proceedings

Proceedings

Is the Internet-of-Things a Burden or a Leverage for the Human Condition? †

José María Díaz-Nafría [1,2] and Teresa Guarda [3,4,5,*]

[1] Universidad de León, Faculty of Education, 24071 León, Spain; jdian@unileon.es
[2] Munich University of Applied Sciences, Department of General Studies, 80636 Munich, Germany
[3] Universidad Estatal Península de Santa Elena (UPSE), Department of Systems, La Libertad, Ecuador
[4] Universidad de las Fuerzas Armadas (ESPE), Department of Security and Defense, Sangolqui, Ecuador
[5] ALGORITMI Research Centre, Minho University, 4800-058 Guimarães, Portugal
* Correspondence: tguarda@gmail.com; Tel.: +593-99314419
† Presented at the IS4SI 2017 Summit DIGITALISATION FOR A SUSTAINABLE SOCIETY, Gothenburg, Sweden, 12–16 June 2017.

Published: 8 June 2017

Abstract: The very common Internet citizen has a very restricted autonomous capacity to move through the network which is becoming the ever stretching milieu where our lives take place. At the same time, the capacity to manage relevant information from ourselves and the environment we are living in offers new avenues to deal with healthcare, sustainability issues and problems of many different kinds and significant social concern which were previously insufficiently attended. While the actual structure of the Internet, geared by big-data technologies, exhibits a network topology highly concentrated, the authors propose a *cyber-subsidiary model* which may solve the conundrum where the human condition seem to be trapped in a blind alley.

Keywords: internet-of-things; network theory; cyber-subsidiarity; viable system model; autonomous agency

1. Introduction

Internet of Things (IoT) connects people, processes, data, and things, turning information into actions, creating new capabilities and extraordinary opportunities, allowing an allegedly perfect symbiosis in the interaction between peoples and machines anywhere, at any time, using any devices through networking technologies, including wearable's with intelligent sensors adapted dynamically to the user's needs [1]. The pillar of IoT is the pervasive presence of a variety of things connected to the Internet and to each other, sensing and collecting data, and interacting with each and with the neighbor's objects [2], supported by a technological (re)evolution in many fields from wireless sensors, to nanotechnology [3].

However, what is the control we have about this connectedness? How pervasive it is? Is it accessible for everybody in the same way? What are the percolation mechanisms that make the signaling effective at different levels? Effective according to what criteria?... When we indeed analyze the real structure of the Internet geared by big-data technologies, as we can do using network theory, Italo Calvino's fictional representation in Priscilla story [4] becomes somehow premonitory:

"As soon as we are out of the primordial matter, we are bound in a connective tissue that fills the hiatus between our discontinuities, between our deaths and births, a collection of signs, articulated sounds, ideograms, morphemes, numbers, punched cards, magnetic tapes, tattoos, a system of communication that includes social relations, kinship, institutions, merchandise, advertising posters, napalm bombs, namely everything that is language, in the broad sense. […] The ceiling that covers us is all jutting iron gears; it's like the belly of an automobile under which I have crawled to repair a fault, but I can't come out from under it because, while I'm stretched out there with my back on the ground, the car expands, extends, until it covers the whole world. There is no time to lose, I must understand the mechanism, find the place where we can get to work and stop this uncontrolled process, press the buttons that guide the passage to the following phase: that of the machines that reproduce themselves through crossed male and female messages, forcing new machines to be born and the old machines to die."

The very common citizen has indeed a very restricted autonomous capacity to move through the network which is becoming the ever stretching milieu where our lives take place. At the same time, the capacity to manage relevant information from ourselves and the environment we are living in offers new avenues to deal with healthcare, sustainability issues or other issues of significant social concern which was previously insufficiently attended [5]. Nevertheless, if we compare the information management model within the living organism with respect to the model behind the internet-of-things (and the internet altogether) mainly geared by big-data technologies we observe a significant difference [6,7]. Concerning their respective sizes, the information volume in the former is still much larger, but while the latter is notably characterized by the overload of information agents (among which we can mostly find information dwarfs and a few information giants), the former is based on the minimization of information management requirements at the higher levels and the recursive coordination of autonomous agency [6]. As we will show, a *cyber-subsidiary model* offers a path to escape from Calvino's conundrum in the context of the information society preserving the human condition [7].

2. An Allegorical View to the Structure of the Internet

In order to consider the human position in the Internet properly, the network of Internet nodes and lines, as typically represented by the IP addresses network (such as Figure 1), is not enough. One need to consider how people actually connect to one another and with other digital assets. We will scrutinize this complex issue in a network theoretical perspective, but first let us approach it allegorically through a more visible but fictional urban landscape [7]:

Imagine a kind of city constituted by a vast number of squares, where people meet and engage in different activities, but among which there is a scarce number of streets you can see. Some people move along them, but if you pay close attention, the number of people popping up or leaving each square are much more than the ones moving along the streets. We distinguish at the sides of the squares some doors through which lots of people pass through. The doors are guarded by watchmen who either let the people enter or not. It may be a sort of custom office, though it is difficult to see whether there is anyone charging. Some of these doors seem to be just for distinguished people—we guess—for whom the doors are opened when they intend to pass through, but there are other doors which are transited by the masses.

Considering the global flow, it is quite obvious that great avenues connecting the squares must be away from the eyes, but they have to be somewhere, surely underground. And indeed the people moving in that underworld must be tremendous, just by taking into account the large number of people in the squares with respect to the people moving along the visible streets. There is another clue to glimpse the complexity of such underworld: most of the people, before leaving one of these squares, go to a kind of small pavilion; seem to ask for something, and then, they go straightforward to some of the doors. Only in strange cases you get to see people going straight to the doors without passing by these pavilions. We presume it maybe the complexity of the underworld they are about to enter what make that people need to be informed. We also guess there is no cartography at hand about the underground streets, maybe it were too complex for human awareness. Although all that are mere conjectures we state from our bird-sight view of this weird city. Nevertheless, it is quite clear that there is no way to acknowledge the semblance of this city from any other one we have experience of.

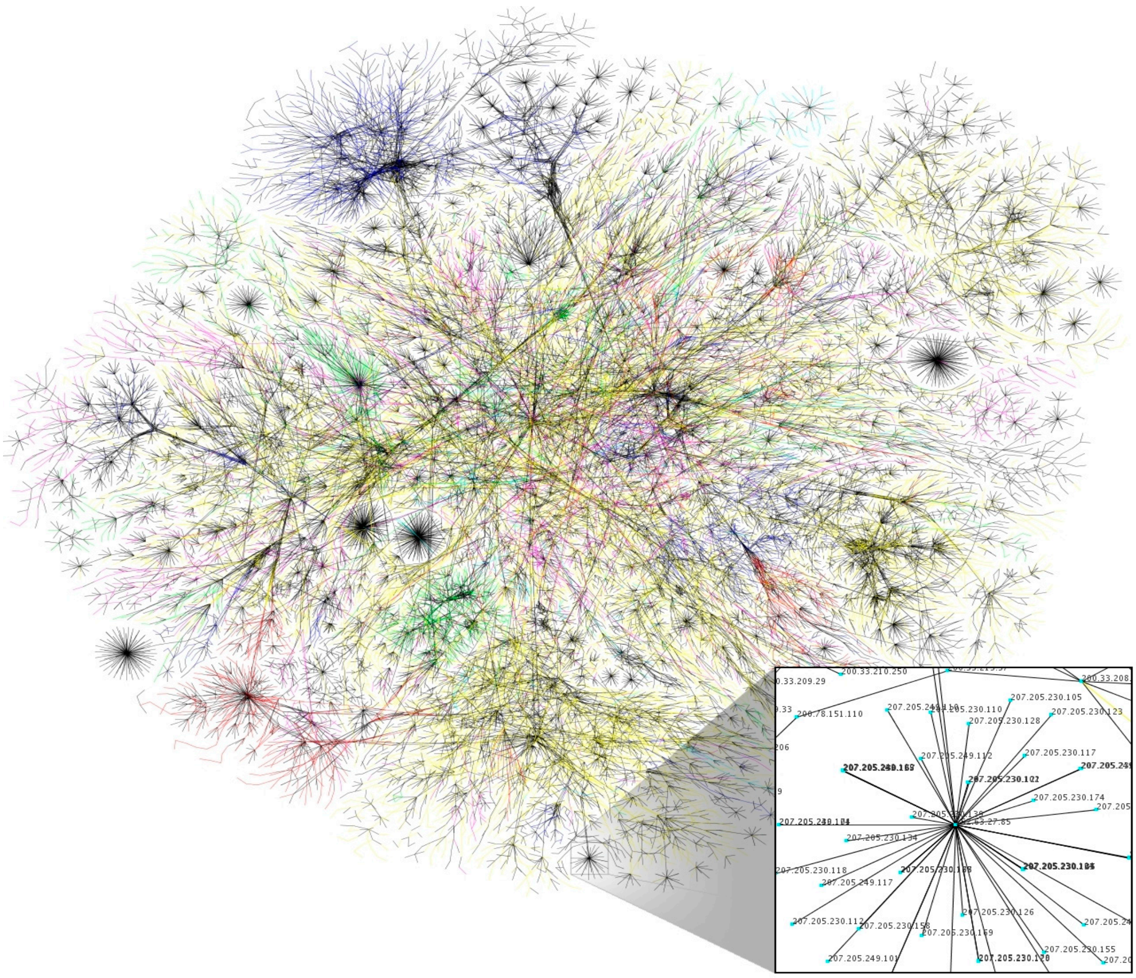


Figure 1. Small look at the backbone of the Internet, actually less than 30% of the Class C networks reachable by the data collection program in early 2005. Each line is drawn between two nodes, representing two IP addresses. The length of the lines are indicative of the delay between those two nodes. Lines are color-coded according to their corresponding RFC 1918 allocation as follows: yellow: net, ca, us; magenta: com, org; light blue: mil, gov, edu; blue: jp, cn, tw, au, de; green: uk, it, pl, fr; dark blue: br, kr, nl; black: unknown (Source: English Wikipedia).

Indeed, when seeking to find out how people actually get access through the Internet to other people and to all kinds of digital assets, one must bear in mind the central role played by big-data technologies. When we do this, we cannot avoid the consideration of the giant data-centers through which most Internet traffic is steered, creating a high concentration of the Internet infrastructure in specific geographic areas. As we can observe in Figure 2 telecommunication lines, though reaching the whole global geography, are extremely concentrated in high-income countries, since the traffic need to pass through the nodes where the giant data-center are connected which distribution is shown in Figure 3 [8,9]. The distribution of this basic infrastructure actually follows approximately the real traffic distribution of telecommunication exchange, due to the fact that in the past two decades new lines have been added following traffic demand very directly.

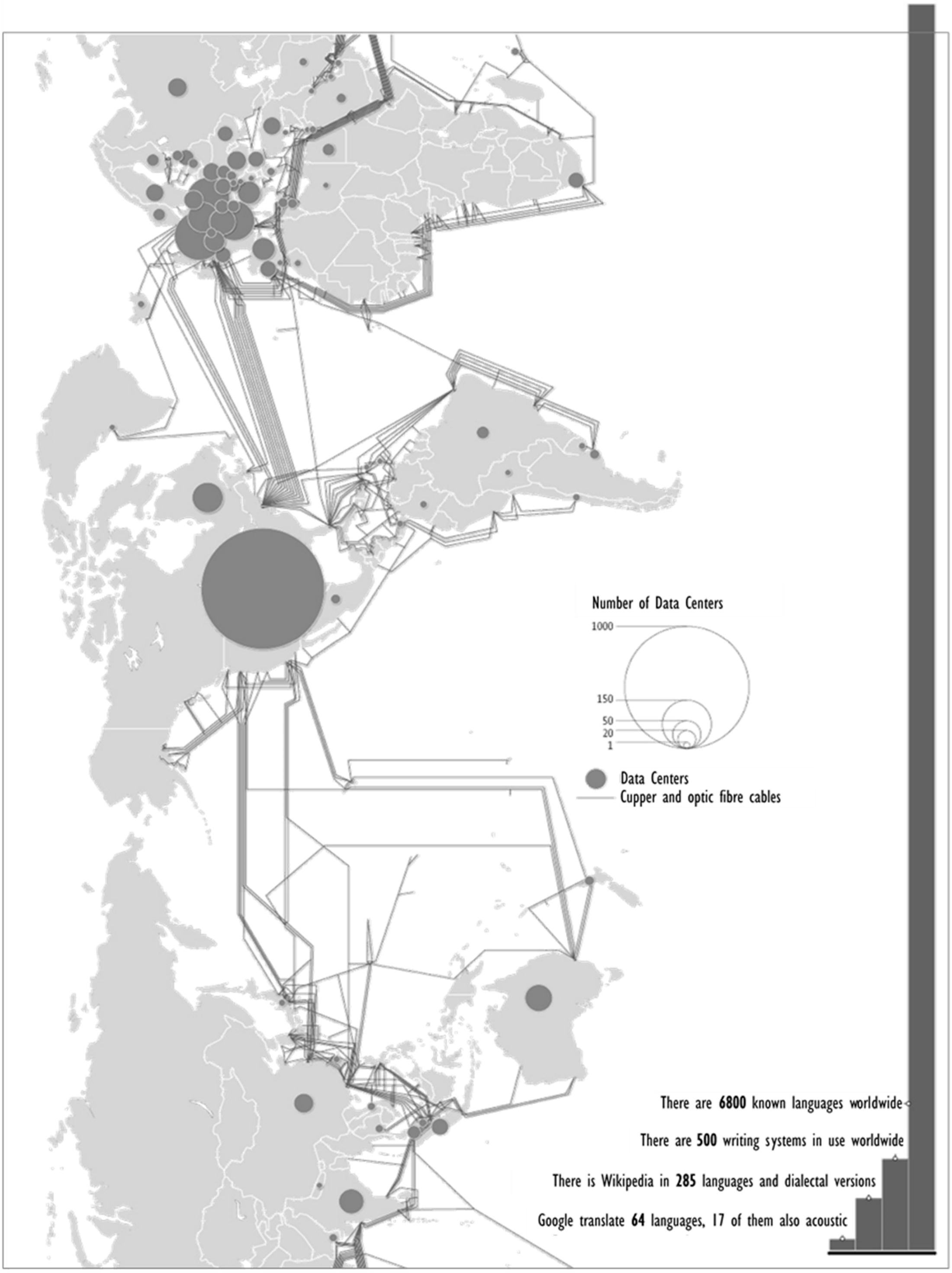


Figure 2. Information Pipes and Data Centers in 2012. Though the representation regarding telecommunication pipes is limited to overseas cables and its relative capacity is not represented, it can be observed that most communication pipes are concentrated among a limited number of nodes, mainly located in Europe and North America. Moreover, most information services as well as data and computing units available in the Internet are not within user devices but in high security infrastructures connected at high speed rates with other network nodes, known as data centers. How much these information services are represented in the language space is illustrated in the right bars, showing that the Internet sphere is dramatically exclusive (Source: Le Monde Diplomatique [8], CC BY-NC 3.0).

Figure 3 displays in more detail how both actual and potential traffic is highly concentrated in the connections among most busy nodes (London, Frankfort, Paris, Amsterdam, New York, Miami, etc., arranged according to 2012 global traffic data); in addition, we can observe that the regional density in Europe and North America with respect to other regions is even higher than income inequality, while peripheral regions, as Latin America or Africa, exchange even more with other regions that with themselves [9].

This represents an important breach in the *subsidiarity principle* we propose as a structural underpinning of a sustainable global information society; feature which is nevertheless preserved by the small-world structure exhibited by the Internet backbone represented in Figure 1 (as we have shown elsewhere [7]). As a consequence of this highly concentrated Internet architecture, we observe that the digital paradise depicted by the cyberutopic perspectives at the dawn of the Internet cannot be hold anymore [10]. Indeed, most of the global population is still off-line, and only a small part (15% in 2016) has access to high-speed services, as observed in Figure 4. Another consequence of this underrepresentation of the periphery, shown in Figure 2, concerns cultural exclusion. The vertical bars at the right hand side of the illustration shows how the language space is represented in some relevant internet services requiring high computing and exchange rates. As we can see a majority of languages (spoken by minorities) are still simply excluded of the Internet.

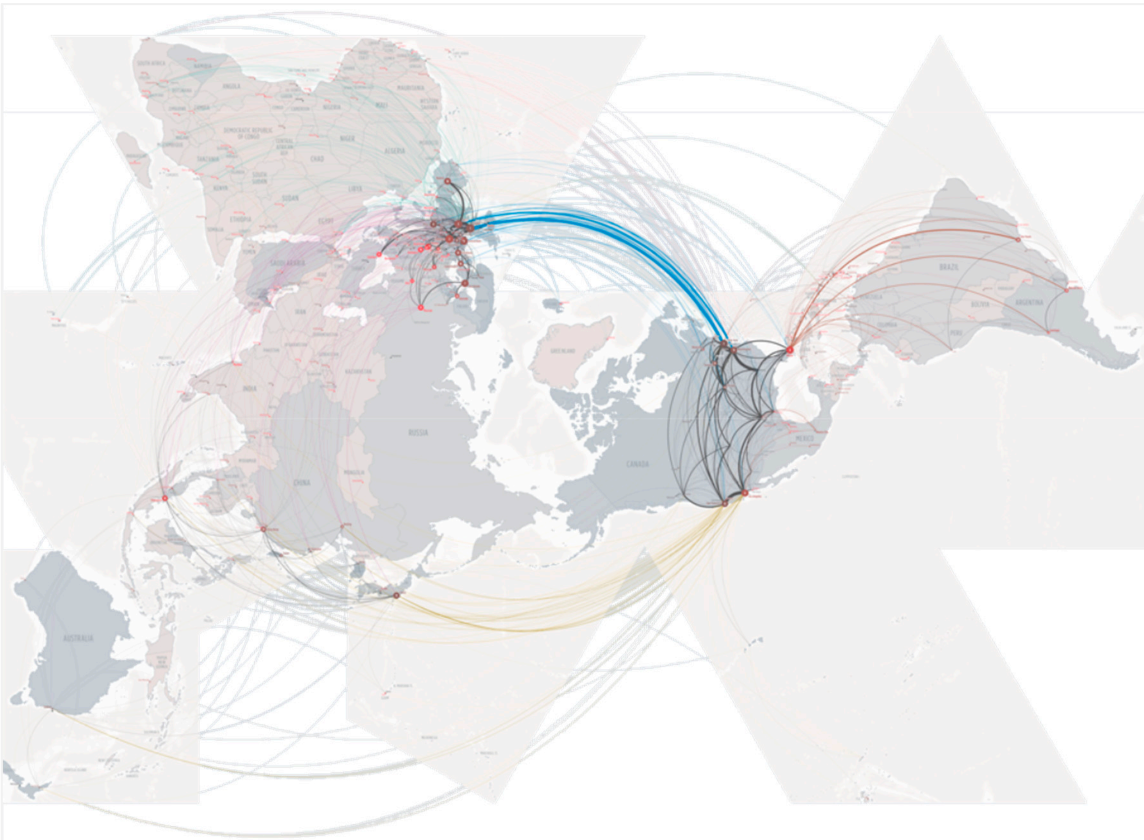
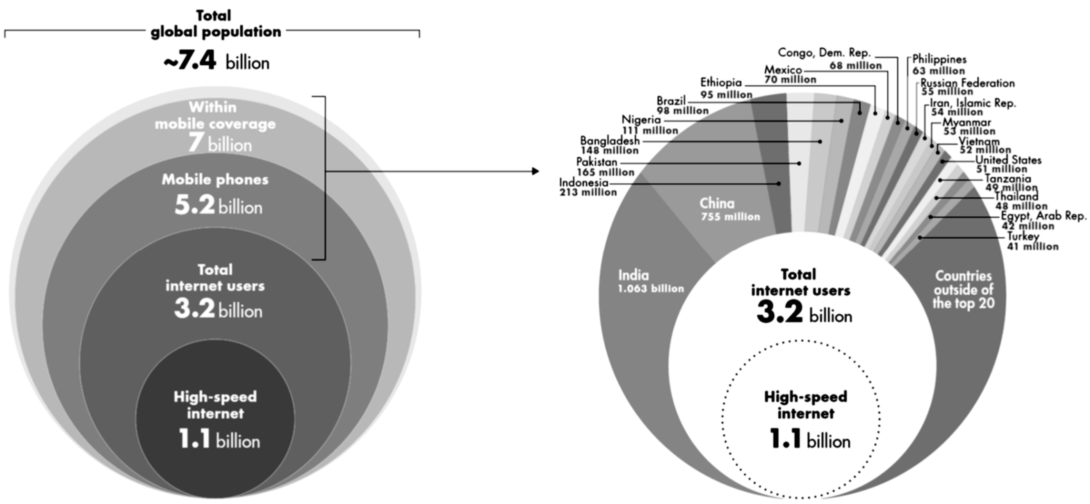


Figure 3. Global Internet Map 2012. The world's highest capacity routes connect core hub cities. More than any other city, London concentrated 11 Tbps of internet international capacity in 2011 (Source: TeleGeography [9], CC BY-NC 3.0).



(**a**) ICT access by population. (**b**) A closer look at the world's offline population.

Figure 4. ICT access by population. High-speed access is restricted to just the 15% of the population, while Internet remains unavailable, inaccessible and unaffordable to a majority of the world's population (Source: World Bank [11], License: Creative Commons Attribution CC BY 3.0 IGO).

How can the huge gap between digital society center and periphery be closed? If the offer and demand of ICT resources is exclusively driven by monetary value, as it is in a substantial extent, the used approach to keep pace of customers' demand cannot suffice to satisfy peoples' demand, unless there is a minimal equality among people's purchasing power, which is far from being the case. The problem is even worse if we consider that telecommunication rates are more expensive the further away you are from the economic center of the Internet (i.e., where more traffic is concentrated), due to the fact that the corresponding service provider is paying more expensive "transit" agreements to interconnect their networks [9]. In sum, if the *subsidiarity principle* is to be a regulatory principle of the global information society (as conceived in *cyber-subsidiarity model* we propose), then we should go beyond the negative sense of subsidiarity claimed by liberal policies to reduce the reach of the public sphere. Instead we need to enact its positive sense to call for action at the higher level in order to enable that a minimal equality is guarantee (as a requirement for an inclusive information society) because at the lower level (with insufficient purchasing power) the problem cannot be solved.

Nevertheless, further properties are required to enact the cyber-subsidiarity model proposed (based on Stafford Beer's viable system model), which would deliver a significantly different network topology and a different kind of gearing technology with a much more distributed process capacity [6,7].

Acknowledgments: The authors wish to express their gratitude to the Bertalanffy Center for the Study of Systems Science (Austria) for their support to the development of this work. In addition they also thank the support, provided by Prometeo's programme of the Ecuadorian government, to a research project concerning the development of general information studies between 2014 and 2017.

Author Contributions: The contents of this paper more directly related to the Internet-of-Things are responsibility of Teresa Guarda, while the network theoretical analysis and the general framework is mostly responsibility of José María Díaz-Nafría.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Guarda, T. Internet of Things Challengs. In Proceedings of the 12th Iberian Conference on Information Systems and Technologies, Lisbon, Portugal, 14–17 June 2017; pp. 628–631.
2. Chiti, F.; Fantacci, R.; Loreti, M.; Pugliese, R. Context-aware wireless mobile autonomic computing and communications: research trends and emerging applications. *IEEE Wirel. Commun.* **2016**, *23*, 86–92.

3. Madakam, S.; Ramaswamy, R.; Tripathi, S. Internet of Things (IoT): A literature review. *J. Comput. Commun.* **2015**, *3*, 164–173.
4. Calvino, I. *The Complete Cosmicomics*; Translated from Italian (orig. 1965); Penguin Books: London, UK, 2010.
5. Helbing, D. Smart Data: Running the Internet of Things as a Citizen Web. In *The Future Information Society: Social and Technological Problems*; Hofkirchner, W., Burgin, M., Eds.; World Scientific Publishing: Singapore, 2017; pp. 213–222.
6. Díaz-Nafría, J.M. eSubsidiarity: An Ethical Approach for Living in Complexity. In *The Future Information Society: Social and Technological Problems*; Hofkirchner, W., Burgin, M., Eds.; World Scientific Publishing: Singapore, 2017; pp. 59–76.
7. Díaz_Nafría, J.M. Cyber-Subsidiarity: Towards a global sustainable information society. In *Handbook of Cyber-Development, Cyber-Democracy and Cyber-Defense*; Carayannis, E.G., Campbell, D.F.J., Efthymiopoulos, M.P., Eds.; Springer: Berlin, Germany, 2017, in press.
8. Scheer, H.; Ramonet, I.; Peinelt, E.; Schulze, B. *Atlas der Globalisierung—Die Welt von Morgen*; Le Monde Diplomatique-Deutsche Ausgabe: Berlin, Germany, 2013.
9. Browning, N.; Krisetya, M.; Lairson, L.; Mauldin, A. *Global Internet Map 2012*; TeleGeography: Washington, DC, USA, 2012.
10. Mattelart, A. *The Information Society: An Introduction*; Sage Publications: Thousand Oaks, CA, USA, 2003.
11. World Bank. *World Development Report 2016: Digital Dividends*; World Bank: Washington, DC, USA, 2016.