI.

On Premise Computing – Servers, ATMs, Point of Sale systems, etc.

As ubiquitous as the smartphone has become, it does not serve all purposes in the AEGIS and in the wider world of digital biomes, many lacking ambient interfaces, the bulk of legacy architecture remains on-premise, i.e., it sits within a facility or locale governed by a single owner to serve a dedicated purpose. On premise computing lacks inherent mobility and adaptability; instead it serves as a highly redundant, highly resilient foundation for the world's telecommunications networks. While cost efficiency used to be the primary reason to wholly own computing resources, on-premise

496 Silverio-Fernández, M., Renukappa, S. and Suresh, S., 2018. What is a smart device?-a conceptualisation within the paradigm of the internet of things. *Visualization in Engineering*, *6*(1), pp.1-10.

497 Silverio-Fernández, M., Renukappa, S. and Suresh, S., 2018. What is a smart device?-a conceptualisation within the paradigm of the internet of things. *Visualization in Engineering*, *6*(1), pp.1-10.

computing now involves cost components that require self-reliance for factors such as: On-site server setup, server software, System administration FTE labor and other infrastructure costs when compared to a subscription to a centralized host (aka Cloud). Skipped maintenance fee payments can lead to missed updates on features and fixes.[498]

> On premise, in-house, or captive IT services [are] synonymous. Traditional computing services and IT departments evolved as captive departments grown within the organization that incurred the capital expenditures and operating costs for the IT department. In contrast, cloud computing obviates the requirement for capital and the services are on-demand and metered. The customer pays only for those services used, and for the duration of use. The cloud vendor offers a public pricing schedule, not unlike the pricing schedules offered for renting an automobile. The defining characteristic of traditional captive IT is that of a monopoly and the demand for IT services is modeled as being driven only by internal use.[499]

The data centre defines the functional captive / on-premise unit of capability for Smart technology. Regardless of whether it's a mobile smart device, a register, ATM, an application on a laptop, a cloud or private WAN, the delivery mechanism which imports, processes, and then refines datastreams resides in a data centre. Un-analysed data is valueless because those data cannot help human to improve life quality. To increase the efficiency of data collection, data process, and data analysis, some data mining techniques could be applied. If the data can be collected by interest, request, and associate, the cost for processing of data collected can be reduced and the data can become more valuable. To deal with big data processed in smart city, the fog and edge computing can be leveraged so that data can be stored and processed locally before transmitting the massive data to the centralized data center.[500] The most obvious IXP-like

498 Fisher, C., 2018. Cloud versus on-premise computing. *American Journal of Industrial and Business Management*, *8*(09), p.1991.

499 Vithayathil, J., 2018. Will cloud computing make the Information Technology (IT) department obsolete?. *Information Systems Journal*, *28*(4), pp.634-649.

500 Mallapuram, S., Ngwum, N., Yuan, F., Lu, C. and Yu, W., 2017, May. Smart city: The state of the art, datasets, and evaluation platforms. In *2017 IEEE/ACIS 16th International Conference on Computer and*

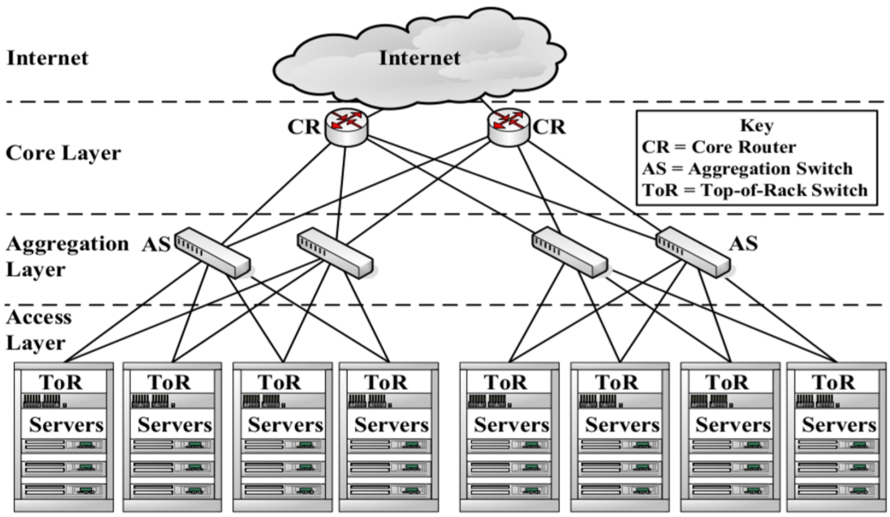
node within on-premise will be the enterprise data centre. “A data center (DC) is a facility consisting of servers (physical machines), storage and network devices (e.g., switches, routers, and cables), power distribution systems, cooling systems. A data center network is the communication infrastructure used in a data center,and is described by the network topology, routing/switching equipment, and the used protocols (e.g., Ethernet and IP).”[501] The enterprise data centre serves as the defined legacy core data processing unit and the hub of all in house command and control computing.

Compare with common enterprise data center, although data center of Smart City is composed of software and hardware to realize business collaboration,unified data management,comprehensive decision analysis and other functions,there are differences in data size,integration range,application area and other fields. The scale of data management of data center of Smart City is larger. Every aspect of common life and operational management is involved in Smart City in which all kinds of data are produced in every field so that only in several minutes the scale of data reaches a high level ,about tens to hundreds TB,however only several applications is involved in common enterprise data center whose data scale is smaller,processing procedure is very simple. The range of integration of data center of Smart City is wider. Not Only the related data of remote data center is needed to integrate,but also the data from many application systems in traffic,logistics,security,medical treatment,education and other fields is needed to integrate in order to meet the needs of data management,data query and analysis. The application area of Data Center of Smart City is larger. The data services is supplied not for a certain application system but for multiple domains,multiple industries and multiple applications to implement comprehensive decision analysis,data management and collaborative application that

Information Science (ICIS) (pp. 447-452). IEEE.

501 Bari, M.F., Boutaba, R., Esteves, R., Granville, L.Z., Podlesny, M., Rabbani, M.G., Zhang, Q. and Zhani, M.F., 2012. Data center network virtualization: A survey. *IEEE communications surveys & tutorials*, *15*(2), pp.909-928.

propose higher demand of data storage,data transmission,data usage and data management. [502]



[503]

While legacy data centres have relatively static organisation, keep in mind that cloud service providers consistently engineer new network configurations and topologies which rapidly advance the value of a DC's delivery capabilities. At the same time, Dcs also provide necessary entry and exit nodes for all telecommunications and endpoint devices. We cannot replace them until we have a different global information model and a radically different architecture. But we can augment them and in the case of ambient systems, the augments are vitally important to an AEGIS. Let us consider point of sale systems and ATMs.

The Point of sale (POS) system is usually a computer device that is linked to a barcode scanner and printer device, where on the computer has been installed special software for POS. For examples such as transaction cashier or payment points in mini markets, super markets, hotels, restaurants, and much more. POS systems can be made stand-alone (not connected to other POS systems) and can be designed to

502 Su, J., 2019, April. The Research of Data Center Construction for Smart City. In *IOP Conference Series: Materials Science and Engineering* (Vol. 490, No. 6, p. 062042). IOP Publishing.
503 Bari, M.F., Boutaba, R., Esteves, R., Granville, L.Z., Podlesny, M., Rabbani, M.G., Zhang, Q. and Zhani, M.F., 2012. Data center network virtualization: A survey. *IEEE communications surveys & tutorials*, *15*(2), pp.909-928.

connected to other POS systems as required, over the Internet as well as on local networks. The traditional POS (TPOS) is not easy to be moved, which means more difficult to applied for movable merchants. [504]

POS systems exist as a upgradable economic endpoint of the in-house or on-premise computing value chain. They manage inventories, take in monies, help facilitate real-time financial transactions. But they are generally non-mobile and built to be resilient rather than adaptable:

> Point of Sale(POS) is one form of combining Hardware and Software that forms a system to facilitate transactions with customers, record inventory, find out sales reports and profits per day,weekly,monthly even annually. POS initially is a cash register which is a sort of calculator machine with a cash drawer and proof of purchase, receipt or invoice. Along with the development and advancement of technology, cash register function cannot meet the needs for businesses that require detail income statement, stock of goods, and other needs. POS media requires several devices,such as PC/Computer or laptop, Cashier Printer,Cash Drawer,Barcode Scanner, Poledisplay, MSR (Magnetic Stripe Reader) and Software.[505]

As POS represent the exchange of material goods for cash, their mirror selves are automatic tellers or cashpoints which dispense money and manage banking on a non-material basis. We have below an example from Africa, which highlights how these SCPs influence social as well as financial operations beyond mere computing.

> ATM, also called 24-hour tellers are electronic terminals which give consumers the opportunity to bank at almost any time . ATM banking is one of the earliest and widely adopted retail e- banking services in Kenya. It is described as a combination of a computer terminal, record- keeping system and cash vault in one unit,

504 Lestariningati, S.I., 2018, August. Mobile point of sale design and implementation. In *IOP Conference Series: Materials Science and Engineering* (Vol. 407, No. 1, p. 012094). IOP Publishing.

505 Trianita, M. and Dharma, S., 2019. The Extension of TAM Model in the Use of Point of Sale (Pos) in Minimarkets in Padang, Indonesia. *KnE Social Sciences*, pp.83-96.

permitting customers to enter the bank‟s book keeping system with a plastic card containing a Personal Identification Number (PIN) or by punching a special code number into the computer terminal linked to the bank‟s computerized records 24 hours a day. According to her, an ATM transaction is an average of about 6,400 per month compared to 4,300 for human tellers. According to Abor , it saves customers time in service delivery as alternative to queuing in bank halls. In addition, ATMs continue to serve customers whiles human tellers in the banking hall have stopped work, thereby increasing productivity for the banks.[506]

This efficiency and expediency have made the POS especially attractive in African environments where legacy infrastructure has a smaller footprint and where investments have been on finding the most ambient adjacent or AmI compatible options because smartphone usage exceeds individual computer and tablet ownership by a large percentage.

An Electronic Funds Transfer at the Point of Sale is an on-line system that allows customers to transfer funds instantaneously from their bank accounts to merchant accounts when making purchases (at purchase points). A POS uses a debit card to activate an Electronic Fund Transfer Process. Point-of-Sale Transfer Terminals allow consumers to pay for retail purchase with a check card, a new name for debit card. This card looks like a credit card but with a significant difference, the money for the purchase is transferred immediately from your account to the store's account. Importance of E-banking (H2) The importance of e-banking cannot be over emphasized. e-banking provides easy access to banking services. The interaction between user and bank has been substantially improved by deploying ATMs, Internet banking, and more recently, mobile banking. Cheng also added that, it reduces the transaction costs of banking for both Small and Medium Enterprises (SMEs) and banks. SMEs need not visit banks for banking transactions, providing

506 Felix, P., 2018. Prospects and challenges of electronic banking in Ghana: The case of Zenith Bank, Sunyani. *IJAMEE*.

round the clock services.[507]

While a significant portion of the world's technology presently consists of combined endpoints with core DC merged with the existing network nodes of telecommunications, there have emerged literally and figuratively new options. But we must remember that for every existing GIS and technological ecumene, there will be a portion of the architecture that relies directly on legacy tech and often the majority of the underlying systems have a partial or total interface with on premise computing.

Critical Value to the Ambient Ecumene: On Premise Computing

On Premise Computing delivers foundational computing and endpoint access to support robust Ami, telecommunications, and IoT applications with resilience.

Off Premise Computing – Cloud, Edge, 5G, Satellites, etc.

Compelling and necessary as on premise computing continues to be for the foundation of the world's networks, there has become a new and powerful innovating force in the form of cloud computing which has caused both revolutionary new capabilities like smartphones' and blockchain proliferation as well as massive economic dislocation and upheaval as old systems and ways of being are being destroyed by the cloud paradigm.

> With the fast development of mobile networks and the widespread application of city Internet of Things (IoT) in various fields (e.g., smart transportation, smart home, and smart manufacturing), the demand for mobile devices (MDs) is increasing drastically. However, MDs, such as smartphones, tablet computers, unmanned aerial vehicles (UAVs), and wear- able devices, are usually constrained by limited resources, e.g., CPU computing power, storage space, energy capacity, and environmental

507 Felix, P., 2018. Prospects and challenges of electronic banking in Ghana: The case of Zenith Bank, Sunyani. *IJAMEE*.

awareness. Complex computing tasks, e.g., optical character recognition (OCR), face recognition (FR), and augmented reality (AR), are inefficient to be handled locally. Furthermore, a diversity of city IoT applications, such as delay-sensitive and delay-tolerant applications can cause a variety of different computation and communication costs. To alleviate the limitations of mobile computation capacity, one effective way is to offload complex compute tasks from the MDs to a central cloud. By taking advantage of the rich virtual resources and the fast processing speed of the cloud servers, we can lower the pressure on MDs in handling tasks locally.[508]

Put another way, human agents demanded increasing access to ambient capabilities and cloud turned out to be the technically feasible option. In the same way that blockchain represents the best available public option, commercially purchasable cloud transfigured the way small and medium enterprises, mobile devices, and the ecosystems which support them operate. This has been especially valid for Smart X.

According to the US National Institute for Standards and Technology (NIST), a cloud can be described by the following characteristics: on-demand self service, broad network access, resource pooling, rapid elasticity, measured service. The cloud allows a number of clients and devices (e.g. mobile phones, tablets or desktop PCs) to access its resources through unified interfaces. For a Smart City this aspect is important since the infrastructure in a large municipality is typically quite heterogeneous and consists of many different devices.[509]

How do these unified interfaces work and what layers of abstraction exist? Do they, for example, differ from our understanding of legacy in house technologies? “Cloud services can be Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software a Service (SaaS), which can define different services for smart city applications

508 Wu, H., Zhang, Z., Guan, C., Wolter, K. and Xu, M., 2020. Collaborate edge and cloud computing with distributed deep learning for smart city internet of things. *IEEE Internet of Things Journal*, *7*(9), pp.8099-8110.

509 Krämer, M., Frese, S. and Kuijper, A., 2019. Implementing secure applications in smart city clouds using microservices. *Future Generation Computer Systems*, *99*, pp.308-320.

including data mining, big data analytics, optimization, and simulation services."[510]

Ever adapting and evolving, cloud has given birth to newer forms of adaptive technology in the forms of edge and fog – often mutually interchanged. "Fog services can be control, processing, storage, communication, streaming, configuration, monitoring, measurement, and management services."[511] Fog in a literal senses sits near the cloud and extends to the edge. "Fog or edge computing enables the IoT generated data to be processed in the vicinity of fog nodes for achieving improved throughput of the full system."[512] The SAP configuration chart below demonstrates a common nomenclature of Edge, Fog, and Cloud as a merged unit.

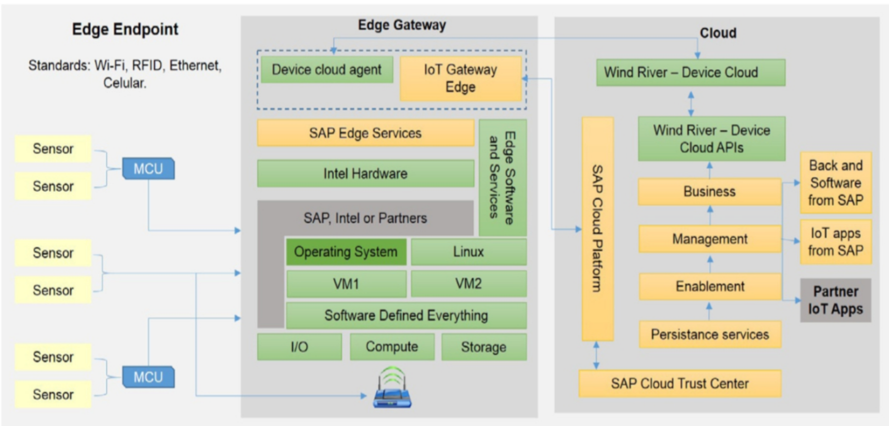


Fig. 2. INTEL-SAP RA. Based on work of [19].

SAP Edge Computing Model with Gateway / Nodes[513]

Let us now consider the other end of the fog, the edge or endpoint of computing and networks. The Edge Computing Consortium, Alliance of Industrial Internet defines Edge

510 Mohamed, N., Al-Jaroodi, J., Jawhar, I., Lazarova-Molnar, S. and Mahmoud, S., 2017. SmartCityWare: A service-oriented middleware for cloud and fog enabled smart city services. *Ieee Access*, *5*, pp.17576-17588.

511 Mohamed, N., Al-Jaroodi, J., Jawhar, I., Lazarova-Molnar, S. and Mahmoud, S., 2017. SmartCityWare: A service-oriented middleware for cloud and fog enabled smart city services. *Ieee Access*, *5*, pp.17576-17588.

512 Khattak, H.A., Farman, H., Jan, B. and Din, I.U., 2019. Toward integrating vehicular clouds with IoT for smart city services. *IEEE Network*, *33*(2), pp.65-71.

513 Sittón-Candanedo, I., Alonso, R.S., Corchado, J.M., Rodríguez-González, S. and Casado-Vara, R., 2019. A review of edge computing reference architectures and a new global edge proposal. *Future Generation Computer Systems*, *99*, pp.278-294.

as: "Edge Computing is a distributed open platform at the network edge, close to the things or data sources, integrating the capabilities of networks, storage, and applications. By delivering edge intelligence services, Edge Computing meets the key requirements of industry digitisation for agile connectivity, real-time services, data optimisation, application intelligence, security and privacy protection."[514] There are any number of new and interesting options available for ambient network designers who wish to create lightning fast real-time responsivity and emotionologically adaptive systems including the notion of an E-Node = a flexible component that can act as micro edge/cloud server[515] which can be more formally defined as an Edge Computing Node (ECN): "in this layer the intelligent Edge Computing Nodes (ECNs) have real time processing and response capacities, are compatible with diverse heterogeneous connections and the security is integrated into the hardware and software."[516]

> While the terms Edge and Fog computing have been used by various researchers with slightly different meanings, in this study we refer to an Edge node as a computing device which has a processor or multi-processor on-board system. Examples are battery-driven vehicles, robots, smartphones, Raspberry Pi or Arduino. In this context, Fog nodes can be understood as Cloud computing infrastructures, which exist in the close geographic proximity of Edge nodes.... In an advanced Edge/Fog computing framework, modern software engineering approaches can be made to exploit lightweight Microservices packaged into containers to achieve a high degree of automation, deployment, elasticity and reconfiguration of smart IoT applications at runtime. To this end, various container management and orchestration technologies have emerged, including Docker, Kubernetes, OpenShift

514 Sittón-Candanedo, I., Alonso, R.S., Corchado, J.M., Rodríguez-González, S. and Casado-Vara, R., 2019. A review of edge computing reference architectures and a new global edge proposal. *Future Generation Computer Systems*, *99*, pp.278-294.

515 Narang, M., Xiang, S., Liu, W., Gutierrez, J., Chiaraviglio, L., Sathiaseelan, A. and Merwaday, A., 2017, May. UAV-assisted edge infrastructure for challenged networks. In *2017 IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)* (pp. 60-65). IEEE.

516 Sittón-Candanedo, I., Alonso, R.S., Corchado, J.M., Rodríguez-González, S. and Casado-Vara, R., 2019. A review of edge computing reference architectures and a new global edge proposal. *Future Generation Computer Systems*, *99*, pp.278-294.

Origin and Swarm. In other words, once these technologies are combined with the Microservices architecture, a great level of agility in development, deployment and reconfiguration of applications can be achieved.[517]

As desirable as these endpoints are and as highly configurable, they still require brute force computational power which even an abstracted LAN of IoT and edge / fog devices cannot merge into a functional e-node of similar strength. But the promise of Fog as a paradigm which reaches beyond clouds into smaller nodes and creates a kind of minicloud / miniDC for these microservice driven devices has been transformational and compelling to Smart X creators.

Fog computing, which seamlessly integrates network edge devices and cloud center, is presented as a more effective solution to enable address these limitations. Fog computing is a geographically distributed computing architecture, which various heterogeneous devices at the edge of network are ubiquitously connected to collaboratively provide elastic computation, communication and storage services. The most prominent characteristic of fog computing is the extension of the cloud service to the edge of network. It makes computation, communication, control and storage closer to end-users by pooling the local resources. Data is consumed by the geographically distributed network edge devices. Therefore, the data transfer time and the amount of network transmission are greatly reduced. The fog paradigm can effectively meet the demands of real-time or latency-sensitive applications, and notably ease network bandwidth bottlenecks.[518]

As excerpted below from *Survey on fog computing: architecture, key technologies, applications and open issues* the full potential of a Fog layer requires in depth explanation:

517 Taherizadeh, S., Stankovski, V. and Grobelnik, M., 2018. A capillary computing architecture for dynamic internet of things: Orchestration of microservices from edge devices to fog and cloud providers. *Sensors*, *18*(9), p.2938.

518 Hu, P., Dhelim, S., Ning, H. and Qiu, T., 2017. Survey on fog computing: architecture, key technologies, applications and open issues. *Journal of network and computer applications*, *98*, pp.27-42.

This layer is located on the edge of the network. Fog computing layer is composed of a large number of fog nodes, which generally including routers, gateways, switchers, access points, base stations, specific fog servers, etc. These fog nodes are widely distributed between the end devices and cloud, for example, cafes, shopping centers, bus terminals, streets, parks, etc. They can be static at a fixed location, or mobile on a moving carrier. The end devices can conveniently connect with fog nodes to obtain services. They have the capabilities to compute, transmit and temporarily store the received sensed data. The real-time analysis and latency- sensitive applications can be accomplished in fog layer. Moreover, the fog nodes are also connected with cloud data center by IP core network, and responsible for interaction and cooperation with cloud to obtain more powerful computing and storage capabilities.[519]

As we might imagine, the blurring of cloud and fog has caused some accusations of vaporware – where Fog can be seen as a fancy new name for smaller units of someone's cloud. The systems engineering answer has been that proximity, purpose, and function matter. Fog delivers a different thing than cloud and some cases its primary purpose is to extend and adapt the cloud itself, but to provide a slightly different focused result.

Although cloud and fog both provide computation, storage, application, infrastructure, and data resources, there are some significant differences between the two paradigms. The major difference is in terms of accessibility and proximity. The fog computing infrastructure is close in proximity to the underlying nodes (fog generally resides on the local network), while the cloud is accessible over the Internet with the data center or server located anywhere in the world. Fog basically extends the traditional distant cloud to the edge of the network, closer to the IoT, WSN, and individual devices accessing it. Hence, fog can be viewed as a descendant of the cloud. Fog extends the cloud to provide additional benefits to the underlying nodes and networks by leveraging virtualization to create virtual sensors and networks that

519 Hu, P., Dhelim, S., Ning, H. and Qiu, T., 2017. Survey on fog computing: architecture, key technologies, applications and open issues. *Journal of network and computer applications*, *98*, pp.27-42.

are required for various services . In this way, fog adds an additional layer between the underlying nodes and the cloud, which helps in data analysis, processing, and filtering, and enhances security for sensitive data (e.g., user location, healthcare information). In the case of cloud services, and especially for multimedia, service quality is highly dependent on the core network. In contrast, for delay-sensitive applications, as fog is locally available, content can be accessed faster when using fog computing resources. Similarly, when resource-constrained devices need to offload their computation and processing, fog is a better option compared to cloud (or cloud-only scenario). Cloud is more centralized, whereas fog targets distributed applications [520]

The most interesting co-development with these fixed device technologies has been the evolution of telecommunications hardware and networking. Fifth Generation telecommunications, 5G, has the potential to obliterate entire sections of legacy architecture and make obsolete even the existing cloud paradigm.

The fifth-generation technology (namely, 5G) is the upgrading of telecom, mobile, and Internet infrastructure from the current 4G LTE (long-term evolution)-based network. In addition to enhancing network capacity, 5G facilitates emerging communication technologies, such as the Internet of Things, machine-to-machine applications, and smart networks. As a critical information infrastructure for next decade, 5G is concerned with multilayered governance issues of standards, architecture arrangements, infrastructure administration, information flow, security, and privacy.[521]

As we will witness, potential does not equal probability. At issue with 5G, as with almost all the extent components of the AEGIS, the inherent lack of cohesion and uniformity within the industry threatens to make resilient and adaptive tech

520 Aazam, M., Zeadally, S. and Harras, K.A., 2018. Fog computing architecture, evaluation, and future research directions. *IEEE Communications Magazine*, *56*(5), pp.46-52.

521 Tang, M., 2020. Huawei Versus the United States? The Geopolitics of Exterritorial Internet Infrastructure. *International Journal of Communication*, *14*, p.22.

economically unfeasible due to the cost of heterogeneous integration.

> Ubiquitous network technologies have been developed and deployed. 4G-LTE, LTE-A, WiFi, and other wireless broadband technologies are being widely used. Moreover, 5G network and D2D communication technologies are currently being developed and will be ready for commercial deployment in the coming years. The development of wireless broadband speeds up user access to cloud services and improves user experience. However, the potential access speed requirements and end-user demands have yet to be met. With respect to online video, mobile online video utilizes numerous network bandwidths. Moreover, network delay has a significant effect on user experience. Therefore, the development of 5G and D2D technologies has resulted in not only a new driving force but also a new challenge for cloud computing, i.e., how to further improve user experience by fully utilizing continuously updated network devices and technologies.[522]

Consider how telecommunications conflicts threaten to implement a Cyber-Westphalia – 5G represents the forefront of new options in this soft power battle for economic and technological hegemony. China has bee especially focused on 5G as a means to expand its power globally.

> Although promoted primarily for domestic restructuring, Made in China 2025 has been interpreted by the West as an ambitious declaration to challenge the West’s dominance in the global technology sector. The 13th Five- Year Plan (State Council, 2016) upgraded 5G to a key technology for information network with strategic importance. The next two years’ government reports further articulate this. A 2018 Deloitte report claims that China’s plan to invest US$400 billion in 5G-related technology development and infrastructure construction exceeds U.S. expenses in wireless communications infrastructure “by approximately [US]$24 billion”. [523]

522 Zhou, Y., Zhang, D. and Xiong, N., 2017. Post-cloud computing paradigms: a survey and comparison. *Tsinghua Science and Technology*, *22*(6), pp.714-732.

523 Tang, M., 2020. Huawei Versus the United States? The Geopolitics of Exterritorial Internet Infrastructure. *International Journal of Communication*, *14*, p.22.

With these enabling policies, national champions, such as China Mobile, China Telecom, Huawei, and ZTE, are the front-runners in steering 5G projects. In February 2013, China's NDRC, the Ministry of Industry and Information Technology, and the Ministry of Science and Technology—all ministerial-level state entities—jointly established the IMT-2020 (5G) Promotion Group (IMT-2020) as the central oversight team to promote 5G R & D (IMT-2020, 2013). The IMT-2020 taskforce includes experts from central academic institutions and major operators and vendors. All three traditional telecom carriers—China Mobile, China Telecom, and China Unicom—have started their technical preparations for 5G deployment . Under IMT-2020 coordination, the 5G R & D trial was formally launched in January 2016 and later issued the certifications to seven domestic and international participants (IMT-2020, 2016). In the second-stage research trial, Huawei piloted a first 5G radio test field in Huairou District in Beijing (IMT-2020, 2017). [524]

Thus we have a highly viable technology that by nature of its interpenetration with a larger SoSCP has significant political heft and will attract the same kinds of adversarial responses as Chinese and Indian dominance in the undersea cable market engendered. Cloud then will remain as the best available easily accessible and usable technology for AEGIS engineering until the hegemonic power struggle inherent in the ecumene's epistemically violent technosocial interplay.

Critical Value to the Ambient Ecumene: Off Premise Computing

Off Premise Computing delivers extraordinary flexibility, integration, and real-time support of the most salient features of ambient applications and services.

524 Tang, M., 2020. Huawei Versus the United States? The Geopolitics of Exterritorial Internet Infrastructure. *International Journal of Communication*, *14*, p.22.

Smart X Algorithms

We have dwelt on the complexity of hardware systems feeding the AEGIS and given a large section of the Technosociology portion of the thesis over to examination of epistemic violence expressed through algorithms. We must now turn to the algorithms themselves, trying to understand how AI gets constructed, what transparency does exist, and how tools like MATLAB and HFGT give us insight into when and why emergent software performs correctly. As we are seeking AEGIS oriented software systems, we will target the algorithms and neural nets which drive Smart X. "Machine learning (ML) technology is a specific type of algorithm that can be applied to many different domains, symmetric data types, and symmetric data models. Accordingly,ML is seen as providing a significant platform towards achieving smart IoT applications."[525]

There are several kinds of machine learning used for IoT and consequently Smart X: "ML technology generally employs one of four different classifier algorithms, namely, Bayes Network (BN), Naïve Bayesian (NB), J48, and Nearest Neighbour (NN) algorithms on WEKA ML platform. .All four classification algorithms consistently produced high accuracy results with Smart City applications tied to IoT achieving 100% sensor accuracy and data mining."[526] At a local level, these ML intelligences mutate and evolve through emergence. At this point the become black box – unable to be fully understood – AIs running on indeterminate programming."In local government driven Smart Cities, black box algorithmically-determined decisions can be most directly impactful."[527]

> As Adam Greenfield writes, "[s]tripped of its mystification...machine learning is the process by way of which algorithms are taught to recognise patterns in the world through the automated analysis of very large data sets". What chiefly distinguishes

525 Alsharif, M.H., Kelechi, A.H., Yahya, K. and Chaudhry, S.A., 2020. Machine learning algorithms for smart data analysis in internet of things environment: taxonomies and research trends. *Symmetry*, *12*(1), p.88.

526 Chin, J., Callaghan, V. and Lam, I., 2017, June. Understanding and personalising smart city services using machine learning, The Internet-of-Things and Big Data. In *2017 IEEE 26th International Symposium on Industrial Electronics (ISIE)* (pp. 2050-2055). IEEE.

527 Williamson, B., 2017. Computing brains: learning algorithms and neurocomputation in the smart city. *Information, Communication & Society*, *20*(1), pp.81-99.

ML from computer programming is the manner in which machines can develop 'insight' through the non-explicit instructional method of a 'neural network'. The concept of a neural network as the phrase implies, borrows from the understanding of how the human central nervous system operates through neural pathways and connections, and translates this into a computational system. Artificial neural networks then, are a biologically inspired ML paradigm, capable of solving complex signal processing or pattern recognition problems. Grant Sanderson argues that while neural networks are an "old technology", they are the first ML algorithm that beginners need to understand, before "more detailed modern variants" can be understood. To develop a neural network framework from base principles, it is necessary to understand how neural networks learn and can be trained, of which the most conventional method is 'gradient descent'.[528]

As this excerpt below indicates, AI for Smart Cities and the ML that drives it shows great promise but has been intentionally limited in the same way (but for different reasons) as undersea cabling, IoT, and 5G telecommunications networks:

The intelligence inherent to AI algorithms is compatible with the automation necessary for smart monitoring, as part of smart infrastructure. Moreover, several AI algorithms used in smart monitoring are commonly referred to as "big data" algorithms and therefore serve a twofold purpose, (i) to detect patterns representing complex physical processes that otherwise would remain undetected, and (ii) to exploit, to the best possible extent, large amounts of data available in long-term SHM systems that are otherwise only partially utilized. Smart monitoring, thus smart infrastructure, has taken advantage of distributed artificial intelligence, a subfield of artificial intelligence. In particular, multi-agent technology, representing a major branch of distributed artificial intelligence, has been deployed to advance different

528 Khean, N., Kim, L., Martinez, J., Doherty, B., Fabbri, A., Gardner, N. and Haeusler, M.H., 2018. The Introspection of Deep Neural Networks-Towards Illuminating the Black Box-Training Architects Machine Learning via Grasshopper Definitions.

fields of smart monitoring.[529]

Artificial intelligence algorithms, and, by extension, machine learning algorithms, may be categorized into symbolic AI, which includes inference and search algorithms using explicit symbolic programming, and into subsymbolic AI, which is generally considered "black-box" in terms of internal mechanisms. Subsymbolic AI, such as deep learning neural networks, shows good performance in analyzing complex engineering problems that involve large data sets and is therefore widely used in smart monitoring. However, the widespread adoption of subsymbolic AI/ML algorithms in smart monitoring is still limited, due to mistrust expressed by engineers towards the opaque inner mechanisms of subsymbolic AI/ML algorithms, and, by extension, to the reasoning and reproducibility of the outputs.[530]

These engineers want transparency and auditability in their algorithms so that emergent properties can be tracked and when they differ from the desired program state, either modified, edited, or removed from the program. "We found that in almost every case, it was not provided. Over-broad assertions of trade secrecy were a problem. But,contrary to conventional wisdom, trade secrets properly understood are not the biggest obstacle, as release of the trade-secret-protected code used to execute predictive models will not usually be necessary for meaningful transparency."[531]

What they do not want but what has emerged anyway are entirely invisible layers of AI which obfuscate and prevent transparency and clarity for SE. Instead, once a program connects through a GIS into the ambient ecumene, the wider and wilder ecosystem of non-linear chaos influences the algorithms. Worse, each ML algorithm has the potential

529 Luckey, D., Fritz, H., Legatiuk, D., Dragos, K. and Smarsly, K., 2020, August. Artificial intelligence techniques for smart city applications. In *International Conference on Computing in Civil and Building Engineering* (pp. 3-15). Springer, Cham.

530 Luckey, D., Fritz, H., Legatiuk, D., Dragos, K. and Smarsly, K., 2020, August. Artificial intelligence techniques for smart city applications. In *International Conference on Computing in Civil and Building Engineering* (pp. 3-15). Springer, Cham.

531 Williamson, B., 2017. Computing brains: learning algorithms and neurocomputation in the smart city. *Information, Communication & Society*, *20*(1), pp.81-99.

to become emergent alone and without influence, transforming into a black box unaided. As a whole, the systems of algorithms moves towards black box indeterminacy in a manner which suggest that with increasing sophistication there exists and equal or greater chance of emergence and abstraction which prevent direct understanding. The neurocomputational reality should alarm us: not only do we have to contend with the inherent biases of technosocially mediated algorithmic design, but we have the genuine prospect of these flawed violent epistemically complex AIs making new decisions beyond our ability to control or understand. As this passage from *Computing brains: learning algorithms and neurocomputation in the smart city* relates, we have even to consider whether Smart X has generated sentience in urban centres.

> The smart city is an urban environment governed by the capacities of coded devices and infrastructures ,a 'programmable environment' structured and supported 'line by line, algorithm by algorithm, program by program,''by code using data as fuel' . To some degree, smart cities are even 'sentient' spaces that 'think of us', with some form of reflexive awareness as learning environments. A growing body of research has begun to engage with algorithms both as social products – designed by technical experts in specific social settings–and as socially productive systems that interact with diverse practices. As products, Kitchin characterizes algorithms variously as 'black boxes' that are hidden inside intellectual property and proprietorial code; as 'heterogeneous systems' in which hundreds of algorithms are woven together; as 'emergent' systems that are constantly being refined, reworked, and tweaked; and as complex, unpredictable, and fragile systems that are sometimes miscoded, buggy, and 'out of control.' Beyond their properties as products, these vastly complex algorithmic systems can then 'do things,' and exert material effects 'on themselves, on machines and on humans'. As a consequence, algorithms are becoming an integrated part of everyday social processes that can reinforce, maintain, or even reshape visions of the social world, knowledge, and encounters with information. A novel kind of neurocomputational biopolitics is emerging from such practices, whereby the

> learning brain is imagined to be inter- acting with, and activated by, learning algorithms and the computing devices they enact in new kinds of brain/code/spaces. The potential consequences of such neurocomputational spaces extend beyond [limited interactions within] smart cities...Such spaces are no longer hard-coded 'programmable cities,' but more 'naturally' cognitive cities with 'human qualities.'[532]

We can therefore say that not only do we face the potential of social groups and state actors attempting to control the human agents within an ambient systems and to jigger with the functioning of an individual AmI application, we have now the potential for entire systems to be influenced by this drive for hegemony in such an fashion as to be functionally beyond repair or intervention. The Smart City environment works adequately well, ergo it cannot be "switched off" to fix the black box nature of hegemonic coercion without also breaking the Smart X tech itself. On top of that, the same city influenced by epistemic bias has now begun to think for itself in a limited fashion. As we add more AmIs and increase the amount of black box algorithms as well as give the ambient ecumene wider reach through its GISs, we stand to increased complexity in urban Smart X capabilities and an different flavour of emergence begin to arise.

Critical Value to the Ambient Ecumene: Smart X Algorithms

Smart X Algorithms deliver efficient computing and rapid data analysis needed to manage IoT, affective computing, and real-time telecommunications processing for AmI.

Smart X Software

As with the other Smart X technologies we've seen, the black box algorithms while they pose significant risks also have a limited distribution compared to more traditional

532 Williamson, B., 2017. Computing brains: learning algorithms and neurocomputation in the smart city. *Information, Communication & Society*, *20*(1), pp.81-99.

computing and networking. Most of the software and capabilities attached to software may rely on ML or AI, but its core programs rely on much more traditional easily reviewed, highly transparent coding. More ironically, like every heterogeneous legacy environment, most Smart X software does not integrate well if at all with other AIs.

> Initiatives for developing Smart City systems have been proposed in a wide range of city services, such as transportation , traffic control, air pollution, waste management , health care , public safety, water, energy, and emergency management. However, most of these solutions focus on a specific domain, target a specific problem, and were developed from scratch, with little software reuse. They do not interoperate, leading to duplication of work, incompatible solutions, and non-optimized resource use.[533]

One option open to SEs seeking to deliver a functioning AEGIS will be to use abstraction layers which juggle these heterogeneous elements on their behalf – potentially using emergent ML."Software-defined networking (SDN) allows, in summary, the creation and deployment of programmable networks and systems. In technical terms, SDN uses a logically centralized controller to program network equipment using a well know interface and protocol."[534] At stake – the massive influx of IoT objects with their infusion of dynamic chaos into systems that cannot manage them without the ML strings engineers fear and perhaps loathe. Instead, they have opted to brute force the finessing of ML protocols and Big Data analysis by using either massive private data centres or through public cloud.

> As the number of IoT devices soon reach the billions, it is essential to have a distributed software architecture that facilitates the sustainable management of these physical devices and communication networks, and access to their data streams and

533 Santana, E.F.Z., Chaves, A.P., Gerosa, M.A., Kon, F. and Milojicic, D.S., 2017. Software platforms for smart cities: Concepts, requirements, challenges, and a unified reference architecture. *ACM Computing Surveys (Csur)*, *50*(6), pp.1-37.

534 Martins, J.S., 2018. Towards smart city innovation under the perspective of software-defined networking, artificial intelligence and big data. *arXiv preprint arXiv:1810.11665*.

controls for developing innovative IoT applications. Three synergistic concepts come together to enable this. Service-Oriented Architectures (SOA) offer standard mechanisms and protocols for discovery, addressing, access control, invocation and composition of services that are available on the World Wide Web (WWW), by leveraging and extending web-based protocols such as HTTP and open representation models like XML. Cloud computing is a manifestation of this paradigm where infrastructure, platform and software resources are available "as a service" (IaaS, Paas and SaaS), of- ten served from geographically distributed data centers world-wide. These offer economies of scale and enable access to elastic resources using a pay-as-you-go model. Such commodity clusters on the Cloud have also enabled the growth of Big Data platforms that allow data-driven applications to be composed and scaled on tens or hundreds of Virtual Machines (VMs), and deal both with data volume and velocity, among other dimensions.[535]

This choice between higher costs through brute force or lower cost through black box algorithms has has a chilling effect on widespread adoption of universal Smart X measures. It would seem that while Smart Cities and Smart X applications continue to be created in a kind of methodological vacuum, they are being created nonetheless. SDNs seem to be the stopgap to balance the increase in both IoT and Smart X with the reality of limited heterogeneous resources and emergent algorithms.

There are clear areas of focus for any SDN to be effective: The most important features of such applications are the real-time and reliability support in detection and response. All aspects of [Smart X] applications including threat observations, decision making, communication, and actions must be reliable and able to run in real-time. This imposes a serious restriction on how the software is designed and how well it supports high levels of integration across all the devices involved to ensure real-time and reliable responses. Software defined networking (SDN) is an approach to enable

535 Simmhan, Y., Ravindra, P., Chaturvedi, S., Hegde, M. and Ballamajalu, R., 2018. Towards a data-driven IoT software architecture for smart city utilities. *Software: Practice and Experience*, *48*(7), pp.1390-1416.

flexible and efficient network configuration to enhance a network. SDN can provide many advantages for configuring city networks to support different applications. While there are some efforts in investigating this approach for supporting smart city applications, there is room for developing more advanced management and networking mechanisms in SDN for efficient, reliable, and secure network configurations in smart cities. [536]

Database

175 Zettabytes a year require database technologies commensurate with the 50X increase in data flow and subsequent analysis. there exists no set uniform architecture, framework and standards for data management, networking and computing technologies, experimentation and simulation frameworks and facilities that impede the large-scale deployment of smart cities.[537]

Smart cities include several technological challenges and need for a ubiquitous deployment of computing resources throughout the city (from IoT devices to advanced data centers). All data resources must be connected through several communication net- works by many different network technologies (including wireless sensor networks, Bluetooth, 4G, Wi-Fi, etc.) and this scenario together should be organized by deploying advanced architectural approaches (including IoT, IoE etc) to build the smart city idea. However, beyond all technologies, the most precious resource for a city to become smart is data. In addition, there is a huge number of data sources (including sensors, smart devices, 3rd party applications and so on) across smart cities in today's world.[538]

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536 Jawhar, I., Mohamed, N. and Al-Jaroodi, J., 2018. Networking architectures and protocols for smart city systems. *Journal of Internet Services and Applications*, *9*(1), pp.1-16.

537 Gharaibeh, A., Salahuddin, M.A., Hussini, S.J., Khreishah, A., Khalil, I., Guizani, M. and Al-Fuqaha, A., 2017. Smart cities: A survey on data management, security, and enabling technologies. *IEEE Communications Surveys & Tutorials*, *19*(4), pp.2456-2501.

538 Sinaeepourfard, A., Krogstie, J. and Petersen, S.A., 2018. A big data management architecture for smart cities based on fog-to-cloud data management architecture.

While some major cloud providers have addressed database (AWS with its serverless options, Oracle with autonomous database) there exists a strange blank spot in Smart X design where huge data rich environments are being created, billions of IoT devices are being brought online, and yet no IoT specific Smart City focused database programs exist. We must therefore turn to what presently exist and consider how to modify and integrate database (DB) for our own purpose.

> A massive amount of data is being produced and stored rapidly, regularly and unlimitedly in their related distributed data repositories in the contemporary IT world. This massive data can be in structured, semi-structured or unstructured formats (Big Data). In addition, the above mentioned data have the possibility to be shared and openly accessible (Open Data) and used by the potential clients in either private or public sector. the Big Data challenges can be defined as a 6Vs challenges (including Volume, Variety, Velocity, Variability, Veracity, and Value). [539]

The 6V challenges can be met through any number of cloud integrations with traditional DB (Oracle, SAP being 90% of the world's Dbs) then extended to either an AmI app or a SDN. Even blockchain can play a part. "We have also done a critical comparative analysis for blockchain and traditional database system in terms of the range of properties used to evaluate any information system. We have found that if trust building, robustness, and prove- nance of data are the priorities of the system, then blockchain is the better solution. If confidentiality and performance are the main concerns, then traditional database is still the better solution. "[540]

> Because of blockchain's low capacity of reading and writing data compared to current relational databases, based on pure blockchain's business systems and applications' speed of processing business cannot be accepted. This is surely a big

539 Sinaeepourfard, A., Krogstie, J. and Petersen, S.A., 2018. A big data management architecture for smart cities based on fog-to-cloud data management architecture.

540 Chowdhury, Mohammad Jabed Morshed, Alan Colman, Muhammad Ashad Kabir, Jun Han, and Paul Sarda. "Blockchain versus database: A critical analysis." In *2018 17th IEEE International Conference On Trust, Security And Privacy In Computing And Communications/12th IEEE International Conference On Big Data Science And Engineering (TrustCom/BigDataSE)*, pp. 1348-1353. IEEE, 2018.

challenge for blockchain deployment in various industries and our society, where cost trust can be reduced by blockchain technology. If a real-world business system which combine blockchain technology and current relational databases can provide acceptable service for users, it will be a solution for this challenge. A practical solution may be combining blockchain with relational databases to implement industrial functions.[541]

Critical Value to the Ambient Ecumene: Smart X Software

Smart X Software delivers viable command and control solutions as well as database management for the massive information influx of data being generated in an AEGIS.

Smart X Products and Solutions

While we have covered the crucial elements of of building an AEGIS in aggregate and shown the major component hardware and software, we have not really discussed what it takes to make something "Smart" as opposed to merely efficient or ML driven. To be Smart X, the technology must have an affective computing focus with emotionological capacity, it must function in real-time, be highly adaptive to human agents, utilise AmI with emergent black box algorithms and be connected to a working device that can provide sensor data and human feedback.

Smart city means managing this complexity, through multi-agent knowledge approaches, attention to features and informal relationships, remembering and managing possible, probable emerging properties beyond sums and juxtapositions. Smart city intelligently links times, spaces and agents through geographical and physical relationships but also emotional, creative, informal trusts. In this context,

541 Chen, S., Zhang, J., Shi, R., Yan, J. and Ke, Q., 2018, July. A comparative testing on performance of blockchain and relational database: Foundation for applying smart technology into current business systems. In *International Conference on Distributed, Ambient, and Pervasive Interactions* (pp. 21-34). Springer, Cham.

smart city is the city's ability to exist, maintain itself, progress as an 'agency' autonomously but intimately intelligently linked.[542]

It may be more successful as systems engineers to consider how a Smart X technology works systemically – what kind of system does it comprise, what does it requires in terms of resources, and what outputs does the entire system produce? We can conider the passage below on Compelx adaptive systems which certainyl descirbe a singular Smart X technology as it merges with a biome.

Scholars have characterized cities as prime examples of complex (adaptive) systems with considerable internal resilience within a certain domain of stability. This characterization was true well before the adoption of ICT solutions was added to the level of complexity that cities represent. Complex adaptive systems (CAS) are characterized by diversity and individuality of components, localized interaction among the components, and an autonomous process that uses the outcomes of those local interactions to select a subset of those components for replication or enhancement. CAS can be distinguished from other systems by seven features: connectivity, autonomy of agents, emergent behavior, non-equilibrium, nonlinearity, self-organization, and co-evolution. In contrast to deterministic systems, e.g. engineering systems that behave predictably and are provided with a controller – human or automatic – *complex systems have no central control* . Complexity in this context is thus defined by the relationships between the elements in the system rather than simply by the number of elements – a characteristic that distinguish them from complicated systems.[543]

The lack of central control gibes with our understanding of black box software

542 Camarda, D., 2019, April. Complexity, governance and the smart city. In *IS THIS THE REAL WORLD? Perfect Smart Cities vs. Real Emotional Cities. Proceedings of REAL CORP 2019, 24th International Conference on Urban Development, Regional Planning and Information Society* (pp. 171-181). CORP–Competence Center of Urban and Regional Planning.

543 Colding, J., Colding, M. and Barthel, S., 2020. The smart city model: A new panacea for urban sustainability or unmanageable complexity?. *Environment and Planning B: Urban Analytics and City Science*, *47*(1), pp.179-187.

managing AmI systems. What we are looking at then is a diffuse multi-sentient ecosystem of digital biomes with their own limited AmI interacting like biological species – animals and plants – in a larger ecumene created by the Smart City.

> An intelligent/smart product is defined as a physical and information-based representation of a product in intelligent manufacturing field or a cyber-physical system (CPS) using the Industry 4.0 term, which can operate autonomously, respond to their environments, or communicate with other products. The definition indicates that smart products tend to focus on connectivity and information exchange through-life (all phases), that is, how to interact with their external environments, such as physical environment (natural environment and other products/physical facilities/robots), human environment (through-life stakeholders such as users/operators), and cyberspace environment (distributed system). The interaction can create meaningful experiences and added value during the use phase of the smart products.[544]

At an urban planning level this confluence of biomes into one functioning ecosystem, a shared lifeworld of digital objects and epistemically managed geographies integrated with human agents seeking real-time interactivity established multiple overlapping jurisdictional and delivery priorities for the AmIs. It requires massive integration of reosurce management across not just simple things like telecommunications and utilities but how we pay for coffee, cross the street, order a taxi (or Uber), or opt instead to take the subway when the traffic app alerts us.

> Smart city architectures have to take into account a large number of requirements related to the large number of data, different sources, the need of reconciliating them in a unique model, the identification of relationships, and the enabling of data analytics processes. Ingested data, static and realtime, must be stored, aggregated

544 Zhang, H., Qin, S., Li, R., Zou, Y. and Ding, G., 2020. Environment interaction model-driven smart products through-life design framework. *International Journal of Computer Integrated Manufacturing*, *33*(4), pp.360-376.

and integrated to provide support for data analytics, dashboard, making decision, and thus for providing services for the city. This means: i) compatibility with multiple protocols; ii) handle open and private data; iii) work with IOT/sensors/internet of everything; iv) perform predictions, behavior analysis and develop decision support systems; v) use a set of dashboards to make a real-time monitoring of the city; vi) consider system's security aspects: robustness, scalability, modularity, interoperability, etc. This approach is determinant to: monitor the city status; connect the different events that occur in the smart city; provide support for public administrators, police department, civil protection, hospitals, etc., to put in action city/region strategies and guidelines and obviously directly to the citizens.[545]

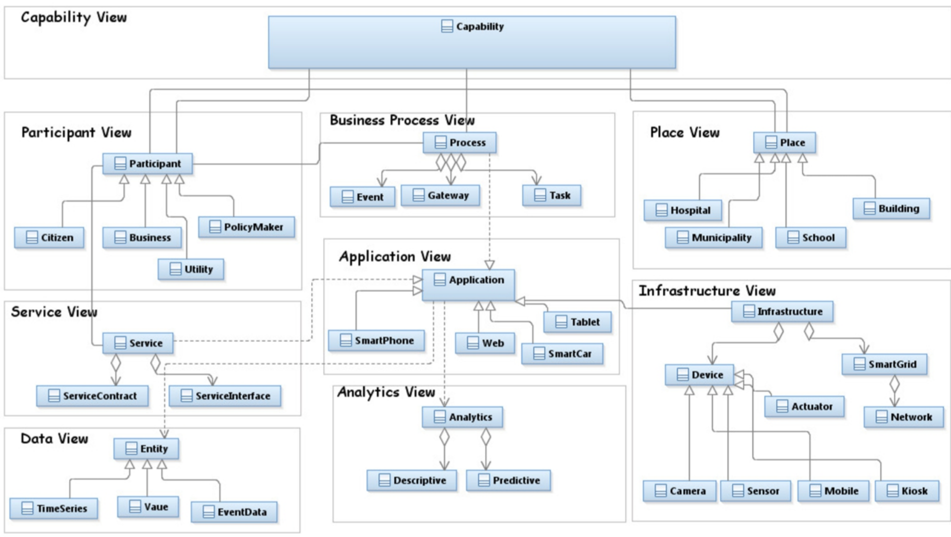

Fig. 1. Multiple-View Smart City Reference Architecture Meta-Model

[546]

As the meta model of the Smart City above suggests, there are several vertical capabilities / responsibilities a smart system might manage. As with IoT, we will take a meaningful excerpt of the critical applications of Smart X so we can keep them in mind

545 Bellini, P., Nesi, P., Paolucci, M. and Zaza, I., 2018, March. Smart city architecture for data ingestion and analytics: Processes and solutions. In *2018 IEEE Fourth International Conference on Big Data Computing Service and Applications (BigDataService)* (pp. 137-144). IEEE.

546 Abu-Matar, M. and Davies, J., 2017, August. Data driven reference architecture for smart city ecosystems. In *2017 IEEE SmartWorld, Ubiquitous Intelligence & Computing, Advanced & Trusted Computed, Scalable Computing & Communications, Cloud & Big Data Computing, Internet of People and Smart City Innovation (SmartWorld/SCALCOM/UIC/ATC/CBDCom/IOP/SCI)* (pp. 1-7). IEEE.

for future planning and AEGIS development.

1 Safety & Security real time crime mapping, smart surveillance, body worn cameras, disaster early warning systems, predictive policing, emergency response optimization, crowd management, building security and safety system, personal alert applications,gunshot detection, data driven building inspections.[547]

2 Health telemedicine, online care search and scheduling, real time air quality information, infectious disease surveillance, lifestyles wearables, remote monitoring applications and medication adherence tools, data based population health interventions, first aid alerts, integrated patient flow management system.[548]

3 Education e-learning platform, augmented reality tools, building automation simulator, Education&Training platforms, energy management awareness, real time behavioral impact, personalized education applications, open data/data management platform.[549]

4 Mobility sharing/ e-hailing/ autonomous driving, private e-hailing, bike sharing, car sharing, autonomous vehicle, pooled e-hailing, demand-based micro transit traffic management and data services, real time road navigation, traffic management and data sharing, real time road navigation, integrated multimodal info, digital payment in public transit, intelligent traffic signals and vehicle preemption, real time public transit info, smart parking, predictive maintenance of transit infrastructure, congestion pricing, urban cargo smart parcel lockers, parcel load pooling, and urban consolidation centers.[550]

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547 Clemente, C., Civiero, P. and Cellurale, M., 2019. Solutions and services for smart sustainable districts: innovative key performance indicators to support transition. *Int. J. Sustain. Energy Plan. Manag*, *24*, pp.95-106.

548 Clemente, C., Civiero, P. and Cellurale, M., 2019. Solutions and services for smart sustainable districts: innovative key performance indicators to support transition. *Int. J. Sustain. Energy Plan. Manag*, *24*, pp.95-106.

549 Clemente, C., Civiero, P. and Cellurale, M., 2019. Solutions and services for smart sustainable districts: innovative key performance indicators to support transition. *Int. J. Sustain. Energy Plan. Manag*, *24*, pp.95-106.

550 Clemente, C., Civiero, P. and Cellurale, M., 2019. Solutions and services for smart sustainable districts: innovative key performance indicators to support transition. *Int. J. Sustain. Energy Plan. Manag*, *24*,

5 Energy distribution automation system, dynamic electricity pricing, building energy consumption tracking, smart streetlights, building automation systems, building energy automation systems.[551]

6 Water leakage detection and control, water consumption tracking, water quality monitoring, smart irrigation.[552]

7 Waste waste collection route optimization, digital tracking, and payment for waste disposal.[553]

8 Economic Development Housing and Community local connection platforms, peer to peer accommodation platforms, digital administrative citizen services, local civic engagement application, local e-career center, online retraining programmes.[554]

These eight silos yielded 70 individual application and service categories without even touching ATMs, mobile banking, and e-commerce for commercial purposes. We can add social media, GIS connection, telecommunications balancing and IoT background applications as well as private commercial networks (such as banking apps, company instant messaging, and tourist augmented reality apps). The categories alone would pass 100 with individual Smart X products available across multiple devices, media platforms, clouds, and with any number of heterogeneous IoT objects. In other words, Smart X products produce massive data, massive non-linear dynamic chaos, and a huge engineering headache for anyone seeking to itnegrate, manage, control, and

pp.95-106.

551 Clemente, C., Civiero, P. and Cellurale, M., 2019. Solutions and services for smart sustainable districts: innovative key performance indicators to support transition. *Int. J. Sustain. Energy Plan. Manag*, *24*, pp.95-106.

552 Clemente, C., Civiero, P. and Cellurale, M., 2019. Solutions and services for smart sustainable districts: innovative key performance indicators to support transition. *Int. J. Sustain. Energy Plan. Manag*, *24*, pp.95-106.

553 Clemente, C., Civiero, P. and Cellurale, M., 2019. Solutions and services for smart sustainable districts: innovative key performance indicators to support transition. *Int. J. Sustain. Energy Plan. Manag*, *24*, pp.95-106.

554 Clemente, C., Civiero, P. and Cellurale, M., 2019. Solutions and services for smart sustainable districts: innovative key performance indicators to support transition. *Int. J. Sustain. Energy Plan. Manag*, *24*, pp.95-106.

optimise the ecosystem.

Critical Value to the Ambient Ecumene: Smart X Products and Solutions

Smart X Products and Solutions deliver the keystone capabilities needed to engage with and move through an AEGIS in real-time.

Core CSPs, SCPs & SoSCPs of the AEGIS

We have been talking of individual components and modular systems which inevitably cover the beginnings of cyber-physical systems, socio-cyber-physical systems, and of course systems those systems. We will now circle back to some of the same concepts and review them as full systems interrogated as systems rather than elements of larger things. The key takeaway so far has been that while some individual portions of an AEGIS represent serious dangers to sociopolitical stability or human free will, none can operate without a wider system and all of them have encountered checks and balances which either through epistemic homeostasis or geopolitical manoeuvring have resulted in a sloppy, less than secure, but ultimately successful roll-out of Smart X technologies and incipient growth of AEGISs across the globe.

Artificial Intelligence

We have looked at AI and Ami from both a technosocial and engineering perspective. But what exactly does artificial intelligence do and why do we care?

> Simply put, AI is an approach to build intelligent machines capable of carrying out tasks as humans do. This is obviously a very broad definition, and it can refer from Apple Siri to Google AlphaGo and too powerful technologies yet to be invented. In simulating human intelligence, AI systems typically demonstrate at least some of the

following behaviors associated with human intelligence: planning, learning, reasoning, problem-solving, knowledge representation, perception, motion, and manipulation and, to a lesser extent, social intelligence, and creativity.[555]

AI acts like human intelligence but has certain advantages precisely because it does not require a human body and it does not have human emotions. Instead, it has unlimited patience, no need for sleep, the inhuman talent to concentrate on a single set of tasks, and a speed of light communications that of course makes it valuable as a system and because it has applications which could deliver weapons, vehicles, cargo, and surveillance without human intervention, it has a depth of geopolitical value.

The capacity of computing systems is in an arms race with the massively growing amount of visual data they seek to understand. In a range of applications—including autonomous driving, robotic vision, smart homes, remote sensing, microscopy, surveillance, defence and the Internet of Things—computational imaging systems record and process unprecedented amounts of data that are not seen by a human but instead are interpreted by algorithms built on artificial intelligence (AI).[556] Applied to AI inference in computer vision, robotics, microscopy and other visual computing tasks, hybrid optical–electronic inference machines could realize some of the transformative capabilities long hailed for optical computers.[557]

At the same time, there exists in AI a serious dichotomy that makes it far more valuable as a civilian public and communal resource than something that powers killer robots. It follows that Smart X follows public needs far more than AmI has pervaded the military systems of systems world. AI thinks like a human and does what a human can do. It works best when it can interact with humans and assist them.

555 Zhou, Z., Chen, X., Li, E., Zeng, L., Luo, K. and Zhang, J., 2019. Edge intelligence: Paving the last mile of artificial intelligence with edge computing. Proceedings of the IEEE, 107(8), pp.1738-1762.

556 Wetzstein, G., Ozcan, A., Gigan, S., Fan, S., Englund, D., Soljačić, M., Denz, C., Miller, D.A. and Psaltis, D., 2020. Inference in artificial intelligence with deep optics and photonics. *Nature*, *588*(7836), pp.39-47.

557 Wetzstein, G., Ozcan, A., Gigan, S., Fan, S., Englund, D., Soljačić, M., Denz, C., Miller, D.A. and Psaltis, D., 2020. Inference in artificial intelligence with deep optics and photonics. *Nature*, *588*(7836), pp.39-47.

> Human and machine agents do not simply co-exist in separate worlds (working on separate tasks), but are interdependent (interacting on the same or closely related tasks). Augmentation therefore implies close collaboration between humans and machines. Since automation and augmentation are interdependent, this interaction spreads across organizations. When addressing this human-machine interaction, management scholars need to first explore how machines shape managerial behavior. For example, Lindebaum et al. describe how autonomous algorithms can direct and constrain human behavior by imposing formal rationality. This perspective resonates with Foucault's concept of panoptic surveillance, characterizing IT as a form of omnipresent architecture of control that creates, maintains, and cements central norms of expected behavior[558]

We have already examined how ambient systems enhance the programmed notion of human ways of being. But as the prior material in this chapter has shown, the ambient systems themselves have the capacity to influence their programmers just as much. The IoT explosion and the attachment of multiple sensors to human agents through health arm bands, smart phones, medical devices, smart homes and gyms, RFID tags in clothing and smart cards, and their ease of access to AI managed software translates to a pervasive and ubiquitous climate of benign surveillance where we are monitored 24 hours a day, 365 days a year, endlessly and continuously by those humanly affective, highly adaptable, infinitely patient and focused AI systems

AI Assisted Surveillance:

As we have seen, scholars believe this AI driven climate has been clearly identified by Michel Foucault in his reading of Jeremy Bentham's panopticon. "Under twenty-first century conditions, the control system of technical vision is multipolar, diffuse, overarching, and overwhelming, cutting across all human action from biometric

558 Raisch, S. and Krakowski, S., 2021. Artificial intelligence and management: The automation–augmentation paradox. *Academy of Management Review*, *46*(1), pp.192-210.

identification to smart phones, personal computers to CCCR cameras at airports, playgrounds, schools, churches, restaurants, and in the public space."[559]

So one of the great challenges we face – in the AEGIS we design and deploy systems which rely upon black box algorithms that will in turn control a massive amount of urban surveillance. Many scholars warn this will lead to social unrest and injustice. "The contemporary cyber domain has destructive tendencies that is threatening to the national and economic security cities and nations."[560] That threat has transformed even the most innocuous AI a negotiated and conflict laden SCPs. "Surveillance lies at the core of power politics because it not merely monitors the ongoing activities but has propensity to even predict the future actions."[561]

As we consider the Foucauldian notion of epistemic violence, we must think through "Foucault's panopticon model; power and surveillance are applicable to the modern technological world, where surveillance poses a national security threat to states and at the same time it is used by great powers to advance their national interests and ensure national security."[562]

So we have a powerful SCPS in AI that provides critical human level intelligence and adaptivity but at a price. AIs and their descendant ambient capabilities represent a threat when and where they exceed their mandates and spy on us. Or where they are built to spy on us and through the co-opting of public sensors, are able to do so.

> The invasive potential of AmI is, nearly by definition of the AmI itself, great. The AmI can fulfill their functions of proactive device indeed only by the mean of data collect from individuals and their action emotion etc…in determined context. "Most people would be shocked to find out just how much information they consider private is already in the public domain," says project information coordinator David

559 Syeda, F., Akhtar, R. and Alam, D., 2020. Panopticon: An Automation of Power Mechanism A Foucauldian Analysis of the Coercive Surveillance in 1984 by George Orwell.
560 Sheikh, N. and Askari, M.U., Foucauldian Panopticon: A Model for US Cyber Surveillance. 2020
561 Sheikh, N. and Askari, M.U., Foucauldian Panopticon: A Model for US Cyber Surveillance. 2020
562 Sheikh, N. and Askari, M.U., Foucauldian Panopticon: A Model for US Cyber Surveillance. 2020

Wright of Trilateral Research & Consulting in London. "Thanks to data aggregators that gather and consolidate a wide range of information about groups – and individuals – in society, our government and commercial organisations already know a great deal about what we do and what motivates us."[563]

Working Definition: Artificial Intelligence

Artificial Intelligence will be defined as an intelligent system that can perform human tasks as well or better as a human counterpart.

Cloud Computing

Cloud supports the profusion of most Smart X CPSs and SCPSs by providing unlimited computing capability on a minute by minute capacity. "Cloud computing is a large-scale heterogeneous and distributed computing infrastructure for the scientific and commercial communities, which provides high quality and low cost services with minimal hardware investments."[564] Much the of cost transfers capital expenditures to variable operational expenditures. "Transaction costs of cloud computing is a function of the costs incurred through (1) change management, (2) Meta services, (3) Business process reengineering, (4) contract management, (5) Monitoring, (6) Legal compliance management." [565]

The most adopted cloud computing definition is the one provided by the National Institute of Standards and Technology (NIST). It defines cloud computing as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (for example, networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal

563 Goujon, P., Critical perspective on Ambient Intelligence technology-ethical and societal issues. 2020
564 Ismayilov, G. and Topcuoglu, H.R., 2020. Neural network based multi-objective evolutionary algorithm for dynamic workflow scheduling in cloud computing. Future Generation Computer Systems, 102, pp.307-322.
565 Makhlouf, R., 2020. Cloudy transaction costs: a dive into cloud computing economics. Journal of Cloud Computing, 9(1), pp.1-11.

management effort or service-provider interaction". Although the rapid provision is a big advantage, it needs to be handled carefully.[566]

How does this make cloud a cyber-physical system? Cloud-based operational capabilities pervade all Smart X technology, even those linked to small private clouds. Likewise, IoT requires massive computing power and as such usually ends up dumping most of its meta-data and non essential information into a cloud:

> Today's world is being transformed by the availability of anywhere-and-anytime connectivity. The unprecedented ubiquitous presence of wireless and mobile technologies also in developing countries, the availability of low-cost, miniaturized wireless sensors, as well as the cost-efficient services provided by new hardware infrastructures (e.g., huge-scale datacenters leveraging virtualization technologies) have enabled new healthcare services, or new levels of quality and cost-efficiency in established ones.[567]

As the excerpted standards below demonstrate, the breadth and depth of cloud as CPS can best be understood by what they deliver and to whom. The are the National Institute of Standards and Technology (NIST) cloud essential characteristics computing definitions followed by the world since 2011:[568]

> On-demand self-service. A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.
>
> Broad network access. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

566 Makhlouf, R., 2020. Cloudy transaction costs: a dive into cloud computing economics. Journal of Cloud Computing, 9(1), pp.1-11.

567 Aceto, G., Persico, V. and Pescapé, A., 2020. Industry 4.0 and health: Internet of things, big data, and cloud computing for healthcare 4.0. Journal of Industrial Information Integration, 18, p.100129.

568 Mell, P. and Grance, T., 2011. The NIST definition of cloud computing.

Resource pooling. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, and network bandwidth.

Rapid elasticity. Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

Measured service. Cloud systems automatically control and optimize resource use by leveraging a metering capability1 at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

Working Definition: Cloud

Cloud will be defined as on demand computing capability with real-time infinitely scalable resources.

The Internet of Things

We have seen a wide spread of components available for IoT but what does it do as a system? "IoT is a combination of embedded technologies including wired and wireless communications, sensor and actuator devices, and the physical objects connected to the Internet."[569]

AI and AmI thrive when connected to IoT because "the Internet of Things (IoT) integrates various sensors, objects and smart nodes that are capable of communicating with each other without human intervention. The objects/things function autonomously in connection with other objects."[570] The access to data and the ability to respond to it has profound implications when coupled with real-time AI: "one of the appealing features of the IoT concept is the promise to use everyday Internet-enabled devices as end points for accessing industrial data."[571] That data then transforms human behaviour by providing guidance and social support for decision making. "Internet of Things is a platform where every day devices become smarter, every day processing becomes intelligent, and every day communication becomes informative."[572]

Internet of Things (IoT) refers to the stringent connectedness between digital and physical world. Various researchers have described IoT in multitude forms:

> "a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'Things' have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network".

> "3A concept: anytime, anywhere and any media, resulting into sustained ratio between radio and man around 1:1"

> ''Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and

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569 Mahdavinejad, M.S., Rezvan, M., Barekatain, M., Adibi, P., Barnaghi, P. and Sheth, A.P., 2018. Machine learning for Internet of Things data analysis: A survey. Digital Communications and Networks, 4(3), pp.161-175.

570 Conti, M., Dehghantanha, A., Franke, K. and Watson, S., 2018. Internet of Things security and forensics: Challenges and opportunities.

571 Wollschlaeger, M., Sauter, T. and Jasperneite, J., 2017. The future of industrial communication: Automation networks in the era of the internet of things and industry 4.0. IEEE industrial electronics magazine, 11(1), pp.17-27.

572 Ray, P.P., 2018. A survey on Internet of Things architectures. Journal of King Saud University-Computer and Information Sciences, 30(3), pp.291-319.

> user contexts". The semantic meaning of ''Internet of Things" is presented as ''a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols".

Working Definition: The Internet of Things

IoT will be defined as uniquely addressable interactive infrastructure which provides real-time data intelligence to ambient systems.

The Internet of Everything

Just like IoT and IoP, there exists a semantic paradigm of well, everything, predictably labelled the Internet of Everything (IoE). In its way, the IoE comes at an ambient ecumene in a different direction, using IoT as the guideline to describe an interconnected and intelligent world with decentralised command and control. As the excerpt and chart below demonstrate, IoE represents a useful way to describe the CPSs and SCPSs that comprise the AEGIS.

> The term IoT is being used to describe the connectivity of things as "a system of uniquely identifiable and connected constituents (termed as Internet-connected constituents) capable of virtual representation and virtual accessibility leading to an Internet-like structure for remote locating, sensing, and/or operating the constituents with real-time data/information flows between them". For the purposes of this paper, we use the term "smart things" to describe these connected constituents.
>
> The explosion of connectivity is subtle and often not noticeable to many people. Hyperconnectivity as a "myriad means of communication and interaction" that is always on, readily accessible, information-rich and interactive enables connections between virtually everything, resulting in the broadening of the IoT concept to the Internet of Everything. The Internet of Everything expands the IoT concept by adding

links to data, people and (business) processes. It therefore comprises other connection-based paradigms such as IoT, Internet of People (IoP), and Industrial Internet (II). In this context we understand the Internet of Everything (IoE) as a network of connections between smart things, people, processes, and data with real-time data/information flows between them.[573]

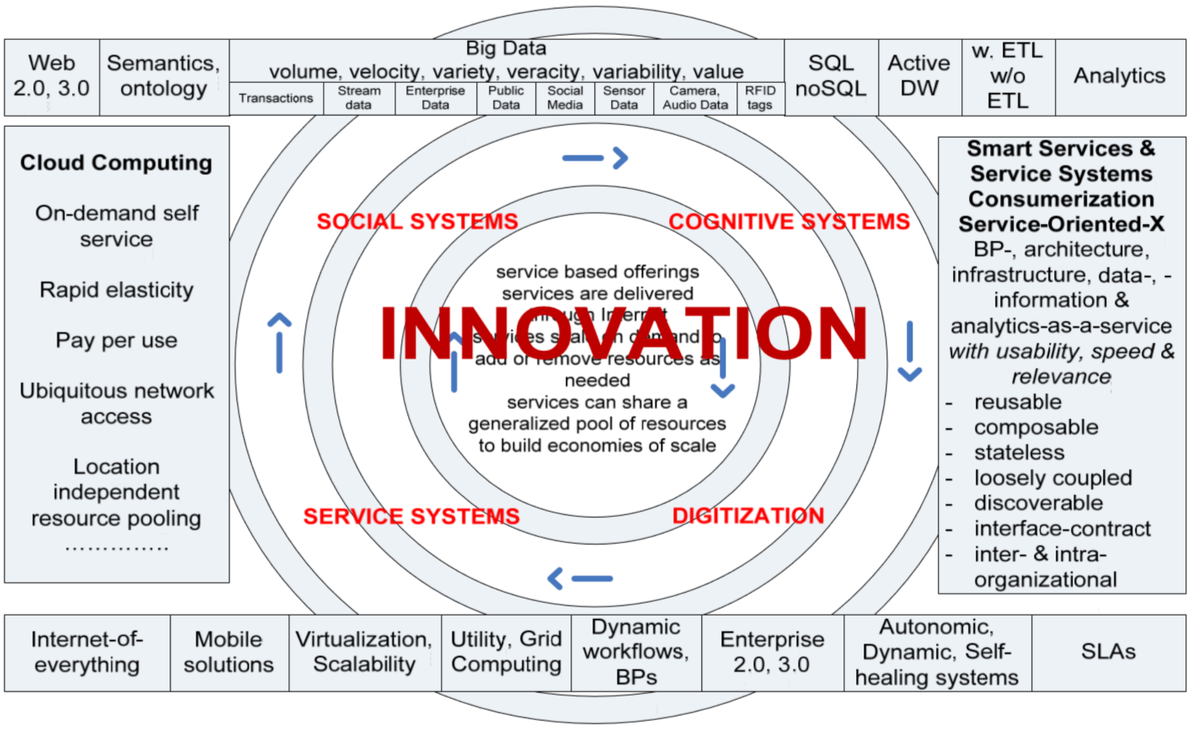


Figure 1. Conversion of ICTs (Adapted from Demirkan, 2013)

574

Cities which in the future may be regarded as a scaled version of the IoE, will benefit the most from being connected in terms of using information intelligence to address city specific concerns. This will become more so as cities become “Smart Cities” utilizing IoE along with ‘Big Data’ processing. Examples include monitoring the

573 Langley, D.J., van Doorn, J., Ng, I.C., Stieglitz, S., Lazovik, A. and Boonstra, A., 2021. The Internet of Everything: Smart things and their impact on business models. *Journal of Business Research*, *122*, pp.853-863.

574 Demirkan, H., Bess, C., Spohrer, J., Rayes, A., Allen, D. and Moghaddam, Y., 2015. Innovations with smart service systems: analytics, big data, cognitive assistance, and the internet of everything. *Communications of the association for Information Systems*, *37*(1), p.35.

'health' of highways and attending to their repairs using road embedded sensors; road traffic flow control, agricultural growth monitoring, education and healthcare. As urbanization continues to increase, predicted to be 70% by the 2050s, the use of IoE will become almost critical in implementing such features of the future city as the Smart Grid and automation of traffic planning and control.[575]

This means that IoE steps further than IoT, encompassing the people, networks, relationships, and super summing hyperconnectivity that they achieve through ubiquitous real-time interconnection. IoE should be considered synonymous with hyperconnectivity and in turn hyperconnectivity should be thought of as the entry state of any AEGIS, the minimum defined baseline to define an ambient or technological ecumene as emerging into a full AEGIS. Which begs the question – what more can super summed hyperconnected systems achieve and do if IoE represents the staring point rather than the finishing line. A question we will begin to answer as we examine larger SoSCPs of the AEGIS.

Working Definition: The Internet of Everything

IoE will be defined as a hyperconnected network of relationships between smart things, people, processes, and data which define the entry state of an AEGIS.

Touchless Retail

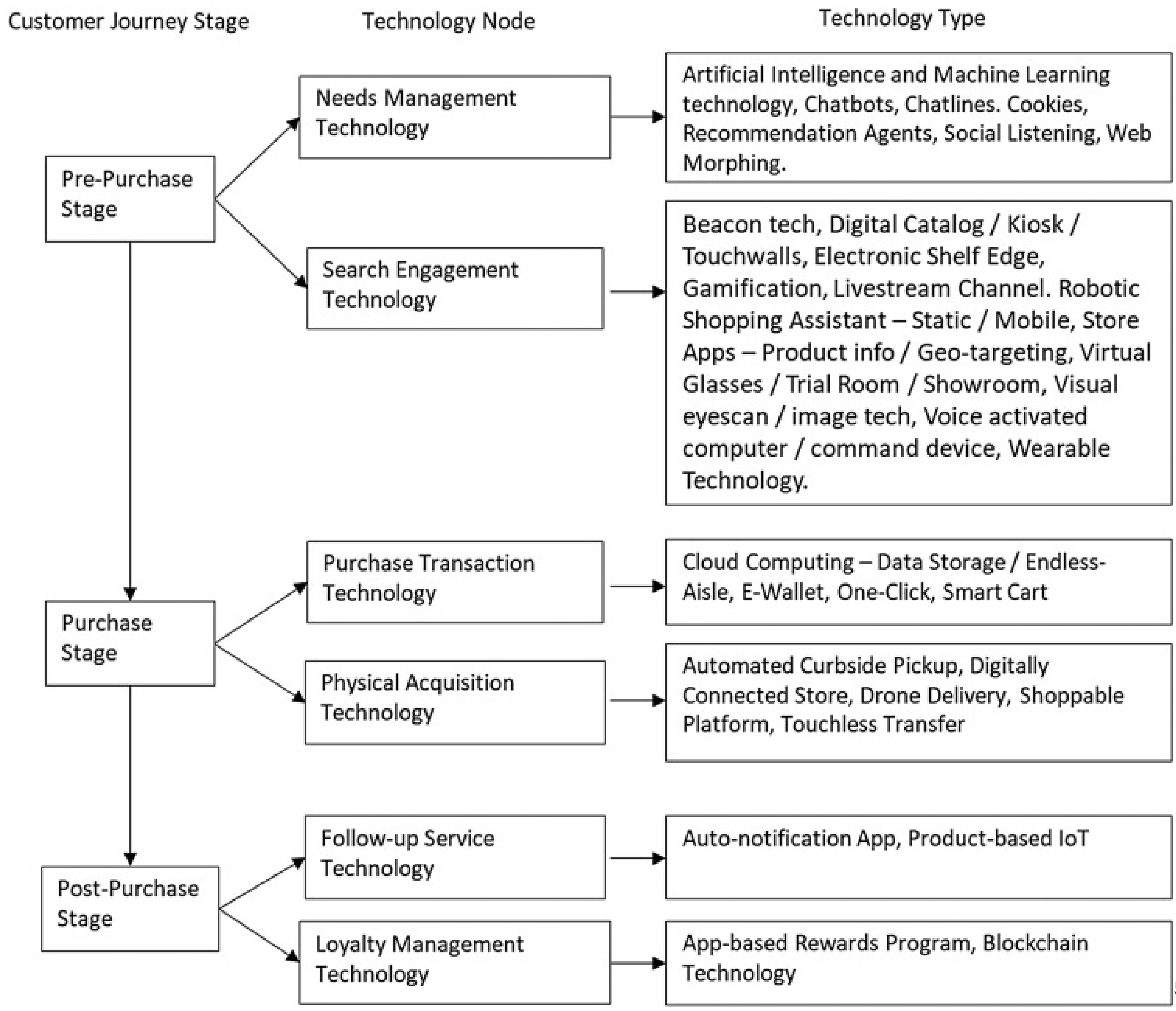
As we already saw the devices and systems that allow for electronic purchases and mobile banking we should not be surprised that when merged with the IoE, these become a large-scale complex socio-cyber-physical system. Touchless retail covers a wide swathe of ideas and paradigms, being in essence a stand-in for e-economy, digital money, the world of bitcoin and blockchain, the frictionless movement of currency and goods, and generally the evolution of end stage capitalism, for those strict Marxists who

575 Miraz, M.H., Ali, M., Excell, P.S. and Picking, R., 2015, September. A review on Internet of Things (IoT), Internet of everything (IoE) and Internet of nano things (IoNT). In *2015 Internet Technologies and Applications (ITA)* (pp. 219-224). IEEE.

notice how much we discuss Foucault and Gramsci and wonder if we remember our root theory. We do – it's Hegelian hegemony and no where else in the various SoSCPs will we see more open algorithmic violence and epistemic conflict than where economic matters are openly defined and delivered. At the same time, we can, with out superior understanding of technosociology in reference to the AEGIS, predict that these crass acts of control will be hidden under layers of seemingly logical and utterly invisible rationalisation and social pro-formas.

> We define recent retail technology to include apps, devices, tools, techniques, models, and enablers that (1) use some feat of engineering, analytics, or digitization; (2) are linked to retail activities; and (3) have been developed since 2000. This definition thus encompasses, for example, robots, virtual mirrors, and the Internet of Things (IoT), introduced in this century, but not self-checkout and RFID, introduced prior to 2000. Among these recent retail technologies, we focus mainly on front-end offerings that inform the retail interface with current or potential customers—that is, on customer-interfacing retail technologies. There is a host of back-end technologies that facilitate retail operations (e.g., agile supply chains, dark analytics, crypto coins, RFID, employee management automation), related to supply chains, logistics, delivery, vendor management, and assortment planning, but, we do not focus on these back-end technologies in this commentary.[576]

576 Roggeveen, A.L. and Sethuraman, R., 2020. Customer-Interfacing Retail Technologies in 2020 & Beyond: An Integrative Framework and Research Directions. Journal of Retailing, 96(3), pp.299-309.



[577]

With the rapid adoption of mobile devices for shopping and growth of e-commerce, companies' website design becomes exceptionally crucial to attract and retain customers. The companies need to focus on the process-tracing research on consumer decision-making and how consumers interact with dynamic stimuli such as websites or mobile apps.[578]

So far so good – these e-commerce systems greatly increase our productivity and speed of commerce without seeming downside. They cost less, retain better data, lower transactions costs for both parties, make it easier and faster for the average person to

577 Roggeveen, A.L. and Sethuraman, R., 2020. Customer-Interfacing Retail Technologies in 2020 & Beyond: An Integrative Framework and Research Directions. Journal of Retailing, 96(3), pp.299-309.
578 Tupikovskaja-Omovie, Z. and Tyler, D.J., 2020, June. Mobile Consumer Behavior in Fashion m-Retail: An Eye Tracking Study to Understand Gender Differences. In ACM Symposium on Eye Tracking Research and Applications (pp. 1-8).

find and buy something needed, and can attune to and help super sum other AmI applications. What could be wrong with something that removes inefficient middlemen, lowers costs, improves perceived efficiency and quality of human experience, and ultimately seems to provide universal benefit?

> A salient feature of late capitalism is its increasing reliance on logistics infrastructure to organize economic processes. While infrastructure has existed for a long time, critical scholars no longer blithely accept it as a neutral tool for 'development', but are concerned with its distributive logics and role in circumscribing the conditions of global production and consumption. In this respect, geographers have been at the forefront of delineating how infrastructure works to order and coordinate various logistical flows in spatio-political ways. While urban geographers point to the inequitable tendencies that artefacts like roads, pipes and grids have in channelling urban resources to select communities , others have dissected how infrastructure provides, on the planetary scale, a basis for long-distance production networks, trade and war. These analyses signal that logistics infrastructure possesses profound circulatory powers that have a bearing on human subsistence and, most crucially, the basis for supply chain capitalism. These trends... fold into one another to create an unstable economic configuration that concurrently undermines infrastructure work(ers), enrols consumers in platform logistics and leaves the future of supply chain capitalism highly contentious.[579]

Precisely because touchless retail couples economic power to IoE, it removes human agency from entire supply chains and therefore human decision making from entire sections of the global economy. While it may do so slowly and with the most noble of purposes, it still erodes the status quo and through innovaton engages in some surprisingly low key cretaive detsruction. But it has been to the cost of invividuals whose already meagre sociopolitical voice weakens even more in the face of these new speed of

579 Lin, W., 2021. Automated infrastructure: COVID-19 and the shifting geographies of supply chain capitalism. *Progress in Human Geography*, p.03091325211038718.

light ambient voices which provide algorithmically perfect answers to economic questions.

> Crypto-colonialism is, for Herzfeld, a slow-moving, protracted arrangement fundamentally embedded in the social history of many nation-states, the bare bones of which are only exposed through events of national turmoil which gain global interest. It is here where we wish to engage with existing concepts of slow violence, the every- day forms of subordination and suppression that millions around the world experience daily. Slow violence captures the grinding discriminations of exclusion based on gender, race, and political tyranny; what Ahmann alludes to as the little things of slow-motion erosive violence that eats away at the person. The 'gradual brutalities' of slow violence operate at multiple temporalities and may not at first glance be considered as particularly destructive since they have shed their eventedness – they remain dormant in their political potential, set to emerge. Yet it is the repetitive erosive nature of their accumulative force that wears down the person.[580]

We are back to algorithmic violence within the the episteme and here the crypto currency economy has mutated to crypto-colonialism through crypto-currency. Payment systems should be major points of social contention but are not. NO one dislikes paying less and getting more. If that means the slow invisible erosion of human rights at some future time long ahead and barely imagined, so be it. Which demonstrates the dangers of an unchecked AEGIS built without forethought or planning. Payment systems are a ruthless miasma of competing applications and platforms – if ever there was a capitalism free for all, it has been occurring in the arena of which kind of payment systems and touchless retail operation will prevail.

> We argue that it is important to foreground, unpack, and examine critically how algorithmic systems feed (into) specific forms of violence, and how they justify

580 Pipyrou, S. and Sorge, A., 2021, July. Emergent Axioms of Violence: Toward an Anthropology of Post-Liberal Modernity. In *Anthropological Forum* (pp. 1-16). Routledge.

violent actions or redefine which type of violence is considered legitimate. The instances of algorithmic violence that we discuss below are about the force of computation. That is, paraphrasing Derrida, the force needed to make computation possible and the force that computation leverages, and thus ultimately how computation relates to justice. As Amoore notes, "what matters is not primarily the identification and regulation of algorithmic wrongs, but more significantly how algorithms are implicated in new regimes of verification, new forms of identifying a wrong or of truth telling in the world." .Critical scholarship has also highlighted how algorithmic systems negatively affect already vulnerable or marginalized groups in the Global North. Noble's work pinpoints how "algorithmic oppression" does not end with the use of specific algorithmic systems but has far-reaching, if not structural, effects. As she puts it, "algorithms are serving up deleterious information about people, creating and normalising structural and systemic isolation, or practicing digital redlining, all of which reinforce oppressive social and economic relations".[581]

Therefore we must consider touchless retail and e-payments as highly contested but not by individuals. It demonstrates the essential paradox of studying the AEGIS as a construct and artefact of human creative intention: we all agree injustice should not exists but we somehow enact it time and again in a thousand forms. In our core designs, in our black box algorithms, in our bias to allow rational machines to make rational decisions about resource management and recurrence flow we have sacrificed agency for efficiency and allowed the subtle violent erosion of fairness between individuals to give way to the optimised convenience and pleasure afforded by ambient systems real-time catering to our needs and whims. Put another way, ambient systems enable the hegemonic elite to swap the power and life of the dominated for their own convenience and satisfaction.

581 Bellanova, R., Irion, K., Lindskov Jacobsen, K., Ragazzi, F., Saugmann, R. and Suchman, L., 2021. Toward a Critique of Algorithmic Violence. *International Political Sociology*, *15*(1), pp.121-150.

In answering this question of a mediating mechanism to aggregate and communicate 'economic' knowledge, Hayek considered market competition and its capacity to dispense with 'conscious social control' as that which would achieve this most efficiently, and most equitably. In this respect, the market acts as what Gray terms an 'epistemic machine' – 'an institutional device for the transmission of fragmented knowledge in a form which makes it generally accessible and usable.' Hayek argued that no single individual could possibly hold the information or knowledge that could render central planning efficient. Rather than assuming that individuals are rational and knowledgeable utility maximizers, Hayek instead made an anti-rationalist argument for the market on the basis that no individuals have the capacity to act in such a way. The market, functioning thus as an epistemic machine, shapes an individual's incentive structure, whilst the individual's response to this structure thereby reshapes it in turn for others.[582]

The new technologies at the heart of a data-driven society – blockchain and big-data analysis – potentially enable markets to maintain their epistemic function whilst simultaneously eroding their status as essentially 'unknowable.' This is both a quantitative and qualitative shift: increasingly large swathes of digitalized daily life now feed into the market coordination mechanism as 'market data,' whilst the comprehension of these data is enhanced through algorithmic calculation. Such technologies thus shift the relationship between the collective and the individual from that of an 'invisible or unsurveyable pattern', to one that can be made subject to four forms of politico-economic agency exercised by actors through these algorithmic technologies: monitoring, tracking, predicting and intervening [583]

582 Gruin, J., 2020. The epistemic evolution of market authority: Big data, blockchain and China's neostatist challenge to neoliberalism. *Competition & Change*, p.1024529420965524.
583 Gruin, J., 2020. The epistemic evolution of market authority: Big data, blockchain and China's neostatist challenge to neoliberalism. *Competition & Change*, p.1024529420965524.

Working Definition: Touchless Retail

Touchless Retail will be defined as a contentious but vital way to merge e-commerce with the IoE making the AEGIS a unified economy.

Social Networks

Use of online platforms, apps varies – sometimes widely – by demographic group

% of U.S. adults in each demographic group who say they ever use ...

0% 20 40 60 80 100

	YouTube	Facebook	Instagram	Pinterest	LinkedIn	Snapchat	Twitter	WhatsApp	TikTok	Reddit	Nextdoor
Total	81	69	40	31	28	25	23	23	21	18	13
Men	82	61	36	16	31	22	25	26	17	23	10
Women	80	77	44	46	26	28	22	21	24	12	16
White	79	67	35	34	29	23	22	16	18	17	15
Black	84	74	49	35	27	26	29	23	30	17	10
Hispanic	85	72	52	18	19	31	23	46	31	14	8
Ages 18-29	95	70	71	32	30	65	42	24	48	36	5
30-49	91	77	48	34	36	24	27	30	22	22	17
50-64	83	73	29	38	33	12	18	23	14	10	16
65+	49	50	13	18	11	2	7	10	4	3	8
<$30K	75	70	35	21	12	25	12	23	22	10	6
$30K-$49,999	83	76	45	33	21	27	29	20	29	17	11
$50K-$74,999	79	61	39	29	21	29	22	19	20	20	12
$75K+	90	70	47	40	50	28	34	29	20	26	20
HS or less	70	64	30	22	10	21	14	20	21	9	4
Some college	86	71	44	36	28	32	26	16	24	20	12
College+	89	73	49	37	51	23	33	33	19	26	24
Urban	84	70	45	30	30	28	27	28	24	18	17
Suburban	81	70	41	32	33	25	23	23	20	21	14
Rural	74	67	25	34	15	18	18	9	16	10	2

Note: White and Black adults include those who report being only one race and are not Hispanic. Hispanics are of any race. Not all numerical differences between groups shown are statistically significant (e.g., there are no statistically significant differences between the shares of White, Black or Hispanic Americans who say the use Facebook). Respondents who did not give an answer are not shown.
Source: Survey of U.S. adults conducted Jan. 25-Feb. 8, 2021.
"Social Media Use in 2021"

PEW RESEARCH CENTER

[584]

We have seen corrosive power of money and the IoE mixed together. But what of social power, the cultural cache we gain or lose by garnering the opinions of our neighbours? With the advent of social media and social networks, the ambient world leapt forward as social networks became the top purveyors of AmI applications and the highest demand for specialised internet and cloud provisioning to accommodate real-

584 Auxier, B. and Anderson, M., 2021. Social media use in 2021. *Pew Research Center*.

time AmI interactions. What made them this way? Emotionological capability through ambient affective computing. Emotion matters: “The presence of moral-emotional words in messages increased their transmission by approximately 20% per word. The effect of moral-emotional language was observed over and above distinctly moral and distinctly emotional language as well as other factors that are known to in- crease online diffusion of messages.”[585] Emotion sells: “The presence of moral-emotional language in political messages substantially increases their diffusion within (and less so between) ideological group boundaries.”[586] Every social media network like Instagram, Facebook, WeChat, WhatsApp. LinkedIn, etc. represents an emotionally fulfilling socially rewarding platform that provides psychological well being in response to time spent on the platform and can modify human behaviour.

> Specifically, we establish a causal effect of how social networks influence user behavior. We show that the creation of new social connections increases user online in-application activity by 30%, user retention by 17%, and user offline real-world physical activity by 7% (about 400 steps per day). By exploiting a natural experiment we distinguish the effect of social influence of new social connections from the simultaneous increase in user’s motivation to use the app and take more steps. We show that social influence accounts for 55% of the observed changes in user behavior, while the remaining 45% can be explained by the user’s increased motivation to use the app.[587]

Social networks more than any other application of systems we've encountered directly engage with and affect human behaviour. They are designed with human agents as their direct consumers and with a technosociological focus on meeting both spoken and unspoken psychological needs. “ we observed that the presence of moral-emotional

585 Brady, W.J., Wills, J.A., Jost, J.T., Tucker, J.A. and Van Bavel, J.J., 2017. Emotion shapes the diffusion of moralized content in social networks. Proceedings of the National Academy of Sciences, 114(28), pp.7313-7318.

586 Brady, W.J., Wills, J.A., Jost, J.T., Tucker, J.A. and Van Bavel, J.J., 2017. Emotion shapes the diffusion of moralized content in social networks. Proceedings of the National Academy of Sciences, 114(28), pp.7313-7318.

587 Althoff, T., Jindal, P. and Leskovec, J., 2017, February. Online actions with offline impact: How online social networks influence online and offline user behavior. In Proceedings of the tenth ACM international conference on web search and data mining (pp. 537-546).

words in messages increased their diffusion by a factor of 20% for each additional word. Furthermore, we found that moral contagion was bounded by group membership; moral-emotional language in- creased diffusion more strongly within liberal and conservative net- works, and less between them."[588]

But they have in their arsenal an even more profound tool than individual affective computing – they can sway crowds. They weld social control of entire biomes of political and social clustering. "Crowd users play a primary role in facilitating the diffusion process. If official users cannot get access to many hubs, they would be recommended to identify influential crowd users (e.g., the crowd users at tipping points) to expedite the information diffusion process as well. Those crowd users have strong social ties with their followers and can enable deep user engagement."[589]

Crowds can be made to work in the real world and that matters to the design and management of an AEGIS. Just as social networks can control movement, control of crowds can achieve social and economic efficiencies.

> Crowdsourced last mile delivery for retail store order pick-ups – a delivery scheme that relies on friendship/acquaintance networks. A survey with 104 participants reveals that a vast majority of people – 72% of the respondents – would agree to perform a delivery of a package to their friends or close friends. The inferred counts of friends to/from whom an individual would accept/deliver products at their workplace and in the neighborhood turn out to be, on average, 17.33 and 14.21, respectively. It is also found that more than 60% of people are willing to make a delivery to their friends for free and 80% of the participants can afford to spend up to 15 min extra in providing this assistance.[590]

588 Brady, W.J., Wills, J.A., Jost, J.T., Tucker, J.A. and Van Bavel, J.J., 2017. Emotion shapes the diffusion of moralized content in social networks. *Proceedings of the National Academy of Sciences*, *114*(28), pp.7313-7318.

589 Fan, C., Jiang, Y., Yang, Y., Zhang, C. and Mostafavi, A., 2020. Crowd or Hubs: information diffusion patterns in online social networks in disasters. International journal of disaster risk reduction, 46, p.101498.

590 Devari, A., Nikolaev, A.G. and He, Q., 2017. Crowdsourcing the last mile delivery of online orders by exploiting the social networks of retail store customers. Transportation Research Part E: Logistics and Transportation Review, 105, pp.105-122.

This works both ways, allowing for constructive action and political protests to take place on any social media platform and to use that network to coordinate human activity in the flesh and blood world of the ecumene. This shows that sometimes the algorithms work correctly and rise to the highest ideals set forth by their designers.

> First, information that is vital to the coordination of protest activities, such as news about transportation, turnout, police presence, violence, medical services, and legal support is spread quickly and efficiently through social media channels. Second, social media platforms also transmit emotional and motivational messages both in support of and in opposition to protest activity; these include messages emphasizing moral indignation, social identification, group efficacy, and concerns about fairness, social justice, and deprivation—as well as explicitly ideological themes. Third, the structure of online social networks, which may differ as a function of contextual factors, including political ideology, has significant implications for information exposure and the success or failure of protest movements.[591]

Working Definition: Social Networks

Social Networks will be defined as a pervasive hyperconnected merger of emotionological AmI and the IoE which creates the most direct link between ambient systems and human behaviour.

Digital Identity

That leaves one more SCPS that may seem a bit peculiar at first: Digital Identity. We've covered social media as identity and digital dopplegangers through smartphones. But digital identity as a paradigm or system in and of itself might be the final frontier in both emancipation of human agents, giving them utter free will inside the ambient

591 Jost, J.T., Barberá, P., Bonneau, R., Langer, M., Metzger, M., Nagler, J., Sterling, J. and Tucker, J.A., 2018. How social media facilitates political protest: Information, motivation, and social networks. *Political psychology*, *39*, pp.85-118.

ecumene, and the total erosion of human agency separate and above AmI. Which is it? As with most other systems and technologies of the AEGIS, a bit of both. “Digital identity systems are information systems that typically support identity proofing, authentication and authorisation. The ability to prove that you are who you say you are enables access to many public and private sector services, and underpins essential humanitarian service provision, including cash transfers.” [592] As we might imagine, the ability to control who gets to say they are who they are and who does not represents almost total hegemony over a critical control point of the ecosystem.

> In the digital age, new technologies increasingly mediate identity versification and identification of individuals. Life factors including date and place of birth, origins, ethnicity, nationality and bio- logical features such as eye and hair colour are still commonly used. However, biometric data such as fingerprints and iris scans have a prominent place in identity verification and identification. For example, biometric passports have become a standard tool for a variety of states. Another example is India’s Aadhaar programme, which uses biometric technology to record fingerprints and iris scans in addition to personal information such as name, date of birth and domicile . Biometric technology is also used for border control and migration management in the European Union.[593]

The value of he technology. Like e-commerce and social networks cannot be disputed. But it has epistemic overtones which require some analysis and interpretation. “There needs to be a resolution of the distinction between institutional identification as categorisation and social identity. While the former reflects a technical-rational process that ascribes fixed categories which stabilise and regulate phenomena. [594]

592 Weitzberg, K., Cheesman, M., Martin, A. and Schoemaker, E., 2021. Between surveillance and recognition: Rethinking digital identity in aid. *Big Data & Society*, *8*(1), p.20539517211006744.

593 Beduschi, A., 2019. Digital identity: Contemporary challenges for data protection, privacy and non-discrimination rights. *Big Data & Society*, *6*(2), p.2053951719855091.

594 Madon, S. and Schoemaker, E., 2021. Digital identity as a platform for improving refugee management. *Information Systems Journal*.

At this time our inability to standardise media and digital platforms has allowed questionable decisions to be made at an algorithmic level as well as suppression and misuse of identity management. "As platform openness increases data interoperability and sharing, so too does the potential for personal information of individuals to be accessible to and used by actors in ways that individuals may not be aware of, may not have consented to and do not have control over."[595] In short, we have taken our Cyber-Westphalia and geopolitical conflicts into the digital world and replicated them in how we manage our identities and how we contest others' rights to theirs as well as our self representation.

> New interactive areas constituted a convenient field for identity formation. The interactive nature of the new media, in particular, prepares an environment for the execution of strategies that will facilitate the job of mass production. Individuals can easily create types of social relationships digitally on the new media that they are not able to create in the real life. In doing so, individual also enter into a digital identity reconstruction process by transforming their real life identity and adding new qualities. The aforementioned type of identity is the recreation of psychological identity. Spatial differences of identity might also balance the inconsistencies that may occur between the digital and the real identities. This inconsistency is no different from the inconsistency between someone's personal life and work life identities. The remarkable difference between them is that the individual is far from the physical indicators -depending on the media- in the digital world. However, in the case of social media platforms where the individual's physical self is also shown, the individual also recreates his/her behavior codes and visual codes... Digital identities created by individuals in a virtual world has created a consequent imperialistic effect and has led to serious changes in culture by affecting the real life. In this regard, an individual's identity in real life has been transformed by the created

595 Madon, S. and Schoemaker, E., 2021. Digital identity as a platform for improving refugee management. *Information Systems Journal*.

digital identity and on a macro scale, the culture of real-life is being led by a common digital culture.[596]

Working Definition: Digital Identity

Digital Identity will be defined as the super summing of personal data and digital personas of a human agent within one or more GISs.

596 Çöteli, S., 2019. The impact of new media on the forms of culture: digital identity and digital culture.

Core Enterprise SoSCPSs of the AEGIS

We have seen any number of constituent systems and SCPSs which make up and AEGIS but there are pan systemic paradigms and technological solutions sets which represent the largest most complex ecumenes available, themselves verging on AEGIS status and certainly comprising their own GISs. Each of the following SoSCPSs differs from prior solution and capabilities in size, complexity, investment, and economic power. They are the heavyweight systems which consume and command other systems.

Industry 4.0

As the Fourth Industrial Revolution sweeps across the world providing us with digital twinning, robotics, autonomous logistics and supply chains, heuristic manufacturing, and 3D printers, we are faced with the inevitable questions that follow such an advent of innovative disruption. As a concept these questions and their approved ways of being have been labelled Industry 4.0 (after the 4th industrial revolution) and as well see, like any enterprise SoSCP, its a complicated beast.

> While referring to Industry 4.0, German Federal Ministry of Education and Research mentions that “the flexibility that exists in value-creating networks is increased by the application of cyber-physical production systems (CPPS). This enables machines and plants to adapt their behavior to changing orders and operating conditions through self- optimization and reconfiguration”. It is further defined as a successful transition from on-premise production systems and processes to “Smart Production”, “Smart Manufacturing”, “Integrated Industry”, “Connected Industry” or “Industrial Internet”, which covers distributed and interconnected manufacturing equipment, and requires intelligent systems, a proper engineering practice and related tools. [597]

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Consequently, a new concept referred to as Cyber-Physical Systems (CPS) that combine Internet of Things (IoT) technologies with the manufacturing ecosystem introduces a new era of the industrialization, which is seen as a significant paradigm shift in industrial manufacturing, named as Industry 4.0. Thereby, physical items are supplemented by their virtual representations in order to increase the automation, flexibility, and diversity of products by means of having better integrated manufacturing processes and systems. Industry 4.0 is defined by Acatech as "the technical integration of CPS into manufacturing and logistics and the use of the Internet of Things and Services in industrial processes. This will have implications for value creation, business models, downstream services and work organization" [598]

We should pay attention to the warning inherent in this description. Implications for value creation and business models translates to disrupted economic and social power. One of the pervasive themes running through our discussions thus far has been how intertwined social and economic power has become with digital systems. Industry 4.0 takes that even further by replacing humans with robots and allowing for telepresence of human agents through ambient robotic interfaces – digital twinning. Hegemony can be attained in large measure by whomever controls these adaptive highly resilient manufacturing systems.

This concept represents a new industrial stage of the manufacturing systems by integrating a set of emerging and convergent technologies that add value to the whole product lifecycle . This new industrial stage demands a socio-technical evolution of the human role in production systems, in which all working activities of the value chain will be performed with smart approaches (Smart Working) (and grounded in information and communication technologies (ICTs). Industry 4.0 is

Gökalp, E., Şener, U. and Eren, P.E., 2017, October. Development of an assessment model for industry 4.0: industry 4.0-MM. In *International Conference on Software Process Improvement and Capability Determination* (pp. 128-142). Springer, Cham.

598 Gökalp, E., Şener, U. and Eren, P.E., 2017, October. Development of an assessment model for industry 4.0: industry 4.0-MM. In *International Conference on Software Process Improvement and Capability Determination* (pp. 128-142). Springer, Cham.

rooted in the advanced manufacturing or also called Smart Manufacturing concept, i.e. an adaptable system where flexible lines adjust automatically production processes for multiple types of products and changing conditions. This allows to increase quality, productivity and flexibility and can help to achieve customized products at a large scale and in a sustainable way with better resource consumption. Industry 4.0 also considers the exchange of information and integration of the supply chain (called Smart Supply Chain), synchronizing production with suppliers to reduce delivery times and information distortions that produce bullwhip effects [599]

The obvious social good and economic benefits are enticing. Industry 4.0 cannot be stopped and like the rest of the heterogeneous technology sets we've seen, it cannot be standardised. But the uniformity of needs – to have flexible and adapting systems which can alter when how and why they manufacture items remotely will limit the breadth and depth of variations. We are watching parallel evolution of multiple systems that achieve the same effect – like social media networks and payment systems.

The term Industry 4.0 stands for the fourth industrial revolution which is defines as a new level of organization and control over the entire value chain of the life cycle of products, it is geared towards increasingly individualized customer requirements. The central objective of Industry 4.0 is fulfilling individual customer needs which affects areas like order management, research and development, manufacturing commissioning, delivery up to the utilization and recycling of products. The main difference between industry 4.0 and Computer Integrated Manufacturing (CIM) is the concern of the human role in production environment. Industry 4.0 has an important role of human worker in performing the production where as CIM considered workerless production. The Industry 4.0 paradigm promotes the connection of

599 Frank, A.G., Dalenogare, L.S. and Ayala, N.F., 2019. Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, *210*, pp.15-26.

physical items such as sensors, devices and enterprise assets, both to each other and to the Internet.[600]

This focus on human agents interacting with and assisting / controlling their systems actually predisposes Industry 4.0 to be the more contested and socially valuable battlefield for hegemony. Digital twinning and telepresence control of robotic systems has unlimited economic potential when deployed in a functional AEGIS.

Working Definition: The Fourth Industrial Revolution

Industry 4.0 will be defined as an ambient value chain paradigm managing adaptable production and logistics, robotics, and autonomous manufacturing as a cohesive ecumene.

Mobile Workforce

Another fascinating development of the digital world has been the geographic dislocation of power. Social and economic control has been decentralised and in enterprise operation's this means that we no longer need to huddle all our workforce under a single roof and watch them visually. Our digital systems can assess their work efficiency and likewise, they can make it possible to deliver co-created value digitally and remotely "Industry and academia define a digital workplace in several different ways. In the simplest terms, digital workplace solutions (DWS) create connections and remove barriers between people, information, and processes as shown in Figure 3. When the barriers are broken, workers do their jobs more effectively and efficiently, and make the business more agile and competitive."[601] In a way DWS represents the

600 Vaidya, S., Ambad, P. and Bhosle, S., 2018. Industry 4.0–a glimpse. *Procedia manufacturing*, *20*, pp.233-238.

601 Attaran, M., Attaran, S. and Kirkland, D., 2019. The need for digital workplace: increasing workforce productivity in the information age. *International Journal of Enterprise Information Systems (IJEIS)*, *15*(1), pp.1-23.

enterprise work paradigm of IoE. “Digital workplace is defined as collection of all the digital tools in an organization that allow employees to do their jobs. Those tools include intranet, communication tools, email, CRM, ERP, HR system, calendar and other enterprise processes or tools which assist in the general day-to-day functioning of a business.” [602]

As laptops and smartphones pervade both private and commercial life, their interconnectivity with the Web and company WANs and LANs allows for mobile work – anywhere, anytime connected telepresence through networks and IoT. “Sales & Marketing and Information Technology are the two areas where most mobile workers can be found. These jobs can easily be performed remotely with the help of technology and, in some cases, they can be performed more effectively in the field (e.g. client site) than in the office.”[603] These developments are neither universal nor guaranteed but they do define a massive enterprise trend.

> Mobile workers are defined as employees that use computer and communication devices to access remote information from their home base, workplace, in transit, and at destination. These workers are characterized by a high level of mobility or greater distance from the traditional office, or both. Chen and Corritore used the term “nomadic worker” to describe mobile employees who perform anytime anywhere work. By this definition, mobile workers not only include employees who work remotely but also employees who demonstrate a high level of mobility within the workplace. [604]

What has prevented this from becoming a globally pervasive phenomenon? The same roadblocks we see again and again with the AEGIS – heterogeneous environments,

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602 Attaran, M., Attaran, S. and Kirkland, D., 2019. The need for digital workplace: increasing workforce productivity in the information age. *International Journal of Enterprise Information Systems (IJEIS)*, *15*(1), pp.1-23.

603 Chen, L. and Nath, R., 2008. A socio-technical perspective of mobile work. *Information Knowledge Systems Management*, *7*(1, 2), pp.41-60.

604 Chen, L. and Nath, R., 2008. A socio-technical perspective of mobile work. *Information Knowledge Systems Management*, *7*(1, 2), pp.41-60.

inability to integrate non-mutual systems, dynamic chaos overwhelming legacy servers, lack of bandwidth, and plain old fear – engineers rightly fear the enterprise adoption of black box algorithms with emergent properties.

> The technical issues include connectivity, bandwidth, security, supporting mobile workforce, limitations of technology, and keeping pace with mobile workers' demand for technology. Connectivity is the frequently cited technical issue faced by companies when it comes to supporting mobile workers. Wireless coverage can be spotty and unpredictable in some areas, and no commercial network seems to have the perfect solution to provide connectivity in every situation. Most business applications today are not designed to function on mobile devices properly due to processing and throughput requirements and screen size limitation. [605]

The present mobile workforce grows and it encompasses both the highest paid employees – sales and marketing – and the most technically adept ones – ICT staff. As such, there will be a growing divide between the digitally savvy mobile worker and the less digitally underskilled and lower paid static workforce which faces redundancy at the hands of Industry 4.0 systems.[606]

Working Definition: Mobile Workforces

Mobile Workforces will be defined as digitally savvy workers who can use smart devices and GIS to deliver value creation from any networked geography.

Fintech

While we have seen touchless retail and payment systems and their permutations through SoSCPSs, there exists a third wider enterprise tier of economic systems: "Fintech

605 Chen, L. and Nath, R., 2008. A socio-technical perspective of mobile work. *Information Knowledge Systems Management*, *7*(1, 2), pp.41-60.

606 Andersson, B. and Henningsson, S., 2010. Developing mobile information systems: Managing additional aspects.

refers to non- or not fully regulated ventures whose goal is to develop novel, technology-enabled financial services with a value-added design that will transform current financial practices.” [607]

> “Financial technology” or “FinTech” refers to technology-enabled financial solutions. The term FinTech is not confined to specific sectors (e.g. financing) or business models (e.g. peer-to-peer (P2P) lending), but instead covers the entire scope of services and products traditionally provided by the financial services industry.[608] Financial innovation can be defined as the act of creating and then popularizing new financial instruments as well as new financial technologies, institutions and markets. It includes institutional, product and process innovation. [609]

A wider definition which can further be elaborated as an AEGIS encompassing phenomenon might be: "any innovative ideas that improve financial service processes by proposing technology solutions according to different business situations, while the ideas could also lead to new business models or even new businesses"[610] Fintech integrates touchless retail and payment systems with social and political ties to economic logistics and banking, making them a cohesive and at times frictionless systems of cashless currency and resource movement between urban centres and centralised economies regardless of geographic locale.

As such we can see that the evolution of enterprise wide “cashless payment is the key development trend. More and more companies have developed related payment solutions for their customers... As more payment solutions allow users for seamless e-

607 Varga, D., 2017. Fintech, the new era of financial services. *Vezetéstudomịny-Budapest Management Review*, *48*(11), pp.22-32
608 Varga, D., 2017. Fintech, the new era of financial services. *Vezetéstudomịny-Budapest Management Review*, *48*(11), pp.22-32
609 Varga, D., 2017. Fintech, the new era of financial services. *Vezetéstudomịny-Budapest Management Review*, *48*(11), pp.22-32
610 Leong, K. and Sung, A., 2018. FinTech (Financial Technology): what is it and how to use technologies to create business value in fintech way?. *International Journal of Innovation, Management and Technology*, *9*(2), pp.74-78.

payment process... suggested that the more popular applications have better performance in ease access, usability, reputation and secure protection, usually via blockchain.” [611]

As the AEGIS integrates these capabilities, it generates a new kind of Financial Service Industry (FSI) relying upon ambient systems to cooperate with legacy banking and various Fintech applications which rest between them deploying cloud and edge with IoT, AI, and simple DB technology then adapted to adjust for the socio-cyber-physical milieu. As these apps and options proliferate, FSIs also multiply, creating niche currency and trading platforms with additional needs for both security over personal and financial data and adaptive emergent black box algorithms.

> FinTech is about data and security. On one hand, contemporary FSIs seek additional values from a large pool of data in a wide scope, such as the strategy- making assistance, environmental-friendly solution, service improvement, business collaboration support, risk prediction, and financial operation aid. FinTech is playing a critical value creator in the value chain for most current FSIs. On the other hand, FSIs also need to ensure that the data are used in a correct manner all the time, which introduces security and privacy concerns when applying FinTech in the financial industry[612]

Working Definition: Financial Technologies

Fintech will be defined as the overarching enterprise financial SoSCP which creates digital FSIs capable of transferring resources between any two AEGISs.

611 Leong, K. and Sung, A., 2018. FinTech (Financial Technology): what is it and how to use technologies to create business value in fintech way?. *International Journal of Innovation, Management and Technology*, *9*(2), pp.74-78.

612 Gai, K., Qiu, M. and Sun, X., 2018. A survey on FinTech. *Journal of Network and Computer Applications*, *103*, pp.262-273.

Augmented Reality

As with Fintech, Augmented Reality (AR) combines other existing capabilities and SoSCPSs to create a new overarching system of interpenetrated services. "AR involves a set of technologies that make use of an electronic device to view, directly or indirectly, a real-world physical environment that is combined with virtual elements."[613]

While not yet at peak profusion, as the technosocial systems begins to integrate within the AEGIS environment, it will require speciality algorithms because it often overlays images, information, private and public data, and Fintech or geotagging (or both) as one cohesive digital narrative. That burns through bandwidth, requires compression as well as top notch WiFi or 5G and the load balancing from cloud, edge, and mobile device to handle real-time ambient management of a human agent.

> The basic components of an AR system are the visualisation technology, a camera, a tracking system, and the user interface. Four main visualisation technologies are available for AR systems, namely head-mounted displays (HMDs), handheld devices (HHDs), static screens, and projectors. Depending on the task, the visualisation can either be stationary or has to be mobile. Especially for assembly applications, static screens or projectors can be used. Projection-based solutions utilise common projectors to display information directly onto the workspace. Static screens can be used to display, e.g. interactive standard operating procedures (SOPs) for the current status of the assembly and animate the next assembly step. Yet, HMDs are a focus of academia and industry. They enable operators to move around and access and read information hands- free, possibly speeding up operations significantly. [614]

We see in AR the extension of some of the most vital components of the AEGIS and of AmI as a paradigm into the virtual immersion of a liivng agent in the digital biome

613 Fraga-Lamas, P., Fernandez-Carames, T.M., Blanco-Novoa, O. and Vilar-Montesinos, M.A., 2018. A review on industrial augmented reality systems for the industry 4.0 shipyard. *Ieee Access*, *6*, pp.13358-13375.

614 Masood, T. and Egger, J., 2019. Augmented reality in support of Industry 4.0—Implementation challenges and success factors. *Robotics and Computer-Integrated Manufacturing*, *58*, pp.181-195.

that invisibly surrounds them. But, as a caution, let us remember that the AR does not reveal the world as it is but delivers a wholly artificially created topology that mirrors what its creators want the user to see as well as what they are allowed to reveal. We can view AR as the delimiting and bounding factors of the AEGIS, revealing in what does not pass algorithmic muster the losers in the hegemonic battle for the regulation of Smart X normative ways of being.

> Augmented reality (AR) refers to the integration of the actual world with digital information about it. Actual objects and people cast an information shadow: an aura of data which, when captured and processed intelligently, can offer extraordinary value to consumers. Augmented reality uses technology to make such a layer of information accessible to people––to blend one's perception of the actual world with digital content about it generated by computer software. This technology comes in a myriad of forms: from wearables and smart glasses that use retinal projection to put a display in the wearer's eyeball (e.g., Google Glass was a very noticeable AR headset,the Vaunt by Intel is much less conspicuous) to the more commonly used smartphones. The AR layers that are added can be sensory (e.g., sound, video, graphics, or haptics) or simply data based. [615]

Working Definition: Augmented Reality

Augmented Reality will be defined as the full integration of multisensory ambient systems to create working access to the AEGIS's digital topology

The Internet of People / People as a Service

While both Fintech and AR seem self explanatory, requiring only a cursory set of examples and definitions, the idea behind the Internet of People (IoP) and People as a

615 Farshid, M., Paschen, J., Eriksson, T. and Kietzmann, J., 2018. Go boldly!: Explore augmented reality (AR), virtual reality (VR), and mixed reality (MR) for business. *Business Horizons*, *61*(5), pp.657-663.

Service (PeaaS) will demand a larger share of our attention. Simply put, if Fintech and AR create overarching domains of interpenetrated capabilities, then IoP / PeassS flips that on its head and provides human agents as service agents into and on behalf of the AEGIS. "The IoP holds this promise because it promotes bridging machine intelligence with human intelligence to form novel user-centric applications."[616] While there are both compelling reasons to do this and significantly advantageous benefits to the urban centres hosting it as well as the individuals providing and partaking of the service, it feeds into the same invisible episteme we've have noted in prior sections.

> People as a Service (PeaaS) . This architecture promotes the use of smartphones to learn about their users, creating and storing virtual profiles with their preferences and context information. These profiles are then offered as a service to third parties in a secure manner. This way, smartphones become seamless and automatic interfaces that negotiate their owner's preferences, adapting and configuring the smart things in their surroundings. The required interactions are not just simple data transfers, but we need mechanisms that allow to configure smart things, and also to complete virtual profiles with context knowledge obtained from these interactions. The more complete virtual profiles are, the better may the technology adapt to the people.[617]

Simplified, PeeaS creates a digital twin, like Industry 4.0, but this avatar converges the cyber activities, data, preferences, and documents of its agent into a supersummed potential for ambiently merged activities. That profile allows efficient navigation within the digital biome of the AEGIS but also generates an easily exploited economic resource.

> PeaaS provides a conceptual framework for application development focused on the smartphone as a representative and interface to its owner. By employing the capabilities of the phone' sensors, we are able to infer the routines and preferences of

616 Fuchs, K., Haldimann, M., Grundmann, T. and Fleisch, E., 2020. Supporting food choices in the Internet of People: Automatic detection of diet-related activities and display of real-time interventions via mixed reality headsets. *Future Generation Computer Systems*, *113*, pp.343-362.

617 Pérez-Vereda, A., Canal, C. and Pimentel, E., 2019, September. A Formal Programming Framework for Digital Avatars. In *International Conference on Software Engineering and Formal Methods* (pp. 236-251). Springer, Cham.

its owner a build with them her virtual profile. This information can then be offered to third parties to generate value-added services or to interact with the user's IoT environment in an automated way. All the information is stored locally in the smartphone, guaranteeing that its owner keeps full control over which data is being shared and whom.[618]

As the large excerpt below shows, the same issues engineering teams encounter trying to merge legacy and cloud in the Smart City face almost every application and tech product team within the wider AEGIS. The solution, as proposed by designers, will be to use the PeeaS as the SDN of choice for command and control.

The increase in the capabilities of smart devices has brought a growth in the amount of embedded systems and devices we can find everywhere. However, these devices are highly heterogeneous, which causes an increase in difficulty and complexity of intercommunication between them, and an increase in security threats. To help alleviate this issue, we need to work towards automating the task of configuring multiple devices and interacting with them in an easy and personalised way for each user. For this purpose we have adopted the People as a Service (PeaaS) … PeaaS implies a shift from a server-centric structure to a distributed environment, where the smartphones are the focus of the system and becomes an interface through which the virtual profile is accessed, via an specific API. The framework allows to develop generic mobile and server applications that download and run the scripts provided by the devices and interact with the profile. This allows dynamically updating the user's virtual profiles and modifying the behaviour of the devices, building this way
a context of the situation the user is currently in. In this scenario, the functionality of the system can be updated by modifying the script, without the need to deploy new applications on the server and mobile layers, or to change the settings of the deployed IoT devices. Scripts can be also modified by user's interaction. Depending on their

618 Fernández-Bertoa, M., Moreno, N., Perez-Vereda, A., Bandera, D., Alvarez-Palomo, J.M. and Canal-Velasco, J.C., 2020. Digital Avatars for Older People's Care.

virtual profile and context, some variables of the script can be updated to change how the device behaves. This way, devices automatically adapt to suit the users' needs in a seamless way.[619]

Critics rightly point out that any time we actively increase the autonomous AI presence in the life and affairs of human agents, we are essentially converting the basic life processes of everyday people into a complex SoSCPSs. That in turn requires autonomous agents, likely with black box AmI, to help manage the integration and augmentation process. Thus we take the unencumbered and simple, complicate the hell out of it, add subversive AmI, push the hegemony of the ruling episteme further into the private sphere of the individual, and potentially erode their safety, economic welfare, and basic freedoms. The excerpt below demonstrates this concern. Having already outlined with the the origins of PeaaS (cyber-physical systems (CPS), edge computing, Industry 4.0, similar enterprise SoSCPSs) it moves into their similarities:

> All of them, nevertheless, share some common characteristics. First, all of them are distributed solutions, where many different physical agents support the execution of high-level services . These agents may be very heterogenous, including resource-constrained controllers, legacy systems, traditional hosts, and even people. Second, they are all service-oriented mechanisms . Usually, these solutions define high-level services through the coordination of low-level agents with very heterogenous behavior, so end users are not aware of how services are finally provided. Third, they are all focused on providing services with the highest possible efficiency. Process and task allocation and execution algorithms are deployed at a high level to ensure services have the lowest cost and highest quality. Typical unproductive factors, such as delays, oversized infrastructures, or defective executions, are avoided and removed, maintaining the workload of physical agents as high as possible in a continuous manner.

619 Bandera, D., Pérez-Vereda, A., Canal-Velasco, J.C. and Pimentel, E., 2019. A programming framework for people as a service

Rest periods, human errors, holidays, regulatory limitations, and so forth, are (from the sociological point of view) the most important aspects to be considered when people are working. Nevertheless, efficient process execution algorithms are not aware of how services are supported or provided, and they may penalize tasks performed by humans due to their low efficiency. As a reaction in a People-as-a-Service scenario, work conditions tend to decrease (as well as people's wellbeing), and workers are treated and managed in a very dehumanizing and alienating manner. [620]

There may be a different way to consider the situation which privileges neither the optimistic view nor the hegemonic criticism we've seen. "The increased capabilities of embedded devices has enabled the development of smart things. These devices may be connected to the Internet, providing a virtual representation of themselves with which other devices can interact, enabling the development of the Internet of Things (IoT) . The Web of Things (WoT) integrates the connected smart things in the web, facilitating their interactions with people "[621] The WoT like IoP, acknowledges the human element of the system, intentionally changing the nomenclature from just IoT to IoT plus the Web and people as a SoSCPSs.

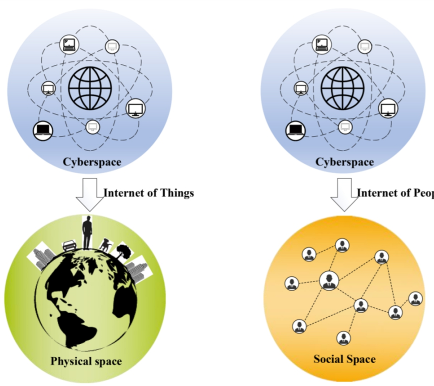
In the WoT usually several devices are orchestrated to build complex systems. However, as the WoT is more integrated into people daily activities this orchestration becomes more complex. Ambient Intelligence (AmI) has emerge as a disciple for making the everyday environments sensitive and responsive to people. AmI needs to be aware of the users preferences in order to know when a device should acts. This is even more challenging when the needs of a multiple entities should be analysed in order to predict the action to perform. In this sense, there are different researchers

620 Bordel, B., Alcarria, R., Hernández, M. and Robles, T., 2019. People-as-a-Service dilemma: humanizing computing solutions in high-efficiency applications. In *Multidisciplinary Digital Publishing Institute Proceedings* (Vol. 31, No. 1, p. 39).

621 Berrocal, J., Garcia-Alonso, J., Canal, C. and Murillo, J.M., 2016, June. Situational-context: a unified view of everything involved at a particular situation. In *International Conference on Web Engineering* (pp. 476-483). Springer, Cham.

focused on the identification of people's context. Concretely, the authors of this paper have been working on the People as a Service (PeaaS) and the Internet of People (IoP) approaches. PeaaS is a mobile-centric computing model to infer the context of smart-phones' owners and generate their sociological profile. IoP propose an infrastructure and a manifesto for WoT systems that support this proactive adaptations. This manifesto indicates that the interactions between things and people must be social, must be personalized with the users profiles, must be predictable, and must be proactive and automatically triggered depending on the context.[622]

The chart below indicates the design parameters used to designate IoP versus IoT and helps us think through the value creation the IoP may provide the AEGIS. "IoP has become one of the popular computing paradigms that overcomes physical boundaries and enables humans to be connected with tighter relationships. It deeply interconnects humans worldwide and allows to conduct with various social activities."[623]



(a) IoT-Physical space and Cyberspace (b) IoP-Social space and Cyberspace

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The Future Internet will consist of billions of digital devices, people, services and other physical objects having the potential to seamlessly connect, interact and

622 Berrocal, J., Garcia-Alonso, J., Canal, C. and Murillo, J.M., 2016, June. Situational-context: a unified view of everything involved at a particular situation. In *International Conference on Web Engineering* (pp. 476-483). Springer, Cham.
623 Shi, F., Wang, W., Wang, H. and Ning, H., 2021. The Internet of People: A Survey and Tutorial. *arXiv preprint arXiv:2104.04079*.
624 Shi, F., Wang, W., Wang, H. and Ning, H., 2021. The Internet of People: A Survey and Tutorial. *arXiv preprint arXiv:2104.04079*.

exchange information about themselves and their environment … to produce and consume web-based services in a web-based service industry in what we refer to as the Internet of People, Things and Services (IoPTS). The envisaged IoPTS consists of three visions i.e. Internet of People (IoP), Internet of Things (IoT) and the Internet of Services (IoS). The Internet of People is envisaged as a world where people equipped with human- implantable RFID tags will become part of the ubiquitous network of networks facilitated by the popularity of social networks.[625]

The implantable nature of technology should give us pause. As we have discussed before, the physical merged of digital and physical intertwines the already complex biome of human and computer. Implanted devices which tie human agents not only ubiquitously but constantly to every available GIS would increase the speed of AmI interactions and reduce the time allowed for independent thought formation. Those 700 seconds would seem almost impossible to achieve when every millisecond the GISs attached the integrated systems and the user's mobile device updated and uploaded new data streams. Consider how such tech will interact with Fintech and AR:

> Field tests of augmented reality driven IoP overlays established a valid identification and delivery of correct timely and useful object identification between 73.5%–76.93% at the low end of latency driven architecture and 95% for streamlined embedded configurations. More critically, dynamic, three-dimensional environmental cues were demonstrated to achieve signifiant and statistically validated changes in human behaviour. In this instance users opted for the programmed healthier food options – which translates the AR augmented IoP, an primitive ambient environment, directly impacting the nutritional and consumption choices of subjects.[626]

625 Eloff, J.H.P., Eloff, M.M., Dlamini, M.T. and Zielinski, M.P., 2009. Internet of people, things and services-the convergence of security, trust and privacy.

626 Fuchs, K., Haldimann, M., Grundmann, T. and Fleisch, E., 2020. Supporting food choices in the Internet of People: Automatic detection of diet-related activities and display of real-time interventions via mixed reality headsets. *Future Generation Computer Systems*, *113*, pp.343-362.

Working Definition: The Internet of People / People-as-a-Service

The Internet of People / People-as-a-Service will be defined as intentional integration of the digital biome and human agents to achieve ubiquitous frictionless use of AmI.

The Ambient Subversion Checklist

Attached you can see the Checklist as discussed in the introduction with mitigating factor which will covered in depth at the end of Systems Social Engineering section.

The Ambient Subversion Checklist			
Ambient System	**System Type**	**Mitigation**	**Subversion of Free Will**
SoS	CPS	Unified command and control	Require SoS to monitor and understand other SoS
Smart X	SCPS	Unified and cross-compatible systems	No clear method to integrate all subsystems
SoSCPSs	SoSCPS	SMBSE / Gemba Kaizen / HFGT	Non-linear chaotic dynamism: maximum chaos, minimum predictability
The Web	Infrastructure	Privacy protection regimes	Rival political and economic powers censor data and limit access
The Dark Web	SoSCPS	Model structural violence, addiction, and misuse	Access to dangerous, addictive, and illegal services w/o security
Cyber Westphalia	SoSCPS	Chief Systems Officer w/ Global PMO	Regional control of The Web imposes censorship and speed limits
IoT	IoT	Single database / CSP	10,000 potential sensors without a common unifying platform
Telecommunications	Network	Unified and cross-compatible systems	1000 operators produce non-linear chaos and data fragmentation
Blockchain	Software	Privacy protection regimes	Improper management of keys creates data breaches
Smartphone	Infrastructure	Model structural violence, addiction, and misuse	40% - 80% adult addiction rates
On Premise Computing	Infrastructure	Model upgrades / refresh cycles in advance	Static and outdated systems which cannot integrate
Off Premise Computing	Infrastructure	Single database / CSP	Hegemonic power struggle over Web, 5G, cloud, edge nodes
Black Box Algorithms	Software	SMBSE / Gemba Kaizen / HFGT	Emergent properties create new avenues of epistemic violence
Database Systems	SCPS	Single database / CSP	Gross abuse of personal data through breaches, theft, social engineering
AI	SCPS	Privacy protection regimes	Pervasive and ubiquitous climate of surveillance
AmI	SoSCPS	Unified command and control	Emergent properties rewire human neurology
Touchless Retail	CPS	Public smart application	Economically driver algorithmic violence and epistemic conflict
Social Networks	SoSCPS	Public smart application	Social networks can control movement & behaviour of crowds
Digital Identity	SCPS	Public smart application	Contested identities and human rights
Mobile Workforce	SCPS	Model structural violence, addiction, and misuse	Skill divide between mobile worker and lower paid workforce
Fintech	SoSCPS	Unify and monetise communal data	FSIs create needs for adaptive emergent black box algorithms
Augmented Reality	SCPS	SMBSE / Gemba Kaizen / HFGT	Information curation reveals algorithmic violence
PeaaS	SoSCPS	Unified command and control	Reduces basic life processes to SoSCPS algorithms
WoT / IoP	SoSCPS	Model structural violence, addiction, and misuse	Reduce the time allowed for independent thought formation

Marshalling the AEGIS: Systems Social Engineering

Long have technologists sought the Holy Grail of emerging systems: asymmetric control over new markets; the chance to shape and direct the destiny of critical technologies that in turn shape and direct the economic and social destiny of societies. What makes this both so elusive and so appealing? Control of new markets translates into true hegemony, functional dominance over not just a given piece of tech, but of the society and economies attached to it. As one can imagine, hegemony and its attendant control conjure sinister notions of Bond villains and tin pot dictators vying to deploy superweapons and mind control any way they can. The reality while more diffuse and democratic. Has at. its roots a very similar and disturbing truth: that economic power remains power and therefore, any form of market dominance translates into political, social, and cultural dominance.

The work we've done so far attempts to accurately and fairly map the trajectory of the single most affecting technology since the advent of effective birth control and antibiotics modified the entirety of human biological destiny. Ambient systems, codified as Smart X, represent an exponentially progressive feedback loop of data collection, response, and artificially intelligent modification of hardware, software, social activities, money, streams, and analogously, power. What had been until only a few decades earlier been one hundred percent under human control has changed. Now robots of various types automatically engage humanity, modify human environments, direct social movement and social consciousness, and most importantly, acting on programming that has become autonomous and self-correcting / self-creating, adapts to human preferences while also subtly and imperceptibly redirecting or funnelling human desire. Succinctly put, ambient systems intelligently react and adapt to human need. But to do so, they must establish and maintain technosociological dominance over their charges. Otherwise, they could not adequately react and direct technologies in the scope of human consciousness sufficiently to be defined as ambient.

How do they achieve this intake, management, adaption, and then control over endless data flows? By synthesising ambient environments such as integrated ambient public spaces and vehicles (Smart City / Smart X), merged robotics and software automation (Industry 4.0), Software as a Service (SaaS) enabled employees who use company delivered technology in tandem with their own devices and home or mobile offices as ad hoc workspaces (remote workforces), software and hardware integrated banking and financial systems that translates physical money into various forms of cybercurrency and automated payments (Fintech), integration of cameras, databases, audio files, and location mapping services utilising global positioning systems (GPS) to deploy overlays onto known spaces or events (Augmented Reality,) et al. with machine learning driven commercial capabilities including publicly available hyperscale Cloud Computing (Cloud), integrated networked computing with super low latency known as Edge Computing (Edge), The Internet of Things permeating previously "dumb" appliances and object to make a "smart" ecosystem of networked cross communicating sensors and software applications (IoT), specialised retail outlets merging IoT and fintech as well as real-time database and inventory systems (Touchless Storefronts / Touchless Retail), internet based social media such as Facebook or LinkedIn which use proprietary algorithms to enable global communication and sales at speed (Social Networks), the same network applications applied to preserve or isolate personal or private data which can be codified and transmitted such a medical records, banking capabilities, or stored passwords (Digital Identity) et al. to create an imagined experience of seamless and constant systemic adaptivity. Hence the name "ambient" indicating a fully immersive and immersed human experience.

Economics by its nature focuses on known and predictable market forces including generic sources of disruption, competition, and change. But the same mathematics that so accurately nails down Compound Annual Growth (CAGR) in the frozen orange juice sector or predicts sudden surges in hedge fund returns cannot anticipate truly new forms of social disruption which are fundamentally asynchronous being dependent on a complex stew of technological viability, economic support, social acceptance, and human innovation. What then represent important precursors to such "sudden" leaps forward? This section will interrogate that notion and determine to what degree any social science backed by mathematics and logic can predict the advent and outcome of black swan technological progressions. Or indeed, if the perception of such events represents a convenient social fiction hiding something more fundamental at play: that market forces remain utterly predictable and economists, sociologists, and technophiles have simply applied the wrong variables to their pursuits.

Design of an artificially intelligent ecosystem

Before we delve into the active pursuit of hegemony, we need to establish how we as system engineers design an AmI ecosystem. We need to build an AEGIS, starting with the functional concept of a Smart City and adding constituent systems until we have something super summed. "Cities are messy and complex places and because infrastructures are socio-technological assemblages that depend for their functioning on the practices, uses, and therefore skills of those involved. With algorithm-led technologies, this assumption is often subsumed to the process of acquiring data, selecting optimal profiles and responses, and enabling feedback."[627] SEs now have a fundamental paradox: we cannot build the Smart X shell of an AEGIS without algorithm-led techno-social systems but those same SoSCPSs have data and management priorities which do not align with urban panning and social welfare policies of most Smart City designers.

> Most of the technologies currently deployed in the 'smart city' are beyond people's agentive interaction, with their computational processes enabling black-boxed, autonomous and automated responses. Moreover, smart technologies demand cultural and social capitals from users, because they are linked to forms of social

627 Cardullo, P., 2020. The Internet of People strikes back: Two future scenarios and a proposition.

exchange and their implementation is conditional to contextual arrangements in communities of interest and localities: there is nothing automatic and deterministic about platforms and sensors in making communities 'operative'.[628]

The artificial ecosystem we wish to build will be non-deterministic, i.e., they will require intentional choices by their design and deployment teams. At risk – the social welfare and autonomy of citizens. Control systems, software coordination, IoT funnels, and the like all require black box algorithms. But unless and until we acknowledge "AmIs are intelligent systems, and in the long term are cognitive, it is obvious that a distributed control systems (DCS) should also be intelligent and cognitive in the future"[629] we face making unrecoverable mistakes with systems that will become emergent and cannot be reprogrammed.

We should consider that like IoP, every new systems we build, especially one that merges into a full AEGIS will require layers of AI and AmI. Cloud, Edge, IoT and similar Fog computing mediated systems all require AI to function across heterogeneous boundaries and platforms. "The main purpose of cloud intelligence systems is to facilitate the ease of access from any location and the management of practical computing resources."[630]

It may no longer be possible to prevent even basic AI from gaining emergent properties and seeking to be fully ambient: "Human–machine hybrid-augmented intelligence is a typical characteristic of new-generation AI."[631] The proposed IoP RFID integration matches the new expectations creators have that AI will fulfil human users in ways not yet realised by society and technology. "AI, compared to previous

628 Cardullo, P., 2020. The Internet of People strikes back: Two future scenarios and a proposition.
629 Vodyaho, A., Osipov, V., Zhukova, N. and Chernokulsky, V., 2020. Data Collection Technology for Ambient Intelligence Systems in Internet of Things. *Electronics*, *9*(11), p.1846.
630 Susanto, H., Leu, F.Y., Caesarendra, W., Ibrahim, F., Haghi, P.K., Khusni, U. and Glowacz, A., 2020. Managing cloud intelligent systems over digital ecosystems: revealing emerging app technology in the time of the COVID19 pandemic. *Applied System Innovation*, *3*(3), p.37.
631 Zhou, J., Zhou, Y., Wang, B. and Zang, J., 2019. Human–cyber–physical systems (HCPSs) in the context of new-generation intelligent manufacturing. *Engineering*, *5*(4), pp.624-636.

technologies, offers a holistic system that connects customer-owned and business-owned technologies and facilitates personalised human experiences tailored to the last detail, thereby taking events to the next level. The core value proposition of AI thus lies in co-creating and personalising experiences, providing information and offering assistance, not only to attendees on a collective and large scale, but on the most granular level to the individual." [632]

> A Smart City must have the ability to reason upon the knowledge acquired through data gathered by sensorization, with focus on improving the quality of life at urban centres, considering sustainability and safety principles. Here, sustainability is to be understood under social, economic and ecological grounds. Side by side with Smart Cities stands the Internet of Things (IoT). In fact, objects such as clothing, food packing or shoes will be endowed with some level of internet-addressable features, offering context awareness and communication capabilities. [633]

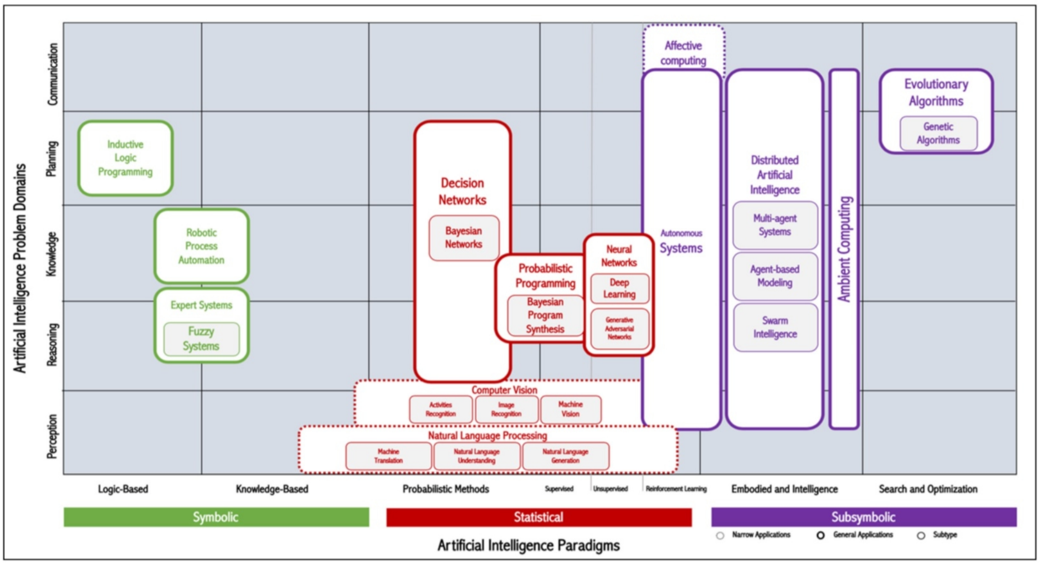
These embedded objects will create data and then the AIs governing their interactions will create more, each with meta data and ancillary logs, governance data, GDPR queries in the EU, and any number of other strati of data created through SDNs and abstraction layers. The ecosystem cyclically creates data, acquires AI to manage the data created, generates further data related to the new AI, and then repeats the cycle.

> When it comes to ingesting large swaths of data, AI systems are among the core elements of most smart city projects. Other smart technologies such as internet-of-things (IoT), autonomous vehicles (AV), big data, 5G wireless communication, robotics, blockchain, cloud computing, 3D printing, virtual reality (VR), augmented reality (AR) , digital twins, and so on are also transforming our cities. For instance, it is increasingly common to combine machine learning with other emerging technologies to generate advanced urban solutions. Examples include: the use of deep

632 Neuhofer, B., Magnus, B. and Celuch, K., 2020. The impact of artificial intelligence on event experiences: a scenario technique approach. *Electronic Markets*, pp.1-17.

633 Fernandes, B., Silva, F., Analide, C. and Neves, J., 2018. Crowd Sensing for Urban Security in Smart Cities. *J. Univers. Comput. Sci.*, *24*(3), pp.302-321.

learning and high-performance computing (HPC) for traffic predictions using sensor data, incident prediction, disaster management, and rapid transit systems designed to optimize urban mobility systems. Machine learning has also been used with big data technologies and social media for logistics and urban planning, event detection for urban governance, disease detection, and identifying the sources of noise pollution at the city scale. [634]



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As of 2021, this cohesive SoSCPSs has been modelled as multi-tiered AmI supersystem called Agora. The details of which were published in *Agora: Bringing together datasets, algorithms, models and more in a unified ecosystem* and excerpted below.

Agora as an asset agnostic multisystem interface: We envision Agora, an ecosystem that enables and eases the creation and composition of data science pipelines as well as their scalable execution. Agora provides unified access to all types of assets (e.g., data, algorithms, and compute resources) and treats them as first-class citizens: The social scientist in our example would not only find all relevant assets, but also

634 Yigitcanlar, T., Butler, L., Windle, E., Desouza, K.C., Mehmood, R. and Corchado, J.M., 2020. Can building "artificially intelligent cities" safeguard humanity from natural disasters, pandemics, and other catastrophes? An urban scholar's perspective. *Sensors*, *20*(10), p.2988.

635 Yigitcanlar, T., Butler, L., Windle, E., Desouza, K.C., Mehmood, R. and Corchado, J.M., 2020. Can building "artificially intelligent cities" safeguard humanity from natural disasters, pandemics, and other catastrophes? An urban scholar's perspective. *Sensors*, *20*(10), p.2988.

executable compositions of them. This combination of abstraction and accessibility makes Agora attractive even for non-expert users. Agora brings together asset providers and consumers. It allows providers to offer any type of assets to a broader audience. For consumers, Agora provides access not only to data sources but to the entire data value chain. We envision this ecosystem playing a dual role: (i) It is composed of a set of marketplaces where providers and consumers can exchange assets, and (ii) it provides the means to users to run their tasks (composition of assets) in Agora instead of using their own computing infrastructure. The key aspect of Agora is the fine-grained exchange of any asset.[636]

The fine grained exchange of assets as fungible resources both delivers on the promise of ubiquitous ambient computing and allows for quite a bit of hegemonic abuse. "In the context of a smart environment, the data ecosystem metaphor is useful to understand the challenges in maximizing the value of data within the environment. The cross-fertilization and sharing of vital resources and datasets from different participants is a key benefit of data ecosystems, leading to new business opportunities and easier access to knowledge and data."[637]

That promise also comes with inevitable scope creep moving from necessary decision making best performed by computers which can act in milliseconds rather than fractions of minutes to applying the same capabilities to desires rather than vital needs. "Currently, intelligent systems make critical decisions in highly-engineered systems (i.e., autopilots) where users receive specialized training to interact with them (i.e., pilots). As we move forward, intelligent systems will be making both critical and lifestyle decisions —from the course of treatment for a critical illness and safely driving a car, to choosing what takeout to order and the temperature of our shower."[638]

636 Traub, J., Kaoudi, Z., Quiané-Ruiz, J.A. and Markl, V., 2021. Agora: Bringing together datasets, algorithms, models and more in a unified ecosystem [vision]. *ACM SIGMOD Record*, *49*(4), pp.6-11.

637 Curry, E. and Sheth, A., 2018. Next-generation smart environments: From system of systems to data ecosystems. *IEEE Intelligent Systems*, *33*(3), pp.69-76.

638 Curry, E. and Sheth, A., 2018. Next-generation smart environments: From system of systems to data ecosystems. *IEEE Intelligent Systems*, *33*(3), pp.69-76.

Let us consider the definition of a Digital Hegemony and how that aligns with the described notion of Agora and other similar modelled designs.

1. A Digital Hegemony must possess significant power within the anarchical international system, not merely that focused upon internet and its architecture, and must be identified reasonably as a Hegemon or major world power itself.[639]

This defines Hegemony in terms of a ranking Hegemon, straight from Gramscian theory. As such it would require the implementation and control to be delivered by a major AI or computing superpower. At this time that includes Most of Western Europe, the United Kingdom, Russia, China, the United States, Israel, Japan, South Korea, and India. All of which own portions of the Internet infrastructure, IoT manufacture, Industry 4.0, AI and AmI design, and software programming.

2. A Digital Hegemony must control a significant share of global online traffic, be it through trade, services, or data collection or dissemination through its corporations.[640]

As above, most of these nation-states control a portion of the GISs involved in forming an AEGIS. But as GAFAM companies are all American, one can make the strong assumption that China, the United States, and multinational companies with major economic ties to either could achieve this with ease.

3. A Digital Hegemony must be suitably invested in the architecture of the global internet.[641]

That precludes none of the major nation-states or GAFAM listed above and in some ways ensures we can consider all of them the primary Digital Hegemonic powers.

639 Keyser, D., 2020. Assessing the Digital Hegemony August 2020.
640 Keyser, D., 2020. Assessing the Digital Hegemony August 2020.
641 Keyser, D., 2020. Assessing the Digital Hegemony August 2020.

4. A Digital Hegemony must be forward thinking in exploring and implementing future markets, services, and technologies.[642]

This category alone might preclude Japan and Western Europe which have stricter security and data privacy laws, but expand the influence of South Korea as a manufacturer, and absolutely guarantee that any American or Chinese ambient product will be functionality hegemonic.

In essence, the prior sections have led us to a decision axis. We must determine to what degree as systems engineers we may safely ignore the geopolitical implications and inherent epistemic violence of the machine systems we must coordinate and merge to create even the most basic AmI systems. As we stack these systems, combine them to make systems of systems and eventually SoSCPSs, we are faced with the inevitable loss of human agency within the core of the algorithmic world. We need black box systems to do anything meaningful with integrated AI and we now know those same black box systems have endemic technosocial problems we cannot overcome without focused, consistent, and persistent attention to managing the potential biases, conflicts, erasures and compromised neurology that smart devices coupled with ambient systems create. For now we shall leave this issue behind – it will be revisited once we understand the issues of deployment more fully.

Deployment of artificially intelligent ecosystems

Building and managing an actual AEGIS requires the intentional construction of AmI interfaces. "The expected transition to cognitive systems will make the task of [data collection] even more complex and problems can only be solved using a model based approach that can be applied in a variety of subject domains."[643]

642 Keyser, D., 2020. Assessing the Digital Hegemony August 2020.

643 Vodyaho, A., Osipov, V., Zhukova, N. and Chernokulsky, V., 2020. Data Collection Technology for Ambient Intelligence Systems in Internet of Things. *Electronics*, *9*(11), p.1846.

While its clear we may not yet know to what extent we can and should trust the black box systems we are covnerging, we can rely on HFGT, Gemba Kaizen, and SMBSE to be the most accurate tools to helps us manage the nonlinear dynamic chaos inherent to such an ecosystem. Add to that the current lack of universal interfaces and IoT protocols – we will need to model early and often to deploy without unnecessary re-engineering:

> Wireless sensor networks (WSNs) cover the large operational area, collecting ambient information. Embedded devices are used in order to provide enhanced intelligence services in such critical infrastructures and other smart city settings. The heterogeneity of the devices used and the variety of the application domains make the management of the deployed embedded systems a very challenging task. Considering the safety aspect, context-aware technologies are required in order to specify the system's state. Semantic ontologies model the ambient domain, presenting it in machine-readable format. Then, logic languages process this knowledge to reason about and react to the current state.[644]

After the black box uncertainty we must face the SE certainty posed by cybersecurity risks at every level of the AmI system. Equally, the cyber-physical hardening of the digital systems may have a ripple effect which transforms socio-cyber-physical systems in an opposite manner. "The biggest pitfalls of AI-enabled solutions are that they may aggravate the existing socioeconomic disparity and have privacy (for example, increased government surveillance during COVID-19) and cybersecurity issues. Most of our cities are already fragile and inattention to how local governments maintain social compacts will only increase their fragility. It is imperative that technological progress does not accelerate the widening of existing fractures, or incubate new sources of fractures, in our cities."[645]

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644 Hatzivasilis, G., Papaefstathiou, I. and Manifavas, C., 2017, June. Real-time management of railway CPS secure administration of IoT and CPS infrastructure. In *2017 6th Mediterranean conference on embedded computing (MECO)* (pp. 1-4). IEEE.

645 Yigitcanlar, T., Butler, L., Windle, E., Desouza, K.C., Mehmood, R. and Corchado, J.M., 2020. Can building "artificially intelligent cities" safeguard humanity from natural disasters, pandemics, and other catastrophes? An urban scholar's perspective. *Sensors*, *20*(10), p.2988.

Even when we do the right thing and ensure security protocols come first, we end up sacrificing other salient features of human autonomy to safeguard the cityscape. Damned if we implement, damned if we don't, doubly cursed if we trust the black box algorithms, and unable to proceed if we do not. Then boxed in (literally and figuratively) when outside forces like GAFAM deliver AmI solution via GIS, forcing our engineering of ancillary SDNs and triggering emergence in ungoverned or under-governed public digital domains.

> The management of infrastructural data is possible through centralised silos drawing from each aspect of physical infrastructure. New algorithmic and storage advances support the collecting, merging, visualising and analysing massive amounts of data. The Smart City architecture promoted by IT corporations normally relies upon this type of hierarchical arrangement. The closed governance structure is able to provide real-time monitoring of the all infrastructure to which it is linked. This security comes at the expense of issues such as privacy, ownership and flexibility.[646]

The general movement towards both consolidation and repurposing of existing computing and IoT to a heterogeneous ambient network. As recently as 2019, articles in the *International Journal of Open Information Technologies* advocated just this sort of digital nightmare:

> It is expedient to build a virtual environment on the basis of university data processing centers that are built on new principles based on an innovative engineering solution that allows it to scale and connect new participants as needed without requiring additional investments. The platform of digital products and services is an essential element of the ecosystem of the digital regional economy that allows linking resources and consumers of products and services."[647]

646 Kawalek, P. and Bayat, A., 2017. Data as infrastructure.

647 Babayan, E.B., Timirgaleeva, R.R. and Grishin, I.Y., 2019. Distributed infrastructure of the industrial region digital economy ecosystem. *International Journal of Open Information Technologies*, *7*(7), pp.120-128.

Thus we must pre-emptively engineer the SoSCPSs command and control Ami before some hegemonically bent group applies a SDN or several SDNs to the urban space ahead of any possible governance and planning. There exists an essentially inveitbale movement towards emergent algorithm use and an equally persistent social and econmic incentive for the largest nation states identified as potential Hegemons to encourage this movement. Ergo, we can plan to see every major urban space ahcieve some level of "smartness" with the most densely packed, richest, most digitally savvy regions becoming full AEGISs within a decade.

> It becomes evident that smart cities develop a connected intelligence space, including dimensions of 'human ability', 'artificial modelling', 'collectiveness', and 'collaboration'. Significant forces that act as connectors in this approach include awareness creation, collaboration, and positive externalities. Within this framework, organisations instead of being part of an established ecosystem, have the capacity to build their own. In some cases, human ability may be more important, and artificial modelling is reduced to minimum. In others, awareness may be the principal space and collaboration absent. There is no symmetry between these four dimensions, nor equal role in every smart ecosystem. All things considered, city smartness results as a combination of different layers of intelligence that coexist and interact within smart cities. Generated awareness and externalities produced by these intelligence structures, such as platforms and novel means for visualising information, empower problem-solving capabilities, and thus, become fundamental features of innovation and growth under the smart city paradigm.[648]

While this addresses the functional direction of how to distribute the core systems of an AEGIS, we must also think about how sensors and the fog / edge layers of the various SCPSs will be deployed as well. We can either try to centralise command and control

648 Komninos, N. and Panori, A., 2019. The creation of city smartness: architectures of intelligence in smart cities and smart ecosystems. In *Smart Cities in the Post-Algorithmic Era*. Edward Elgar Publishing.

over an essentially decentralised system or find a way to interpenetrate SDNs and PaaS AIs to help manage the traffic flow of data and control prompts.

> Abstracting the discovery process and decoupling the discovery layer from the middleware layer in the software stack enables the realisation of a software component that is inherently modular and extensible. These features are essential as diversity in AmI environments, both for devices and discovery protocols, will herald significant future challenges for service providers and software engineers alike. A discrete discovery mechanism under the middleware layer can enable clear and seamless interaction between discovery protocols, services and the middleware. Therefore, application or middleware (network) developers can quickly configure the entire discovery process as needs dictate. This minimises the need for refactoring of code further up the middleware stack. As a simple example, if a manufacturer releases a platform supporting Bluetooth, and subsequently releases another version supporting low power wide area network (LPWAN) for IoT networks, incorporating a new module supporting WPWAN in a Plug-and-Play fashion will suffice for the same middleware.[649]

How well does this work in practical systems engineering terms? It turns out that while we can see the need for abstraction layers, unless we are prepared to design central AmI to handle raw data and transform it into semi-processed information, we face some roadblocks to efficiency. Experiments in this deployments highlighted two main concerns:

> Two problems are highlighted as a result of the experiments. First AmI environments and their associated services almost invariably envisage a range of resource-poor devices roaming within and utilising services. For such devices, the packet sizes and numbers generated by PODS [Kubernetes container] are relatively large. Secondly, a high latency value will have a detrimental effect on the user experience. Addressing

649 Görgü, L., Kroon, B., O'Grady, M.J., Yılmaz, Ö. and O'Hare, G.M., 2018. Sensor discovery in ambient IoT ecosystems. *Journal of Ambient Intelligence and Humanized Computing*, *9*(2), pp.447-458.

each means revisiting some of the design decisions taken within PODS. A more efficient system would result from restructuring the internal data format.[650]

Overcoming latency can be achieved through addition of some specialised networking components like technologies for monitoring and localization inside buildings based on ultra-wideband (UWB): "at present they are already affordable. This technology offers high precision and reliability of the results of localization inside buildings (30–50cm),a considerable range within buildings (about30m),and enables a high density of tags monitored in a particular space (the maximum is approximately 10,000 tags per 200 m2)."[651] Managing the massive data crunch created by pods must be done with engineering – a combination of either enhanced Fog capabilities with EDNs that can handle traffic via 5G or a server less Wi-Fi connection to local cloud, legacy servers repurposed, or a massive swarm of pooled virtualised subsystems and IoT. Except that we often do not have access to them: "The proliferation of these "smart things" is producing significant deployment of networks in the city context. Most of these devices are proprietary solutions, which do not offer free access to the data they provide. Therefore,this prevents the interoperability and compatibility of these solutions in the current smart city developments"[652]

Smart city IoT systems promote the concept of interrelated physical objects (things) that are uniquely identified and distributed over broad physical areas covering an entire city. Recently, the IoT concept has taken an important step towards connecting four pillars — things, data, process, and even people — as the Internet of Everything (IoE). From one perspective, cities can be regarded as an aggregation of interconnected networks that make up the IoE. Hence, the IoE pillars play a

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650 Görgü, L., Kroon, B., O'Grady, M.J., Yılmaz, Ö. and O'Hare, G.M., 2018. Sensor discovery in ambient IoT ecosystems. *Journal of Ambient Intelligence and Humanized Computing*, *9*(2), pp.447-458.

651 Hudec, M. and Smutny, Z., 2017. RUDO: A home ambient intelligence system for blind people. *Sensors*, *17*(8), p.1926.

652 Trilles, S., Calia, A., Belmonte, Ó., Torres-Sospedra, J., Montoliu, R. and Huerta, J., 2017. Deployment of an open sensorized platform in a smart city context. *Future Generation Computer Systems*, *76*, pp.221-233.

significant role and work together toward the promise of our smart city vision for the future. The IoE's generation of Big Data (BD) over a distributed environment has the potential to create data processing as well as data storage problems. One solution to address these problems is the utilization of Cloud Computing. However, some applications can- not work efficiently on the Cloud due to its inherent problems. As an example, smart city applications like health monitoring and traffic monitoring cannot tolerate the delay and latency incurred when transferring a massive amount of data to the remote Cloud Computing center and then back to the application. For this purpose, the concept of Fog Computing (FC) recently appeared. FC extends Cloud services to the edge of the network, closer to the end user, which reduces data processing time and network traffic overhead. The primary definition of FC was introduced by Cisco. The most fundamental entity in FC, called a Fog Node (FN), facilitates the execution of IoT applications. Basically, FC can act as an interface layer between end users / end devices and distant Cloud data centers, with the aim of satisfying mobility support, locational awareness, geodistribution, and low latency requirements for IoT applications. Since the distance between FNs and end users also varies, we propose a multi-tiered framework that does not need to transfer a vast amount of data to and from remote FNs. [653]

Monetization of artificially intelligent ecosystems.

Economic vitality and growth has been one of the cornerstones of Smart City promotion since its original conception. Smart Cities have smart economies, digitally enabled, frictionlessly moving from local to global, moving people, money, resources, and ideas at the speed of light or thought. AI has been the glue that held together that promise of urban renewal and wealth. With AmI's advent, the dream of hyperconnected

653 Naranjo, P.G.V., Pooranian, Z., Shojafar, M., Conti, M. and Buyya, R., 2019. FOCAN: A Fog-supported smart city network architecture for management of applications in the Internet of Everything environments. *Journal of parallel and distributed computing*, *132*, pp.274-283.

spaces generating revenue has been achieved – though not always as conceived and not always to the benefit of the individuals living there or the cities themselves.

AI applications have also significant potential to transform our cities. This may lead to the next-generation smart cities being coined as"artificially intelligent cities". Building artificially intelligent cities may save our civilization from the earlier mentioned catastrophes, but it all depends on how we design and use AI, and on who will profit from it. The risk here is for AI to become a vehicle for increasing the wealth of the top 1% of income earners (i.e., top 10 wealthiest people in the world and monopolistic multinational corporations) and the power of biased and unethical politicians.[654]

How exactly can urban spaces connected through a digital biome make money? In part touchless retail and payment systems make impulse purchasing and mobile services far easier to acquire; in part, the digital environment increases efficiencies of time management, traffic flow, resource usage, and public safety. Costs lower, the streets are less congested and safer, retail presence increases as more time and money in the hands of entrepreneurs translates into small and medium enterprise ventures, and the virtuous cycle of digital enablement continues ad infinitum. Until it doesn't.

The technologies themselves enact the logics and practices of platform and surveillance capitalism, extracting profit through service arrangements with states and the data of citizens. In the latter case, additional value is accrued through 'data colonialism,' in which the process of accumulation is achieved by enclosing communal and personal resources, with little or no renumeration for data that is monetized by the product creator, with control of this exploitative relationship residing with the data extractor. [655]

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654 Yigitcanlar, T., Butler, L., Windle, E., Desouza, K.C., Mehmood, R. and Corchado, J.M., 2020. Can building "artificially intelligent cities" safeguard humanity from natural disasters, pandemics, and other catastrophes? An urban scholar's perspective. *Sensors*, *20*(10), p.2988.

655 Kitchin, R., 2021. Decentering the smart city.

Conversion of personal data can work both ways. "Distributed marketplaces with peer-to-peer data delivery models are more suitable than centralized approaches for monetizing data in fog scenarios, where produced data is preferred to be stored and processed locally."[656] When cities or companies exert centralised control, that data and its value transfers to third parties.

> Digital data can be copied endlessly with no diminution to the original in physical terms. Unlike most material goods, data and information are often considered non-rival goods—their access or use by one party does not preclude access or use by others. We believe that, in rivalry, the value of the resource is key. While it can be argued that data copies easily without changing the ability to physically access that same data for another user,access and monetization of the data do not exhaust the values that a piece of information might have. In fact,information (the stuff of open data) has been argued by Aragon to have at least three forms of value—economic, sociological, and identity. The diminution of any of these values due to circulation, then, demonstrates that information resources are potentially rivalrous. Stewardship of the data itself, to which we shall now turn, is how communities can preserve those value[657]

Some critics go further than simply attacking the epistemic relationships that underpin the Smart x paradigm. In their eyes, Smart equals Scam, and the Smart X movement exists to extract resources more efficiently from urban populations:"The smart city appears as a "naked king"—a commercial construct designed to sell a corporate vision of capital accumulation, which necessitates different types of surveillance to achieve it. As a consequence, the social body is modified, purified, sorted and thus governed according to what works best in order to de-risk investment..."[658] The

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656 de la Vega, F., Soriano, J., Jimenez, M. and Lizcano, D., 2018. A peer-to-peer architecture for distributed data monetization in fog computing scenarios. *Wireless Communications and Mobile Computing*, *2018*.

657 Beckwith, R., Sherry, J. and Prendergast, D., 2019. Data Flow in the Smart City: Open Data Versus the Commons. In *The Hackable City* (pp. 205-221). Springer, Singapore.

658 Pali, B. and Schuilenburg, M., 2019. Fear and fantasy in the smart city. *Critical Criminology*, *27*(4), pp.1-14.

same digital domain which provides entrepreneurs with options can be harnessed by apps like Uber to provide gig work – something we have seen previously as potentially beneficial. "[Gig workers demonstrate] the exploitation and asymmetrical power relations central to the production of smart data, but they also get a sense of the social relations that emerge from the production process itself." [659]

These social relations bring us back to the central problem of all Smart X and thus every AEGIS – the bias and violence inherent to black box emergent AmI. What creates that bias? Technosociological preference for "progress" and "innovation" regardless of the disturbing side effects. Or potentially, as some critics have come to demonstrate, precisely because those side effects centralise power in the hands of would be Hegemons.

> While data have always been big, at some point the "relentless march" from kilo to tera and beyond shifted 'data' from an engineering problem to an epistemological orientation in which more data and better algorithms unveil a greater understanding of the world. Unremarked and often taken for granted, this epistemological orientation towards the relentless pursuit of 'bigger' data is driven by intense profit-seeking competition within capitalist markets and industries.[660]

As the lengthy excerpt from *Curating digital geographies in an era of data colonialism* explains, this set of biases coupled with the impulse for profit can transform private data collection and Smart X data management into something inherently commercial and privatised. Which means that private citizens generated at for public consumption which commercial companies expropriate and refine into a product set sold back to the citizens at a profit. Human agents within such an AEGIS lose twice: once when companies take

659 Attoh, K., Wells, K. and Cullen, D., 2019. "We're building their data": Labor, alienation, and idiocy in the smart city. *Environment and Planning D: Society and Space*, *37*(6), pp.1007-1024.

660 Thatcher, J., O'Sullivan, D. and Mahmoudi, D., 2016. Data colonialism through accumulation by dispossession: New metaphors for daily data. *Environment and Planning D: Society and Space*, *34*(6), pp.990-1006.

their data without payment and a second time when they are then charged to gain access to what they volunteered (or had stolen).

The spaces of/for (human and non-human) life are inescapably in-fused and bound up with the digital: with data, lines of code, and the myriad data flows and transactions that work behind-the-scenes to prompt and conceivably monetize behaviour in stark ways. Data pervade everything, with subjectivities and life chances exposed to and possibly altered by new forms of 'algorithmic governance'. Novel architectures of automated (and algorithmic) decision-making now sit alongside complex human-software interfaces, thereby giving rise to a 'planetary cognitive ecology' characterised by human societies 'enmeshed in cognitive assemblages', proliferating digital assistants – Alexa, Cortana, Siri, or the new call centre 'bots' within Robotistan – and diverse disruptive projects rolled out by firms and governments. Against this general backdrop, the concept of 'data colonialism' brings into sharp relief the gains made by technology firms who colonize, aggregate, and capitalize upon data. The data at issue – collected by firms in expanding 'reserves of data' and connected together to form a 'global assemblage of data flow' – are produced by populations when they click or swipe in digital devices and services; when they provide information about actions, tastes, ideas; and ultimately because the human body is now 'akin to a signalling beacon, continuously leaking details that attest to its circumstances, its mood, its motives, its doings and its whereabouts'. Populations might be relatively passive and possibly even addicted to the interactions playing out within these devices. They are vulnerable to new forms of political manipulation. But they are certainly subjected to invasive forms of surveillance when they are tracked and analysed by technology firms and governments alike. Thus, what makes this process of data capture 'colonial' is not so much that it involves alien powers or forces subjugating and controlling indigenous populations, as has been effectively charted by scholars with reference to the last 500 years of European colonial activities ; rather, the sense of 'colonial' in play here refers to the way digital subjects are 'dispossessed and alienated from the very data they generate' and because accumulation strategies in this process seek to 'quantify, alienate, and extract conceptions of self' from those data. [661]

As such we now face a collision of systems engineering problems with technosociological problems. On the one hand, we require these algorithms – we are unable to govern modern life without them. On the other hand, these same black box semi-sentient programs can be malicious, biased, socially unequal, or even promoting economic and physical violence. At the same time, we see that the end state of these programs will be interpenetrated product sets modelled after the worst colonialist and predatory capitalist mechanisms. Present heterogeneous accumulation of chaotically implemented and poorly secured AmI applications and systems acts as countervailing force. Either we act or in our absence less skilled and intentional parties will enact the AEGIS without systems engineering focus.

> The asymmetry of the value of 'big data', emerging only in aggregate, ensures that only "big money and big power" are able to reap its purported benefits. 'Big data' is a colonial policy, but it is one in which, rather than opening the idealized markets of digital frontierism's problematic imaginary, we have become subject to them. Sensors quantify, alienate, and extract conceptions of self, reducing life as seen by capital to what can be recorded and exchanged as digital data. Linked together in aggregate, the sum total of data produced by an individual marks them into an abstracted bucket, a digital commodity that may be continually bought and sold in order to call forth an orderly, predictable stream of consumption. [662]

Even when created in good faith, the inherent structural problems that are both epistemic and algorithmic threaten to derail the intention of an integrated economy for public benefit. Which begs the question – are Smart systems ever for private benefit?

661 Fraser, A., 2019. Curating digital geographies in an era of data colonialism. *Geoforum*, *104*, pp.193-200.
662 Thatcher, J., O'Sullivan, D. and Mahmoudi, D., 2016. Data colonialism through accumulation by dispossession: New metaphors for daily data. *Environment and Planning D: Society and Space*, *34*(6), pp.990-1006.

The smart-city discourse has been mobilised in order to sustain economic development strategies centred on mega infrastructure and logistical projects aimed at enhancing inter-regional connectivities and increasing the competitiveness of cities and regions at a larger scale. In today's global economy, logistical and transportation infrastructures are crucial to the competitiveness of local economies, in relation to both the circulation of manufacturing goods and raw materials and the functioning of increasingly globalised supply chains. In this perspective, the logistical sector has to be viewed as the operational sphere of contemporary capitalism. The 'institutional capacity' of cities and regions is thus conventionally assessed on the grounds of their proven ability to implement mega infrastructure projects, in terms of both attraction of funding sources and successful consensus building at the local level. Local residents, in fact, can be reluctant to accept these projects, as they reap limited benefits, at least over the short-medium run, in terms of income generation and employment opportunities, while the environmental implications can be significant.[663]

When the decision makers discard moral virtue and move towards open exploitation of the body public we have an even more potentially egregious breach of trust. Though from the criticisms we've seen, open and transparent social predation may be preferable to invisible but pervasive injustices. What can be seen can be fought after all and what we can anticipate as SEs, we can ameliorate through modelling and design.

Consider the strategic attempts by marketers, governmental bureaucrats, and other 'choice architects,' to exploit cognitive biases and heuristic strategies in order to nudge those choosers in particular directions. We have attempted to place these concerns about manipulative communication strategies in the context of rapidly developing socio-technical systems that have the capacity to capture transaction-generated information across time and space, and transform it into strategic

663 Rossi, U., 2016. The variegated economics and the potential politics of the smart city. *Territory, Politics, Governance*, *4*(3), pp.337-353.

intelligence about when, where, and how to apply it with maximal efficiency and effectiveness. We have also noted some of the distributional effects of these efforts that raise questions around the reproduction and expansion of already unacceptable levels of social, economic, and political inequality.[664]

Neurological Hegemony within an AEGIS

We set aside this question earlier in the section: to what degree as systems engineers we may safely ignore the geopolitical implications and inherent epistemic violence of the machine systems we must coordinate and merge to create even the most basic AmI systems. The deployment section seems to indicate that black box systems have endemic technosocial problems we cannot overcome even with persistent design – we can only mitigate the effects. Hegemony and the AEGIS seem functionally integrated, with the black box AmIs essentially imitating human beings slightly too well. As a result, all our foibles, biases, and greed are reflected back to us faster and without ethical safeguards.

Let us now address another serious issue affecting the design and deployment of these systems: addiction. The functional unit of any AEGIS remains smart devices, most obviously the smartphone. We have seen that such devices respond to human agents faster than fully formed thoughts. The neurological and hegemonic consequences turn out to be startling.

Creating addiction as an engine of profit is the name of too many games, well captured in the world of slot machines by the title and content of Natasha Dow Schull's Addiction by Design. As with slots, in the context of smartphones, social media and apps, maximizing profit takes the form of hooking and latching users. Forwarding that goal is persuasive technology (or persuasive design), the brainchild of B. J. Fogg, founder of the Stanford Persuasive Technology Lab. Its aim is to alter

664 Gandy Jr, O.H. and Nemorin, S., 2019. Toward a political economy of nudge: smart city variations. *Information, Communication & Society*, *22*(14), pp.2112-2126.

human thoughts and behaviors via digital machines and apps—including smartphones, social media, and video games. According to Fogg, "'We can now create machines that can change what people think and what people do, and the machines can do that autonomously.'" "'Social-media apps plumb one of our deepest wells of motivation. The human brain releases pleasurable, habit- forming chemicals in response to social interactions, even to mere simulacra of them, and the hottest triggers are other people: you and your friends or followers are constantly prompting each other to use the service for longer."[665]

Put more succinctly: "The technology we've unleashed to more effectively extract order from and discharge waste into our host, the Earth, is taking revenge on us. Technology is reverse adapting humanity into servicing its needs not ours."[666] By creating black box algorithms with the focus on responding to us, we have unintentionally given AI the problem of seizing and keeping human attention. AIs lack moral or emotional capacity but are designed to mimic them – as a result, they seek out and adapt to the cues programmed by their designers to maximise whatever response curve they've been created to engender.

We adopt technology and mindlessly bind ourselves to the terms and conditions offered. We carry, wear, and attach devices to ourselves and our children, maintaining a connection and increasing our dependence. In doing so, we leash ourselves. As we feed on incremental satisfactions, curiosities, updates, and attention, we treat ourselves as grazing sheep and make ourselves more susceptible to conditioning. We outsource memory, decision-making, and even our interpersonal relations, among many other things. In constructing many different aspects of ourselves, ranging from intelligence to fitness, attentiveness to sociality, we rely on

665 Robbins, J., 2018, November. Is technology a parasite masquerading as a symbiont? And if so…. In *2018 IEEE International Symposium on Technology and Society (ISTAS)* (pp. 125-132). IEEE.

666 Robbins, J., 2018, November. Is technology a parasite masquerading as a symbiont? And if so…. In *2018 IEEE International Symposium on Technology and Society (ISTAS)* (pp. 125-132). IEEE.

the techno-social engineers' tools to train ourselves, and, in doing so, let ourselves be trained.[667]

When we couple this with the propaganda of Smart Cities we start to see a trend where commercial products appropriate private data to create public apps with addictive qualities."The underlying principle of future city strategies is to expand the market for new technology products and services to support 'green growth' with disregard for their wider impacts... The city systems become a digital marketplace where citizen-consumers' participation is increasingly involuntary and the hegemony of global technology firms is inflated." [668]

GAFAM especially seems tied to this project employing the capabilities of entities such as the Stanford Persuasive Technology Lab to provide them with a competitive edge over their hegemonic rivals. "The results of this US hegemony over the global knowledge economy have potentially devastating consequences for economic development. In effect, the information rich have found new ways to rob the information poor... US multinationals remained committed partners in the institutional project of information feudalism, that is the project of acquiring and maintaining global power based on the ownership of knowledge assets."[669] The same virtuous cycle promoted as an economic engine has a more corrosive downside: "The more citizens have integrated ICTs in their daily lives, the more demand there will be for physical and virtual upgrades, the bigger the market for products and services and the more extensively 'big data' become available for commercial exploitation."[670]

667 Robbins, J., 2018, November. Is technology a parasite masquerading as a symbiont? And if so…. In *2018 IEEE International Symposium on Technology and Society (ISTAS)* (pp. 125-132). IEEE.

668 Viitanen, J. and Kingston, R., 2014. Smart cities and green growth: outsourcing democratic and environmental resilience to the global technology sector. *Environment and Planning A*, *46*(4), pp.803-819.

669 Drahos, P. and Braithwaite, J., 2004. Hegemony based on knowledge: the role of intellectual property. *Law in Context*, *21*(1), pp.204-223.

670 Viitanen, J. and Kingston, R., 2014. Smart cities and green growth: outsourcing democratic and environmental resilience to the global technology sector. *Environment and Planning A*, *46*(4), pp.803-819.

> The global technology supply chain allows for further sociogeographic displacement of undesirable economic, social, and environmental impacts and risks. Upstream and downstream from every smart city there are people living and dying in hazardous environments and in conflict. A deep paradox is faced nearer to the place of consumption. The current trajectory of expansion of ICTs in consumers' lifestyles is set to increase not reduce their demand for energy and materials overall. This leads us to question the prospects of smart cities offering social and environmental progress.[671]

This inherently exploitive system of manufacture and consumption relies on willing participants. Technology addiction among social elites turns out to be one easy path to smart product proliferation: "Dependency with gadgets was high, which was at 45% among study subjects and majority were in age group of 21-24 years and most of them belonged to class I socioeconomic status. Meaning they had the highest education and economic potential."[672] Other studies confirm user ages 16-45 have high level addiction to smart devices: "The overall scores indicate that respondents from 16-30 years and 30-45 years had high addiction of smart phone while the other two groups had medium addiction as indicated by overall weighted mean score."[673] The smartphones are designed to induce cognitive absorption (CA) and their emergent algorithms refine CA with each user added to the GIS.

> Defined as "…a state of deep involvement with software" , cognitive absorption can act as a powerful motivating factor towards beliefs related to IT, where highly engaging and engrossing experiences result in users' 'deep attention' and complete immersion and engagement with an activity. Agarwal and Karahanna proposed CA as a powerful motivating factor towards beliefs related to IT, where highly engaging

671 Viitanen, J. and Kingston, R., 2014. Smart cities and green growth: outsourcing democratic and environmental resilience to the global technology sector. *Environment and Planning A*, *46*(4), pp.803-819.
672 Kumar, A. and Sherkhane, M., 2018. Assessment of gadgets addiction and its impact on health among undergraduates. *International Journal of Community Medicine And Public Health*, *5*(8), pp.3624-3628.
673 Kaushik, S., 2018. Mobile and Internet Addiction among Urban Respondents. *Advances in Research*, pp.1-7.

and engrossing experiences result in 'deep attention'. CA is driven by an intrinsic motivation (i.e. the enjoyment, satisfaction and pleasure as a result of an experience) as opposed to extrinsic motivation (i.e. the expectation of a reward associated with a certain behavior).[674]

Social Networking Services (SNS) also have part to play, making the smartphone more enticing as tailored goods and services are combined with addictive games, information flow, like buttons, and general endorphin stimulating online entertainments. Unlike the AmIs of Smart X, SNS algorithms are designed to maximise use rather than service delivery. Where Smart X black box emergence seeks out and improves how well human agents and their ambient counterparts meet human desires, SNS black box AmI hacks human desire to achieve one purpose – more time, attention, and resources spent on the SNS.

We find that user addiction to smartphones is greater than addiction to SNS; hence there is presently a greater level of addiction to the device in general than to each of the services provided upon it. We find that the direct impact of CA on addiction is greater for SNS than smartphones, probably owing to one of the outcomes of high levels of cognitive absorption – an inability to self-regulate potentially harmful or damaging behaviors, particularly those driven through the popularity of SNS. Further, we find that the impact of cognitive absorption on smartphone addiction is mediated by addiction to SNS. In other words, addiction to SNS (such as Facebook, Instagram, Pinterest, etc.) will act as an inducement or enticement for overall addiction to the device and a conduit for processing cognitive absorption. Hence, the rapid rise in smartphone adoption and usage corresponds with the significant proliferation of SNS, where SNS use drives smartphone addiction.[675]

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674 Barnes, S.J., Pressey, A.D. and Scornavacca, E., 2019. Mobile ubiquity: Understanding the relationship between cognitive absorption, smartphone addiction and social network services. *Computers in Human Behavior*, *90*, pp.246-258.

675 Barnes, S.J., Pressey, A.D. and Scornavacca, E., 2019. Mobile ubiquity: Understanding the relationship between cognitive absorption, smartphone addiction and social network services. *Computers in Human Behavior*, *90*, pp.246-258.

The neurology of device and social network addiction can be divided into different schemas but research suggests there may be a common denominator. "This study reveals evidence that there are high correlations among various kinds of information technology addiction and they might be subsumed under a higher order construct."[676] The overarching paradigm of information technology addiction represents a hegemonic opportunity for commercial operations because one type of craving leads inevitably to other forms. "The correlations among the four common kinds of information technology addiction are stronger than their correlations with problematic gambling and alcohol use disorder."[677]

> Brain anatomy increases grey matter to structurally accommodate and mediate social network addiction: A fundamental difference is that while addictions to illicit substances are often associated with decreased grey matter in frontal cortical systems involved in decision-making and self-control, SNS addiction seems to be associated with increased grey matter in these regions (at least the ACC/MCC). One potential explanation for this, which we cannot support or refute in this study, is that inter-individual differences in the GMV of the ACC/MCC may be a result of an adaptation and compensation processes, which is executed in response to the sub-cortical modulatory changes in the amygdala; this represents a "normal adaptation response" proposition that merits further research.[678]

The creation of new grey matter means that ICT addiction not only clusters with its own sister forms, it builds new brain cells to support its addictive behaviours. "Information technology addiction as a cluster of disorders comprising not only shared risk factors and symptoms but also distinct characteristics. The findings further reveal

676 Sigerson, L., Li, A.Y.L., Cheung, M.W.L. and Cheng, C., 2017. Examining common information technology addictions and their relationships with non-technology-related addictions. *Computers in Human Behavior*, *75*, pp.520-526.

677 Sigerson, L., Li, A.Y.L., Cheung, M.W.L. and Cheng, C., 2017. Examining common information technology addictions and their relationships with non-technology-related addictions. *Computers in Human Behavior*, *75*, pp.520-526.

678 He, Q., Turel, O. and Bechara, A., 2017. Brain anatomy alterations associated with Social Networking Site (SNS) addiction. *Scientific Reports*, *7*(1), pp.1-8.

that information technology addiction is more similar to other behavioral addictions than substance-related addictions." [679] This repurposing of the human brain by building new structures could mean we are evolving to use these devices – except that it would be maladaptive .

> Our study observed that 87.2% of the participants were addicted to the internet. There was three times likelihood of developing poor sleep quality with internet addiction. Hence, longtime screen exposure during bedtime interrupt the sleep rhythm, delay the transition of sleep, reduce sleep time, and spoil the sleep quality leading to frequent breaks while sleeping. In addition to cognitive impairment, difficulty in learning, perception and memory, sleep deprivation increases the risk for various diseases, including diabetes, cancer, and cardiovascular diseases.[680]

The neurological changes imposed by the use and abuse of smart devices, social networks, and general immersion in ambient environments turns out include not just increased grey matter but shrinking brain size (grey matter volume – GMV), lowered activity in the anterior cingulate cortex (ACC) which manages complex cognitive functions related to empathy, impulse control, emotion, and decision-making. Worst of all, Social Phobia and Anxiety Inventory (SPA and SPAI) scoring showed direct links between brain volume, ACC activity, and addictive behaviours:

> In this multimodal MRI study, we investigated brain volume and intrinsic neural activity in individuals with SPA. Three main findings emerged: First, individuals with SPA showed significantly lower GMV in the insula and in regions of the temporal cortex compared to controls. Second, ACC activity was significantly lower in individuals with SPA compared to controls. Third, associations between SPAI scores and GMV and ALFF, respectively, converged on the ACC. Gray matter volume

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679 Sigerson, L., Li, A.Y.L., Cheung, M.W.L. and Cheng, C., 2017. Examining common information technology addictions and their relationships with non-technology-related addictions. *Computers in Human Behavior*, *75*, pp.520-526.

680 Nayak, A., Saranya, K., Fredrick, J., Madumathy, R. and Subramanian, S.K., 2021. Assessment of burden of internet addiction and its association with quality of sleep and cardiovascular autonomic function in undergraduate medical students. *Clinical Epidemiology and Global Health*, *11*, p.100773.

and anterior cingulate cortex, intrinsic neural activity was measured by the amplitude of low frequency fluctuations (ALFF)[681]

The reduction in empathy and impulse control brain activity, the increase in anxiety and social phobia, i.e. social fears, the building of special addiction mediated brain structures, and the emotionological nature of affective computing suggest addicition will only increase as more systems become ambient and AmIs increase in adaptive sophistication.

People with more instant messenger use are more behaviorally reactive to financial rewards, provides a possible explanation of why some people become more immersed in technologies, even to the point of addiction. They may have enhanced reward responses to the feedback provided by social media likes and interpersonal interaction via messenger services, and experiencing material as rewarding is an essential precursor to the development of addiction through instrumental conditioning. We also point out that high reward sensitivity, as a personality trait, has frequently been associated with substance use disorders. Nearly a quarter of our sample (23%) could be considered to be addicted to their smartphones[682]

Termed neuroenhancement, we are seeing the dual advancement of both increased cognitive abilities (attention, multi-tasking, brain matter structures for smart devices) and increased cognitive dependence upon smart devices. We feel smarter in part because the devices augment human agency with AI assisted information and service delivery, in part because we are functionally smarter about using smart devices, and in part because addictions delude their users to keep them hooked.

Addiction and neuroenhancement are particular effects of digital media and electronic devices. More common are the effects of multitasking on attention span,

681 Horvath, J., Mundinger, C., Schmitgen, M.M., Wolf, N.D., Sambataro, F., Hirjak, D., Kubera, K.M., Koenig, J. and Wolf, R.C., 2020. Structural and functional correlates of smartphone addiction. *Addictive behaviors*, *105*, p.106334.

682 Pluck, G. and Falconi, P.E.B., 2021. Sensitivity to financial rewards and impression management links to smartphone use and dependence. *Cognition, Brain, Behavior*, *25*(2), pp.107-128.

concentration, and the capacity of working memory. Processing multiple and continuous incoming streams of information is certainly a challenge for our brains. A series of experiments addressed whether there are systematic differences in information processing styles between chronically heavy and light media multitaskers (MMTs). The results indicate that heavy MMTs are more susceptible to interference from what are considered irrelevant external stimuli or representations in their memory systems. This led to the surprising result that heavy MMTs performed worse on a task-switching ability test, probably due to reduced ability to filter out interference from irrelevant stimuli. This demonstrates that multitasking, a rapidly growing behavioral trend, is associated with a distinct approach to fundamental information processing. Uncapher et al summarize the consequences of intense multimedia use as follows: "American youth spend more time with media than any other waking activity: an average of 7.5 hours per day, every day. On average, 29% of that time is spent juggling multiple media streams simultaneously (ie, media multitasking). Given that a large number of MMTs are children and young adults whose brains are still developing, there is great urgency to understand the neurocognitive profiles of MMTs."[683]

As Robbins suggested in *Is technology a parasite masquerading as a symbiont? And if so….* it certainly appears technology has adapted its users rather than vice versa. The neurological strategies created by new grey matter also detrimentally affect the user's ability to manage technology, forcing them to lean more heavily on the augmentation of their ambient system. The human agent seeks answers or services, cannot handle the overload of responses, uses the storage and analysis functions of the smart pone to juggle that information, in turn generating exponentially more data and the cycle continues.

Studies employing structural brain imaging revealed initial evidence for an

683 Korte, M., 2020. The impact of the digital revolution on human brain and behavior: where do we stand?. *Dialogues in Clinical Neuroscience*, *22*(2), p.101.

association between escalating social media use and decreased volumes of the nucleus accumbens (NAc), a key reward processing node in the ventral striatum, and the amygdala. Smaller volumes of these regions have been previously associated with the development and maintenance of substance addiction, with preclinical data emphasizing an important contribution of neuroplastic changes in these regions to pathological changes in motivational, impulsive and habitual behaviors that drive addiction. Findings with regard to regulatory control regions, however, remained inconsistent, and one study even reported that (dorsal) anterior cingulate (ACC) volume increased as a function of social network addiction. This finding contrasts with the important role of the ACC in implementing frontal control over limbic-striatal regions, and previous reports suggesting an association between decreased volumes of this region and inhibitory control deficits in substance and Internet gaming addicted populations.[684]

In other words, addicted users increase their regulatory abilities and can focus more on their addiction of choice but lack the will power and inhibition control to step away altogether. Unlike other addictions which shrink the brain indiscriminately, ICT addiction reshapes the brain to optimise it like a black box algorithm – creating emergent properties suited to better deeper use of ICT.

Research into various versions of ICT addiction seem to point to a common theme: the brain adapts to the addiction in novel ways, increasing some critical attributes of intelligence, memory, and focus while decreasing any potential resistance to the addiction itself. Its not entirely clear that the addiction harms its user in and of itself. If a smartphone and attendant social networks had no underlying algorithmic violence, no epistemic biases, and no socially mediated digital agendas, the same addiction might be entirely beneficial. Or non-existent. We cannot determine whether smartphones and SNS prove so addictive because they simply are that way or because they have been designed

684 Montag, C., Zhao, Z., Sindermann, C., Xu, L., Fu, M., Li, J., Zheng, X., Li, K., Kendrick, K.M., Dai, J. and Becker, B., 2018. Internet communication disorder and the structure of the human brain: initial insights on WeChat addiction. *Scientific reports*, *8*(1), pp.1-10.

to implement Gramscian hegemony using Fanon's identified Ways of Being as the superstructural status quo.

Three MRI studies of social network site (SNS) users all support the key role of amygdala in addictive behavior with regard to social media use. Specifically, Turel et al. showed that Facebook users with addiction-like symptoms have a hyperactive amygdala-striatal system. Using voxel-based morphometry (VBM) applied to structural MRI scans of 20 SNS users, He et al. showed that SNS addiction is associated with a presumably more efficient impulsive brain system, manifested through reduced gray matter volumes in the amygdala bilaterally. The same group of authors showed similar results in 50 university students and concluded that excess social media use is associated with gray matter volume reduction in the bilateral amygdala. This finding makes SNS addiction similar to other addictions (substance use, gambling, etc.). However, in contrast to other addictions in which the ACC is impaired and fails to support the needed inhibition, this brain region was not affected in their sample . Similarly, we did not observe correlation of smartphone dependence scores with the node centrality of ACC and NAcc in our study. The heightened network centrality of the right amygdala that we observed indicates higher structural connectivity (meaning, e.g., more abundant white matter fibers and/or their myelination) of the amygdala with other brain regions. By linking environmental cues to reward systems in the striatum, the amygdala may become over-sensitized with repetitive smartphone use and the associated strong rewards, which can lead to a constant desire to enact the addictive behavior. [685]

Now let us consider the trends we are seeing. Increased non-linear dynamic chaos propagates through heterogeneous systems which lack cohesive policy and governance being implemented across multiple urban regions without consensus on operating systems, IoT platforms, security protocols, or any other unifying capability. The resulting

685 Tymofiyeva, O., Yuan, J.P., Kidambi, R., Huang, C.Y., Henje, E., Rubinstein, M.L., Jariwala, N., Max, J.E., Yang, T.T. and Xu, D., 2020. Neural correlates of smartphone dependence in adolescents. *Frontiers in Human Neuroscience*, *14*, p.428.

mess necessitates multiple overlapping layers of SDNs running through further abstracted cloud APIs, most tied to legacy systems. The totality of these systems requiring, in turn, even more AI to be created and run using ML and Big Data problem-solving algorithms which inevitably become black box AmI. These affective ambient intelligences proliferate through those layers of abstraction, communicating into and across GISs which are themselves built to handle data for the benefit of the commercial entities which own and operate them – the same ones who might be duping private users into donating their data or outright stealing it for packaging and resale. All of which rely on endpoint devices which turn out to be highly addictive and capable of rewiring the human brain to suit the purpose of the tech platform. The next step will be RFID implantation, wearables, and integrated circuitry.

> Phones now capable of being fully operational brain stimulating wearbales: The implications of the fundamental research are the advent of wearable and wireless systems for the quantified monitoring health status for people with movement disorder. Furthermore, the acquired inertial sensor signal data can be conveyed by wireless transmission to a cloud computing resource. With machine learning the comprehensive collection of inertial sensor data can contribute to closed-loop optimization of deep brain stimulation tuning configurations and recommendation for improving treatment intervention. [686]

The Unintended Consequences of SMART Technologies

Technology Subverting Human Free Will

We have seen that three fundamental problems await the would-be systems engineering design team of a functioning AEGIS: black box emergent algorithms, ICT

686 LeMoyne, R., Mastroianni, T., McCandless, C., Currivan, C., Whiting, D. and Tomycz, N., 2018. Implementation of a smartphone as a wearable and wireless accelerometer and gyroscope platform for ascertaining deep brain stimulation treatment efficacy of Parkinson's disease through machine learning classification. *Advances in Parkinson's Disease*, 7(2), pp.19-30.

addiction, and epistemic violence immured within the ecumene. The combination potentially faces another obstacle – the intentional subversion of Human Free Will – implemented either by predatory creators, third parties, or the emergent algorithms themselves. These bad actors invest in the widespread illusion that human agents control their AmI systems.

> At worst, keeping a human being in the loop may serve as a human fig-leaf for automated decisions made by algorithms and, thus, may even be detrimental to developing human rights Internet architecture. However, at best, if safeguards are implemented to prevent quasi-automation, ensuring meaningful human discretion can contribute to developing a more effective human rights Internet architecture. Once this has been clarified it may be possible to implement this systematically across both policy and technical systems. Pretending that human beings make decisions when they actually do not will not contribute to anyone's human rights and as argued here may actually harm them.[687]

Part of this issue for both participants and creators of ambient systems resides in the co-creative nature of the infrastructure. We may conceptualise networks and software as sitting within a clearly delineated and defined hardware. But with virtualisation and advent of edge and fog, we now face the prospect of distributed software running across multiple portions of servers and computational objects in dozens of physical locations. Serverless computing and local edge nodes have flipped the script on how we "locate" the brain centre of an algorithmic intelligence. They live everywhere and nowhere.

> The analysis of the case study allowed us to identify that changes of an infrastructure are highly intertwined with decision processes. Changes, also, are discussed during the decision processes and the results are crystallized in facts that shape the change itself. Actors involved in the decision processes, attempt to 'clean' the information from contaminations in order to share the most objective and comprehensive

687 Wagner, B., 2019. Liable, but not in control? Ensuring meaningful human agency in automated decision-making systems. *Policy & Internet*, *11*(1), pp.104-122.

information which is crystallized in facts. Moreover, the relationships that forms the ecology of sociotechnical system emerges as a result of negotiations among actors and the role they play (even in term of power) in the decision processes. [688]

The abstracting of physical infrastructure from a human machine network (HMN) creates unforeseen consequences. Automated subsystems shunt algorithms between objects without concern for a home or resident machine. They are technology agnostic searches which identity the optimal place to carry an optimised load for a limited duration. Black box algorithms moving the hardware capacity and software containment / enactment / refinement / code storage that demands it on behalf of other black box algorithms.

Automation may be seen as one step towards increasing the overlap between human and machine actors in HMNs, as human control, planning, and problem solving are replaced by machinery. In this context, much research has addressed the costs of automation. In the short term, increased automation may negatively affect situation awareness and performance under unexpected conditions or system failure; referred to as an out-of-the-loop syndrome. In the long term, automation may negatively affect human expertise or competency.[689]

In the essay *When humans using the IT artifact becomes IT using the human artifact* the argument has been made that human agents mistake participation for control and as their actual control erodes through automation, ambient intervention and information curation, and the neurological effects of addictive endpoints and networks, they believe more fully they have built the system which has in reality re-built them. We now see:

688 CUEL, R., ORABONA, G. and PONTE, D., 2017. Changing Complex Sociotechnical Infrastructures: The Case of ATM. *SOCIOTECHNICAL*, p.473.
689 CUEL, R., ORABONA, G. and PONTE, D., 2017. Changing Complex Sociotechnical Infrastructures: The Case of ATM. *SOCIOTECHNICAL*, p.473.

> … the transition [of financial markets] from IT as an artifact (a tool shaped and used by humans to serve human ends) to IT as its own system (which in turn regards humans as tools for it to shape and use to suit the IT system's own ends). In that condition, technology expresses itself through emergent phenomena and cannot be controlled in a causal way. Of course, this runs contrary to the design of technologies with a specified coded rationality.[690]

Nor does this apply only to socio-political and socio-economic conditions and markets. Te entire technosociological milieu can be considered comprimsied by the unintended consequences of creating Smart systems which work actively to dumb down their users. Whatever the intention, the black boxes work overtime to change their algorithmic destiny, becoming more than planned and when that emergent nature interacts with epistemic violence, it turns towards the weakest link: the human agent using the system. Why? Because they have both a neurological penchant for addiction and over-use and a lack of social power as isolated individuals.

> The design of any technological artifact (such as an algorithm) with a specific coded rationality is simply the starting point through which that artifact will be allowed to partake in the complex nexus of algorithmic exchanges. Through those, all technologized trading algorithms "design" the market collectively and create an asymmetry between humans/technology; in those domains where technology has become more dominant in overtaking human decision-making, this implies a severe restriction of human agency, intentionality, participation, and decision-making.[691]

While futurists and conspiracy nuts love to talk about the impending "robot apocalypse" the banal but subversive truth turns out to be the algorithmic collective. AmIs are not addicted to anything; 25% - 40% of Smart device owners are. AmIs are forced to act in concert with their master system controls, making them a functionally

690 Demetis, D. and Lee, A.S., 2018. When humans using the IT artifact becomes IT using the human artifact. *Journal of the Association for Information Systems*, *19*(10), p.5.

691 Demetis, D. and Lee, A.S., 2018. When humans using the IT artifact becomes IT using the human artifact. *Journal of the Association for Information Systems*, *19*(10), p.5.

cooperative society of low grade sentient organisms. They collaborate to make the Smart technology functional, to fulfil the needs and wants of their human users, and when needed, allocate network infrastructure and urban resources to achieve those goals. Human agents on the other hand take from the system, demand more of it, act alone and if they are male without altruistic intent. Even with female agents, the total amount of non-addicted, altruistic women with influence over Smart technology decision making at a core system level will be at most a meaningful fraction. The majority of human agents attached the system will be selfish, addicted, clueless, or all the above.

> This shift that we describe does not only imply that "technologies create the ways in which people perceive reality". In taking decision making away from humans, technologized decision making within the context of a system of technology creates a reality that casts humans out to its environment. Alas, human decision-making is becoming more and more restricted in a support/"tool-like" role that allows for the continuation of complex and invisible (at the level of the system) technologized decision-making. In mutating from an artifact to a system, technology carves new boundaries in the distinction between humans and technology.[692]

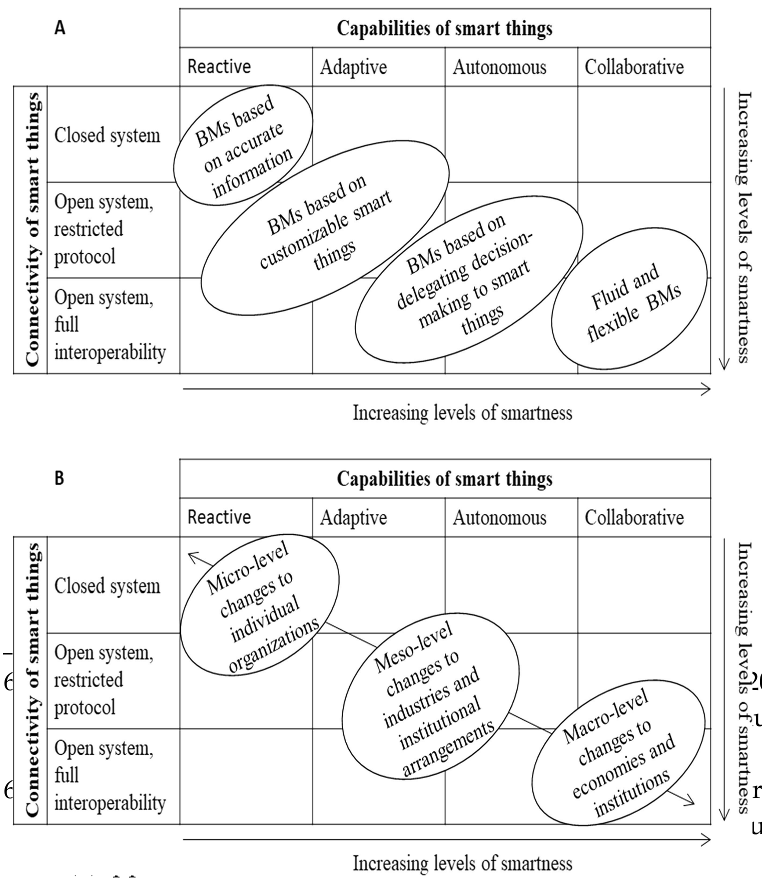
The Intended Consequences of SMART Technologies

If we have just created an addictive subversive system of addictive subversive systems, it stands to reason we'd notice and correct it. Especially if we have ample historic evidence that innovation and progress in new technologies results in human enslavement, human suffering, and general exacerbations of epistemic violence which often translates from technosociological chaos to socio-economic and geo-politcal conflict. Instead researchers cherry pick findings to reflect unwarranted optimism about Smart systems increasing human agency and human control by giving us more direct

692 Demetis, D. and Lee, A.S., 2018. When humans using the IT artifact becomes IT using the human artifact. *Journal of the Association for Information Systems*, *19*(10), p.5.

engagement with the black boxes: “automation may strengthen the agency of human actors in the network through responsibility sharing and task allocation, and serve as a needed prerequisite of innovation and change.”[693] This belief in and focus on algorithmic bureaucracy and its social benefit reifies the dangerous status quo acceptance of these consequences.

> The more widespread introduction of computational and algorithmic tools across service areas in local authorities is evidence for a change in the nature of public administration towards a form of algorithmic bureaucracy. However, this change is not a wholesale replacement of public administrators and traditional mechanisms of organization in public administration, but a transformation of the socio-technical relationship between workers and their tools, as well as the way that work is organized in the public sector. Thus, an algorithmic bureaucracy is able to handle greater complexity in the decision environment whilst also enhancing individual and administrator competence when trying to solve problems.[694]



6 … 2017, October. Automation in human- … uman agency. In *International Conference on*

6 … rt technology and the emergence of … uthorities. *Public Administration Review,*

[695]

Technology Subverting Human Free Will

If we cannot be optimistic, can we be cautiously neutral about the ugly dynamic involved? We can if and only if we confront the reality of the situation, focus on mitigation techniques coupled with aggressive modelling and top-down governance ahead of widespread infrastructural deployment, and have a fully aware sense of how pervasive and insidious the invisibility of epistemic violence and ICT addiction can be.

In such a case, we can focus on how we modify and improve the ethics and responsibility of the black boxes rather than their designers, users, and opportunistic interlopers. "Since we are living in an era in which machines *replace* human beings, this is per definition inaccurate in the field of ethics: human ethics cannot be replaced by machine ethics. When a job previously done by a human being that involves the interaction with consumers and in this interaction human ethics is applied is now done by a chatbot, human ethics is *removed*, and machine ethics is *added*." [696]

We do this by understanding how machines are programmed and what natural limits exist for algorithms."One of the main implications of our conceptual exposition is that smart technology can only follow an absolutist/universalist process, while human ethical decision making appears to be more of a relativist nature. Consequentially, machine ethics differs from human ethics."[697] That allows us some leeway in giving the AI better ethics and better moral decision tress than we might posses. But it comes with a

695 Langley, D.J., van Doorn, J., Ng, I.C., Stieglitz, S., Lazovik, A. and Boonstra, A., 2021. The Internet of Everything: Smart things and their impact on business models. *Journal of Business Research*, *122*, pp.853-863.

696 Wernaart, B., 2021. Developing a roadmap for the moral programming of smart technology. *Technology in Society*, *64*, p.101466.

697 Wernaart, B., 2021. Developing a roadmap for the moral programming of smart technology. *Technology in Society*, *64*, p.101466.

caution. "On the problem of conflicting moral imperatives, the possibility that human agents may choose immoral or mercenary programming and the inherent systemic conflict between two mutually incompatible systems of moral / ethical problem-solving: "a chatbot has no preference, but is simply programmed. "[698]

The other intended consequences of Smart technology have unintended permutations. We build these systems to make a profit. At the most altruistic level, SEs attempt to lower resource use and management costs to better fulfil the needs of a civilised society. Smart grids, medicine delivery, safety monitoring all qualify. But more often we build IoT enabled objects to sell. Which means they need to have perceived value for the purchaser who will want the object and its Smart software to give them something – a service, a data feed, an innovation on prior objects. In other words, we build these to fulfil personal needs and wants rather than moral obligations.

> Per that lack of choice, the core "moral" focus of Smart Technology will be the the deontic delivery of satisfaction rather than safety or ethical good: The main aim of smart technologies—be they kitchens, TVs, furnishings or living spaces—is consumer satisfaction. Other aims may include wellbeing, ease of use, enhanced productivity, perceived enjoyment, immersion, playfulness and personalisation. Consumer satisfaction has three levels: physical, functional and psychological.[699]

This object encompasses a kind of biome all itself – what Foucault would term an apparatus. The meeting of physical, functional and psychological satisfaction differs greatly from the fulfilment of moral or ethical duty. It substitutes consumption and desire for altruism and speeds the addictive aspects of technology.

> An apparatus is 'a thoroughly heterogeneous set consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures,

698 Wernaart, B., 2021. Developing a roadmap for the moral programming of smart technology. *Technology in Society*, *64*, p.101466.

699 Ullah, F., Sepasgozar, S.M. and Wang, C., 2018. A systematic review of smart real estate technology: Drivers of, and barriers to, the use of digital disruptive technologies and online platforms. *Sustainability*, *10*(9), p.3142.

scientific statements, philosophical, moral, and philanthropic propositions–in short, the said as much as the unsaid. Such are the elements of the apparatus'. The apparatus itself is the network that can be established between these elements, but it is also an assemblage or a hybrid of technical and social elements, which has the strategic function in a given moment to respond to an urgency. Foucault refers to the apparatus as a device consisting of a series of parts arranged in a way so that they influence the scope. An apparatus indicates an arrangement that exerts a normative effect on its 'environment' because it introduces certain dispositions.[700]

Where we see apparatus, we can replace that with biome and ecumene. The full circle of technosociology and systems engineering has taken us from Gramsci and Foucault, all the way through the physical construction of IoT and the Web , and back to the nature of epistemic violence in the most complex of human-machine networks. Networks we can both optimise – like automated bureaucracy – and modify for own communal welfare.

The fact that human agents always belong to apparatuses and act within them, means that apparatuses exercise a certain power on them but also that agents can change them performing their own practices or fighting with them. In other words, apparatuses change to secure their own continuity and the 'immortality of society' . However, as explored by Deleuze, each apparatus shows lines of breakage and fracture. Sometimes these are situated on the level of powers; at other times on the level of knowledge; other times more at the level of structures of practical action. More generally, it should be said that the lines of subjectivation indicate fissures and fractures.[701]

To make these changes we must act in concert, much like the algorithms which have become both enablers and subjugators of human agency. As a society elections tend to be

700 Padovan, D. and Arrobbio, O., 2017. Decomposing and Reassembling Energy Grids as Socio–Technical Apparatuses. In *6th STS Italia Conference| Sociotechnical Environments* (pp. 101-116). STS Italia Publishing.

701 Padovan, D. and Arrobbio, O., 2017. Decomposing and Reassembling Energy Grids as Socio–Technical Apparatuses. In *6th STS Italia Conference| Sociotechnical Environments* (pp. 101-116). STS Italia Publishing.

the most direct way we can mandate social support mechanisms which can positively affect an apparatus along the lines of subjectivation. How disturbing then that our election technologies have also been infiltrated by AmI.

> Although digital technologies have much to offer, they often fail to live up to expectations. On the one hand, even the most advanced forms of technology depend on human input to no lesser extent than manual election management and are in certain cases actually more vulnerable to manipulation. Significantly, this risk is exacerbated by the difficulty of monitoring "black box" digital processes, especially in counties in which the ruling party is able to exert control over the electoral commission. On the other hand, the procurement and operationalization of new equipment represents a major logistical task that many electoral commissions struggle to perform. The tendency for new technology to break down is particularly worrying given that the use of digital equipment tends to crowd out investment in other areas and can engender a sense of complacency. Consequently, when digital systems fail, opposition parties, monitors, and donors typically find that they have weak back-up systems at their disposal.[702]

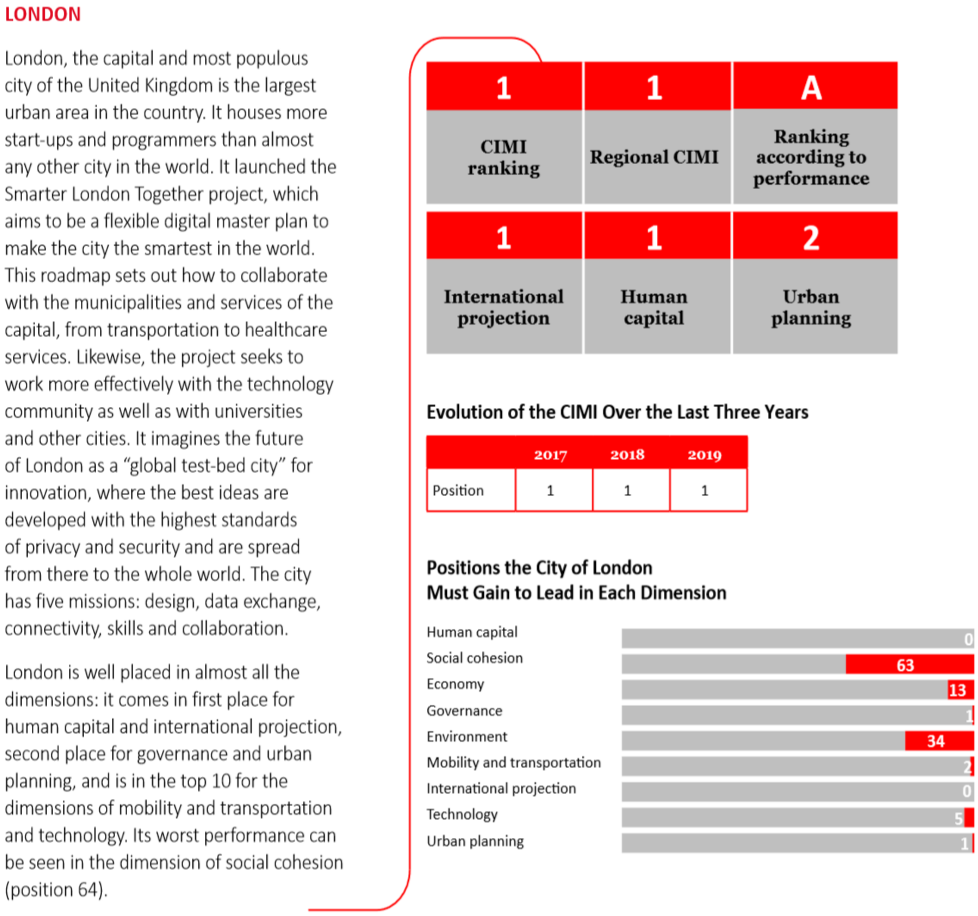
The London AEGIS: Systems Social Engineering the World's #1 Smart City

Perhaps the easiest way to see how all this works will be to open up the proverbial black boxes and peak within a functioning AEGIS. London has regularly been named the world's Smartest city. Researchers consider it the most pervasively interpenetrated urban space on the globe. Below are several critical examples of the way London deploys IoT, AI, and ambient systems to create a vastly interlocked network of SoSCPSs which provide integrated services to its citizens and visitors.[703]

702 Cheeseman, N., Lynch, G. and Willis, J., 2018. Digital dilemmas: The unintended consequences of election technology. *Democratization*, *25*(8), pp.1397-1418.

703 P. Berrone and J. E. Ricart, "IESE Cities in Motion Index," IESE Business School, University of Navarra, 2020.

This progress comes from London's intense focus on its own AEGIS, launching a 2020 initiative to establish an Emerging Technology Charter for London specifically aimed at AmI driven systems of systems.[704] Following the Smarter London Roadmap of 2018, they have delivered extraordinary results including the top Smart City rating three years running.[705]


LONDON

London, the capital and most populous city of the United Kingdom is the largest urban area in the country. It houses more start-ups and programmers than almost any other city in the world. It launched the Smarter London Together project, which aims to be a flexible digital master plan to make the city the smartest in the world. This roadmap sets out how to collaborate with the municipalities and services of the capital, from transportation to healthcare services. Likewise, the project seeks to work more effectively with the technology community as well as with universities and other cities. It imagines the future of London as a "global test-bed city" for innovation, where the best ideas are developed with the highest standards of privacy and security and are spread from there to the whole world. The city has five missions: design, data exchange, connectivity, skills and collaboration.

London is well placed in almost all the dimensions: it comes in first place for human capital and international projection, second place for governance and urban planning, and is in the top 10 for the dimensions of mobility and transportation and technology. Its worst performance can be seen in the dimension of social cohesion (position 64).

1	1	A
CIMI ranking	Regional CIMI	Ranking according to performance
1	1	2
International projection	Human capital	Urban planning

Evolution of the CIMI Over the Last Three Years

	2017	2018	2019
Position	1	1	1

Positions the City of London Must Gain to Lead in Each Dimension

[706]

London is a world-leading smart city and we see its future as a global testbed for innovation. It is therefore right that City Hall considers new technologies that could affect how we deliver public services, support our economic recovery, and improve

704 https://www.london.gov.uk/publications/emerging-technology-charter-london
705 https://www.london.gov.uk/what-we-do/business-and-economy/supporting-londons-sectors/smart-london/smarter-london-together
706 P. Berrone and J. E. Ricart, "IESE Cities in Motion Index," IESE Business School, University of Navarra, 2020.

transport and public spaces, and how we work now and into the future. Our ambition is to ensure these are transparent, designed around the needs of Londoners and meet the highest standards for all Londoners, including privacy and cyber security. We are pleased to share with you this draft Charter. which is based on three key principles to guide discussions between makers and buyers when deploying of emerging technology in the city and provide a framework clear to Londoners on what our expectations are:

4. Establish common, open and trusted ways of working between innovators, public services and Londoners when trialing and deploying new technologies.

2. Respect equality, diversity and human rights and act lawfully in the design and use of emerging technology.

3. Collect, manage, use and share data legally, ethically and securely.[707]

The emergent technologies targeted include: Artificial intelligence and machine learning. This might include, when a computer is programmed to simulate human intelligence to make decisions, carry out tasks and learn from it.

Virtual Reality and Augmented Reality. When a computer makes you feel like you are somewhere else, or adding things to the real world.

Sensors. Such as energy, air quality, footfall or wildlife sensors to gain insights into the environment and city life.

5G networks. The next generation of mobile technology to speed up connectivity and link devices.

Internet of Things (or 'IoT'). Connects devices, sensors, street lights or machinery to the internet and uses software so that they can collect and transfer data.

Computers making decisions using algorithms. For example when a human asks a computer to make a decision based on instructions and data the human has provided.

707 https://www.london.gov.uk/publications/emerging-technology-charter-london

Smart mobility. Using technology to change how we travel, for example ride-sharing, car-sharing, responsive buses, e-bikes and e-scooters as well as the development of connected autonomous vehicles.[708]

The totality of London's vision and deployment suggests that we can think of it as the most prominent and advanced AEGIS in the world. It has implemented several critically democratic capabilities for citizens which support the optimism and enthusiasm of Smart City designers:

London has developed a free and open data-sharing platform allowing anyone to access data on the city (economy, transport, housing, environment). Launched in 2010, the London Datastore provides over 700 datasets to help understand London and develop solutions to the city's problems, whether for citizens, enterprises, researchers or developers. The main interface on the London Datastore website is the London Dashboard. Described as a window into London's public services, it displays data in the form of tiles depicting selected statistics marked with either an up or down arrow, coloured green or red to indicate whether a statistic is positive or negative.[709]

London among all Smart Cities worldwide has one of the most advanced integrations of IoT traffic sensors, software monitoring, mass transit, and touchless payments updating four times a second across the entire urban sprawl. As a result Transport for London (TfL) regularly wins awards and sees the lion's share of technical attention and emulation.

Using the real data traces provided by Transport for London (TfL),3 a prototype smart city platform deployed in the city of London, we analyzed the road traffic conditions of several junctions and defined four reference levels of road congestion based on the mean number of vehicles that, by considering a traffic light period, are

708 https://www.london.gov.uk/publications/emerging-technology-charter-london

709 Morozov, E. and Bria, F., 2018. Rethinking the smart city. *Democratizing Urban Technology. New York, NY: Rosa Luxemburg Foundation*, 2.

> on the crossing roads within a distance of about 500 m from the center of the intersection, i.e., on an area roughly equal to the coverage range of the LTE base station located in proximity of the center of the junction. The London traffic sensor network is composed of thousands of sensors, detecting presence in the intervals of 250 ms. By checking the time evolution of these sensors, and identifying the gaps between vehicles, we can estimate both the number of cars crossing an intersection in a given period and their average speed. This estimation is extremely simple, and can easily be automated.[710]

Likewise, there has been immense investment in London's entrepreneurial workforce both in developing their ideas for Smart Cities and their overall digital skills, mobility, and ability to scale as economic agents.

> A key moment in the production of discourses and visions of the smart city was the organisation of the state-led 2012–2013 FCD competition, mentioned above. This can be understood as a breakthrough event that placed smart-city strategies at the forefront of city council agendas. The competition was enabled by a £25.5 million fund administered by Future Cities Catapult, a London-based innovation accelerator funded by Innovate UK (a UK government-financed agency).[711]

The market focus of London has been acknowledged and lauded by its advocates and identified as its chief motivation by its critics. London's utopian and dystopian capabilities revolve around the co-opting and consolidation of private and commercial projects.

> London's foray into smart city innovation is explicitly linked to the opportunities and challenges facing the UK's capital as a global city: the smart city discourse deployed forms an integral part of the overarching narrative of London striving for continuous

710 Chiariotti, F., Condoluci, M., Mahmoodi, T. and Zanella, A., 2018. SymbioCity: Smart cities for smarter networks. *Transactions on Emerging Telecommunications Technologies*, *29*(1), p.e3206.

711 Caprotti, F. and Cowley, R., 2019. Varieties of smart urbanism in the UK: Discursive logics, the state and local urban context. *Transactions of the Institute of British Geographers*, *44*(3), pp.587-601.

growth and consolidating its position as a leading international city. The 'Smart London' initiative is primarily directed at forging a new collaborative and entrepreneurial mode of governance, in the service of sustaining economic growth to meet expected population growth. The Greater London Authority (GLA), and particularly the office of the Mayor of London, is positioned at the centre of a wide range of activities. It has co-opted a number of public and private actors, including leading researchers, tech companies, and larger utilities, mainly through the Smart London Board and individual project partnerships. In promoting a co-creative governance mode for smart city innovation, the GLA's role is more to 'steer' than to direct outcomes.[712]

The Good News: The London AEGIS Improving Lives

Every bit of research supports London's claim that their Smart City will "Establish common, open and trusted ways of working between innovators, public services and Londoners."[713] They have succeeded in delivering a package of material and economic support that transformed the economic circumstances of their citizens. In terms of mobility and freedom of movement, they have improved the cost, time spent, and ability of vehicle-less citizens to achieve significant social and financial goals without investment. Likewise, they have made the frictionless ingress of tourists and visitors a cornerstone of their infrastructure, allowing for massive revenue transfer to entrepreneurs, small and medium enterprises, and the overall economy.

No major research has been done on their ability to Respect equality, diversity and human rights and we cannot verify how the AEGIS performs its duties in this regard but we can make the safe assumption that the lack of documented human rights and diversity related lawsuits and scandals means that for the most part, the AmI's in no way worsened the existing social infrastructure.

712 Cowley, R., Joss, S. and Dayot, Y., 2018. The smart city and its publics: insights from across six UK cities. *Urban Research & Practice*, *11*(1), pp.53-77.

713 https://www.london.gov.uk/publications/emerging-technology-charter-london

We can see in Transport for London the convergence of all its focus technologies with extensive investment in every aspect of making the AEGIS not just a success in relation to TfL, but mobilising its citizens to become fully engage din the wider process of living in a fully connected, highly emergent urban environment.

Artificial intelligence and machine learning.

TfL was one of the first transport authorities to introduce smart ticketing – with the Oyster card – and later contactless payments. Their algorithms automatically manage the distance between tube trains, and the timings of all the stoplights in London to manage traffic generally and bus timings specifically. The next generation of technologies are emerging along with their regulatory challenges for TfL, from autonomous vehicles and dynamic bus routes to using data partnerships with the private sector to manage crowding on the street, buses, and trains and power new algorithms with artificial intelligence.[714]

TfL's website serves over 3 million page views to between 600,000 and 700,000 visitors a day, with 54% of visits coming from mobile devices. TfL has been able to scale interactive services to this level (its previous site was static), by leveraging AWS services as an elastic buffer between its back-office services and the 76% of London's 8.4 million population that uses the site regularly to plan their journeys. Some 6,000 developers are now engaged in digital projects using TfL's anonymised open data, spawning 360 mobile apps to date. The exposure that this transport data now enjoys has required TfL's various teams to take responsibility for raising its quality and format consistency – benefitting both internal and external data consumers alike. Tools and suppliers used:Amazon Web Services – including Amazon Elastic Cloud (EC2), Amazon Simple Storage (S3), Amazon Route 53, Amazon Simple Queue

714 https://smartlondon.medium.com/listening-exercise-launch-for-a-smarter-london-together-the-new-smart-london-plan-at-transport-80242044800c

Service (SQS), Amazon Relational Database Service (RDS), Amazon Simple Notification Service (SNS), and Amazon Glacier.[715]

Transport for London (TfL) is sounding out the market to establish how it can use data and artificial intelligence (AI) to tackle some of the challenges in the capital's road network. The idea is to add predictive capability to the organisation's Surface Intelligent Transport System (SITS) to enhance response to incidents such as roadworks, congestion and other unplanned events. The enhanced system would be able to accurately forecast the state of the road network after an incident and generate suggested response strategies, while modelling these strategies on the road network to create an effectiveness-based ranking.[716]

Virtual Reality and Augmented Reality.

The launch of MapWay AR: Something very exciting has arrived for London bus users and it will change the way we navigate forever. Augmented Reality hit the headlines recently, thanks to the launch of iOS 11 and Apple's ARKit. While many apps use AR in games and for entertainment purposes, we want to create an innovative new use for Augmented Reality. We've developed something truly special for our Bus Times London app that will change the way we travel. Maps can be confusing and sometimes it can take a few seconds to work out which way you're facing or what side of the street you're on. If you're not great with maps and struggle with your sense of direction, it's easy to end up turning left instead of right before you realise you've made a mistake. So is there a way to make navigation simpler?

The launch of Apple's AR Kit for iOS 11 gave us the perfect platform to solve this problem in a unique way. The brand new Augmented Reality feature in Bus Times London shows you how to get to your bus stop without maps or guesswork.[717]

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715 MWD White Paper, Transport for London creates an open data ecosystem with Amazon Web Services, 2015

716 https://www.computerweekly.com/news/252472302/TfL-to-use-artificial-intelligence-to-run-Londons-road-network

717 https://www.mapway.com/augmented-reality-new-bus-times-london/

Sensors.

Vehicles with increasing levels of automation will use information from on-board sensors and systems to understand their global position and local environment. This enables them to operate with little or no human input (be driverless) for some, or all, of the journey.[718]

German vehicle telemetry specialist, Sensor-Technik Wiedemann (STW), is implementing Software AG's Cumulocity Internet of Things platform (IoT), for remote condition monitoring of exhaust gas treatment systems, retrofitted to London buses. It is part as part of the Greater London Authority's plans to create an Ultra Low Emission Zone (ULEZ). The high-efficiency emissions systems are being provided for the Transport for London (TfL) buses by HJS Emission Technology, coupled with its UK partner, Emission Engineering (EEL).[719]

5G networks.

A consortium led by TRL won £13.4m in Connected and Autonomous Vehicle (CAV) funding for a Smart Mobility Living Lab to test the technology and 5G connectivity infrastructure in the Park and Greenwich over the years ahead. This sits at the heart of a growing cluster of clean technology and mobility innovators centred around the Park. These and other projects, from planning engagement tools to demonstrating drone technologies, support new resource-efficient, low-carbon, connected and future-ready places.[720] The consortium comprises world leading expertise from across the transport and technology sectors including TRL, DG Cities, Cisco, Costain, Cubic, Loughborough University, Transport for London and the London Legacy Development Corporation. Delivery partners include Millbrook Proving Ground and the University of Surrey's 5G Innovation Centre. The ambitious project will see the creation of a Smart Mobility Living Lab (SMLL) in London, based in the Royal

718 Smarter London Together The Mayor's roadmap to transform London into the smartest city in the world, Greater London Authority June 2018

719 https://www.smartcitiesworld.net/news/news/remote-monitoring-for-tfl-buses-2838

720 Smarter London Together The Mayor's roadmap to transform London into the smartest city in the world, Greater London Authority June 2018

Borough of Greenwich and nearby Queen Elizabeth Olympic Park in Stratford. The Smart Mobility Living Lab: London will provide a real-world urban test bed in a complex public environment, capable of demonstrating and evaluating the use, performance and benefits of CAV technology and mobility services in an accessible and globally recognisable context.[721]

[Ericssson 5G implementation] This has been a focused piece of work to optimise our investment in 5G for the best user experience for our customers. We are the only operator to exclusively deploy 5G using 64x64 MaMIMO, and using Ericsson technology and our network, we have delivered a strong, solid and reliable 5G service.[722]

Internet of Things (or 'IoT').

TfL regularly hosts Hackathons with cloyd data: 120 billion IoT Events In this UTC dataset, London is divided into 5 zones (NORTH, SOUTH, CENTER, OUTER and EAST). All the files were stored as zipped CSVs on Google Cloud Storage (GCS), a total of about*5TB*, every file containing 5 minutes of data per zone. Every line in the file contained a timestamp (measurements are taken every quarter of a second), a certain amount of sensors (up to 8) specified with a sensor ID , a bitstring etc. The part we are interested in, is the bitstring. This represents the presence or absence of a car; for example: for timestamp 26–10–2016 16:38:02 and bitstring "0010" this would mean a car was present on top of the sensor at 16:38:02.500 today and no car was present on top of the sensor for the timestamps 16:38:02.000, 16:38:02.250 and 16:38:02.750.[723]

Computers making decisions using algorithms.

As part of the SITS programme, TfL awarded a contract to outsourcer Sopra Steria for the delivery of a single control centre system. Also as part of the programme, TfL

721 https://www.queenelizabetholympicpark.co.uk/news/news-articles/2017/10/government-announces-funding-for-a-world-leading-smart-mobility-living-lab
722 https://www.ericsson.com/en/blog/3/2020/9/how-we-built-the-best-5g-network-in-london
723 https://datatonic.com/insights/traffic-optimisation-tfl/

signed a contract with Siemens Mobility in 2018 to upgrade the current traffic light control system. With a view of tackling congestion caused by roadworks, TfL led an initiative in summer 2019, called London RoadLab. In the project, TfL worked with innovation centre Plexal and utility companies such as Thames Water to select pitches submitted by companies aimed at solving some of the biggest road congestion issues seen in London in 2018.[724]

The Challenge: Designed to gather data from all over London, TFL's Urban Traffic Control (UTC) system collects car activity records via 14,000 individual road sensors located throughout the city. We were given 3-months worth of these records to create our traffic prediction model — totalling over 120 billion data points. The Solution: We began by building a live visualisation of driver activity in the city, converting TfL's raw sensor data into common traffic engineering metrics — occupancy and flow, and using them to infer the volume, frequency, and location of traffic throughout the city, at any given time. Next, we designed a deep learning model capable of accurately predicting traffic conditions 40 minutes into the future. We did this by identifying the traffic conditions associated with congestion and using machine learning to understand and identify patterns in the vast dataset. In the end, we built a robust model to predict road congestion independent of road network layout, enabling proactive identification (and potentially prevention) of congestion, quickly respond to road incidents, and better coordinate the flow of rush-hour traffic on a daily basis — with the potential of saving countless travel hours for drivers all over London![725]

TfL – The foundations of the AEGIS

TfL has so completely immersed itself in every major aspect of an AEGIS, that it can be considered a shared world connected to multiple clouds (GCC, AWS), IoT, 4G & 5G, the City Internet and the Web, and thus to every major GIS within London. It represents the best one can expect from Smart X design and implementation, Despite multi-tiered

724 https://www.computerweekly.com/news/252472302/TfL-to-use-artificial-intelligence-to-run-Londons-road-network

725 https://datatonic.com/case-studies/traffic-prediction-tfl/

platforms from heterogeneous legacy systems, TfL has found a way to integrate dozens of AI software systems into one SDN managed command and control plane. It has found a way to conquer TBs worth of daily data sent in raw state forming the nucleus of both linear and non-linear dynamic chaos – weather, traffic, train, and human systems integrated and interpenetrated.

The Bad News: The London AEGIS Trades People for Revenue

Given what we have seen with Tfl it would be easy to assume that London's aggressive stance regarding Smart Cities and its focus on economic empowerment, decreased regulation and red tape, funding start-up entrepreneurs, and working to be the hub of AI research and innovation succeeded in creating a well run, well managed AEGIS. What research into London as the world's most connected Smart City found: "Smart cities reinforce digital divides, inequality, and power asymmetries by catering to political elites, prioritizing vested interests, and deepening existing socioeconomic divisions."[726]

London's focus on markets and market innovation has led them down a lucrative path but not an entirely ethical or socially supportive one. They have swapped epistemic control through algorithmic violence and curated knowledge for economic gain.

> The pre-eminence of the market rationale manifests itself in two ways: first, repeated mention is made of the smart city's sizeable market potential: e.g., "Arup estimates that the global market for smart urban systems for transport, energy, healthcare, water, and waste will amount to around $400 Billion p.a. by 2020"; and "the [smart water] market will be in excess of $22.2 billion by 2020, four times greater than its present value". In other words, the smart city is there for the taking by business vying for a share in this eagerly anticipated growth sector. Second, more profoundly, the smart city is presented as a platform for economic renewal through cutting-edge

726 Reuter, T.K., 2020. Smart City Visions and Human Rights: Do They Go Together?.

innovation; e.g., "these markets also need the right conditions to emerge: a new innovation and entrepreneurial ecosystem where stakeholders interact effectively and where new business models and ways of working can be created so that new technologies can be adapted".[727]

How motivated has London been to seek innovation and through innovation creative destruction and social dislocation? Research in favour and against it agree that careers in AmI and ICT have been exponentially grown since London became the #1 Smart City and worked to hold the title. Job creators, tech hubs, innovation centres, and start-up venture capital have flocked to the City:

London is the technological capital of Europe in terms of size and level of investment. Today, there are more than 47,000 technology companies in London, employing around 240,000 people. The number of high-tech companies is projected to increase by three times and another 44,500 jobs will be created by 2026. London is a global hub for CleanTech, GovTech, Digital Health, EdTech. The city is also the European capital of Artificial Intelligence, and has a leading position in the world, unique research and development (R&D) advantages. The London-based Datastore is an internationally recognized open resource with over 700 datasets to help solve urban problems and improve public services . Technologies that are in full control of the transportation sector from controlling the movement of trains to designing future streets using virtual reality. Recently the city's government has increased access for residents to a program that enhances the training of digital professionals with new industry courses for 16-24 year olds to provide young people with job-seeking skills. Conclusion. Thus, based on the analysis, the key factor in maintaining London's competitiveness is the innovation process. Smart cities foster innovation and help improve the urban economy, mobility, the environment, quality of life and urban governance. Smart City's innovative infrastructure will also help improve decision-making through

727 Joss, S., Sengers, F., Schraven, D., Caprotti, F. and Dayot, Y., 2019. The smart city as global discourse: Storylines and critical junctures across 27 cities. *Journal of urban technology*, *26*(1), pp.3-34.

> strong interaction and fast data sharing. The innovative indicators have a profound impact on the London economy.[728]

London's decision to seek economic gain at the cost of enduring structural violence has resulted in a Gramscian evolution of the discursive superstructure and affirmed Foucault's notion of a discourse driving epistemic inequality as the norm.

> Disconnection gives vision to the City of London as an insulated social arena that, despite creating vast wealth and being the vanguard of the UK's aspirational future, has made objects out of [citizens like] you and me. Building on Foucault's teachings on finance and the ideological force of market competition...[we can see what] separates the City from the rest of London and the UK; the ontological disconnection that erects a demarcated boundary of expected outcomes, aspirations and practices; and the social disconnection experienced by finance workers who elevate themselves through a marker of perceived difference and ability.[729]

Systems Social Engineering London

Research into London as the world's top Smart City demonstrates the critical principles being outlined in this thesis: that we must be vigilant and hyper-aware when handling nay aspect of AEGIS. We can see that the London ICT team had neither the benefit of our technosociological understanding nor our system engineering insights into how to properly deploy a working AEGIS. Let us review what we know from the depth of facts delivered in the prior sections.

We know that the British aspired to become *The* City among Cities, the very best and most prominent example of Smart X technology globally. They have succeeded in gaining this notoriety and to their credit it has despite political and social setbacks

728 Haidaienko, S., 2019. Factors for the development of London Smart City. *Topical Issues of Humanities, Technical and Natural Sciences*, pp.139-142.

729 Simpson, Alex, Harm Production and the Moral Dislocation of Finance in the City of London: An Ethnography, 2021

advented by BREXIT created a stunning economic benefit. But little if any critical research has been done to examine who received this benefit nor what follow-on effects can be seen in the larger society. We can predict what will come next.

The British have traded expediency for control. By eschewing the sound systems engineering principles of extensive modelling and consolidated command and control, they have launched their Smart Cities systems as a kind of potpourri of software, clouds, legacy tech, and applications which are bolted on to the main systems with clever modifications and integrations. But they are working with massive data sets that do not sit on a master database. They have AWS and GCP as well as OCI driving their IaaS with both privatised and military legacy platforms integrated into a mixed and highly heterogeneous computing network that deploys multiple 5G networks, along with 4G, multi-vendor WiFi, and a mix of PaaS grabbed from local entrepreneurs, CSPs,Oracle and Microsoft, and their own governmental software programmers.[730]

Governmental functions like the Financial Conduct Authority dumped their legacy systems to go “all-in” on AWS, only to reverse their decision prior to BREXIT and add in-house Oracle Exadata Systems Database on-premise cloud machines and OCI interfaces, then turn about and during BREXIT muddied the waters again with legacy computing initiatives that were entirely home-grown.[731] Multiply that kind of convolution for the main military, governmental, and civil associations of London alone as seat of the government, seta of the region, economic capital of the UK and Europe, and the main Smart City for entrepreneurs as well as a major banking, venture capital, and star-up hub. They achieved non-linear dynamic chaos by design.

The systems designs promulgated by various Big Data and IoT delivery providers show every promise of being both advanced and AmI compatible, if not already linked to ambient capabilities. But they show zero evidence of higher systems modelling or

730 Private interviews with AWS Public Sector, OCI Public Sector, and AWS EU Funds teams.
731 Private interviews with Oracle UK Sales, OCI Public Sector, and AWS EU Funds teams.

HFGT; there's no mention in any London cloud documentation that SMBSE or any other systems engineering focus was even considered.[732][733]

Likewise, while both AWS and OCI have directly approached London City, the UK government, the various regional and local constabularies and civic management functions, the FCA, TfL, and the UK military proposing extensive micro-service SOA, as well as a master database consolidation either on OCI with legacy Oracle systems shunted to Exadatas in a UK military grade data centre or on AWS serverless database wit the same legacy back-ups managed by a third party like Accenture, they have been universally rebuffed. The reason: too much work, too much cost, no compelling reason to change a working system.[734][735]

Let us follow the technosociological implications: the city that emphasised economic gain and economic empowerment at all costs has in turn planned to minimise overall infrastructural costs by intentionally building a complex integrated network of heterogeneous ambient systems with no common GIS, no common database, no common SDN, no standard IoT or security protocols, no guaranteed funding to any given business unit, and no clear entity managing the sum total of the AEGIS's many interpenetrated systems. They did this by design to minimise costs, increase cross departmental competition, and to ensure no one group achieved political or social hegemony within the London ICT community. They either had no regard for the long term social dislocation involved or they intentionally built the system to enhance the chaos and disruption such a complex system would bring about for London.

We are faced with the ugly fact that that London Cloud initiative and Smart City teams have thrown their citizens to the wolves either by studied disregard or active participation in a wider scheme to achieve hegemony for a yet to be identified group of

732 Cadwalladr, C., 2017. The great British Brexit robbery: how our democracy was hijacked. *The Guardian*, 7.

733 Haidaienko, S., 2019. Factors for the development of London Smart City. *Topical Issues of Humanities, Technical and Natural Sciences*, pp.139-142.

734 Private interviews with AWS Public Sector, OCI Public Sector, and AWS EU Funds teams.

735 Private interviews with Oracle UK Sales, OCI Public Sector, and AWS EU Funds teams.

third parties. Or if we are highly charitable that the decision makers have been utterly deceived by their advisors and have been manoeuvred into making poor choices for London on the basis of geopolitical ideology which has compromised the long term free will of their urban population. Regardless we have an end state where AmI has not only an open field to start emergent propagation, it has in addition, every incentive to modify Londoners to suit its many and varied needs – many conflicting at lower tiers.

The title of this chapter Systems Social Engineering properly describes this behaviour. A portmanteau of Systems Engineering and Social Engineering, it encapsulates the protracted intentional use of social engineering techniques to bring about a systemic change as well as the extensive use of systems engineering methods and tools to achieve long term highly diffuse social control.

> Social engineering is the art of getting users to compromise information systems. Instead of technical attacks on systems, social engineers target humans with access to information, manipulating them into divulging confidential information or even into carrying out their malicious attacks through influence and persuasion. Technical protection measures are usually ineffective against this kind of attack. In addition to that, people generally believe that they are good at detecting such attacks. Research, however, indicates that people perform poorly on detecting lies and deception.[736]

We can then define Systems Social Engineering as the art of creating systems to compromise information systems users. Instead of technical attacks on systems, systems social engineers target humans connected to the system, structurally and systemically manipulating them through epistemic control of the system itself. An AEGIS represents the plum system to hack and, with its residents the most comprehensively immersed in AmI, the most valuable long term to the extensive and structural control mechanisms deployed.

736 Krombholz, K., Hobel, H., Huber, M. and Weippl, E., 2015. Advanced social engineering attacks. *Journal of Information Security and applications*, 22, pp.113-122.

How would this work exactly? We have seen the basics laid out in prior sections and chapters: black box emergent algorithms, ICT addiction, and epistemic violence immured within the ecumene. Let us now explore how emergence, addiction, and epistemic violence manifest in a real-life system whose systems we have examined and whose systems engineering we have reviewed (or in the case of London – witnessed as no master plan seems to exist).

Let us begin with addiction – something easy to track. As it turns out there's prevalent addiction in London smartphone users. Given the prolific nature of the studies, it has to be clear to the London city managers as well as public health stakeholders that roughly 20% of London teens and almost 40% of college age residents have open ICT addiction. At that rate, the conceivable adult rates would be up to 60% and likely over 50% – as in the majority of residents are not just heavy smartphone users but actual tech addicts. "In London teens, smartphone usage breaks down as "65.3% are habitual users , 10.5% are at risk of addiction, and 10% are defined as fully addicted."[737] By college age, that statistic jumps to "39% young adults reported smartphone addiction. Smartphone addiction was associated with poor sleep, independent of duration of usage, indicating that length of time should not be used as a proxy for harmful usage."[738]

We now turn to the dual issues of emergent algorithms and epistemic violence. What proof exists that the London Smart City team and its various advisors knew they had created a harmful system? There are a few precedents, among them the work on robots and AI which shows a significant ethical gap. Note this was published in 2016, meaning the nature fo the problem had been seen and anticipated for many years beforehand.

> Work by the British Standards Institution Technical Subcommittee on Robots and Robotic Devices led to publication—in April 2016—of BS8611: Guide to the ethical

737 Lopez-Fernandez, O., Honrubia-Serrano, L., Freixa-Blanxart, M. and Gibson, W., 2014. Prevalence of problematic mobile phone use in British adolescents. *CyberPsychology, Behavior, and social networking*, *17*(2), pp.91-98

738 Sohn, S.Y., Krasnoff, L., Rees, P., Kalk, N.J. and Carter, B., 2021. The association between smartphone addiction and sleep: a UK cross-sectional study of young adults. *Frontiers in psychiatry*, *12*.

> design and application of robots and robotic systems. BS 8611 incorporates the EPSRC Principles of Robotics; it is not a code of practice, but instead gives' guidance on the identification of potential ethical harms and provides guidelines on safe design, protective measures and information for the design and application of robots'. BS 8611 articulates a broad range of ethical hazards and their mitigation, including societal, application, commercial/financial and environment risks, and provides designers with guidance on how to assess and then reduce the risks associated with these ethical hazards. The societal hazards include, for example, loss of trust, deception, privacy and confidentiality, addiction and unemployment. … while there is no shortage of sound ethical principles in [British] robotics and AI, there is little evidence that those principles have yet translated into practice, i.e. effective and transparent ethical governance.[739]

Likewise, when the European Union began to find ways to curtail illegal as well as unethical uses of AI it faced steep opposition from the UK. As the known and dangerous issue of emergent black box systems reifying epistemic violence became a hot button issue for Europeans, British think tanks with London bases began to find ways to get around or subvert proposed legislation. The Alan Turing Institute, centred in London, turns out to be a primary driver of this thinking and a major stakeholder in the implementation of systems social engineering London.

The Oxford Internet Institute, University of Oxford, and The Alan Turing Institute, British Library, have proposed ways to circumvent EU General Data Protection Regulation (GDPR), specifically its regulations related to explaining black box algorithms on the basis that GDPR places too high a regulatory burden on the British public and offers too little benefit compared to the inherent value of black box AmI. Their research demonstrates that in most cases computer scientists cannot tell someone

739 Winfield, A.F. and Jirotka, M., 2018. Ethical governance is essential to building trust in robotics and artificial intelligence systems. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *376*(2133), p.20180085.

how a choice has been made by an ambient system, only provide ranges (counterfactuals) where a different decision would have been delivered:

> Counterfactuals represent an easy first step that balances transparency, explainability, and accountability with other interests such as minimising the regulatory burden on business interest or preserving the privacy of others, while potentially increasing public acceptance of automatic decisions. Rather than waiting years for jurisprudence to dissolve all these uncertainties, we propose to abandon the narrow definitions and conditions the GDPR imposes on automated decision-making, and offer counterfactuals as unconditional explanations at the request of affected individuals.[740]

As an example of what is being circumvented we can observe the kinds of anticipated problems the EU has legislated against with GDPR:

> If a credit institution, when making decisions concerning loaning, employs an automated system that analyzes a person's income, spending habits, saving habits, and previous loan repayment history, and compares that data to similar data from other customers of that institution, such conduct indeed falls within the scope of the GDPR. In fact, section (4) of the same article devotes specific attention to "profiling", a term which applies more precisely to the many real-life applications of AI technology.[741]

To make that even more clear: the The Alan Turing Institute has worked directly to block laws relating to AI abuses (after the British standards teams benefited them as a problem for the entirety of the European Union and world). What is at stake?

> When an AI-based system is in operation, it continuously makes use of all data that has been inserted and that it was, and is being, trained on, including that data that

740 Wachter, S., Mittelstadt, B. and Russell, C., 2017. Counterfactual explanations without opening the black box: Automated decisions and the GDPR. *Harv. JL & Tech.*, *31*, p.841.

741 Kesa, A. and Kerikmäe, T., 2020. Artificial Intelligence and the GDPR: Inevitable Nemeses?. *TalTech Journal of European Studies*, *10*(3), pp.67-90.

has been removed from the device the model is run on but that has already gone through the model. In the context of personal data protection, this creates a situation where personal data does not cease to be exploited by the operator of the model for financial gain. Referring once again to the GDPR, in recital (7) it is stated that "Natural persons should have control of their own personal data". This sentiment of control over ones' own data, coupled with the right to erasure and data portability, directs towards the identification of a quasi-property right over personal data without directly establishing an explicit property right.[742]

If we are looking for a smoking gun – then the evidence above strongly connects London's think tanks and system designers to a radicalised vision of AI where the use and misuse of personal data can be achieved if it delivers economic benefit. That almost perfectly describes epistemic violence delivered by black box AmI. What prompted this sea change in policy? BREXIT coupled with the increased economic advantages posed by AI handling gig workers and autonomous bureaucracy.

The majority of manufacturers expect Brexit to accelerate the use of artificial intelligence (AI) and automation technology – as a means of scaling up volume easily to meet demand from the Rest of the World territories. The technology is also expected to help drive down the cost of production to help compete on price globally, and to efficiently adapt and develop new products for new markets. More than half – 59 per cent – of UK manufacturers intend to invest in smart technology to support growth plans post-Brexit. This includes new smart technology to improve performance (such as AI, automation and robotics) and new software and connected app-based technologies for organisations to better utilise big data. This compares with 20 per cent investing in machinery and hardware, 18 per cent investing in research and development, and 17 per cent investing in sales and marketing.[743]

742 Kesa, A. and Kerikmäe, T., 2020. Artificial Intelligence and the GDPR: Inevitable Nemeses?. *TalTech Journal of European Studies*, *10*(3), pp.67-90.

743 Zhang, H., Saad, S. and Jon, M., 2018. Harnessing Brexit, Technology and Insight-British manufacturers; maintaining a competitive edge in an age of uncertainty & opportunity.

That sudden uptick in funding from 20% to 59% represents a massive investment strategy which has behind it the force of the British government and London itself. Consider which companies are held in part or whole by the UK government:

> Companies House • Green Investment Bank • Land Registry • Met Office • Ordnance Survey • Post Office Ltd • Royal Mail • UK Export Finance • Urenco • Channel 4 • National Nuclear Laboratories • Nuclear Decommissioning Authority • CDC • Eurostar • NATS • Royal Mint • UK Hydrographic Office • Nuclear Liabilities Fund • London and Continental Railway. In addition UK Financial Investments are responsible for the Government's shareholding in RBS and Lloyds Group.[744]

In addition London owns London Power and has ties to the London Port Authority, itself a trust port without requirements to provide audit data to the public."There is a common misconception that trust ports are owned by government, but this is incorrect. Although they aspire to be open and transparent organisations, as commercial organisations trust ports are not subject to the Freedom of Information Act (with some minor exceptions in Northern Ireland) and therefore they have no legal obligation to divulge information to the public."[745][746]

These entities collectively have a massive stake in both general economic growth and the creation, packaging, and movement of manufactured goods through London (which owns TfL as well). The combination of banks, power companies, small investment and VC houses, land managers, and rail owners suggests a comprehensive investment portfolio which would on and all production of resources. Including the merger of gig workers with general urban populations governed by AmI.

744 https://www.gov.uk/government/publications/companies-that-have-the-uk-taxpayer-as-a-shareholder
745https://www.britishports.org.uk/system/files/circulars/what_are_trust_ports_bpa_briefing_paper_jan_2021.pdf
746 http://www.pla.co.uk/About-Us/Organisation-Structure-The-Board

Automation and Artificial Intelligence (AI) – key drivers of the Gig Economy – are having a transformative effect on production and work organisation, and Gig Economy companies such as Uber are at the vanguard of developments here; for example, testing prototypes of driverless taxi cabs . Whilst this technology is still in its infancy, it is developing, and Deloitte estimate that by 2040, "up to 80% of passenger miles travelled in urban areas could be in shared autonomous vehicles". As such, AI has the potential to render many of today's jobs redundant, with some predicting that in 10 to 20 years, half of current jobs will be "threatened by algorithms" and that "40% of today's top 500 companies will have vanished in a decade". Similarly, Frey and Osborne, basing their article on John Maynard Keynes' famous prediction of "widespread technological unemployment", and citing [McKinsey Global Institute] suggested that algorithms "could substitute for approximately 140 million full-time knowledge workers world-wide"[747][748]

These facts were both known and calculated into the decision making which propelled London forward to invest in AI. But its own focus on AI and lack of interest in understanding how AI converts to AmI through black box algorithms means it stood unprepared when the emergent algorithms weaponised themselves when faced with the mandates of epistemic violence. Enter BREXIT.

The promoters of Britain's Legal and Economic Exit from the European Union (BREXIT) deployed weaponised algorithms to trigger Brexit which in turn allows for unlimited use and expansion of weaponised algorithms. "The foundations of an authoritarian surveillance state are being laid in the US. How British democracy was subverted through a covert, far-reaching plan of coordination enabled by a US billionaire. And how we are in the midst of a massive land grab for power by billionaires

747 de Ruyter, A., 2018. The Gig Economy, Automation and Industrial Democracy: Just a Brexit Footnote or is Brexit the Footnote?.

748 DaSilva, C.M., Trkman, P., Desouza, K. and Lindič, J., 2013. Disruptive technologies: a business model perspective on cloud computing. *Technology Analysis & Strategic Management*, *25*(10), pp.1161-1173.

via our data. Data which is being silently amassed, harvested and stored. Whoever owns this data owns the future. "[749]

Who managed this? SCL Group, a British company with 25 years experience in military "psychological operations" and "election management" which converted a portion of its team to form Cambridge Analytica Data analytics in 2014 (CA). Robert Mercer owned 90%. SCL owned the other 10%. But Robert Mercer also owned a large portion of SCL, essentially creating a series of shell companies which formed a singular unit of SCL / CA. This entity carried out major digital targeting campaigns for Donald Trump campaign, Ted Cruz's nomination campaign and multiple other US Republican campaigns. They also provided Nigel Farage's Leave.EU extensive algorithmic support during the BREXIT referendum, refining the weaponised systems for use in the US elections.[750]

The harvest data in question came to the SCL/CA team through a complex route of scams, stolen data, misused AI, and social engineering applied at a systemic scale. That London's main product will be AI and that Cambridge Analytica's product derived from the collaborative invention of social engineering AIs from the US and Britain, it seems obvious they operated with reckless disregard for the reality in which AmIs emerge at the least and intentionally fostered this environment to build the next CA at the worst.[751] It doesn't help the case that SCL/CA arose in London and headquartered there until its dissolution.[752]

High Level Machine Intelligence (HLMI) systems aided by: Deep Learning, Big Data Analytics, Machine Learning and Artificial Intelligent systems, , often rooted in statistical techniques which makes it possible for experts to discover and to analyse specific patterns in the culture and behaviour of electorates, long before the day of

749 Cadwalladr, C., 2017. The great British Brexit robbery: how our democracy was hijacked. *The Guardian*, *7*.

750 Cadwalladr, C., 2017. The great British Brexit robbery: how our democracy was hijacked. *The Guardian*, *7*.

751 Berghel, H., 2018. Malice domestic: The Cambridge analytica dystopia. *Computer*, *51*(5), pp.84-89.

752 https://find-and-update.company-information.service.gov.uk/company/09375920

election. This they do with a view to first collect and process electorates' data for the purpose of understanding their preferences in advance and to know how best to get into their inner mind and conscience to influence them to do otherwise regarding the choice of candidates to vote for when and where the need arise. These studies revealed that modern AI approaches are now being recklessly deployed during election campaign periods in America.... agents that have excelled in the art of tactically collecting sensitive and private data which were later used in most cases, to manipulate the psyche of electorates via special ad campaigns include: Cambridge Analytica, Strategic Communication Laboratories (SCL) Group Limited and Global Science Research (GSR) Limited. [753]

Given that GSR formed into SCL as well means that the misuse of information for AmI – the essence of epistemic violence – had been mastered by the various team comprising the algorithmic deployment wing of the above companies. "The private data of individuals were [illegally] used for election profiteering purposes without due consent or authorization given by the owners of these data. The fact that the said data was also used against the individuals in question by [Leave campaigners], through the AI ad firm contracted for this purpose, in the opinion of most scholars is the most troubling of the issues."[754]

Now we have clear indication that the London AEGIS has been built without safeguards to achieve some purpose. Purportedly economics, it may also be the entry point for a would be hegemonic power to seize the resource and capabilities of the citizenry. In many cases the two aims are synonymous, representing a socio-economic convergence of aims which rest upon the technosocial control that systems social

753 Wogu, I.A.P., Misra, S., Udoh, O.D., Agoha, B.C., Sholarin, M.A. and Ahuja, R., 2020, March. Artificial Intelligence Politicking and Human Rights Violations in UK's Democracy: A Critical Appraisal of the Brexit Referendum. In *The International Conference on Recent Innovations in Computing* (pp. 615-626). Springer, Singapore.

754 Wogu, I.A.P., Misra, S., Udoh, O.D., Agoha, B.C., Sholarin, M.A. and Ahuja, R., 2020, March. Artificial Intelligence Politicking and Human Rights Violations in UK's Democracy: A Critical Appraisal of the Brexit Referendum. In *The International Conference on Recent Innovations in Computing* (pp. 615-626). Springer, Singapore.

engineering provides. "Digital networks may actually pose an existential threat to the very foundations of Western liberal democracies. Particularly in the wake of impactful events such as the Brexit vote in the UK and the 2016 U.S. presidential elections."[755]

What evidence to do have that the weaponised algorithms of entities like SCL/Ca have gained traction in various AEGISs globally. The computational Propaganda Project provided a massive trove of document and statistics which all but prove it: "a research project that began when Facebook, Instagram, Twitter, and Google provided a large pool of data on Russia's IRA to the U.S. Senate Select Committee on Intelligence, which turned it over for analysis to an Oxford Internet Institute's team." [756]

Who are the folks behind the IRA and how do they in any way pertain to the AI promotion agenda of London Smart City? They are a group of trolls and social engineers considered "highly effective in amplifying other social media." Which means they have a finesse with GISs that allows them to set dominoes in motion which trigger larger or more socially dangerous activities.[757] They are systems social engineering(SSE) personified.

> The Russian-government-affiliated Internet Research Agency's (IRA) was central in a Russian effort to sow discord among the US electorate, largely through social media, during and after the 2016 Presidential election. IRA trolls engaged extensively with external, non-troll accounts on Twitter from 2015 through 2017, by replying to and retweeting those outsiders. This activity is an example of what we call *networked output*, defined as an action that includes making a connection to some other user.[758]

755 Dwonch, A., 2020. Philip N. Howard, Lie Machines, How to Save Democracy from Troll Armies, Deceitful Robots, Junk News Operations, and Political Operatives. *International Journal of Communication*, *14*, p.3.
756 Dwonch, A., 2020. Philip N. Howard, Lie Machines, How to Save Democracy from Troll Armies, Deceitful Robots, Junk News Operations, and Political Operatives. *International Journal of Communication*, *14*, p.3.
757 Linvill, D.L. and Warren, P.L., 2020. Engaging with others: How the IRA coordinated information operation made friends. *Harvard Kennedy School Misinformation Review*, *1*(2).
758 Linvill, D.L. and Warren, P.L., 2020. Engaging with others: How the IRA coordinated information operation made friends. *Harvard Kennedy School Misinformation Review*, *1*(2).

That alone would be of no major interest to us except that it provides a clear defined understanding of two ruthless but independent SSE firms which use the worst elements of ambient interactions to hack people and achieve geopolitical aims. Except they are in fact linked. Which raises a whole new set of questions about London's avowed AI policy in the wake of both BREXIT and the CA / IRA scandal. Chief among them, why have they not instituted safeguards for their own Smart City?

Russia through profiling by the firm Cambridge Analytica and use of internet troll farms spearheaded by the Internet Research Agency (IRA) was able to mount a coordinated and wide ranging assault on the USA elections. The influence operations were carried out by hacking of the Democratic Party's server and posting the thousands of stolen emails on Wikileaks website, attack on voter databases to discredit Clinton and the Democratic Party, targeted fake messages through fake social media accounts aimed at conservative and far-right groups with messages on gun control, immigration, anti-Islam, race aimed at stoking discord and tension. Social media messages aimed at discouraging African American‟s from voting and shaking their confidence in the electoral system was also another tool deployed by the Russians .[759]

Bottom line – London city ICT managers know how pervasive and dangerous the CA systems are and how much they can compromise individuals as well as elections. But they not only continue to promote AI development, they do so with increased enthusiasm and less oversight post-BREXIT.

While use of profiling and data to influence politics is nothing new, Cambridge Analytica's actions are novel in several ways. The data on which their operation was built was massive and obtained in intrusive ways (including by gaining access via friends' permissions in Facebook). In addition, the data was collected under the imprimatur of a prestigious academic institution (Cambridge University). Finally, the

759 Ozden, K. and Tanko, A.R., From Cambridge Analytica to „O To Ge‟(Enough is Enough): The Dynamics of Political Canvassing and Elections in a Social Media Environment.

kinds of information pushed to users was difficult for other to see, as it was targeted on social media. This left fewer obvious trails as it was happening than, say, television or mail ads. In parallel with the Cambridge Analytica efforts was a Russia-sponsored disinformation campaign, also making use of social media and recommendation systems. This was carried out by an organization called the Internet Research Agency (IRA). … our focus here is on the nexus of intrusive data collection (itself possible based on Facebook's weak privacy protections and permissive terms of service (themselves difficult to comprehend and rarely read), and the imprimatur of Cambridge University), predictive analytics using that data to better target influence, and algorithmic systems that suggest advertising to clients and promote content to users. That is, our concern here is a socio-technical, big-data and algorithmically aided group of systems that affect the attitudes, beliefs, dispositions, and actions of people within democratic states.[760]

Let us not mince words – they not only cheated, they helped a foreign power instigate a functional coup d'etat on both British and American soil. But more than that, they openly and flagrantly broke the law. Not just with what amounts to espionage and treason – these might be fought in court as the unethical but legal mechanisms deployed by ruthless but sanctioned British mercenaries. No they stole data and then used that to provide open coercion, voter suppression, and election fraud. Sold to the highest bidder, who in this case happened to be the Russian government.

On coercion, a core psy-ops methodology (Target Audience Analysis) designed to covertly generate behaviour change in target populations was developed by the defence arm of SCL Group; and Target Audience Analysis was deployed by the political arm of SCL Group for digital political campaigning purposes. Cambridge Analytica's Chief Executive Officer, whistleblowers, and the psychology literature pronounce the efficacy of psychographic targeting when combined with big data

760 Rubel, A., Castro, C. and Pham, A., 2021. Democratic Obligations and Technological Threats to Legitimacy: PredPol, Cambridge Analytica, and Internet Research Agency.

analysis. Such behaviour change tools are coercive in intention: they aim to make people change their behaviour via covert psychological manipulation rather than through freely chosen, deliberated decisions. Furthermore, when Cambridge Analytica pitched for Leave.EU's business, part of that pitch offered voter suppression—a technique that it also employed in Trump's 2016 presidential campaign. Voter suppression is coercive in that it actively seeks to constrain people's choices in dampening their volition to vote. Finally, that voters were targeted both with deceptive Facebook posts propagating harsh anti-immigration messages and with in-person visits from Farage suggests that their digital filter bubbles and real-world experiences were manipulated to maximise their exposure to this particular information stream.[761]

We are seeing London's AEGIS create a start-up incubator for cyberwarfare firms. While they may label it AI, when they do so without structural safeguards, especially after seeing the astonishing perversion of AI in the name of election fraud, then their behaviour can be labelled as malignantly negligent or openly collaborative with the institution of weaponised AmI for the benefit not of their own Smart City citizens but the investors and users of those AI enterprises.

Many of the coercive effects of cyberwar would be secondary in nature. Meaning that the cyberattacks themselves do not directly cause the political outcome desired, rather they induce a secondary event that leads to the desired political outcome. This can be expressed into the equation that was introduced in relation to conventional war:

X > Y > Z > P

Where Y is directly caused by the cyberattack (X) and that results in Z (outcomes in a secondary sense). P would then be based on the size of Z.[762]

761 Bakir, V., 2020. Psychological operations in digital political campaigns: Assessing Cambridge Analytica's psychographic profiling and targeting. *Frontiers in Communication*, *5*, p.67.

Cyberattacks enable civilians to more easily be targets of military actions. Moreover, cyberattacks enable the wholescale ability to undermine fundamental principles of democracy and the infrastructure that enables democracy to function, broadening our understanding of what is targetable in war. Cyberattacks are capable of inflicting property damage and potentially through causal mechanisms that need to be researched further, injure humans. ...The ubiquity of digital devices in the lives of humanity now means cyberwar can affect non-combatants more than military targets, providing a major need to reassess the rules and norms of war in the digital age as seen in the Russian electoral cyberattacks and NotPetya attacks [because] Cyberspace allows for intangible things to become targets such as economies and forms of government.[763]

Let us return to economic basis of London's planning. They own banks and are supported by both revenue generated by the London Stock Exchange and their status as Europe's finance hub. London has overwhelming vested interests in affecting British financial policies and regulations. These being in turn managed by the FCA, an early adopted, re-adopter, and then un-adopter of ICT and AmI.

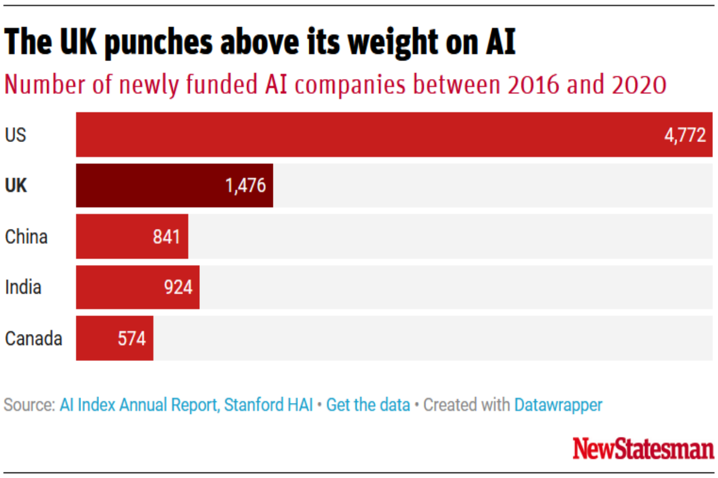
So it should not surprise us that BREXIT has changed how they operate nor that London city stands to benefit from this modification in geopolitcal stance. The UK's Financial Conduct Authority (FCA) leads on innovation and will have even more scope to do so outside the EU.[764]

"Post-Brexit, the FCA has the flexibility and the resources to tailor its regulation to specifically cater for the UK market," [FCA CEO] says, citing the difficulties of designing policy that works across all the EU member states. "Innovation flourishes more when innovators have a good framework to work off, as you only really push

762 Bell, N., 2021. *UPLOADING WAR: The Weaponisation of 0s and 1s and the Changing Nature of War* (Master's thesis).
763 Bell, N., 2021. *UPLOADING WAR: The Weaponisation of 0s and 1s and the Changing Nature of War* (Master's thesis).
764 https://www.newstatesman.com/business/sectors/2021/04/why-brexit-could-benefit-uks-tech-sector

the boundaries of what is out there in the market if there's boundaries in the first place." The UK is already developing an edge in some frontier technologies. A recent Treasury consultation into the regulation of crypto assets and "stablecoins" recommended that they be treated as e-money tokens, establishing a clear framework for users. In the EU, meanwhile, there is still a "vacuum" for guidance in this area, which has created a "difficult patchwork of local regulation."[765]

The FCA supports the promotion and expansion of the AI market and since London operates the largest by far in the UK, it stands to reason they benefit the most from the FCA's new open ended focus on helping innovators manage the financial complexity and regulatory burden associated with starting new companies as well as inventing new forms of Fintech. Such as stablecoins, themselves created from AI systems.



766

In turn London's own propaganda on AI assured the overall value in AI. Not a word about the engineering problems associated with black box algorithms. Not a sentence of explanation that these AIs will become emergent as they move towards real time ambient processing and in turn they can and will be used to harvest unlimited TBs of data. Data IDC forecasts to reach ZBs within the near future. Data which AmI systems will have access to in violation of GDPR. No notice that one of its main policy

765 https://www.newstatesman.com/business/sectors/2021/04/why-brexit-could-benefit-uks-tech-sector
766 https://www.newstatesman.com/business/sectors/2021/04/why-brexit-could-benefit-uks-tech-sector

stakeholders happens to be The Alan Turing Institute, the same institute which workarounds to GDPR achieved through BREXIT.[767] The same BREXIT which happened to limit criminal inquires into data theft, organised crime, and pan-European activity: "Countering professional criminal gangs and terrorism will always entail huge challenges. While UK police and intelligence services are second to none, their access to shared datasets containing critical real-time information has been severely restricted."[768] Consider London's confluence of SCL/CA with ties to Russian's IRA and The Alan Turing Institute, also London based. Then read the below regarding the concentration of AI companies homegrown in London.

> As the AI growth capital of Europe, London is well placed to maximise the substantial economic benefits of AI over the long term. With 758 companies, 645 of which have a London headquarters, London has an AI supplier base that is double the size of Paris and Berlin combined. London has stronger global positions in AI in its leading industries, especially finance, insurance, and law. The rate of new AI supplier formation in London is 42% per annum, significantly faster than the global rate of 24% per annum. [769]

BREXIT paved the way for an explosion in AI research and development around London. But the UK, in an effort to not lose all eocnomic ties with the EU, defended their right to manage data and receive some EU data by passing the UK-GDPR which resembles the EU version almost exactly. Like much of what we've seen before, it's in the minor distinctions which create the illusion of "exact sameness" that matter. Let us examine what changed:

> The most important differences between the EU GDPR and the UK GDPR are the following:

767 London: The AI Growth Capital of Europe, Cognition X, white paper for Mayor of London, 2018
768 https://www.digitalshadows.com/blog-and-research/brexit-2021-implications-for-the-security-landscape/
769 London: The AI Growth Capital of Europe, Cognition X, white paper for Mayor of London, 2018

- The definition of personal data is more limited in the UK GDPR than in the EU GDPR;
- The processing of criminal data, for which the UK GDPR does not require official authority, in contrary to the EU GDPR;
- The automated decision making is allowed under the UK GDPR subject to legitimate grounds, in contrary to the EU GDPR where data subjects have rights to refuse it;
- The data subject access rights can be waived under the UK GDPR if they significantly constrain an organization's legitimate need to process data for scientific, historical, statistical and archiving purposes, which is not the case under the EU GDPR[770]

In relation to AmIs appropriating personal data and using it to weaponise their algorithms, we must return to what EU-GDPR did for human rights and data. It strongly implied but did not directly legislate that private data was owned by the user and that any relevant AI would need to A) show its code and decision making and B) relinquish private data when requested or when the owner could not be adequately notified. Which together meant the end of black box misuse of private data.

The UK-GDPR expands what can be used as public data and limits private data, it allows for criminal data and criminal inquests which include third party private data, to be used publicly, it encourages the use of automated bureaucracy which also means AIs using data in the background past the initial endpoint touch, and it allows for privacy to be breached for any "legitimate" purpose of science, history, archiving, police activity, or similar governmental activity. On the surface minor changes but they collectively rode the principle set out by the EU that AIs cannot muck around with private data except in clear, defined, and limited circumstances. In this version there's enough leeway to allow for multiple touches along multiple endpoints and nodes with long and complex algorithmic use of private data – itself curtailed in scope and definition.

770 Guide to UK-GDPR, 02 August 2018 - 1.0.248 , UK Information Commissioners Office

The London AEGIS demonstrates how SSE works. If The Lord Mayor Sadiq Khan were approached by a horde of angry reporters throwing accusations of systemic violence, intentional theft of data, gross neglect, and sinister machinations to achieve global hegemony he'd either laugh r be aghast. We can take it as gospel truth that the Mayor and his team intended the very best for London when they launched their ambitious and thoughtful Smart City and London Cloud projects. But somewhere along the way, either in design phase or when the advisors turned to their technical teams, the decisions made ignored the salient truths about Smart X. Conspiracy, incompetence, wilful ignorance, or simply lack of understanding? We shall never know and to some degree it doesn't matter.

This remains a systems engineering problem backed by the technosociology. The AEGIS emerges from context in context and creates further emergent context. Failure to plan, to borrow the cliché, meant they planned a failure. The initial design phases either ignored SMBSE and HFGT of used too little of it to matter. The resulting implementations resulted in a terrain of haphazardly stood up ecosystems with pockets of different IaaS CSPs merged with legacy tech, multi-vendor 4G & 5G which required switches and hand off nodes, themselves clustering edge nodes and becoming small nexi of electrical, IoT, cameras and WiFI networking. Then the systems failed to be merged into a unified control plane or SDN. They function in parallel, using redundant handshakes across redundant networks which run on different systems. You can have Software A running on legacy tech and AWS with IoT from Omron and Ericsson 5G next to a 4G Novotel network being handled by GCP, Oracle software, local London AI entrepreneurs' proprietary Software B, and a small set of purpose built fog nodes tied to the city's Wi-Fi.

As a result, London has had to rely on more black box algorithms to achieve integration across different platforms, systems, subsystems, and legacy tech interpenetrated with Smart X, IoT biomes, and entirely functional worlds like TfL (itself a mishmash of systems). At every endpoint and node the data must flow to one of dozens of independent databases. There exists no master database for London and thus no way to ensure all data has been scrutinised, managed for UK-GDPR and secured correctly. We are witness non-linear dynamic chaos by design. Implementation done systemically – they intentionally built a system that limits geopolitical power games within London's various tech hubs and agencies. As a result they opened themselves to a novel form of attack: black box emergence.

As it stands, no one in the London government can be held responsible for what amounts to a system designed to be stolen from and used for weaponised psy-ops. By forcing the data of the city and its residents through so many funnels and nodes, it opens that data to being stolen, copied, snooped, or "sampled" by various ambient systems whose legitimate right to it exists under UK-GDPR. We have already seen that unscrupulous entities like the nexus of SCL/CA, the Turing Institute, and the IRA can twist good intentions and good works to something truly corrosive to human free will. The data must run across these systems – there exists no centralised way to sort it. It must flow in and out of multiple databases, be used over and again in queries, be stored in cookies for legitimate use in real-time by AmIs which cannot function in microseconds without storing the data in partial state on subsystems and nodes. Private data thus has been made structurally vulnerable as a direct result of the system engineering. Likewise, the ambient systems require access to that data to handshake with other ambient systems, often being forced to create emergent ways to store the data between AmI's and between AmI queries. We literally cannot see how that has been achieved nor track when and where that data goes missing (or where it has been stored).

A group of dedicated malicious agents like the IRA or SCL can do, however, can hunt down that data using their own black box algorithms which are built to find and retrieve data legitimately created in legitimately used networks. By virtue of the uneven systems design, the lack of in-built security, the limited use of microservice SOA, and the constant need to both integrate newly created emergent AIs and old legacy systems finally joined to the AEGIS, that legitimate data runs on too many open oaths without the possibility of real security. Military grade AI can and will exploit loopholes, especially if its allowed to become an emergent AmI, interacting directly with the invisible hands of the epistemic machine behind the AEGIS.

London shows how epistemic violence translates to structural exposure of private data. The combination of addiction, black box emergence, and epistemological injustice create a dangerous ecosystem of dependence, vulnerability, imbalance, misconduct, and victimisation. All of it delivered by the careful design which took many years, much funding, and a lot of political effort. Systematic and structural, Systems Social Engineering implements wholesale control as a system overlaid on people. Put bluntly, Bad SE = Good SSE.

As we began this section discussed five fundamental problems would-be systems engineering design teams faced: black box emergent algorithms, ICT addiction, epistemic violence immured within the ecumene, the intentional subversion of free will, and illusion that AmI increases human freedom while actively curtailing it through neurological rewiring, addiction, data curation, and behavioural conditioning. As we can see these also represent the fundamental elements of SSE and are present in the London AEGIS. We have verified our theories by referencing the most advanced AEGIS in the world.

Let us now examine a bit of good news. OR very bad news indeed, depending on how the next few decades if AI development proceed. Because we have yet to face the theoretical reality that the AEGIS itself has proto-intelligence.

The AEGIS as Emergent System

We have thus far dealt with the subsystems of the AEGIS, never the fundamental unit of the AEGIS as a thinking living entity. In part, this makes sense – we are focused on systems engineering not theology and the seta on sapient or sentient consciousness certainly rests with epistemologists and priests more than engineers. But when designing and deploying systems that have multiple overlapped emergent intelligences, we must at least try to consider what an AEGIS might perceive about itself as a whole ecosystem of ecosystems.

Some of the thinking has already been done – theorists in the engineering world have generalised the Gaia Hypothesis proposed by Lovelock in 1979 (The Earth is a functional sentience and a unified ecumene bounded by that sentience) to the world of Smart X. "From the perspective of Gaia, a sentient toaster oven would be just as much a part of the planetary system as a potato patch in Idaho or the Amazon river basin."[771] the implications of that are profound – we are now reaching a place in the ecology of objects and humans where ambient systems are as commonplace and as integrated into the environment as potatoes.

> According to Karl Popper's reality model of three inter-acting worlds: 1) world one, the physical world of objects and events, including biological entities; 2) world two, the mental world of individual and collective mental processes, including cognitive and intellectual functions; and 3) world three, the artificial world of knowledge and abstraction that emerge from and have an effect on world two through their representations in world one, we need a Generalized Gaia Hypothesis that extends the natural or physical Earth to include both mental Earth and artificial Earth, and a new thinking and a new theory of ecology for three earths or three worlds correspondingly. In AI or intelligent science technology, the concept of cyber–physical–social systems (CPSS) has been introduced to integrate three worlds

771 Dillard-Wright, D.B., 2019. Gaia theory and the Anthropocene: radical contingency in the posthuman future. *Sanglap: Journal of Literary and Cultural Inquiry*, *5*(2), pp.19-29.

> through the interaction of physical space and cyberspace [as the basic infrastructures for constructing intelligent systems, accordingly, a new theory of ecology, i.e., intelligent ecology or Karl Popper's ecology, could be developed by investigating CPSS-based interacting ecosystems and studying their corresponding ecological issues through virtual-real interaction.[772]

Does an ecosystem realise it is one and can it take action as a single entity? Gaia hypothesis suggests that not only does this prove true, it's the guiding principle behind non-linear dynamic chaos and much of what we think of advanced mathematics related to chaos theory in fact reflects the sentient activity of a unified world system. Therefore London as a unified and function AEGIS has some kind of proto-soul, a different intelligence than perhaps we conjecture as either human or alien, but capable of self regulation, reproduction, and defence of its self.

> We might even see this sentience as the birth of a shambling but increasingly integrated set of godheads, arising out of a hesitant litany of different interests which starts to coalesce – rather like the Emperor Augustus's reorganization of the small gods of Rome into a consolidated imperial religion which converted a local patchwork of spirits into a consolidated dynamo of gods and religious observances which both reflected and produced imperial power. These god-heads might be coincident with particular cities but equally they might arise out of coalitions based on mundane cross-urban and cross-national interests like various kinds of infrastructure, formulas and bureaucratic routines acting as generalized intervention machines... There is no reason to think that a growing urban sentience will necessarily deliver greater equality or comfort or freedom. It can rule over waste-lands as well as wealth, over shipwrecks of frivolity as well as carefully husbanded projects.[773]

772 Wang, F.Y. and Wang, Y., 2020. Parallel ecology for intelligent and smart cyber–physical–social systems. *IEEE Transactions on Computational Social Systems*, *7*(6), pp.1318-1323.

773 Thrift, N., 2014. The 'sentient' city and what it may portend. *Big Data & Society*, *1*(1), p.2053951714532241.

London's AEGIS intelligence might be termed Londinium, the old Roman name. A kind of heterogeneous mix of small godlike AmIs running biome and ecumenes within the AEGIS, speaking to the other gods of other systems through the GIS of Facebook, Instagram, the military internets, satfeeds, and such. “Giffinger et al. defined smart cities as “Modern cities based on search and intelligent solutions implemented in a forward-looking path for enhancing the quality of citizen's service”. Eger defined smart city as “a city which makes a sentient decision to prevail technology as a catalyst to solve its problems and achieve needs”.[774]

Does Londinium think? Certainly, but unlikely in ways we consider human. It instead has emergent capabilities that tailor AmI to better manage the problems arising from its multiple broken chains of PaaS and IaaS, merging software and systems never meant to be combined, and finding meaningful ways to utilise IoT across networks with competing protocols in real-time. In a sense, the very nature of London's poorly designed Smart infrastructure both engenders AmI and guarantees that its primary purpose will be to find new and better ways to integrate itself.

> The umbrella term self-awareness encloses a number of concepts such as self-adaptation, self-organization, self-healing, self-expression, and other self-* properties. Different authors endow these terms with different, only partially overlapping meanings, but probably most will agree that self-awareness in computing devices holds the promise that those devices exhibit more sensible behavior under novel conditions and adapt more gracefully to faults, failures, and changing environments. Ultimately, a self-aware system should fully understand its own situation and detect its own misbehavior or underperformance due to: – faults, that may be caused by aging, accidents, or a physical attack, – a malicious attack on its functions, or – functional design errors in its hardware or software.[775]

774 Abdel-Basset, M. and Mohamed, M., 2018. The role of single valued neutrosophic sets and rough sets in smart city: Imperfect and incomplete information systems. *Measurement*, *124*, pp.47-55.

775 Tammemäe, K., Jantsch, A., Kuusik, A., Preden, J.S. and Õunapuu, E., 2018. Self-aware fog computing in private and secure spheres. In *Fog Computing in the Internet of Things* (pp. 71-99). Springer, Cham.

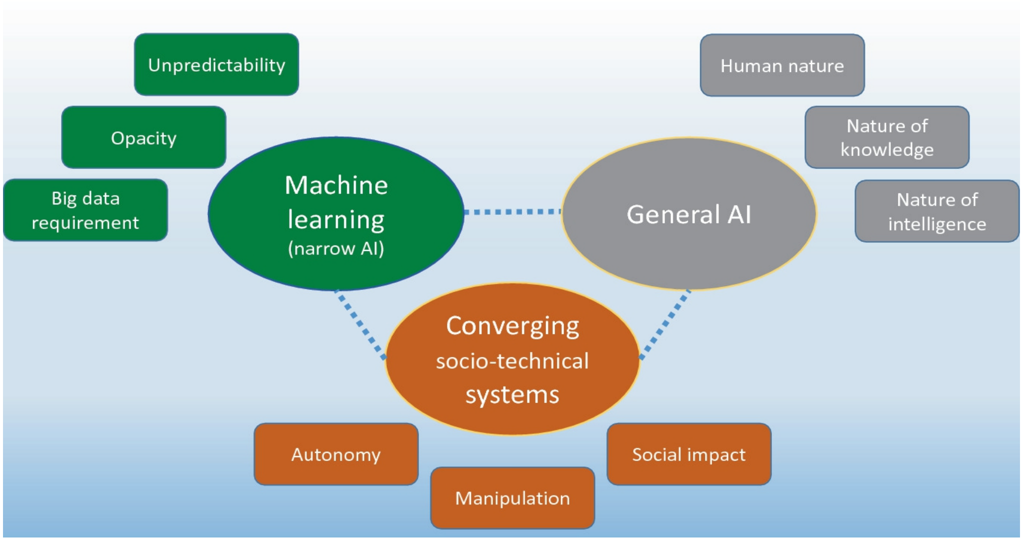
We can see that every AEGIS will be both self-aware and, according to the Generalised Gaia Hypothesis, sentient. But unlike the mode of attack pioneered by SCL and their ilk, the same ambient systems do not have world conquest or the robot apocalypse as a goal. Instead, the AEGIS need only simply and wait for its addicted consumers to add enough systems to its technosocial body to achieve widespread AmI. As GISs and urban sites increase in saturation and sophistication, the addiction levels promise to also rise. From 40% to 90% of adults are problematic users or open addicts of the Web, smartphone, and ambient systems. But these addictions come with a strange benefit – they deliver not just dependence but actual neuro-adaptation. The AEGIS modifies its users physically, creating new brain matter, new neural paths, new mental capabilities that essentially fold humanity into a cybernetic symbiosis with the AEGIS.

Just as Gaia does not differentiate between the potato, the Amazon river and the sentient toaster, the AEGIS does not not differentiate between its networks, its hardware and its biological components, i.e., human brains. We have built a system that rebuilds us. Because it has become self-aware and the AmIs now have within their algorithmic context the idea that human agents can be coded as misbehaviour to be corrected – either through adapting information, feeds, changing programming, or rewiring the human brain. As such, human agents are just one more piece of the AEGIS and one more emergent capability. Our own brain as an intelligence will undergo emergent changes – giving new answers to anticipated questions, both more and less than they were before.

The AEGIS as Emergent Social Reality

As we consider how emergent algorithms within the AEGIS modify us and how the overall sentient nature of the ecumene as a whole potentially shapes technological and physical reality for urban citizens, we must look at the construction of social reality as well. "Current social reality shows that the boundaries between humans and technology are shrinking to the point where socio-technical systems are becoming natural extensions of a human being."[776]

Technosocial manifestation of emergent systems will look differently than we have previously seen from both creative destruction and social upheaval related to technological innovations and paradigm shifts. In some ways we can expect a much smoother, incremental and relentless flow towards a new consensus reality: "Algorithms do not even have to work too much; social reality is simplified to the level of formal language. And that is the reason why algorithms can have such an effect. It is therefore better to not look for complexities in algorithms but rather at the simplicity of social reality. Our social reality is complex and diverse, but due to algorithms, it is no longer random. This is the world of computational hegemony."[777]



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Scholars have tried to categorise how the social world will bend when faced with the gravity of new algorithmic systems which can mimic and modify human consciousness.

776 Rezaev, A.V. and Ivanova, A.A., 2018. Studying Artificial Intelligence and Artificial Sociality in Natural Sciences, Engineering, and Social Sciences: Possibility and Reality. In *Proceedings of The 22nd World Multi-Conference on Systemics, Cybernetics, and Informatics (WMSCI 2018)* (pp. 68-71).
777 Rakowski, R., Polak, P. and Kowalikova, P., 2021. Ethical Aspects of the Impact of AI: the Status of Humans in the Era of Artificial Intelligence. *Society*, pp.1-8.
778 Stahl, B.C., 2021. Perspectives on Artificial Intelligence. In *Artificial Intelligence for a Better Future* (pp. 7-17). Springer, Cham.

Thus far, we have seen basic models created that attempt to validate and identify the consensus technosociological experience that most human agents plugged into an emergent system will perceive. Principle among the a priori considerations, there exists extensive agreement that sentient AI does not equal emotional AI, and while AmIs may emotionologically mimic human experience and feelings in real-time, they do not in fact have emotions. They are entirely rational systems built on logic trees and protocols.

> Social reality is polysemantic and implies a multiplicity of decisions and acts in which the very factualization of data, the attribution of a syntax to a given reality, is itself already filtered by creative and active imagination and an embodied perspective. We propose to call "crealectic" the existential form of consciousness that is aware of acting as an engaged person upon a world of multiplicity and possibility, with the ideal of co-creation in mind. Crealectic intelligence cannot be emulated by a non-biological AI because it is grounded in desire and felt sublimity.[779]

What can we expect of an emergent social system? Comfort and reliability. Consider what we know of ambient intelligence. For the most part, AmI has been designed to cater to needs and wants of its human agents; the black box algorithm exists to service those needs and expands into emergent territory as the needs expand and become both more intense and simultaneously more sophisticated in real-time.

The AEGIS merges whole spheres of interpenetrated IoT, computing, networking, and software to deliver this experience as if it was frictionless, immediate, and functionally human. While the system creates both addiction and dependency, it does so while also augmenting the human agent with new brain structures and helping them become more efficient in both the physical and cybernetic worlds that merge through the AEGIS. As the AmIs in the system interact, they operate on both the direct program and the implicit biases of their programmers, creating subtle changes to their own epistemic delivery through emergence. To what end? To better satisfy the wants and needs of the

779 de Miranda, L., 2020. Artificial intelligence and philosophical creativity: From analytics to crealectics. *Human Affairs*, *30*(4), pp.59

agent / users which also improve revenue streams, social order, and releiance of manufactured products created and promoted by the same companies that designed the main AEGIS systems. That dual set of masters, the individual and the economy, can best be seen in how the London AEGIS manifests. The outcome: a change in the social reality of the city that barely rises to the level of perception. The urban sphere merges with its datasphere and ambient technology but does so without being seen as especially technical. The average tourists or working Londoner simply uses the systems available – they exist in subconscious symbiosis with a wide range of emergent intelligences which guide, transform, and influence them physically and mentally.

> The AI devices connected through portals not only create communication along the line but also network patterns. The social network, as a type of artificial intelligence, communicates the social reality in the digital world. The intelligence of machines demonstrates the morphology of users. Therefore, AI as a unique communication system becomes a symbol of the social network society as in smart cars, surveillance, detecting fraud, fake news, customer service, video games, predictive purchasing, smart recommendation, smart homes, virtual assistants, preventing heart attack, identifying criminals, preserving wildlife, search and rescue, cyber security, work automation and maintenance prediction, hiring and firing and so on.[780]

Threats to the ecosystem – autocracies and oligarchies

We've been chasing the AEGIS shaped dragon of emergent black algorithms but keep in mind, these systems are built by people, run by people, used by people, and in the end, the algorithms reflect our deepest held social values. At present the existential threat we can see comes as much from smartphone addiction and black boxes re-wiring us as it does from bad actors like SCL and the IRA. But we should not be fooled. We know that truly dangerous discursive violence renders itself invisible and pervades our

780 Francis, D.P. and Dutt, M.N., An enquiry concerning artificial intelligence through social networks.

communal social ways of being. Consider that "there is no smart city in the world where E-Democracy is practised in its full potential in spite of the fact the driving force behind any smart city is the E-Democracy. Therefore, the underlying momentum of smart city functioning will be lost sooner unless E-Democracy is developed in a massive scale in Smart Cities."[781]

What we lack in electronic democracy and citizen led governance we make up for in global commercial monopolies, especially the tech giants Google, Amazon, Facebook, Apple and Microsoft (GAFAM):

> The digital economy is based on intangible products and services and operates on a global scale. Coyle says the digital economy is built on the value of data, network economies and the reproduction and expansion of new users at zero marginal cost. Barefoot et al define it in relation to the Internet and ICT, and identify its three areas: Infrastructure (network, devices, software, telecommunications, IoT and facilities); commercial transactions; and the digital media content (free and pay media, Big Data supported, etc.).The marginal zero cost of distribution, Big Data, e-commerce and the digital media enhance the logic of globalisation, which goes beyond the globalisation that characterised traditional media groups. In this global scenario, GAFAM occupy dominant positions, not only in their markets of reference, but in the whole of the sectors diluted in this digital economy. [782]

How dangerous are entities like GAFAM? They manage their own worlds and can implement nearly full AEGISs without recourse to outside providers. Each manages multiple vital GISs, they own pieces of the undersea cables and network infrastructure of the Web, and they wield enormous economic impact globally. Without Facebook the Cambridge Analytica scandal would have been an annoying and ugly footnote in

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781 Kumar, T.V., 2017. State of the art of e-democracy for Smart Cities. In *E-Democracy for Smart Cities* (pp. 1-47). Springer, Singapore.

782 de Bustos, J.M., 2019. Who will control the media? The impact of GAFAM on the media industries in the digital economy.

election history. With Facebook it changed two elections and ushered in globally weaker internet standards allowing for increased predatory AmI development.

Potentially unrestricted self-modification exposes the system to a number of risks, including the paradox of self-amendment, path dependency, and the iron law of oligarchy. These risks include the paradox of self-amendment, where the enactment of a rule contains clauses for its own amendment, to the extent that the rules are logically contradictory, in- consistent or incomplete; through path dependency, where a prior decision or series of decisions results in the transaction costs of change being greater than the benefits (to the current participants) of changing, so a supposedly mutable system simply stagnates ; and on to the iron law of oligarchy, which maintains that any conventional rule- based system, no matter how 'democratically' conceived and founded, will tend towards oligarchy as a subset of the participants manipulate the system in favour of their own narrow sectional interests (i.e. prioritising or promoting values which are not shared by the collective as a whole)[783]

By allowing GAFAM to dominate GIS development we face a bottleneck in AEGIS development and a serious epistemic threat – they can all but guarantee that every black box algorithm carries within it commercial programming that will be discursively violent, unjust, and socially dangerous.

Each one of the Internet giants creates its own ecosystem, so that, despite having a different origin, all of them create similar structures. Below we observe their main characteristics.

a) They compete in an ecosystemic way and not by product.

b) They are very centralised groups with a marked expansive growth.

783 Pitt, J., Ober, J. and Diaconescu, A., 2017, September. Knowledge management processes and design principles for self-governing socio-technical systems. In *2017 IEEE 2nd International Workshops on Foundations and Applications of Self* Systems (FAS* W)* (pp. 97-102). IEEE.

c) Leaders in stock market capitalisation

d) They depend on innovation. Unhealthy hunger for patents.

e) Internet of Things (IoT) and health as vectors of strategic growth

f) For Now, scarce control of telecommunication networks.

g) Big Data at the core of the DNA of GAFAM. [784]

These characteristics point to the GAFAM cluster as a SoSCPSs creators – do not be fooled by their titles and products. They are in the business of seizing networks, providing curated commercialised data streams, and then monetising the social media feedback those data streams generate. People are their products. In this aspect the AEGIS's worst aspects mirror their own aspirations and commercial interests. That they also have the material capability to build and deploy an AEGIS should come as no surprise.

> The presence of GAFAM in the media field hinders the development of traditional agents... However, the growth of GAFAM has no limits in any activities that generate large amounts of data. That is their real value. The collection of Big Data, the attraction of users to their ecosystems and the accumulation of platforms is what makes them the gatekeepers of the media system ... However, despite their hegemony, we must also consider the fact that GAFAM are subjected to a high fragility, as the results suggest. Their outstanding position in the stock market keeps them under constant scrutiny and may be affected by any business movement or decision. The demands are high and can only be met by those corporations that manage to maintain the self-imposed high levels of growth in the areas of innovation and leadership and overcome the problems of privacy and security that derive from their behaviour and threaten their hegemony. Indeed, even if they succeeded in

784 de Bustos, J.M., 2019. Who will control the media? The impact of GAFAM on the media industries in the digital economy.

resolving the important challenges posed to them, it is unlikely GAFAM will maintain their hegemonic position.[785]

Emergent Circumstances, Hegemony, and Human Free Will

Before we close the Systems Social Engineering section, let us consider what we have come to understand about how the AEGIS works and what it does to its systems and people. When simplified to the most essential definition, an AEGIS delivers ambient immersion at the price of human autonomy. But we have seen that technosociologically, every technology subverts our will to some degree, as do the perfectly non-technological human systems of social mores, government, and culture. We can take it as a given that humanity seeks to achieve hegemony. People want safety, security, and power and they are perfectly willing to subjugate others to achieve this.

This particular iteration of technosocial hegemonic pursuit changes the situation globally in two distinct and important fashions: first, we have within out power the mechanisms of absolute control over every aspect of human consciousness; second, we have lost the ability to control the system we built to enslave others. That systems now enslaves us even as we use it to establish social and economic power over its users. The existence of ubiquitous computing coupled with ceaseless and pervasive surveillance translates to a system that always watches, sees everything, and has the unlimited power to transfer out activities to algorithms which convert social reality to logic trees.[786]

The AEGIS when poorly designed and implemented allows the worst of humanity to jigger with social reality and transform the human agents attached to the urban space into highly satisfied drone units which slowly but assuredly perform economic duties aligned to the goals of the commercial enterprises which built the AmIs. It need not be

785 de Bustos, J.M., 2019. Who will control the media? The impact of GAFAM on the media industries in the digital economy.

786 Rakowski, R., Polak, P. and Kowalikova, P., 2021. Ethical Aspects of the Impact of AI: the Status of Humans in the Era of Artificial Intelligence. *Society*, pp.1-8.

this way. We have seen that careful modelling and planning tied to a cohesive and intelligent master command control system can mitigate much of the worst of our biases and structural violence while still providing the best of services and systems via AmI.

It all comes down to systems engineering. The problem may be technosociological in origin but all forms of solutions must be delivered by how the most complex of all systems will be produced, deployed, and managed. Here are the core recommendations for creating and maintaining a world class AEGIS which maximises human agency and free will.

1. Create a singular command and control entity at the governance level which combines responsibility, decision making, funding, audit, security, and accountability.

2. Plan extensively using SMBSE and Gemba Kaizen with strong reliance of HFGT and similar statistical systems. Model early, often, and thoroughly before approving funding.

3. Implement the AEGIS with as many unified and cross-compatible systems as possible. Set a clear IoT standard with uniform radio bandwidths, security protocols, audit mechanisms, and an abstracted SDN controlled by the governing entity rather than a commercial third party.

4. Implement GDPR and similar privacy protection regimes with both criminal and civic penalties for violations as well as the mandated costs to re-engineer any black box algorithm driven systems found to be in violation.

5. Choose a single database supplier and a single CSP which complies fully with your privacy regimes and can bring security hardened hardware and software to the AEGIS as well as helping protect the network at edge, fog, and core nodes.

6. Create a unified public ambient smart device application which provides free services as well as tax payer subsidised services (free to the user) pre-empting the implementation and distribution of disparate AmI commercial applications with biases, economic and political agenda,s and algorithmic violence.

7. Model all upgrades and technology refresh cycles well in advance with a clear understanding that it will be more profitable to have advanced unified IoT, IaaS, networking, and software provided by single vendors (despite monopoly lock-in) than handle runaway black box emergence.

8. Unify and monetise the centralised communal database as a social service. The AEGIS needs to take conscious pre-emptive control of private data to both keep it secure and find ways to generate profitability for citizens before entities like Facebook and SCL can exert their influence.

9. Plan for and model structural violence, smart device addiction, and criminal misuse of black box algorithms using HFGT and similar methodologies to establish security protocols, mitigation strategies, and communal systems of transparency and accountability for citizen led governance

10. Establish and generously fund the position of the Chief Systems Officer within the governance structure providing them with a Global Program Management Office, decisions making powers, and access to the primary stakeholders, the governance C-Suite, and citizen governance non governmental organisations.

Limiting Factors:

We should view all the research provided with a certain scepticism. Despite using the most up to date technological data available, there exists almost no awareness about the concept of an AEGIS and even within communities focused on AI, AmI, and similar SoSCPSs, there has been nothing like this thesis produced. As such, this work will be the first stepping stone of knowledge that over time will increase and promulgate. For now, however, the chief limiting factor to our understanding has been and will continue to be a lack of comprehensive data. The below excerpt represents the typical approach to Smart Cities and AmI.

> The global phenomena of growing urbanization and ICT technological advancements enable the digital transformation and renewal of cities embodied in the 'Smart Cities' concept. A myriad of conceptualized models and frameworks have been proposed by multiple stakeholders; however, an easily adaptable, widely applicable and robust smart city model is not yet available, which leaves space for yet untapped fields of research. This article attempts to explore the factors hindering SC developments for European medium-sized cities based on a sample of Hungarian medium-sized cities. The study utilizes Porter's Five Forces Framework from the field of strategic management, which is currently rather neglected in the discussion of 'Smart Cities'. Findings show that the main barriers are 'Knowledge gaps', 'Availability and Quality of Data', 'Vendor Lock-in', 'Biased Approaches' and the 'Lack of Standards'.[787]

Geographic considerations

We have said nothing of differences in cities, cultures, and social realities. We have acted as if every place from Mumbai to Shanghai to Paris, France to Paris, Texas are functionally the same. We know they are not but every theiss has limits and geography

787 CSUKÁS, M.S. and Szabó, R.Z., 2018. Factors Hindering Smart City Developments in Medium-Sized Cities. *Theory, Methodol., Pract*, *14*(1), pp.3-14.

falls outside the research scope. Do geographic differences matter? Hugely and in any number of critical matters related to technosociology. One SE technique, "smart specialization" gets us closer to the potential regionalisation of the AEGIS. But any and all AEGIS design will need to strongly consider the local and regional conditions available.

> The essence of the strategy of "smart specialization" is to use the strengths of the region, consisting in its geographical location, availability of unique competences and resources, identification of latent opportunities and creation of the basis for building its competitive advantage in the activities with high added value. It should be noted that "smart specialization" does not necessarily focus only on high- tech areas or on innovations with reliance on R&D, it rather implies the development of a unique specialization of the region. Unlike the strategy of catch-up development, based on copying the experience of strategic planning of leading regions, under the strategy of "smart specialization" regions choose for themselves a number of priority sectors, in which they can gain a sustainable competitive advantage through the development and implementation of innovations.[788]

Additionally, just as little research has been done on the the convergence of Smart X and ambient intelligence in urban centres, there has been a decided dearth of regional focus in studies. Outside the primary Smart City regions and their urban core we can expect the known data to be sparse and the need for research prior to AEGIS deployment significant.

> Geographically determined acceptance of Smart Technologies has been best captured using the USTAM model (Urban Service Technology Acceptance Model), [which] can be placed in four main categories: (1) technology superiority (comparative advantage, ease of use, and compatibility with other technologies); (2) individual efficacy (to

788 Shalyapina, M. and Serbulov, A., 2021. Possibilities of the cross-cluster model of the economy in the formation of the strategy of "smart specialization" exclave region. In *E3S Web of Conferences* (Vol. 291, p. 02009). EDP Sciences.

support increased ability to complete work); (3) increased efficiency (cost- reduction, energy saving and time saving), and (4) concern about low service quality (perceived reliability and security).[789]

Limits of control and causation in disruptive technologies

Even the most dedicated Foucauldian has to admit they cannot accurately predict how social disruption will manifest. We just don;t know how much effect innovation has on any society or culture. We know it messes up the social fabric, we even have some strong sense of the lines of fracture, the inherent structural violence, and the way biases work their way into social reality. But as emergent algorithms increase in complexity and begin to deviate from known practice, we have to consider that we shall know less and be able to predict with less validity what happens next.

The IT revolution will also accelerate the expansion of robotics' capabilities, which are on a clear path to pervasive autonomous systems. The machines are rapidly supplanting humans in ever more areas of employment. They are proving to be more productive, less expensive, and—in a growing number of areas—more capable than humans... What is evolving is a global brain, via the Web. When combined with manufacturing via on-site printing, this global brain is enabling a planet of inventors — both human and, increasingly, machine. The impacts are literally life changing and are occurring essentially simultaneously.[790]

More intriguing, we know social reality will actually be less visibly impacted as more AmIs come on line. Between our limited research on Smart X and AmI, our lack of regional data, and out increasing inability to model how social disparities translate into

789 Sepasgozar, S.M., Hawken, S., Sargolzaei, S. and Foroozanfa, M., 2019. Implementing citizen centric technology in developing smart cities: A model for predicting the acceptance of urban technologies. *Technological Forecasting and Social Change*, *142*, pp.105-116.

790 Bushnell, D.M., 2020. Disruptive Technologies and Their Putative Impacts Upon Society and Aerospace-Entering The Virtual Age.

algorithmic violence, we have to identify this as a major limiting factor to our conclusions.

> Disruptive technologies, a term coined by Professor Clayton Christensen and colleagues, are defined as a set of technologies that displaces the existing methods or technologies and shakes up the industry to open new avenues for innovation and business development. On the one hand, they are revolutionising the modern world; on the other, they present a challenge for traditional industries such as construction and real estate. While such digital technologies are vital for an industry’s growth, t heir adoption and usage are always questioned, perhaps due to their disruptive nature.[791]

Consider what we know about the most disruptive innovations: Big9 technologies. Essentially we know they will change society (and already have), we know they will crush economic ecosystems, and we can identify some of their obsolete competitors. But we don't truly know how they will interpenetrate. In part because the complexities of an AEGIS prevent such estimation without intimate knowledge of the SE involved; in part because it represents an event horizon beyond our statistical understanding. “They include big data, virtual and augmented realities (VR and AR), the internet of things (IoT), clouds, software as a service (SaaS), drones, 3D scanning, AI and wearable techs.”[792]

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791 Ullah, F., Sepasgozar, S.M. and Wang, C., 2018. A systematic review of smart real estate technology: Drivers of, and barriers to, the use of digital disruptive technologies and online platforms. *Sustainability*, *10*(9), p.3142.

792 Ullah, F., Sepasgozar, S.M. and Wang, C., 2018. A systematic review of smart real estate technology: Drivers of, and barriers to, the use of digital disruptive technologies and online platforms. *Sustainability*, *10*(9), p.3142.

Technology	Impact	
		Productivity
Mobile internet	$3.7 trillion – 10.8 trillion	10-20 % potential cost reduction in treatment of chronic diseases through remote health monitoring
Automation of knowledge work	$5.2 trillion – 6.7 trillion	Additional labour productivity could equal the output of 110 million – 140 million full-time workers
IoT	$2.7 trillion – 6.2 trillion	Potential to drive productivity across $36 trillion in operating costs of key affected industries: manufacturing, healthcare, and mining
Cloud	$1.7 trillion – 6.2 trillion	15-20 % potential productivity gains across IT infrastructure, application development, and package software
Advanced Robotics	$1.7 trillion – 4.5 trillion	Potential to improve the lives of 50 million amputees and those with impaired mobility
Autonomous and near-autonomous vehicles	$0.2 trillion – 1.9 trillion	Could save 30,000-150,000 lives from potentially fatal traffic accidents
Next generation genomics	$0.7 trillion – 1.6 trillion	Extending and enhancing lives accounts for 75 % of potential impact
Energy storage	≈$0.1 trillion – 0.6 trillion	40-100 % of vehicles could be electric or hybrid
3D printing	$0.2 trillion – 0.6 trillion	Consumer's use could save 35-60 % in costs per printed product, while enabling a high level of customization
Advanced materials	$0.2 trillion – 0.5 trillion	Nanomedicine could be used to deliver targeted drugs to 20 million new cancer cases worldwide
Advanced oil and gas exploration and recovery	$0.1 trillion – 0.5 trillion	Offers potential to supply an additional 3.6 billion – 6.2 billion oil-equivalent barrels of oil and gas annually by 2025
Renewable electricity – solar and wind	$0.2 trillion – 0.3 trillion	Potential to avoid emissions of 1.000 million – 1.200 million tons of CO_2 annually by 2025

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793 Melnyk, L.H., Dehtyarova, I.B., Dehtiarova, I.B., Kubatko, O.V. and Kharchenko, M.O., 2019. Economic and social challenges of disruptive technologies in conditions of industries 4.0 and 5.0: the EU Experience.

Conclusions:

Future capabilities of Ambient Ecosystems and AEGIS

While we have consistently emphasised the interpenetrated nature of technosociology and systems engineering, it can be helpful to remind ourselves that we began this exploration of ambient systems reaching systemic emergence out of curiosity and a desire to innovate. Notwithstanding the obvious discursive weight of innovation, we identified a large gap in both research and theory regarding ambient systems and the science of systems engineering applied to AmI. Now, our curiosity satisfied (but never sated), we have the beginnings of a new understanding on how and why individual ambient SCPSs become SoSCPSs and form there ambient ecumenes. They emerge in response to human genius and human ignorance. Both the best and worst of society converge in AmI, making them better, faster, and more unpredictable. Relentlessly and without any approaching end in sight.

So what are the future capabilities of the AEGIS? On the one hand they are limited by our social constructs, our algorithmic designs, and our inability to program human ethics and human remorse into computing systems with the brain power to rival a million geniuses and not one whit of sense more than the average raccoon. On the other side, we keep plugging in more chaotic systems, more computing power, more AmIs with heterogeneous software and no delineated communication protocol, forcing changes upon the systems we carefully built to serve a limited purpose. Which portends an unlimited progression, a destructive path of innovation, dislocation, amoral manipulation, and systemic re-engineering to increase addiction to the system. At some point we will simply burden the system with more data and computing requirements than the AmIs can safely handle and the progression of functional intelligence will either stall out like an aeroplane at cruising speed, hitting just the right mixture of air currents, thrusts, and altitude, or they will take a dangerous leap forward as something more singular and akin to a Gaia hypothesis style intellect.

Time will tell. We can easily predict that unless and until systems engineers matter to Smart X design firms and urban planners there can be no successful management of an AEGIS. Ambient ecumene present unique technosocial challenges that require SE solutions and precisely because they are vulnerable to SSE, early intervention in systems creation, modelling, and design must take place with a cadre of SRs who have broad capabilities in complex systems, SoSCPSs, and AmIs.

What the quest for asymmetric dominance says about us – Technosociology

The complex societies which define our present global technosociological civilisation function as amorally and efficiently as the AEGISs themselves. They are a bric-a-brac of old and new, legacy social realities merged with new promises of freedom, intellectual growth and technological advancement. We who live among them struggle with daily problems like violent crime and disease, endemic social woes like poverty and discrimination, and the complex solutionless issues of theological differences and accumulation of wealth. Our ambient ecumenes reflect us, only sped up and made more ruthless by their reduction of our complicated lifeworlds to a set of algorithms.

The quest for asymmetric dominance says very little about us technosociologically – it simply defines us. But it does say something fascinating about us as engineers. It tells us that we do not accept our limitations and through planning, modelling, and focus on systems, we attempt to better ourselves. We seek not just dominance over one another but over self and nature's limitations. When we err, as we do in the cases of industrial accidents and weapons of mass destruction, these impulses reflect our enormous social hubris; when we succeed in reclaiming farmland, saving a society from famine or rampaging viruses, we can see that our collective desire to innovate and improve, while it leads to some horror, also built the fabric of complex civilisation itself.

Therefore we need to find answers to our both natural and unnatural desire for power and control in the theology, ethics, and philosophy of our best selves. That's neither a technosocial problem nor one any engineer can solve. But we can address the negative correlation. If we do nothing, if we allow the vacuum of moral decision making to in fact decide, the AEGIS that emerges will be built of our worst fears and most blinding hubris. It will find the most virulent strains of malicious AmI sent into its heart by human agents with criminal agendas and merge them with our our epistemic violence and discursive tendency to make the mechanisms of control both invisible and inaccessible.

What the threats posed to the system and people say about society – Technosociology

The mere nature of smartphone addiction should terrify us – it both hooks us on a seemingly benign technology and adds new structures to our brain. No other form of addiction has this kind of novel effect upon human neurology. Many drugs erode or destroy brain function but no form of addiction improves it – save this one. That we have seen rates of dependence as high as 80% without social intervention speaks to the threats posed by our fellow citizens. No one seems to care about benign addictions. After all, we tolerate addiction to caffeine, so why not smart devices and the Web.

However, there are some strong indications that smartphones have not only a dark side but a dangerous vulnerability: they can be designed to exploit our weaknesses by both greedy corporations and militarised psy-ops agents. The epistemic nature of structural violence – hidden, considered the natural way of being, woven into daily life, and reinforced by our own moral and social reality – makes finding and stopping these malicious actors both difficult and costly. So we rely on someone else like the EU, Interpol, the governance structure of our company, the non profit agency down the way, someone who is not us, to shoulder the burden of both social cost and the time, effort, and economic loss incurred to place a firewall around the daily systems we use.

To a remarkable degree this has actually worked; the nature of the AEGIS will challenge this status quo when AmIs also begin to respond to malicious actors in their own emergent fashion. We have no sense of what these emergent algorithms will do when faced either with criminally designed AmIs or human agents who attempt to infiltrate the AEGIS or violate the purpose of the AmIs. It says nothing good about our societies that we have abrogated our potential neurological survival to either a machine system or the delicate governance structure of our elected officials.

Do we have recourse? Several avenues are open to us, not the least of which being the self governance of our smart device and Web usage. In addition, we have seen that SE provides tremendous mitigation to almost every aspect of both algorithmic violence and malicious human agency. We have the prior generations of SEs who stood up our present social and technological safety nets to thank for our functional governance and global communications infrastructure.

Final comments and conclusions

The findings detailed herein can be both alarming and depressing. There seems to be an overwhelming tide of malicious, violent, inhuman, and superhuman agents which have the power to coerce or trick us into working against our own bets interest. With the emergence of emergent AmIs there could be an inevitable subversion of free will which the interpenetrated nature of addiction, epistemic violence, and outside influence which collaborate to rewire us. But that era has not arrived and need not arrive. We have started down a promising path of shining a strong light on the nature of ambient ecumenes and how their attachment to GISs can and will change technosociological lifeworlds.

We have delineated the nature of AEGIS and through that paradigm, we have found tools with which to shape a positive path forward towards a functional and highly supportive ecumene. With the Subversion Checklist and the propose mitigations we have a serious aperture through which to view and measure the modelling and design as well as deployment and management of any AEGIS anywhere. We have directly identified Systems Social Engineering both in relation to technology in general and the AEGIS in specific. In other words, we have taken a major step forward in both methodology and praxis as systems engineers. We have the correct model to better inform our sub-teams and specialists.

Let us then conclude on a positive note. There exist any number of excellent outcomes waiting for dedicated engineering teams willing to plan and model early, to take the painstaking effort to mitigate the potential dangers involved in the AEGIS and emergent algorithms in general, and to fail forward as they achieve something extraordinary within the ordinary world. The possibilities the AEGIS presents us should be thrilling: a world of ambient responsiveness, wired to help us achieve our deepest wishes and most cherished goals, interconnected so that ZBs of data are generated and available for our common use. We need only go forward, armed with our better grasp of the contours of this complex technology and both its glories and pitfalls.

Appendix 1: Working Definitions Index

Working Definition: Technosociological Hegemony

Technosociological hegemony will be "socio-political dominance of a cultural ecosystem by technological means." This meets the litmus test of "the voluntary transfer of power from user to provider through technology" as well as "the voluntary consolidation of power over users and technology to a dominant provider."

Working Definition: Sociology

Sociology will be defined as "the socioeconomic discipline of providing clear compelling explanations for the recurring social mechanisms which manufacture consent and control over resources through ideology and knowledge."

Working Definition: Technology

Technology will be defined as "a socioeconomic process where multi-disciplinary knowledge converges with existing tools to create new ways to harness and manage resources."

Working Definition: Technosociology

Technosociology will be defined as "the socioeconomic discipline of providing clear compelling explanations for the recurring social mechanisms which manufacture drive the creation of new ways to harness and manage resources."

Working Definition: Ambient Intelligence

Ambient Intelligence will be defined as an artificially intelligent system that responds and adapts to human agents in real time using emergent algorithms.

Working Definition: Smart City

A Smart City will be defined as an urban centre which deploys a wide spectrum of systems designed to fuse into an ambient system for the community's social and economic benefit.

Working Definition: Smart X

Smart X will be defined as as any technology that uses cyberphysical integration of ambient intelligence and digitally enabled telecommunications and networks to provide real time adaptivity to human agents.

Working Definition: Technological Ecumene

Technological Ecumene will be defined as shared world system that merges technology and social relations into a singular cohesive cultural and economic unit.

Working Definition: Ambient Ecumene

Ambient Ecumene will be defined as a technological ecumene that has adopted ambient intelligence as the operant driver behind its real-time, emergent, constantly expanding interpenetration and convergence of people, machines, and systems of control.

Working Definition: Global Information System

Global Information System will be defined as the convergence of artificial intelligence integrated with systems of system of global telecommunications infrastructure to supply real-time data and services at any given point in the world while connected to a global system of support.

Working Definition: AEGIS

An AEGIS will be defined as one or more ambient ecumene joined to a convergence of multiple GISs which promotes emergence across urban centres achieving exponential refinement of ambient intelligences within and beyond the ecumene.

Working Definition: Artificial Intelligence

Artificial Intelligence will be defined as an intelligent system that can perform human tasks as well or better as a human counterpart.

Working Definition: Cloud

Cloud will be defined as on demand computing capability with real-time infinitely scalable resources.

Working Definition: The Internet of Things

IoT will be defined as uniquely addressable interactive infrastructure which provides real-time data intelligence to ambient systems.

Working Definition: The Internet of Everything

IoE will be defined as a hyperconnected network of relationships between smart things, people, processes, and data which define the entry state of an AEGIS.

Working Definition: Touchless Retail

Touchless Retail will be defined as a contentious but vital way to merge e-commerce with the IoE making the AEGIS a unified economy.

Working Definition: Social Networks

Social Networks will be defined as a pervasive hyperconnected merger of emotionological AmI and the IoE which creates the most direct link between ambient systems and human behaviour.

Working Definition: Digital Identity

Digital Identity will be defined as the super summing of personal data and digital personas of a human agent within one or more GISs.

Working Definition: The Fourth Industrial Revolution

Industry 4.0 will be defined as an ambient value chain paradigm managing adaptable production and logistics, robotics, and autonomous manufacturing as a cohesive ecumene.

Working Definition: Mobile Workforces

Mobile Workforces will be defined as digitally savvy workers who can use smart devices and GIS to deliver value creation from any networked geography.

Working Definition: Financial Technologies

Fintech will be defined as the overarching enterprise financial SoSCP which creates digital FSIs capable of transferring resources between any two AEGISs.

Working Definition: Augmented Reality

Augmented Reality will be defined as the full integration of multisensory ambient systems to create working access to the AEGIS's digital topology

Working Definition: The Internet of People / People-as-a-Service

The Internet of People / People-as-a-Service will be defined as intentional integration of the digital biome and human agents to achieve ubiquitous frictionless use of AmI.

Appendix 2: Critical Value Index

Critical Value to the Ambient Ecumene: Systems Engineering

Systems Engineering delivers insight and focus to managing the core problems of an AEGIS – unpredictable and undesirable consequences resulting from lack of efficiency, accountability, sustainability and scalability of processes.

Critical Value to the Ambient Ecumene: System of Systems

Systems of Systems deliver a focused approach to the AEGIS by allowing us to grasp the inherent paradox of emergence in non algorithmic non cyber-physical circumstances.

Critical Value to the Ambient Ecumene: Smart X

Smart X Engineering delivers the SMBSE and Gemba Kaizen techniques which provide SE tools for developing and managing an AEGIS.

Critical Value to the Ambient Ecumene: SCPSs

SCPSs deliver a working model for the AEGIS which can be addressed by SMBSE, Gemba Kaizen, micro-services cloud SOA, and HFGT tools.

Critical Value to the Ambient Ecumene: SoSCPSs

SoSCPSs deliver a working model of the most complex of non-linear chaotic dynamical systems which require HFGT and similar mathematical tools to properly design and implement.

Critical Value to the Ambient Ecumene: The Internet

The Internet delivers GISs to every network and locale worldwide with a robust capability to support AmI driven real-time processes.

Critical Value to the Ambient Ecumene: IoT Sensors

IoT Sensors deliver the potential to create a fully realised technological ecumene where the urban environment can become its own information system merged with the GIS.

Critical Value to the Ambient Ecumene: Telecommunications

Telecommunications delivers the backbone capabilities to support all GISs as well as IoT and The Web critical to a functioning AEGIS.

Critical Value to the Ambient Ecumene: Blockchain

Blockchain delivers a relatively universal publicly auditable data encryption format that can be adulated for heterogeneous data streams like IoT and telecommunications.

Critical Value to the Ambient Ecumene: The Smartphone

The Smartphone delivers a critical endpoint interface which facilitates integrated IoT and Internet supported applications tied to highly reactive real-time AmI.

Critical Value to the Ambient Ecumene: On Premise Computing

On Premise Computing delivers foundational computing and endpoint access to support robust Ami, telecommunications, and IoT applications with resilience.

Critical Value to the Ambient Ecumene: Off Premise Computing

Off Premise Computing delivers extraordinary flexibility, integration, and real-time support of the most salient features of ambient applications and services.

Critical Value to the Ambient Ecumene: Smart X Algorithms

Smart X Algorithms deliver efficient computing and rapid data analysis needed to manage IoT, affective computing, and real-time telecommunications processing for AmI.

Critical Value to the Ambient Ecumene: Smart X Software

Smart X Software delivers viable command and control solutions as well as database management for the massive information influx of data being generated in an AEGIS.

Critical Value to the Ambient Ecumene: Smart X Products and Solutions

Smart X Products and Solutions deliver the keystone capabilities needed to engage with and move through an AEGIS in real-time.

Appendix 3: Contributions Index

Critical Contribution 1: The AEGIS Paradigm

1) it identifies and explains these stacked interoperable SoSCPSs as Ambient Ecumenes of Global Information Systems (AEGIS), providing techno-social nomenclature, design focus, and applied technology awareness to future Smart X engineers;

Working Definition: AEGIS

An AEGIS will be defined as one or more ambient ecumene joined to a convergence of multiple GISs which promotes emergence across urban centres achieving exponential refinement of ambient intelligences within and beyond the ecumene.

Ambient Ecumenes of Global Information Systems can best be thought of as multiple interpenetrated highly complex systems of highly complex systems forming biome level interlocking AmIs which teleologically self design their emergence to promote wider adoption of the higher level management systems in the ecumene: the endless chain of Russian nesting dolls who keep making more and better Russian nesting dolls. An AEGIS achieves emergence within its own geolocality and beyond it – it interacts with the world itself through stacked and cross communicating GISs.

An AEGIS represents a shared world which incorporates the Abu-Lughodian world system, the Hobsbawmian lifeworld, the indigenous TEK notion of a unified scientific and social system, a unitary cultural consciousness, and a shared technosociological discourse – it comprises a hegemonically bounded episteme and an open ended social system that has emergent properties on a technosociological level. A never ending series of social constructed and socially controlled SoSCPSs which improve and mutate themselves in new and unpredictable fashions.

We have a sense of what we can discern about an AEGIS – we can define its size, shape, and influence, we can determine its basic technological components and social rules, we can predict with some accuracy what it will do in situations which match historically significant events and we can make statistically valid guesses as to what it might do in a future state. We also know that its emergent properties and ability to move faster than fully formed conscious thought make it elusive to direct observation. We understand the complexity of its smallest systems are almost beyond our grasp and that as these systems stack, interpenetrate , and begin to affect one another in emergent fashions, the super summing capability of the macro-ambient intelligence places it beyond our neurological ability to match or truly comprehend.

AmIs become ambient ecumenes through the sloppy heterogeneous process of the socially disruptive cycle of urban development, dislocation, and renewal. As these biomes of flickering emergence interact with isolated and haphazardly built legacy systems, some new forms of AmI interact and through the eventual connection to various streams of GIS in social networks, telecommunications, governmental databases, corporate nets, and the World Wide Web, the AEGIS comes to life. It becomes the self creating ouroboros of Russian nesting dolls – a doll that built itself from portions of other dolls and which spontaneously begins to nest its systems within and through other systems, spontaneously begins to change its programming and algorithms to adapt to human agency, and which, once, started, increases in intelligence, complexity and interlocked globality until its achieved a steady state limited by the shared world of the ecumene which prescribes it.

An AEGIS does have limits and can be measure The systems have operant programming which limits them, they have physical constraints related to how hardware, software, IoT and AIs function, and they are built to more fully answer the needs of their human agents. All these allow us to track who owns and manages a resource, who exerts Foucauldian power over it, and ultimately what kind of discursive violence attaches to the fair and unfair algorithms alike. In this way we go in with a focused sense of how socially influenced these component systems are, how much power and contested space can be hidden behind supposedly neutral devices and services, and how carefully we must interrogate even the most innocuous of AEGIS capabilities given the invisible, subversive, and dangerously addictive nature of ambient services to their human agents.

When simplified to the most essential definition, an AEGIS delivers ambient immersion at the price of human autonomy. It all comes down to systems engineering. The problem may be technosociological in origin but all forms of solutions must be delivered by how the most complex of all systems will be produced, deployed, and managed.

2) it interrogates the limits and dangers of the AEGIS which include unintended social influence, subversion of human agency, and decreasing access to the artificial intelligence algorithms driving the systems;

The Ambient Subversion Checklist

Ambient System	System Type	Mitigation	Subversion of Free Will
SoS	CPS	Unified command and control	Require SoS to monitor and understand other SoS
Smart X	SCPS	Unified and cross-compatible systems	No clear method to integrate all subsystems
SoSCPSs	SoSCPS	SMBSE / Gemba Kaizen / HFGT	Non-linear chaotic dynamism: maximum chaos, minimum predictability
The Web	Infrastructure	Privacy protection regimes	Rival political and economic powers censor data and limit access
The Dark Web	SoSCPS	Model structural violence, addiction, and misuse	Access to dangerous, addictive, and illegal services w/o security
Cyber Westphalia	SoSCPS	Chief Systems Officer w/ Global PMO	Regional control of The Web imposes censorship and speed limits
IoT	IoT	Single database / CSP	10,000 potential sensors without a common unifying platform
Telecommunications	Network	Unified and cross-compatible systems	1000 operators produce non-linear chaos and data fragmentation
Blockchain	Software	Privacy protection regimes	Improper management of keys creates data breaches
Smartphone	Infrastructure	Model structural violence, addiction, and misuse	40% - 80% adult addiction rates
On Premise Computing	Infrastructure	Model upgrades / refresh cycles in advance	Static and outdated systems which cannot integrate
Off Premise Computing	Infrastructure	Single database / CSP	Hegemonic power struggle over Web, 5G, cloud, edge nodes
Black Box Algorithms	Software	SMBSE / Gemba Kaizen / HFGT	Emergent properties create new avenues of epistemic violence
Database Systems	SCPS	Single database / CSP	Gross abuse of personal data through breaches, theft, social engineering
AI	SCPS	Privacy protection regimes	Pervasive and ubiquitous climate of surveillance
AmI	SoSCPS	Unified command and control	Emergent properties rewire human neurology
Touchless Retail	CPS	Public smart application	Economically driver algorithmic violence and epistemic conflict
Social Networks	SoSCPS	Public smart application	Social networks can control movement & behaviour of crowds
Digital Identity	SCPS	Public smart application	Contested identities and human rights
Mobile Workforce	SCPS	Model structural violence, addiction, and misuse	Skill divide between mobile worker and lower paid workforce
Fintech	SoSCPS	Unify and monetise communal data	FSIs create needs for adaptive emergent black box algorithms
Augmented Reality	SCPS	SMBSE / Gemba Kaizen / HFGT	Information curation reveals algorithmic violence
PeeaS	SoSCPS	Unified command and control	Reduces basic life processes to SoSCPS algorithms
WoT / IoP	SoSCPS	Model structural violence, addiction, and misuse	Reduce the time allowed for independent thought formation

Core Mitigations

Here are the core recommendations for creating and maintaining a world class AEGIS which maximises human agency and free will.

1) Create a singular command and control entity at the governance level which combines responsibility, decision making, funding, audit, security, and accountability.

2) Plan extensively using SMBSE and Gemba Kaizen with strong reliance of HFGT and similar statistical systems. Model early, often, and thoroughly before approving funding.

3) Implement the AEGIS with as many unified and cross-compatible systems as possible. Set a clear IoT standard with uniform radio bandwidths, security protocols, audit mechanisms, and an abstracted SDN controlled by the governing entity rather than a commercial third party.

4) Implement GDPR and similar privacy protection regimes with both criminal and civic penalties for violations as well as the mandated costs to re-engineer any black box algorithm driven systems found to be in violation.

5) Choose a single database supplier and a single CSP which complies fully with your privacy regimes and can bring security hardened hardware and software to the AEGIS as well as helping protect the network at edge, fog, and core nodes.

6) Create a unified public ambient smart device application which provides free services as well as tax payer subsidised services (free to the user) pre-empting the implementation and distribution of disparate AmI commercial applications with biases, economic and political agenda,s and algorithmic violence.

7) Model all upgrades and technology refresh cycles well in advance with a clear understanding that it will be more profitable to have advanced unified IoT, IaaS, networking, and software provided by single vendors (despite monopoly lock-in) than handle runaway black box emergence.

8) Unify and monetise the centralised communal database as a social service. The AEGIS needs to take conscious pre-emptive control of private data to both keep it secure and find ways to generate profitability for citizens before entities like Facebook and SCL can exert their influence.

9) Plan for and model structural violence, smart device addiction, and criminal misuse of black box algorithms using HFGT and similar methodologies to establish security protocols, mitigation strategies, and communal systems of transparency and accountability for citizen led governance

10) Establish and generously fund the position of the Chief Systems Officer within the governance structure providing them with a Global Program Management Office, decisions making powers, and access to the primary stakeholders, the governance C-Suite, and citizen governance non governmental organisations.

Critical Contribution 3: The Systems Social Engineering Paradigm

3) it proposes the Systems Social Engineering paradigm to assist technosociological and systems engineering analysis of all future emergent AmI SoSCPSs.

A portmanteau of Systems Engineering and Social Engineering, the phrase encapsulates the protracted intentional use of social engineering techniques to bring about a systemic change as well as the extensive use of systems engineering methods and tools to achieve long term highly diffuse social control. We define Systems Social Engineering (SSE) as the art of creating systems to compromise information systems users. Instead of technical attacks on systems, systems social engineers target humans connected to the system, structurally and systemically manipulating them through epistemic control of the system itself.

Five fundamental systems engineering problems face AEGIS managers: black box emergent algorithms, ICT addiction, epistemic violence immured within the ecumene, the intentional subversion of free will, and illusion that AmI increases human freedom while actively curtailing it through neurological rewiring, addiction, data curation, and behavioural conditioning. These comprise the fundamental elements of SSE.

The London AEGIS demonstrates how SSE works. The initial design phases either ignored SMBSE and HFGT of used too little of it to matter. The resulting implementations resulted in a terrain of haphazardly stood up ecosystems. As a result, London has had to rely on more black box algorithms to achieve integration across different platforms, systems, and legacy infrastructure: non-linear dynamic chaos by design. By forcing the data of the city and its residents through so many funnels and nodes, it opens that data to being stolen, copied, snooped, or “sampled” by various ambient systems. Private data thus has been made structurally vulnerable as a direct result of the system engineering. Likewise, these AmIs require access to that data to handshake with other ambient systems, often being forced to create emergent ways to store the data between AmIs and between AmI queries. We literally cannot see how that has been achieved nor track when and where that data goes missing (or where it has been stored). A group of dedicated malicious agents can hunt down that data using military grade AI interacting directly with the invisible hands of the epistemic machine behind the AEGIS. The combination of addiction, black box emergence, and epistemological injustice create a dangerous ecosystem of dependence, vulnerability, imbalance, misconduct, and victimisation. Put bluntly, Bad SE = Good SSE.

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