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Perspectives from FSF Scholars
April 27, 2018
Vol. 13, No. 16

Free Market Policy Prescriptions for the "Internet of Things"

by

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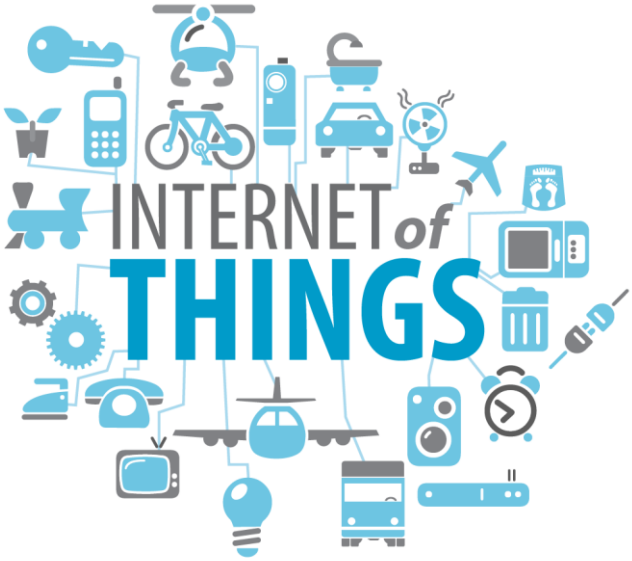
Introduction and Summary

The U.S. economy is only in the early stages of the sweeping wave of smart device connectivity now widely known as the "Internet of Things" (IoT). Within the next three years, networked devices and applications will proliferate – likely exceeding 20 billion by 2020. Sensor-embedded networked devices will become an increasingly common feature of industrial, manufacturing, agricultural, transportation, and other commercial enterprises. According to Gartner, by 2020, IoT technology will be in 95% of new electronic product designs. Connectivity in products for home use will also become much more frequent. Cisco projects connected home automation, home security, refrigerators, washing machines, and the like representing as much as 46% of all such connections by 2021.

Accenture projected global IoT-related cumulative real GDP contribution totals of $10.6 trillion in U.S. dollars by 2030. Yet for America to fully realize the economic and social benefits of the IoT, market freedom must be maintained. And non-restrictive means of promoting investment and innovation through new technologies and services must be pursued. Federal policy should prioritize licensed and unlicensed spectrum availability and streamlined measures for deploying broadband network infrastructure. Experimental uses of wireline, wireless, and satellite technologies necessary to deploy IoT networks should be encouraged by agencies such as the

FCC and NTIA. Efforts to streamline federal and state siting policies for broadband infrastructure must be continued. And federal agencies should cooperatively promote industry efforts to establish standards and best practices for privacy and cybersecurity for the IoT.

Unlike mass-market retail broadband Internet access services that transmit data to and from all public Internet endpoints and which consumers routinely access through smartphones, tablets, and PCs, IoT networks provide specialized or managed network connectivity for myriad types of devices used by business enterprises and consumers. Indeed, the IoT will generate tremendous value for consumers and likely even greater value for enterprises. Different sectors of the U.S. economy will be able to reduce costs and improve service quality through the use of real-time data transmissions and analytics. Using IoT networks, industries will be able to more precisely and safely operate sophisticated heavy machinery and manufacturers will be better able to monitor factory conditions and control environmental settings. Also, transportation enterprises will be better able to track and coordinate product shipments and agricultural enterprises will be better able to plan and implement farming operations.



Enterprise and consumer IoT services, devices, and applications will vary widely. Increasingly, IoT connections will traverse multiple delivery platforms – including fiber-based broadband networks, 5G mobile and fixed wireless networks, as well as geostationary and non-geostationary satellite networks. Indeed, mobile service providers such as AT&T, T-Mobile, and Verizon recently have launched, or are in the early stages of launching, 4G LTE-enabled IoT networks.

Future deployment of 5G networks will further improve IoT connectivity options for enterprises and businesses. Likewise, new subsidiaries of cable broadband providers, including Cox2m and Comcast's machineQ, are expanding IoT network coverage through the use of their backhaul and Wi-Fi hotspots. Additionally, pending at the FCC for some time is Ligado's application to launch an integrated satellite and terrestrial IoT network. Ligado's proposed network will focus on providing networked device and equipment IoT connectivity to industrial, manufacturing, and

other enterprise customers. By one economist's estimation, if the FCC grants the application, Ligado's IoT network could generate between $250 and $500 million in social welfare benefits.

Given the potentially dizzying diversity of network infrastructure, smart devices, and applications, the IoT is not conducive to one-size-fits-all prescriptive regulation. A hands-off approach toward nascent IoT technologies and services should be maintained in order to ensure timely IoT proliferation and also to avoid undermining investment and innovation. Sophisticated enterprise customers can bargain at arm's length with IoT service providers for data privacy and other protections that best meet their needs. Claimed breaches of consumer privacy protections involving IoT-related services could be subject to the FTC's Section 5 power to address unfair and deceptive trade practices on a case-by-case basis. And industry efforts to set IoT standards and best practices for privacy and cybersecurity should be bolstered through inter-agency coordination.

Speedy preparation and licensing of spectrum bands for commercial usage must be an ongoing imperative. The FCC should act with dispatch, for example, in auctioning higher spectrums bands, such as the 28 GHz and 24 GHz, as well as above 95 GHz and mid-band spectrum. Additionally, the House of Representatives should promptly take up the MOBILE NOW Act (S. 19), which was passed by the Senate in August 2017, and which includes several provisions for the allocation of spectrum for commercial mobile use. A competitive IoT environment will also depend on allocation of unlicensed spectrum that can be used to connect devices through WiFi-enabled low power wireless area networks.

Likewise, expeditious review and approval processes for spectrum use applications are essential to achieve accelerated and widespread IoT deployment. More particularly, FCC and NTIA policies should operate with a strong presumption favoring grant of applications and permits for new and experimental services, products, and uses of spectrum. The FCC can formalize such an approach to new technologies and services in its Section 7 proceeding. Agency reviews of mergers and other transactions involving the transfer of spectrum licenses must also be conducted with dispatch to best ensure that limited spectrum resources are allocated to IoT providers willing to make the capital investments necessary promptly to put such resources to their highest use.

Finally, Congress and federal agencies must follow through on recent proposals to reduce unreasonable federal, state, and local government regulatory and other costly barriers to deployment of fiber and wireless infrastructure that will be critical to the IoT. For example, the MOBILE NOW Act contains infrastructure siting provisions that the House should consider in earnest. And follow-through is needed on President Trump's January 2018 executive order to streamline the siting of broadband facilities on federal buildings and federal real property.

By maintaining a policy favoring market freedom and non-restrictive means of promoting investment and innovation, federal policymakers can ensure that America rapidly and fully realizes the sizeable economic value offered by the coming "Internet of Things."

What is the Internet of Things?

In its 2016 Green Paper on the "Internet of Things," the U.S. Department of Commerce recognized that there is no widely held consensus definition of the term. Analysts have similarly observed a variety of competing IoT definitions in current usage. As the Commerce Department's Green Paper astutely points out, "Internet of Things" is even a misnomer insofar as many smart devices do not use Internet protocol or connect to the Internet. For its part, the Commerce Department's Green Paper describes the IoT as an "umbrella term" for the technological development of greatly increasing numbers of devices connected to each other and/or the Internet. For purposes of this *Perspectives* paper, the term "Internet of Things" simply refers to networked intelligent or smart devices or other equipment capable of sending or receiving communications.

Unlike mass-market retail broadband Internet access services that transmit data to and from all public Internet endpoints and which consumers routinely access through smartphones, tablets, and PCs, IoT networks provide specialized or managed network connectivity for myriad types of devices used by business enterprises and consumers.

Among its many manifestations, the IoT encompasses machine-to-machine (M2M) devices, or devices that communicate directly with each other. Typically, M2M communication does not require close supervision by enterprise users or consumers. Smart devices that operate with varying degrees of active supervision by enterprise users and consumers also exist within the IoT ecosystem. A brief overview demonstrates the variety of functions and enhancements that IoT services can bring to different sectors of the economy and to consumers.

IoT Solutions for Enterprise, Manufacturing, Industrial, Agricultural, and Energy Sectors

Business enterprises are poised to be perhaps the greatest beneficiaries of the IoT. Indeed, IoT services and functionalities can optimize processes and output for manufacturing, industrial, agricultural, and energy service sectors of the economy. For example:

- Real-time or near-real time data communications enabled by sensors and other electronics embedded in equipment enables enterprise operators to ascertain when equipment or assets need to be repaired or replaced. Reduced equipment inspection times and costs and improved timeliness of maintenance generate operational efficiencies.

- Additionally, the IoT can optimize the quality and timing of supply chains by allowing enterprises to track and adjust the location of their equipment and products. Enterprises can also monitor and alter the temperature and other environmental conditions of their supply chains. For transportation-related services, use of networked devices and equipment can improve routing and lower fuel costs.

- For retail enterprises, sensors embedded in store-stocked products can provide valuable theft detection capabilities. Such IoT-enabled functionalities can enhance

video monitoring and other current security practices and thereby reduce theft-related losses incurred by retail enterprises.

- Networked device connectivity can likewise help manufacturing enterprises synch operational data across geographic locations and equipment to optimize fabrication processes and output quality.

- IoT-based precision agriculture can enhance production efficiency. By collating and processing large volumes of data regarding atmospheric, soil, crop, and livestock conditions received from numerous censors as well as from weather or other information services, IoT systems and applications can inform farmers' decisionmaking regarding planting, fertilizing, irrigation, harvesting, and feeding.

Explosive IoT Growth Projections

A continuous stream of industry and analyst reports provides staggering IoT device connectivity estimates as well as market investment projections regarding IoT-related technologies and services.

According to Cisco's Visual Networking Index (VNI) (June 6, 2017):

- M2M connections that support IoT applications will constitute more than half of the 27.1 billion global devices and connections by 2021.

- IoT innovations in connected homes, connected health care, smart cars and transportation as well as other M2M service will grow from 5.8 billion in 2016 to 13.7 billion by 2021.

- IoT-related applications in the health sector will have a compound annual growth rate (CAGR) of 30%. Such applications will involve health monitors, medicine dispensers, first-responder connectivity, and telemedicine.

- IoT apps in the connected car and connected city segments will have 29% CAGRs.

- Connected home applications, such as home automation, home security and video surveillance, connected white goods [refrigerators washing machines], and tracking applications, will represent 46% of total M2M connections by 2021.

Gartner, Inc. has also made a series of IoT future forecasts:

Worldwide spending on IoT security will reach $1.5 billion in 2018.

Connected things in use will reach 20.4 billion worldwide by 2020.

By 2020, IoT technology will be in 95% of electronics for new product designs.

Additionally, based on an analysis of public policy and IoT investment trends in 20 countries, Accenture projected cumulative real GDP contributions of $10.6 trillion in U.S. dollars by 2030. Accenture further concluded that increased investment and other IoT-related adjustments could boost cumulative real GDP contributions to $14.2 trillion by 2030. BI Intelligence Estimates has projected that, by 2020, 100 million cars will have their own Internet connections. A report by ABI Research forecasted that the U.S. cellular M2M market will grow beyond 300 million connections by 2022, with adoption of IoT technologies involving connected vehicles being the leading type of applications to benefit U.S. cellular operators. According to Ericsson's 2017 Mobility Report, by 2023 there will be approximately 20 billion IoT-related connected devices including connected cars, machines, meters, sensors, point-of-sale terminals, consumer electronics, and wearables.

Technological and Market Developments Are Enhancing IoT's Attractiveness

Importantly, a number of ongoing positive technological and market developments are making IoT services and applications increasingly viable to enterprises and consumers. Energy efficiency and overall performance metrics for miniaturized sensors and other micro-electrical-mechanical systems will continue to improve. Computer processing power and data storage costs will continue to fall. Widespread adoption of IPv6 will enable 340 trillion trillion trillion (that is, an undecillion) IP addresses to accommodate the deployment of tens of billions of IoT devices over the coming years. And, as will be discussed below, deployment of both 5G mobile networks, Wi-Fi enabled Low-Power Wireless Area Networks (LPWANs), and integrated satellite/terrestrial networks will provide competing distribution platforms for IoT services.

Next-Generation Network Deployments Will Enhance IoT Offerings

Major market participants in the IoT ecosystem include Intel, Cisco Systems, Bosch, and IBM. Those and a myriad of other market participants typically specialize in discrete aspects of IoT services, such as infrastructure, networks, devices, sensor equipment, software programs, and user applications. Such participants work in partnerships with each other to provide enterprises and consumers sophisticated and integrated IoT offerings. Among countless examples, CenturyLink's location-based analytics IoT system offering combines CenturyLink-managed WiFi and analytics with Cisco Meraki cloud-controlled WiFi access points to provide business enterprises operating large venues and retail locations with real-time information about customer behavior based on physical location, allowing such enterprises to better understand and proactively meet customer demands.

To date, participants in the IoT ecosystem have invested billions in network deployments and technological capabilities, with billions more in investment expected over the coming years. On April 4, for instance, Microsoft announced it would invest 5$ billion in IoT during the next five years – a sharp increase over the $1.5 billion in IoT-related investments it made during the prior four years. Microsoft's IoT-related offerings include device operating systems software, cloud services, data analytics, and user applications.

Cellular or mobile broadband service providers are playing a key role in enabling M2M communications and smart device connectivity. According to a study from Berg Insight, by mid-2017, AT&T had 36 million cellular IoT connections and Sprint and Verizon each had 15 to 20 million cellular IoT subscribers. To date, such connections have primarily been provided using GSM or equivalent mobile wireless technologies. But next-generation mobile technologies are now being harnessed to deliver IoT services.

Next-Generation IoT Networks

Using LTE-M and narrowband IoT (NB-IoT) technologies with licensed spectrum, major mobile broadband service providers have launched nationwide IoT networks or have announced the impending launch of such networks. These IoT networks support low-cost IoT service plans for enterprises and consumers.

In April 2017, Verizon Enterprise Solutions launched its LTE Category M1 network, or LTE-M network, providing a gateway for developers and business enterprises to M2M and IoT device operations using 4G and cloud technologies. Through its LTE Cat-1 network and ThingSpace IoT web platform, Verizon offers Smart Cities or Smart Communities solutions, telematics for monitoring and coordinating vehicle fleets, asset management and tracking, as well as mobile commerce capabilities.

In May 2017, AT&T announced the nationwide availability of its IoT plans for developers and enterprises. AT&T's IoT connectivity offerings are provided through its LTE-M network, enabling functionalities and services such as Smart Cities, smart energy metering, supply chain management, security monitoring, and personal wearables.

Following trials in Las Vegas, T-Mobile announced it would begin offering narrowband IoT (NB-IoT) plans nationwide in 2018, connecting devices with data streams using LTE-Advanced technology. Its NB-IoT network uses very low power, thereby enabling long battery life and high numbers of connections per cell site. T-Mobile is marketing its NB-IoT plans for smart utility metering, enterprise asset tracking, lighting and environmental censors, agricultural, and smart home personal use. Additionally, T-Mobile is planning a nationwide launch of LTE-M or Cat-M technology sometime after its nationwide NB-IoT network is made available.

Meanwhile, cable broadband providers are also operating and planning future expansion of IoT-related services. Newly formed cable subsidiaries such as Cox2M and Comcast's machineQ provide IoT services through LPWANs using their backhaul capacities, public Wi-Fi equipment, and unlicensed spectrum.

In March, Cox2M announced that its pilot-tested LPWAN would be providing real-time vehicle tracking services to auto-auctioneer Manheim, a company owned by a Cox subsidiary. Cox2M's network is planned for operations across the U.S. and Canada, with the capability of connecting over 500,000 vehicles. Moreover, Cox2M's IoT capabilities are said to include support for smart cities and smart campuses, energy services, utilities, agriculture, and retail enterprises.

Currently, machineQ offers IoT coverage in over 15 major metropolitan areas within Comcast's cable broadband footprint, with plans for future coverage expansion. Use cases for machineQ include property management, such as sensors for detecting fixture, appliance, and multi-dwelling unit water usage and leak identification. Additional IoT functionalities supplied by machineQ include advanced water utility metering and real-time crop irrigation monitoring. Also, machineQ is planning to roll out "Connectivity OnDemand," an e-commerce platform for business enterprises.

Additionally, integrated satellite and terrestrial networks constitute a competing technology platform for delivering IoT services. Use of satellites will increasingly be essential for transmitting extraordinar?y geo-location data to machinery, vehicles, and other equipment used in manufacturing and a variety of industrial processes. Real-time relay of such data can increase precision and improve safety. Satellite transmission will also provide connectivity to assorted smart devices and other physical assets used by business enterprises.

Ligado Networks has filed with the FCC an application to operate a network combining both satellite and terrestrial technologies to provide IoT support to transportation, energy, electric utility, and public safety sectors. Its application proposes use of mid-band spectrum in the 1-2 GHz range for its integrated satellite terrestrial IoT network. The application calls for Ligado to devote 23 megahertz of its licensed spectrum as a guard band next to neighboring GPS services, thereby avoiding signal interference issues. And Ligado's application has garnered a consensus of support amongst mobile broadband Internet access service providers. Economist Coleman Bazelon concluded that $250 to $500 million in social welfare benefits would result from the FCC granting Ligado's application. Although the FCC's public comment period for Ligado's application proceeding concluded in August 2016, its IoT network application still needs to be signed off by NTIA and to be acted on by the FCC. To realize the enormous potential benefits of Ligado's integrated satellite/terrestrial IoT network, federal agency review should be finally concluded.

Free Market Policy Imperatives for a Thriving Internet of Things

Because IoT connections will traverse multiple delivery platforms – including fiber-based broadband networks, 5G mobile and fixed wireless networks, as well as geostationary and non-geostationary satellite networks – and because enterprise and consumer services, devices, and applications will vary so widely, the IoT is not conducive to one-size-fits-all prescriptive regulation. A hands-off approach toward nascent IoT technologies and services must be maintained in order to ensure timely successful IoT proliferation and also to avoid restricting or undermining investment and innovation. Going forward, policy affecting IoT networks and device connectivity should be characterized by market freedom and emphasize non-regulatory means for promoting innovation and investment in IoT-related infrastructure.

To the extent that enterprise is a principal customer and beneficiary of the IoT, sophisticated enterprise customers can bargain at arm's length with IoT service providers for data privacy and other protections that best meet their needs. Claimed breaches of consumer privacy protections or other terms of service involving IoT-related services could be subject to FTC enforcement.

Pursuant to FTC Act Section 5, the FTC has authority to address specific instances of alleged unfair and deceptive trade practices.

Concerted agency action regarding spectrum is critical to the future of the IoT. Speedy preparation and licensing of spectrum bands for commercial usage must be an ongoing imperative. Likewise, expeditious review and approval processes for spectrum use applications are essential to accelerated and widespread IoT deployment. A competitive IoT environment will also depend on allocation of unlicensed spectrum that can be used to connect devices through WiFi-enabled low power wireless area networks. The FCC should act with dispatch, for example, in auctioning higher spectrums bands, such as the 28 GHz and 24 GHz, as well as above 95 GHz and mid-band spectrum. New spectrum must also be identified for commercial usage. And for its part, the House should promptly take up the MOBILE NOW Act (S. 19), which was passed by the Senate in August 2017, and which includes several provisions for the allocation of spectrum for commercial mobile use.

More particularly, the FCC and NTIA policies should operate with strong presumption of favorability to granting applications and permits for new and experimental services, products, and uses of spectrum. The FCC can formalize such an approach to new technologies and services in its Section 7 proceeding. Agency reviews of mergers and other transactions involving the transfer of spectrum licenses must also be conducted with dispatch to best ensure that limited spectrum resources are allocated to IoT providers that are willing to make the heavy capital investments necessary to promptly put such resources to their highest use.

Policymakers should also reinforce efforts to streamline deployment of infrastructure that will be critical for pervasive smart device connectivity. Congress and federal agencies must follow through on recent proposals to reduce unreasonable federal, state, and local government regulatory and other cost barriers to deployment of fiber and wireless infrastructure that will be critical to the IoT. For example, the MOBILE NOW Act contains infrastructure siting provisions that the House should consider in earnest. And timely follow-through is needed on President Trump's January 2018 executive order to streamline the siting of broadband facilities on federal buildings and federal real property.

Conclusion

The U.S. economy is only in the early stages of the "Internet of Things." For American to fully realize the economic and social benefits of the IoT, market freedom must be preserved and non-regulatory means of promoting investment and innovation through new technologies and services must be pursued. Congress and federal agencies should prioritize licensed as well as unlicensed spectrum availability. And policymakers must further efforts to streamline permit processes for deploying broadband network infrastructure. Experimental uses of wireline, wireless, and satellite technologies necessary to deploy IoT networks should be encouraged by agencies such as the FCC and NTIA. Efforts to streamline federal and state siting policies for broadband infrastructure must be continued. And federal agencies should cooperatively promote industry efforts to establish standards and best practices for privacy and cybersecurity for the IoT.

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