Before the
DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Washington, DC 20230

In the Matter of	)	
	)	
The Benefits, Challenges, and Potential Roles for Government in Fostering the Advancement of the Internet of Things	)	Docket No: 160331306-6306-01

COMMENTS OF NOKIA

Nokia offers these comments in response to the National Telecommunications and Information Administration's Request for Public Comment on The Benefits, Challenges, and Potential Roles for Government in Fostering the Advancement of the Internet of Things.

I. NOKIA'S 5G LEADERSHIP

Nokia is an innovation powerhouse and, with the acquisition of Alcatel-Lucent, represents unparalleled leadership in the technologies that connect people and things.[1] With the integration of Alcatel-Lucent, Nokia now possesses the capabilities and global scale to meet the extraordinary demands and opportunities of a world where everyone and everything is increasingly connected. Nokia is leveraging its strengths to create a new type of network that is intelligent, efficient, and secure, and which will serve as a critical enabler of many capabilities and use cases associated with the Internet of Things (IoT) that are still aspirational. We are weaving together the networks, data, and device technologies to create the universal fabric of our connected lives. In this new paradigm, new applications and data will flow without constraint,

[1] *See* "Nokia and Alcatel-Lucent to Combine to Create an Innovation Leader in Next Generation Technology and Services for an IP Connected World," April 15, 2015, available at http://company.nokia.com/en/news/press-releases/2015/04/15/nokia-and-alcatel-lucent-to-combine-to-create-an-innovation-leader-in-next-generation-technology-and-services-for-an-ip-connected-world.

services and industry will automate and run seamlessly, communities and businesses can rely on privacy, security, and near instant response times by connecting through the cloud.

The acquisition of Alcatel-Lucent earlier this year brings together two high-performing companies to create a single portfolio, converging mobile broadband with fixed line access, and the underlying IP routing and optical technology that connects them. Nokia has made pioneering advancements in reducing the footprint of mobile base station infrastructure, from compact yet full power macro sites down to the full range of "small cell" solutions, which are expected to be critical to enabling 5G deployment and the IoT. Nokia also offers the industry's most comprehensive portfolio of services for integrating heterogeneous networks ("HetNets"), encompassing analysis, optimization, deployment, and management.

The combined company is uniquely positioned to create the foundation of seamless connectivity for people and things wherever they are. This foundation is essential for enabling the next wave of technological change, including the IoT and transition to the cloud. The acquisition of Alcatel-Lucent, and with it Bell Labs, has provided Nokia unparalleled innovation capabilities. With approximately 40,000 employees performing research and development ("R&D") and a combined spend of approximately $4.5 Billion in 2014 on R&D,[2] Nokia is well placed to play a leading role in shaping the new revolution in connectivity.

II. NOKIA RESPONSES:

Are the challenges and opportunities arising from IoT similar to those that governments and societies have previously addressed with existing technologies, or are they different, and if so, how?

Technology as a broad industry has historically seen major periods of creative destruction followed by new innovation and rapid expansion as entrepreneurs capitalize on the new opportunities that are enabled by a new generation of technology. So, there are in fact lessons

[2] This total excludes Nokia's HERE business, which was recently sold.

that can be learned from previous periods of technological growth and evolution. One theme common to both previous generations of technological evolution and the IoT is that disruption will occur wherein existing ecosystem participants will expand in to new areas (for example cable companies offering telephony, telephony companies offering video and more recently applications) at the same time there will be new entry. Because of ubiquitous connectivity, common communications protocols and reduced barriers to entry that the Internet provides, it is very likely that within the IoT space governments will see startups competing side-by-side with established companies moving in to new areas like intelligent transportation and connected health care. One lesson that can be drawn from previous periods of technological evolution is that policymakers need to maintain a position of technology neutrality, being careful not to promote rules and policies that treat companies offering similar applications and services differently based on previous regulatory regimes.

Previous examples of rapid technological evolution and change also demonstrate that the key to sustaining that evolution and growth of new industries is maintaining the right environment for innovation. As noted, technology neutrality is one dimension of a strong innovation environment. A second dimension is the promotion of risk taking and rewarding investment through fair and balanced intellectual property rights policy. Unfortunately, the United States has begun to deviate from this type of environment in recent years, enacting policies that limit the rights of patent holders. As noted further in these comments, the Internet ecosystem has led to some segmentation between the application and service community that utilize technology and infrastructure provided by other participants in the ecosystem to reach their customers on the one hand, and the companies whose considerable research and development activity facilitates the evolution and expansion of the infrastructure foundation that

sustains the Internet ecosystem on the other.

Aggregators of technology have continued to press for legal and policy reforms that limit the rights of patent holders to enforce their patents through the use of injunctions and other exclusionary relief while at the same time pursuing so-called reforms to domestic patent law that raise the barriers and costs to enforcement of patents in the courts. The net result of this is to make investment in new technologies riskier. A more balanced patent rights framework, one which curtails abusive litigation tactics while also requiring users of technology to engage in good-faith negotiations for licenses to use others' technology, is the appropriate way to ensure that the United States maintains a positive innovation environment.

While past evolutions of technology underscore the need to maintain technology neutrality with limited regulatory barriers and a positive innovation environment, the IoT does raise some new challenges. The promise of great connectivity not just of computers, tablets, and hand held devices but also of industrial infrastructure, transportation, health care delivery and even entire cities creates significant technical challenges. Chief among these is how to ensure continued expansion of the infrastructure needed to support the connectivity demands, the seamless access to connectivity and data even while mobile, and how to securely manage the large amounts of data created by billions of connected devices and machines. So called "big data" and the growing field of data science and analytics are a key catalyst for the growth of the IoT. Policymakers must balance a desire for transparency, privacy, and consumer protection with the need to maintain an environment that allows innovation, experimentation, and growth. In approaching these issues, Nokia believes that policymakers need to remain cognizant of several important realities.

First, the is tremendous diversity of companies and business models within the IoT space

in terms of the data they collect, how it is processed and utilized, and how privacy rules impact their business models. Ecosystem participants ranging from the application or over-the-top (OTT) service provider, to the network operator and on down to the infrastructure vendor all have significant needs to access data about consumer activity. Doing so allows for further refinement and evolution of applications and services, improvement of network performance and reliability, and future design of infrastructure solutions. Privacy and consumer protection regimes designed for an IoT world must be flexible enough to allow for growth and change. Second, policymakers must understand that disclosure and meaningful consent from consumers is an important regulatory design principle, but attempting to dictate this through opt-in, opt-out, or do not collect regimes creates substantial risk.

Again, ecosystem participants have different business models and while the debate on these type of data collection regimes is usually driven by application and OTT companies, it is important for policymakers to understand that overly restrictive data collection frameworks impact the entire ecosystem. As an example, network operators and their infrastructure suppliers need to understand how consumers are using their devices and the network, and where issues like demand bubbles or loss of connectivity may occur.

The ability to access live and stored data on a network is key to network management. So, limiting access to information including geo location data could impede this. And, data localization rules or frameworks that limit access to data from outside a particular geography complicate efforts to ensure network performance and reliability. At the same time, policymakers should also understand that how consumers utilize devices and networks is a valuable source of information to a variety of market participants and can be a significant source of value creation for network operators and infrastructure companies whose continued R&D

expenditure and network investment are key to advancing the IoT ecosystem. Opt-in, opt-out and do not collect regimes are therefore potentially destructive of this value if they are not carefully considered. Nokia believes that it is possible to design regimes that promote transparency, consumer choice, and protections against misuse of consumer information while allowing for this value creation to occur throughout the ecosystem.

Finally, with respect to technical infrastructure, in the wireless context, demand for new spectrum to enable networks to support IoT is higher than ever with increasingly limited opportunities for "clean" single use spectrum and competing uses complicating sharing concepts. Policymakers will need to think creatively about how to overcome these limitations in order to ensure a steady and predictable supply of spectrum to allow the rapid evolution of wireless networks. Wireless networks are an essential element of ensuring that many of the aspirational use cases within the IoT paradigm such as autonomous driving vehicles and connected health care become a reality.

a. What are the novel technological challenges presented by IoT relative to existing technological infrastructure and devices, if any? What makes them novel?

The substantial increase in connected devices and machines, and their associated demands that will define IoT, will strain the capabilities of currently deployed infrastructure. Nokia expects tens of billions of new devices and machines to come online, and supporting these devices and the applications that run on them will require significant investment from both the public and private sector in new infrastructure. As noted in the policy views paper attached to these comments, IoT will require a massive advance in wireless communications technology and densification of infrastructure deployment to improve coverage and performance of wireless networks. This evolution, which most call 5G, is needed to ensure near zero latency in the

network, extremely high throughput everywhere including at the edge of cells as consumers move around, and to manage the growing problem of demand bubbles. Many of the emerging IoT use cases can be accommodated on current 4G networks and with the natural evolution of these networks, but certain other use cases like autonomous driving will place demands on networks such as the need for no latency (delay) and no loss of data rates even during congested periods.

In short, the emergence of the concept of a totally connected world where access to data and applications anywhere, anytime is a paradigm shift that will require new thinking about infrastructure design, deployment, and management. One principle technical demand will be an exponential expansion of backhaul to accommodate the increased use and flow of data, which is a key driver of the ongoing need for wireless spectrum. Finally, as the number of applications grows exponentially and as the uptake of devices begin to scale, the device management aspect becomes critical infrastructure to the new Internet of things wave.

b. What are the novel policy challenges presented by IoT relative to existing technology policy issues, if any? Why are they novel? Can existing policies and policy approaches address these new challenges, and if not, why?

Nokia welcomes this opportunity to provide the NTIA with input regarding the benefits, challenges and potential roles for the government in fostering the advancement of the Internet of Things (IoT). IoT represents a tremendous step-change in the connectivity of our society. As noted in this request for comment, consensus has emerged that the number of connected devices is expected to grow exponentially and the economic impact of those devices will increase dramatically. The proliferation of these devices will require increased performance from the mobile telecom infrastructure and a concurrent increased demand for standardization.

As previously noted, enabling the IoT to develop will require massive commitments by

the private sector for new research and development into infrastructure, particularly wireless network equipment, software and systems management, data storage, and security. In order to facilitate the massive deployment of new wireless infrastructure to improve coverage and performance, infrastructure providers like Nokia must develop new equipment that is capable of supporting multiple frequencies and deployment scenarios with lower power consumption requirements and overall cost to enable the mass deployment required to attain 5G performance objectives.

In the United States, policymakers have been able to address some of these needs in the past, but current efforts may not be sufficient to meet the timelines and requirements necessary to support IoT development. Spectrum supply has been fragmented and unpredictable. That cannot continue. There must be a steady and predicable supply of spectrum coming on line for use regularly. This will require improved coordination and cooperation between the Department of Commerce and the Federal Communications Commission as well as the cooperation of the many government users with existing spectrum allocations. Policymakers should fully explore allocation models and methods including auctions for low band spectrum essential to wireless operators, spectrum sharing arrangements to create opportunities for low cost spectrum access to support smaller operators and to support backhaul needs, and actively promote secondary markets for spectrum that can facilitate the movement of spectrum rights between licensees to ensure that previously allocated spectrum is fully utilized.

While policymakers have engaged on these topics in the past, the needs of wireless 5G and the IoT demand greater speed and predictability. Nokia believes that several important principles can guide policymakers moving forward. First, piecemeal consideration of spectrum bands imposes design limitations. Policymakers should bear in mind that it will ultimately be

less expensive and more efficient for vendors to design generations of equipment capable of supporting multiple frequencies. For example, the FCC's current Spectrum Frontiers proceeding identifies a number of potential bands for rulemaking including 28 GHz, and 37 and 39 GHz. Some commenters have suggested splitting 28 GHz or other bands out for rulemaking quickly and returning later to address the remaining bands. While this approach can accommodate political pressures that make moving a comprehensive framework forward more difficult, it forgoes considerable advantages to the ecosystem in research and development work and ultimately in the design of products for deployment, advantages that could prove important in keeping costs to operators down to facilitate robust deployment.

Second, too frequently the debate surrounding spectrum sharing and coexistence between uses in various bands is driven by anecdote rather than data. If the spectrum sharing model is going to work, policymakers must demand of incumbent users actual evidence that concerns about interference are valid. This can be done through cooperative testing, public inquiries, and validation. Decisions whether to permit sharing in bands where existing users, public and private, have operations must be based on factual inquiries. If policymakers cannot create this environment, the type of inter-industry disagreement and delay associated with many current spectrum sharing discussions expand and make infrastructure design and deployment for 5G more difficult and expensive.

With respect to the need for standardization, in addition to the proliferation of connected devices, other aspects of IoT and 5G (which IoT will depend upon) will increase demand for standardization. These include the following:

- The increase in network density: Spectrum is the limiting resource in mobile communications. One solution to this limitation is frequency reuse which demands ever smaller cells and more numerous mobile cells. The graceful co-existence of these cells will need to be managed by standards.

- Spectrum sharing and the co-existence of different radio access networks: Different radio access methods and networks have the ability to both support each other and to interfere with each other. Examples include 2G v. 3G v. 4G v. 5G and Wi-Fi v. LTE-U. Single use spectrum is a luxury that is no longer practical. The graceful co-existence of these different radio access technologies, in the same or adjacent spectrum, will require standardization.
- Prioritization of data: The priority of IoT data will vary greatly. Some functions, such as the reporting of smart meters, are narrow band applications which are not time-critical. Other applications, such as those associated with self-driving vehicles may require relatively low bandwidth but require exceptionally low latency. Medical applications may require both high bandwidth and low latency. The appropriate prioritization of such data, across multiple network resources, will require standardization and permissive regulatory regimes that allow data prioritization.
- The transformation of mobile network infrastructure: At the same time that IoT is accelerating, the architecture of mobile networks for 5G is changing in fundamental ways to support, among other things, IoT. Network functions are being virtualized and sliced. Standardization will be necessary to allow the various functions to work together seamlessly in the virtual environment. These network functions are also being moved to the cloud. This will change the purpose and structure of front haul and backhaul communications. Low latency requirements will drive new features and computational resources at network edges. High bandwidth requirements will require optimal use of a variety of different network resources. The orchestration of these demands will require a new level of software defined networking. All of this needs to be standardized to work together.
- Open source software: The virtualization and the move to the cloud of network functions, and the demands of software defined networking, have created greater needs for the use of open source software (OSS). OSS provides opportunities for industry collaboration which allows critical technologies to get to market quicker. While there are tensions between open standards and OSS, it is clear that they rely upon each other and that greater reliance on OSS will require greater reliance on standards to ensure interoperability and performance.

These increased demands for standardization can be met through either open standards or more proprietary platforms. Mobile networks have historically, and successfully, been based upon the open 2G, 3G and 4G standards. These have been platforms have integrated the best technologies from across the globe. They have welcomed new entrants. And they have supported new devices, apps, networks and business models that define our world today. Platforms which are less open, and more proprietary, have been built on top of the mobile networks. Examples are the two dominant mobile operating systems. They provide a variety of functions, some of which

are interoperable with the other, and some of which are not. Consumers tend to be locked into one ecosystem or the other.

It is unclear if the increased demands for standardization will result in more open standards or more proprietary platforms. The advantages of open standards seem clear. They provide access to all, utilize the best technologies available and are based upon consensus. There is no dominant gatekeeper as there can be in more proprietary systems. Open standards, however, are not necessarily the norm. They require the proper incentives for voluntary R&D contributions, and a supportive regulatory environment. Even mobile networks started out as partially closed ecosystems. Only in recent years have mobile technologies become fully interoperable with the success of the UMTS and LTE standards for 3G and 4G. The success of these open standards has been dependent upon fair, reasonable and non-discriminatory (FRAND) licensing of standard essential patents (SEPs).

FRAND licensing of SEPs is the backbone of open standardization. It provides wide access to the open standards and provide incentives for companies to voluntarily contribute their best R&D to the open standards. The quick and successful progression from 2G to 3G to 4G is evidence that this system works. Unfortunately, FRAND licensing and SEPs are under attack by those who wish to avail themselves of this technology for little or no cost. This has resulted in proposals to devalue SEPs being advanced at various standard setting organizations (SSOs) and in front government regulators. If such proposals are widely adopted it would reduce incentives for open standardization when the need for open standards is growing. The DOC should not support such proposals and instead promote policies which support open standardization.

c. What are the most significant new opportunities and/or benefits created by IoT, be they technological, policy, or economic?

The IoT is the next major technological tidal wave offering benefits to society. A

fundamental concept of the IoT is to make physical infrastructure mobile, digitizing and managing data for analysis and to supplement the decision-making process with "big data" to optimize choices and to facilitate advancements in a variety of fields. As more devices and machines come online, and more physical infrastructure becomes mobile, economic models will evolve significantly. Disruptive business practices are enabled and economies have the opportunity to scale because in theory more individuals and businesses can move in and out of the economy via mobile technology.

Beyond scaling effects, economies will benefit because an increasing number of individuals will have the ability to participate in economic development and growth. Intelligent transportation options can improve safety and efficiency of goods transport making roads safer and reducing consumer costs. Advancements in connected healthcare will greatly improve the quality of rural health care delivery by enabling access to diagnostic procedures and specialists currently in short supply in many areas of the country. Barriers to entry will be lowered for individuals looking to start businesses and the expanded access to education platforms for students and working professionals will improve professional mobility. Critically, as healthcare, manufacturing, financial services and entertainment evolve to the IoT, policymakers must focus on ensuring confidence in the security and privacy of personal data associated with these activities. If consumers are not confident in the security and privacy of their data and their activities, it could undermine the uptake and utilization of applications and services associated with the IoT.

3. With respect to current or planned laws, regulations, and/or policies that apply to IoT:
a. Are there examples that, in your view, foster IoT development and deployment, while also providing an appropriate level of protection to workers, consumers, patients, and/or other users of IoT technologies?

Conceptually, IoT is the Internet of everything, every individual within a society has the

opportunity to contribute to this technological paradigm and also benefit from this evolution. As technologies become more standardized, the physical infrastructure and engineered circuits are built to standards that are global in nature. This is preferable to regionalized standards because it allows for design and manufacturing at scale and those efficiencies and cost benefits transfer to network operators that are responsible for deploying and maintaining the infrastructure that is central to IoT. The benefits of standardization facilitate the deployment of infrastructure and the development of important technologies like encryption that are an important part of providing the reliability, resiliency, and security necessary for consumer confidence in IoT to flourish. Therefore, preserving and supporting the global multi-stakeholder model for standardization across the entire ecosystem is critical. As noted below in response (b), efforts to alter standards body intellectual property policies undermine the willingness of companies like Nokia to contribute time and technology to the development of global standards.

Separately, the most exciting and innovative aspect of IoT is that all participants within society truly have the potential to create something through ideation that could have a major impact on society. Applications and analytics become the true backbone for the IoT economy. In essence, almost anybody can learn a computer programming language and create something new and impactful. IoT & Technology development ecosystems & living labs, computational linguists training and an increased focus on science, technology, engineering and math are key areas for investment and policy development to foster and enable IoT to successfully scale.

b. Are there examples that, in your view, unnecessarily inhibit IoT development and deployment?

Nokia previously noted that privacy frameworks must be carefully calibrated to ensure that while promoting transparency, disclosure, and meaningful consent opportunities to consumers, policymakers do not foreclose sources of vital value creation by assuming that

everyone in the IoT ecosystem collects, protects, and utilizes the same data or for the same purposes. There are many different business needs and business models centered around data and data science. Rigid opt-in, opt-out, or do not collect frameworks do not account for these differences and are therefore a blunt instrument and a poor fit for such a diverse ecosystem. Restricting access to and use of data, much of which can be or is currently anonymized, will constrain the ability existing network operators, application providers, and even infrastructure suppliers to improve performance of existing products and services. And, it is impossible to know how poorly designed and overly restrictive privacy rules would inhibit the design and development of new applications and services.

Critically, policymakers must recognize that IoT is not just "edge providers" or those within the application community. Without constantly evolving and improving physical infrastructure, the Internet ecosystem will not flourish. Policymakers need to keep in mind that software companies, telecommunications network operators, and infrastructure companies are critical participants in the Internet ecosystem. Innovation does not just happen in the app stack or at the edge of the network. Advances in the network are crucial enablers of the IoT and as key participants in the Internet ecosystem, software companies, network operators and infrastructure companies must be allowed to participate fully in the ecosystem. Policy frameworks driven in whole or in part by concern for the app and edge community run the risk of denying other participants important sources of value creation that will fuel R&D and further innovation. The FCC's Open Internet Order failed to recognize this fact and the resulting rules ex ante prohibit activities such as differentiated consumer facing pricing based on speed, time of day, application or other criterion that could both offer additional choices to consumers and improve monetization of data on operator networks. This occurred with a minimum of debate or

economic analysis because of the focus on edge providers as the most critical participant in the ecosystem. Policymakers need to avoid outcomes like this in order to ensure value creation for the entire ecosystem and a virtuous cycle of innovation.

4. Are there ways to divide or classify the IoT landscape to improve the precision with which public policy issues are discussed? If so, what are they, and what are the benefits or limitations of using such classifications? Examples of possible classifications of IoT could include: Consumer vs. industrial; public vs. private; device-to device vs. human interfacing.

The Internet of things includes everything, but to make this palatable for assessing optimal strategies for ongoing success, the private sector has segmented IoT into a few core industrial verticals. For each vertical, specific expertise are required to thoroughly and effectively understand policy needs.

CLASSIFICATION 1: Health Care and Clinical Data
CLASSIFICATION 2: Environmental, Physical infrastructure, Transportation
CLASSIFICATION 3: Extra Large Enterprises and Industry, Manufacturing and Utilities
CLASSIFICATION 4: Public safety & Public Sector
CLASSIFICAITON 5: Digital Content & Cloud, i.e. Education, i.e. Entertainment

8. How will IoT place demands on existing infrastructure architectures, business models, or stability?

Bandwidth needs will be further constrained by high cost and intermittency due to demands coming from a substantial increase in devices and machines connected to networks. This can cause incomplete data collection – creating difficulties for thorough spatial analysis, or identifying patterns for future decision making. A widespread and reliable infrastructure is necessary for sensors and other technologies to communicate effectively. In terms of business model limitations consider as just one example that relatively few Science, Technology, Engineering, Mathematics (STEM) graduates currently pursue careers in the agriculture sector. Some commentators take the view that this may be partly due to a perception that farming is not ‘academic’ or modern, or that higher education does not provide the right combinations of skills.

Moreover, technology companies may fail to identify agri-tech market opportunities.

Universities and colleges will need to change if the Internet of Things is to be applied effectively to agriculture. In particular, the sector needs enhanced links between scientific, engineering and digital skills in agricultural engineering.

10. What role might the government play in bolstering and protecting the availability and resiliency of these infrastructures to support IoT?

To enhance innovation and resiliency and to promote the growth of cross-border Cloud based services that fuel IoT, governments can build upon existing commitments in international trade agreements and International Standards and devise new initiatives in a way that facilitates the free movement of data across borders while maintaining appropriate legal protections that promote competition, transparency, and respect for privacy.

11. Should the government quantify and measure the IoT sector? If so, how?

Demand for broad band access, cost savings that could result from technology and IoT implementations and new IP and innovations contributing to the National GDP.

As devices manufactured or sold (in value or volume)?

This could serve as a good metric to understand quantity demand.

As industrial/manufacturing components?

This assessment could help guide IoT implementation and correlate value via overall operations cost savings. A tax credit could be offered to industrial and manufacturing market actors to stimulate this market segment and potentially jump start new economic models.

As part of the digital economy?

Yes, new innovation and IP YoY affecting the national GDP on a per market segment level. These include ICT & IoT implementations in Health Care YoY, ICT & IoT

implementations in Transportation YoY, ICT & IoT implementations in Public Safety YoY, ICT & IoT implementations in Critical Infrastructure YoY.

In providing services?

This is economic segment is the most promising from a growth potential perspective as it relates to the next wave of ICT innovation, including cloud computing, IoT, and Big Data.

12. Should the government measure the economic impact of IoT? If so, how?

Yes, as mentioned above: New innovation and IP YoY affecting the national GDP on a per market segment level. These include ICT & IoT implementations in Health Care YoY, ICT & IoT implementations in Transportation YoY, ICT & IoT implementations in Public Safety YoY, ICT & IoT implementations in Critical Infrastructure YoY.

Are there novel analytical tools that should be applied?

IoT devices will mostly be platform enabled, i.e. they will served to consumers through cloud based connected platform that contains the mechanics of the technology. The platform itself can have embedded analytics to assess, device details, usage and security.

Does IoT create unique challenges for impact measurement?

The sheer potential volume of data could be extremely challenging to manage, the current ICT infrastructure will need more investment and evolve to support connected devices.

16. How should the government address or respond to cybersecurity concerns about IoT? What are the cybersecurity concerns raised specifically by IoT?

How do these concerns change based on the categorization of IoT applications (e.g., based on categories for Question 4, or consumer vs. industrial)?

With all things being equal, the industry is made of consumers and as the Internet of things will transform the physical world into a digital world; the differentiation between consumers and industrial will be very hard. Hence applications will dominate the economic

landscape.

What role or actions should the Department of Commerce and, more generally, the federal government take regarding policies, rules, and/or standards with regards to IoT cybersecurity, if any?

The DoC and the federal government should focus on selecting companies with integrated supply chains, demonstrated protections and best practices such as security by design, transparency of operations, and a reputation for performance to supply critical government infrastructure. In addition, DoC should continue to facilitate voluntary best practices and support commercial standards bodies product assurance procedures while avoiding specific government mandates or establishing any review process for hardware or software which would slow deployment and increase costs.

23. Are there policies that the government should seek to promote with international partners that would be helpful in the IoT context?

The increasing use of cloud-based services, combined with new devices that accommodate their use by consumers, enterprises, and governments is changing the global economy. Adoption of online services facilitates an increasing number of activities and solutions in our day-to-day lives and is benefiting economies locally and globally far beyond the ICT industry. Governments should promote widespread adoption of online services by providing incentives, fostering user confidence, and providing consistent and clear guidelines for online service providers, including in the areas of privacy and security. For example, governments can further develop a legal framework that includes innovation-friendly, nondiscriminatory, and predictable rules that govern online services vendors and offers clear guidelines for handling personal data. To enhance innovation and the growth of cross-border Cloud based services, governments can build upon existing commitments in international trade agreements and International Standards and devise new initiatives in a way that facilitates the

free movement of data across borders while maintaining appropriate legal protections that promote competition, transparency, and respect for privacy.

24. What factors can impede the growth of the IoT outside the U. S. (e.g., data or service localization requirements or other barriers to trade), or otherwise constrain the ability of U.S. companies to provide those services on a global basis? How can the government help to alleviate these factors?

The digital economy is the new enabler for the global economy. Internet enabled technologies and cloud computing help companies of every size and across every industry to be more productive and reach new customers. Strong trade agreements and trade policies as a complement to other economic policies are needed to compete in the 21st century economy, such as building trust in technology with privacy and security policies and in preparing the workforce of the future. With these principles in mind, government can cultivate trade agreements and promote polices such as the Trans-Pacific Partnership (TPP) that deal directly with the digital economy, including provisions on the rule of law, respecting privacy and security and promoting the free flow of data. These measures strengthen trading rules and expand market access opportunities for goods and services. The ICT sector can advocate for outcomes that facilitate digital trade and build trust in technology in other ongoing negotiations, such as the Trade in Services Agreement (TISA) and the Transatlantic Trade and Investment. Partnership (T-TIP), and among members of the World Trade Organization (WTO).

26. What role should the Department of Commerce play within the federal government in helping to address the challenges and opportunities of IoT? How can the Department of Commerce best collaborate with stakeholders on IoT matters?

The DoC can serve as the custodian of the Internet of Things for the U.S. as well as the globe. Promoting global standards and cultivating innovation via NIST and NTIA. Technical advisory committee should be created for all industries that will effectively embrace IoT and

emerging technologies such as health care, public safety, connected cities, transportation, and utilities.

27. How should government and the private sector collaborate to ensure that infrastructure, policy, technology, and investment are working together to best fuel IoT growth and development? Would an overarching strategy, such as those deployed in other countries, be useful in this space? If the answer is yes, what should that strategy entail?

Intellectual property laws promote important incentives for innovation and creativity by enabling innovators to recoup their investments in research and development (R&D) and protect the value of their efforts. Consumers and the public also benefit through access to new creative works, innovative products and services, and the sharing of innovations among larger communities of customers and innovators. A patent system that supports innovation across all areas of technology— including new, cutting-edge technology—promotes economic growth, job creation, and competitiveness in global markets. Enforcing existing IP laws and updating them as necessary to adapt to new technologies is also critical. IP rules should evolve to address online activities in ways that both encourage new and beneficial uses of Internet technologies and foster respect for the rights of all participants, including copyright owners and content creators. At the same time, policymakers should provide greater clarity to ensure that IP laws do not impinge on legitimate activity, such as reasonable use by consumers of lawfully acquired content.

Government investment in basic research is critical to strengthening national competitiveness. Government-funded research at universities and labs stimulates innovation and helps to train the next generation of scientists and engineers. Academic research is especially important because it can spur advances that lead to future entrepreneurial ventures and thereby create new jobs and potentially new industries. Private-sector research also plays a critical role and can be stimulated through R&D tax credits.

28. What are any additional relevant issues not raised above, and what role, if any, should the Department of Commerce and, more generally, the federal gov.

Governments should work to facilitate greater access to unused spectrum by finding a balance between licensed and unlicensed approaches. In particular, rural and remote areas and underserved populations should not be left behind, and state-of-the-art connectivity for schools, libraries, and hospitals is also vital.

Creating opportunities for youth and young adults is important. The planet has more young people than ever before, but youth unemployment is double the rate of the adult population—on course to reach 12.8 percent by 2018, according to a 2013 International Labor Organization study. As countries struggle to develop the skilled workforce required for economic success, unemployed workers fall further behind. Beyond the risk to economic growth, this opportunity divide—the gap between those who have the access, skills, and opportunities to be successful and those who do not—leaves many young people with an increasingly uncertain future. Closing this divide is one of the most important actions we can all take—together—to secure the future of our youth and thus the future of our global economy.

STEM skills training, industry recognized certification attainment and high paying IT job opportunities for service members transitioning back into civilian life in the U.S. are also important considerations. We should also work on improving education through greater use of technology. IT can play a key role in transforming education and promoting lifelong learning. For this to happen, teachers need access to IT-based teaching methods that enable a richer, more personalized learning experience for their students, and administrators need access to enterprise-level software infrastructure to improve efficiency and productivity. Online services, in particular, can be instrumental in expanding the quality and accessibility of education—by enabling collaborative environments and anytime, anywhere access to learning resources. Online

learning can also provide opportunities in remote and underserved communities, and it can facilitate improvement in educational approaches through the collection and analysis of data. Game-based learning and other interactive learning experiences can also help to improve literacy, computer science and math skills, and even physical fitness.

Invest in the next generation of innovators. More than 100 million young people around the world lack access to education, and millions more do not get the quality of education they deserve. If governments are to maintain and strengthen their ability to compete globally, they must adapt and improve their education systems to prepare students for the global economy—with emphasis on science, technology, engineering, and math (STEM) skills, and in particular disciplines like computer science which are critically needed for a broad array of readily available and high-paying jobs across a wide variety of industries. For example, computer science is the foundation of today's innovation economy, but too few students have access to computer science instruction. Governments should promote interest and participation in STEM fields, especially computer science, and they should work to raise educational and teaching standards, reward effective educators, and provide teachers with the technology, support, and tools they need.

Respectfully submitted,

Nokia

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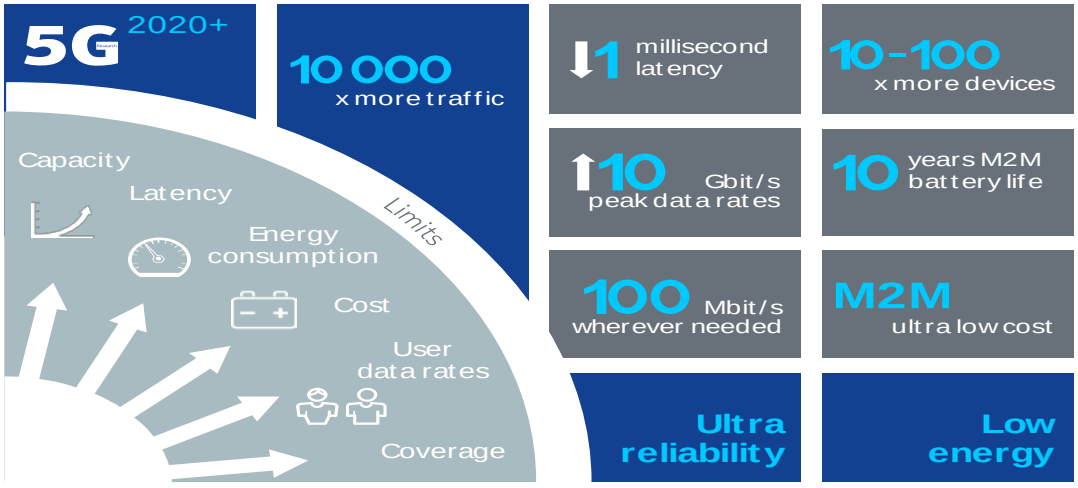
5th generation (5G) of communication networks a key enabler of the Internet of Things (IoT)

Background

The United States has been an early adopter in each generation of wireless technology including the current generation called 4G, or Long-Term Evolution (LTE). This has been a major driver of innovation and employment. The advancement of wireless networks in 4G has enabled a similar advancement in mobile applications and services. The appetite of consumers, however, for a new generation of capabilities, such as self-driving cars, healthcare and fitness "wearable" technologies, and the capability to control their home environment while on the move is placing increasing demands on existing networks. For the Internet of Things (IoT) to meet any of the lofty ambitions policymakers frequently cite, a future evolution of mobile broadband networks must take place utilizing technologies and techniques that are still largely aspirational or in their early development. For the mobile broadband ecosystem that is a critical part of the IoT to develop as technologists and policymakers imagine, key technology and policy enablers are needed.

What is at stake for the United States?

- **Jobs & growth:** 5G is a key technology for many growing U.S. business sectors including software, video, gaming, data analytics, and machine-to-machine (M2M) communications.
- **Investments:** significant early investment in 5G will help close the gap in ultrafast mobile broadband between the U.S. and other countries.
- **Research:** sustained investment in 5G research will begin to address limitations in mobile broadband availability in rural areas.



Why 5G matters for citizens?

Demand: Consumers generate an increasing amount of mobile traffic, which necessitates more capacity and lower latency. 5G will offer an expected peak data rate higher than 10 Gbit/s compared to the 300 Mbit/s LTE can offer today, combined with virtually zero latency, meaning that the radio interface will not be the bottleneck even for the most challenging use cases.

Societal innovations. 5G will support applications and industries of the future such as innovative health care services, self-driving cars and the next generation of industry automation. 5G will mean stepping away from best effort towards truly reliable communication. Flexible integration of existing access technologies such as LTE and Wi-Fi with new technologies creates a design that is future proof at least until 2030.

Internet of things. 5G will be designed for use cases expanding from humans to machines requiring more of networks. 5G supports the huge growth of machine-to-machine type communication, also called Internet

of Things (IoT), through flexibility, low costs and low consumption of energy. At the same time, 5G will be reliable and quick enough for even mission-critical wireless control and automation tasks such as self-driving cars.

Energy and cost. 5G will lower costs and the consumption of energy. Energy efficiency is an integral part of the design paradigm of 5G. Virtualized and scalable technologies will further facilitate global adoption. Taking all of these factors together, 5G could bring Internet access to a larger group of people and things.

Technology Challenges and Policy Enablers

The research that must be undertaken by mobile broadband equipment companies like Nokia in order to bring 5G into reality is substantial. Multiple generations of technology already deployed must work seamlessly together under the 5G umbrella that requires new approaches and capabilities, all with lower power consumption and lower deployment costs as key demands.

Intellectual property rights policy: 5G research activities become risky when genuine innovation is neither protected nor rewarded. Current proposals in Congress for "patent reform" are allegedly focused on abusive patent trolls not engaged in true innovation, however, *the proposals do not limit the litigation reform provisions to trolls*. These provisions make it more time consuming and expensive for real innovators to pursue legitimate infringement claims by imposing additional filing requirements, building in delay, and providing tools for infringers to avoid liability for the unlicensed use of others' technology. Robust protections for intellectual property are an essential ingredient to the successful realization of 5G and the IoT. Congressional patent reform efforts should not make it more difficult for innovators to protect these rights, which are essential to the business case for undertaking the research and development risk.

Spectrum needs: Additional radio spectrum for mobile networks needs to be allocated and put into use quickly to meet the increased capacity and coverage demands of 5G. This means looking at new spectrum bands such as millimeter wave and centimeter wave, and using available spectrum efficiently.

Net Neutrality regulation: It is imperative that the FCC allow operators to innovate by offering specialized services that are necessary to emerging applications and services that require predictable service quality. Restrictions on legitimate network management and the development of specialized services drain value creation from the mobile broadband ecosystem and will impair the development schedule for 5G.

Density: 5G we will need to use many more base stations to meet the performance needs of future applications. These dense networks will be deployed as heterogeneous networks, combining macro sites with smaller base stations and using a range of radio access technologies including LTE-A, Wi-Fi and any future 5G technologies.

Performance: In 5G the best possible network performance will not be just about peak speed. There will be a wide range of performance measures to meet individual requirements imposed by each use case. Some real-time applications, such as driverless cars, will require virtually zero latency, while others, such as 3D video capture, will be more tolerant to latency but will require high capacity upload instead.

Recommendations for policy makers

- Allocate more spectrum quickly and put a plan in place for spectrum for mobile broadband between 3.5 and 100 GHz.
- Do not allow technology aggregators to utilize the abuse of trolls to weaken the IP rights of legitimate innovators. Limit litigation reform efforts to the actual problem: patent trolls and abusive demand letters in the pursuit of nuisance value settlements.
- Any overhaul of telecommunications legislation should have the goal of increasing investment and reducing regulatory barriers to innovation. Clear, stable, and predictable rules of conduct backed by enforcement are preferable to ongoing rulemakings that regularly change the regulatory environment.

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