After the Internet: Cloud Computing, Big Data and the Internet of Things

Après l'Internet : le Cloud, *les* big data *et l'Internet des objets*

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Paper Outline (Section headings by the editor)

Abstract

This paper identifies key features in the next phase of Internet development by focusing on cloud computing, big data analytics, and the Internet of Things. Together they expand opportunities to centralize control over data, deepen the commercialization of information, and extend the Internet's reach from connecting people to building data-rich networks of things. They also raise significant social policy questions including the concentration of power in a handful of companies closely tied to the military/intelligence world; the environmental consequences of building, powering, and connecting people to a global network of cloud data centers; the privacy and security implications of connecting billions of objects; and the impact of intelligent devices on the future of work. The paper concludes by suggesting that we are at a critical crossroads in Internet development and asks whether it is possible to build the Next Internet without eliminating its foundational values.

Keywords

Big Data, Cloud computing, Internet of Things.

Résumé

Le présent article identifie les traits caractéristiques de la prochaine phase du développement d'Internet en mettant l'accent sur l'informatique en nuage (le *cloud computing*) les services d'analyse des données (*big datas analytics*) et l'Internet des objets. Ensemble ils étendent les possibilités de centraliser le contrôle sur les données, d'approfondir la commercialisation de l'information et d'élargir la portée d'Internet de la connexion des individus à la formation basée sur les données de réseaux d'objets. Ils soulèvent également d'importantes questions de politique sociale, parmi lesquelles la concentration du pouvoir dans une poignée de compagnies étroitement liées au monde du renseignement militaire; les conséquences environnementales de la construction, de la mise sous influence et de la connexion des populations à un réseau mondial de centres de données en nuage (*cloud computing*); les conséquences de la connexion de milliards d'objets sur la vie privée et la sécurité; et l'impact des dispositifs intelligents sur l'avenir du travail.

Mots clé

Les *Big Data*, le *Cloud*, Internet des objets.

Resumen

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Palabras clave

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Introduction

On March 12, 2014, Google called on the world to celebrate the twenty-fifth anniversary of the Internet, which was born, in its view, when the first web browser was released to the public (http://www.webat25.org). Although the earliest Internet communication dated back to 1969, only those few with advanced technical skills could use it. With the arrival of graphical browsers, the Internet was opened to many more users, and Google, with help from early government investment, took off to become one of the richest corporations in the world. By 1993 the Internet was so widespread that the *New Yorker* magazine could publish a cartoon that remains its most viewed. It features a dog sitting in front of a computer screen and telling a fellow canine, "*On the Internet, nobody knows you're a dog*" (Cavna 2013).

Even as the tech world celebrated the Internet's adulthood, the Next Internet was emerging from infancy. Google acknowledged as much when in a revealing 2015 interview, the company's head of search declared that the search engine, which helped to define the Internet, was now a "legacy" system (a euphemism for "still useful but soon destined for the trash heap"). Now Google, along with other large firms and small startups, is hoping to develop new forms of mobile-friendly search engines appropriate to the Next Internet (Dougherty 2015).

It would be presumptuous to map out the precise composition of this next stage in the digital world, but it is reasonable to conclude that the Next Internet may do more to disrupt the world than its older sibling. The Next Internet is far from fully formed and still bears some of the characteristics of the one born in 1989. But it is growing rapidly and already challenging its founders' vision of a

democratic, decentralized, and pluralistic digital world. The Next Internet brings together three interconnected systems: Cloud Computing, Big Data Analytics, and the Internet of Things. It promises companies and government agencies centralized data storage and services in vast digital factories that process and analyze massive streams of information gathered by networked sensors stored in every possible consumer, industrial, and office device, as well as in living bodies. But it is also creating major environmental, privacy and labor challenges.

The Next Internet: Founding Principles

Cloud Computing

The brilliance of the original Internet was figuring out how to get a decentralized, distributed world of servers to talk to one another and thereby connect users through simple, universal software standards. This began to change with the growth of Cloud Computing, the first building block of the Next Internet. The Cloud is a system for storing, processing, and distributing data, applications, and software using remote computers that provide IT services on demand for a fee. Familiar examples include Google's Gmail, the online storage company Dropbox, and Microsoft Office, which increasingly distributes its widely-used word processing and business software through the Cloud for a monthly fee.

The Cloud enables businesses, government agencies and individuals to move their data from onsite IT departments and personal computers to large data centers located all over the world. What is saved in storage space also opens a rapidly growing business for companies that profit from storage fees, from services provided online, and from the sale of customer data to firms interested in marketing products and services. Government surveillance authorities like the NSA and CIA also work closely with Cloud companies including Amazon to meet their security and intelligence needs (Kunkel 2014). The diverse collection of servers providing the foundation for the original Internet has evolved into a centralized, global system of data centers, each containing tens or hundreds of thousands of linked servers, operated primarily by private corporations and government military and surveillance agencies. The leading science journal *Nature* made very clear the practical difference between the original Internet and one based in the Cloud when it called on the US government to establish a Cloud Commons for biological research, especially in genomics. It did so because research on large data sets is far easier and faster to carry out in the Cloud than through servers based in university research facilities (a difference in project time alone of between 6 weeks for the Cloud and 6 months for the old Internet). (Stein *et al.* 2015).

Sparked by such research potential and even more so by a massive advertising campaign to encourage individuals and organizations to move "to the Cloud," including high-priced ads in the 2011 Super Bowl football game, the Cloud is now familiar to most Internet users. Indeed it is fair to claim that if the New Yorker canine cartoon gave birth to the first Internet than the next one began with the magazine's 2012 ad featuring a sad-looking young boy explaining to his teacher that "*The Cloud ate my homework.*" (http://www.newyorker.com/cartoons/a16350)

The Cloud is more like a data factory than a storage warehouse because it processes data to produce services such as marketing, accounting, customer relations, as well as legal and financial services. That makes companies and government agencies partners in service provision with the companies that own and manage data centers. It also marks a major step toward creating a centralized, globalized and fully commercial Internet. The major Cloud providers are almost all large corporations including familiar names like Amazon, by far the world's largest Cloud business, Microsoft, IBM, and Google. Through service contracts, most of these are well integrated into the military, intelligence, and surveillance arms of government. Amazon, for example, provides Cloud computing storage and services for both the Central Intelligence Agency (through a $600 million contract) and the National Security Agency. Meanwhile government agencies demanding heightened levels of security are

building their own Cloud facilities, including the NSA, which in 2015 opened one of the world's largest, in a remote mountain location in Utah.

The Big Data

Big Data Analytics makes up the second leg of the Next Internet. In spite of the proliferation of fancy new titles, like data science professional, that fuel enthusiasm for Big Data, there is very little that a social scientist would find novel. It generally involves taking a large, often massive, and almost always, quantitative data set, and examining the specific ways the data do or do not cohere or correlate, in order to draw conclusions about current behavior and attitudes and go on to make predictions.

Facebook, for example, takes the data generated by its 1.3 billion or so users and relates the likes associated with posts about everything from celebrities, companies, and politicians to views about society, products (and, of course, cats). These enable the company to develop profiles on its subscribers that are then sold to marketers who are able to target Facebook users with customized ads sent to their Facebook pages. Google does the same for search topics as well as for the content of Gmail, and Amazon creates profiles of its users based on searches and purchases on its site. Given the limitations of quantitative correlational analysis, especially the absence of context, theory, and subjectivity (qualitative data is ignored or poorly translated into numbers), such analysis is not always accurate and incidents of Big Data failures, on such projects as seasonal flu forecasting and building models for economic development, are mounting, as are the opportunities to make mischief with data for profit (Mosco 2014). Nevertheless, for simple questions such as what are the likes and dislikes of every conceivable demographic cohort or for drawing conclusions about users based on their friendship and follower networks, the massively large stores of data available for analysis in the digital factories that make up the Cloud, offer major incentives for companies and governments to invest in both Cloud data centers and in Big Data analysis. It is reasonable to be concerned that singular reliance on Big Data in research is paving the way for what one might call digital positivism.

The Internet of Things

The Cloud and Big Data are enhanced substantially by the growth of the Internet of Things. From watches that monitor blood pressure to refrigerators that prompt you to buy more milk, from assembly lines "manned" by robots to drones that deliver weapons, it promises a profound impact on individuals and society. The Internet of Things refers to a system that installs sensors and processing devices into everyday objects (e.g. watches) and production tools (robotic arms), and connects them in networks that gather and use data on their performance. We refer to the admittedly awkward term the Internet of Things because, unlike the Internet we know, which links people, the Internet of Things primarily connects objects. The sensors in a refrigerator form a network of things that report on what's inside and how it is used. The Internet of Things is made possible by advances in the ability to miniaturize scanning devices and provide them with sufficient processing power to monitor activity, analyze usage, and deliver results over electronic networks (Greengard 2015).

A 2015 report from the private think tank McKinsey concluded that by 2025 the Internet of Things will have an economic impact of between $3.9 and $11.1 trillion (US) which, at the high end, is over ten percent of the world economy (Manyika, 2015). Even discounting for the hyperbole that often accompanies tech forecasts by research organizations that are looking to drum up business from the industries they cover, the report is interesting for highlighting likely impacts and for identifying affected organizations. Significantly, it is the manufacturing sector that leads the way as machine production and opportunities for operational surveillance enable more tightly managed and efficient factories and global supply chains. But these will also extend, McKinsey maintains, to offices, retail operations, the management of cities, and overall transportation, as automated vehicles take to the streets and highways made "smart" by sensors embedded everywhere. Heightened monitoring will also extend to the home, promising greater control over heating and cooling, ordering food and supplies and to the body as well where sensors will continuously monitor fitness, blood pressure,

heart rate, and the performance of vital organs. This sounds futuristic and, depending on your point of view, either dystopian or utopian, but it speaks to the power of the new technology and to the fundamental differences between the original Internet and its successor.

The Next Internet: Actual Concerns

Companies have been quick to take advantage of their leading positions in the digital world to rush into the Internet of Things. Prime examples include Google's driverless car, the Apple Watch, and Amazon's embrace of robotics in its warehouses to speed the work of order fulfillment. Amazon is also preparing to use drones for deliveries, and is developing entirely new forms of packaging containing pushbuttons that automate ordering refills. The Internet of Things has also given new life to an old industrial firm, General Electric, which was remade in the 1990s by shifting from manufacturing to finance. GE has now all but abandoned the increasingly regulated world of banking only to emerge as a dominant player producing devices essential to the Internet of Things and making use of them in its own industrial processes. Along with the benefits to corporations, the Internet of Things holds out great promise for the military, because it greatly strengthens opportunities to automate warfare through robotics and drone weapon delivery, in addition to enhancing the overall management of troops.

Reinforced Control over Data

One enormously valuable result of monitoring every device and connecting them in a global grid of objects is the exponential growth in commercially useful data. Today, according to a Cisco report, only 1 percent of the world's objects are linked, so the big promise of the Internet of Things remains just that. Nevertheless, it is forecast that by 2020 50 billion connected devices will join the Next Internet, gathering and reporting data all the time (Evans 2011). Making use of this surge in data will require both new Cloud data centers and widespread use of data analysis. As McKinsey puts it, "*Currently, most Internet of Things data are not used. For example, on an oil rig that has 30,000 sensors, only 1 percent of the data are examined. That's because this information is used mostly to detect and control anomalies—not for optimization and prediction, which provide the greatest value*" (Manyika 2015). How to use data, internally and as a marketable commodity, is one of the biggest challenges facing the Internet of Things industry.

Most of what is written about the Next Internet is technical or promotional, emphasizing the engineering required to build it or touting the potential in sometimes dreamily hyperbolic terms-nonstop leisure, friction-free capitalism, and the Singularity. We are just beginning to see some discussion of the serious policy issues that arise in a world of massive data centers, nonstop analysis of human behavior, and ubiquitous connectivity. These include the concentration of power over the Next Internet in a handful of mainly U.S. companies and the military-intelligence apparatus; the environmental consequences of building and maintaining massive data centers and powering systems; threats to privacy and security; and the impact of automated systems on human labor.

Two things stand out about the early configuration of the Next Internet industry. It is already highly concentrated and is dominated by American firms. These are led by Amazon which controls over one-third of the market in Cloud computing and has a formidable presence in Big Data and the Internet of Things. The company was among the first to build a one-size-fits-all Cloud service that attracted individuals and organizations with its simplicity and discount prices. Indeed some have suggested that Amazon, and competitors Google and Microsoft, have engaged in the not so fine art of predatory pricing by charging below cost for Cloud services and compensating with above market prices in other businesses where they enjoy market power. Facebook and Apple round out the list of firms that use their control over the original Internet to become leaders in the Next Internet. Legacy firms like IBM, Oracle, HP, and Cisco have scrambled to replace their expertise in servicing IT departments that are now disappearing and pivot to the new digital world. However the need to

cannibalize old systems and remake their organizations has made the going slow. In addition, there are firms that specialize in one or another of the constituent Next Internet systems, such as Rackspace and Salesforce.com, but these are constantly undermined by encroachment from the dominant companies. An unknown force of potentially great significance in the Next Internet arena is General Electric, which is betting heavily on reinventing factories with the Internet of Things.

Historians of technology will recognize the similarity of this pattern to the early days of electrification, telegraphy, telephony and broadcasting. In each of these cases, regulation and outright state ownership were required to control abuses and increase access at affordable rates. However, these remedies are less likely to be applied in a world where regulation and government ownership are no longer in favor. Moreover, as in the past, dominant firms are benefitting from their close ties to the military and intelligence communities, providing them with Next Internet services and cooperating more often than not with requests for information on users. In fact, close ties to the Pentagon, including its well-funded research arm DARPA, as well as with the NSA, and the CIA helps to explain why there are no challengers to U.S. hegemony over the Next Internet coming from Europe, whose telecommunications companies once led the world.

China provides the only serious competition. There, government has invested heavily in Next Internet technologies going as far as to integrate them into its five-year plans and build entire Cloud cities. This has benefited leading companies like Alibaba, Baidu, Huawei, and Tencent, among others. Signaling that it intends to challenge America's lead, Alibaba has set up shop in Silicon Valley and, like other Chinese firms, is building on the enormous domestic market to extend its reach internationally (Tse and Hendrichs 2016).

A look at the remaining policy issues reveals why the concentration of corporate power is such a significant problem and why it is essential that societies begin to consider the need for public intervention.

Environmental and Privacy Issues

Because the digital world is made up of invisible electrons zipping through the air, there is a tendency to deem it immaterial. Nothing could be further from the truth and the sooner this is recognized, the more likely the environmental problems associated with the Next Internet will be addressed. Cloud data centers are very material structures and, as they come to fill the world, there are numerous emerging environmental policy issues. It is expected that by 2017 data centers will consume 12 percent of the global grid (Sullivan 2015). Moreover customer demand for 24/7 services requires several layers of backup power, including some, like diesel generators, that have been found to be carcinogenic. Furthermore, many data centers require large, continuous supplies of water for their cooling systems and this raises serious policy issues in places like the U.S. West where years of drought have taken their toll. So far, data center operators have used their economic power to pressure local governments to provide property tax breaks, cut-rate power deals, and relief from pollution regulations.

Some companies have responded to opposition from environmental groups, especially Greenpeace, by incorporating solar and other sustainable energy sources into their data center power supplies. But as data requirements grow, systematic regulation is required, including a broad review of discount power deals. Notwithstanding any progress in this area, the primary source of power consumption in the Next Internet is in the sensors embedded in what is expected to be billions of connected devices and the communication systems that link people and things through cellular and other wireless networks. A world of ubiquitous, always-on connected devices, is enough to make energy executives salivate, especially the lobbying arm of the coal industry which views the Next Internet as an opportunity to build on what a study for the U.S. National Academy of Sciences calls "*the renaissance of coal*" (Steckel, Edenhofer, and Jacob 2015). As a report sponsored by the coal industry concluded, "*The inherent nature of the mobile Internet, a key feature of the emergent*

Cloud architecture, requires far more energy than do wired networks. . . . Trends now promise faster, not slower, growth in ICT energy use" (Mills 2013).

Privacy and security concerns rise exponentially in the Next Internet because greater connectivity increases opportunities for technical breakdowns and criminal hacking. Indeed one tech journalist referred to the Internet of Things as "the greatest mass surveillance infrastructure ever" (Powles 2015). By the standards anticipated in a digital world where the Internet of Things is fully developed, today's Internet is far from creating a connected world, let alone the singularity that fills the dreams of Internet enthusiasts. About 40 percent of the world's population now uses the Internet at least once a year, and, as one might expect, access is concentrated in the developed world and in urban centers (Gagliordi 2015). With only 1 percent connectivity among objects we are far from the promised land of ubiquitous computing. But even at this relatively low level, technical problems and criminal hacking plague the system. On one day alone in 2015 the entire U.S. fleet of United Airlines planes were grounded, the New York Stock Exchange shut down for several hours, and the Wall Street Journal's computers simply stopped operating. All of these were explained as the result of technical "glitches." Just as this calamity hit the news stream, the U.S. government reported that hackers had stolen the personnel records of 22.1 million federal employees, contractors, and their families and friends who provided information for background checks. The haul also included over one million sets of fingerprints (Nakashima 2015).

It is no wonder that observers are concerned about the impact of technical failures and hacking in a world whose people and objects are growing more connected by the day. Who wants her car or, for that matter, her sensor-equipped heart pacemaker, open to hackers? Nevertheless, the most significant threats arise from data-hungry businesses and governments. After all, the greatest attraction of ubiquitous computing is the valuable data on the behavior of people and the performance of objects. These offer opportunities as businesses refine targeted advertising and product development well beyond the crude systems that today's Internet makes possible and governments deepen tracking and control of citizen behavior and attitudes. Consider the commercial benefits to insurance companies that will be able to continuously monitor the health of customers, their driving habits, and the state of their homes; or to governments that can adjust benefits and other services based on citizen behavior registered in their actions, as well as their interactions with one another, and with the things that fill their lives; or to employers that are even now requiring office workers to wear sensor devices on and under the skin for ubiquitous performance monitoring (Wilson 2013). Discussions of anticipatory selling as well as of algorithmic policing, euphemistically called "predictive analytics", are worrisome to privacy advocates because they are attracting great interest from businesses and governments (Davenport 2014).

The impact of the Next Internet on jobs and the nature of labor is also an important policy issue. At first glance, it is tempting to think "here we go again" because the impact of technology on jobs has been discussed for many years but especially since the end of World War II when the computer scientist Norbert Wiener generated considerable public debate by raising the specter of massive job loss due to automation (Wiener 1948). Moreover, the Next Internet is creating and will likely continue to create work, including traditional construction jobs in the build out of global networks of data centers, in the new profession of data science, and in the control, maintenance, and monitoring of networked things. There is another reason why it is important to approach the impact of computer technology on jobs and the economy with caution. As research documents, overall employment has been much more closely tied to GDP than to computerization and, except for the late 1990s when there was massive investment in hardware, the long-promised productivity gains from IT have failed to materialize (Gordon 2016).

However, today there are far more opportunities for the new technology to eliminate human labor, especially professional knowledge work. In fact, one expert consultant prefers to define Cloud computing as "nothing more than the next step in outsourcing your IT operations" (McKendrick

2013). This is in keeping with a general tendency which one researcher for Gartner Associates summarizes succinctly: "*The long run value proposition of IT is not to support the human workforce – it is to replace it*" (Dignan 2011a). The Next Internet creates immediate opportunities for companies to rationalize their information technology operations. Again, from Gartner, "CIOs believe that their data centers, servers, desktop and business applications are grossly inefficient and must be rationalized over the next ten years. We believe that the people associated with these inefficient assets will also be rationalized in significant numbers along the way" (Dignan 2011a).

Next Internet companies maintain that their systems can break a pattern in business organizations that began when the first large computers entered the workplace. Back then all business and government agencies insisted that it was essential to operate their own IT departments and, for larger organizations, their own data centers. Next Internet supporters insist that it is no longer essential to build and run thousands of organization-specific facilities when a few large data centers can meet the demand at lower cost with far fewer professional personnel. This process has already begun and early studies demonstrate that, even with limited downsizing of IT departments, companies are saving between fifteen and twenty percent of their IT budgets (Howlett 2014).

The Next Internet also makes possible the widespread rationalization of practically all knowledge and creative labor because the work of these occupations increasingly involves the production, processing, and distribution of information. According to one observer, "In the next 40 years analytics systems will replace much of what the knowledge worker does today" (Dignan 2011b). A 2013 report concluded that almost half the current U.S. workforce is directly threatened and in the high-risk category for job loss (Frey & Osborne 2013). Whatever the precise share, there is no doubt that the current trend is to use software to move knowledge worker labor to machine systems. We are now beginning to see the impacts on education, health care, the law, accounting, finance, sales and the media. Private and public sector organizations are encouraged to outsource all but their core business processes to companies like Salesforce.com which specializes in managing vast databases of customer information, a job that marketing and client service departments inside companies typically performed.

The expansion of outsourcing to computers raises serious questions for the entire global system of flexible production. According to Gartner, "*That outcome will hit all economies -- especially emerging ones like India that now dominate technology outsourcing*" (Dignan 2011a). The Next Internet also expands the range of potential outsourcing practices. It may be an overstatement to declare, as did Forbes magazine, "*We are all outsourcers now*," but it certainly makes feasible more kinds: "*Outsourcing is no longer simply defined by multi-million-dollar mega-deals in which IT department operations are turned over to a third party. Rather, bits and pieces of a lot of smaller things are gradually being turned over to outside entities*" (McKendrick 2014). Amazon is a leading force in this process with its Mechanical Turk business that charges individuals and organizations to outsource micro-tasks to a worldwide reserve army of online piece workers. Combined with the promise of product warehouses full of robots to locate, pack, and ship goods, and drones to deliver them, Amazon is the leading edge of the Next Internet's push to expand labor intensification throughout the world. Whatever the impact on the number of jobs, the Next Internet is already changing the labor process. Workers at a Swedish firm can attest to this as they arrive at the office each day with RFID chips implanted under the skin to improve productivity and management control (Cellan-Jones 2015).

What to be done?

What can be done to address these problems? First and foremost, it is essential to view them as intrinsically social and not just technological. While technology plays a role in addressing serious policy issues, there is no simple digital fix to solve them. It will take concerted political action to tame the concentrated corporate power that is now making the Next Internet a tool to expand the power

and profit of a handful of digital giants. It will also take global social movements, stronger versions of what supporters called a New World Information and Communication Order in the twentieth century, to build a digital commons for the twenty-first. Furthermore, we need to make environmental protection and sustainability central to all decision-making about the Next Internet. It is also important to rethink privacy as the human right of access to the psychological space essential to develop individual autonomy. Above all, privacy is an essential right of citizenship and not a tradable commodity. Protection of personal, interpersonal and autonomous space from commercial and government surveillance must also be central to the choices made about the Next Internet. Finally, we need social policies about employment and income that address the state of human labor in an age when automation threatens jobs, including now those of the white-collar workforce, and massive invasive surveillance threatens worker dignity. Does this mean we should reopen the discussion of a guaranteed annual income? What is the right balance between job creation and such a guaranteed income? How can we facilitate organizing digital workers who tend to be employed in the "gig" economy of precarious jobs? Are unions at Gawker, Salon and Vice, all pioneering web-based successes, good models for the future?

The digital world is at a critical juncture represented by two clashing visions. The first imagines a democratic society where information is fully accessible to all citizens as an essential service. In this vision information is managed through forms of regulation and control that are governed by representative institutions whose goal is the fullest possible access and control for the greatest number of citizens. Governance might take multiple forms, including different combinations of centralized and decentralized approaches at local, regional, national, and international levels. The second envisions a world controlled by global corporations and the surveillance and intelligence arms of national governments. Under this model, the market is the leading force shaping decisions about the production, distribution and exchange of information, and corporations with market power hold the most influence. In this fundamentally undemocratic world, digital behemoths share power with governments that make full use of technology for surveillance, control, and coercion.

Fifty years ago, long before the first Internet, the Canadian scholar and policy analyst Douglas Parkhill chose the democratic vision in his book about the need to create a global system of computer utilities that would guarantee public control and universal access. Social movements had helped to tame private monopoly power over essential resources like water and electricity by making them public utilities. Parkhill (1966) made the case that information was no less essential and no less in need of public control. The Next Internet is an opportunity to build on his vision.

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