Technological Ecosystems' Role in Preventing Neo-Feudalism in Smart-City Informatization

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ABSTRACT
The paper argues that the Smart City idea lacks grounding in shared base technology and instead yields black-box artefacts. The reliance on black-box systems in public governance is considered a great hazard since it may result in sinecures, stifles democratic control of the public domain, and results in neo-feudal monopolies. Base technology (such as the WWW technology stack) on the other hand is use-neutral, implementation-neutral, open, and teach-/learn-able, thus enabling the emergence of cascading technological ecosystems, which can drive large-scale economic and societal progress. The concepts of a primary, secondary, and tertiary technological ecosystem are introduced to delineate the role and importance of base technology. The paper calls for stronger focus on Smart City foundational research and a change in culture from quick fixes to solutions that would survive generations.

CCS Concepts
• **Applied computing~E-government** • *Applied computing~Business-IT alignment* • *General and reference~Reference works* • General and reference~Computing standards, RFCs and guidelines

Keywords
Informating Governance; Beyond Bureaucracy; Neo-Feudalism; Bazaar-Paradigm; System Evolution; Democracy;

1. INTRODUCTION
Who would be in control over future smart cities? Will it be their citizens, or neo-feudal structures?

Smart City is a term that refers to a broad set of concepts, ideas and trends, related to the utilization of technology in modern urban spaces. Söderström *et al.* [1] trace the roots of the idea, explaining that the "smart city" was born and raised as a marketing term in mid-'90ies, where it soon lost focus, only to resurface ten years later in the end-'00s. The smart city, Söderström *et al.* (ibid.) argue, is foremost a narration of corporate mythology where innovations in technology and organization play the role of an agent that should transform the urban ecosystem into a "smart" one, rather than a clear technological agenda. From a perspective of design science [2], [3], the smart city idea yet remains to establish foundational artefacts, such as a clear architecture [4], or base technology for informatization [5], [6].

Informatization has been defined [7] as the ability to control a system (not necessarily a technical one) by means of information technology; as such, informatization is the driver behind "smart" stages of evolution, such being the case in 4^{th}-generation manufacturing, smart logistics, or smart service provision (ibid.). The term "smart" hereby is to be understood as a word *"applied as a prefix to technological terms to indicate special capabilities, intelligence, and/or connectivity, as in smart phone or smart card"* [8]. In the context of social function provision, "smart" has been used also to denote non-technical, as well as non-state actors which contribute to an anticipating intelligence on the relation between citizens and the state [9].

Against this backdrop, the smart city idea is focused on transforming the manifold functions of urban ecosystems into technology-enhanced functions, aiming to ultimately provide an intrinsic level of *smartness*. The same goals are shared (albeit on a broader level) by e-governance, a research field dedicated to the exploration and application of technology along the boundaries of public governance, public management, public service provision, collaborative decision-making, and stakeholder participation (cf. [10]). Although cities, states, and municipalities may differ in specific functions they fulfill and in particular in the constraints they are exposed to, they are all forms of public domain organizations, which are subject to democratic and legal principles. In a nutshell, these organizations and the technology supporting them, are supposed to be *common goods* (rei publicae).

It is exactly these latter constraints, Paulin [11] argues, which are inadequately addressed when technological artefacts are developed for outbound-relations of public domain organizations towards dependent stakeholders (such as citizens, the state, or other public domain organizations). The resulting solutions thus become publicly funded, neo-feudal sinecures for monopolistic providers, over which future generations will have lost all control. (ibid.)

Even though the threat posed by monopolistic structures appears to be mitigated by standardization efforts ([4] provides a good overview), open formats [12]–[14], accessible documentation [15], or interoperability engineering [16], the focus of these efforts is on levels, which, as shall be explored below, do not contribute to overcoming neo-feudalization.

This research note discusses the role of technological ecosystems in overcoming the threat of rising digital feudalism in the domain of the management of digital public good. Ecosystems can be generally defined as self-balancing systems of loosely coupled

WWW'16 Companion, April 11–15, 2016, Montréal, Québec, Canada.
ACM 978-1-4503-4144-8/16/04.
DOI: http://dx.doi.org/10.1145/2872518.288861

actors interacting in a shared domain, whereby the interaction is centered around the shared resources (goods, information, services, ideas, etc.) of the ecosystem's domain (cf. [8]). The concept of an ecosystem is relative to the perspective on the ecosystem as such, allowing for overlapping, or cascading ecosystems to co-exist: the forest can be seen as a macro-level ecological ecosystem of animals, plants, microorganisms, etc. Overlapping with the ecosystem of the forest are e.g. the economic ecosystem of the wood industry, or the economic ecosystem of the hunting culture. Latter two are both overlapping with the monetary ecosystem, etc. Technological ecosystems are then those ecosystems, which are characterized by the crucial reliance on specific technologies, such as e.g. centered around the provision of Web technologies, where the technological ecosystem includes engineers, standardization bodies, technology evangelists, toolset developers, etc., devoted to providing resources for Web development. Based on technological ecosystems, advanced ecosystems can emerge, such as the ICT-based online provisioning of tourism services [8], distributed Internet security [17], or ICT (information and communication technology) platforms [18]. Such ICT-based ecosystems can then be called *digital* ecosystems [8].

An overview over the implications of control over public-domain information systems shall be presented in section 2, and in section 3.3 focus of this discussion shall be laid on outlining the role of economy-fostering open technological ecosystems as an alternative to the modern culture of bespoke monolithic governance information systems.

2. LOSE-LOSE: A PATH TO FEUDALISM?

Ever since, cities were special ecosystems sharing a common public domain. This public domain based on a common system of public governance, common infrastructure, and a mutual understanding of community, which demarcated the members of the city from outsiders. The boundaries of ancient imperia were determined by the networks of cities subjected to the bureaus of the imperium, which provided to former social functions such as the protection of economic systems (e.g. trade routes), infrastructure (roads, rivers) security and maintenance, and taxation. Within these imperia, city communities kept rights to self-organize internal affairs, like the control of markets, waste management, and law and order. Community governance was ever since about maintenance of the city infrastructure on the one hand, and about balancing competing interests of power networks on the other hand. Around provided social functions adjoining economies emerged, securing their perpetuation in the manner of public *bureaus* [19].

This public sphere of the city is determined and controlled by public-domain organizations (bureaus), who emerge out of the possibility for their existence (see [20] for the emergence of power as a society's "mother"-organization, and [19] for the motivation and dynamics of further evolution of bureaus). Before the digital era, the work of bureaus was set in a context, which could conveniently be controlled by law, moral, or technical architecture (cf. [21]). If in such setting the course of a bureau was to be changed, such was done through changing the law, or otherwise changing the constraints of the organization's context. Bureaus' operational capital, infrastructure, and knowledge was tangible and comparably easy to control, as long as it is comprised of things like real estate, railway tracks, mechanical machinery, registries, or files. In such context, bureaus could comparably easy be controlled by means of a public-law legal system, which can be subjected to democratic principles.

The digital era however brought change to the consistency of bureaus' means and tools. The transition from street-level bureaucracy to system-level bureaucracy [22] introduces a new type of assets to the portfolio of bureaus, namely large-scale information systems, which encapsulate, virtualize, and automate the bureaus' social functions. The ownership and control over such systems makes bureaus gain the upper hand in the relation to legislators, since the functioning of the society becomes systemically dependent on these new "to-big-to-fail" bureaus [11].

The resulting systems thus become sinecures over which future legislators will have lost all control. The owning bureau's monopoly to control the conditions for using the system, thus leads to a neo-feudal order, which excludes market competition and imprisons society within a functionally frozen societal system [11]. The evolution towards digital feudalism has been previously discussed in the context of Internet governance [23], but is a novel notion in the concept of technology for public-domain governance. This evolution impacts the legitimacy and regulative abilities of the democratic order on the one hand, and stifles markets and innovation on the other.

So-far provided technology for social function provision comes in form of *concrete* artefacts: public-domain bureaus build systems tasked with delivering specific functionality, like e.g. portals to serve information, backend-systems to store, manage, and exchange taxation data, or systems to administer data and processes relevant to other manifold functions of public administration bureaus. Each of these systems have been lovingly handcrafted by system developers, and sold to the state with warranty and a service agreement. The crux of bespoke artefacts however is that they fit only to foreseen situations. Changes in law, organizational priorities, or the context in which a bureau operates either render such artefacts void, or prevent changes to take place in the first place [11].

At the end of this path lies a lose-lose situation: publicly funded sinecures lead to no relieve of burdens for citizens, but only increase the might of monopolistic bureaus. Latter in turn grow in strength and independence from law, fostering a shift of societal power away from lawmakers and politics, towards private enterprises with social function monopolies.

3. WIN-WIN: THE ECOSYSTEM!

Despite problematic monopolization [11] and challenging pitfalls in implementation [15], [24] of public-domain artefacts, the vision that technology can disruptively transform the way societies are governed remains alive amongst top scientific challenges [25]. Disruptive progress in the world of technology however requires a clear foundation on which progress is pursued. Such foundational (base) technologies in the realm of modern ICT are e.g. the Internet and Web technology stacks, or languages such as SQL, Java, C, R, etc.

What these base technologies have in common is that 1) they exist as artefacts in form of *open models*, which can be freely instantiated by any accordingly capable person[1], and 2) they come as *generic* technologies, i.e. they do not predefine the characteristics of the final system which they are part of. The generic character of base technologies allows them to be either used to construct infinitely complex systems (as is the case with programming languages), or to be integrated in such. Both characteristics, i.e. the existence as *open models*, and their *generic*

[1] See [2] for a good description of the different types of technical artefacts, such as constructs, models, instantiations, etc.

character enable the rise of ecosystems, which gravitate around base technologies.

3.1 The three ecosystems

A typical set of base technologies is the core WWW stack, which comprises the HTTP protocol, the HTML markup language, the CSS presentation system, and the JavaScript language[2]. The openness and the model form of these core artefacts allows that anybody can build their own webserver, browser, web page, or web search engine from scratch and do so independent of the tools and technology used to realize the instantiations.

3.1.1 The primary ecosystem

The openness of the models and their technology-independence means that anybody can gain knowledge how to deal with them, and this in turn provides economic incentives to teach the base technology, to standardize it, to consult on it, or to research towards improvement and innovation. The economic incentives provided lead to the development of self-sustaining and self-propagating ecosystems, with potential for eternity.

We shall name the ecosystem, which evolves around base technology as the *primary*[3] technological ecosystem. The primary ecosystem is the basis for the further propagation and evolution of its underlying base technology. This ecosystem then gives birth to tools (developer tools such as compilers, debuggers, or integrated development environments like Visual Studio, Eclipse, or MySQL Workbench), use optimizations (cf. the GoF object oriented programming design patterns [26]), and workable instantiations of the base-technology models (e.g. the Apache webserver, or the Gecko web browser engine, which is used in the Firefox browser).

3.1.2 The secondary ecosystem

The propagation of knowledge on and about base technology provides grounds for the emergence of a *secondary* technological ecosystem, which is about utilizing base technology for developing consumer-oriented artefacts. In the case of the Web, such consumer-oriented artefacts are webpages, web portals, globally successful mass-consumer systems like Facebook or Amazon, systems enabling business transactions that leverage Web technology, like the Amadeus CRS (cf. [27]) for the distribution of travel tickets, or the global credit transfer system for bank transactions SWIFTNet (cf. [28]), or academic resource directories like Web of Science, or Google Scholar.

Again, the secondary ecosystem comes with self-sustaining economic incentives: it is consumer-/end-user-oriented, and like the primary ecosystem, bears potential for consulting, teaching, standardization, research, innovation, consolidation, integration, etc., etc. The dominating principles of the secondary ecosystem however are trade secrets and black-box solutions, which serve concrete means, which is in stark contrast to the open and generic nature of base technology.

(Also, this is the level where social science's social construction theory, which argues that society shapes technical systems rather than the other way around (cf. [29] for a discussion in the context of the Internet / Web), steps in [30].)

3.1.3 The tertiary ecosystem

Systems around which the secondary ecosystem forms, will often provide means for system-level inclusion of third parties through dedicated interfaces. Thus, in the realm of the Web, Facebook, or Google provide application programming interfaces (API), which independent developers utilize to develop apps / widgets / plug-ins that base on the functionality provided by the main systems.

These interfaces enable the evolution of *tertiary* ecosystems, which then rely on the proprietary interfaces provided. A developer crafting an iPhone app, a Firefox plug-in, or integrating Google Maps into its application, is thus contributing to the propagation and success of the particular provider's tertiary ecosystem, and hence subjects its system to the terms and conditions of the respective provider. The main characteristic of the tertiary ecosystem is therefore its existential reliance on proprietary technology.

3.2 The society: a very different animal

The three technological ecosystems have the potential to sustain and perpetuate themselves, whereby the driving force behind this perpetuation lies in the self-actualization of individual zealots (cf. [18] for the power of individual's zealotry in the domain of ICT development, or [19] for the domain of societal causes). The focus of modern ICT's primary ecosystem was on delivering advanced digital *communication* of data or information, to be used for computerization (digital computer-enabled automated processing), virtualization (emulation of resources), or informatization (control of real-world technical or non-technical systems by means of ICT). Such technization of communication enabled the rise ecosystems and adjacent economies and enabled the rise of global players like Google or Facebook. Technization of communication is sufficient to build complex systems like Facebook, since any web site (Facebook, technically, is not more than a website) in its core is about communication of data between the web server and web client (if seen technically), or between the organization and its customers.

However, governance of societies goes beyond mere communication: it is about collaborative decision making, about control of resources, control of power, control of social services, and about systems of law and belief[4]. While these factors include communication, they introduce constraints and requirements which exceed the scope of the capabilities of the present-day ICT landscape [6], [11], [15]. The society is a very different kind of animal: while the functionality of Facebook can be provided to its *markets* of prosumers, advertisers, or intelligence agents as is, a society can not (or rather: must not) be subjected to system with locked functionality, but instead must be able to flexibly extend / contract / limit / release the functionality and constraints of its governance system to its fullest extent (ibid.).

A first attempt towards base technology, which would directly address societal governance, has been proposed by Paulin [6], [31], [32], however remains yet in a very early phase of pioneering [33]. Aside from this, research has not yet set focus on artefacts that would address the informatization of societal governance. Thus, the observed theoretical frameworks [34] behind e-governance / e-government research (within which scope also falls smart-city related research) focus on prediction of organizational transformations of bureaus (there: the public

[2] Adjacent Web-related base technologies such XML, DOM, HTML5 etc. can be added to this list without harming the argument. Proprietary Web-related technologies such as e.g. Flash, on the other hand, do not fit the definition of base technology.

[3] The herein used terms *primary / secondary / tertiary* ecosystem have no relation to the p./s./t. economic sectors used in economics.

[4] See e.g. the *fiat* monetary system, or *fiat* social security system.

administration), and the general application of technology to support functions of particular governance agencies. The level at which technization in the e-governance domain steps in however, is the level of the secondary ecosystem, where trade secrets and functionally closed black-boxes dominate. (Attempts to create tertiary ecosystems have been undertaken e.g. by open government data initiatives [13], [14], [35], albeit with meagre success; likewise the *Government as a Platform* idea [36] aims at the evolution of a tertiary ecosystem based on a monolithic secondary ecosystem platform.)

The otherness of societal governance as compared to market-oriented products is a reason why established approaches from e-business do not and can not work in e-governance [11], [37]. On the other hand, this otherness comes with great potential to develop new primary ecosystems, which would sustainably open societal governance for technical science.

3.3 Might of ecosystems: a win-win situation

Publicly funding potential future sinecures, as argued in section 2, is a path leading towards a democratic dead end – it is a road to neo-feudalism, or, to paraphrase Hayek, a road to serfdom [38]. The potentials of co-productive technological ecosystems however bear the ability to provide on the one hand economic potentials by creating work and revenue, while on the other the openness and neutrality of base technology enshrines intrinsic democratic and liberating potentials, as shall be described below.

3.3.1 Economic might

The power of global players of the dotcom era, like eBay, Uber, Airbnb, Alibaba, Facebook, Twitter, Google, or Apple, is owed to the possibilities of the secondary ecosystem. The products of these companies are themselves part of the secondary ecosystem, whom they helped to rise to prominence and economic might. With the creation of tertiary ecosystems by providing APIs, these companies significantly expanded their outreach and increased revenues by harvesting the fruits of their digital fields.

Economic might of technological ecosystems has meanwhile reached impressive levels: California's economy – substantially due to the power of Silicon Valley, is said to be the 8th-largest economy in the world [39] – outperforming the economies of Russia or Italy. The existence of these global players however would not be possible without the underlying existence and perpetuation of the primary ecosystem, whose surplus know-how and innovative spirit pioneered and remains fueling the innovations leading to the secondary ecosystem (cf. [18] for an excursion through a zealotic IT developer's mindset).

Harvests of economic potentials of the technological ecosystems can be great assets in the economies of the information society. Monopolistic systems on the other stifle economy, prevent competition and hinder innovation.

3.3.2 Democratic power

Technological ecosystems in the domains of the Internet and the Web have many times proven their ability to self-organize, innovate, and coordinate targeted action in ad-hoc global organization. Schmidt [17] for example discusses decentralized peer-production (remote collaboration) in the case of Internet cybersecurity; Raymond [18] on the other hand focusses on open source technology provision.

The value of openness and neutrality of base technology for democratic action and *anarchic* (as in *without government*) production has proven itself duly during the Browser Wars [40], where the once one-and-only Netscape web browser was first superseded by the Microsoft's Internet Explorer, which in turn was ousted by open-source-first (though Netscape-sponsored) competitor Mozilla (Firefox). The success of Linux, itself an open-source-first project, is yet another – and even the most prominent one, confirmation of democratic potentials to rival economically motivated solutions.

The ability to gain knowledge about and on base technology implies potential to hinder feudalization of derived ecosystems: by knowledge of the particular base technology, anybody can build a new and better social network system, a new and better operating system, or a new and better web browser, much like anybody can write a book, or verify a mathematical equation, because the *base technology* required – i.e. knowledge of the alphabet, or the algebraic system, come as *open* and *generic* artefacts.

4. CONCLUSIONS

This paper set out to explore the concept of technological ecosystems and their role in furthering the technization of societal governance. The modern approach to develop technology in the context of societal governance (including, but not limited to the focus of smart city research) was criticized as one that leads to neo-feudalism, and as such is a challenging development from the perspective of established democratic values. Aside from the implications in this regard, the modern approach, which yields in monopolistic governance technology, was criticized for stifling competition and consequently economic and innovative potentials.

Against this backdrop naturally evolving technological ecosystems were presented as alternatives to monolithic governance technology. The ecosystem – in general – was defined as a self-balancing system of loosely coupled actors interacting in a shared domain. Taking the evolution of the Web as an example, three technological ecosystems were identified, namely the *primary ecosystem*, which evolves around *base technology*, the *secondary ecosystem*, which is characterized by trade secrets and black-box end-user oriented solutions, and the *tertiary ecosystem*, which evolves based on platforms or APIs provided by artefacts from the secondary ecosystem. Existence of base technology was identified as the crucial enabler of the evolution of the three ecosystems, whereby base technology has been described as coming in the form of open and generic artefacts, i.e. in the form of constructs or models, rather than concrete instantiations.

The openness and genericness of base technology prevent phenomena such as vendor lock-ins, or the monopolization of knowledge. From this perspective, the paper concludes, base technology would be able to prevent feudalization of societal governance, while at the same time fostering the emergence of new ecosystems that would feed back to prosperity in form of economic progress. With this in mind, the paper calls for adequate focus on research and development towards base technology focused specifically on societal governance, which is a challenge that goes beyond the already well-addressed objective of ICT to transform communication in general.

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