S. HRG. 115–90

EXPLORING THE VALUE OF SPECTRUM TO THE U.S. ECONOMY

HEARING

BEFORE THE

SUBCOMMITTEE ON COMMUNICATIONS, TECHNOLOGY, INNOVATION, AND THE INTERNET

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

MARCH 2, 2017

Printed for the use of the Committee on Commerce, Science, and Transportation

U.S. GOVERNMENT PUBLISHING OFFICE

27–651 PDF WASHINGTON : 2017

For sale by the Superintendent of Documents, U.S. Government Publishing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

JOHN THUNE, South Dakota, *Chairman*

ROGER F. WICKER, Mississippi	BILL NELSON, Florida, *Ranking*
ROY BLUNT, Missouri	MARIA CANTWELL, Washington
TED CRUZ, Texas	AMY KLOBUCHAR, Minnesota
DEB FISCHER, Nebraska	RICHARD BLUMENTHAL, Connecticut
JERRY MORAN, Kansas	BRIAN SCHATZ, Hawaii
DAN SULLIVAN, Alaska	EDWARD MARKEY, Massachusetts
DEAN HELLER, Nevada	CORY BOOKER, New Jersey
JAMES INHOFE, Oklahoma	TOM UDALL, New Mexico
MIKE LEE, Utah	GARY PETERS, Michigan
RON JOHNSON, Wisconsin	TAMMY BALDWIN, Wisconsin
SHELLEY MOORE CAPITO, West Virginia	TAMMY DUCKWORTH, Illinois
CORY GARDNER, Colorado	MAGGIE HASSAN, New Hampshire
TODD YOUNG, Indiana	CATHERINE CORTEZ MASTO, Nevada

NICK ROSSI, *Staff Director*
ADRIAN ARNAKIS, *Deputy Staff Director*
JASON VAN BEEK, *General Counsel*
KIM LIPSKY, *Democratic Staff Director*
CHRIS DAY, *Democratic Deputy Staff Director*
RENAE BLACK, *Senior Counsel*

SUBCOMMITTEE ON COMMUNICATIONS, TECHNOLOGY, INNOVATION, AND THE INTERNET

ROGER F. WICKER, Mississippi, *Chairman*	BRIAN SCHATZ, Hawaii, *Ranking*
ROY BLUNT, Missouri	MARIA CANTWELL, Washington
TED CRUZ, Texas	AMY KLOBUCHAR, Minnesota
DEB FISCHER, Nebraska	RICHARD BLUMENTHAL, Connecticut
JERRY MORAN, Kansas	EDWARD MARKEY, Massachusetts
DAN SULLIVAN, Alaska	CORY BOOKER, New Jersey
DEAN HELLER, Nevada	TOM UDALL, New Mexico
JAMES INHOFE, Oklahoma	GARY PETERS, Michigan
MIKE LEE, Utah	TAMMY BALDWIN, Wisconsin
RON JOHNSON, Wisconsin	TAMMY DUCKWORTH, Illinois
SHELLEY CAPITO, West Virginia	MAGGIE HASSAN, New Hampshire
CORY GARDNER, Colorado	CATHERINE CORTEZ MASTO, Nevada
TODD YOUNG, Indiana	

CONTENTS

WITNESSES

APPENDIX

EXPLORING THE VALUE OF SPECTRUM TO THE U.S. ECONOMY

THURSDAY, MARCH 2, 2017

U.S. SENATE,
SUBCOMMITTEE ON COMMUNICATIONS, TECHNOLOGY,
INNOVATION, AND THE INTERNET,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 9:30 a.m. in room SD–G50, Dirksen Senate Office Building, Hon. Roger Wicker, Chairman of the Subcommittee, presiding.

Present: Senators Wicker [presiding], Thune, Blunt, Fischer, Moran, Inhofe, Lee, Johnson, Capito, Gardner, Young, Schatz, Nelson, Cantwell, Klobuchar, Markey, Booker, Udall, Peters, Hassan, and Cortez Masto.

OPENING STATEMENT OF HON. ROGER F. WICKER, U.S. SENATOR FROM MISSISSIPPI

Senator WICKER. Good morning. On behalf of my friend, Senator Schatz, I'm glad to convene the first hearing of the Subcommittee on Communications, Technology, Innovation, and the Internet for the 115th Congress. So welcome to you all.

As we all know, in today's connected world, the demand for spectrum increases with every new technology. Spectrum is the lifeblood of this connectivity, improving the lives of people around the globe.

Our discussion of spectrum policy today comes on the heels of this committee's approval of the MOBILE NOW Act. Under Chairman Thune's leadership, we have taken a significant, bipartisan step toward freeing up spectrum for the next generation——

Senator KLOBUCHAR. I thought it was in keeping with the Committee——

Senator WICKER.—and people should silence their devices, by the way.

[Laughter.]

Senator WICKER. But right on key, for the next generation wireless services with the approval of this legislation. I hope to see Senate passage of the bill in the near future. Our discussion of spectrum policy should continue. With rapid growth in the use of mobile devices and the Internet of Things, demand for spectrum will only increase.

Spectrum for mobile broadband is giving rural America the tools and resources it needs. Applications that utilize mobile broadband provide the means to deliver quality healthcare in the most remote

corners of our states and transmit real-time data for improved crop production on our farms. Satellite services are providing television, broadband, and Earth observation for a variety of applications.

Next Gen TV has the potential to deliver better emergency services and ultimately save lives. This is particularly important to states like Mississippi that can be situated in the paths of hurricanes, tornados, and other natural disasters. Unlicensed spectrum offers opportunities for businesses of all sizes to innovate and continue to fuel the vast expansion of the Internet of Things. Although innovation demands more efficient spectrum use, innovation will also be what solves the problem of limited spectrum.

We are here today to talk about the value of spectrum to the economy. We are here to talk about what we have learned from the FCC's recent spectrum auctions and how unlicensed spectrum is a vital piece of the puzzle. I also hope our discussion will encourage a focus on the future of spectrum policy and set the stage for this committee to look at ways to address spectrum demand.

I would like to welcome all of our witnesses, and I will introduce them in a moment after we have turned for an opening statement to our colleague, Mr. Schatz.

STATEMENT OF HON. BRIAN SCHATZ,
U.S. SENATOR FROM HAWAII

Senator SCHATZ. Thank you, Mr. Chairman, for convening this hearing and to the witnesses for being here today.

Spectrum is the invisible infrastructure that has become the on-ramp to access the Internet. Thanks to mobile and wireless technologies, people can read the news, transfer money, watch shows, video chat with a doctor, all from their mobile device. In a very short time, these technologies have transformed our lives. With new 5G wireless networks and the Internet of Things, demand for spectrum will continue to grow.

The value that that spectrum delivers to the economy is hard to overstate. As we will hear from the witnesses today, spectrum generates new investments, facilitates innovation, and supports job growth across a range of industries. Advancements in mobile and wireless clearly benefit consumers and most industry sectors, but have also revolutionized citizen engagement in politics, transformed news, and enhanced public safety.

Although the focus of today's hearing is on the economic benefits of commercial spectrum, it is vital to point out that the Federal Government also has critical spectrum needs for national security, transportation, weather forecasting, and a wide range of other government services. So we must continue to work with the agencies to ensure that they have the spectrum resources they need now and in the future. But we should also build on the successes of the Spectrum Relocation Fund to make it more attractive for agencies to vacate or share bands with more commercial users where that is possible.

Since we can't create more spectrum, we need to be more creative in how we manage competing spectrum needs. I'm confident that industry will find innovative ways to make better use of the bands that they have, but we also need to find a balance between the competing public and private sector needs for more terrestrial and

satellite capacity and the need to have adequate spectrum available for both licensed and unlicensed uses.

Spectrum policy has been a priority for this Congress and this committee, which has passed the MOBILE NOW Act which would make more licensed spectrum available and facilitate the deployment of supporting infrastructure for 5G. MOBILE NOW also includes a bill that Senator Moran and I introduced that will require the government to develop a national plan for unlicensed spectrum.

While a lot of attention focuses on how to make new frequencies available for the licensed side, we also need a clear plan to support continued innovation in the unlicensed bands. These shared bands have become an affordable way for people to get online. Consumers benefit, technology companies benefit, and ISPs benefit from unlicensed spectrum. I trust that the Committee will continue to work with the agencies and stakeholders to make more bands available to commercial users over the coming weeks and months.

While we do that, though, we also have a responsibility to ensure that people from all walks of life, especially in rural, isolated, or hard to reach areas across the country, have access to wireless broadband services. I know that the Chairman and many of our colleagues on the Committee share this point of view.

To pursue new spectrum opportunities, every stakeholder must be an effective partner in this conversation. A fully staffed FCC led by a chairman and four commissioners is, therefore, critical to accomplishing these goals. I am appalled that the White House withdrew all pending nominations for Federal commissions. That is an unnecessarily provocative act. The administration should defer to congressional leaders on both sides of the aisle on nominees for these commissions, as has been the norm.

Of specific relevance to this committee is Commissioner Rosenworcel's nomination. She has been a leader on spectrum policy and a strong advocate for consumers. I hope that the White House will re-nominate her and the Senate will keep its commitment to confirm her as we should have done a year ago.

Thank you, Chairman Wicker, for initiating this important discussion, and I look forward to the witnesses' testimony.

Senator WICKER. Thank you very much, Senator Schatz.

We have a distinguished panel that we are looking forward to hearing from at this point. Our witnesses include, from left to right: Mr. Scott Bergmann, Vice President of Regulatory Affairs CTIA—The Wireless Association; Mr. Roger Entner, Founder and Lead Analyst, Recon Analytics; Mr. Dave Heiner, Vice President and Deputy General Counsel, Microsoft Corporation; Mr. Pat LaPlatney, President and CEO, Raycom Media; and Mr. Tom Stroup, President, Satellite Industry Association.

Now, a lot of people have prepared, come long distances, and put a lot of thought into this hearing. We have votes at the top of the hour, but we want to be respectful of the time and preparation of our witnesses. It is the Chair's intention to proceed on with the testimony, and members will simply proceed in and out during the two votes, which will begin at the top of the hour, and we'll be able to proceed in that fashion without having to recess and take the valuable time of these participants.

So we'll begin to my left, and, Mr. Bergmann, you're recognized for 5 minutes for an opening statement.

STATEMENT OF SCOTT BERGMANN, VICE PRESIDENT, REGULATORY AFFAIRS, CTIA

Mr. BERGMANN. Good morning, Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee. On behalf of CTIA, thank you for the opportunity to speak about the significant economic contributions of the U.S. wireless industry.

The power of wireless is transforming how we live and work in every community across the country and in every sector of the economy, and we're about to have a breakthrough with 5G, the next generation of wireless. 5G will add trillions of dollars to our economy and 3 million new jobs, from 333 in Tupelo to nearly 3,500 in Honolulu. To deliver on this promise, the wireless industry needs this committee's continued leadership to deliver more spectrum and modernize infrastructure siting policies.

The wireless industry today is a powerful contributor to the U.S. economy. Our members have invested over $300 billion over the last 10 years and are responsible for more than 4.6 million jobs. Consumers and businesses continue to adopt mobile broadband, with data traffic increasing more than 25 times since 2010 and expected to increase another five times by 2021.

America's wireless industry stands ready to invest another $275 billion to deliver 5G networks that will be faster, more responsive, and connect more devices. 5G will enable a new generation of smart communities and unlock the Internet of Things. It will unleash innovation and growth in industries across our economy, from energy, healthcare, public safety, and transportation. With mHealth, smart grids, and self-driving cars, 5G will unlock trillions of dollars of economic benefits and help save thousands of lives.

The U.S. has been the global leader in 4G LTE deployment, and we're poised to lead in 5G. But the global competition is fierce. China, Japan, South Korea, and the EU are all in the chase, making spectrum available, streamlining siting, and investing. The keys to U.S. leadership are sound spectrum and infrastructure policies. Licensed spectrum, in particular, is a key input in mobile networks and a powerful creator of economic growth and jobs.

Fortunately, Congress and the FCC have taken bipartisan steps to make spectrum available for wireless. Now, more work remains to enable 5G leadership. Let me highlight a few steps that the Committee can take.

First, we must ensure timely access to new spectrum made available through the 600 megahertz incentive auction. The auction will deliver 70 megahertz of spectrum for mobile broadband and 14 for unlicensed use. It raised $19.6 billion, making it the second largest FCC auction ever. We support a seamless repacking process and are committed to working collaboratively to achieve the FCC's 39-month schedule so that 5G is not delayed.

Second, the FCC's decision to dedicate high-band spectrum to mobile services was also critical. The FCC can enhance those rules by making targeted reforms and by acting on the additional 18 gigahertz of spectrum identified in the MOBILE NOW Act.

Third, we appreciate this committee's continued attention to the spectrum pipeline. It takes, on average, 13 years to reallocate spectrum for wireless use. This underscores the need to start today. Policymakers should continue to review Federal use of spectrum and consider ways to incentivize agencies to use spectrum more efficiently.

Finally, we must modernize our Nation's infrastructure siting policies so that wireless networks can be deployed rapidly and efficiently. Current Federal, state, local, and tribal siting practices were designed to review large cell towers, not the small cells that will be essential for 5G. Small cells are far less intrusive, the size of a pizza box or a lunch box, and will be deployed by the hundreds of thousands.

We can remove barriers to deployment by addressing burdensome local permitting, ensuring access to rights-of-way and poles with costs and fees that are reasonable and cost-based, modernizing our historic preservation and environmental review processes, and directing agencies to speed deployment on Federal lands and properties. With a continued focus on spectrum and infrastructure, we'll be able to ensure that wireless providers can continue to invest, create jobs, and lead the world in 5G.

Thank you, and I look forward to your questions.

[The prepared statement of Mr. Bergmann follows:]

PREPARED STATEMENT OF SCOTT BERGMANN, VICE PRESIDENT, REGULATORY AFFAIRS, CTIA

Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee, on behalf of CTIA®, thank you for the opportunity to participate in today's panel on "Exploring the Value of Spectrum to the U.S. Economy."

This is an important and timely hearing. The power of wireless is transforming how we live and work, in every community across the country and in every sector of the economy. The next generation of wireless, 5G, will add three million new jobs and half a trillion dollars to our economy. To deliver on this promise, the wireless industry needs more spectrum and streamlined siting rules to facilitate our deployment of that spectrum. 5G cannot happen without this Subcommittee's continued leadership and focus on spectrum.

Recent studies highlight the wireless industry's significant impact on the U.S. economy today. By way of example:

- *We invest in America.* U.S. wireless providers have invested more than $300 billion in their networks over the last 10 years, including more than $32 billion in 2015.[1] Indeed, a 2016 study of companies that invest substantially in the U.S. listed wireless providers as the top two "investment heroes."[2]
- *We are a job multiplier.* More than 4.6 million Americans have jobs that depend directly or indirectly on the wireless industry.[3] And employing one person in the wireless industry results in 6.5 more people finding employment, an employment multiplier that outperforms scores of other sectors, including manufacturing.[4]

---

[1] *Annual Wireless Industry Survey,* CTIA, *http://www.ctia.org/industry-data/ctia-annual-wireless-industry-survey* (last visited Feb. 22, 2017).

[2] Michelle Di Ionno and Michael Mandel, PPI, *Investment Heroes 2016: Ignoring Short-Termism* (Oct. 2016) *https://docs.google.com/viewerng/viewer?url=http://www.progressivepolicy.org/wp-content/uploads/2016/10/InvestHeroes_2016.pdf&hl=en_US*

[3] *See* Roger Entner, *The Wireless Industry: Revisiting Spectrum, the Essential Engine of U.S. Economic Growth,* RECON ANALYTICS, at 18 (Apr. 2016), *http://www.ctia.org/docs/default-source/default-document-library/entner-revisiting-spectrum-final.pdf.*

[4] Coleman Bazelon & Giulia McHenry, *Mobile Broadband Spectrum: A Vital Resource for the American Economy,* THE BRATTLE GROUP, at 2, 20 (May 11, 2015), *http://www.ctia.org-/docs/default-source/default-document-library/brattle_spectrum_-051115.pdf* ("Brattle Group Report").

- *We grow the economy.* The wireless industry as a whole generates more than $400 billion in total U.S. spending,[5] and the wireless industry's value-add is larger than the agriculture and petroleum and coal production industries.[6]
- *We are only getting started.* The mobile industry is expected to make a value-added contribution of $1 trillion to the North American economy by 2020, representing 4.5 percent of GDP by the end of the decade.[7]

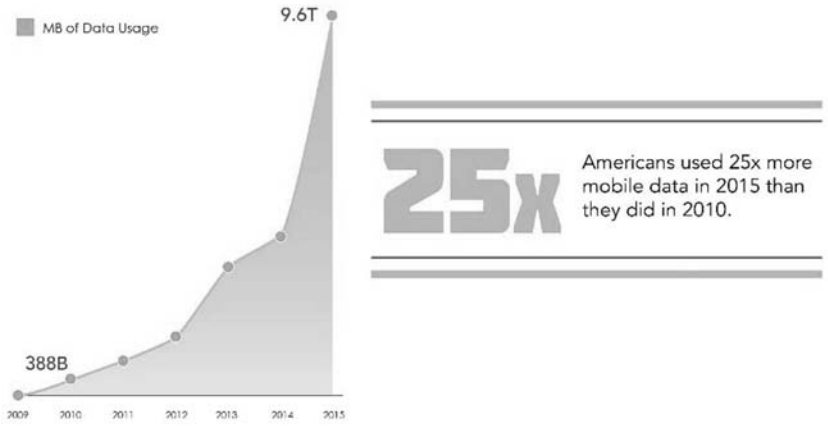
Spectrum is the key input in wireless, fueling our "mobile-first" life and future economic growth. We all know how wireless changes our daily lives; launching more licensed spectrum into the marketplace is also a powerful accelerant for economic growth and job creation.

Fortunately, members of this Subcommittee and policymakers more generally have demonstrated a keen understanding of the critical role spectrum plays—and have worked together to free up more spectrum. The Federal Communications Commission (FCC) has taken several notable steps to help meet the need for more wireless broadband spectrum, including opening up more than 10 gigahertz of high-band spectrum to help realize the transition to 5G and launching the first-ever spectrum incentive auction, which will soon repurpose 84 megahertz of low-band spectrum to wireless broadband. Moreover, recognizing that we must continually focus on the spectrum pipeline, Congress required Federal agencies to relinquish 30 megahertz of spectrum over the next decade to support consumers' ever-increasing need for mobile broadband services.

From the FCC to Capitol Hill, CTIA believes there is widespread and bipartisan agreement on the profound impact of wireless—and spectrum is the key. Despite this strong foundation, more spectrum will be needed to fuel consumers' continued demand for mobile broadband and the innovation that 5G will unlock for industries across our economy.

Growing Demand for Data and the Next Driver of Demand, 5G

The demand for mobile has skyrocketed in recent years, driving home the need to free up more spectrum for mobile broadband. The amount of data flowing over U.S. wireless networks more than doubled in 2015 [8] to a level 25 times greater than in 2010.[9]



[5] Brattle Group Report at 19.

[6] Roger Entner, *The Wireless Industry: Revisiting Spectrum, the Essential Engine of U.S. Economic Growth,* RECON ANALYTICS, at 18 (Apr. 2016), *http://www.ctia.org/docs/default-source/default-document-library/entner-revisiting-spectrum-final.pdf.*

[7] GSMA Press Release, Mobile Industry to Add $1 Trillion in Value to North American Economy by 2020, Finds New GSMA Study (Nov. 1, 2016), *http://www.gsma.com/newsroom/press-release/mobile-industry-add-1-trillion-value-north-american-economy-2020-finds-new-gsma-study/.*

[8] Press Release, Americans' Data Usage More than Doubled in 2015, CTIA (May 23, 2016), *http://www.ctia.org/industry-data/press-releases-details/press-releases/americans-data-usage-more-than-doubled-in-2015.*

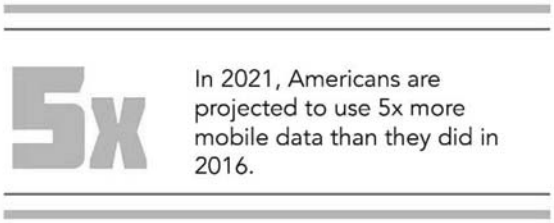
[9] *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016–2021 White Paper,* Cisco (Feb. 7, 2017), *http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html* ("Cisco VNI 2017").

This is due to the advent of smartphones and tablets, massive growth in mobile video (64 percent of all U.S. mobile data traffic [10]), and the nationwide deployment of 4G LTE networks.

In just seven years, wireless providers have blanketed the country with $200 billion in network spending to deliver 4G LTE mobile broadband nationwide.[11] Today, 99.7 percent of Americans have access to 4G LTE service, and 95.9 percent can choose from three or more 4G LTE providers.[12]

Mobile broadband has unlocked opportunities for all Americans. Whether you are low-income, a person with disabilities, or live in a rural community, wireless has helped bring the United States closer to closing the digital divide.[13] In fact, nearly half of all American homes are "wireless-only." [14]

And there is no end in sight when it comes to growth in mobile demand. Cisco projects that mobile data traffic in the U.S. will grow by a factor of five from 2016 to 2021, or roughly 125 times mobile data levels in a decade's time.[15]



[10] Cisco VNI Forecast Highlights, 2016–2021 (United States—Mobile Applications), *http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/#~Country* (last accessed Feb. 23, 2017).

[11] *See, e.g.,* Press Release, Americans' Data Usage More than Doubled in 2015, CTIA (May 23, 2016), *http://www.ctia.org/industry-data/press-releases-details/press-releases/americans-data-usage-more-than-doubled-in-2015.*

[12] *Implementation of Section 6002(b) of the Omnibus Reconciliation Act of 1993,* Nineteenth Report, 31 FCC Rcd 10534, ¶39, Chart III.A.2 (2016).

[13] *See, e.g.,* Aaron Smith, *Record Shares of Americans Now Own Smartphones, Have Home Broadband,* PEW RESEARCH CENTER (Jan. 12, 2017), *http://www.pewresearch.org/fact-tank/2017/01/12/evolution-of-technology/* (noting that 77 percent of Americans now own a smartphone—up from 35 percent in 2011—and nearly three quarters have broadband service at home).

[14] National Center for Health Statistics, Wireless Substitution: Early Release of Estimates from the National Health Interview Survey, January-June 2016 (December 2016) *https://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless201612.pdf* (last visited Feb. 23, 2017).

[15] Cisco VNI Forecast Highlights, 2016–2021 (United States—2021 Forecast Highlights), *http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/#~Country* (last accessed Feb. 23, 2017).

Communities across the country, and industries including agriculture, automobiles, healthcare, appliance manufacturing, and energy, have already begun harnessing the power of wireless connectivity. For example, farmers have been using wireless technology to prevent the over- and under-watering of crops and to preserve resources during droughts, demonstrating the benefits of the Internet of Things (IoT) and next-generation technologies in rural areas.[16] And medical researchers have been using wearables and movement sensors to monitor and improve the progression of diseases such as Parkinson's.[17]

We are about to have a revolutionary breakthrough in the next generation of wireless—known as 5G. 5G networks will be 10 times faster and five times more responsive than today's networks. They will be able to support 100 times more wireless devices from beacons to wearables.

The deployment of 5G networks and increased competitiveness will create jobs for communities of all sizes. From 333 new jobs in Tupelo, Mississippi to more than 1,500 in Sioux Falls to nearly 3,500 in Honolulu, and almost 8,000 in Jacksonville, cities and towns across the country will benefit from the rapid deployment of next-generation 5G services.

America's wireless industry is ready to make significant new investments to bring these benefits to communities all over the country. One recent study estimates that wireless operators will invest $275 billion over the next decade to deploy 5G. That investment is projected to create a new 5G job for every 100 Americans: three million total jobs.

5G will unlock the Internet of Things. Machine-to-machine devices make up about 23 percent of all wireless connections today but are expected to grow more than five times to reach 58 percent of all wireless device connections by the end of the decade.[18]

5G will also enable a new generation of Smart communities. 5G and Smart Cities will have dramatic impact and savings for municipalities and consumers. With 5G, integrated technologies that assist in the management of vehicle traffic and electrical grids will produce $160 billion in benefits and savings through reductions in energy usage, traffic congestion, and fuel costs.[19]

5G will unleash innovation and growth for industries across our economy.[20] Sectors that are expected to leverage 5G's speed, connectivity, and responsiveness, include:

- *Energy.* Wireless-enabled smart grids could create $1.8 trillion for the U.S. economy, saving consumers hundreds of dollars per year.
- *Health.* Wireless devices could create $305 billion in annual health system savings from decreased costs and mortality due to chronic illnesses.
- *Public Safety.* Improvements made by wireless connectivity can save lives and reduce crime. A one-minute improvement in emergency response time translates to a reduction of eight percent in mortality.
- *Transportation.* Wireless-powered self-driving cars could reduce emissions by 40–90 percent, travel times by nearly 40 percent, and delays by 20 percent. That translates to $447 billion per year in savings and, more importantly, 21,700 lives saved.

Each of these industry sectors is leveraging the wireless platform today and stands to benefit from the increased speeds, connectivity, and responsiveness that 5G is poised to deliver.

---

[16] David L. Sunding, Martha Rogers & Coleman D. Bazelon, *The Farmer And The Data: How Wireless Technology Is Transforming Water Use In Agriculture* (Apr. 27, 2016), *http://www.mondaq.com/unitedstates/x/487024/Telecommunications+Mobile+Cable+Communications/The+Farmer+And+The+Data+How+Wireless+Technology+Is+Transforming+Water+Use+In+Agriculture.*

[17] See Intel, *Using Wearable Technology to Advance Parkinson's Research* (2015), *http://www.intel.com/content/dam/www/public/us/en/documents/white-papers/using-wearable-technology-mjff.pdf.*

[18] Cisco VNI Forecast Highlights, 2016–2021 (United States—Potential M2M Connections), *http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/#~Country* (last accessed Feb. 23, 2017).

[19] *See How 5G Can Help Municipalities Become Vibrant Smart Cities,* ACCENTURE STRATEGY, at 1 (Jan. 12, 2017), *http://www.ctia.org/docs/default-source/default-document-library/how-5g-can-help-municipalities-become-vibrant-smart-cities-accenture.pdf* ("CTIA Smart Cities Report").

[20] *See Wireless Connectivity Fuels Industry Growth and Innovation in Energy, Health, Public Safety, and Transportation,* DELOITTE, *http://www.ctia.org/docs/default-source/default-document-library/deloitte_20170119.pdf.*

The Economic Benefits of Spectrum

To unleash 5G and these substantial economic benefits, the wireless industry depends on policymakers to make additional spectrum available for mobile wireless services. Indeed, there are few other actions the government can take to jumpstart such dramatic private-led job creation and economic growth.

CTIA favors a policy that supports both licensed and unlicensed spectrum, recognizing that licensed spectrum is the foundation for our world-leading 4G LTE networks. Licensed spectrum provides exclusive access and clear interference protection rights, delivering the certainty necessary for carriers to invest billions of dollars in network deployment. This exclusivity is also critical to delivering the high-quality, secure, and reliable service that consumers have come to demand.

Licensed spectrum is a proven difference maker for the economy. One recent study found that the introduction of 20 megahertz of AWS–1 spectrum increased U.S. GDP by $48.6 billion from 2011 to 2014.[21] And the economic value of all licensed spectrum made available to date is estimated to be approximately $500 billion, with social benefits at least 20 to 30 times that amount.[22] A 2017 Accenture report projected the future economic impact of 5G to be even more astounding: boosting the U.S. GDP by $500 billion.[23]

With the right policies in place, wireless will have a profound impact on U.S. economic growth. As one recent report concluded, "[m]obile broadband is, and will continue to be, an essential catalyst for the U.S. economy, spurring economic growth and innovation in existing industries while motivating entirely new industries."[24]

The other economic benefit of licensed spectrum is to our Nation's debt. The U.S. wireless industry has now spent more than $100 billion at FCC spectrum auctions for licensed spectrum—with most of that money going straight to the U.S. Treasury, reducing the debt and funding other Congressional priorities.

Global Leadership in Wireless

The United States has been the global leader in 4G LTE deployment and we have the ability to lead in 5G as well. The wireless industry is conducting a number of 5G trials across the country, building on years of research and development investment. And as I noted previously, the FCC opened up 10 gigahertz of high-band spectrum last year that serves as an important down payment on the spectrum needed to support 5G. We are well-positioned to lead, but this time around, global competition is fierce.

Many nations are vying to seize the 5G leadership mantle. South Korea, for example, has committed $1.5 billion to its "5G Creative Mobile Strategy,"[25] and expects to launch a 5G trial network for the Winter Olympic Games in 2018.[26] Japan plans to follow suit with its own 5G trial network for the 2020 Summer Olympics.[27] The European Commission has committed 700 million Euros ($759 million) of public funds to support 5G activities as part of its Horizon 2020 Programme.[28] And this past September, the European Union released "5G for Europe: An Action Plan" that calls for making provisional spectrum bands available for 5G ahead of the 2019 World Radio Communication Conference.[29] The EU and Brazil have an agreement to develop 5G, along with similar key cooperation initiatives with South Korea, Japan, and China.[30] And the Chinese government has an ongoing 5G technology

---

[21] *The Impact of 10 MHz of Wireless Licensed Spectrum,* RECON ANALYTICS, at 1 (Dec. 2015).

[22] Brattle Group Report at 1.

[23] CTIA Smart Cities Report at 1.

[24] Brattle Group Report at 1.

[25] Tammy Parker, *China, South Korea Commit to 5G Leadership, While Japan and U.S. Rely On Private Efforts,* FIERCE WIRELESS (June 8, 2014), *http://www.fiercewireless.com/tech/china-south-korea-commit-to-5g-leadership-while-japan-and-u-s-rely-private-efforts.*

[26] Daniel Fuller, *2018 Winter Olympics To Have 5G Thanks To Samsung And KT,* ANDROID HEADLINES (Oct. 28, 2016), *https://www.androidheadlines.com/2016/10/2018-winter-olympics-to-have-5g-thanks-to-samsung-and-kt.html.*

[27] Joseph Waring, *Docomo's 2020 5G launch 'Not just for Olympics',* MOBILE WORLD LIVE (Oct. 7, 2015), *https://www.mobileworldlive.com/featured-content/home-banner/docomos-2020–5g-launch-not-just-for-olympics/.*

[28] Jorge Valero, *Europe Hopes to Make 5G Networks a Reality by 2018,* EURACTIV (Feb. 19, 2016), *https://www.euractiv.com/section/digital/news/european-industry-to-bring-5g-network-by-2018/.*

[29] Press Release, 5G for Europe Action Plan, European Commission, *https://ec.europa.eu/digital-single-market/en/5g-europe-action-plan* (Sept. 14, 2016).

[30] Press Release, EU and Brazil Work Together on 5G Mobile Technology, European Commission (Feb. 23, 2016), *http://europa.eu/rapid/press-release_IP-16-382_en.htm.*

trial in the 3400–3600 MHz band[31] and it has set ambitious goals for domestic 5G as part of its Made in China 2025 project.[32]

The U.S. wireless industry will continue to invest, deploy, and innovate, but our continued global leadership depends on a committed and comprehensive spectrum and infrastructure policy.

Policies to Advance the Economic Impact of Spectrum

CTIA encourages policymakers to take several actions to preserve continued U.S. leadership in wireless, ensure the availability of 4G LTE and 5G services for American consumers, and foster continued U.S. economic growth. Moreover, as policymakers consider proposals to devote hundreds of billions of, or even a trillion, government dollars to infrastructure investment, we note that the wireless industry stands ready to invest billions of its own dollars, if policymakers update national and local siting and zoning rules to reflect the wireless networks of today and tomorrow. These steps will expedite the wireless industry's investment of over $275 billion, and will not cost taxpayers a dime.

Incentive Auction. The successful 600 MHz incentive auction will deliver 70 megahertz of new mobile broadband spectrum, and an additional 14 megahertz of spectrum for unlicensed uses like Wi-Fi and LTE–U/Licensed Assisted Access services. It has already raised $19.6 billion, making it the second largest FCC auction ever—by spectrum allocated or by revenue. CTIA is keenly interested in ensuring timely access to this spectrum, which is critical to our leadership in 5G services. We support a seamless repacking process for remaining broadcasters, and we are committed to working collaboratively to achieve the 39-month transition. Three years and three months is significantly longer than the wireless industry has had to wait to begin deploying new services to consumers in recent auctions, and any delay would put at risk 5G development, rural buildout, and be inequitable to those companies investing nearly $20 billion in new spectrum.

High-Band Spectrum. The FCC's decision last year to repurpose high-band spectrum for mobile services was an important step for U.S. leadership in 5G. The FCC should enhance those rules with targeted reforms, and promptly move forward with the 18 gigahertz of high-band spectrum previously identified by the FCC and this Committee through the MOBILE NOW Act. In making additional high-band spectrum available, the FCC should emphasize large contiguous blocks of exclusive, licensed spectrum.

Spectrum Pipeline. We appreciate this Committee's continued attention to the spectrum pipeline and the need to identify additional spectrum bands that can meet the ever-increasing demands for mobile broadband services. The process of bringing spectrum to market is time consuming—it takes on average 13 years to reallocate spectrum for wireless use. The AWS–3 band, for example, was a 13-year journey to free up 65 megahertz of spectrum that culminated in a 2015 auction resulting in more than $40 billion in revenues to the U.S. Treasury. This underscores the urgency of beginning this process today, as the ability of the United States to remain a global leader in wireless depends on the ability of policymakers to identify sufficient licensed spectrum.

We need a clear plan for additional licensed spectrum across a wide and diverse range of frequencies to meet tomorrow's needs. As part of this process, government should continue to review spectrum currently allocated for Federal use and consider ways to incentivize Federal agencies to use their spectrum resources more efficiently and effectively. The direct impact of new spectrum cannot be underestimated. For every 10 megahertz of licensed spectrum made available, the U.S. GDP increases by more than $3.1 billion and U.S. employment increases by at least 105,000 jobs.

Modernizing Infrastructure Siting Policies. Lastly, we must move forward with modernizing infrastructure siting policies so that spectrum can be fully utilized and wireless networks can be rapidly and efficiently deployed. Wireless carriers invest billions of dollars building cell sites to provide faster broadband wireless networks that will enable new products and services. Unfortunately, current federal, state, local, and tribal siting laws and policies were designed to review large cell towers one by one, but not to process small cells that are far less intrusive, more numerous, and leverage existing structures. As a nation, we need to update those laws and policies to remove barriers to efficient deployment of small cells and 5G services. These outdated policies are slowing wireless providers' significant investment and must be addressed.

---

[31] *5G Spectrum in Europe,* Global Mobile Suppliers Association (Dec. 23, 2016), *http://www.slideshare.net/soksitha/5g-spectrum-in-europe.*

[32] Lilian Rogers, *What's at Stake in China's 5G Push?,* APCOFORUM (Dec. 14, 2016), *http://apcoworldwide.com/blog/detail/apcoforum/2016/12/14/whats-at-stake-in-chinas-5g-push.*

To speed deployment of broadband services, Congress and the FCC should address burdensome local permitting processes; modernize right-of-way access and pole attachment policies; and streamline and clarify the historic preservation and environmental review processes. We would suggest reasonable shot clocks for new site and collocation permit applications and broader application of existing deemed granted remedies. Additionally, permit fees and other charges for wireless siting should be reduced to reflect small cells' minimal impact and be limited to the actual, incremental costs to localities for processing these applications.

Federal agencies should also adopt streamlined policies to enable small cell deployment on Federal lands, properties, and buildings. In particular, streamlined processes for siting on Federal lands in rural and remote areas would greatly improve the ability of the wireless industry to serve these hard to reach customers.

By promoting sound infrastructure policies at the federal, state, local, and tribal levels, we will enable wireless providers to invest resources more quickly—expediting connectivity, adding jobs, and advancing 5G leadership.

* * *

CTIA appreciates the opportunity to work with the Subcommittee, Congress, and other interested parties to ensure that we have spectrum policies that allow the wireless industry to meet growing consumer demands and support U.S. economic growth to its fullest extent. We look forward to engaging with you to accomplish these objectives.

Thank you for the opportunity to testify today. If CTIA can provide any additional information you would find helpful, please let us know.

Senator WICKER. Thank you very much.

At this point, our Ranking Member of the Full Committee has a unanimous consent request.

STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Senator NELSON. To insert my comments into the record on this extremely important subject, and thank you, Mr. Chairman and Ranking Member of the Subcommittee, for holding this hearing.

Senator WICKER. Without objection, the remarks will be inserted at the appropriate place in the record.

Thank you, Senator.

[The prepared statement of Senator Nelson follows:]

PREPARED STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

I want to welcome all of our witnesses for joining us and thank Subcommittee Chairman Wicker and Ranking Member Schatz for holding this hearing on the value of spectrum to the U.S. economy.

The wireless sector contributes billions of dollars yearly to the U.S. economy.

Frankly, very few of us today can imagine a world without our smartphones and tablets, and even fewer businesses could imagine running their operations efficiently and effectively without robust wireless technologies.

And the integration of wireless connectivity into every facet of the U.S. economy increases every day. In fact, according to some, the day is not far away where the total number of wireless devices and equipment will double or triple the number of humans living on the globe.

Similarly, our Nation's broadcasters serve as pillars of the local communities in which they serve. Free over-the-air broadcasting remains an important and valuable use of spectrum. And the satellite industry uses its spectrum to provide service and support to important Federal Government customers. Satellite services can also reach customers in even the most rural areas and provide important connectivity to so many other spectrum-based services.

As I have said before, the Nation must have a balanced spectrum policy to continue to support wireless technologies as an engine of innovation for the Nation. That means we need additional licensed spectrum, but also we have to make more spectrum available for unlicensed services. The reality of spectrum utilization today is that both licensed and unlicensed commercial wireless services will need to share

spectrum with other operators. As I have said before, we should relocate spectrum when we can, and fully embrace spectrum sharing when we cannot.

But in all of this talk of the value of spectrum to the economy, we cannot forget the need to make sure that the Federal Government, and in particular our national security and homeland security agencies, have enough spectrum today and into the future for their mission-critical operations. That's not to say that we should not have cooperative conversations with those agencies to determine where there are opportunities to make available additional spectrum to commercial services. But those efforts should not hamper mission critical Federal operations.

But this is not just a public safety and national security concern. These same Federal spectrum operations make their own contribution to the economic success of the Nation. The weather monitoring performed by NOAA and NASA, along with the use of spectrum for satellites and other sensors, provides essential information for transportation, shipping, and environmental protection.

NASA's use of spectrum for near-Earth and deep space exploration may lead the Nation into its next wave of technological innovation, just as the lunar program did many years ago. And the spectrum that powers the defense and intelligence community's wireless operations translates into thousands of private-sector jobs in terms of the government contractors upon whom those agencies rely.

Spectrum is a finite resource, and it is essential for Congress to collaborate with the private sector and the public sector to make sure adequate spectrum is available for all of these services. And as I am sure we will hear from the witnesses today, the 5G revolution that is coming quickly will need more spectrum and more infrastructure to reach its full economic potential. I am glad this committee came together to pass the MOBILE NOW bill earlier this year to help foster this 5G revolution—a bill developed through that collaborative process. And I know we will continue to work together to address additional spectrum issues, including those being raised by our witnesses today.

Senator WICKER. Our next witness is Mr. Roger Entner.

Sir, you are recognized.

STATEMENT OF ROGER ENTNER, FOUNDER, RECON ANALYTICS LLC

Mr. ENTNER. Good morning, Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee. Thank you for giving me the opportunity to testify this morning. My name is Roger Entner. I am the founder of Recon Analytics, a telecom research and consulting firm with a focus on wireless. Today, I'm here to discuss my research into the effect that the U.S. mobile industry has on the U.S. economy and to highlight the importance of Federal Government continuing to free up additional spectrum to support 5G and future network evolutions.

First, a quick overview of the U.S. mobile industry. In 2015, Americans spent 2.9 trillion minutes talking on their mobile phones, sent 1.9 trillion text messages, 218 billion pictures, and used 9.6 trillion megabytes of data. U.S. wireless network operators have constructed over 307,000 cell sites. From 2000 to 2015, U.S. network operators have spent $77.8 billion to buy spectrum and have invested $423 billion to build out and expand the capacity and speed of the networks.

Competition in the U.S. mobile industry is intense. Two weeks ago, Verizon re-introduced its unlimited plan with HD video. In less than 4 days, competitors matched and tried to beat the offer. Just today, AT&T launched another new pricing plan. Ninety-seven point nine percent of Americans can choose from three network-based operators, and 93.4 percent can choose from four operators plus more than a dozen virtual operators. The mobile industry is equivalent of over-the-top competitors.

How does this relate into jobs? The mobile industry directly and indirectly supports 7 million jobs in the United States. These jobs are a function of the amount of investment the companies spend to build the networks, operate the networks, advertise their networks and services, and otherwise work with a wide variety of vendors and others to create and sustain what we know as the American mobile consumer experience and the U.S. wireless industry. As a result, the mobile industry contributed $194.8 billion in GDP in 2014.

The app and mobile content market is a $36 billion industry whose very existence is dependent on the ubiquitous vast mobile broadband network American companies have built. Companies like Uber, Lyft, and Airbnb would be unthinkable without the direct and immediate connections and data flows mobile networks give them and their customers. Together, these three companies alone are valued at $98 billion. To say that the U.S. mobile industry is one of the driving factors to create new jobs and businesses in a digital economy is an understatement. But there is no guarantee the industry will be able to support the kind of exponential demand for mobile networking that a fully connected network economy is expected to need.

From 2008 to 2015, mobile data usage increased 643-fold and growth is expected to continue unabated. And today, the Internet of Things is the newest frontier for wireless, and it has implications for improvements in manufacturing, healthcare, transportation. There is not a sector in our U.S. economy that won't be improved by access to fast mobile broadband networks.

Deploying new spectrum is the most effective and quickest way to provide more capacity ahead of this tsunami of demand and ensure the industry can continue to drive economic growth and new job creation. Consider every 10 megahertz of deployed licensed spectrum creates $3.1 billion in GDP and 100,000 new jobs. The MOBILE NOW Act is a great next step in the journey to clear more spectrum. But as demand for mobile services is increasing, the need for spectrum is increasing as well.

My suggestions for policymakers are few but specific. First, licenses should be allocated in larger channel sizes. 5G deployments need at least 20 by 20 megahertz channels, ideally in low, medium, and high frequencies. Second, 5G deployments having access to cleared spectrum for which providers have exclusive use. Third is to help streamline the approval process for new and existing cell sites further.

Thank you again for the opportunity to testify at this important hearing. I look forward to answering your questions.

[The prepared statement of Mr. Entner follows:]

PREPARED STATEMENT OF ROGER ENTNER, FOUNDER, RECON ANALYTICS LLC

Introduction

Chairman Wicker, Ranking Member Schatz, and Members of the Subcommittee, thank you for giving me the opportunity to testify this morning. My name is Roger Entner and I am the Founder of Recon Analytics, a boutique research and consulting firm focused on the telecom industry, and, in particular, the wireless sector. For more than 20 years, I have been tracking and reporting on the business and technology evolutions occurring in the U.S. wireless industry.

For more than a decade, I have been analyzing the impact that the mobile industry has had and can have across the U.S. economy, especially with regard to promoting job creation. Today, I am here to discuss this research and to highlight the importance of the Federal Government continuing to free up additional spectrum to support 5G and future network evolutions.

State of the U.S. Mobile Wireless Industry

I'd like to begin with an overview of the U.S. mobile wireless industry:

- There are more than 370 million mobile connections in the U.S., of which 329 million are smartphones and regular phones.
- In 2015, Americans spent 2.9 trillion minutes talking on their mobile phones, sent 1.9 trillion text messages, 218 billion pictures and used 9.6 trillion MB of data. This compares to 2.2 trillion minutes talking on their mobile phones, 2 trillion text messages, 57 billion pictures and 388 billion MB only 5 years ago.
- We have 307,626 cell sites in this country, compared to 183,689 ten years ago.

Competition in the U.S. wireless industry remains intense. When Verizon reintroduced its unlimited plans with HD video it took its three nationwide competitors only four days to match its offer. 99.9 percent of Americans have access to at least one wireless operator, 99.7 percent have the choice between two operators, 97.9 percent between three operators, and 93.4 percent between four operators. In addition, Americans can choose from a variety of plans that fit their best needs with different amounts of data attached to them. Even the smallest service plans now include unlimited voice calling and texting.

Other aspects of the industry also remain very competitive. Americans can choose from dozens of devices from their mobile operator or bring their own devices to use with their operator's service. Americans also have a wide variety of choices how they pay for mobile services.

U.S. Wireless Industry and Job Creation/Economic Growth

The mobile industry, directly and indirectly, supports 7 million jobs in the United States. In 2014, wireless carriers spent more than $21 billion on network equipment and another $27.1 billion on professional services. The wireless industry contributed $194.8 billion in GDP in 2014, up from $146.2 billion three years' prior. As of 2014, mobile wireless services created a consumer surplus of $640.9 billion.

The carriers themselves are not the only source of job creation and economic growth. The App and Mobile Content market—such as movies and TV shows consumed on wireless devices—is a $36 billion industry. New business models such as Uber, Lyft, and Airbnb that rely on fast, mobile broadband networks would be unthinkable without mobile connectivity. Together, these three companies alone are valued at $98 billion.

Keeping the Pump Primed with Additional Allocations of Spectrum is the Single Most Important Factor to Keeping the U.S. Mobile Industry an Engine of Economic Growth for the U.S. Economy

Over the last four decades, Congress and the FCC have provided the wireless industry with increasing amounts of spectrum to expand network reach and capacity. However, the allocations have consistently proven to be stop-gap measures because more capacity begets demand for more capacity. Initially, exploding demand for voice services was the big driver for spectrum, but by 2008, data took over as the big driver. From 2008 to 2015, data usage increased from 15 million MB to 9.6 trillion MB, a 643x increase.

Cisco and Ericsson are forecasting a 5-fold increase in data usage in the United States over the next six years. In order to increase capacity and download speeds to satisfy the demand for unlimited data, especially video, the United States needs at least ten times more spectrum allocated for commercial mobile use. While there are certainly tremendous innovations happening in the world of spectrum efficiency such as carrier aggregation technologies, increases in the efficiency of wireless networks can only do so much. Deploying new spectrum is the most effective and quickest way to provide more capacity and drive economic growth and new job creation.

Deploying new spectrum has a direct impact on U.S. economic growth. Every 10 MHz of deployed spectrum creates $3.1 billion in GDP and 200,000 new jobs.

The Internet of Things—The Next Frontier

The Internet of Things (IoT) is the next frontier of wireless. Virtually every device benefits from being connected. Connected cars are rapidly becoming the industry standard. Trucking companies are tracking all their vehicles and the goods they

transport at all times. The medical community is undergoing massive change by remotely connecting patients with doctors for tracking vitals and diagnosing illnesses.

Video is also coming to IoT. Consumers and municipalities alike are placing more cameras in their homes and cities and connecting them to the web. Some are connected through unlicensed spectrum; some are connected through licensed spectrum. Smart cities in particular will rely on licensed spectrum to connect disparate assets.

Suggestions for Spectrum Policy in the 21st Century

The Mobile Now Act is a great next step in the journey to clear more spectrum. But, as demand for mobile services is increasing, the need for spectrum is increasing as well. In addition to dedicating more spectrum for commercial mobile use, Congress and the FCC need to take additional steps to facilitate continued growth in wireless use, including for IoT.

For example, licenses should be allocated in larger channel sizes. In the past channel sizes did not matter; now, they do. Fully realized 5G deployment needs at least 20x20 MHz channels.

Such deployments also need cleared spectrum for which providers have exclusive use. Such use is preferable to sharing, which creates a whole new set of challenges for licensees which could undermine 5G deployments. In addition, all spectrum users—commercial and governmental—need to use spectrum as efficiently as possible, which will make surplus spectrum available for new uses.

While increasing the overall quantity of available spectrum is important, it is also now critical to ensure that spectrum with different propagation characteristics is made available for commerce mobile use. We need more spectrum in low, medium and high bands for specific usages. Low frequency spectrum is particularly useful to cover large swaths of land and to provide service inside buildings. Medium frequency spectrum provides coverage and capacity in many places. High frequency spectrum is ideal for small areas of high usage to deliver maximum capacity while minimizing interference with other cell sites.

Further, regulatory actions impede the deployment of new networks and services. Local zoning regulations are often a roadblock to deployment, slowing down, if not preventing, the deployment of new equipment or even making modest changes to existing equipment. At a minimum, the Federal Government could accelerate the deployment of mobile services by streamlining the approval process for small cells, DAS and other equipment that do not require the construction of a new tower. In addition, Congress can provide regulatory certainty that establishes a reliable planning framework to deploy more wireless facilities by clarifying that broadband providers are not subject to Title II of the Communications Act.

Conclusion

Thank you again for the opportunity to testify at this important hearing. The wireless industry has helped drive economic growth and job creation, even during the Great Recession, and can continue to do so as long as Congress and the FCC implement sound spectrum and regulatory policies. I look forward to answering your questions.

Senator WICKER. Thank you very much.

Mr. Heiner, you are recognized.

STATEMENT OF DAVE HEINER, VICE PRESIDENT, REGULATORY AFFAIRS, MICROSOFT CORPORATION

Mr. HEINER. Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee, thank you for inviting me to testify. My name is Dave Heiner, and I am Microsoft's Vice President of Regulatory Affairs. I'm pleased to have the opportunity to speak with you today about the critical importance of unlicensed spectrum to the U.S. economy.

We all use unlicensed spectrum every day without giving it much thought. If you unlocked your car with a key fob or opened your garage door with a remote this morning, if you make a hands-free call in your car, you're using unlicensed spectrum. If you have a fitness tracker, you're connecting to your phone with unlicensed spectrum. And, of course, we all use Wi-Fi every day. PCs, laptops, tablets, mobile phones, game consoles, smart TVs, thermostats,

web cams, lighting systems, and countless other devices connect to the Internet and one another with unlicensed Wi-Fi spectrum.

This success story is no accident. Congress and the FCC had great foresight decades ago in opening up spectrum to unlicensed use. Today, unlicensed spectrum is powering the nation's Internet economy. We can see it all around us. For example, most U.S. homes have a Wi-Fi connection. Away from home, there are 94 million public Wi-Fi hotspots around the world, and that is projected to grow to more than 500 million by 2021. People want Wi-Fi wherever they go, and they want it for all of their many devices. As of 2015, the industry had shipped more than 10 billion Wi-Fi enabled devices.

All of this means, of course, that the unlicensed spectrum is very heavily utilized. In fact, according to a report from Cisco, in the United States, 55 percent of total Internet traffic is carried over a Wi-Fi network. By comparison, just 3.4 percent of Internet traffic is carried by licensed mobile networks. This flood of traffic has translated into enormous economic growth. As detailed in my written testimony, a recent study estimated that by this year, unlicensed spectrum would contribute nearly $50 billion to the GDP and $547 billion in economic surplus annually.

The public availability of unlicensed spectrum is important to Microsoft because our customers depend on connectivity to reach our services. Our business strategy is mobile first, cloud first. What that means is enabling customers to use any connected device to access Internet services running in massive data centers, which we call the cloud. Our products like Windows and Office used to be standalone programs, but no more. Today, they are always connected, enabling new features and being continuously updated with security and other improvements.

In recent years, we have developed a new platform called Azure to enable anyone to build and deploy cloud services accessible via the Internet. Cloud computing is taking off because it offers tremendous economic efficiencies. But the cloud is wholly dependent upon connectivity, and the unlicensed bands are the workhorse that enable it. For example, our telemetry shows that 98 percent of Windows 10 devices are connected to Wi-Fi, and nearly half of all the data that comes onto and off those devices flows over the Wi-Fi connection.

Of course, unlicensed spectrum is more than just Wi-Fi. The Bluetooth connections that we're all familiar with operate in unlicensed spectrum as well. The Internet of Things depends upon unlicensed spectrum, and TV white spaces technology, which carries the promise of bringing broadband to rural communities, depends upon unlicensed as well. The unlicensed bands have spurred these and so many other innovations because they provide immediate access to shared spectrum resources with low barriers to entry and light regulation.

In closing, I would offer two suggestions to promote optimal use of spectrum. First, Congress should advance a balanced spectrum policy that includes both licensed and unlicensed spectrum as is done in the MOBILE NOW Act, which we support. Second, through this Act and others, policymakers should look for additional oppor-

tunities in the low, mid, and high-frequency unlicensed bands to help satisfy ever-growing demand.

Thank you again for the opportunity to testify. At Microsoft, we look forward to working with you to promote optimal spectrum policy.

Thank you.

[The prepared statement of Mr. Heiner follows:]

PREPARED STATEMENT OF DAVE HEINER, VICE PRESIDENT, REGULATORY AFFAIRS, MICROSOFT CORPORATION

Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee, thank you for inviting me to testify. My name is Dave Heiner, and I am Microsoft's Vice President for Regulatory Affairs. I am pleased to speak with you today about the value of unlicensed spectrum to the U.S. economy.

We all use unlicensed spectrum every day without giving it much thought. If you unlock your car with a key fob, open your garage door with a remote, make a hands-free call in the car, or buy a coffee with an Apple Pay tap, you are using unlicensed spectrum. If you are tracking your steps with a Fitbit, you are using unlicensed spectrum to communicate with your phone. And, of course, nearly everyone uses Wi-Fi. In fact, more than half of all Internet traffic transits over a Wi-Fi connection. PCs, laptops, tablets, game consoles, smart TVs, mobile phones, and other devices all routinely connect to the Internet via unlicensed Wi-Fi spectrum. Together, these technologies combine to create billions of dollars in economic value to the U.S. economy every year.

Licensed spectrum is important too, and Microsoft is very much in favor of a balanced policy that aims to promote the availability and efficient use of both unlicensed *and* licensed spectrum. In developing optimal spectrum policy, we think it is important to bear in mind that unlicensed spectrum is carrying 16 times more Internet traffic than licensed spectrum. That is remarkable considering there is substantially more commercially viable licensed spectrum than unlicensed spectrum below 6 GHz, where the vast majority of broadband traffic resides. Wi-Fi traffic to the Internet is growing very rapidly—by 2015, Wi-Fi handled more than half of all global Internet traffic, wireless or wireline. That share of overall traffic continues to rise. And Wi-Fi is ubiquitous: most U.S. households have Wi-Fi and there are nearly 100 million public Wi-Fi access points around the world. Looking forward, forecasters expect the number of Wi-Fi access points to grow to well over 500 million by 2021.

Wi-Fi is only one of many uses of unlicensed spectrum. The low barriers to entry and permission-less innovation enabled by easy access to this shared resource has enabled large companies and small companies alike to innovate in a wide range of wireless technologies and even enabled the emerging category of the "Internet of Things" (devices communicating with one another, and with users, via the internet).

Unlicensed spectrum is critical to innovation at Microsoft and the technology sector

All of this is very important for Microsoft and, of course, for the technology sector as a whole. Wireless connectivity is very much at the center of the "mobile first, cloud first" business strategy that Microsoft's CEO Satya Nadella is pursuing. From cloud computing to the Xbox platform to the Internet of Things, Microsoft's ability to invest and innovate depends on the availability of broadband spectrum governed by commercially reasonable rules—so our individual and enterprise customers have a great experience at home, at work, and on the go.

When I started at Microsoft in 1994, our software was primarily delivered to customers via floppy disks or CD–ROMs. The software typically had little interaction with the internet. Those days are gone. All of Microsoft's major business lines are now dependent on continuous and reliable Internet connectivity for key features and continuous updating. Those businesses—Windows, Office, and our relatively new Azure "cloud" platform—make Microsoft the third most valuable company in the world. (The first two are Apple and Alphabet, and they are dependent on Internet connectivity too.) Microsoft is employing more than 70,000 people in the United States and investing close to $13 billion in R&D annually (88 percent of which is spent in the United States) to grow those businesses. The Microsoft cloud serves over 1 billion customers, generating over 1 trillion data points every day managed through more than 100 data centers around the world connected to the internet.

Cloud is critical to consumers, enterprises of all sizes, and even governments—stimulating innovation and enabling economic growth.

Our cloud services include Windows, Office 365, MSN, OneDrive, Skype, Azure, Outlook.com, and more. And all of these services depend upon consistent and ubiquitous Internet access for key features. For example, Windows enables customers to synchronize their files to the cloud and other devices and to "roam" settings and preferences from one device to another. Windows includes Cortana, the personal digital assistant that relies upon cloud processing to help people stay organized and get things done. Our Office 365 customers are continually getting new features, without having to wait years as in the past for major new versions to be released. For all of these efforts, last-mile connectivity is critical—and unlicensed spectrum is meeting that need for us and our customers.

Microsoft's Azure cloud platform enables software developers to quickly and inexpensively build new cloud services. More than 90 percent of Fortune 500 companies are using Azure today to efficiently deliver enterprise solutions. GE Healthcare is an example. Microsoft Azure powers mission-critical patient care applications for GE Healthcare, including solutions that streamline communication between clinicians, patients, and hospital administrators with secure, centralized, real-time access to the diagnostic scans and reports that physicians need to make decisions. And it is unlicensed spectrum—which links the data to tablets, smartphones, and a wide variety of connected devices—that makes all of this possible.

Microsoft's cloud also supports our new "mixed reality" platform, HoloLens. Unlike virtual reality, "mixed reality" merges people, places, and objects from the physical and virtual worlds together, allowing users to interact with content and information in far more accessible and intuitive ways. Developers have created apps for HoloLens that range from games to art museum tours to simulated lab experiments. Enterprise users can benefit from HoloLens too, with architecture tools, power plant monitoring, and aircraft maintenance training. Microsoft's HoloLens headset relies on unlicensed spectrum to connect our customers to the worlds—physical and online—around them.

Microsoft's Xbox game console is dependent on unlicensed spectrum too. Game consoles serve as central hubs not only for multi-player gaming, but also for making calls on Skype, watching TV on Netflix, and controlling home IoT devices. Advanced game consoles depend on Wi-Fi-linked Internet access for all of these features, and they use unlicensed Wi-Fi and Bluetooth technologies to distribute data to different devices throughout our customers' homes, and to link game controllers—including guitars and steering wheels—to consoles.

The businesses and consumers we serve expect every application to work both in the office and on the go, and they expect access to the same cloud applications on laptops, smartphones, tablets, and wearables.

The unlicensed bands are the workhorses that make this happen. *Our telemetry shows that ninety-eight percent of Windows 10 devices are connected to Wi-Fi and nearly half of all data flows over the Wi-Fi connection.* This is the case because consumers and enterprises overwhelmingly use Wi-Fi to link to their fixed wireline broadband service, whether that service is delivered by cable or a telco.

Unlicensed spectrum fuels economic growth

Of course, the importance of Wi-Fi is not limited to Microsoft, or even to Internet firms generally. Wi-Fi access points serve an ever-growing ecosystem of devices, including not only laptops, smartphones, and tablets, but also doorbells, irrigation systems, thermostats, refrigerators, lighting systems, and wearables.

Two relatively recent economic studies help to quantify the value of unlicensed spectrum.

In 2014, Raul Katz, a professor at Columbia University, estimated that by this year unlicensed spectrum would contribute $547.22 billion in economic surplus annually and nearly $50 billion to the annual GDP.[1] He arrived at that estimate by building on his historical assessment of unlicensed spectrum's economic value in 2013 ($222.4 billion in total economic value and $6.7 billion contributed to the GDP)[2] and analyzing two key drivers of growth in the area. First, Professor Katz analyzed growing adoption of then-widely deployed technologies and applications, including Wi-Fi-cellular off-loading, residential Wi-Fi, Wireless Internet Service Providers, Wi-Fi-only tablets, wireless personal areas networks, and radio-frequency identification devices. As Professor Katz explained, research from a wide variety of

[1] Telecom Advisory Services, LLC, Assessment of the Future Economic Value of Unlicensed Spectrum in the United States at 4 (Aug. 2014), *http://www.wififorward.org/wp-content/uploads/2014/01/Katz-Future-Value-Unlicensed-Spectrum-final-version-1.pdf.*

[2] *Ibid.*

industry resources anticipated very rapid growth in adoption of those technologies. For example, Cisco estimated that between 2013 and 2017 the number of tablets in use in the United States would grow by more than 300 percent and the Internet traffic generated by each of those units would increase nearly five-fold. Dr. Katz also accounted for increased economic value generated by the "deployment of emerging innovations, such as machine-to-machine communications and agricultural automation." Though his estimate attempted to account for those future developments, Dr. Katz underscored that "estimates of economic value of future technologies are extremely conservative."

Also in 2014 Richard Thanki conducted a study for the Consumer Electronics Association focusing on retail sales attributable to products that depend upon unlicensed spectrum.[3] To estimate the economic value generated by that spectrum, Thanki collected sales data for the wide variety of devices that use it—Wi-Fi devices, but also less obvious parts of the unlicensed ecosystem, such as broadcasting hardware, medical devices, and baby monitors. Thanki concluded that unlicensed spectrum generates more than $62 billion in "incremental retail sales value," a number that he cautions is overly conservative because it focuses solely on "the sale of devices using unlicensed spectrum to end-users" and does not attempt to quantify "indirect contributions in terms of savings, productivity, and utility" that "greatly exceed" the study's assessment of direct benefits.

These indirect benefits, including the innovation gains described above, should not be overlooked. In addition to its direct value in driving the adoption of new devices and technologies, unlicensed spectrum yields a wide range of indirect economic spillover benefits that prove more difficult to quantify. These indirect impacts reverberate throughout the economy in job growth, wage gains, and productivity.

Unlicensed spectrum fuels innovation

Congress and the FCC had great foresight in enabling use of unlicensed spectrum decades ago, and, in particular, the release of the ISM band for unlicensed spread spectrum use in 1985. Today this spectrum is powering our cloud economy. The unlicensed bands produce the exceptional economic value discussed above because anyone can use them as long as they follow basic FCC rules on power limits and emission restrictions that are designed to protect other users from harmful interference. Today, innovators of all types—incumbents as well as start-ups—recognize this powerful combination of light regulations and low barriers to entry. And this advantage has helped make the Internet of Things a reality. But the growing number of IoT applications will require access to enough low-, mid-, and/or high-frequency spectrum to succeed. A variety of protocols operating in unlicensed spectrum have been developed to enable IoT devices, including Wi-Fi, zigbee, Bluetooth, WirelessHART, and z-wave.

Smart home technologies are already bringing unlicensed IoT technologies into millions of American homes through devices like Sonos connected speakers, which form their own mesh networks using the 2.4 GHz and 5 GHz unlicensed bands. Many other IoT devices rely on radio-frequency identification, commonly known as RFID. RFID tags most often use unlicensed spectrum to communicate with everything from container cars to lost luggage. These popular devices are already on their way to becoming ubiquitous. Ericsson has estimated that, by 2018, IoT devices will surpass mobile phones as the largest category of connected devices.

As you can see, unlicensed spectrum is critical to a wide variety of technologies and applications, and the numbers tell the story of just how much value this creates:

- Innovators have seized on the opportunities created by unlicensed spectrum to develop a wide range of new devices. In January 2015, the Wi-Fi Alliance announced that the industry had shipped its 10 billionth Wi-Fi device.[4]
- Unlicensed frequency bands support more traffic than any other band. In the United States 54.9 percent of total Internet traffic transited a Wi-Fi network. (By comparison, just 3.4 percent of total Internet traffic transited a mobile network using licensed spectrum.)[5]

---

[3] Consumer Electronics Association, Unlicensed Spectrum and the American Economy: Quantifying the Market Size and Diversity of Unlicensed Services at 2 (Aug. 4, 2014), *https://ecfsapi.fcc.gov/file/7521751149.pdf.*

[4] WI–FI ALLIANCE, Total Wi-Fi® device shipments to surpass ten billion this month (Jan. 5, 2015), *http://www.wi-fi.org/news-events/newsroom/total-wi-fi-device-shipments-to-surpass-ten-billion-this-month.*

[5] Cisco, VNI Forecast Highlights Tool: 2020 Forecast Highlights, *http://www.cisco.com/c/m/en_us/solutions/service-provider/vni-forecast-highlights.html,* (accessed Feb. 23, 2017).

- We've seen tremendous investment in unlicensed access points. To carry the huge wave of data I've described, the number of public Wi-Fi access points around the world will grow six-fold from 2016 (94.0 million) to 2021 (541.6 million).[6]

In addition to delivering direct value to consumers and enterprises, unlicensed networks are also valuable because they sustain licensed networks. Mobile traffic is asymmetric: considerably more data (especially video) is downloaded than uploaded. Licensed network providers and device makers increasingly choose to offload downlink traffic from licensed networks to Wi-Fi, harnessing the power and pervasiveness of unlicensed access points. And, as data caps and speeds become more of a concern, smartphone users now take advantage of Wi-Fi as an option for their most data-intensive applications. By one estimate, 85 percent of the traffic generated by smartphone video apps goes over Wi-Fi—one of the reasons that "although cellular data usage on smartphones is growing, Wi-Fi data growth is dramatically outpacing it."[7] By 2021, 64 percent of the traffic from smartphones will be offloaded from mobile devices to fixed networks via Wi-Fi or small cells. For tablets, that number is projected to be 72 percent.[8]

The flexibility in the FCC's unlicensed rules is also clearing the way for innovators to take advantage of underutilized spectrum, such as television whitespaces (TVWS). Certified TVWS devices allow consumers, Internet service providers, local governments, and others to access unassigned and unused spectrum that exists between television stations. At these frequencies, a signal can travel over much larger distances than conventional Wi-Fi, making it perfect for providing broadband access to unserved and underserved rural areas. There are many potential uses for such technology. As described in a recent article in the The Economist,[9] Microsoft researchers are using TVWS to collect data from far-flung sensors on a farm in Washington state. The sensor data, once analyzed in the cloud, enables the farmer to engage in "precision farming," to minimize both irrigation and pesticide use. And because FCC rules ensure that white-spaces devices will protect over-the-air broadcasters and other licensed services from harmful interference, they will add economic value without causing any harmful interference.

Microsoft has invested significantly in white-spaces technologies, and is committed to their success. Even though the Incentive Auction created uncertainty among white-spaces users and the developing ecosystem, Microsoft has continued to invest in white spaces to ensure that this technology lives up to its transformative potential once the auction and repack is concluded and the FCC's updated rules are finalized. We have spearheaded white-spaces projects in the United States and around the world.

In southern Virginia, for example, Microsoft has partnered with Mid-Atlantic Broadband Communications and the Commonwealth of Virginia to use white spaces to bring high-speed Internet access into the homes of previously unconnected students. In these areas, as many as 50 percent of school children lack access to high-speed Internet at home, making it hard for them to do their homework, and excluding them from the revolution in education that the Internet has brought for students in many wealthier areas. Using white spaces, we are able to leverage the fiber connections that run to these schools, allowing students in surrounding areas to access school networks wirelessly from home. With this single project, Microsoft and its partners will serve 7,500 primary and secondary school students when the system is fully deployed. If deployed statewide, this approach could help to connect a quarter million unconnected students in Virginia alone.

Microsoft has also worked to deploy white-spaces networks in previously unserved parts of rural Africa, proving that this technology will play an important role in U.S. and international communities where infrastructure challenges are even greater. In Kenya, Microsoft and its partners have used white spaces to deploy Internet access points in areas that do not even have access to an electrical grid. We have used white-spaces technologies to connect these rural access points to distant fiber connections, and used conventional Wi-Fi to bring these connections to individual de-

---

[6] Cisco, Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016–2021 (Feb. 9, 2017), *http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html.*

[7] Ericsson, Ericsson Mobility Report: On the Pulse of the Networked Society at 25 (June 2016), *https://www.ericsson.com/res/docs/2016/ericsson-mobility-report-2016.pdf.*

[8] Cisco, *supra* note 6.

[9] The Economist, TV Dinners: Unused TV Spectrum and Drones Could Help Make Smart Farms a Reality (Sept. 27, 2016), *http://www.economist.com/news/science-and-technology/21707242-unused-tv-spectrum-and-drones-could-help-make-smart-farms-reality-tv-dinners.*

vices. These access points are solar powered, allowing them to be completely isolated from any other physical infrastructure.

These projects are just the beginning. We are committed to taking on more investments with partners around the United States this year, with a focus on supporting connectivity, skills, and local innovation in rural and underserved communities. We strongly support action at the FCC to ensure that enough TV white-spaces channels remain available for unlicensed use, and hope the FCC will finalize commercially reasonable white-spaces rules soon so we can move ahead.

Next steps toward meeting the growing demand for unlicensed spectrum

As this Subcommittee has long recognized, radio spectrum is an essential input to economic growth and innovation. Under the Subcommittee's and full Committee's leadership, the United States has adopted a set of core spectrum policies that can guide effective decision-making by Federal agencies. Central among these are that agencies should find additional spectrum resources to support affordable broadband for all Americans and to meet the seemingly insatiable consumer and enterprise demand for wireless data services. Agencies should free new spectrum bands for commercial service and find ways to use underutilized spectrum bands more efficiently through sharing. And agencies should continue to advance a balanced spectrum policy that identifies potential spectrum bands for licensed and unlicensed use—in low, mid, and high frequency bands.

While the unlicensed ecosystem has produced exceptional economic value and innovation to date, our existing unlicensed bands will not be able to support the continued growth of wireless data produced by consumers, enterprises, and the Internet of Things. Last month, the Wi-Fi Alliance released the *Wi-Fi Spectrum Needs Study*. It concludes that an additional 500 MHz to 1 GHz of spectrum is required to satisfy expected growth in busy-hour demand for Wi-Fi through 2025.[10] Importantly, the analysis also found that unlicensed spectrum should be "assigned with sufficient contiguity such that wide channels of 160 MHz, or perhaps even wider in the future, can be constructed."[11] Wider channels would enable greater throughput, which will result in faster downloads for users.

Based on our analysis of the Nation's spectrum bands, Microsoft believes that spectrum sharing will be required to meet the demand for unlicensed spectrum. Depending on the specific frequency range, sharing may involve Federal or non-federal spectrum users. So we are strong supporters of the MOBILE NOW Act, which would kick-start this process by initiating proceedings on sharing mid-band spectrum for licensed and unlicensed use.

We close with three recommendations.

First, the Subcommittee, both through MOBILE NOW and more broadly, should continue to promote a balanced spectrum policy that includes adequate unlicensed frequencies. Future spectrum needs will likely be met through heterogeneous networks where different spectrum bands—some licensed, some unlicensed—will be mixed and matched over the communications path to provide the necessary bandwidth for a given device at a given location at a given time. This means that Congress and the FCC should act to free up new licensed, unlicensed, and shared spectrum for wireless broadband at low, mid, and high frequencies. We therefore support the MOBILE NOW Act, reported out of the full Committee, and hope that the Committee will aggressively push agencies to free new bands for commercial licensed and unlicensed services.

Second, the Subcommittee should oppose efforts to over-protect incumbents through onerous technical regulations when the FCC permits unlicensed users to access underutilized bands on a shared basis. Under the Commission's rules, unlicensed devices cannot cause harmful interference and cannot claim protection from interference. Yet some incumbents seek far more than this. They ask Congress and the FCC to impose technical rules that would hobble unlicensed technologies by making investment uneconomic and creating a perpetual state of regulatory uncertainty. Committee oversight of the FCC should therefore ensure that the Commission adopts only reasonable technical rules that support economically rational investment for growth in unlicensed bands.

Third, the Subcommittee can lend its support to voluntary industry standard-setting efforts. Standards bodies such as the IEEE have been critical for decades in developing industry consensus standards for unlicensed devices. Engineers from Microsoft work hard with their peers at other companies to develop standardized

---

[10] Quotient Associates, Wi-Fi Spectrum Needs Study: Final Report (Feb. 2017), *https://www.wi-fi.org/download.php?file=/sites/default/files/private/Wi-Fi%20Spectrum%20Needs%20Study.pdf*.

[11] *Id* at 2.

techniques for sharing the unlicensed bands. Given all the demand for access to unlicensed spectrum, it is more important than ever that companies work together at IEEE and in other appropriate standards organizations to ensure new technologies share effectively and equitably with existing users. These consensus-driven efforts can often obviate the need for costly government regulation.

Thank you for addressing these important issues today. As I've noted above, unlicensed spectrum plays a critical role in innovation and our economy. We look forward to finalization of the TV white-spaces rules, resolution of outstanding dockets relating to unlicensed spectrum, and successful passage of the MOBILE NOW Act. At Microsoft, we are committed to working with you to ensure that a balanced spectrum policy continues to produce value for the American economy, support innovation, and increase access to the internet.

Senator WICKER. Thank you very much.

Mr. LaPlatney?

STATEMENT OF PAT LAPLATNEY, PRESIDENT AND CHIEF EXECUTIVE OFFICER, RAYCOM MEDIA ON BEHALF OF THE NATIONAL ASSOCIATION OF BROADCASTERS

Mr. LAPLATNEY. Good morning, Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee. My name is Pat LaPlatney, and I'm the President and CEO of Raycom Media, where I oversee 60 broadcast television stations stretching from Hattiesburg to Honolulu, as well as a number of production and digital media properties.

I'm testifying today on behalf of the National Association of Broadcasters and its 1,300 full-power television stations that serve communities across the country with free, locally focused programming. I appreciate you inviting me here to speak about the upcoming voluntary upgrade that broadcasters across the country and in other parts of the world are making to the next generation television standard, ATSC 3.0.

In a world where broadband access is an expectation on par with electricity and water and social media is ubiquitous, the importance of local broadcasting and the trusted news coverage it affords is paramount. Through Next Gen TV, broadcasters will deliver all of this, along with the most watched entertainment programming and sports, to your constituents in new and exciting ways.

So what is Next Gen TV? Next Gen TV is a crystal clear, ultra high-def picture that enhances the broadcast viewing and listening experience. Next Gen TV has more effective emergency alerting capabilities that will save more lives. Next Gen TV integrates the best of broadcast and broadband to offer interactive content, such as dropdown menus of sports scores or movie information. Next Gen TV enables access to broadcast television through smart phones and tablets, ensuring that our local stations' content is available virtually anywhere, anytime, and through any platform that viewers desire.

Finally, Next Gen TV is spectrally efficient, meaning it offers more channels for free with the same amount of spectrum. No expensive cable bill or data plan is required. Simply put, Next Gen TV will enhance the ability of local broadcasters to impact the communities we serve.

The recent broadcast coverage of the tragic tornado in Hattiesburg, Mississippi, and the hurricanes in the Puna District on the Big Island of Hawaii provided ample evidence of the potential viewer benefits that Next Gen TV will afford. Through my stations'

wall-to-wall coverage, Next Gen TV would have enabled more and better emergency services, including enhanced alerting, interactive menus of hyperlocal detail, and the potential for mobile access had cellular signals failed.

A broad coalition, including public and commercial broadcasters, consumer electronics manufacturers, and public safety advocates, has petitioned the FCC to allow stations to conduct a voluntary market-driven transition to this new Next Gen TV standard. After several months, the FCC unanimously approved a Notice of Proposed Rule Making last week. Broadcasters stand willing and ready to make the necessary investments in our infrastructure to enable an upgrade to Next Gen TV. We simply need the FCC to quickly finalize these rules in order to move forward. We applaud the FCC for its work to date, and we encourage the Committee to stay engaged.

Before I conclude, I want to highlight one issue currently before Congress that does pose challenges to viewers' ability to enjoy the benefits of Next Gen TV—successful completion of the broadcast incentive auction. As the auction winds its way to completion, one thing is certain. The broadcast industry will end up with less spectrum. So the ability of those nonparticipating stations to repack successfully into a smaller broadcast band without viewer disruption is critical.

To that end, I want to thank the Committee leadership, Senators Moran and Schatz, as well as their co-sponsors, Senators Blumenthal, Blunt, Fischer, and Udall, for the work on draft legislation that ensures broadcasters will have adequate time and resources to successfully repack following the close of the incentive auction. Your legislation will make certain that no consumer will lose access to their broadcast service as a result of the repack. It is just this certainty that investment in Next Gen TV requires.

Thank you, and I look forward to answering your questions.

[The prepared statement of Mr. LaPlatney follows:]

PREPARED STATEMENT OF PAT LAPLATNEY, PRESIDENT AND CHIEF EXECUTIVE OFFICER, RAYCOM MEDIA, ON BEHALF OF THE NATIONAL ASSOCIATION OF BROADCASTERS

Good morning, Chairman Wicker, Ranking Member Schatz and members of the subcommittee. Thank you for inviting me to testify today on behalf of the National Association of Broadcasters (NAB). My name is Pat LaPlatney, and I am the President and Chief Executive Officer of Raycom Media, where I oversee 60 broadcast television stations stretching from Hattiesburg to Honolulu, as well as a number of production and digital media properties.

I am testifying today on behalf of the National Association of Broadcasters, where I serve as a member of the Television Board of Directors and represent more than 1,300 full-power local television stations. This includes stations owned by major networks like ABC, CBS, Univision, Fox and NBC; separately-owned network affiliate stations and independent broadcasters. Each of these stations serves its community with free over-the-air television that combines locally-focused content, including highly valued local news, with the most-watched entertainment programming in the media landscape.

I appreciate you inviting me here today to speak about the upcoming, voluntary upgrade that broadcasters across the country, and throughout the world, for that matter, are planning to make to the Next Generation Television standard, ATSC 3.0. Next Gen TV will drastically improve and expand the experience of the large and growing population of over-the-air broadcast television viewers—and in a more spectrally efficient manner that requires no additional government funds. Next Gen TV is based on an Internet Protocol backbone, which supports a seamless blending

of Internet and TV content. The result is a higher quality interactive viewing experience that combines the best of broadcast and broadband and that will enable innovative broadcasters to bring new services to viewers. In today's increasingly fragmented video space, Next Gen TV will improve the quality and features of the country's most-watched programming, allowing viewers the potential to consume it wherever and however they choose and permitting broadcasters to compete more effectively against other digital video providers.

In a world where preteens have smartphones, broadband access is an expectation on par with electricity and water, and social media enable a wide range of viewpoints to spread around the globe instantly, locally-oriented broadcasting and local news coverage from trusted sources are more important than ever. Through Next Gen TV, broadcasters are able to deliver to our viewers—your constituents—sharp ultra HD images, in addition to interactive features, customizable content and multichannel immersive sound. Viewers can also look forward to more choices, more channels and more flexibility. Mobile devices and TV sets equipped with Next Gen receivers will make over-the-air TV available virtually anywhere. And it will provide even more effective alerting to the public in times of crisis.

One need only look at the impact broadcasters have in their communities today to recognize the potential public safety benefits Next Gen TV affords local viewers. Earlier this year, near Hattiesburg, Mississippi, a tornado touched down shortly before dawn, leaving a 25-mile wake of destruction and four casualties. Local broadcasters gave residents advanced warning of where to go, or not go, and provided a communications lifeline to emergency services. Or look at Hawaii News Now, which embedded news crews for an extended period of time in the Puna District on the Big Island while back-to-back hurricanes battered houses only to be followed by a threatening lava flow. Next Gen TV would have enabled more and better emergency services, including enhanced alerting, interactive menus with hyper-local detail and the potential for mobile access even when cellular signals fail. Moreover, Next Gen capabilities would enhance the recovery efforts of local broadcasters, such as our local NBC affiliate WDAM–TV in Hattiesburg, to publicize specific resources available to particular storm victims, instruct viewers on safe havens and conduct fundraising drives.

Broadcasters live in the communities we serve. And regardless of where they reside, our broadcasters are committed to ensuring that local residents in communities across the country have the same opportunities as people in large cities to benefit from advances in technology. Next Gen TV is critical to affording these opportunities.

Next Gen TV represents a unique partnership between the technology industry (CTA), first responders (AWARN) and commercial (NAB) and public (APTS) broadcasters. We petitioned the Federal Communications Commission (FCC) to allow stations to conduct a *voluntary,* market-driven transition to this new standard, specifically outlining the many ways viewers will benefit from this standard while also ensuring no viewer disruption during the transition. To that end, any broadcast upgrade to Next Gen TV will be facilitated by channel-sharing arrangements that allow broadcasts to continue in the current standard as well. In response to our petition, the FCC released on February 24 a rulemaking notice proposing to authorize TV broadcasters to use the Next Gen standard.

Some of my fellow panelists will outline the advancements they hope to accomplish either on their current spectrum or in newly designated spectrum bands over the years and decades to come. One thing they will *not* say, however, is that they are asking the FCC for permission to make investments to enable these innovations. In fact, broadcasters are the *only* licensees required to ask the FCC for permission to innovate. It's like having to ask the governor for permission to plant a garden in your own yard.

Broadcasters are willing and ready to make the necessary investments in our infrastructure to provide what we believe will be truly groundbreaking improvements to free, over-the-air television for the benefit of viewers across the country. The new standard will allow us to transmit in Ultra High Definition with High Dynamic Range (HDR) and enhance viewer experiences through interactivity, as well as provide enhanced emergency and weather alerts to TVs, phones and tablets. Most importantly, the Next Gen TV standard is flexible enough to allow us to continue innovating *within* this new standard to adapt to the next—and as yet unknown—ways consumers will want to consume broadcast content in the future.

Before I conclude, I do want to highlight one issue currently before Congress that poses challenges to viewers' ability to enjoy the benefits of Next Gen TV—the successful completion of the broadcast incentive auction. As the broadcast incentive auction winds its way to completion, one thing is certain: We will end up with less spectrum for broadcasting and fewer stations. In light of this, we will need to make

the most of the broadcast spectrum that remains, and provide the most compelling services we can, to be competitive and continue serving our communities. Next Generation TV provides a vehicle for broadcasters to do just that.

To that end, I want to thank Senators Moran and Schatz, as well as your cosponsors, including Senators Blumenthal, Fisher and Blunt, for your work on draft legislation that ensures broadcasters have adequate time and resources to successfully repack following the close of the incentive auction. Legislation that ensures no television or radio broadcaster will pay out of pocket to cover repack costs and that no broadcaster will be forced off the air due to circumstances beyond their control, provides the certainty that an investment in Next Gen TV requires.

Thank you again for inviting me here today. I look forward to answering any questions.

Senator WICKER. Thank you very much.

Mr. Stroup, you're recognized.

STATEMENT OF TOM STROUP, PRESIDENT, SATELLITE INDUSTRY ASSOCIATION

Mr. STROUP. Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee, I would like to thank you for the opportunity to appear before you today. I am Tom Stroup, President of the Satellite Industry Association.

Since its creation over 20 years ago, SIA has been the unified voice of the U.S. industry on policy, regulatory, and legislative issues affecting the satellite business. Like the other industries represented on the panel today, the satellite industry supports hundreds of thousands of jobs and generates billions of dollars in revenue. Beyond strictly financial metrics, however, I would encourage the Subcommittee to consider that our very way of life depends on the benefits we receive from satellite-based services and applications.

Satellites, providing truly ubiquitous coverage that enables communications; Earth observation; and position, navigation, and timing services, have transformed how we communicate; how we map, navigate, and see our world; how we produce food and energy; conduct banking; predict weather; perform disaster relief; ensure national security; and so much more. Of course, delivering these diverse services to a broad range of customers is only possible because of our ability to access spectrum.

Satellites have long played a central role in distributing virtually all television content to American viewing audiences. In particular, live events, like breaking news and sports, depend on the point to multi-point coverage and high service quality that satellites provide. Communication satellites also provide connectivity to business networks, mobile platforms like commercial aircraft and maritime vessels, as well as direct to household consumers.

Satellite broadband, a high-quality and cost-effective solution, is playing an increasingly important part in addressing the digital divide across the United States, including in the most rural and remote areas of the country where it remains uneconomical for terrestrial services to build. Today, the commercial satellite industry has approximately 2 million customers nationwide enjoying high-quality broadband services, no matter where they are located. And with the addition of multiple high throughput, high speed broadband satellites this year, we expect the prevalence of broadband services by satellite to increase rapidly.

It is also extremely important to mention the critical nature that satellites provide to our safety and national security. Satellites are often the only means of communicating after a natural or other disaster. Furthermore, they enable our military to project power in the air, on land, and at sea. To cite just one example, satellite communications enable agile connectivity and efficient mission control for remotely piloted aircraft carrying out critical missions abroad.

Let me turn to innovation and growth. Even as demand for spectrum has increased, the satellite industry has developed ways to use this limited natural resource more efficiently. High throughput satellites, for example, rely on frequency re-use and spot beam technology to produce increased output factors upwards of 20 times that of traditional satellites, meeting FCC benchmark broadband speeds. The industry has seen similar increases in the capacity of its systems.

In another highly anticipated advancement in the industry, hundreds of new high throughput, non-geostationary satellites will soon provide additional high-speed capacity at low latency levels. Existing high throughput satellites already support the delivery of 3G and 4G services, and in the future, satellite fleets will be a part of the system architecture that delivers new 5G, IoT, and intelligent connected transportation services to consumers.

Advances in commercial remote sensing satellites are also occurring at a rapid pace. SIA member companies are launching satellites that can view and sense the Earth across multiple spectral bands at unparalleled spatial resolutions and with unprecedented global coverage and re-visit rates. Data from the U.S. remote sensing operators are building new markets based on geospatial data from agriculture to business intelligence to weather prediction.

Of course, all the breakthroughs we've seen because of satellite technology should not be taken for granted. They depend upon our industry's ability to access spectrum. In order for our industry to sustain and meet the growing demand for satellite services, we encourage regulators to continue to allocate sufficient spectrum for satellite use. Together, we have an opportunity to address the digital divide, meet the growing needs of U.S. consumers, ensure our country's safety and national security, and do so in a manner that utilizes spectrum most efficiently.

I appreciate the opportunity to appear before you, and I'm happy to answer any questions.

[The prepared statement of Mr. Stroup follows:]

PREPARED STATEMENT OF TOM STROUP, PRESIDENT, SATELLITE INDUSTRY ASSOCIATION

Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee, I would like to thank you for holding this important hearing and for the opportunity to appear before you today. I am Tom Stroup, President of the Satellite Industry Association (SIA)[1]. Before joining SIA in late 2014, I served as CEO of Shared Spec-

[1] *SIA Executive Members include:* The Boeing Company; AT&T Services, Inc.; EchoStar Corporation; Intelsat S.A.; Iridium Communications Inc.; Kratos Defense & Security Solutions; Ligado Networks; Lockheed Martin Corporation; Northrop Grumman Corporation; OneWeb; SES Americom, Inc.; Space Exploration Technologies Corp.; SSL; and ViaSat, Inc. *SIA Associate Members include:* ABS U.S. Corp.; Artel, LLC; Blue Origin: DigitalGlobe Inc.; DRS Technologies, Inc.; Eutelsat America Corp.; Global Eagle Entertainment; Glowlink Communications Technology, Inc.; Hughes; Inmarsat, Inc.; Kymeta Corporation; L–3 Electron Technologies, Inc.; O3b Limited; Panasonic Avionics Corporation; Planet; Semper Fortis Solutions; Spire Global Inc.;

trum Company (SSC), a leading developer of spectrum intelligence technologies. For a little more than ten years, I also served as the President of the Personal Communications Industry Association (PCIA). I have also founded and run several companies in the technology industry, including Columbia Spectrum Management, P-Com Network Services, CSM Wireless, and SquareLoop.

The Satellite Industry Association is a U.S.-based trade association representing the leading satellite operators, manufacturers, launch providers, and ground equipment suppliers who serve commercial, civil, and military markets. Since its creation almost twenty years ago, SIA has been the unified voice of the U.S. satellite industry on policy, regulatory, and legislative issues affecting the satellite business.

Before I go any further into my remarks, let me first commend the Federal Communications Commission (FCC), who I know will be testifying here next week, and the National Telecommunications and Information Administration (NTIA) for decades of experience and for their foresight in allocating spectrum to useful technologies and applications, including satellite services. Their efforts have resulted in innovative government and commercial capabilities, which have benefited U.S. consumers and the Nation.

Today, the satellite industry supports over 213,000 American jobs, many of which reside in the home states of several of this Subcommittee's members. This number includes tens of thousands of well-paying manufacturing jobs. Just to mention one area of growth, more of these jobs will be added in states like Florida, where this week one of our members will be breaking ground on a new plant.

The satellite industry's 2015 estimated revenue was $89 billion. These figures of course do not reflect revenues from businesses made possible by our services, services which, like satellites themselves, are not always apparent. But satellites are constantly operating in the background of space, enabling the American economy in ways consumers might not be aware, such as supporting smartphone app transactions, to use just one close at hand example. Beyond strictly financial metrics, I would encourage the Committee to consider that our very way of life depends on the benefits we receive from satellite-based services and applications. Satellites—communications, earth observation, and position, navigation, and timing—have transformed how we communicate, how we map, navigate, and see our world, how we produce food and energy, conduct banking, predict weather, perform disaster relief, ensure national security, and so much more. Of course, delivering these diverse services to a broad range of customers is only possible because of our ability to access spectrum in a number of frequency bands.

I want to go into a little more detail on just a few of the qualitative benefits we receive from satellites because of their ubiquitous coverage, which enables cost-effective service even in rural and remote areas.

Satellites have long played a central role in distributing virtually all television content to American viewing audiences. In particular, live events like breaking news and sports events such as the Super Bowl and the upcoming NCAA Tournament depend on the point-to-multipoint coverage and high service quality that satellites provide. Communications satellites also provide connectivity—including broadband connectivity—to business networks, to mobile platforms like commercial aircraft and maritime vessels, as well as direct to household consumers.

As you all know all too well, advances in information technology and communications continue to spur economic growth in the United States, but they also highlight a growing disparity between the haves and have-nots. Satellite broadband, a high-quality and cost-effective solution for broadband services, is playing an increasingly important part in addressing the digital divide across the United States, including in the most rural and remote areas of the country where it remains uneconomical for terrestrial services to build. Currently the commercial satellite industry has approximately 2 million customers nationwide enjoying high-quality broadband services at reasonable rates, no matter where they are located. This includes the 14 percent of consumers that currently are not served by terrestrial broadband. Commercial satellite operators, which have already invested billions of dollars in the construction and deployment of high-throughput satellites, offer service to those consumers today.

With the addition of multiple high throughput, high speed broadband satellites this year, we expect the prevalence of broadband services by satellite to increase rapidly and the number of satellite broadband customers across the United States to continue to grow substantially. Further, given that most of these satellites and their ground equipment will be built in the United States, we should see the creation of additional domestic design and manufacturing jobs.

TeleCommunication Systems, Inc.; Telesat Canada; TrustComm, Inc.; Ultisat, Inc.; and XTAR, LLC.

It is also extremely important to mention the critical nature that satellites, and the use of spectrum, provide to our safety and national security. Satellite capabilities enable our military's ability to project power in the air, on land, at sea and in cooperation with allies. To list all of the ways satellites and spectrum are utilized by the U.S. military and Intelligence Community would take too long and quickly lead to classified discussions. So, I will mention just a few examples.

- Satellite communications (SATCOM), both commercial and military, provide agile connectivity and efficient mission control capability to our forces and operations in the continental U.S. (CONUS) and forward deployed locations, including for remotely piloted aircraft or (RPA), other advanced weapons systems like the F–35, and U.S. Navy warships. Capacity demand for the bands supporting these needs routinely outpaces supply and continues to grow rapidly.
- Intelligence, surveillance and reconnaissance (ISR) satellites and aerial platforms are essential to capabilities that allow us to see global threats to our nation, including from missiles, terrorism, as well as more traditional activities of enemy combatants and potential adversaries, and they demand dedicated high-capacity satellite links.
- The Global Positioning System (GPS) provides position, navigation, and timing services which are critical to every phase of military operations, commercial networks, critical infrastructure, and more.

All of these satellite capabilities depend upon spectrum availability and heavily factor in the Department of Defense's decisions concerning future force structure and concepts of operation. From individual special operations teams to large scale theater-level air, land and sea operations, none of these would exist as we know them today without the command and control and delivery of data that satellites provide. In short, it is hard to overstate how integral satellites are to our Nation's ability to defend our interests in a conflict-filled world.

In addition, satellites play a critical role when our national terrestrial communications infrastructure is unavailable because of a national disaster, electrical outage or, worse yet, terrorist attack. Unlike their terrestrial counterparts, satellite networks are not susceptible to damage from such disasters, because the primary repeaters are onboard the spacecraft and not part of the ground infrastructure. Handheld terminals, portable Very Small Aperture Terminal (VSAT) antennas, and temporary fixed installations can all be introduced into a post-disaster environment to provide support relief and enhance recovery efforts. This is why the Department of Homeland Security has designated commercial satellite systems as critical infrastructure.

Indeed, emergency preparedness networks are increasingly including satellite networks as part of their system design in order to ensure sufficient resiliency and cost-effectiveness. Government and intergovernmental agencies use satellite networks to provide seismic, flood-sensing, and other early warning data. Public Safety Answering Points (PSAPs) have begun incorporating satellite back-up into their next generation 911 systems to cost-effectively mitigate potential network outage risks caused by any ground-based or environmental disruptions.

I alluded earlier to the fact that satellites have been relying on the use of spectrum for many years, but this should not lead anyone to conclude that the industry has been doing anything but driving technology forward in exciting ways. So, let me say a word on innovation and growth. The satellite industry is today investing tens of billions of dollars to innovate and increase connectivity in the U.S. and across the globe. Specifically, even as demand for spectrum has increased, the satellite industry has developed ways to use this limited natural resource more efficiently. High throughput satellites, for example, rely on frequency re-use and spot beam technology to produce increased output factors upward of 20 times that of traditional satellites, meeting FCC benchmark broadband speeds. The industry has seen similar increases in the capacity of its systems. The first broadband satellite began service in 2008 with a capacity of 10 gigabits per second (Gbps) and today they have capacity of 180 Gbps or more.

In another highly-anticipated advancement in the industry, hundreds of new high-throughput (non-geostationary) satellites will soon join existing operators in Low-Earth and Medium-Earth orbits to provide additional high speed capacity at low latency levels. Existing high throughput satellites already support the delivery of 3G and 4G services, and in the future satellite fleets will be a part of a system architecture that delivers new 5G, IoT, and intelligent, connected transportation services to consumers.

To expand further on another area of growth, mentioned at the outset, advances in commercial remote sensing satellites are also occurring at a rapid pace. SIA

Member companies are launching satellites that can view and sense the Earth across multiple spectral bands, at unparalleled spatial resolution and unprecedented global coverage and revisit rates. The U.S. industry's capacity to monitor, evaluate, and understand change is allowing for more frequent insights into the impacts and opportunities of human activity in all aspects of life and business, and enabling a data revolution from space. Data from U.S. remote sensing operators are building new markets in agriculture, mapping, business intelligence, and weather prediction; they are supporting global efforts for humanitarian assistance and disaster response; and they are providing unique information to the U.S. national security community that, by virtue of it being commercial and unclassified, can be shared at critical times with our allies and partners.

One final, general note on innovation: the satellite industry also helps drive our exploration of frontiers in science and space, ensuring American technological leadership continues in these increasingly competitive areas.

Of course, all of the breakthroughs we've seen because of satellite technologies should not be taken for granted. They depend upon our industry's ability to access spectrum. And here I would like to note that satellites can and often do operate in bands with other users. In most cases satellite networks have different—often higher—requirements for sharing. In order for our industry to sustain and meet the growing demand for satellite services, we encourage regulators to continue to allocate sufficient spectrum for satellite use. In a similar vein, we also ask the Senate and this Subcommittee to consider how to pursue a balanced approach to making additional spectrum available for future growth, that you ensure that satellite is a part of that equation. Together we have an opportunity to address the digital divide, meet the growing needs of U.S. consumers, ensure our country's safety and national security, and do so in a manner that utilizes spectrum most efficiently.

I appreciate the opportunity to appear before you and I am happy to answer any questions.

Senator WICKER. Thank you, Mr. Stroup, and thank you all for your excellent testimony and for helping us by staying in the time. Now, as I explained earlier and I've gone over this also with consultation with Senator Schatz—I will now turn the gavel over to Senator Gardner, go vote, and immediately come back. At this point, I think it's probably best to recognize Senator Schatz for questions, and then we'll proceed along the list that has been prepared for us by our staff.

Senator SCHATZ. Thank you, Chairman Wicker.

My first question is for Mr. Heiner. The use of wireless devices in the unlicensed bands is so popular that the Wi-Fi Alliance predicts that we will need another 500 gigahertz of spectrum in the unlicensed bands to accommodate demands by 2025. I'm going to ask you three questions just in the interest of time so you can knock them all out in a row.

Which bands are the most important for unlicensed spectrum today? What are the industry's plans to identify more bands for unlicensed spectrum? And then do tech companies generally agree or differ greatly in terms of a strategy for the unlicensed bands?

Mr. HEINER. Thank you for those questions, Senator Schatz. I'll answer the first two sort of together. We very much need to find and sort of utilize as efficiently as possible additional unlicensed spectrum in the low, mid, and high-frequencies. At the low end, around the 600 megahertz, after the incentive auction, we have the possibility of really investing very heavily in TV white spaces technology. That's technology that enables signals to travel quite a long distance, four or five miles. It's only—think of, like, FM radio, 88 to 108 on the dial. Of course, an FM station can cover the whole city—600 megahertz not far off from that. So at very low power, we're able to serve an entire community. We have an example of this coming up in southern Virginia as a test pilot.

At the mid frequencies, that's where most Wi-Fi is today, 2.4 and 5 gigahertz, and that's very good spectrum for within a home. It can penetrate a couple of walls. As you know, your signal falls off outside the home. But we'd like more contiguous spectrum next to what we already have to build out more channels.

And then at the high end, at the millimeter waves, the recent Spectrum Frontiers proceeding at the FCC has opened up new spectrum, which we're very enthused about. This spectrum can carry very heavy throughput, but only for short distances, so we're talking about line of sight. And there are great applications for that technology to be able, for example, to have your PC connect to a monitor with no cables to stream video within the home, for augmented reality scenarios where you're wearing a headset and devices in the room are actually communicating with the headset via these high millimeter waves.

So we very much want to see it in all three bands.

Senator SCHATZ. Mr. Heiner, in the interest of time, I'll take the last question for the record so I can get to my second and final question.

This is for Mr. Bergmann and Mr. LaPlatney. We all want faster Internet service and better wireless service coverage that will result from the current incentive auction. But at the same time, a lot of us are concerned that consumers would lose access to their local broadcast news if channels are forced off the air in the repacking process. So the question for Mr. Bergmann and Mr. LaPlatney is: Isn't there a way to balance these concerns and make sure that member companies can deploy quickly after the auction while also protecting our constituents' access to local news?

Mr. Bergmann first.

Mr. BERGMANN. Thank you, Senator. So we're absolutely committed to a smooth transition process. We do believe it's important to have timely access to that spectrum. We have confidence that the FCC will be able to stick to its 39-month schedule. The faster we get access to those bands, the faster we can invest, create jobs, and build out our 5G spectrum, and we're very confident that we'll be able to work collaboratively to get that done.

Senator SCHATZ. Thank you very much.

Mr. LaPlatney?

Mr. LAPLATNEY. Thank you, Senator Schatz, again, for your question, and thank you for your leadership on a bill to help address these issues. We believe currently with the information we have that both the time and the financial resources are going to be inadequate, again, based on current information. Speaking for Raycom, we got our letter, our repack letter, about a month ago, and we will have 22 of our stations that will need to be repacked in markets from West Palm Beach, Florida, to Cape Girardeau, Missouri; Evansville, Indiana; and Hattiesburg—or, pardon me—Biloxi, Mississippi.

It's a complicated process. For instance, a couple of our markets will have to move from Channel 12 to Channel 8, and that could involve—it will involve putting a new antenna that's going to weigh potentially thousands of pounds more on an existing tower. There's all kinds of issues surrounding that. We've begun engineering studies already in a number of these markets. So we're concerned about

the timeline. We're concerned about the amount of money. But we will work collaboratively, and we'll work as quickly as we can to move through the repack, to be as efficient and effective as we can in working on this.

Senator SCHATZ. I'd just like to indulge the Chairman, if I could have his indulgence for a minute.

Mr. Bergmann, can we have your commitment, yes or no, to working out a solution that accommodates these very serious concerns?

Mr. BERGMANN. We're absolutely committed to working with you, with our partners in the broadcast industry. Thirty-nine months is an eternity in the wireless industry. As you can imagine, after spending $20 billion to purchase something that's essentially the value of T. Rowe Price or Hilton Hotels or Jet Blue two times over, we want to make sure to put that spectrum to good use. We'll absolutely work collaboratively with you all to make that happen.

Senator SCHATZ. Thank you.

Senator GARDNER [presiding]. Thank you, Senator Schatz.

Senator Klobuchar?

STATEMENT OF HON. AMY KLOBUCHAR,
U.S. SENATOR FROM MINNESOTA

Senator KLOBUCHAR. Thank you very much.

Thank you to all of you. I love that the broadcasters are having issues with the microphones.

[Laughter.]

Senator KLOBUCHAR. I think we all know how important this topic is. We have a very active broadband caucus, and, in fact, Senator Capito and I led a letter that was signed by 48 Senators urging the President to include broadband in any kind of infrastructure package, because I think we could really have the potential of making something that's progressing even much bigger. We've also been working on the dig once legislation with Senator Gardner and Senator Daines to make it easier to deploy broadband. But I specifically wanted to focus on rural issues.

First, Mr. Bergmann, part of the MOBILE NOW Act that I worked on with Senator Fischer would require the FCC to explore ways to provide incentives for wireless carriers to lease unused spectrum. How could leasing or disaggregating spectrum in rural areas improve wireless service for rural customers?

Mr. BERGMANN. Senator Klobuchar, thank you for the work that you and Senator Fischer have done on the Rural Spectrum Accessibility Act. We really think that's a creative tool that can help. We recognize that our members compete to expand their service maps. They want to serve the entire country. They took LTE coverage from zero to over 99 percent in 7 years. But we recognize that rural areas have particular challenges, geography, topography, fewer people, and we really need to think creatively about how to get there. The legislation that you've worked on is a big part of that.

Getting access to that 600 megahertz spectrum will be really important as well, too. It has those propagation characteristics that enable us to provide service in rural areas. So making sure we have that smooth and timely process to get that spectrum put to use is really important.

Senator KLOBUCHAR. OK. Thank you.

Mr. Stroup, I am Co-Chair of the 911 Caucus and Senator Nelson and I actually have announced new legislation, the Next Generation 911 Act of 2017, to provide more Federal funding through the existing 911 Grant Program. As you know, everything is changing. 911 people are now using—can have the ability for firefighters to get blueprints of buildings, and for people who get stranded in the woods of Minnesota, we could use location accuracy to find them. Can you explain how a satellite backup can improve the resiliency of Next Gen 911 systems?

Mr. STROUP. The satellite networks today have ubiquitous coverage and the opportunity to provide backup communications, whether it's in time of an emergency or when people are lost. So it is the ubiquitous nature of the coverage that allows them to be able to enhance these services that are provided by terrestrial providers.

Senator KLOBUCHAR. Thank you.

And then finally, Mr. LaPlatney, ensuring our communications networks can effectively support public safety includes natural disasters and emergency events—like we have flooding in North Dakota and Minnesota—and these kinds of things can destroy communications infrastructure. How can public safety be enhanced by a Next Generation TV standard?

Mr. LAPLATNEY. So the Next Gen Television standard allows for better targeted alerts in emergencies, whether it's flooding or tornadoes or hurricanes. It also has the capability to awake dormant televisions and mobile devices.

Senator KLOBUCHAR. Did you just say awake dormant televisions?

Mr. LAPLATNEY. Yes. Essentially——

Senator KLOBUCHAR. I couldn't just let that go. What does that mean?

Mr. LAPLATNEY. That's OK. You're all over me today, Senator.

[Laughter.]

Mr. LAPLATNEY. So if you're asleep at 3 in the morning and there's a tornado bearing down on you, this technology has the capability to wake your phone up or wake your television up and say, "You're in the path of a storm. Please take cover."

Senator KLOBUCHAR. Wow. So it would turn it on without your control.

Mr. LAPLATNEY. Essentially, turn it on, awake it.

Senator KLOBUCHAR. All right. So this idea with the new standards with the 911 and what we're working on here could help to make that more standard across the country?

Mr. LAPLATNEY. Absolutely.

Senator KLOBUCHAR. Thank you very much. Thank you, all of you. We're excited about the possibilities on a bipartisan basis here to move forward on broadband as well as enhance 911 services.

Senator GARDNER. Senator Cortez Masto?

STATEMENT OF HON. CATHERINE CORTEZ MASTO, U.S. SENATOR FROM NEVADA

Senator CORTEZ MASTO. Thank you, Mr. Chair.

Gentlemen, thank you for joining us. As a new member, I'm excited to be working with you on this issue. First of all, let me just say thank you for the bipartisan willingness to work together.

The broadcasters from Nevada—and I represent the great state of Nevada—have the same concerns that you just brought out today, and it's nice to hear, Mr. Bergmann, you're willing to work with them. So that's something I will be paying attention to.

And then my colleague talked about rural areas. The challenge for us in Nevada is getting access to wireless broadband, you name it, in our rural areas for so many needs, where we can bring telemedicine, we can bring education, we can bring behavioral services through broadband wireless to those areas. Thank you for your comments.

I'm curious if there are any other areas you can see that we should be looking toward to incentivize and bring additional services through wireless, through spectrum, that we should be looking at in those rural areas. I know you addressed it with access to 600 megahertz. Was there anything else that we should be looking to do to enhance the ability to bring those services to our rural areas?

Mr. BERGMANN. Thank you, Senator Cortez Masto. Reaching rural areas does require creativity, and as I mentioned, the wireless industry invested $32 billion last year to try to build out and improve its networks. And just to assure you that we continue to expand that coverage footprint, just over the last 2 years, we added 800,000 road miles to our coverage and over 500,000 citizens. So we continue to make that a priority.

But you're right. We have to be creative, in addition to, you know, creating incentives to share spectrum, and that happens today in the marketplace. Verizon has a very successful LTE in Rural America program, where it shares spectrum with smaller companies that serve rural areas. Incentivizing that is incredibly helpful. Having a robust mobility fund is important. So we commend FCC for adopting a mobility fund at its last open meeting and we look forward to that implementation.

I would say, particularly in western states, siting on Federal lands is a real opportunity, where today, it can take 2 to 4 years to site on Federal lands. If we could speed that up, you reduce the cost, you make it easier to get out there and serve citizens who might be near areas with lots of Federal land. So those are just a couple of ideas.

Senator CORTEZ MASTO. That's very helpful. Thank you very much.

Senator WICKER [presiding]. Thank you very much, Senator Cortez Masto.

You know, I kind of felt like I would get a turn if we proceeded in this fashion.

Let me start with you, Mr. Heiner. What's the takeaway in terms of Federal policy coming out of this committee with regard to the unlicensed spectrum? Do we need to leave it like it is? What do we need to do? What decisions do we need to make from a legislative standpoint or from a standpoint of giving advice to our regulatory friends?

Mr. HEINER. Well, a couple of points I was mentioning a minute ago, and so I won't repeat it at length now. But we do need to en-

courage the FCC to enable unlicensed spectrum in the low bands, the mid bands, and the high bands. There are a couple of FCC proceedings that are open, and we look forward to their conclusion.

In the incentive auction, for instance, which was a success in that 70 megahertz was made available for licensed use and 14 megahertz for unlicensed use. We just need to finalize that and get the repacking of the broadcast stations done and try to do that in such a way that there are new unlicensed channels open that are open in every part of the country, including urban areas, so that the device manufacturers for TV white spaces devices will know that if they sell their device, it can be purchased and used any place. There are some open proceedings, I believe, also relating to 2.4 gig and 5 gig, and then also up in the millimeter bands. So we need to see all of them sort of concluded in ways that encourage the unlicensed use.

The only other point I would make is, you know, it's important that we all work together in the unlicensed space to prevent interference to other users of the same frequencies, and it's important that regulation not be so onerous that the effect of it is actually to block people from using the unlicensed spectrum. So we just need to find the right balance there.

Senator WICKER. OK. I may ask other members of the panel if they'd like to weigh in on that issue. First, let me talk about another aspect of your testimony, and that is the data centers that constitute the cloud. Where are these data centers located? I understand a lot of them are right outside of town here. How safe are they? How safe is their infrastructure? Then I'll ask other members of the panel to volunteer if they'd like to weigh in on either of these matters.

Mr. HEINER. Well, thank you for that question. You know, we have——

Senator WICKER. It's not up in the air somewhere, is it?

Mr. HEINER. Yes, it's——

Senator WICKER. It's a big building.

Mr. HEINER. What happens is people used to go to the white board and say, like, you know, we're going to connect to a server someplace, and they would draw like an image of a cloud, and then it became—you know, that's the cloud. The data centers are on the ground. They are massive——

Senator WICKER. This could be front page news tomorrow.

[Laughter.]

Mr. HEINER. They are massive, massive buildings with just racks and racks and racks of servers. You know, we have one in Washington State on the Columbia River, and the idea is to get hydroelectric power, you know, which is cheap and efficient. But we have about 100 data centers around the world. We try to have them close to—spread around the world to reduce latency, so that, you know, we have a very fast connection to customers wherever they are.

These are highly, highly secure facilities. People sometimes worry about, "Gee, if my data is in these facilities, are they safe? Is it safer if I keep the data at home?" Our point of view is really that it's sort of like is your data safe—is your money safe in a bank, or is it safer under the mattress? And, actually, it's safer if

it's professionally managed. So we put tremendous resources into ensuring that security of those systems.

Senator WICKER. If somebody launches a rocket propelled grenade at my bank, I'm not going to lose my money. What if they attack the fibers that connect to these data centers? Also help me out—where are the bulk of them? You told me where yours are. If you could answer those two——

Mr. HEINER. Well, they are spread around the world. In terms of the effect of an attack on any one data center, all the data is replicated and backed up in a professional way to many, many other locations, and so that shouldn't be a concern. In terms of where they're located, it really is all over the world. The leaders in running these data centers, of course, are Microsoft, Amazon, which has Amazon web services, and Google, and they all have their own policies on where they site them.

Senator WICKER. OK. Is there any other member of the panel who would like to talk about either unlicensed spectrum or the data centers that comprise the cloud?

Mr. Stroup, were you raising your hand?

Mr. STROUP. Actually, I was. This is somewhat related to the question relating to the information in the cloud. One member on the panel whose members provide service above the cloud—one of the great advantages in times of emergency is that infrastructure is protected from the kinds of attacks that you mentioned or natural disasters. So that directly going to the point that you had raised in terms of data in the cloud. It does go to the security of the information in the communications networks.

Senator WICKER. Yes, sir, Mr. Bergmann.

Mr. BERGMANN. Chairman Wicker, just to the question about providing both licensed and unlicensed spectrum, we believe that's important as well, too. The wireless industry relies on unlicensed spectrum and looks to launch new services in unlicensed bands. I would just encourage this committee to continue to focus on the needs for licensed spectrum as well, too, particularly as we look towards 5G.

We're looking for high bands as an initial platform for 5G services, and so one of the things that we want to make sure of is that we have enough high band spectrum in large channels, large contiguous channels. So even after the FCC adopted its Spectrum Frontiers order last year, there are now 14 gigahertz of spectrum for unlicensed use in the high bands and just under four for licensed spectrum in the high bands.

So we really want to make sure that we have enough spectrum there so that we can invest—again, the industry is looking to invest $250 billion over the next 7 years, creating 3 million jobs, really enabling us to take that 5G lead. So we just encourage you all to prioritize both of those.

Senator WICKER. What, if any, recommendations do you have to the FCC in this regard?

Mr. BERGMANN. We would love it if the FCC would move forward with its further notice, where it's teed up 18 additional gigahertz of high band spectrum that could be used for 5G services, and we really want to make sure that the FCC prioritizes licensed spec-

trum and make sure that we have enough to maintain that leadership as we move from 4G into 5G.

Senator WICKER. Mr. LaPlatney, you emphasized Next Generation TV in your testimony. What needs to happen at the Federal level to help your goals become a reality?

Mr. LAPLATNEY. Thank you for the question, Senator Wicker. There is an NPRM out there currently. I believe we're in a comment period. And I think the short answer to your question is just continued oversight by this committee. It would be the hope of the industry——

Senator WICKER. That would be a Notice of Proposed Rule Making.

Mr. LAPLATNEY. Correct. I'm sorry. Notice of Proposed Rule Making—thank you—at the FCC. We're in a comment period now. We expect that comment period to end sometime during the summer, and it would be our hope that the standard would be adopted sometime during the fall.

Senator WICKER. Have you made recommendations? Have you responded to this notice with suggestions?

Mr. LAPLATNEY. Yes, sir. I think a number of industry participants have.

Senator WICKER. Anyone else?

[No verbal response.]

Senator WICKER. OK. Well, Mr. Bergmann, many industries are leveraging digital platforms for innovation and growth in healthcare. It's a very exciting area in which we are actually helping people lead longer and more meaningful lives. In Mississippi, there's a great example of this called the Diabetes Telehealth Network. It provides patients with remote care management, resulting in cost savings of over $300,000 for only 100 patients. Of course, we would like to write this large. If expanded, this program could save Medicaid $189 million.

How do we ensure that there's sufficient spectrum available to continue to fuel this innovation in tele-medicine and provide quality healthcare access to all Americans regardless of where they live?

Mr. BERGMANN. Thank you, Mr. Chairman. We certainly agree with you. mHealth is one of the most promising applications that 5G looks to bring. Whether we're talking about remote patient monitoring, chronic disease management, there are tremendous opportunities to cut costs, as you mentioned, but to also improve outcomes, to save lives and make sure that patients have a better quality of life. So just a couple of things that this committee can do, again, focusing on making spectrum available in low, mid, and high bands, making sure that we have licensed spectrum that enables us to provide those guarantees of performance, that reliability and security that we really want to have out of our health applications.

And then maybe a sometimes overlooked aspect is infrastructure siting, particularly as we look to build out high band spectrum which will have that incredible capacity, five times the responsiveness, 10 times the speeds of what we have today. It's important that we have this new 5G infrastructure. So being able to site

those small cells quickly and without unnecessary costs or delays is really important.

Senator WICKER. Thank you. Anyone else want to talk about telehealth?

Yes, sir, Mr. Heiner.

Mr. HEINER. Just one additional comment, which is that the TV white spaces technology could also be very helpful for telemedicine, because it has the capability, as I mentioned earlier, of sending signals over long distances. And, in fact, Microsoft has a system up and running in Botswana, where circumstances can be difficult, specifically focused on telemedicine, and in this way, the doctors in the more urban areas are able to reach out to patients in rural areas.

Senator WICKER. Now, the administration believes, and I support, certainly, in a general sense, the idea that regulations many times, though well intended, have stifled job creation, and that we need regulatory reform, not only from the standpoint of legislation, but also coming out of the administration. So would each of you five experts give us the benefit of some recommendations, two or three recommendations, that you might send to the administration for regulatory reform in the early months of this administration?

Mr. Bergmann?

Mr. BERGMANN. Thank you, Mr. Chairman. So just a couple of thoughts. Certainly, two places where we would appreciate this committee's guidance are with respect to the privacy regulations and the open Internet regulations that the past FCC adopted; in the case of privacy, where the FCC departed from longstanding FTC precedent; in the case of Title II, where public utility regulation was applied to broadband services. Both of these areas are places where we believe the Committee can help guide the FCC.

A third area, as we look forward toward things like the Internet of Things, making sure that we have consistent national framework to guide innovation in that space is very important for the future growth of those services.

Senator WICKER. Let me make sure I understand what you're saying with regard to Title II. It's your view that the FCC made a mistake in that regard in recent years and that that should be turned around?

Mr. BERGMANN. Yes, Mr. Chairman. We're certainly very encouraged to hear Chairman Pai talk about reversing that decision and recognizing the competition and the innovation that's happening in the mobile broadband space.

Senator WICKER. All right. Mr. Entner?

Mr. ENTNER. Thank you, Chairman. In my opinion, the American people have benefited tremendously from a light touch regulatory approach to telecom and technology, in general, and the growth speaks for itself. I think we should return to light touch regulation and make it possible for companies across the whole competitive environment to compete with each other. Competition is really the lifeblood here of the industry, and Americans have benefited tremendously from it. I think that's the importance here, that the same rules apply to everybody the same way, no matter how they compete with each other with similar services.

Senator WICKER. With regard to returning to light touch, would you agree with Mr. Bergmann on the Title II issue?

Mr. ENTNER. I would.

Senator WICKER. All right. Now, members of the public should know that the panel is a panel suggested by both the Republican and Democratic membership of this committee. It's not a one-sided show at all.

Would anyone care to take issue with either Mr. Bergmann or Mr. Entner with regard to the Title II issue?

[No verbal response.]

Senator WICKER. All right. What suggestions do you have for policymakers, the administration, Congress, or the regulators with regard to regulatory reform?

Mr. HEINER. So I would just focus on unlicensed spectrum, which is already a success story in terms of the very low regulation that those bands entail. That low regulation means that barriers to entry for innovators are incredibly low. Anybody can, you know, dream up some device and transmit on the frequencies with almost no regulation. So I would just urge the Congress and the FCC to continue to maintain that approach, which is a proven success, and expand to the extent possible the amount of bandwidth available to unlicensed spectrum.

On the net neutrality point, I would just say that Microsoft very much supports the core principles of net neutrality, would like to see it enshrined, however that's done. The specifics around Title II is not something that's at all important to us.

Senator WICKER. Mr. LaPlatney, do you have anything to add?

Mr. LAPLATNEY. Yes, Senator Wicker. The broadcast industry is highly regulated, and we would love to see the FCC take up local ownership rules, the local media ownership rules. We think there's—whether it's the newspaper or broadcast press ownership or the local duopoly rule, we think that those rules—it's time for those rules to be revisited. So that would be our suggestion.

Senator WICKER. Mr. Stroup?

Mr. STROUP. Yes. First, I'd like to commend the FCC for many of the modifications they made to the Part 25 rules last year, working with the industry. However, we would like to see them make some modifications to the restrictions on the industry that were adopted in the Spectrum Frontiers proceeding on where we can locate our Earth stations, and, of course, going to the core of this proceeding, ensuring that there is sufficient spectrum made available for the growth of the industry.

Another area that we would recommend relates to export reform. Fortunately, a number of the ITAR restrictions were removed, allowing manufacturers of satellites to export and compete in the market on a worldwide basis. But there were some restrictions that remain with respect to Earth imaging, and we would request that that be revisited.

Senator WICKER. Thank you very much.

Ranking Member Schatz, I've tried my best to stir up a disagreement among these panelists, and I'm having an awful time doing it. So I'll yield to you for a few questions.

Senator SCHATZ. Thank you, Mr. Chairman. If you need disagreement, I think I can provide it for you.

My additional question is for Mr. Bergmann. The U.S. has been a global leader in the development of mobile technology, and there has been a lot of anticipation for the implementation of 5G. In fact, the Committee passed MOBILE NOW in January, which will make additional spectrum available for 5G networks.

My question for you, Mr. Bergmann, is can you put this in a global context in terms of how we are viewed in the highly competitive world of international technology companies and why it's so important for the United States to lead on 5G?

Mr. BERGMANN. Thank you, Senator Schatz. We are clearly recognized as the world's leader in 4G LTE. We invested first, innovated first, and that's paid dividends over the last 7 years. If you look at the mobile ecosystem, the two largest operating systems are both based here in the U.S. A stunning 76 percent of apps developers are located here in the U.S. So we think it's paid tremendous dividends in terms of innovation. We believe that 5G has seen more greater opportunities as we look at these services that have much greater capacity to impact industries across the economy and our consumers' lives.

So there truly is a global race. I mentioned some of the other countries around the world that are taking steps to make large swaths of spectrum available and to streamline the way that they site that infrastructure and architecture. So it's really critical that we do the same here in the U.S.

Senator SCHATZ. Can you flesh out what those new opportunities are as opposed to the last generation?

Mr. BERGMANN. Sure. So, you know, if we look at healthcare, you look at the opportunity to have remote patient monitoring or chronic disease management, or, as you look at the ability to use high band spectrum, we have the opportunity to have ultra HD, so you might have remote surgery and be able to extend the reach of expert doctors beyond urban centers into rural areas.

Similarly, in the education space, where you might have virtual reality applications that allow students in Hawaii to, in the blink of an eye, be in the center of the Roman Coliseum. There are tremendous opportunities in transportation and energy as well, too, where we have the ability to cut traffic times, reduce fatalities, cut emissions. There are tremendous opportunities associated with that.

Senator SCHATZ. So could you give me a status report? Where are we? Who are our greatest competitors? Who is on top of this? Are we already behind? Just tell me where we are.

Mr. BERGMANN. I think we're really poised to lead. The FCC's actions to make that high band spectrum available have led to over two dozen trials here in the U.S. Companies have already invested in R&D. So we're out ahead of the standards process. One of our member companies announced just earlier this week a pilot program to offer 5G services in 11 different markets. So I think we're very much poised to lead. But it is a race, and it will be important that we make the right policy decisions here.

Senator SCHATZ. Who are we in a race with?

Mr. BERGMANN. Japan, the EU, South Korea, China.

Senator SCHATZ. Thank you. Anyone else care to comment on that?

Mr. Entner?

Mr. ENTNER. Thank you, Senator. I want to highlight the importance of configuring the spectrum in large channel configurations, because think of these channels as like water pipes, and the bigger the pipe, the faster the speed. In the United States, spectrum is typically allocated in 5 by 5 or 10 by 10 megahertz channels. Overseas, it is in 20 by 20 megahertz channels very frequently.

And, inherently, how you can provide for speed is you have now carrier aggregation, where you essentially can glue three of these pipes together, three of these channels, and if you glue together three 5 by 5s, it gives you 15 megahertz of spectrum as one channel. Or if you glue together three 20 by 20s, that's 60. Inherently, whoever has the 20 by 20s will be four times faster, and that is a really important consideration to keep the U.S. competitive with the rest of the world.

Senator SCHATZ. And is one of our unique challenges the spectrum currently allocated, I think, appropriately, to national security and other needs, that maybe not every country has quite that obligation and quite that same public policy?

Mr. ENTNER. It is within the existing spectrum, not necessarily about different and new spectrum. It's just like when we have spectrum, how do we divide up that spectrum?

Senator SCHATZ. Oh, this is within the bands that are allocated.

Mr. ENTNER. Correct.

Senator SCHATZ. Is that an FCC decision that has to be made, or are these technical changes that can be made at the operating level?

Mr. ENTNER. Initially, it's an FCC decision of how they are allocating the spectrum. If through pure happenstance, a company wins several licenses in the market, and they lie next to each other, they can create this. But that doesn't happen very often. So through regulatory foresight, this problem can be alleviated.

Senator SCHATZ. OK. Thank you very much.

A question for Mr. LaPlatney. I want to talk to you about the Next Gen TV. You know, I understand the transition that was made from analog to digital and the consumer benefits, the economic benefits, and the need to sort of subsidize that transition. As a television watcher, I can understand the desire for better and better TV, more and more cross platform utility, and sharper and sharper resolution.

But I'm not yet persuaded that this is as fundamental of a shift as the analog to digital shift was, and I want to be persuaded of how revolutionary this technology is, because I'm not there yet. So give me your best shot.

Mr. LAPLATNEY. Well, so I think the best way to explain it, you know, is the points we talked about earlier. So there's the ability in this standard to better target emergency warnings, including turning on devices, which I think is so far removed from what we can do today. I think that's a much larger step than the analog to digital. I think also the standard, because of the hybrid IP broadcast architecture——

Senator WICKER. Can I just interrupt there?

Senator SCHATZ. What's that?

Senator WICKER. Let me just interrupt there. So what you're saying is I've got a device on my night stand, and suddenly there's a tornado. So what happens?

Mr. LAPLATNEY. So we could alert your phone.

Senator WICKER. So it turns my phone——

Mr. LAPLATNEY. On. If it has power, it would turn your phone on, and there would be an alert that would come up and say, "You are in the path of a storm" or "You're in imminent danger. Take cover immediately." In fact, you know, the tornadoes that went through Hattiesburg back on the twenty-first of January—if we would have had that technology, I believe we could have saved some lives.

Senator WICKER. Nobody has that technology now?

Mr. LAPLATNEY. That technology is—we can alert, but this technology allows us to target much more effectively. So, as an example, today's alerts sometimes conform to county lines, and as a tornado moves through geography, it doesn't conform to county lines. So you could alert just those consumers in the path of the storm, the polygon in front of the storm, as opposed to Montgomery County and Prince George's County. It's a much more targeted alert that would be more effective.

Senator WICKER. Thank you, Senator Schatz, for letting me interject there.

Senator SCHATZ. So I want to understand—when you talk about Next Gen TV, it sounds like a platform that's integrating several different kinds of new technology, because this ability to turn on your device for civil defense, this preparedness purpose, is not the—I mean, that's not the central technology that I was thinking of when I hear about the Next Gen TV.

Mr. LAPLATNEY. Again, it's a hybrid broadcast standard, so it allows better, more relevant advertising for our viewers and users, and that, I think, is important to the broadcast industry, because, currently, our targeting capabilities are way behind our friends over on the mobile side or the cable folks or Facebook or Google. And, you know, in a given market today, Facebook or Google could take 40 percent, 50 percent, 60 percent of the advertising revenue to market. So there's that capability.

It also offers the ability for a user to have a more Hulu or Netflix type of experience. So you have a dropdown menu, and you want to know what the score is of some game other than the one you're watching, or you want to know who that actor is. It allows that type of interaction. And then it also—you know, it can transmit to suitably equipped mobile devices, which I think for our industry is almost a game changer. As you know, the growth——

Senator SCHATZ. It can transmit from the TV to——

Mr. LAPLATNEY. Tower.

Senator SCHATZ. Oh, from the tower to any platform, a tablet or whatever it may be.

Mr. LAPLATNEY. Right, if it has a 3.0 chip in it. So it would have to have a——

Senator SCHATZ. Aren't there other ways to do that right now?

Mr. LAPLATNEY. There are ways to get a signal——

Senator SCHATZ. To get TV on your tablet, right?

Mr. LAPLATNEY. You can, but it's over IP, essentially. So this is broadcast, and I think the key there is that if you—and having four boys, I can tell you that we have data cap issues in our house. And, you know, if somebody wants to watch movies over 3.0, it's not going to hit their data cap. So if they're consuming a lot of video——

Senator SCHATZ. Having one boy, I like it when we hit our cap. [Laughter.]

Mr. LAPLATNEY. So there are a number of different capabilities, and it really is a—it's a game changer for the industry.

Senator SCHATZ. Thank you very much.

Senator Fischer?

STATEMENT OF HON. DEB FISCHER,
U.S. SENATOR FROM NEBRASKA

Senator FISCHER. Thank you, Senator Schatz.

Senator Hassan?

STATEMENT OF HON. MAGGIE HASSAN,
U.S. SENATOR FROM NEW HAMPSHIRE

Senator HASSAN. Thank you, Senator Fischer, and thank you to all of the panelists. I, too, apologize for us being in and out on this morning of votes.

Mr. Heiner, I wanted to follow up a little bit on your testimony where you advocated for a balanced, all-of-the-above approach to spectrum policy, and I can't agree more. I think Granite Staters and folks around the country benefit most when we have both licensed and unlicensed spectrum available to them. You know, you talked about the example, I think, of the wireless phone industry. I know that data from Cisco shows that 60 percent of wireless traffic was offloaded onto Wi-Fi networks last year, which helped create a positive consumer experience where network traffic was alleviated, and the industry all around thrived as a result.

So can you elaborate a little bit more specifically on how a balanced, all-of-the-above approach to national spectrum policy that includes both licensed and unlicensed spectrum will benefit rural communities, specifically?

Mr. HEINER. Yes, I'd be happy to, and thank you very much for the question. Mr. Bergmann was describing just a few minutes ago the possibilities of greater access for rural communities through 5G and new spectrum, and what I would focus on as well, then, is the possibility of using TV white spaces technology.

So this is in the 600 megahertz band, where some new spectrum was made available as a result of the incentive auction, and this band has propagation characteristics such that—at very low power and so, you know, low cost. A transmitter can serve quite a large community.

So, for instance, we have this trial running—we're getting it running—in southern Virginia, where the school has fixed broadband access, so a wired connection. The students are dispersed around that rural area, and through just a series of just a handful of transmitters, we will be able to reach 7,200 kids and thereby address the homework gap. So in that region, half the kids do have broadband at home and half the kids don't.

So the concept is you give each of those—the kids who don't—this little device that will only cost about $50, and it picks up the TV white spaces signal and basically turns it into a Wi-Fi signal. So in this manner, we can help to address the homework gap.

Senator HASSAN. That's fabulous. And I expect that there would be telehealth applications as well?

Mr. HEINER. There would be. I mean, we were just actually discussing that a minute ago. We have a trial in Botswana, actually, specifically focused on telemedicine, and we're bringing doctors, you know, in the urban areas to patients in the rural areas through this technology.

Senator HASSAN. Thank you very much.

I wanted to follow up, too, with Mr. LaPlatney, because I am strongly supportive of the recent spectrum auction. I think it holds great promise for innovation and our economy, and I'm pleased to see it moving forward. You've talked this morning about some of the challenges that broadcast stations face as they need to move to different frequencies and to what I'm learning as an industry term, repack. I've been talking with broadcasters in New Hampshire and across the country, and I know we all want to make sure we're prepared.

I wanted to just focus a little bit on the issue for radio stations—I know we've talked about television broadcasting—but, in particular, those that share towers with television stations. I'm concerned that they could be negatively impacted or temporarily go off the air. If so, are there any resources or recourse available, or is there more that needs to be done to address the issue for radio, in particular?

Mr. LAPLATNEY. Thanks for your question. There are a number of towers, television towers, that have radio occupants throughout the country. During the repack process, when we have tower riggers climbing up and down towers, there will be times where those radio antennas will be powered down or shut off. So it's a real issue. It could be for hours at a time or for days at a time.

So I do think something needs to be done. I really think it just underscores the need for the FCC to take up a rational approach to the repack, and I know that the members of the NAB are currently in conversation with folks at the FCC around—talking about this issue and trying to come up with some answers.

Senator HASSAN. Thank you very much.

Senator GARDNER [presiding]. I see the Chairman of the Full Committee, Senator Thune, has arrived.

Senator Thune?

STATEMENT OF HON. JOHN THUNE, U.S. SENATOR FROM SOUTH DAKOTA

The CHAIRMAN. Thank you, Mr. Chairman, and I appreciate the Subcommittee having this hearing and putting together such an excellent panel.

I just want to say how much I appreciate the work that you all do connecting people across the country from remote rural areas to cities to each other and the world and providing education, entertainment, and public safety services, which contributes greatly to the economy and to the quality of life of every American. You all

drive the innovation and investment that's made the United States a leader in advanced wireless technology. Our job in Congress is to make sure that, consistent with our national security and public welfare obligations, the market has access to spectrum and that industry is not unduly burdened when getting the spectrum into service.

This committee reported out a bill here recently called the MOBILE NOW Act, and that makes a down payment on that obligation. It would make available 255 megahertz of prime spectrum, both licensed and unlicensed, in the next three years, but that really is just the beginning. To meet America's demand for mobile broadband, it's estimated that the wireless industry will need more than 350 megahertz of new licensed spectrum by 2019.

The MOBILE NOW Act would direct the FCC and NTIA to study the potential for commercial service in a number of additional spectrum bands, but having access to spectrum is only part of the challenge. It can take years and tremendous investment to deploy new wireless services, and so the bill also streamlines the process of applying for easements, rights-of-way, and leases for federally managed property and establishes a shot-clock for review of those applications, which we think is something that's essential.

MOBILE NOW would also establish a national broadband facilities asset database listing Federal property that could be used by private entities for the purpose of building or operating communications facilities. I'm hoping we can get the bill passed. I look forward to the full Senate acting on that in the coming weeks and I'm very much focused on working with our colleagues on this committee and the entire Senate and the House in making the next payment toward America's wireless leadership.

I just have one quick question I want to ask, and I want to direct this to Mr. Bergmann. The widespread deployment of small cells is a massive undertaking for companies and also for state and local officials. Are there opportunities for companies and government officials to work collaboratively and to streamline the approval process so that it focuses only on sitings that raise significant deployment issues?

Mr. BERGMANN. So, thank you, Chairman Thune, and we certainly commend you and Ranking Member Nelson and the Committee for the work on MOBILE NOW, and that focus on infrastructure is tremendously important as we look to lead in that race to 5G, and, certainly, small cell deployment is an absolutely critical part of that equation. Our companies are looking to deploy hundreds of thousands of small cells to deliver that high-capacity service, and being able to move quickly is something that will reduce costs and enable us to move faster.

Right now, today, there are challenges both with the local zoning process and, as you mentioned, with Federal agencies. So we would certainly appreciate this committee's attention to finding opportunities to right-size that process so that we exclude small cells, where appropriate, that are the size of a pizza box or a lunch box. I don't think anyone thinks that the process that applies to a 200-foot tower should apply when you're putting a lunch box on top of an existing building.

So we would love to work with you to try to find opportunities to speed those deployments. In the end, what it will mean is $275 billion of investment and 3 million jobs. So it's a real priority.

The CHAIRMAN. All right. We appreciate that.

Mr. Chairman, thank you, and thanks again for the opportunity to speak at this hearing.

STATEMENT OF HON. CORY GARDNER,
U.S. SENATOR FROM COLORADO

Senator GARDNER. Thank you, Mr. Thune.

I'm going to go ahead and take my questions now, and then Senator Udall is after this.

Mr. Entner, recently, in my home state of Colorado, a company announced that they would be pursuing a launch of a 5G pilot project in Denver, bringing us closer to the next generation of wireless 5G. Of course, companies have to evaluate or reevaluate their spectrum holdings to determine how best to play a role in this wireless innovation. As you talk about in your testimony, high, mid, and low band spectrum will all be critical to building the next generation of wireless service.

What are some of the specific bands you believe could help advance this effort? I know Mr. Heiner was asked a similar question. But could you elaborate a little bit further?

Mr. ENTNER. Thank you. We could certainly use more spectrum below 1 gigahertz, as it is ideal to penetrate walls and cover rural areas. Adjacent to the current bands would be most appropriate. When we look at mid spectrum again here, bands that are currently idle or largely idle would be appropriate around navigation, for example, and then the large swaths in the millimeter band that are actually unused at this time should also be brought in, and the FCC has several proposals here on this space.

I just want to bring to the attention of the Committee—you know, over the last few weeks, all the wireless carriers have reintroduced unlimited plans so that people like the fellow witnesses here no longer have the problem with data caps. I think it is unappreciated what impact it will have, actually, on spectrum.

When we look at LTE, we currently are getting faster speeds from our mobile networks than we get from Wi-Fi. And when unlimited is now back, the whole incentive of using Wi-Fi has been diminished significantly, because there is no cost advantage anymore to shifting over to Wi-Fi. That will drive, really, the demand for licensed spectrum further, and that's why we need more spectrum.

Senator GARDNER. Thank you, Mr. Entner.

Mr. Bergmann, while the United States is a global leader, as we've discussed today, in wireless service, other nations are quickly catching up and trying to exceed advances in this space, particularly nations like South Korea and Japan. It's important that we retain our competitive advantage by being number one in the world, and wireless technologies rely on spectrum to operate. That's going to mean we need even more spectrum than currently available for commercial and nonfederal users, and that's why I support freeing up more Federal Government spectrum for such uses.

What do you think the impact on American competitiveness would be if we don't have adequate spectrum in the pipeline?

Mr. BERGMANN. Thank you, Senator Gardner. What we're seeing is more wireless being integrated into every major sector of the economy. We talked a little bit earlier about energy, transportation, and healthcare. These are places where our leadership in 4G gave us tremendous advantages. An apps economy that didn't exist 7 years ago now employs over 1.6 million people. So we want to make sure that in that race to 5G with even more capabilities, we're out in front, and that we keep innovation here in the U.S. That's why the work that you all are doing on spectrum, on infrastructure siting is really critical.

Senator WICKER [presiding]. Thank you.

Next is Senator Moran.

STATEMENT OF HON. JERRY MORAN,
U.S. SENATOR FROM KANSAS

Senator MORAN. Chairman, thank you very much.

Thank you all for being here. Let me start with Mr. Bergmann, and I apologize for my absence for your testimony and also most of the questioning, so you may be repeating in answering me something that's already been asked. We've paid a lot of attention to spectrum issues and want to make sure that good things are happening.

Last summer, the FCC identified several high bands in their Spectrum Frontier proceedings. Did the FCC do enough, or is there a need for additional high band spectrum above 24 gigahertz for terrestrial mobile systems? What else can be done to ensure?

Mr. BERGMANN. Thank you, Senator Moran. The FCC's action in the Spectrum Frontiers proceeding to make that high band spectrum available is really important. That's going to be the initial platform where 5G services are tested and launched. So that's an important step. I really commend this committee for your focus on additional bands, and at the FCC, the leadership of Chairman Pai, Commissioner O'Rielly, Commissioner Clyburn, all of whom have talked about the importance of high band spectrum. They have a proceeding now where they've proposed to make 18 additional gigahertz of high band spectrum available, and that's spectrum that will deliver speeds that are 10 times what we have today, services that are five times more responsive—and when you think about applications like self-driving cars, you want to make sure that you have responsive services—and the ability to connect 100 times the devices that we have today.

So as we think about the Internet of Things and what that will open up in terms of opportunities for savings in the energy sector, there's tremendous potential from that high band spectrum. Making sure that we get that to market quickly, that we have large contiguous channels, as my co-panelists have said, and that we have an emphasis on licensed spectrum that will allow us to provide that performance, provide that reliability, and that security that we expect out of those kinds of healthcare and other services is really critical.

Senator MORAN. Let me turn to Mr. Heiner in regard to unlicensed spectrum. Senator Schatz and I have worked on trying to

encourage a balanced approach to licensed and unlicensed spectrum. Let me ask you about the continued demand for unlicensed spectrum, I assume growing at exponential rates. Where do we look? What bands might we find?

Mr. HEINER. Well, the demand is growing, you know, very, very rapidly. We do need to look across all three bands: low, middle, and high. Low, I've explained a little bit. It gives us the opportunity for TV white-spaces technology to serve rural areas, and it can work in urban areas as well. In the mid-range, that's where we have the existing technology at 2.4 and 5 gig, and there are opportunities there to expand those bands.

And then in the millimeter bands, you know, we're very enthused by the Spectrum Frontiers proceeding where spectrum was opened up between 57 and, I think, 72 gigahertz. And as Mr. Entner was saying, with that much spectrum, there's the possibility of setting up wider channels. Those wider channels have more throughput, and so it's a very efficient use of technology.

A new standard has been developed. This is the industry coming together on a consensus basis through a standard setting body and creating a standard beyond Wi-Fi called WiGig, and the Gig is for very high throughput. And I believe that standard requires the 160 megahertz channels, which the millimeter bands can afford. So we're very enthused about that.

Senator MORAN. Keep looking is your answer, and look everywhere.

Mr. HEINER. And keep—that's right.

Senator MORAN. Let me turn to Mr. LaPlatney. Although I didn't hear your testimony, I'm astute enough to know that you mentioned my name, so thank you. Senator Schatz and I have been working on an issue of importance. I come from a place in which getting broadband opportunities to rural America is significantly important. Spectrum matters to us, but so does community broadcasting.

I want to indicate that we want to be in a position to make certain that good things happen in this repack process. What's going on that has a consequence on next-generation technologies in your world?

Mr. LAPLATNEY. Well, so we are in the early stages of the repack. We talked a little earlier about, you know, broadcasters now doing engineering studies, and it appears, based on current data, that there will be 1,000 to 1,100 stations repacked, which is a pretty significant number. So we, as of today, believe that the amount of time we have to complete the repack and the amount of money we have is insufficient. So we will appreciate your continued oversight, and as we get more information, we will certainly pass that along, but we have some concerns today. That said, we will do everything we can to make sure that if there's a way to do it in 39 months, we're going to do it.

Senator MORAN. I appreciate that. I think I would back the idea that there's any desire to slow this process down. We all want it to work very quickly for the benefit of all.

Mr. LAPLATNEY. Absolutely.

Senator MORAN. Mr. Chairman, thank you very much.

Senator WICKER. Thank you, Senator Moran.

Senator Udall?

STATEMENT OF HON. TOM UDALL,
U.S. SENATOR FROM NEW MEXICO

Senator UDALL. Chairman Wicker, thank you so much.

This has been a fascinating panel, I think, with a lot of excellent testimony. So thank you for bearing with us in the middle of the vote and continuing here.

As you all know, today, there are more wireless devices than there are people in the United States, and with so many new wireless devices connecting to the Internet, we could face a spectrum crunch that could hinder the next Internet revolution. That's why I'm pleased that my Spectrum Challenge Prize Act has been approved by this committee. This contest would provide a significant monetary award to the first person who finds a way to make spectrum use vastly more efficient. This approach helps incentivize more innovators and researchers to focus on the problem and will help use American ingenuity to solve it.

Chairman Wicker, I'm also pleased that Mr. LaPlatney is here to give a broadcaster's perspective. We tend to forget that broadcasting is our first wireless technology and is still relevant today.

Mr. Bergmann, my first question is for you. Senator Moran and I worked in 2015 to reform the Spectrum Relocation Fund. This multimillion dollar fund pays the cost of relocating Federal users when a particular spectrum band is auctioned for commercial use. The Spectrum Pipeline Act made $500 million of existing money available for R&D and pilot projects that could lead to more efficient Federal use of spectrum. Last year, OMB issued guidance to agencies for proposing plans to use these funds.

Mr. Bergmann, do you agree that the OMB should continue to make Spectrum Reallocation Fund resources available to Federal agencies that are exploring how to use spectrum more efficiently?

Mr. BERGMANN. Senator Udall, we truly appreciate the work that you and Senator Moran have done to improve the Spectrum Relocation Fund. That's a really important tool for making sure that there are the right incentives and opportunities for win-win solutions to put spectrum to efficient use. We know that Federal agencies have exclusive or primary access to somewhere between 60 percent to 70 percent of the spectrum below 3 gigahertz. So trying to make sure that we're using that spectrum efficiently and trying to identify opportunities to make that available for commercial use is a really important goal, and that tool is a very strong one.

We believe that there truly are opportunities for win-wins. The AWS–3 auction was an opportunity for government users to upgrade their systems and resulted in making available 65 megahertz of spectrum that went on to produce the world's largest—or the U.S. largest spectrum auction. So we certainly appreciate your work on that.

Senator UDALL. Thank you, and I appreciate that answer.

Mr. Heiner, your testimony briefly discusses cloud computing. This is a topic of keen interest to me, and Senator Moran and I have worked together for several years now on Federal IT reform legislation and oversight to increase cloud adoption. I believe replacing so-called legacy IT systems with modern solutions can save

the Federal Government billions of dollars and improve cyber security.

Can you share more about why Microsoft and other companies are increasingly leveraging the cloud and what that means for future broadband connectivity needs?

Mr. HEINER. Yes, and thank you for the question. You know, every 15 years or so, there's a major shift in the computing landscape. We had the mainframe era in the 1960s; then the revolution of personal computing; then the shift to client server computing, so these were PCs and then servers running, you know, in the back end at enterprises; and today, it's cloud computing.

The basic concept is that it's incredibly economically efficient to run servers in central locations, these data centers, rather than at each individual company. The analogy someone offered is to energy, where in the 1880s, it was a revolution that you could have electric power, and each factory had its own generator. And someone dreamt up, "You know, I'll make power for the whole city," and then we had Con Ed, and that was much more efficient.

Well, it's similar with the cloud as well. So, you know, we really believe—and we're seeing it in the marketplace—that enterprises around the world will be more efficient and will have better access to data analytics and even artificial intelligence techniques if they are delivered via the cloud. The same is true for the Federal Government, and, obviously, it's a big lift to move legacy systems over to that new approach, and it will take a long time. But we believe that ought to be done as well.

Now, the cloud is operating its data centers in remote locations, and so people need connectivity to reach those data centers. It's just as simple as that. It's an absolute, you know, sine qua non for the cloud computing to have first-rate connectivity, and that's whether it's licensed or unlicensed.

Senator UDALL. Thank you very much

And thank you, Mr. Chairman.

Senator WICKER. Thank you, Senator Udall.

Senator Peters?

STATEMENT OF HON. GARY PETERS,
U.S. SENATOR FROM MICHIGAN

Senator PETERS. Thank you, Mr. Chairman.

And thanks to each of our panelists today for your testimony on a very important subject.

Mr. Heiner, I have a question for you in some area that I find particularly fascinating, and that's what's being done by American manufacturers that are using the white space spectrum. I was particularly intrigued by some of the work that Microsoft is doing in Virginia to help the homework gap by using white spaces to leverage the fiber connections that run through these schools and allows students in the surrounding areas to access their school's network wirelessly from home, which is incredibly important for education today.

In your estimation, what must be done at the FCC to ensure that we have enough TV white space channels available so that we can have this kind of unlicensed use that can be so beneficial?

Mr. HEINER. Well, we just need to conclude the incentive auction process and the so-called "repacking" of the TV channels in such a way that there's as much spectrum available for TV white spaces as possible. And, in particular, there's this possibility of having vacant channels in some areas where there are not enough TV stations to fill up all the available spectrum, and we'd like to see as many vacant channels as possible that we can leverage for TV white spaces and also have a system where, from coast to coast in both rural and urban areas, certain channels are just set aside for TV white spaces. In that way, the device manufacturers will know that they can build a device and it can be deployed any place in the country.

Senator PETERS. Do you see any other challenges in expanding school connectivity, which I think is so important, or things that we should be working on?

Mr. HEINER. Well, it's a question of setting up incentives for investment. You know, nothing is free. But the technology is very efficient. We can have low-power transmitters that are relatively inexpensive, and the devices in the students' homes are relatively inexpensive as well. We do have a petition pending at the FCC to try to clarify that the E-rate program should cover TV white spaces as well as the other means of access to the Internet, and we hope that moves forward.

Senator PETERS. Mr. Entner, I know you addressed this next topic in your written testimony. I don't think you addressed it before us here as a panel. But this is really to all of you. I think it's an important question for us to think about. We know that the advances in technology that we're seeing are all accelerating at an exponential rate, and that curve seems to get steeper and steeper every year as we go forward.

Then on our side, when it comes to public policy, we know the rate of progress from us moves at a pretty consistent rate, which is called the "snail's pace," as it goes forward, which means that it is tough for some of our regulatory agencies to keep up, particularly if they're underfunded, lack personnel, lack expertise. They probably need all those things, but we also know that that's a difficult sell in this current fiscal environment. So we have to look for opportunities to collaborate with academia, standard setting bodies, industry, to come up with some voluntary standards to deal with all of these various technologies to kind of find a unified approach.

Mr. Entner, you mentioned this in your written, but if you want to expand on that—and I would certainly encourage the other witnesses if you have some thoughts as to how we put together these kinds of partnerships to make sure that we're allowing the technology to flourish and innovation to flourish, but also dealing with some of the regulatory challenges associated with it.

Mr. HEINER. Well, I would just touch on the benefits of collaborative industry standard setting. The Blue Tooth technology that we're all using every day—that was a voluntary industry standard. Wi-Fi is a standard, and WiGig, which I referred to earlier. Certain issues can arise in terms of avoiding interference when you have shared spectrum with other users in that spectrum or in adjacent channels, and sometimes it seems as if the FCC regulation may get a little heavier than is needed to really address those concerns, and

we would encourage that wherever possible the industry work together, again, through standard setting bodies to achieve that.

More broadly, I think we need to work with the International Telecommunications Union, and Microsoft, for its part—we are sort of part of the government delegation to the worldwide spectrum discussions that are going on through the ITU, and we very much support the efforts of working with academics as well.

Mr. LAPLATNEY. Thank you for your question, Senator Peters. I would suggest that the ATSC 3.0 has been a tremendously collaborative and very quickly moving process relative to past standard changes, and I think the last time we changed the TV standard, it took 19 years. This particular transition, or this standard development, is moving at a much quicker pace, so we're encouraged by that, and encouraged by the current FCC that's helping us to move that along. So thank you.

Mr. STROUP. I think we saw the beginning of that opportunity in some discussions between the wireless industry and the satellite industry in the Spectrum Frontiers proceeding, something that becomes more important as we look at the millimeter wave bands, because despite all of the discussion that's taken place, many of those bands have been identified for the growth of the satellite industry. And the topic of service to world areas came up several times during the course of the discussions today. That's been an area where the satellite industry has been providing service, including telemedicine services, for decades.

I noted in my testimony the growth of the industry, the new high throughput satellites that are being launched—already have been launched and providing FCC broadband speeds, and the continued growth with all Earth orbit satellites. So being able to access that spectrum and, in some cases, on a shared basis continues to be very important, and, hopefully, it will be done through voluntary discussions.

Senator PETERS. Great.

Mr. BERGMANN. Thank you, Senator Peters. I would say the wireless industry participates in a variety of different standard setting bodies, both for unlicensed spectrum and for licensed spectrum. It's a tremendously important tool for the industry in terms of being able to develop and bring new products to market. Certainly, one reason why we like a mix of both unlicensed and licensed spectrum is with licensed spectrum, we're able to bring new services to market quicker sometimes, because we can launch services before standards are developed.

To your point about collaborative processes, I think that's another great one. That's certainly a model that we in the wireless industry have embraced, whether it's wireless emergency alerts or 911 location accuracy. We've found a successful ability to partner in those two cases with public safety, but in other cases as well, too, to try to advance public policy goals in a flexible and nimble way.

Senator PETERS. Right. Thank you.

Mr. ENTNER. Thank you, Senator. I think one of the things that—as you mentioned, technology is progressing exponentially, whereas government policy not always is following the pace. I think it just needs more foresight so that we are using more ambi-

tious goals in what we are clearing and making available to industry.

I think, overall, the technology and telecom industry has worked very well together. One notable example is, for example, LTE-U and license assist access. So I think we should encourage these types of voluntary processes with a light touch regulatory environment.

Senator PETERS. Thank you.

Senator WICKER. Thank you, Senator Peters.

Senator Inhofe?

STATEMENT OF HON. JIM INHOFE,
U.S. SENATOR FROM OKLAHOMA

Senator INHOFE. Thank you, Mr. Chairman. I guess the panel knows that we're simultaneously meeting with other committees, so I have to reprogram my Senate Armed Services concerns here, and so I don't know really what you've already gone over.

Mr. Bergmann, deployment of the next generation of telecommunications technology will allow faster Internet speeds, which will require a substantial infrastructure investment. Now, have you really discussed what we can do? This is Congress. We're your partner, and we want to help. What should we be doing?

Mr. BERGMANN. So, Senator Inhofe, you're right. We're facing a great opportunity and a great challenge. As we look to lead in 5G, we recognize that it's a whole new network, built not just around tall towers, but also around hundreds of thousands of small cells that are the size of pizza boxes or lunch boxes that will enable us to have these much faster and much higher capacity services.

A couple of things this committee can do is to work with us to make sure that local permitting processes are not overly burdensome, to make sure that we have access to rights-of-way and poles on a timely basis and at fees that are reasonable and cost-based, to make sure that Federal agencies move quickly and have deadlines. So, particularly, as we look to parts of the country that have large areas of Federal lands or Federal buildings, the delays today can be on the order of 2 to 4 years and sometimes much longer than that. So if we can start to shorten some of that siting, we'll be able to get that infrastructure out there more quickly and more cheaply.

Senator INHOFE. I spent 30 years on that side of the table. The problem I had with the Federal Government very often was predictability and knowing in advance what's going to happen. You mentioned the towers. You have to know well in advance before huge expenditures are made and what the rules are going to be when you finally get to the point where you're going to try to make it happen. I assume that would be one of your concerns.

I understand that consumer demand for wireless has more than doubled in 2015 alone. I didn't know this. I'm the newest one on this committee. To meet this, you have to rely on licensed spectrum, which you exclusively own, and unlicensed spectrum, which anyone can use. Could you share with the Committee why it's important to use both licensed and unlicensed spectrum to meet the growing consumer demand, which has doubled in the last year alone?

Mr. BERGMANN. Sure, Senator. Both licensed and unlicensed are really important parts of the wireless industry's ability to serve. We offload traffic to unlicensed spectrum. We're looking to launch new LTE-based services in unlicensed spectrum. Licensed remains the foundation of mobile networks, and that's a place that enables us to build in highly reliable, highly secure services. So as we look to 5G and the kinds of things like self-driving cars or remote surgery, where we want to have a really high level—a high quality of service, licensed will be a critically important part of that overall equation.

Senator INHOFE. Yes. And, Mr. Heiner, Microsoft has been a leading innovator in the use of unlicensed spectrum. Congress and the FCC have directed more spectrum be made available, balancing between licensed and unlicensed spectrum. Do you believe there is an appropriate balance between the two, licensed and unlicensed?

Mr. HEINER. Well, I think a theme coming out of the hearing today is everyone on this side of the table would like to see as much spectrum as possible allocated to both licensed and unlicensed use. We speak very much in terms of a balanced spectrum policy. That doesn't necessarily mean, like, 1 megahertz for unlicensed and 1 megahertz for licensed. At different bands, it may make more sense to allocate more to licensed or more to unlicensed in a particular circumstance.

We are enthused about the extra bandwidth that opened up in the 600 megahertz band as a result of the incentive auction, and we're enthused about the Spectrum Frontiers proceeding, where new spectrum has opened up as well.

Just to your point about predictability, of course, that is important, too, because you need to know ,sort of, years ahead in order to plan and develop standards and then build devices. It's been a little bit of a challenge in the TV white spaces area over the past 10 years, where the rules have been a little bit in flux. We really feel like we need to move forward with investing in that technology now, and we're, sort of, redoubling our efforts, and we feel like the rules are sort of almost done, and so we're ready to move forward.

Senator INHOFE. Yes, I like to bring that up because that's true with any issue we could be talking about right now. It seems like government doesn't have the understanding that they really need to know what's going to be expected of them next year or 10 years from now because the investment sometimes has to be made way in advance.

I'm sure you covered quite a few things. I apologize for those of us on Armed Services not being here.

That's all I have, Mr. Chairman.

Senator WICKER. Thank you, Senator Inhofe.

Well, this has been a very interesting and enlightening two hours. I think this was an important hearing with a very talented and knowledgeable panel. We've been interrupted by votes and other committee meetings, so it may be that you did have to reiterate a few themes, but that's helpful to us also. Thank you very, very much.

We'll stand adjourned and express our appreciation on behalf of the entire Subcommittee.

Without objection, the record will stay open for two weeks. Thank you.

[Whereupon, at 11:28 a.m., the hearing was adjourned.]

A P P E N D I X

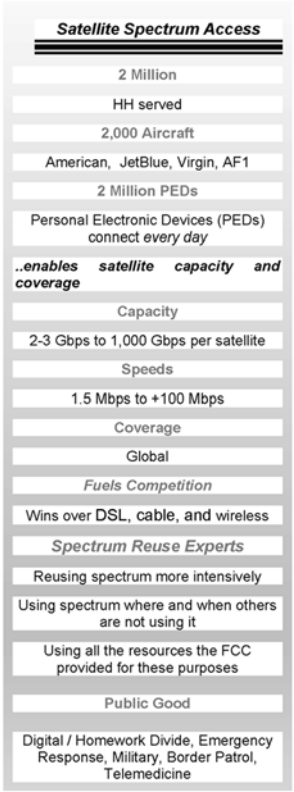
PREPARED STATEMENT OF VIASAT

Satellite Broadband White Paper

Exploring the Value of Spectrum to the U.S. Economy to explore the future spectrum policy and how wireless technology benefits consumers and the economy.

ViaSat, as a leading provider of satellite and terrestrial broadband communications solutions would like to thank the Committee for holding this important hearing on the future of spectrum policy and for providing an opportunity to submit input for the record.

Spectrum is the life blood of wireless technology, both terrestrial and satellite, and our industries collectively need to be good stewards of its use, work together to enable spectrum sharing where feasible, and continue our efforts to increase spectrum efficiency for the benefit of consumers, emergency response teams, enterprise users, government/military users, and for the benefit of the American economy.



ViaSat uses a wide variety of technologies, both terrestrial and satellite, to provide spectrum-based broadband service to about 700,000 residences and small busi-

ness, and about 1,000 aircraft, including United Airlines, American Airlines, JetBlue, Virgin American, and the United States government's senior executive service fleet.

We also deliver broadband service on unlicensed frequencies to over 10 million Wi-Fi access points worldwide.

ViaSat's advanced satellite broadband network technology has revolutionized the efficient use of spectrum, increasing the total network capacity provided by the spacecraft and associated ground infrastructure. Typical spacecraft systems dedicated to satellite communications have historically delivered a mere 2–3 Gbps of capacity. Ten years ago, the top speed provided was 1.5 Mbps.

Today, ViaSat has surpassed all satellite providers in capacity with advanced spectrum use and reuse techniques implemented in ViaSat-1 in November 2011 with its 140 Gbps of capacity—fifty to seventy times more total capacity that what previously was in place. We're now offering 25/3 Mbps service in many parts of the Nation over ViaSat-1.

ViaSat is continuing this revolutionary efficient reuse of spectrum, with the launch of ViaSat-2, scheduled in April 2017, which will deliver over 280 Gbps of capacity (twice the amount on ViaSat-1). ViaSat-2 will have seven times the coverage of ViaSat-1, and will be able to support 25/3 Mbps service.

ViaSat's global fleet of third-generation (ViaSat-3) satellites begin launching in 2019. Each of the ViaSat-3 spacecraft efficiently use spectrum to deliver over 1000 Gbps of capacity, more capacity than of all of the existing satellite communication spacecraft on-orbit combined. That is seven times what we have on ViaSat-1 today. And ViaSat-3 will support even faster speeds.

In a decade, ViaSat has achieved nearly three orders-of-magnitude, 1000-fold, improvement in spectrum efficiency. We have significantly increased the number of broadband users we can support, we are providing faster and faster speeds, we're on a path to provide virtually unlimited data allowances, and we're winning customers from terrestrial alternatives. In other words, we're providing a fully competitive broadband alternative, and are reaching consumers in urban, suburban, and rural locations and also serving users in the airborne, maritime, and land mobile environments.

In a decade, ViaSat has achieved nearly three orders-of-magnitude, 1000-fold, improvement in spectrum efficiency. We have significantly increased the number of broadband users we can support, we are providing faster and faster speeds, we're on a path to provide virtually unlimited data allowances, and we're winning customers from terrestrial alternatives. In other words, we're providing a fully competitive broadband alternative, and are reaching consumers in urban, suburban, and rural locations and also serving users in the airborne, maritime, and land mobile environments.

These developments have made possible by new spectrum sharing techniques—advanced methods of spectrum reuse that do not affect other spectrum users.

By increasing spectrum efficiency through reuse and sharing techniques, ViaSat has been able to reduce the "cost per bit" of delivering broadband service. Achieving this result was critical to developing a high-quality broadband product and affording millions of Americans an effective competitive alternative to wired and wireless terrestrial services.

ViaSat's broadband customers include individual consumers, small and large businesses, emergency response teams, government and military users, and major airlines such as United, JetBlue, Virgin, and now American. The locations of ViaSat's Ka-band broadband network customers at fixed locations are shown in figure 1. Figure 2 shows typical flight routes of the many commercial aircraft that have Wi-Fi powered by our satellite broadband service.

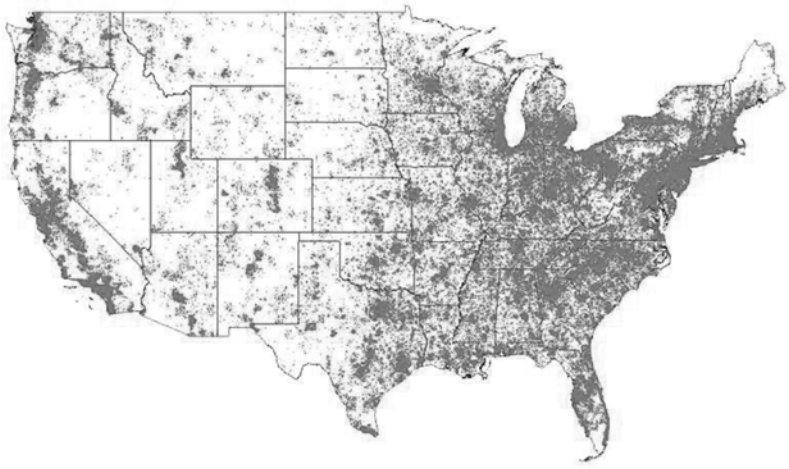


Figure 1: ViaSat's fixed satellite broadband customers are distributed across the United States in a manner that roughly follows the U.S. population distribution. The service is not a last resort, but a viable alternative to Cable and DSL as well as a cost effective means to deploy services to remote locations.

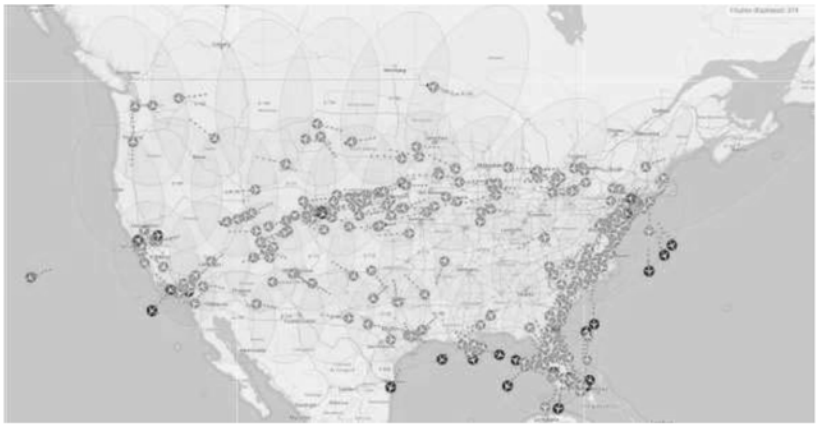


Figure 2: The aircraft that utilize ViaSat's broadband service traverse the United States, as well as international routes.

In fact in America, over 2 Million Personal Electronic Devices (PEDs) connect every day to these broadband Internet networks, with over 1 Million PEDS operating on commercial aircraft Wi-Fi service each month.

ViaSat also provides these satellite broadband services to emergency response organizations, like the Red Cross, businesses, schools, medical facilities, and government and military users for their essential missions and communications needs.

Telecommunication customers demand higher speeds, and higher data allowances without paying a commensurate increase in service fees. This dynamic drives ViaSat, as well as other industry players to be good spectrum stewards. We've done a lot with a little.

"Service providers around the world share concerns about running out of bandwidth. Business challenges surrounding continued bandwidth growth, linked to video, mobility, and cloud applications, are significant. Service providers also report declining revenue from a cost-per-bit perspective, so not only does the network need to grow, it also needs to grow more cost effectively." [1]

ViaSat's satellite broadband service currently relies primarily on a fleet of three spacecraft and associated ground segment:

(i) Ka-band payload on Anik F2

(ii) WildBlue-1, and

(iii) ViaSat-1, it's first-generation, high-capacity satellite.

To continue to acquire customers and to expand the infrastructure to deliver broadband service competitive with terrestrial alternatives, ViaSat's network of earth stations will continue to expand. To illustrate as shown in Figure 4, ViaSat-1 with capacity of 140 Gbps uses 20 earth stations to connect to the Internet backbone. ViaSat's second-generation ViaSat-2 doubles this capability, and requires more than 40 earth stations to to connect to the Internet. With the planned deployment of multiple third-generation ViaSat-3 high-capacity satellites, each of which will provide over 1 Terabit per second (over 1,000 Gbps) of throughput and support even higher customer speeds, hundreds of earth stations to connect to the Internet are required.

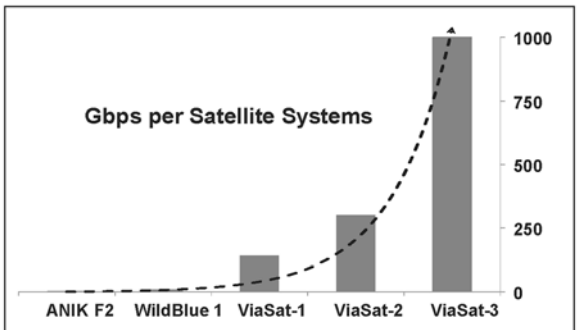


Figure 3: ViaSat's Ka-band satellite network spectrum efficiency improvements in terms of capacity achieved.

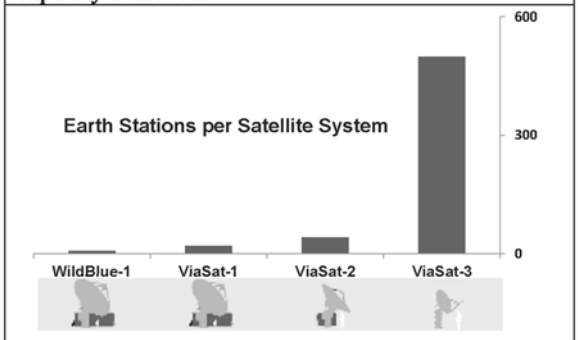


Figure 4: ViaSat's Ka-band ground network is achieving comparable capacity improvements while also improving ground network diversity, network resilience, availability and security.

[1] Cisco, Connect-World, the information and communication technology (ICT) decision makers' magazine, 18 Jan 2015

These earth stations are distributed across the United States—they are not primarily located in remote or rural areas. To the contrary, they are located close to the customers and connections to the Internet backbone, which are often in more populated areas as seen in Figure 1.

These revolutionary advances in efficient use of spectrum leading to higher capacity have been made possible by incorporating greater bandwidth into satellites, facilitated by the FCC's decision to allocate 2.5 Ghz of the Ka-Band for satellite services (in each direction) after: (i) wisely predicting the increased demand for satellite-based services that exists today;[2] *and (ii) correctly recognizing that satellite operations might not be able to be "fully and economically accommodated in the only frequency bands [then] available."*[3] Specifically, ViaSat's newest spacecraft are designed to operate across a wide range of the Ka band. ViaSat-1 was the first commercial spacecraft to operate across that range. ViaSat-2 and ViaSat's third-generation, ViaSat-3 spacecraft under construction will employ even more of this satellite spectrum to provide increased capacity.

Large parts of this segment currently is used by the earth stations that aggregate and interconnect to the Internet backbone, and in a manner that is compatible with existing terrestrial uses of same spectrum. In fact, these types of earth stations have successfully shared spectrum with authorized terrestrial users without any reported cases of interference. ViaSat also obtained authority to reuse this spectrum to serve aircraft above 10,000 feet, likewise in a manner that is compatible with existing terrestrial uses.

Satellite broadband technology advances have attracted customers who have switched to satellite broadband from terrestrial alternatives, such as 3G and 4G wireless, cable, and DSL. In fact, ViaSat's satellite broadband service now has an overall user satisfaction rating on par with that of many broadband service providers. The level of satisfaction of ViaSat customers has been rising, and is considerably higher since before it launched ViaSat-1 in 2011. To emphasize, the satellite broadband capabilities that have made this level of service possible require the spectrum inputs that the FCC authorized for the ViaSat network.

ViaSat's focus is on providing efficient and cost-effective broadband solutions, regardless of technology, and it works with and employs terrestrial-based communications to meet the communications needs of its customers.

By way of example, ViaSat recently acquired NetNearU Corp., a wireless network systems provider that delivers managed Wi-Fi Internet access services on unlicensed frequencies to over 10 million Wi-Fi access points worldwide.

Leveraging the management platform acquired in that transaction, ViaSat now provides wireless network systems that deliver broadband service to consumers, businesses, and government customers, in buildings and through outdoor hotspots.

Our experience as a leading provider and innovator of communications technologies, including those that rely on shared spectrum, and as a provider of both satellite and terrestrial wireless services, is depicted in Figure 5; more bandwidth and higher data allowances leads to increased customer satisfaction.

---

[2] *See Proposed Frequency Allocations and Radio Treaty Matters,* 37 Fed. Reg. No. 151, 15714–717, 15733 (Aug. 4, 1972); *corrected at* 37 Fed. Reg. 25175 (Nov 28, 1972); *Frequency Allocations and Radio Treaty Matters,* 38 Fed. Reg. No. 40, 5565, 5595–7 (Mar. 1, 1973).

[3] *Establishment of Domestic Communication-Satellite Facilities,* Further Notice of Inquiry and Notice of Proposed Rulemaking, 25 FCC 2d 718, at ¶2 (1970) (citing *Establishment of Domestic Communication-Satellite Facilities,* Report and Order, 22 FCC 2d 86, at ¶11 (1970)).

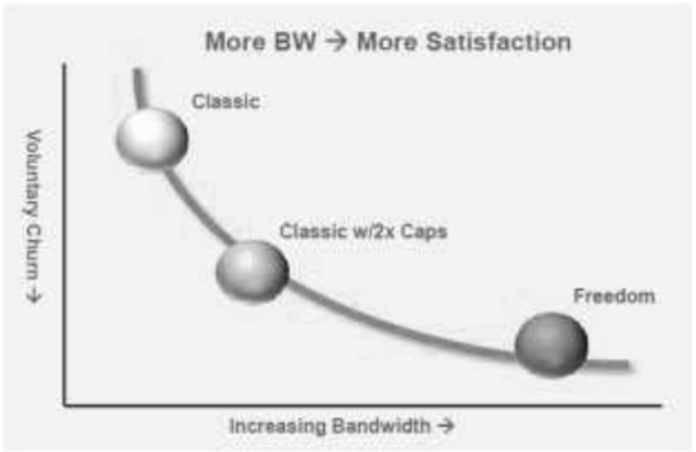


Figure 5: ViaSat's broadband experience clearly reflects higher speeds and increase or elimination of data caps improves customer satisfaction.

ViaSat is uniquely positioned to offer insights in this Committee supporting solutions for making the most efficient use of spectrum while enabling flexibility for the development and operation of a wide range of technologies and services.

In conclusion, ViaSat, like other wireless broadband providers, requires access to additional spectrum to meet the insatiable demand for higher speeds and data requirements. ViaSat will continue to innovate and develop mechanisms for sharing the valuable spectrum resources to facilitate state-of-the-art broadband service delivery.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DEB FISCHER TO SCOTT BERGMANN

Question 1. Mr. Bergmann, as you know, estimates suggest that as many as 50 billion devices may be connected to the Internet by 2020. The advancement of the Internet of Things has the potential to stimulate economic growth and enable consumer benefits through the sharing of data from device to device. However, it will also increase the demand for spectrum. What can we do to ensure there is adequate spectrum available to meet the needs of the growing Internet of Things?

Answer. CTIA appreciates your leadership on this issue and supports the bipartisan DIGIT Act you introduced with your colleagues to encourage the growth of the Internet of Things. There is broad consensus among policymakers, CTIA's members, and other stakeholders that more spectrum needs to be made available in order to supply the capacity needed to meet the public's insatiable demand for wireless services—demand that will further accelerate with the next generation of wireless networks, 5G, and the Internet of Things. With the recent close of the FCC's Incentive Auction, for the first time in several years there are no other auctions scheduled. Identifying substantial amounts of spectrum across a variety of bands, with a clear, defined timeline, should be a national priority. The MOBILE NOW legislation takes important steps toward achieving that objective, and should be part of a comprehensive, ongoing plan to designate low-, mid-, and high-band frequency to meet the public's growing reliance on wireless connectivity. Given that it takes on average 13 years to reallocate spectrum for wireless broadband use, we encourage Congress to provide a clear plan for additional licensed spectrum across a wide and diverse range of frequencies to meet tomorrow's needs.

Question 2. Mr. Bergmann, a recent study by Deloitte observed that to realize the full potential of 5G networks, it is imperative for governments at all levels to make the permitting and regulatory process more efficient. As we work here in Congress and with the FCC to develop a process for the deployment of small cell technologies, where should we focus our efforts?

Answer. Unlocking the promise of 5G networks requires modernized permitting and regulatory processes that will enable wireless providers to deploy the infrastructure needed to support those networks. Small cells are already being deployed across the country to create greater capacity to accommodate the ever-increasing demand for 4G LTE services. And 5G will require initial deployment of as many as 300,000 new small cells around the country in just the next few years—roughly as many cell sites as have been built over the last 35 years.

States and localities across the country are beginning to understand the importance of small cell technologies. They are working to update their permitting processes to reflect this evolution and position their communities to be the connected, smart cities of the future. The Nebraska legislature is currently considering the Small Wireless Facilities Act (LB 389), supported by CTIA, which will remove barriers to efficient deployment of small cell wireless infrastructure. But in many localities across the nation, siting and zoning regulations create barriers that impede wireless infrastructure deployments, including small cells. These barriers take several forms. First, some localities prohibit new wireless infrastructure altogether, or impose restrictions that have the effect of prohibiting it. For example, some have enacted moratoria on all new wireless deployments, prohibiting any facilities in downtown or residential areas, and/or imposed design and operating requirements that make deployment technically and economically infeasible. Second, some localities take very long times to approve new deployments, as long as eighteen to twenty-four months, despite the urgent need for the facilities to accommodate ever-growing consumer demand. Third, some localities impose excessive fees for access to local rights of way that far exceed any costs they may incur from reviewing permit applications and managing deployments along public rights of way. And wireless providers often face annual fees for each small cell that can reach thousands of dollars or more per facility, which can make deployment cost-prohibitive and divert resources away from new investment, particularly in rural areas. Congress and the FCC can address these barriers, while maintaining localities' traditional role in permitting new facilities, by prohibiting unreasonable restrictions that impede investment, putting time limits on review periods, and curbing excessive and discriminatory fees.

In addition, modernizing the review process for wireless infrastructure deployments on Federal lands and Federal properties would also facilitate additional network investment to advance wireless coverage and 5G capabilities for the public and the Federal Government. MOBILE NOW includes much-needed Federal siting reforms. But the lack of a uniform practice across agencies for conducting siting reviews, the failure to use a standard siting agreement, and delays in those reviews have impeded new infrastructure. Additional Congressional oversight over agencies administering Federal lands to address these issues, and agencies' adoption of standardized processes and deadlines for action, would do much to advance needed new infrastructure on the nearly 30 percent of lands across the Nation that are owned by the Federal Government, including lands and properties in hard-to-serve rural and remote areas.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO SCOTT BERGMANN

Question 1. In your written testimony you state: "We would suggest reasonable shot clocks for new site and collocation permit applications and broader application of existing deemed granted remedies. Additionally, permit fees and other charges for wireless siting should be reduced to reflect small cells' minimal impact and be limited to the actual, incremental costs to localities for processing these applications." Is CTIA advocating broad preemption of state and local siting laws and regulations?

Answer. CTIA is not advocating broad preemption. However, the Federal Government has long played a role in promoting communications networks and providing guiderails for state and local authority where necessary to achieve deployment goals. In 1993, for instance, Congress took action to prohibit state and local governments from regulating rates for personal wireless services and from restricting access to the marketplace for new entrants. Again, in 1996, Congress acted to limit state and local government authority over tower siting by mandating that they consider requests to site wireless facilities within a reasonable period of time. In 2009,

the FCC interpreted that language to create specific timelines for acting on collocation and other applications and, in 2014, further updated its rules to implement provisions of the 2012 Spectrum Act that further recognized the evolution of wireless technologies. Now, consistent with these past legislative and regulatory efforts, we are seeking to further modernize the Federal approach to reflect the challenges of today's and tomorrow's networks. States and localities have legitimate interests in managing the siting of wireless facilities. We are asking only that the FCC to interpret the Communications Act to ensure localities issue permits for wireless facilities within reasonable times, without unreasonable requirements or discriminatory policies, and with fees that fully recover their costs to process those permits. In particular, many local laws and regulations governing the placement of small cells—including where they can go, how long it takes to review their applications, and how much it costs—are the same for the requirements that govern traditional macrocell deployments. Yet, small cells are much smaller facilities, usually no more than a few feet in any dimension, and are typically placed on poles along local streets or on existing structures such as rooftops, water towers, and the sides of buildings. They have far less potential for visual and other impacts than the traditional macrocell towers that existing state and local procedures were designed to address. Streamlining permitting procedures for these smaller facilities will account for their limited impact and will greatly speed deployment of critical facilities needed to support the public's exploding demand for broadband.

Question 2. If CTIA is not advocating Federal preemption of state and local law, is CTIA willing to partner and coordinate with groups that represent state and local governments and Tribes in order to come up with an outreach and capacity building game plan that includes things like: education about small cell and 5G services, model applications, best practices in handling applications, concerns about fee gouging, discussions of legitimate public interests and concerns of local communities?

Answer. CTIA and our members work closely with state and local organizations and remain committed to continuing that dialogue. Our members have worked successfully with state and local governments to develop state laws and ordinances. For example, in Arizona and Colorado legislation to streamline siting of small cells was recently adopted. These bills were the result of discussions with organizations representing many jurisdictions across the state. CTIA and our members will continue to engage with state and local organizations on similar legislation as well as on other efforts to improve wireless siting processes in other states while ensuring that actions to modernize our Nation's infrastructure policies are not delayed. The FCC's recently created Broadband Deployment Advisory Committee is an ideal forum for such discussions, as it is designed to provide timely, informative feedback to the FCC on ways to improve the state and local permitting processes. CTIA also has worked with tribal representatives for many years regarding ways to modernize the process while protecting tribal interests. CTIA has participated in several meetings and working sessions toward those ends, and looks forward to working with Congress, the FCC, and the tribal representatives to update these processes.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. CATHERINE CORTEZ MASTO TO SCOTT BERGMANN

Question 1. Mr. Bergmann, in your testimony you mentioned a number of sectors that benefit from the wireless industry. I was interested in you elaborating about innovations on the public safety and transportation side. Could you give me some specific examples and where we're going in the future?

Answer. Today's Fourth Generation ("4G") wireless services are delivering innovations that directly benefit public safety and transportation. Fifth Generation ("5G") wireless services, with their higher speeds and more robust capabilities, promise even more innovations in these sectors.

On public safety, the improvements in data speeds, capacity and latency that 4G and 5G offer over previous wireless technologies can provide first responders with on-the-scene access to building information, traffic flows, improved E911 network capabilities, and other critical information. And rescue services will be able to transmit more extensive data about patients to the hospitals that will receive them, improving emergency medical care. The January 2017 Accenture report on 5G that I referenced in my testimony identified other public safety benefits such as more robust, integrated video surveillance, wireless sensors to identify the use of firearms, and flood sensors to provide motorists with route guidance to steer them away from flooded roads. Likewise, the January 2017 Deloitte study that I mentioned found

that a 60-second improvement in first-responder response due to improved wireless connectivity translates to a reduction of eight percent in mortality.

4G and 5G can deliver similar benefits to the Nation's transportation systems. As I noted in my testimony, these technologies are essential for wireless-powered self-driving cars, which could reduce vehicle emissions by 40–90 percent, cut travel times, and save tens of thousands of lives. The Accenture report explained how 5G will help communities to enhance public transportation, reduce traffic congestion, and generate revenues from more efficient public parking systems. The various public safety and transportation innovations, coupled with the use of smart electrical grids, 5G-enabled smart cities can see $160 billion in benefits and savings.

Question 2. Also, since you addressed this in your testimony, are there specific telecom infrastructure siting stories or issues with places like public lands, that make up 84 percent of my state, or tribal lands, that you can share and you've seen that we should be addressing? Also please include your specific ideas on how we alleviate them. Lastly, please elaborate on examples of the kinds of local siting and zoning rules that have become the most challenging to your members.

Answer. The wireless industry's ability to build facilities on Federal lands is important in all states but is particularly critical in Nevada because of the vast expanse of Federal lands there. CTIA members have worked with the multiple Federal agencies that manage those lands. While facilities have been constructed, many more are needed to ensure that Federal employees who work on those lands, and the public that lives on or visits them, can benefit from 4G and 5G wireless connectivity. But the lack of a uniform practices across agencies for conducting siting reviews, the failure to use a standard siting agreement, and delays in those reviews have impeded new infrastructure. Additional Congressional oversight over agencies administering Federal lands to address these issues, and agencies' adoption of standardized processes and deadlines for action, would materially promote needed new infrastructure in Federal lands across Nevada and elsewhere.

CTIA members also work closely with tribes when seeking to site wireless facilities on tribal lands. In addition, however, tribes play a role in reviewing the siting of wireless facilities on non-tribal lands—and it is this review of non-tribal land siting that was the focus of my testimony. CTIA supports the dual goals of protecting sites of historic, religious, and cultural significance to Indian tribes, and delivering nationwide communications services to all Americans. The tribal review process for siting on non-tribal land, which is a consultative role, can nonetheless take an extremely long time and fees can be costly. The Federal Government can provide some guidance to streamline the review process while ensuring sites of historic, religious, and cultural significance are protected.

Finally, local siting and zoning rules are extremely challenging for CTIA's members because they block needed wireless investment. These local obstacles take several forms. First, some localities prohibit new infrastructure altogether, or impose restrictions that have the effect of prohibiting it. For example, some have enacted moratoria on all new deployment, prohibit any facilities in downtown or residential areas, and/or impose design and operating requirements that make deployment technically and economically infeasible. Second, some localities that do not prohibit new deployments often take very long times to approve them, often six months or longer and even over a year, despite the urgent need for new facilities to accommodate ever-growing customer demand. Third, some localities impose excessive fees for access to local rights of way which far exceed any costs they may incur from reviewing permit applications and managing deployments along local streets. CTIA's members face annual fees for each small cell of typically thousands of dollars or more, which make deployment cost-prohibitive and thus block new investment. CTIA is working with Congress, the FCC, and states and localities to modernize the state and local siting and zoning rules and ensure that fees for use of public properties and rights of way are based on the actual, direct costs to the communities for reviewing those applications and managing the public rights of way.

Question 3. With the barrier of siting broadband projects on Federal public and tribal lands, would you favor an interagency working group that coordinates agencies like the Federal Communications Commission, the Bureau of Land Management, Bureau of Indian Affairs, and National Telecommunications & Information Administration to come up with streamlined solutions to barriers denying rural Nevadans quality online access? Who are the other stakeholders or Federal agencies that would need to be represented in these discussions to ensure we close the digital divide?

Answer. Yes, CTIA supports the creation of such an interagency working group with the goal of identifying ways to improve and streamline procedures for siting wireless facilities on Federal and tribal lands. To effectively develop modernized

policies that reflect the evolution of wireless infrastructure, the working group must include other Federal agencies with substantial Federal land holdings, including NTIA; Department of Defense; the Department of Agriculture, including the U.S. Forestry Service; the Department of the Interior, including the National Park Service, the Bureau of Land Management, and the Bureau of Indian Affairs; and the Department of Transportation; among others. It should also include the General Services Administration ("GSA") because of GSA's responsibilities to manage Federal buildings and properties, which can serve as sites for new infrastructure. Such a working group should consider the benefits of shot clocks and standardized processes and fees for siting wireless facilities on Federal lands. Adoption of these changes could help alleviate the delays currently experienced by the industry in locating facilities on the nearly 30 percent of lands in this country that are owned by the Federal Government.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. DEB FISCHER TO DAVE HEINER

Question. Mr. Heiner, as you know, estimates suggest that as many as 50 billion devices may be connected to the Internet by 2020. The advancement of the Internet of Things has the potential to stimulate economic growth and enable consumer benefits through the sharing of data from device to device. However, it will also increase the demand for spectrum. What can we do to ensure there is adequate spectrum available to meet the needs of the growing Internet of Things?

Answer. Senator Fischer, Microsoft appreciates your leadership on advancing policies that support the growth of the Internet of Things (IoT). Microsoft is a provider of the hardware, software, and cloud services that power IoT. We help our customers connect, monitor, and manage millions of devices and related assets, and we provide the cloud services that help organizations unlock the value of new business models that are possible only through the combination of connected devices, machine learning, and big data analytics that power IoT.

Today, the majority of IoT traffic is carried over unlicensed spectrum. The specifics of a given IoT application determine its spectrum requirements such as frequency, size of the channel required for the IoT data (bandwidth), and how often the IoT data needs to be sent. It is still early, but it may turn out that applications such as IoT in agriculture can most cost-effectively be delivered using periodic transmissions over narrowband low-frequency spectrum, while other IoT applications, such as remote operation of devices or equipment, may require high-bandwidth, high-frequency, almost continuous transmissions, with a guaranteed high quality-of-service.

Microsoft expects over time that there will be a continuum of spectrum requirements across different IoT applications and use cases. Microsoft agrees with your assessment that the growth of IoT traffic will increase demand for spectrum. At present, Microsoft does not believe additional spectrum bands be should allocated specifically for IoT use. With some exception, IoT-enabled devices and equipment will be either at a fixed or part of or attached to something that is moving. For this reason, Microsoft suggests that the Congress authorize the Commission to identify low-, mid-, and high-band spectrum currently allocated to either mobile and/or fixed wireless services and inquire about the corresponding changes to the technical and services rules required to enable a full range of IoT devices to share the band without causing harmful interference to incumbents.

We believe that it makes sense for latency-sensitive IoT applications or those that require an assurance of high Quality of Service to require licensed spectrum. For this reason, a mobile operator should be able to use its existing licensed spectrum for IoT applications. With respect to unlicensed spectrum, Microsoft envisions that, in some bands, unlicensed IoT devices will be able to share spectrum with incumbent services under the Commission's Part 15 regulatory framework.

For example, Microsoft is pioneering the application of cloud-based IoT and analytics using the unassigned and unoccupied spectrum in the broadcast television bands, known as the TV White Spaces (TVWS). Signals in the TV bands travel much further and pass through more obstacles than signals at higher frequencies for the same radiated power level. Therefore, TVWS frequencies are particularly well-suited for IoT for agriculture applications.

Last September, an article in *The Economist*[2] documented our work on cloud-powered IoT solutions for agriculture. The goal of this work is to leverage cloud-services,

---

[2] *http://www.economist.com/news/science-and-technology/21707242-unused-tv-spectrum-and-drones-could-help-make-smart-farms-reality-tv-dinners*

connectivity, and sensors to improve agricultural yields on small farms. This work is happening under an experimental license obtained from the FCC. We have found that while unlicensed IoT devices can access the TVWS as long as they meet the FCC's technical and operational rules, these rules were created with wide channels for broadband communication in mind and do not adequately accommodate narrowband IoT applications. To be clear, Microsoft strongly supports last-mile broadband service delivered over the TVWS. The company has been engaged in the policy and regulatory discussions regarding TVWS for more than a decade, and only in recent years has begun exploring the potential of the UHF and VHF bands for IoT use in addition to broadband.

Microsoft believes that the FCC's technical rules for TVWS access can be modified to accommodate both wideband and narrowband applications. Microsoft, therefore, in principle would support complementary changes to the FCC's technical rules for TVWS devices that will accommodate a full range of narrowband IoT applications, including in the agricultural domain.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO DAVE HEINER

Question 1. We need to think creatively about how to promote broadband buildout in rural America and in a way, that takes advantage of advances in technology and leverages existing infrastructure. This will both speed deployment and make sure we are spending our precious broadband dollars efficiently.

In rural Washington, there are Public Utility Districts and Port Districts that have deployed fiber to run their own operations. Often, these fiber networks have excess capacity. We should be figuring out ways to leverage these kinds of existing infrastructure to extend broadband into unserved areas.

In your written testimony, you talked about the ability of unlicensed spectrum to meet the need for last mile connectivity. Microsoft has had success with TV White spaces technology in rural areas around the globe.

Based on your experience, what are the key features that make these projects work? Specifically, what type of partners are you working with? What type of broadband infrastructure are you leveraging and what type of legal or regulatory environment is best to permit this type of innovation?

Answer. Senator Cantwell, under Microsoft's Affordable Access Initiative, we develop partnerships with local Internet access providers and other local entrepreneurs to deploy new last-mile access technologies, cloud-based services and applications, and business models that reduce the cost of Internet access and help more people affordably get online.

Microsoft's participation is intended to reduce the technical, business, and (in some countries) regulatory risk associated with launching such efforts in hard-to-reach and often economically distressed areas around the world, where the first hurdle is often convincing potential Internet access providers that such a business is viable. Our comprehensive approach means addressing all potential barriers and, depending on where the project is located, may include suitable consumption models and payment methods, relevant applications and services, reliable Internet access, access to power, and access to capital. It also means that we must leverage the existing local infrastructure to the greatest extent possible to increase affordability. Over time, Microsoft's role in each project winds down, because we have absolutely no interest in becoming an Internet service provider.

One last-mile access technology featured in many of our Affordable Access Initiative projects are devices that can access the TV white spaces (TVWS). Radio waves in the TVWS (unused UHF and VHF channels) travel further and can penetrate common building materials better than radio waves operating at higher frequencies for a given transmitted power level. The UHF and VHF TV bands are global spectrum bands, potentially leading to economies of scale for TVWS devices. Access to the TVWS is authorized today on an unlicensed (*i.e.,* free and open access) basis in the U.S., Canada, UK, South Korea, and Singapore. Other countries have initiated consultations regarding access to the TVWS under a variety of proposed rules. In countries where there are no applicable laws or rules in effect, Affordable Access Initiative projects using TVWS spectrum obtain temporary authorizations from the relevant National Regulatory Agency. The challenge is that where there are no rules in place there is regulatory uncertainty, which weighs heavily on investment decisions.

Question 2. As we are thinking about broadband infrastructure, does a focus on technology neutrality make sense to support unlicensed spectrum use or should we be focusing on fiber?

Answer. Senator Cantwell, I agree that we need to think creatively about ways to promote broadband buildout and affordable access across rural America. Microsoft believes that regardless of where someone chooses to live in the United States, they should be able to access the Internet at broadband speeds. It is equally essential that the broadband access be available at a price point that is affordable to rural consumers, but also is profitable to the service provider. Fiber is a great long-term goal. However, given the distances often involved in reaching rural and remote areas, challenging geography such as mountains, limitations of specific technologies, cost considerations, etc., most of these last mile broadband networks will consequently be wireless, heterogeneous, and all backhauled to the nearest Internet point-of-presence, which will most likely be a fiber-optic cable connected to the Internet backbone. We also see fixed broadband delivered over satellites as being a viable option in certain circumstances.

Our experience with a number of overseas Affordable Access Initiative projects in remote areas is that the last-mile TVWS network is really only a segment of a larger broadband network. TVWS radios can operate point-to-point and point-to-multipoint, the latter of which is similar to how Wi-Fi operates. At a given power level, there is a tradeoff between the size of the coverage area of a fixed TVWS radio and the amount of data in megabits per second a network can carry. We have found that fixed TVWS transmitters can operate at data rates providing robust broadband access at distances greater than 10 kilometers. This means that other wireless network technologies must be used in conjunction to connect the TVWS network to the Internet point-of-presence. Depending on the distances and the terrain involved, the wireless signal may have to bounce off multiple point-to-point microwave dishes to cover the span.

For this reason, Microsoft views unlicensed access to the TVWS as a tool for network designers to use when and where appropriate in the design of communications networks. It is a tool, though, that requires regulatory authorization, because it must not cause harmful interference to other users of the spectrum bands. The simple answer here is that unlicensed access to the TVWS is complementary to optical fiber with respect to enabling affordable broadband access in rural America. The Committee can and should support policies that allow optical fiber to be cost-effectively deployed further out in less densely populated areas and support policies that ensure a sufficient amount of unlicensed spectrum is available in rural markets for incorporation into last-mile broadband access networks.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. BRIAN SCHATZ TO DAVE HEINER

Question. Do tech companies generally agree or differ greatly in terms of a strategy for unlicensed bands?

Answer. Most tech companies that prioritize unlicensed spectrum are generally in agreement that more unlicensed spectrum in needed. When advocating for specific low, mid, and high frequency bands, companies sometimes have varying business-specific interests. As I mentioned in my testimony, Wi-Fi is an important use case of unlicensed spectrum. The Wi-Fi Alliance, which is a not-for profit organization consisting of the worldwide network of companies including Microsoft that form the Wi-Fi ecosystem, has identified the frequency range 5950–7250 MHz ('6 GHz band') as a spectrum band that warrants consideration for its potential to support unlicensed gigabit-speed Wi-Fi.

Increasingly, as consumers access the broadband Internet wirelessly over their portable devices, the critical metric is becoming the speed to the device rather than the speed to the home or to the curb. As broadband service providers in more densely populated areas are now beginning to offer gigabit broadband access to the home and office, Wi-Fi congestion could become a bottleneck that keeps individual consumers from experiencing gigabit speeds on their devices.

In densely populated areas, during busy times of the day, most users can only access channels in the 2.4 GHz Wi-Fi band that are 20 MHz wide. In addition to the individual channel size being too small to support gigabit Wi-Fi, the 2.4 GHz band as a whole often suffers from congestion due to its comparatively small size and the enormous quantity of applications (Bluetooth devices, microwave ovens, baby monitors, etc.) that use the band in addition to Wi-Fi. This congestion is most noticeable during the busiest hours and in the busiest places, and degrades the mobile experience for all Wi-Fi users.

Segments of the 5 GHz band are being used for Wi-Fi. Some of these sub-band segments requires Wi-Fi devices to use a technique called Dynamic Frequency Selec-

tion to ensure that the device does not cause harmful interference to military and other radar systems.

IEEE 802.11n protocol allows for 20- and 40-MHz wide channels in the 5 GHz band. A newer standard, IEEE 801.11ac protocol allows for 40-, 80-, and 160-MHz wide channels in the 5 GHz band. Wi-Fi devices accessing 160–MHz wide channels can attain gigabit speeds. The vision for 5 GHz band (5150–5850 MHz) gigabit Wi-Fi established several years back assumed that it would concurrently support multiple contiguous 160–MHz channels. Last fall, NTIA reported its conclusion that it would not be possible for unlicensed Wi-Fi devices to share spectrum with Federal and other license holders in the 5350–5470 MHz band. That decision means that a maximum of two 160 MHz channels can operate in the 5 GHz band at the same time.

The Wi-Fi Alliance commissioned a study[1] on spectrum needs for future Wi-Fi use. The study determined the amount of spectrum required to support Wi-Fi traffic by taking into consideration existing and future device capabilities and projected deployment needs for business, residential, and public locations under two different growth scenarios. Four key findings on the report released in February 2017 are:

- The ever-growing number and diversity of Wi-Fi devices along with increased connection speeds and data traffic volumes will exceed the capacity of spectrum currently available in the 5 GHz band by 2020;
- Between 500 MHz and 1 GHz of additional spectrum in various world regions may be needed to support expected growth in Wi-Fi by 2020;
- If demand for Wi-Fi exceeds expected growth, then between 1.3 GHz and 1.8 GHz more spectrum may be required by 2025; and
- Wi-Fi spectrum needs to be sufficiently contiguous to support 160 MHz wide channels, which are required to support a growing number of bandwidth-intensive applications and to allow maximum Wi-Fi benefits to be attained.

The Wi-Fi Alliance initiated a process to identify potential spectrum bands to address the Report's findings. Based on criteria such as the availability of large contiguous blocks of spectrum to support multiple 80- and 160-MHz channels, a Wi-Fi signal's ability to penetrate two walls across the frequency range, limitations in the power of the client device (*e.g.,* game system, handset, tablet, laptop) across the frequency range, a current allocation for mobile services, etc., the focus was narrowed to sub-10 GHz spectrum.

The experience of several Wi-Fi Alliance members, including Microsoft, in the unsuccessful multi-year effort to examine sharing the 5350–5470 MHz band with Federal and other users led the organization to look at spectrum bands where there was little or no Federal usage. In the 6 GHz band, Federal usage begins at 7025 MHz and continues at higher frequencies, with some breaks. Discussions with several Wi-Fi radio manufacturers indicated that current 5 GHz radios can be rapidly modified for 6 GHz operation. Review of the types of communication services operating in the band indicate that it would not be a good candidate for licensed use. The Wi-Fi Alliance also noted complementary efforts in Europe to begin study of the 5925–6425 MHz band for potential Wi-Fi use on a shared basis.

Separately, several Wi-Fi Alliance members, including Microsoft, have banded together to support an independent measurement, modeling, and mitigation effort to determine whether Wi-Fi devices can share spectrum with the other users of the 6 GHz band without causing harmful interference.

Microsoft is under no illusion about the magnitude of the challenge ahead to develop mitigation strategies and techniques enabling unlicensed devices to share access with incumbent 6 GHz band license holders. However, the consensus of the Wi-Fi community is that all-in-all, the 6 GHz band is the most promising and practical place to look to address its future spectrum needs. Our starting point is examining whether a Wi-Fi access point operating both indoors and outdoors with a maximum radiated power of 4 Watts EIRP can share the 6 GHz band successfully with incumbents. Measurement data and modeling will guide mitigation efforts and overall direction.

Microsoft requests that, in future spectrum legislation, the Committee include language directing the FCC to begin the process for amending the technical and service rules necessary for Wi-Fi to share the 6 GHz band with incumbent users. Additionally, we ask the Committee to consider authorizing NTIA's Institute for Telecommunication Sciences in Boulder, Colorado to perform measurements and provide other technical support of industry as it relates to the 6 GHz efforts. If noth-

[1] *http://www.wi-fi.org/beacon/alex-roytblat/wi-fi-study-reveals-need-for-additional-unlicensed-spectrum*

ing else, an authorization provides a signal to help focus the organization's priorities.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TOM UDALL TO DAVE HEINER

Question 1. Microsoft's website describes using TV "white space," the unused bandwidth between television channels, "to bring broadband connectivity to some of the 4 billion global citizens who are not currently online" (see *https://www.microsoft.com/empowering-countries/en-us/decent-work-and-economic-growth/tv-white-space/*). Do similar opportunities exist within the United States to deploy broadband to unserved and underserved areas?

Answer. Senator Udall, under Microsoft's Affordable Access Initiative, we develop partnerships with local Internet access providers and other local entrepreneurs to deploy new last-mile access technologies, cloud-based services and applications, and business models that reduce the cost of Internet access and help more people affordably get online. The Initiative supports both domestic and overseas projects. The 'homework gap' project in southern Virginia is an example of the type of collaborative project supported under the Initiative.

Unlicensed TV White Spaces (TVWS) devices is one such new last-mile access technology that can serve as an important tool for the designer of broadband networks connecting rural communities. Microsoft views high-power fixed-wireless TVWS devices as part of a heterogeneous network that can provide last mile connectivity between the nearest Internet point of presence and unserved and underserved areas within the United States. TVWS radios can operate point-to-point for wireless backhaul and operate point-to-multipoint, similar to Wi-Fi.

The reason we refer to TVWS as a network element is that there is a design tradeoff between range and the megabits per second that can be delivered. Based on our experience, under the current technical rules, the sweet spot for a TVWS radio's range is somewhere over 10 kilometers for commercially attractive data transfer rates. For communities within 10 kilometers of the nearest Internet point-of-presence, a single TVWS network can provide connectivity. Communities located considerably beyond 10 kilometers from the Internet point-of-presence may require the broadband network to combine multiple wireless technologies (and frequencies) to cover the distance. To increase the affordability of the resulting broadband service, the Initiative looks to leverage the existing local infrastructure to the greatest extent possible.

Question 2. Many school children in New Mexico and across the country face a particularly cruel aspect of the digital divide: the homework gap. Teachers increasingly assign homework that requires an Internet connection. This makes just getting assignments done a real challenge for the nearly one-third of New Mexico kids without access to the Internet at home. When former FCC Commissioner Jessica Rosenworcel and I visited Hatch Valley High School, we heard from students, teachers, parents and school administrators about the need to ensure all kids have access to broadband. Students told us how they go to the school parking lot or local Pick Qwik store to access free Wi-Fi and complete their homework. Could you share more about how Microsoft is developing new approaches to help close the homework gap?

Answer. Microsoft and its partners are extending the E-rate-covered broadband Internet access service of 18 participating schools to the homes of eligible students that live in Charlotte County and Halifax County, Virginia via wireless transmission using TV White Spaces technology over unlicensed spectrum—at no additional cost to the E-rate fund and for no charge to the students. This pilot project will assist in closing the homework gap for thousands of eligible students in the participating school districts. They will obtain authenticated access to their school Internet service, subject to the same rules and restrictions applicable to their Internet connectivity in school, so that the students can conduct research, do their homework, collaborate on projects with other students online, and pursue other educational opportunities from the safety and convenience of their homes. In the longer run, ISPs—in conjunction with the schools they serve in other areas—could use this technology to close the connectivity gap for the millions of other students across the United States who either cannot afford or do not have access to the Internet at home. Microsoft and its partners submitted a petition to the FCC asking it to clarify that this is permitted under the existing E-rate rules and, if not, to issue a waiver for the project. The petition is pending.

Question 3. I am interested in learning your thoughts about how to craft spectrum policy that is "future proof." The United States Frequency Allocation Chart (available at *https://www.ntia.doc.gov/files/ntia/publications/january_2016_spectrum*

_wall_chart.pdf) indicates that essentially all available spectrum has already been allocated. So the challenge today seems to be finding efficiencies and repurposing spectrum when new uses become important. How do we ensure that allocations made today do not unintentionally prevent us from meeting spectrum needs in the future?

Answer. Senator Udall, a fundamental challenge in developing laws and regulations regarding information and communications technology policy is that the technology (and market opportunities) moves much faster than Congress and the Federal Communications Commission (FCC) can react. Spectrum policy is no different. What makes spectrum policy even more challenging is that, as you rightly point out, essentially all spectrum considered for some form of wireless communications has already been allocated to one or more commercial radio communication services or for Federal use. It means spectrum policy is often a hard-fought zero-sum game where there are clear winners and losers, which makes it an even more challenging process. It usually takes many years between when a spectrum band is identified for repurposing at a policy level and when the repurposing of the band has been completed and the new service is up and running.

Microsoft believes that the continued demand for spectrum can be met more rapidly by increasing spectrum utilization through static and dynamic spectrum sharing between and among different radio communications services, and, where possible, with unlicensed devices as well. The potential for spectrum sharing will be different for every spectrum band based on the radio service(s) operating in the band, how they are deployed, the protection requirements, mitigation techniques available, etc. This detailed technical work is best left to the expert agency, the FCC. If Federal spectrum use is involved, the FCC needs to consult with NTIA.

Nonetheless, Congress can play a significant role in defining the objectives of our spectrum policy. For example, Congress can make clear that the Commission:

- should identify and examine for shared use more low-, mid-, and high-frequency spectrum bands:
- should ensure that a balance of licensed and unlicensed spectrum is available:
- should signal that the technical and service rules for accessing shared spectrum are fair and economically feasible; and
- should take steps to discourage spectrum warehousing, which can create an artificial shortage.

Ultimately, spectrum policy should support long-term competition in broadband services and be technology-neutral to the greatest extent possible.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TOM UDALL TO PAT LAPLATNEY

Question 1. Mr. LaPlatney, your testimony states that you oversee Raycom Media's 60 broadcast television stations stretching from Hattiesburg to Honolulu. This includes ABC, CBS, and NBC affiliate stations. President Trump declared via Twitter on February 17th that "FAKE NEWS media" including "NBCNews, ABC, CBS" and others are "the enemy of the American People!" (*see https://twitter.com/realDonaldTrump/status/832708293516632065*). President Trump reportedly later told a gathering of conservatives in Washington, D.C., that "A few days ago I called the fake news the enemy of the people, and they are—they are the enemy of the people" (*see* Jackson, David. "Trump again calls media 'enemy of the people'" (*see* Jackson, David. "Trump again calls media 'enemy of the people'." *USA Today*. Feb. 24, 2017. available at *http://www.usatoday.com/story/news/politics/2017/02/24/donald-trump-cpac-media-enemy-of-the-people/98347970/*). Do you agree with President Trump that ABC, CBS, or NBC News are enemies of the American people?

Answer. Senator Udall, we take great pride in the fact that Raycom Media is a trusted source of emergency information and news in every community we serve. Respectfully, we disagree with that characterization of the media.

Question 2. Could you share your views on the importance of the First Amendment protection of press freedom and the role of a free press in our democracy?

Answer. The right to speak freely without fear of incrimination and the right of the press to challenge the government and root out corruption remains one of the most important rights our founders enshrined in the Constitution. Broadcasters have been, and continue to be, proud stewards of these ideals in the modern media age. It is a mission we hold dear to our hearts. We shine a light on injustice and empower citizens to take action. In this digital world, it is very easy for the average

American to find information that confirms their beliefs rather than challenges them. This is where local broadcasters play such an important role in our democracy. We present the public with facts, provide information about issues that matter to people where they live and remind viewers about the incredible acts of service taking place in our communities. As newspapers continue to struggle, broadcasters have been carrying the mantle for locally focused investigative reporting. In fact, Raycom Media launched a new national investigative unit in late March which will produce high impact, interesting and informative series of national importance with a core focus on localism. The national unit will work closely with local investigative units across Raycom media properties placing a spotlight on subject areas of importance to your constituents.

Question 3. I appreciate the availability of free, over-the-air television. Although broadcasting is one of our first "wireless" technologies, it still provides a lot of value for many Americans, particularly during severe weather events or other emergencies. So I am excited about continued innovation and upgrades to TV broadcast technology. Your testimony describes new and enhanced services broadcasters will be able to offer TV viewers thanks to the ATSC 3.0 standard. Will these "Next Gen TV" features be available in rural areas that still lack reliable broadband service?

Answer. Senator, we are grateful for your appreciation of free, over-the-air (OTA) broadcasting and your support for ATSC 3.0. The renaissance of local TV is playing out in New Mexico and across the country as over 17 percent of U.S. TV households now rely exclusively on OTA signals (according to Gfk market research) for television viewing. While ATSC 3.0 deployment will be a station-by-station determination, we expect that deployment to be national in scope across a range of markets—urban and rural. One important factor that is essential to the successful deployment of ATSC 3.0 is a successful completion of the voluntary incentive auction repack. As we work through the extremely complicated repack as quickly as possible, we look forward to working with you on ensuring that New Mexican's that receive a TV signal today, will be able to do so after the auction. This will allow your constituents that live in more remote portions of the state to benefit from these new innovative services and help close the digital divide.

Question 4. I am concerned about reports that there is no intention of making the new ATSC 3.0 standard "backward compatible" with older television sets. Will viewers with older TVs still be able watch their favorite over-the-air channels after broadcasters switch to ATSC 3.0?

Answer. Next Gen TV is not backwards compatible with the current standard, meaning that current television sets cannot receive Next Gen TV signals without additional equipment. That is why broadcasters have proposed to protect consumers during the Next Gen TV deployment by partnering with other stations in their market to continue to transmit their programming in the current standard as well. This will ensure that every viewer maintains access to broadcast programming whether it through the current signal, or an ATSC 3.0 signal. Serving viewers is our business, and we have no interest in leaving viewers behind.

Question 5. The transition from analog to digital TV transmission forced consumers to either buy a digitally-compatible TV or a digital converter box to continue to watch over-the-air channels. The Digital Television Transition and Public Safety Act of 2005 (PL 109–171) authorized a TV Converter Box Coupon Program that provided up to two coupons worth $40 each to eligible households that wanted to continue to watch broadcast channels without buying a new TV. My understanding is that this $40 coupon covered the full cost of purchasing a converter box. Will there be an equivalent to a digital converter box available to TV viewers who have older TV sets that are not compatible with ATSC 3.0? If so, how much will it cost?

Answer. We anticipate that consumers interested in receiving Next Gen TV signals will have several options. These could include purchasing a new television set, a gateway device that will receive Next Gen TV signals over-the-air and transmit them on a consumer's home wireless network, or a small device that a consumer could plug into their existing television set. Consumers will also have the option to continue receiving broadcast programming through the current standard. At this point, it is too soon to predict pricing points for any of these options, and NAB is not advocating for a government subsidy to cover these costs.

Question 6. I am interested in learning your thoughts about how to craft spectrum policy that is "future proof." The United States Frequency Allocation Chart (available at *https://www.ntia.doc.gov/files/ntia/publications/january_2016_spectrum_wall_chart.pdf*) indicates that essentially all available spectrum has already been allocated. So the challenge today seems to be finding efficiencies and repurposing spectrum when new uses become important. How do we ensure that allocations

made today do not unintentionally prevent us from meeting spectrum needs in the future?

Answer. Broadcasters operate in only one spectrum band, and our innovation strategy contemplates doing more within that current capacity. While our competitors continue to seek more and more spectrum allocations in multiple bands, broadcaster innovations will enable the ability to do more with less. Next Gen TV allows broadcasters to make even more efficient use of their existing spectrum, providing customers with better service using the same 6 MHz channels stations use today. Encouraging this kind of innovation, without making overly prescriptive regulatory requirements a condition of permission to innovate, is the best way to future proof spectrum policy.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TOM UDALL TO TOM STROUP

Question 1. Do you have any suggestions for universal service reforms or other policy changes that would help expand broadband access in rural and remote areas where satellite providers can offer Internet access more affordably than cable, wireline and wireless providers?

Answer.

Satellite Industry Association [1,2]

Broadband Definition [3,4]

To begin, there are no real limitations on what broadband can become, and therefore, it is better to avoid rigid definitions at the early phase of deployment. Rather, it is more appropriate to define broadband in terms of evolving performance characteristics, based on the technologies and applications that consumers want and use, not fixed "top down" performance definitions. In the past, there has been a singular focus on "speed" as the sole factor that should define broadband (*e.g.,* Gigabit service). While this may be important for some applications, it may not be necessary at arbitrary levels for all essential applications or on all devices. Different speeds may be more suitable to different types of applications. Furthermore, the government should ensure that reforms or changes encourage the provision of enterprise broadband as well as consumer broadband. Enterprise broadband is heavily relied upon by U.S. businesses—including small business in rural and remote areas—that fuel the U.S. economy and provide a multitude of products and services available to U.S. consumers.

Other factors such as differentiated service or pricing models, data caps, service availability, jitter, bursting, symmetry, latency, mobility and portability may emerge to play a role in consumer broadband choice and requirements. Given a competitive market, those solutions that are most responsive to consumer needs and preferences should succeed, while those that do not respond to such needs and preferences are likely to fail. Universal service policies should reflect these preferences by embracing consumer choice not government preferences and should be structured to be technology neutral

---

[1] *SIA Executive Members include:* The Boeing Company; AT&T Services, Inc.; EchoStar Corporation; Intelsat S.A.; Iridium Communications Inc.; Kratos Defense & Security Solutions; Ligado Networks; Lockheed Martin Corporation; Northrop Grumman Corporation; OneWeb; SES Americom, Inc.; Space Exploration Technologies Corp.; SSL; and ViaSat, Inc. *SIA Associate Members include:* ABS U.S. Corp.; Artel, LLC; Blue Origin: DigitalGlobe Inc.; DataPath Inc.; DRS Technologies, Inc.; Eutelsat America Corp.; Global Eagle Entertainment; Glowlink Communications Technology, Inc.; Hughes; Inmarsat, Inc.; Kymeta Corporation; L–3 Electron Technologies, Inc.; O3b Limited; Panasonic Avionics Corporation; Planet; Semper Fortis Solutions; Spire Global Inc.; TeleCommunication Systems, Inc.; Telesat Canada; TrustComm, Inc.; Ultisat, Inc.; and XTAR, LLC.

[2] These proposals are supported by all SIA members except for AT&T, which abstains from participation.

[3] 47 CFR 8.2 (a) "*Broadband Internet access service.* A mass-market retail service by wire or radio that provides the capability to transmit data to and receive data from all or substantially all Internet endpoints, including any capabilities that are incidental to and enable the operation of the communications service, but excluding dial-up Internet access service. This term also encompasses any service that the Commission finds to be providing a functional equivalent of the service described in the previous sentence, or that is used to evade the protections set forth in this part."

[4] FCC 2016 Broadband Progress Report, FCC 16–6. Speed benchmarks are 25 Mbps download/3 Mbps upload (25 Mbps/3 Mbps) for fixed services and the report states that "the current record is insufficient to set an appropriate speed benchmark for mobile service."

Technology Neutrality [5]

Technology neutral funding is also important. Government funding decisions that favor one technology over another interfere with market forces, including investment and deployment decisions by the private sector. On the other hand, for areas that are truly difficult for the market to serve, the government should offer funding for the broadband providers that offer the best value for universal service dollars. This ensures that the American Universal Service Fund (USF) contributor gets the "most bang for the USF buck" and that broadband service reaches the most subscribers with the limited budget.

USF Portability

Another idea that has been around for a while is "portable consumer subsidies." Under this proposal, existing USF subsidies would belong to the consumer who would have the option of transferring to other broadband service providers and taking their subsidy with them. This would be similar to number portability for telephone service. This would introduce consumer choice in the process and open up competition for USF dollars, allowing the consumer to choose the service that is best suited for his or her needs rather than government mandated technologies.

Question 2. Could you address concerns that satellite Internet service providers do not currently offer fast download speeds with low latency that can match the offerings of wireline and wireless Internet service providers? Do you expect newer generations of satellites and other innovations to make satellite broadband more competitive with other types of ISPs?

Answer.

Today's Advanced High-Speed Satellite Broadband Networks

To borrow a phrase from a recent commercial campaign, today's satellite broadband service is not "your father's satellite broadband." Just as satellite TV and satellite radio took time to develop and become significant competitors in the video distribution and audio markets a decade ago, satellite broadband is becoming competitive in the broadband market. With base speeds on new high throughput broadband satellites reaching 25/3 Mbps and beyond for residential, aviation wi-fi, maritime and enterprise customers, to name a few, we are now seeing customers turn to satellite broadband as an alternative to DSL, cable, and, in some cases fiber, in urban and suburban markets as well as rural and remote areas. Up to one-third of satellite broadband customers are former cable or DSL subscribers.

The newer high throughput broadband satellite designs are allowing higher speeds and data volumes, as well as supporting more subscribers for both voice and data services. Keeping up with the trends of Internet traffic, today most of the demand (80 percent and growing) is for over-the-top video downloading (*e.g.,* Netflix, Hulu, YouTube). Very limited amounts of Internet traffic are latency-sensitive. Therefore, satellite broadband, that connects consumers directly into enterprise-level fiber, is often a better solution than existing terrestrial networks. In fact, experience shows that many consumers prefer satellite broadband over terrestrial solutions because of price, service, and the type of applications that they routinely use.

Future LEO/MEO Satellite Broadband Networks

In addition to today's advanced geostationary broadband satellite networks, there are new low earth orbit (LEO) and medium earth orbit (MEO) satellite systems under design and anticipated for launch and operation the next few years. Many of these systems will be able to offer low latency broadband that competes directly with terrestrial networks. They could also complement high throughput geostationary satellite networks, all making satellite broadband a viable alternative for consumers.

Appropriate Policy Choices Are Critical

In order to facilitate the full use of these advanced satellite broadband networks, policymakers need to make the right choices by allocating sufficient spectrum resources and not put the regulatory finger on the spectrum scale in favor of purely terrestrial wireless technology. Technology neutrality is also critical in the context

---

[5] Maxwell, Winston J. and Bourreau, Marc. "Technology Neutrality in Internet, Telecoms and Data Protection Regulation" *Computer and Telecommunications Law Review, Issue 1, 2015.* According to Maxwell and Bourreau, technology neutrality refers to a) where "technical standards designed to limit negative externalities (*e.g.,* radio interference, pollution, safety) should describe the result to be achieved, but should leave companies free to adopt whatever technology is most appropriate to achieve the result"; b) that "the same regulatory principles should apply regardless of the technology used."; and c) that "regulators should refrain from using regulations as a means to push the market toward a particular structure that the regulators consider optimal."

of making subsidy choices where the government must encourage competition among platforms. This will allow satellite broadband to flourish as a competitor to incumbent technologies, reducing the need for regulation, and increasing choices for American consumers, wherever they may choose to live and work.

Question 3. I am interested in learning your thoughts about how to craft spectrum policy that is "future proof." The United States Frequency Allocation Chart (available at *https://www.ntia.doc.gov/files/ntia/publications/january_2016_spectrum_wall_chart.pdf*) indicates that essentially all available spectrum has already been allocated. So the challenge today seems to be finding efficiencies and repurposing spectrum when new uses become important. How do we ensure that allocations made today do not unintentionally prevent us from meeting spectrum needs in the future?

Answer. It is critical that any spectrum policy adopted by the United States not favor one technology over another—either explicitly through one policy or implicitly through technical rules that by application advantage one over the other. There needs to be competition among competing platforms. Given the enormous investment costs of providing communications services—particularly satellite services—the expansion of one service should not come at the expense of another.

Today, in many cases, spectrum is shared among different, but compatible services and is being used efficiently by the satellite industry. The satellite industry has been sharing spectrum successfully for many decades—both in the context of coordinated use among satellite operators, but also with a number of non-satellite services, *e.g.,* fixed backhaul.

It is also critical to remember that there is a wide variety of spectrum needs for communications services other than those that meet individual consumer demand. For example, enterprise broadband, is relied on by small, medium, and large U.S. businesses through the 50 states, fuels the U.S. economic growth and provides a multitude of products/services available to U.S. consumers. Banking transactions rely on satellite communications services, as does the distribution of almost all video programming throughout the United States. Our military and first responders utilize commercial satellite broadband technologies for mission critical applications. As policy makers make spectrum allocations and licensing decisions, the broader needs of the country must also be considered and the impact of these decisions must be appropriately weighed.

Finally, it is critical to understand that spectrum "need" can also be met by innovation rather than solely by additional allocations. Because of changes in technology, the same amount of spectrum is often able to be used much more efficiently today than it was even a decade ago—enabling demand to be met through innovation.

While it may not be possible to future proof all allocation decisions, creating a regulatory environment that incentivizes and rewards innovation in spectrum compatibility with incumbent users and maintaining a technology neutral approach to the delivery of services in the United States will go a long way to ensuring that the U.S. leads both at home and abroad in technology and services.

○