Testimony before the Political Subdivision Taxation Committee in support of the Telecommunication Infrastructure Sales Tax Exemption

- June 29, 2016 -

Chairman Dockter, Political Subdivision Taxation Committee members, for the record my name is Todd D. Kranda and I am an attorney with the Kelsch Kelsch Ruff & Kranda Law Firm in Mandan. I appear before you today as a lobbyist on behalf of Verizon Wireless to express support for the existing telecommunication infrastructure sales tax exemption found in Chapter 57-39.2 of the North Dakota Century Code at Section 57-39.2-04.9.

As background information for this telecommunication equipment infrastructure sales tax exemption, the 2007 Legislature passed HB 1018, which included in Section 28, a study of wireless providers and how wireless service impacts the business climate in ND. The interim study was assigned to the Industry Business & Labor Committee. As a result of that study the interim Industry Business & Labor Committee approved SB 2040 for the 2009 Session. SB 2040 was intended to promote the expansion of businesses in ND by the additional investments that are made with the construction and expansion of telecommunication infrastructure. SB 2040 provided a sales and use tax exemption for equipment used in telecommunications infrastructure development. SB 2040 passed and became Section 57-39.2-04.7 NDCC. Subsequently, in 2011 SB 2171 was presented to extend the sunset that was included with the 2009 legislation. SB 2171 passed to extend the sunset provision through December 31, 2012. In 2013, SB 2142 was passed to reestablish the sales and use tax exemption for equipment used in telecommunications infrastructure development that was lost with the December 31, 2012 sunset provision. As indicated, the current incentive is found in Section 57-39.2-04.9 which is effective through June 30, 2017.

The tax incentive is an efficient way to decrease the cost to deploy telecommunications infrastructure necessary to provide advanced wireless telecommunication services to more areas across the state. Several other similar sales tax exemptions have been implemented in the past in North Dakota to help promote building or expanding certain industries. The exemption helps facilitate deployment of advanced communications systems across the state and in rural areas where it may not otherwise be feasible to do so. Attached is a map showing the existing state-

by-state sales tax exemptions for telecommunication manufacturing equipment.

Verizon as well as other telecommunication industry companies do not have unlimited capital budgets and they are all faced with complex decisions on where to spend their limited resources. Sales taxes imposed on telecommunication infrastructure directly reduce the amount of capital available to invest which is a contributing factor to investment decisions.

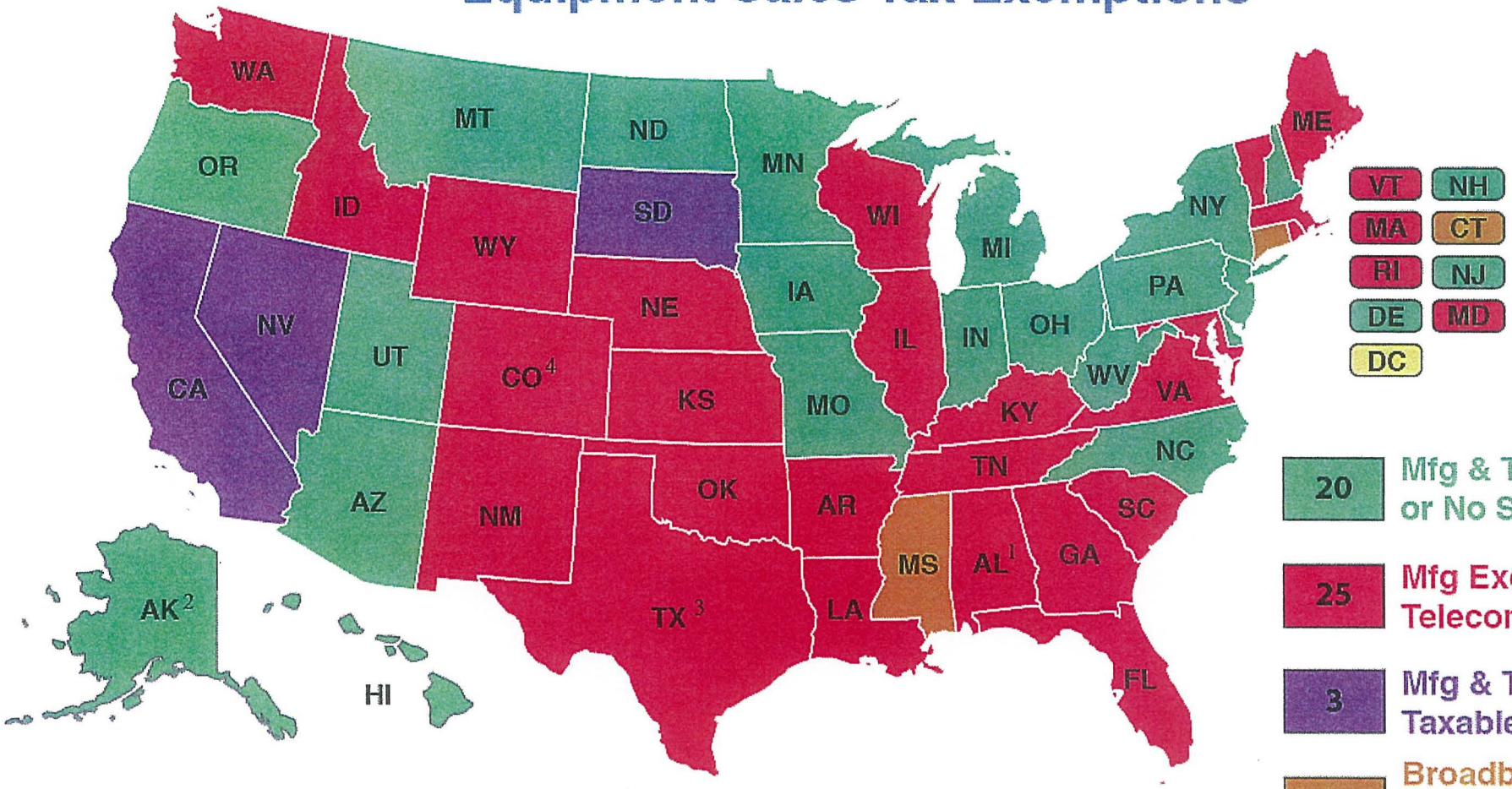
In 2013, a bipartisan group of legislators on the National Conference of State Legislatures' State and Local Taxation Task Force examined several studies about the link between state taxation of communications investment and overall investment levels and economic growth. The Task Force adopted a policy statement encouraging states to consider exempting communications infrastructure investment from sales taxes to encourage broadband deployment and promote economic growth. A copy of the Resolution is attached.

North Dakota, along with most other states, allow a sales tax exemption for equipment used by manufacturers. This is generally accepted as the correct policy to avoid taxing the business inputs that are used to produce a product that is taxable upon consumption. This same rationale supports a sales tax exemption for equipment used by telecommunications companies to provide a service that is taxable upon consumption. The correct policy becomes even clearer considering the countless direct and indirect benefits that flow through an economy from advanced telecommunications networks.

Technology will continue to evolve, and even as Verizon is now in the process of building out its 5G network in North Dakota and across the country, the next wave of communications technology is already being anticipated. See attached CTIA 5G Brochure which explains the new technology that is being implemented by Verizon and the telecommunication industry.

In conclusion, the implementation of policies that will ensure the continuation of robust investment in that type of advanced service and technology in North Dakota is important to establishing the long term competitiveness of the state. Accordingly, Verizon supports the existing sales and use tax exemption for investments in telecommunications service infrastructure as an effort to induce continued investment in the infrastructure necessary to bring advanced communication services to the citizens and businesses of North Dakota in a timely manner.

Telecommunications/Manufacturing Equipment Sales Tax Exemptions



20	Mfg & Telco Exempt or No Sales Tax [2]
25	Mfg Exempt; Telecom Taxable [1, 3, 4]
3	Mfg & Telecom Taxable
2	Broadband Equipment Exempt; Mfg Exempt
1	Mfg Taxable; Telecom Exempt

[1] Alabama - special reduced 1.5% rate

[2] Alaska - local sales taxes may apply

[3] Texas - rebate of taxes paid capped at $50 million

[4] Colorado - rebate of taxes paid capped at $1 million

NATIONAL CONFERENCE *of* STATE LEGISLATURES

The Forum for America's Ideas

NCSL RESOLUTION ON COMMUNICATIONS NETWORK EQUIPMENT EXEMPTION

EXECUTIVE COMMITTEE TASK FORCE ON STATE AND LOCAL TAXATION

Whereas, American consumers increasingly rely on high-speed communications networks in their everyday lives for work, entertainment, emergency communications, and other purposes; and

Whereas, communications networks have become an integral part of the business process for millions of American businesses in sectors as diverse as agriculture, health care, manufacturing, retail, transportation, and many others; and

Whereas, communications networks, both wired or wireless, have become integral to the delivery of government services and have the potential to allow for more efficient and cost effective delivery of government services; and

Whereas, the United States is a technology leader with respect to wired and wireless broadband deployment; and

Whereas, this technology leadership has allowed American businesses to lead the way in the global marketplace in areas such as applications development, "cloud-based" services, and the utilization of software in the communications networks; and

Whereas, the rapid adoption of new communications technologies by American businesses and consumers requires the investment of tens of billions of dollars to keep pace with the exponential growth in demand for network capacity; and

Whereas, state economic growth and competitiveness is dependent upon the deployment of modern, efficient communications networks; and

Whereas, a 2013 study by Ernst & Young confirmed what many prior economic studies have concluded – that the taxation of business inputs results in tax pyramiding, economic distortions, and a lack of transparency in the tax system; and

Whereas, a study by Dr. Raul Katz at Columbia University found that (1) sales taxes on communications network investment reduce economic growth by increasing the cost of investment and slowing communications network investment, and (2) that the elimination of sales taxes on communications network investment in the states that impose such taxes could increase economic growth by $33 billion and lead to the creation of 243,000 jobs in 3 years; and

Whereas, the National Conference of State Legislatures supports the policy goal of encouraging deployment of high speed communications networks across all States, including rural and underserved areas;

Be it therefore resolved, that the National Conference of State Legislatures recommends that states who wish to encourage broadband deployment consider exempting communications network equipment from the sales and use tax.

Adopted November 23, 2013 by NCSL Task Force on State and Local Taxation

ctia Everything™ Wireless

The Next Generation of Wireless: 5G Leadership in the U.S.

Thomas K. Sawanobori
SVP and Chief Technology Officer, CTIA
February 9, 2016

Source: Volvo Cars

5G

Entire industries, from agriculture to transportation, will be transformed to be more capable, efficient, and intelligent. That's the promise of the next-generation of wireless technology, known as 5G.

Wireless connectivity touches every aspect of our daily lives today, but we are just scratching the surface of its consumer benefits. Imagine a future where nearly everything is connected to ubiquitous, very high-speed wireless networks. Imagine enjoying enriched entertainment while riding to work in a self-driving car, doctors that monitor patients' vital signs remotely in real-time, and communities that are smarter and more connected.

Entire industries, from agriculture to transportation, will be transformed to be more capable, efficient, and intelligent. That's the promise of the next-generation of wireless technology, known as 5G.

United States leadership in this next-generation of wireless is critical. We are a global leader in 4G LTE. 99.6% of Americans now have access to a 4G LTE network,[1] thanks to nearly $150 billion invested since 2010[2] by wireless operators large and small.

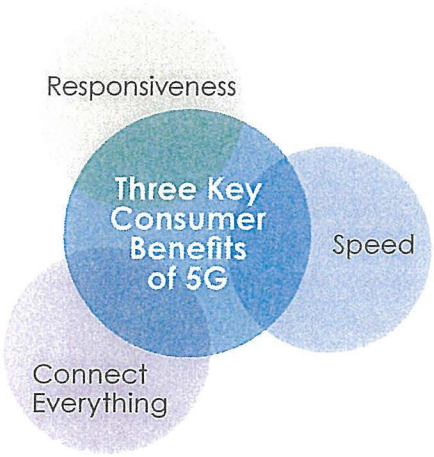
That means nearly every American can access mobile broadband at speeds up to tens of Mbs a second.

This 4G LTE leadership has paid dividends throughout the U.S. economy and our mobile ecosystem. Licensed wireless service generates over $400 billion in annual economic activity and every wireless industry job results in another 6.5 people finding employment. American entrepreneurs capture 91% of the world's mobile app downloads, and U.S. companies run the operating systems on 9 out of 10 smartphones worldwide.

Other countries have seen our 4G LTE success and want to seize the mantle of 5G leadership. South Korean carriers have announced trials at the Winter Olympics in 2018, and Japanese operators plan to demonstrate 5G in 2020 at the Summer Olympics in Tokyo. The EU has committed 700M Euro to 5G R&D.

The U.S. wireless industry is committed to maintaining our global leadership as the wireless ecosystem evolves from 4G LTE to 5G. U.S. carriers including AT&T, T-Mobile, Verizon, Sprint, US Cellular, and suppliers, including Ericsson, Nokia, Intel, QUALCOMM, Samsung, Cisco, Microsoft, Motorola, CommScope, HP, and others are partnering to drive foundational 5G activities on technology and global standards-setting fronts. One U.S. operator has announced trials of 5G networks; others are working hard on technical requirements and standards.

The advanced US trials, the standards process commitment, and the science and engineering are critical to 5G efforts. The technical development of 5G is evidenced by the significant amount of literature and papers produced by Next Generation Mobile Networks,[3] 4G Americas,[4] Ericsson,[5] Nokia,[6] Samsung, QUALCOMM, Intel, and others. Leading operators have been very active in 4G Americas defining requirements for 5G including AT&T, T-Mobile, and Sprint.[7] Next Generation Mobile Networks has key representatives from around the globe including AT&T, Sprint, T-Mobile, Verizon, and US Cellular.[8] Signals Ahead has published a paper "Understanding the Ins and Outs of the 5G Use Cases" examining 72 use cases possible with 5G. CTIA's focus is on what 5G will mean for consumers, the benefits consumers will experience with 5G networks, and how public policy can advance these consumer interests.



Specifically, this paper explores three key aspects – speed, connection ubiquity, and immediacy – of 5G networks that will transform consumers' wireless experience and enable a fully-connected mobile life. We also provide clear steps policymakers can take to help maintain U.S. wireless leadership and support future 5G investment.

In particular, current spectrum planning by the Federal government needs to account for the increased demand that is projected for mobile broadband services; working with stakeholders, the Administration and the FCC must not only keep on track with respect to current efforts, but must also identify new bands capable of being auctioned and develop a timetable for those auctions. Along with smart infrastructure and siting policies, as well as wise R&D investments, more focused spectrum re-allocation planning will be vital to robust development and deployment of 5G in the U.S.

"5G is about more than faster mobile services – it will enable new use cases related to the Internet of Things." • **Rima Qureshi,** SVP and Chief Strategy Officer, Ericsson

The Evolution Of Wireless Networks

Wireless has evolved significantly over the last thirty years. With every generation of technology new consumer benefits are unleashed and we become one step closer to our connected life future.

In 1981, the first generation of wireless (1G) gave us analog wireless voice, connecting Americans on the go for the first time. 2G enabled digital voice, increased capacity, and introduced text messaging in the 1990s.

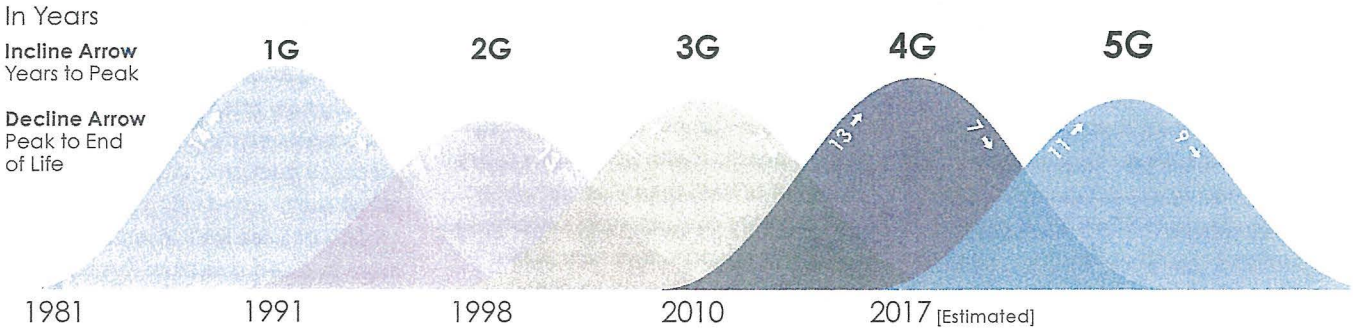
3G brought us the first true wireless data in the 2000s, giving consumers access to the Internet everywhere they go. And 4G LTE, first deployed in 2010, has delivered the ubiquitous high-speed wireless broadband we enjoy today, unlocking the potential of mobile video and so much more innovation.

Today's 4G LTE networks offer consumer speeds of 10-20 Mb/s on average,[9] with network latency – the time it takes between a consumer's request for data and when that data arrives back at their device – is approximately 50 milliseconds end-to-end (including 10 millisecond air link). 4G LTE networks offer a device density of approximately 2000 active devices per square kilometer, which has helped support the introduction of the Internet of Things.

Thanks to these advances, and the mobile innovation that rides on those networks, consumers have embraced 4G LTE wireless service. Mobile data use keeps growing, and the trend lines are daunting, with a six-fold growth in traffic expected by the end of the decade.

While we are focused here on longer-term developments, the 4G LTE platform will continue to evolve and carriers will continue to innovate at breakneck speed with network capabilities like carrier aggregation to provide more capacity and increased download speeds, voice over LTE (VoLTE) for a higher quality voice experience, and Rich Communications Services (RCS) for video chatting and enriched messaging. Operators throughout the U.S. including AT&T, Sprint, T-Mobile, Verizon, US Cellular and others are aggressively working to implement new capabilities. Carriers in the US are laying the strong foundation for 5G today with 4G LTE. Leading U.S. operators have been deploying wide band carriers and two carrier aggregation for the last couple of years. Beyond that operators are doing more. For example, T-Mobile is employing new spectrum, 3 carrier aggregation, and new service capabilities to make 4G LTE a great platform for serving usage and meeting

North American
Mobile Network Life Cycles



consumer needs.[10] Sprint is upgrading its network to LTE Plus with 3 carrier aggregation and believes 4G LTE will be the 'foundational layer' for what 5G becomes.[11] Wireless carriers are also leveraging new capabilities in low power, less expensive 4G LTE chipsets to foster greater growth in the IoT. Thanks to these advances in 4G LTE technology, consumers' wireless experience will continue to improve significantly even before the rollout of next generation technology and services.

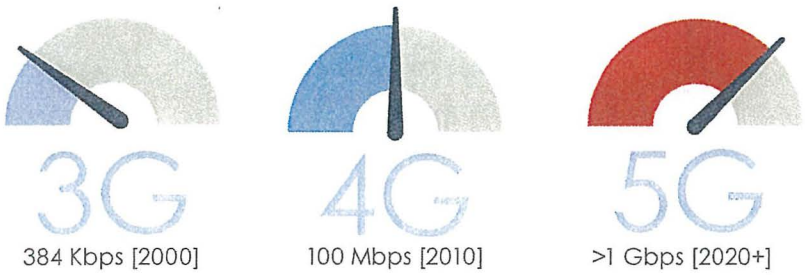
Yet we stand on the cusp of a significant new development in the wireless industry: 5G. Standards will be developed by 2018, and the U.S. wireless industry expects to rollout 5G services the following few years. Some have suggested commercial rollout will start before 2020 with early versions of the standards.

5G is not just another evolution in wireless technology, 5G will be a game-changer for consumers. Here's why.

Key Consumer Benefits

5G will benefit wireless consumers in three key ways:

- ***5G will be very fast**, even in densely populated areas.*
- ***5G will connect everything,** supporting the Internet of Things.*
- ***5G will be real-time**, minimizing delays in network response and enabling entirely new services and applications.*



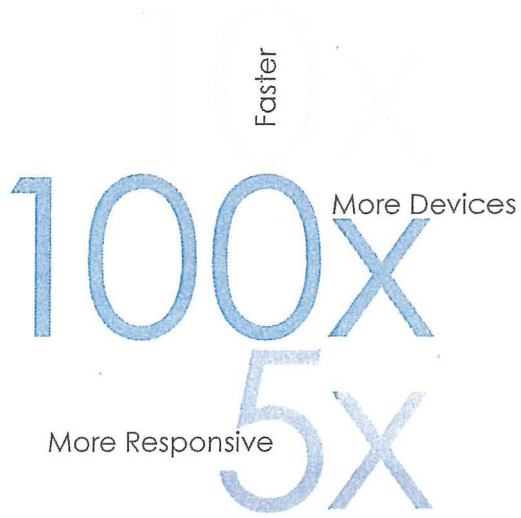
5G: Very Fast

Each generation of wireless technologies leapfrogs the capabilities of the prior generation, and the most tangible change is a significant increase in network speed. 5G will be no exception.

Our 4G LTE networks are fast, with speeds that can approach ~100 Mb/s peak rates. But thanks to innovations like millimeter (mm) wave technology, 5G networks will be extremely fast – generating a throughput more than 10 times faster, potentially over 1 Gb/s – particularly in dense urban locations and initially likely in localized "hot spots." Indeed, technology leaders such as Samsung,[12] Ericsson,[13] Nokia,[14] Intel,[15] QUALCOMM,[16] and others are demonstrating and testing 5G speeds in excess of 1 Gb/s in initial testing and collaboration with industry players.

Consumer Benefits of 5G

By the Numbers



"5G will really change the game, and I think it will be another spike of growth in the wireless industry." • **Lowell McAdam,** Chairman and CEO, Verizon

The 5G revolution in data speeds will unleash a host of consumer benefits, including:

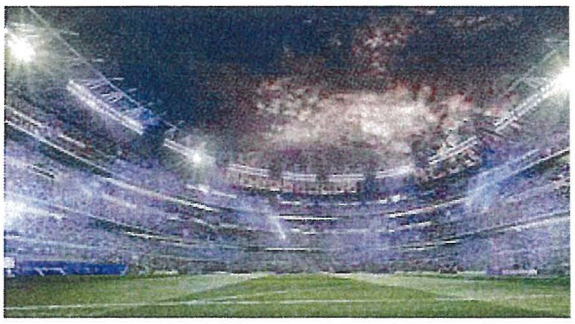
Very high speed broadband to businesses, train stations, airports, campuses, public venues, stadiums, shopping malls, or other locations

It is envisioned that 5G will be best suited to handle traffic where there is considerable demand and a high concentration of users.

All consumers have experienced the challenge of posting a photo or making a phone call from a crowded stadium or event. 5G will not only provide faster peak speeds, it is designed to handle highly dense environments and will provide a consistent very fast speed consumer experience.

Specifically with the capacity gains from 5G, consumers will be able to experience 5G without a diminution in speed or quality.[17] For businesses in particular, this high speed connectivity can improve connectedness with employees who work remotely or travel frequently and reduce operating costs.[18]

Beyond these venues, 5G is suitable for fixed wireless connectivity. It can provide businesses and residences with very high speed wireless broadband. 5G can provide these capabilities indoors and outdoors.



Movies, video, and other media

The average consumer usage patterns have changed dramatically with 4G LTE. Internet browsing, social media, and video drive the majority of consumer usage on smartphones.[19] Consumers now spend an average of 2.8 hours per day with mobile content thanks to LTE speeds and functionalities.[20]

Downloading a movie or large file can still take minutes if not longer.

Very high speed hotspots can enable rapid downloads of movies and video, or streaming to a smart device, tablet, or laptop, faster than ever before. Nokia, for example, promises speeds fast enough to download a 3-D movie in seconds, compared to several minutes over 4G LTE, or more than an hour on 3G.[21]

New video applications

5G will enable fast access to ultra HD content including 4K and 8K video. The benefits of Ultra HD will be especially compelling on tablets, laptops, and other larger screen devices.

High speed wireless connections will also revolutionize gaming and entertainment, providing an immersive experience that allows users to actively interact with simulated elements.[22]

For example, attending a football game in the future could be enriched by having access to ultra HD content from a variety of perspectives – quarterback, defensive player, or coach, among others. These could be provided to enhance the stadium experience for viewers with equipped devices.

5G: Connecting Everything

5G will be much more than faster speeds. 5G promises consumers a more connected wireless network with much higher device density, enabling the connectivity of virtually all of our physical world. 5G will provide the scale for wireless networks to support billions of sensors, wearables, and devices that will unlock new innovations and functionalities.

While 4G LTE provides a solid foundation for IoT where advancements are being made to 4G LTE with lower cost, lower power chipsets to support IoT, the wireless network of today ultimately has a connection density limitation that needs to be addressed to support the massive number of active sensors, wearables, and connected devices.

Specifically, the massive number of new wireless Internet of Things (IoT) devices – nearly 28 billion in total and roughly 1.5B M2M and consumer connected wireless (cellular) devices by 2021, will ultimately need a technology upgrade.[23] The limitations in today's technology could impact the responsiveness a consumer perceives in accessing the network. 5G will be able to support massive connection density, possibly on the order of 100 times greater than 4G LTE.

Consumers can expect an array of connected devices with 5G networks, including:

Smart Cities

Cities are looking to use wireless technology and the IoT to create impactful solutions for their citizens.

Many consumers today rely on applications like Waze that provide real-time information. Imagine sensors that provide automatic real-time information on parking, traffic, and every other facet of your daily life. Intelligent systems can help route you optimally to your destination and direct you to the most convenient parking location.

To make smart cities a reality for consumers, operators are forming alliances with technology companies, industry leaders, and universities to create a framework for smart cities and more connected communities.

For example, AT&T is partnering with Cisco, Deloitte, Ericsson, GE, IBM, Intel, and Qualcomm in cities such as Atlanta. In addition to enabling wireless connectivity to things like utility meters, street lights, and water systems. The new framework will enable new categories such as:

- **Infrastructure** – *remote monitoring of roads, bridges, buildings, parks, and venues*
- **Citizen convenience** – *real-time traffic information including consideration of traffic lights and smart parking, in which you can find a spot and reserve one*
- **Public transportation** – *digital signage to let commuters know when the next bus or train will arrive*
- **Public safety** – *manage traffic patterns of pedestrians at stadiums, parks, and busy intersections. Alerts of incidents such as a shooting could enable better response and improved safety.*[24]

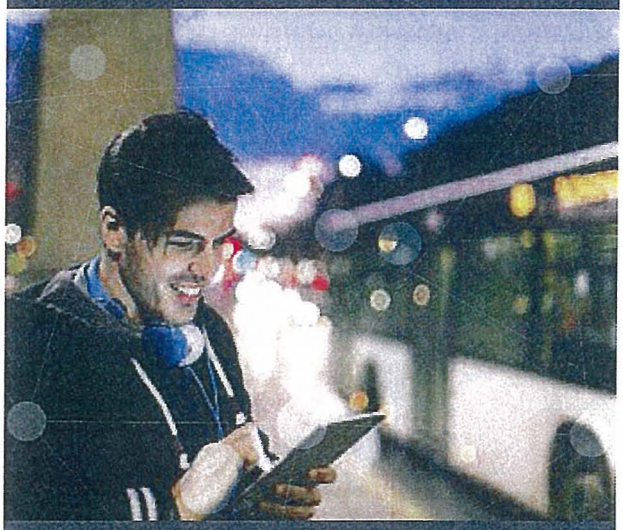
While sensor networks are already starting to enable smart cities, 5G will also greatly expand the number of sensor devices, optimizing traffic and parking. As just one example, 5G will make flexible bus management possible, allowing bus stops and people to tell buses when people are waiting, and bus drivers to skip empty stops or send more buses when demand is high.[25]

AT&T is also developing a new digital dashboard—the Smart City Network Operation Center—which will provide a comprehensive overview of public infrastructure and conditions. This will offer cities a dashboard view of how assets are performing in near-real time. City officials also will be able to keep tabs on power outages, water leaks, traffic issues, and more – all from one location.

5G's higher throughput and lower latency is expected to enable such

5G Case Study

Using 5G to Improve Urban Transportation



Ericsson's Connected Mobility Arena project, designs prototype 5G-enabled solutions addressing mass transportation impacts. Initial use cases will focus on improving the transport of people and goods through Driver Assistance (providing real-time recommendations for drivers to improve travel efficiency) and Semi- and Fully Automated vehicles.

With Driver Assistance, bus drivers will be instructed in real time how long to wait to pick up passengers, and passengers can be instructed which bus to take and when. The resulting efficiencies will lower costs for consumers and reduce environmental impacts. Likewise, Semi- and Fully Automated vehicles will be able to use "vehicle platooning" to have vehicles coordinate braking and acceleration, which will increase road capacity and reduce traffic congestion.

While these 5G solutions will evolve from existing technologies, they will include Quality of Service requirements that specify the maximum network delay and/or minimum guaranteed throughput.

solutions. Capabilities like these can enable cleaner, more efficient cities with better use of city resources. Global smart city economic benefits are estimated to range from $644B-1.2T by 2025.[26]

Wearables and Tag Devices

With 5G, wearables and tag devices are expected to become more prevalent. Wearables remain in their infancy – just 21% of adults have a fitness device today[27] – but the opportunities are vast. The projected annual value of wearables is $600B globally by 2025.[28]

Unlike today's devices, however, future 5G wearables will be fully connected devices – in other words, devices that do not need to be tied to a smartphone to connect to the Internet.

Samsung, for example, is developing connected healthcare and fitness devices that not only record exercise performance and make recommendations, but also can send real-time vital heath statistics (like brain function, heartbeat, and blood pressure) to healthcare experts to prevent emergencies before they happen.[29]

Tag devices (which allow individuals to stay in constant connection with valuable items or loved ones) present a host of potential consumer uses: tracking and monitoring bicycles, motorcycles, pets, briefcases, handbags, keys, and even children.

Automotive

The auto industry has already leveraged 4G LTE for entertainment, information, and safety in vehicles across the country. But even as in-car 4G LTE use continues, 5G promises real-time vehicle solutions with richer information and safety options.

For instance, vehicle broadband access can enable maintenance-type notifications for vehicle servicing needs. Instead of a simple 'check engine' light, a sensor could alert the driver that engine cleaning is recommended and allow the driver to schedule an appointment. More serious concerns such as low tire pressure could direct the driver to the nearest service station.

Vehicle broadband access could also include video streaming, video downloads, music and audio, broadband Internet access, and new emerging applications such as virtual or augmented reality.

Smart Homes

With 5G, our homes will continue to grow smarter through enhanced home security (remote video security monitoring and controls; wireless-controlled door locks), and smart appliances (refrigerators that notify you when low on certain products). New technology will enable much higher throughputs which can enable multiple high resolution cameras and other sensors to be connected and remotely monitored.

"[W]e see 5G as a big step forward ... You can call it a revolution, it's definitely not incremental change." • **Matt Grob,** CTO, Qualcomm

M-Health and Telemedicine

The next generation of wireless technology will unlock the potential of mHealth and telemedicine. Already today, remote diagnostic vital signs are being trialed and utilized, but with a wireless network that can connect consumers' body sensors with health care facilities, consumers will see improvements in health care outcomes and efficiency gains.

For instance, sensors for health monitoring are going to be more prevalent, with automated reporting to a doctor's office or nurses' station. These advances will improve safety, health, and efficiency.

In the area of health monitoring, there are many opportunities for improved, remote monitoring. For instance, researchers at the University of Virginia are working to transform type 1 diabetes management by introducing an "artificial pancreas" solution, which will automatically monitor patients' blood-sugar levels and deliver insulin as needed. The system will use a body sensor to report insulin levels to a smartphone app, which will then analyze the data and wirelessly control a wearable insulin pump.[30] In the future, high resolution images and video can be used by doctors to rapidly and cost-effectively diagnose problems and affect quicker medical outcomes. Emergency medical teams may transmit high resolution images to doctors in hospitals for diagnosis and treatment en route. The potential global benefits are considerable, including longer lives and the improved quality of those lives,[31] estimated to reach somewhere between $700B and $1.2 T globally by 2025.[32]

Smart Grid

The energy area will expand from meter reading and collecting to the smart grid opportunity. Projections indicate that smart grid modernization investments could total $1.3T over the next 15 years. Wireless connections will enable monitoring of the grid, particularly in the distribution network. Substations will require wired connections, but sensors deployed throughout the distribution network and on remote meters will enable the utilities to better serve customers. Companies such as Sprint are already deploying solutions for smart grid for companies such as Tollgrade Communications, a global leader of Smart Grid Sensors with Predictive Grid® Analytics.[33]

Smart grid technology provides three main consumer benefits:

1. *keeps the lights on by enabling overhaul of the grid system; ensuring the grid grows to meet expected increases; and limiting brownouts / blackouts / surges;*
2. *lowers energy costs by giving consumers' control over their usage and facilitating troubleshooting; and*
3. *helps secure energy independence by enabling full scale vehicle charging, focusing on renewable energy.*[34]

Industrial and Other IoT Examples

Agriculture is another area where IoT has great potential. Sensors with wireless connectivity for crop fields can help optimize growing and minimize use of water and fertilizers through more targeted application. Livestock can be monitored remotely, as can tanks and other farm equipment, making farming more efficient.

Consumers will benefit from fresher produce and products that are produced using more efficient farming methods. All told, economic benefits in agriculture are estimated in the $53-341B range annually.[35]

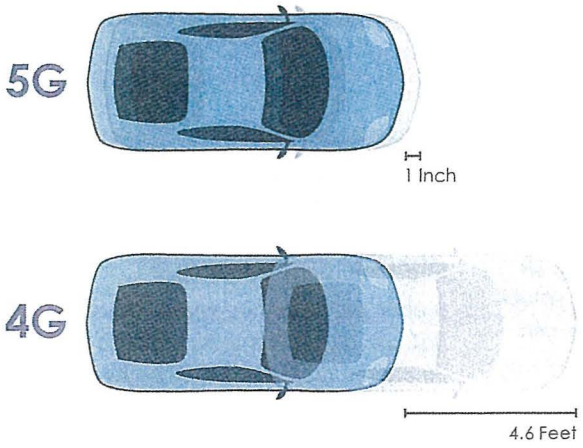
Public safety is a key area where IoT can deliver benefits in terms of improved disaster and emergency services and improved crime detection and monitoring. Wireless connections will inform public safety personnel of the status of threats and help coordinate response tactics.

Hardened wireless cameras may be used to provide video of fire status around walls and inside buildings. 5G will help public safety save lives through better responses to emergencies, and economic benefits range from $38-72B annually.[36]

Source: Volvo Cars

Reduced latency has significant real-world implications.

For instance, it would take about 4.6 feet for a 4G car to apply its brakes. Just an inch for a 5G car to do so, helping avoid collisions and accidents.



5G: Real-Time

5G also promises a marked improvement in wireless network lag time – enabling faster communications.

4G LTE latency rates – the technical term for the delay between your request for data and when your mobile device receives it – are low, roughly 10 milliseconds over-the-air; 50 milliseconds end-to-end. This enables consumers to have good quality voice over IP (VoIP) calls and video calls with little delay or jitter. 5G latency rates will be even lower – targeted to be five to ten times lower.[37]

This reduction in latency may seem inconsequential, but a near real-time consumer wireless experience will enable a host of benefits and applications not possible today.

The real-time abilities of 5G will unlock:

Vehicle Safety and Collision Avoidance

Automobiles will increasingly use sensors and collision avoidance capabilities to alert the drivers to stay in lanes, avoid collisions, and to contact emergency services in the event of an accident.

Sensing with vehicles at speed requires very low latency and the real-time nature of 5G should provide such capabilities. With the reduced latency of a fully optimized ideal 5G network, a self-driving car travelling at roughly 60 mph will move just over one inch from the time it identifies an obstacle to the time when the braking command is executed. This performance is comparable to a standard anti-lock braking system.

By contrast, with the latency on a 4G LTE network, the car would move 4.6 feet under the same conditions.[38]

There are some unique applications of Vehicle-to-Vehicle (V2V) communications, including: intersection movement assistance, left hand turn assist, and emergency electronic brake lights (for poor visibility). In addition, V2V communications can enhance forward collision warnings, blind spot and collision warnings, and do-not-pass warnings. While there are some Direct Short Range Communications (DSRC) technologies being evaluated, 5G may play a role in the future.

V2V safety applications have the potential to prevent or reduce the severity of up to 80% of non-alcohol-related crashes.[39] 5G, with its device density and real-time capabilities, has the potential to advance V2V features.

Source: Volvo Cars

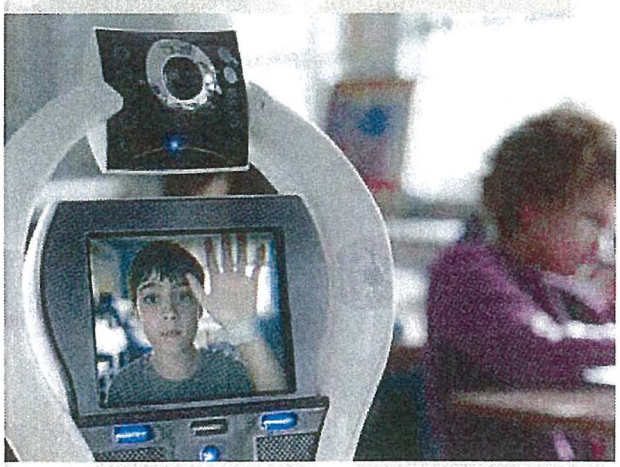
Augmented and Virtual Reality

5G has the potential to dramatically change consumer uses and experiences with respect to enriched medical training, education, entertainment, and retail by enabling real-time interactions that take place wirelessly, without visual delay. Virtual reality is becoming available to consumers today with the launch of products such as Samsung's Gear VR,[40]

Case Study

Verizon VGo Robotic Telepresence

Several companies have established innovation centers to enable wireless companies to develop and test innovative wireless technology solutions. One of the early examples is the VGo Robotic Telepresence, a wireless, robotic telepresence unit. The unit is mobile and can be used to provide video conference capabilities for education, health, and other situations where a robot is useful. It can be used to allow a sick child to attend class real-time or for a home-bound person to communicate live with a medical practitioner.



Verizon recently established a 5G Technology Forum with key leaders/ partners in the industry: Alcatel Lucent, Cisco, Ericsson, Nokia, Samsung, and Qualcomm as well as several East and West Coast venture capitalists. The collective companies represent billions of dollars in R&D investment and are the innovative leaders collaborating to develop the 5G standards. This will help bring the reality of 5G in the U.S., enabling a vision of a more fully connected world.

Microsoft HoloLens,[41] Oculus Rift, Sony Playstation VR, and HTC Vive Pre.[42]

These virtual and augmented reality applications will be enabled by the real-time communications made possible with the extremely low latency rates possible with 5G.

For instance, virtual reality is being used to provide medical training, job training astronauts, medics, police officers and for skilled trades such as welders, as well as in automotive product development and in a wide range of advertising applications – from promoting movies to tourism in British Columbia.[43]

5G's low latency will play a pivotal role in the evolution of virtual reality applications like these, affording users life-like experiences on the move.[44]

In the health sector, medical facilities are using the wireless Oculus Rift, which provides a 360 degree immersive experience on the go, as a training tool that allows medical students to experience a procedure from a surgeon's perspective.[45]

Western University of Health Sciences in Pomona, California, for example, is using the Oculus Rift at its first-of-its-kind virtual reality learning center, which allows students from every program—dentistry, osteopathic medicine, veterinary medicine, physical therapy, and nursing—to learn through virtual reality technologies.[46]

In education, Google is piloting a field a trip simulation system called Expeditions, providing students a 3D-rich experience that simulates going on a field trip to far-off places. Imagine schools with limited resources being able to bring the Colosseum in Rome or the Parthenon in Greece to students.[47]

Virtual reality and augmented reality can also provide absorbing educational opportunities such as visiting virtual museums that assemble lost artworks or provide the context for an artist like Van Gogh's life's work.[48] This can deliver benefits in the form of sustainability, by eliminating costly travel, as well as environmental preservation in touring sensitive areas.[49]

Virtual reality will dramatically change the world of entertainment including movies, concerts, and other immersive experiences. Imagine being able to experience your favorite band or artist in a virtual concert in 3D in the comfort of your own home.[50] Virtual reality can even be used for retail. Tommy Hilfiger just announced the use of Virtual Reality in their stores where consumers can experience a fashion show in 3D.[51] Virtual reality holds out the promise of more customized experiences, which can be updated and enabled wirelessly, and the prospect of cost savings and increased demand for actual as well as virtual goods.[52]

Real-time Video Conferencing

With enhanced real-time capabilities from 5G networks, video conferencing will become more pervasive, which enables telecommuting, richer meetings, and energy savings.

"5G represents a once-in-a-generation opportunity to transform our homes, our cities, and our society. But that means working together on the right framework for wireless innovation and investment." • **Meredith Attwell Baker**, President and CEO, CTIA

What We Need From Policymakers

Policymakers play an important role in advancing 5G technology with a focus on three key issues: more spectrum, streamlined infrastructure deployment, and support for research and development. If consumers are to benefit from 5G services by 2020, we need a committed effort to provide operators with the tools they need to invest in another generation of networks.

Beyond a light-touch, investment friendly regulatory approach, we need to:

Find more spectrum

America's global leadership in mobile depends on spectrum. Countries around the world are looking to 5G not merely as a wireless technology, but as a key input for economic growth. We must do the same or risk innovation and investment being exported overseas. Because wireless fosters innovation across nearly every industry sector, the potential consequences of falling behind are stark.[53]

The cornerstone for wireless growth and innovation will be clearing additional spectrum for 5G. Very large swaths of high band spectrum are required to support localized 5G "hotspots." Additional low and mid band spectrum will enable 5G technology to support much higher device density throughout wide coverage areas.[54]

The FCC should act on the Spectrum Frontiers High Band docket this year in order to make spectrum available for 5G in a timely manner. It is important that spectrum be available to allow operators to deploy as early as they choose for business and technical reasons.

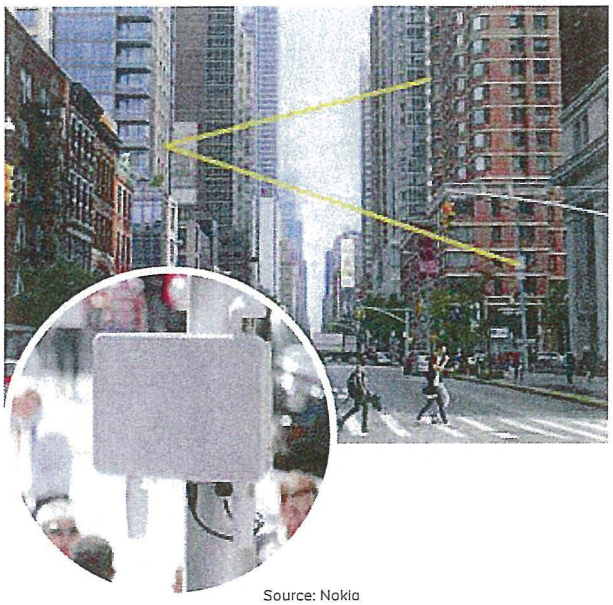
Furthermore, Congress and the Administration should act to identify additional spectrum to be auctioned as soon as practicable. This will provide the low and mid band spectrum to keep up with growth and to enable deployment of the latest technology.

Streamline infrastructure deployment

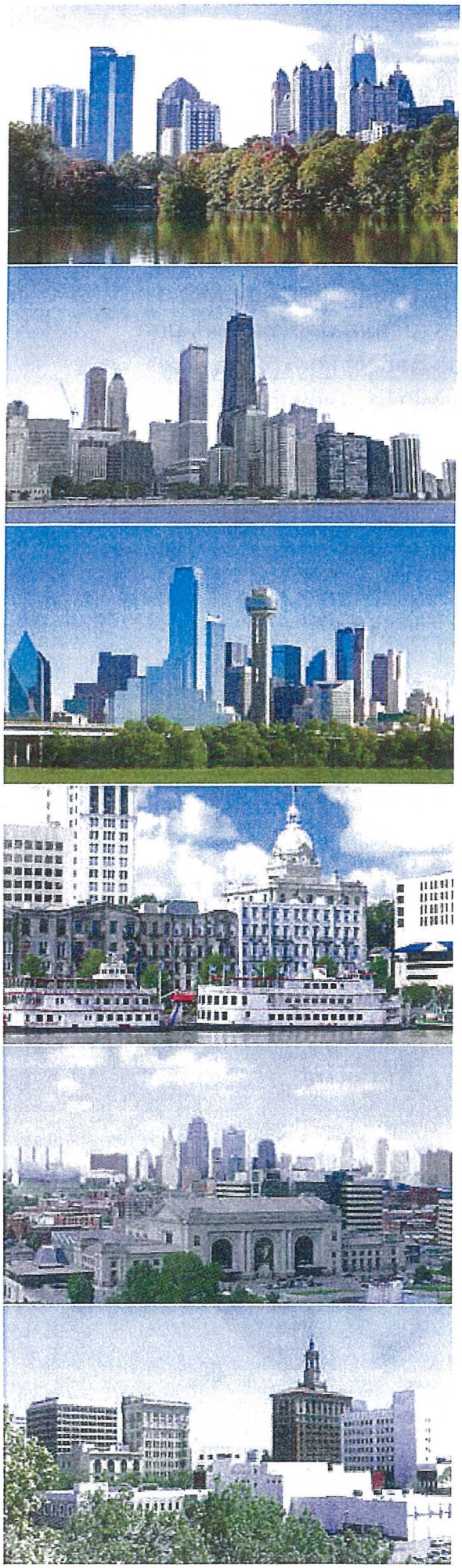
Sound infrastructure policy is a necessary complement to sound spectrum policy. When and how we introduce 5G depends, in part, upon removing barriers to the deployment of cell sites and antennas.

Ultra-dense network configurations, particularly in metro areas heavy with users, will be a major component of 5G. Small cells are key to creating these ultra-dense networks. Moreover, because the propagation of higher frequencies is limited in range and building penetration, wireless deployments will be needed for both indoor and outdoor environments. Towers also will have to be constructed to provide 5G coverage across the nation.

Urban small cells



Source: Nokia



To enable these deployments, policymakers should continue to adopt reasonable, predictable siting processes. Such steps include imposing a deadline on federal agencies to act on wireless siting applications and further streamlining by the FCC of small cell and DAS environmental processing.[55]

In addition, cities and municipalities should look for ways to facilitate new deployments using existing and new facilities.

Increase support for 5G R&D

The U.S. needs a robust ecosystem of research and development (R&D) in wireless technologies, infrastructure, chipsets, devices, and applications. Focused R&D is needed to realize the full innovation potential of spectrum made available for 5G services. Policymakers should continue efforts to increase support for R&D; last year's decision to make permanent the R&D tax credit is a good first step.[56]

Many technology companies including QUALCOMM, Samsung, Intel, Cisco, Ericsson, Motorola, and others are investing in R&D and funding research internally and with universities. Nokia, which recently acquired Alcatel-Lucent (Bell Labs), has been investing in 5G R&D and has funded NYU Poly, one of the leading U.S. universities in millimeter wave technology, to develop and demonstrate 5G technology capabilities.[57]

Furthermore, the government should continue to make direct investments in 5G, such as through the National Science Foundation (NSF).[58] NSF is funding several research programs using their various research programs, testbed infrastructure programs, and testbeds. Partnering with other government agencies including the White House Office of Science and Technology (OSTP), NTIA, DARPA, and others, the NSF can be an important tool to advance 5G research and strengthen the partnership between industry and universities.

Together, with appropriate new spectrum, streamlined infrastructure deployment, and favorable R&D, the ecosystem will help ensure the U.S. is a leader in 5G.

Smart Cities

Operators and technology companies are partnering with cities to provide sensors, connectivity, platforms and solutions to enable consumer benefits, efficiency and energy savings.

Endnotes

1. FCC, Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Eighteenth Report, DA 15-1487, at Chart III.A.3 (Dec. 23, 2015).

2. Id. at ¶ 106.

3. NGMN Alliance, NGMN 5G White Paper (Feb. 17, 2015), at

https://www.ngmn.org/uploads/media/NGMN_5G_White_Paper_V1_0.pdf

4. 4G Americas Recommendations on 5G Requirements and Solutions (Oct. 2014), at http://www.4gamericas.org/files/2714/1471/2645/4G_Americas_Recommendations_on_5G_Requirements_and_Solutions_10_14_2014-FINALx.pdf and 4G Americas, 5G Spectrum Recommendations (Aug. 2015), at

http://www.4gamericas.org/files/7814/4606/7589/4G_Americas_5G_Spectrum_Recommendations_White_Paper-2015.pdf

5. Ericsson, 5G Use Cases (Jul. 8, 2015), at http://www.ericsson.com/news/150708-5g-user-cases_244069645_c

6. Nokia, 5G Use Cases and Requirements, at http://networks.nokia.com/sites/default/files/document/5g_requirements_white_paper.pdf

7. 4G Americas, 5G Technology Evolution Recommendations (Oct. 2015), at http://www.4gamericas.org/files/2414/4431/9312/4G_Americas_5G_Technology_Evolution_Recommendations_-_10.5.15_2.pdf

8. NGMN 5G White Paper, at https://www.ngmn.org/uploads/media/NGMN_5G_White_Paper_V1_0.pdf

9. This varies considerably depending on many factors – device type, application (video, browsing, e-mail), technology capability, radio environment, mobility, and other uses on the network.

10. Neville Ray, Taking America's Fastest 4G LTE Network Even Further, T-Mobile USA CTO blog (Dec. 23, 2015), at

https://newsroom.t-mobile.com/issues-insights-blog/2015-end-of-year-network-recap.htm

11. Jeff Hawn, In-Depth: State of 5G for the Big Four Carriers, RCRWIreless (Nov. 29, 2015), at http://www.rcrwireless.com/20151129/carriers/5g-efforts-for-the-big-four-carriers-tag15

12. James Geddes, Samsung Testing 5G Network With Lightning Speed Standards Of 20 GB Per Second, TechTimes (Jul. 14 2015), at http://www.techtimes.com/articles/68237/20150714/samsung-testing-5g-network-with-lightning-speed-standards-of-20-gb-per-second.htm

13. Joe Lorrio, Volvo and Ericsson Partner on the Real Killer App for Autonomous Cars: Streaming HD Video, Car and Driver (Jan 4, 2016), at http://blog.caranddriver.com/volvo-and-ericsson-partner-on-the-real-killer-app-for-autonomous-cars-streaming-hd-video/

14. Nokia Press Release, Nokia Networks showcases 5G speed of 10Gbps with NI at the Brooklyn 5G Summit (Apr. 8, 2015), at http://networks.nokia.com/news-events/press-room/press-releases/nokia-networks-showcases-5g-speed-of-10gbps-with-ni-at-the-brooklyn-5g-summit

15. Deb Miller Landau, How 5G Will Power the Future Internet of Things, at http://iq.intel.com/how-5g-will-power-the-future-internet-of-things/

16. QUALCOMM, Qualcomm's 5G Vision (Nov. 20150), at https://www.qualcomm.com/media/documents/files/qualcomm-5g-vision-presentation.pdf

17. See Jo Best, The Race to 5G: Inside the Fight for the Future of Mobile As We Know It, TECH REPUBLIC, at http://www.techrepublic.com/article/does-the-world-really-need-5g/; Jonathan Farfield, What Is 5G, when will it launch and what will it mean for you?, THAITECH (Jan. 21, 2015), at http://tech.thaivisa.com/5g-will-launch-will-mean/3053/.

18. See Rob Chamberlin, What will 5G mean for consumers, businesses, and the Internet of Things, Geektime (Jan. 3, 2016), at http://www.geektime.com/2016/01/03/what-will-5g-mean-for-consumers-businesses-and-the-internet-of-things/.

19. Ericsson Mobility Report 2015 (Nov. 2015), at http://www.ericsson.com/res/docs/2015/mobility-report/emr-nov-2015-regional-report-north-america.pdf

20. Mary Meeker, Internet Trends 2015 (May 27, 2015), at http://kpcbweb2.s3.amazonaws.com/files/90/Internet_Trends_2015.pdf?1432738078

21. David Goldman, 5G will cost you a bundle, CNN MONEY (May 19, 2015), at http://money.cnn.com/2015/05/18/technology/5g-cost-wireless-data.

22. See SAMSUNG, 5G VISION 2-4 (Jun. 2015) ("SAMSUNG 5G VISION"), at http://www.samsung.com/global/business-images/insights/2015/Samsung-5G-Vision-1.pdf; Neal Ungerleider, 5G Wireless Is Coming ... But What Is It Anyway, FAST COMPANY (Oct. 26, 2015), at http://www.fastcompany.com/3051626/elasticity/5g-wireless-is-coming-but-what-is-it-anyway.

23. Ericsson Mobility Report 2015, at http://www.ericsson.com/res/docs/2015/mobility-report/ericsson-mobility-report-nov-2015.pdf

24. AT&T Newsroom, ATT launches smart cities framework with New Strategic Alliances, Spotlight Cities, and Integrated Vertical Solutions (Jan. 5, 2016), at

http://about.att.com/story/launches_smart_cities_framework.html

25. Mary-Ann Russon, What will 5G be used for? Self-driving cars, connected home appliances and incredibly smart cities, INTERNATIONAL BUSINESS TIMES (Nov. 7, 2015), at http://www.ibtimes.co.uk/what-will-5g-be-used-self-driving-cars-connected-home-appliances-incredibly-smart-cities-1527420.

26. McKinsey Global Institute, The Internet of Things: Mapping the Value Beyond the Hype (June 2015), (hereafter McKinsey), at http://www.mckinsey.com/insights/business_technology/the_internet_of_things_the_value_of_digitizing_the_physical_world, Smart Cities, p. 89 including $403-693B air and water monitoring; $223-504B adaptive traffic management; $5-9B smart solid waste pickup; $13-16B public transit schedule management.

27. Aditi Pai, Forrester: 35 percent of millennials will buy a fitness wearable in the next year, MOBILE HEALTH NEWS (Sept. 30, 2015), at http://mobihealthnews.com/47134/forrester-35-percent-of-millennials-will-buy-a-fitness-wearable-in-the-next-year.

28. McKinsey, Wearables, p. 45.

29. SAMSUNG, 5G VISION 2 (June 2015), at http://www.samsung.com/global/business-images/insights/2015/Samsung-5G-Vision-1.pdf.

30. Beth Mole, Smartphone-based system does job of a pancreas, treats type 1diabetes, ARS TECHNICA (Jan. 9, 2016), at http://arstechnica.co.uk/science/2016/01/smartphone-based-system-does-job-of-pancreas-treats-type-1-diabetes. See also Press Release, Medtronic and Samsung Partner to Enhance Diabetes Management and Empower Overall Patient Health (June 5, 2015) (discussing the development of additional mobile diabetes solutions, including remotely viewing diabetes data, remote alerts for loved ones, and integrating mobile and wearable devices into diabetes management systems), at http://www.fiercemedicaldevices.com/press-releases/medtronic-and-samsung-partner-enhance-diabetes-management-and-empower-overa.

31. McKinsey, Healthcare, pp. 38-43 including cost savings of $110-470B for treatment of chronic diseases; $35B in reduced costs of clinical trials; and $520B in improvements of lifespan and quality of life. Diseases considered include heart disease; respiratory disease; diabetes; HIV/AIDS; cancer; other chronic diseases; non-chronic diseases; neuropsychiatric conditions; and sensory organ diseases; $30-117B counterfeit drug reductions; $2-14B improved medical devices.

32. McKinsey, Healthcare, pp. 38-43 including cost savings of $110-470B for treatment of chronic diseases; $35B in reduced costs of clinical trials; and $520B in improvements of lifespan and quality of life. Diseases considered include heart disease; respiratory disease; diabetes; HIV/AIDS; cancer; other chronic diseases; non-chronic diseases; neuropsychiatric conditions; and sensory organ diseases; $30-117B counterfeit drug reductions; $2-14B improved medical devices.

33. Sprint Release, Sprint Introduces Worldwide Control over All Connected Devices Through a Simple Self Service Portal (Apr. 23, 2015), at http://newsroom.sprint.com/news-releases/sprint-introduces-instant-worldwide-control-over-all-connected-devices-through-a-simple-self-service-portal.htm

34. SmartGrid Consumer Collaborative, SmartGrid 101 Consumer Benefits, at http://www.whatissmartgrid.org/smart-grid-101/consumer-benefits

35. McKinsey, Agriculture, p. 69 including $1-3B livestock monitoring; $52-338B agricultural yield improvement.

36. McKinsey, Public Safety, p. 89 including $24-41B disaster and emergency services; $14-31B crime detection and monitoring.

37. 4G AMERICAS, IGNITING MOBILE BROADBAND 20 ("4G AMERICAS, LTE AND 5G INNOVATION"), http://www.4gamericas.org/files/9214/3991/2167/4G_Americas_Rysavy_Research_LTE_and_5G_Innovation_white_paper.pdf.

38. Huawei, 5G Vision: 100 Billion connections, 1 ms Latency, and 10 Gbps Throughput, at http://www.huawei.com/minisite/5g/en/defining-5g.html.

39. National Highway Traffic Safety Administration, V2V Communications Fact Sheet, at http://www.safercar.gov/staticfiles/safercar/v2v/V2V_Fact_Sheet_101414_v2a.pdf.

40. Nicole Lee, Samsung Gear VR review (2015): A no-brainer if you own a Samsung phone, Engadget (Nov. 25, 2015), at http://www.engadget.com/2015/11/25/samsung-gear-vr-review-2015/

41. Max Slater-Robins, Here's everything we know about Microsoft's augmented reality headset HoloLens, Business Insider (Oct. 17, 2015), at http://www.businessinsider.com/microsoft-hololens-augmented-reality-headset-roundup-2015-10?r=UK&IR=T

42. Paul Lamkin, The best VR headsets: Oculus Rift, Playstation VR, Gear VR, HTC Vive... virtual reality is back, baby!, Wareable (Jan.7, 2016), at http://www.wareable.com/headgear/the-best-ar-and-vr-headsets

43. Eric Carson, 9 industries using virtual reality, TechRepublic (Mar. 10, 2015), at http://www.techrepublic.com/article/9-industries-using-virtual-reality/. See also Sarah Evans, Using virtual reality welding to evaluate and train welders, The Fabricators (Mar. 18, 2014), at http://www.thefabricator.com/article/arcwelding/using-virtual-reality-welding-to-evaluate-and-train-welders, and Destination British Columbia, The Making of the Wild Within VR Experience, at https://www.youtube.com/watch?v=4SkH-dRvPbv4&t=144

44. See Quinten Plummer, Oculus VR Promises a Rift for All in 2016, TECH NEWS WORLD (May 6, 2015), at http://www.technewsworld.com/story/82018.html; SAMSUNG 5G VISION at 4.

45. Brian Crecente, Watch the first Oculus Rift operation meat to change the way surgeons are taught, POLYGON (Aug. 14, 2014), at http://www.polygon.com/2014/8/14/6001841/oculus-rift-surgery-video-first-person.

46. John Gaudiosi, How this med school is using virtual reality to teach students, FORTUNE (Oct. 16, 2015), at http://fortune.com/2015/10/16/western-university-is-using-virtual-reality-to-teach.

47. Natasha Singer, Google Virtual-Reality System Aims to Enliven Education, The New York Times (Sept. 28, 2015), at http://www.nytimes.com/2015/09/29/technology/google-virtual-reality-system-aims-to-enliven-education.html and Google, Introducing the Expeditions Pioneer Program, at https://www.google.com/edu/expeditions/

48. Kyle Vanhemert, See the World's Greatest Stolen Artworks in this Virtual-Reality Museum, Wired (Jan. 16, 2015), at http://www.wired.com/2015/01/see-worlds-greatest-stolen-artworks-virtual-reality-museum/. See also Alex Radsky, Where History Comes Alive: Augmented Reality in Museums, The Synapse (May 6, 2015), at https://medium.com/synapse/where-history-comes-alive-augmented-reality-in-museums-64a81825b799#.e7uzmrszp

49. Daniel A. Guttentag, Virtual reality: Applications and implications for tourism, Tourism Management (Oct. 2010), at http://www.sciencedirect.com/science/article/pii/S0261517709001332

50. 9 Industries Using Virtual Reality, Tech Republic, http://www.techrepublic.com/article/9-industries-using-virtual-reality/

51. Rachel Arthur, Hands-On With Tommy Hilfiger's In-Store Virtual Reality Catwalk Experience, Forbes (Oct. 25, 2015), at http://www.forbes.com/sites/rachelarthur/2015/10/25/hands-on-with-tommy-hilfigers-in-store-virtual-reality-catwalk-experience/

52. Brian Shuster, Utherverse Digital, Could Virtual Reality Revitalize the Economy? Wired (Oct. 2014), at http://www.wired.com/insights/2014/10/virtual-reality-economy/. See also Matthew Yeomans, Oculus Rift isn't just a game; it could have powerful effect on sustainability, The Guardian (Mar. 26, 2014), at http://www.theguardian.com/sustainable-business/oculus-rift-facebook-acquisition-sustainability-effect

53. See Meredith Attwell Baker, President & CEO, CTIA – The Wireless Association®, ISART 2015 Remarks (May 14, 2015), at http://www.ctia.org/docs/default-source/default-document-library/isart-speech-public.pdf.

54. See Comments of CTIA – The Wireless Association®, GN Dkt. No. 14-177 (Jan. 15, 2015), at http://www.ctia.org/docs/default-source/fcc-filings/150115-filed-ctia-5g-noi-comments.pdf?sfvrsn=0.

55. See Testimony of Scott Bergmann, Vice President, Regulatory Affairs, CTIA – The Wireless Ass'n, Breaking Down Barriers to Broadband Infrastructure Deployment: Hearing Before the House Energy & Commerce Subcomm. on Commc'ns & Tech. (Oct. 28, 2015), at http://docs.house.gov/meetings/IF/IF16/20151028/104121/HHRG-114-IF16-Wstate-BergmannS-20151028.pdf.

56. See Alisa Chang, 8 Things Congress Actually Did This Year, NPR (Dec. 30, 2015), at http://www.npr.org/2015/12/30/461388614/8-things-congress-actually-did-this-year. See also TechNet: Preserve Research and Development Inside U.S.; 21 organizations urging renewal of the critical R&D tax credit (Apr. 4, 2014), at http://www.technet.org/technet-preserve-research-and-development-inside-u-s/.

57. Nokia Press Release, Nokia Networks showcases 5G speed of 10Gbps with NI at the Brooklyn 5G Summit(Apr. 8, 2015), at http://networks.nokia.com/news-events/press-room/press-releases/nokia-networks-showcases-5g-speed-of-10gbps-with-ni-at-the-brooklyn-5g-summit

58. National Science Foundation, 5G Wireless Network Research at NSF, at http://www.nsf.gov/cise/5G/

ctia™

Everything Wireless

CTIA.ORG