

THE RACE TO 5G: A VIEW FROM THE FIELD

FIELD HEARING

BEFORE THE

COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

OCTOBER 12, 2018

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

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THE RACE TO 5G: A VIEW FROM THE FIELD

FRIDAY, OCTOBER 12, 2018

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Sioux Falls, SD.

The Committee met, pursuant to notice, at 3:08 p.m. CDT, at Carnegie Town Hall, 235 W. 10th Street, Sioux Falls, South Dakota, Hon. John Thune, Chairman of the Committee, presiding.

Present: Senator Thune [presiding].

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

The CHAIRMAN. Let me just say good afternoon and welcome to everybody and thank you for coming. Today, I've convened this hearing of the Senate Commerce Committee to explore ways to maintain global leadership in the race to 5G, while ensuring the benefits of remarkable new wireless technologies reach rural America.

Over the past two years, I have convened several hearings in Washington, D.C., aimed at identifying barriers to the deployment of next-generation services and what we can do in Congress to help lower them. I am pleased that today we will be able to discuss these very important issues right here in South Dakota.

I've heard from stakeholders throughout the country who represent American businesses that are on the ground building and maintaining our communications networks, deploying infrastructure, and bringing to market cutting edge technologies like autonomous vehicles, precision agriculture, and remote health care services that will transform our everyday lives.

We have also heard from the community and tribal leaders, small businesses, hospitals, schools, and everyday Americans that will benefit from this important technology.

The race to 5G has begun, and the United States has the technology to win it. But as I've said before, technology is only part of the equation. We must ensure that wireless providers have spectrum on which their systems can operate, and they must be able to deploy those networks in a reasonable and timely manner. The MOBILE NOW Act, which is a bill I authored last year, and it was enacted earlier this year, addressed both spectrum and infrastructure needs, but more work needs to be done.

In July, the Committee examined ways to free up more spectrum for 5G. I am pleased to see both the Federal Communications Commission and the National Telecommunications and Information Administration are taking critical steps this year to make more spec-

trum available for wireless use. And our Committee will continue to encourage innovative approaches to using spectrum more efficiently

Indeed, spectrum is critical to winning the race to 5G, but removing barriers to infrastructure deployment is the final piece of the puzzle. Earlier this year, I introduced a bill called the STREAMLINE Small Cell Deployment Act on a bipartisan basis with Senator Schatz. The STREAMLINE Act reflects more than a year of hard work with stakeholders, including many here today, to eliminate needless barriers to deploying 5G and to bring the benefits to American consumers. In fact, just last week we received a letter of support for the STREAMLINE Act signed by 25 groups representing a range of stakeholders from health care to agriculture, the automotive and manufacturing industries, Internet companies, consumer technologies, and more.

I am confident that our legislation will allow Americans across the country, no matter where they live, the ability to reap the benefits of 5G leadership while at the same time respecting the important role that State and local governments play in deployment decisions.

Additionally, I am very pleased that the FCC, as part of an effort led by Commissioner Carr, has just taken an important step to modernize its siting rules consistent with the goals of the STREAMLINE Act.

As Mayor TenHaken knows, making infrastructure siting easier is particularly important for those of us in rural America, where the business case for deployment is different than in larger metropolitan areas. Lowering deployment costs is especially important in more rural communities, where we simply don't have the population density to justify deployment if those barriers are high. Excessive fees, delays, and uncertainty can ruin the case for deployment of 5G for a community. I'm proud that our home state of South Dakota is leading the way in 5G.

Dr. Griffiths together with Dakota State University are training the young men and women who will design and protect our 5G networks and the services that they will offer.

Mayor TenHaken and Commissioner Carr are leading the way with their work to establish rules and policies that encourage 5G deployment.

And Justin Forde, from Midco; Mark Shlanta, from SDN Communications; and Robert Fisher, from Verizon; are working to deploy the 5G networks and related infrastructure that will bring South Dakota the next generation of wireless communications.

I want to thank all of you for being here today. I look forward to hearing from you, as well as an opportunity to enter into discussion as we get a chance to fully drill down on some of these issues and what we can do to bring 5G more quickly and more effectively here to South Dakota.

So I'm going to start on my left with Commissioner Carr, Brendan Carr, who, by the way, this is his second trip to South Dakota, and every time he comes out here, he goes and does things to enjoy the state. Today, he climbed a 2,000-foot tower, I'm told, so maybe he'll tell us about that. But I appreciate the interest that he has taken in the challenges of delivering these types of services

to rural areas of the country and his attempts to understand the unique needs and challenges that we have.

So we'll start with him and then move to the Mayor of Sioux Falls, the Honorable Paul TenHaken; Dr. José-Marie Griffiths, who is President of Dakota State University; Robert Fisher, who is Senior Vice President of Federal Government Relations for Verizon; and, as I said, Mr. Justin Forde, who is Senior Director of Government Relations at Midcontinent Communications; and then Mr. Mark Shlanta, who is Chief Executive Officer for SDN Communications.

It's great to have all of you here today. Thank you for being here.

And we'll start with Commissioner Carr. Please proceed. We look forward to hearing from you.

**STATEMENT OF HON. BRENDAN CARR, COMMISSIONER,
FEDERAL COMMUNICATIONS COMMISSION**

Commissioner CARR. Thank you, Chairman Thune, for the invitation to testify. It's great to be back with you in South Dakota for this field hearing on 5G and to join this distinguished group of witnesses. I can think of no better way to identify the barriers that slow down deployment and the steps we can take back in Washington to remove them, than spending time like this outside of D.C.

On my way here, I spent time in Minnesota, North Dakota, and South Dakota. I heard firsthand the challenges that broadband providers face in building next-gen networks in rural America. And I saw the grit and determination the telecom crews demonstrate in getting the job done. Whether it was Justin on top of an already snow-covered grain elevator in Thompson, North Dakota, that's now beaming broadband in a community of 1,000; or with Steve while he attached a new radio on a water tower in Shorewood, Minnesota, that's adding capacity to the network; or this morning with Amos and Mike on a 2,000-foot tower in Rowena, South Dakota; these visits underscore the work we need to do to make these jobs easier.

This week I also heard from the Great Plains innovators, job creators, and health care providers, that simply would not be operating in these communities without a broadband connection.

So this field hearing is important. It puts our shared goal for 5G front and center. We want every community in the country to see the economic opportunity that 5G can enable. Spectrum and infrastructure are key.

So I want to commend the Committee for leading on them. Chairman Thune championed the MOBILE NOW Act, which frees up the spectrum needed for next-gen services.

And I want to acknowledge both Chairman Thune and Senator Schatz for their work on the bipartisan STREAMLINE Small Cell Deployment Act, which would cut red tape that's been slowing down small cell deployments.

And at the FCC, we're building on the Committee's efforts. In the U.S., as you know, we're on the cusp of a major upgrade in wireless to 5G. The *Wall Street Journal* has called it transformative from an economic and technological perspective, and they're right. Winning the global race to 5G, seeing this new platform deployed in the U.S. first, is about our economic leadership for the next decade.

Those are the stakes. And here is how we know it. Think back 10 years ago when we were on the verge of upgrading from 3G to 4G. Think about the largest stocks, the biggest drivers of our economy. It was big banks and big oil. Now it's U.S.-based technology companies that have transformed our economy and our lives. Think about your own life. A decade ago, taking a road trip, like I've done this week, meant walking into your local AAA office, telling them the stops along your way and waiting for them to print out a TripTik booklet filled with maps that you'd unfold as you drove down the highway. Now an app lets you get real-time directions right on your phone.

American companies led the way in developing these 4G innovations. It is not by chance that the U.S. is the world's tech and innovation hub. We have the strongest wireless economy in the world because we won the race to 4G. And being first to 5G will matter even more. As Deloitte put it, "First-adopter countries . . . could sustain more than a decade of competitive advantage."

And, after all, we're not the only country that wants to be first to 5G. One of our biggest competitors is China. They view 5G as a chance to flip the script. They want to lead the tech sector for the next decade, and they're moving aggressively to deploy the infrastructure needed for 5G. Since 2015, China has deployed 350,000 cell sites. We've built fewer than 30,000. China is deploying 460 cell sites a day. That's 12 times our pace.

So we have to be honest about this infrastructure challenge. And from Congress, to the White House, to the FCC, to State and local leaders, we have a plan, and we're executing on it. For our part, the FCC is working to get the government out of the way so the private sector can construct the hundreds of thousands of new small cells needed for 5G.

In March, we excluded small cells from the costly review procedures designed for 100-foot towers. That decision cut \$1.5 billion in red tape, and one provider is now clearing small cells for construction at six times the pace as before. So we're making progress.

When I think about success, when I think about winning the race to 5G, the finish line isn't the moment we see next-gen deployments in New York or San Francisco; success can only be measured when all Americans have a fair shot at next-gen connectivity.

So just two weeks ago, the FCC took another step in the right direction. We built on the bipartisan ideas championed by Senators Thune and Schatz, as well as dozens of State and local leaders. We streamlined the local permitting process. That decision cut another \$2 billion in red tape, will stimulate \$2.4 billion in new small cell deployments, 97 percent of which will be in rural and suburban communities, and we can accelerate that progress with the commonsense ideas contained in the STREAMLINE Small Cell Deployment Act. Doing so would represent another solid win for the U.S. in the race to 5G.

So, Chairman Thune, thank you again for holding this hearing. I look forward to hearing from the other witnesses, and welcome your questions.

[The prepared statement of Commissioner Carr follows:]

PREPARED STATEMENT OF BRENDAN CARR, COMMISSIONER,
FEDERAL COMMUNICATIONS COMMISSION

Chairman Thune, thank you for the invitation to testify. It is great to be back with you in South Dakota. I want to commend you and the Committee for holding this field hearing on 5G. Spending time like this outside of D.C.—hearing directly from community leaders and broadband providers alike—is critical. I can think of no better way to identify both the regulatory barriers that needlessly slow down broadband deployment and the steps we can take back in Washington to remove them. And this field hearing helps put our shared goal for 5G front and center: We want every community in the country, from New York to Yankton, to see the economic opportunity that broadband enables.

As this hearing makes clear, spectrum and infrastructure are key for 5G. So I want to start by commending the Committee for leading on these two issues. Chairman Thune championed the MOBILE NOW Act, which frees up the spectrum necessary for next-generation wireless service. And on the infrastructure side, I want to acknowledge both Chairman Thune and Senator Schatz for their work on the bipartisan STREAMLINE Small Cell Deployment Act. This bill would update our Nation’s infrastructure policies by cutting the red tape that threatens the deployment of 5G networks. At the FCC, we are building on your efforts, and we recognize that the time to act is now.

In the U.S., we are on the cusp of a major upgrade in wireless to 5G. The WALL STREET JOURNAL has called it transformative from a technological and economic perspective. And they’re right. Winning the global race to 5G—seeing this new platform deployed in the U.S. first—is about economic leadership for the next decade. Those are the stakes, and here’s how we know it.

Think back ten years ago when we were on the verge of upgrading from 3G to 4G. Think about the largest stocks and some of the biggest drivers of our economy. It was big banks and big oil. Fast forward to today: U.S.-based technology companies, from FAANG (Facebook, Apple, Amazon, Netflix, and Google) down to the latest startup, have transformed our economy and our lives.

Think about your own life. A decade ago, catching a ride across town involved calling a phone number, waiting 20 minutes for a cab to arrive, and paying rates that were inaccessible to many people. Today, we have Lyft, Uber, Via, and other options.

A decade ago, sending money meant going to a brick-and-mortar bank, standing in that rope line, getting frustrated when that pen leashed to the table was out of ink (again!), and ultimately conducting your transaction with a teller. Now, with Square, Venmo, and other apps you can send money or deposit checks from anywhere, 24 hours a day.

A decade ago, taking a road trip across the country meant walking into your local AAA office, telling them the stops along your way, and waiting for them to print out a TripTik booklet filled with maps that you would unfold as you drove down the highway. Now, with Google Maps and other apps you get real-time updates and directions right on your smartphone (Otherwise, there’s little doubt that I’d still be lost in Yankton instead of speaking to you today).

American companies led the way in developing these 4G innovations. And it’s not by chance or luck that the United States is the world’s tech and innovation hub. We have the strongest wireless economy in the world because we won the race to 4G. No country had faster 4G deployment and more intense investment than we did. Winning the race to 4G added \$100 billion to our GDP. It led to \$125 billion in revenue for U.S. companies that could have gone abroad. It grew wireless jobs in the U.S. by 84 percent. And our world-leading 4G networks now support today’s \$950 billion app economy.

That history should remind policymakers at all levels of government exactly what is at stake. 5G is about our leadership for the next decade.

And being first matters. It determines whether capital will flow here, whether innovators will start their new businesses here, and whether the economy that benefits is the one here. Or as Deloitte put it: “First-adopter countries. . . could sustain more than a decade of competitive advantage.”

After all, we’re not the only country that wants to be first to 5G. One of our biggest competitors is China. They view 5G as a chance to flip the script. They want to lead the tech sector for the next decade. And they are moving aggressively to deploy the infrastructure needed for 5G.

Since 2015, China has deployed 350,000 cell sites. We’ve built fewer than 30,000. China is deploying 460 cell sites a day. That is twelve times our pace. China now has 1.9 million cell sites. We have around two to three hundred thousand. Put differently, China has more than 13 times the number of cell sites per mile as the U.S.

We have to be honest about this infrastructure challenge and show the courage to act.

From Congress, to the FCC, to the White House, we take this challenge seriously. The U.S. has a plan, and we're executing on it. For our part, the FCC is working to get the government out of the way, so that the private sector can construct the hundreds of thousands of new cell sites needed for 5G in this country.

In March, we updated Federal historic and environmental reviews to reflect new, 5G technology. While the old rules were written for 200-foot towers with large footprints, the majority of wireless infrastructure being built today is made up of small cells, often the size of a backpack. Requiring every new small cell to go through the lengthy and costly review designed for 200-foot towers was like requiring a commercial pilot's license to fly a paper airplane. The outdated reviews were not providing any real benefit to Americans. And they had real costs—in both dollar figures and in the race to 5G.

For evidence of the problem, look no further than last year's Super Bowl, which was played at NRG stadium in Houston. The construction of the stadium itself, including the parking lot, did not involve any Federal historic review. But when a wireless provider tried to build 23 small cells on the stadium and on poles in the parking lot so that fans could send pictures and videos from the Big Game, our old approach required historic preservation review for those backpack-sized antennas. In the end, one wireless provider paid nearly \$180,000 in historic review fees to attach small equipment onto the massive concrete stadium and parking lot.

Unfortunately, that was not an isolated incident. Twelve thousand dollars for reviewing a small cell outside a steel factory in East Chicago, Indiana. Another twelve thousand dollars for reviewing a small cell placed between a sidewalk and a highway in Ohio. A million dollars for reviewing small cell nodes in Atlanta. The fees were pointless, increasing, and draining the limited capital needed to deploy broadband and 5G in communities across the country.

So the FCC stepped in to fix that broken Federal review process. Given their much smaller size and footprint compared to large towers, we held that small cells should not go through the costly and lengthy reviews designed for 200-foot towers. And we're already seeing results. That decision cut \$1.5 billion in red tape, and one provider reports that it is now clearing small cells for construction at six times the pace as before.

So we're making progress. But hurdles remain. We've heard from dozens of mayors, local officials, and state lawmakers—including officials right here in South Dakota—who get what 5G means. They understand the economic opportunity that comes with next-gen networks. But they worry that the billions in investment needed to deploy these networks will be consumed by the high fees and long delays imposed by big, "must-serve" cities. They worry that, without Federal action, they may not see 5G. I'd like to read from a few of the many comments I've received over the last few months.

Duane Ankney is a retired coal miner from Montana, a Member of the Montana State Legislature, and chair of its Energy and Telecommunications Committee. He writes: "Where I see the problem is, that most of investment capital is spent in the larger urban areas. This is primarily due to the high regulatory cost and the cost recovery [that] can be made in those areas. This leaves the rural areas out."

Mary Whisenand, an Iowa commissioner, writes: "With 99 counties in Iowa, we understand the need to streamline the network buildout process so it's not just the big cities that get 5G but also our small towns. If companies are tied up with delays and high fees, it's going to take that much longer for each and every Iowan to see the next generation of connectivity."

Ashton Hayward, the Mayor of Pensacola, Florida, writes: "[E]xcessive and arbitrary fees . . . result[] in nothing more than telecom providers being required to spend limited investment dollars on fees as opposed to spending those limited resources on the type of high-speed infrastructure that is so important in our community."

And the entire board of commissioners from a more rural area in Michigan writes: "Smaller communities such as those located in St. Clair County would benefit by having the [FCC] reduce the costly and unnecessary fees that some larger communities place on small cells as a condition of deployment. These fees, wholly disproportionate to any cost, put communities like ours at an unfair disadvantage. By making small cell deployment less expensive, the FCC will send a clear message that all communities, regardless of size, should share in the benefits of this crucial new technology."

They're right. When I think about success—when I think about winning the race to 5G—the finish line is not the moment we see next-gen deployments in New York

or San Francisco. Success can only be achieved when all Americans, no matter where they live, have a fair shot at next-gen connectivity.

So just two weeks ago, we built on the many smart infrastructure policies championed by state and local leaders. We ensured that every city is compensated for its costs in reviewing and approving small cell deployments, while putting guardrails in place to address excessive fees. We updated the shot clocks that have long applied to local reviews to account for the lower impact of new small cell deployments. And we ensured that local governments can take reasonable aesthetic considerations into account when reviewing deployments. After all, it is these local leaders—not FCC commissioners—that will get pulled aside at their grocery store or post office if a provider puts up an ugly small cell.

This was a balanced approach that will help speed the deployment of 5G. It will cut \$2 billion in red tape. To put that in perspective, that's about \$8,000 in savings per small cell—on top of the \$10,000 in savings from our March decision on Federal historic reviews. Cutting these costs changes the prospects for communities that might otherwise get left behind. It will stimulate \$2.4 billion in new small cell deployments. And, importantly, that new investment is enough to cover 1.8 million more homes and businesses with 5G—97 percent of which are in rural and suburban communities. That means more broadband for more Americans.

So I am pleased with the progress we're making. But there is more work ahead. The commonsense ideas contained in the STREAMLINE Small Cell Deployment Act would solidify the progress we've made while further simplifying the process governing the construction of next-gen networks. It would represent another solid win for the U.S. in the race to 5G.

Chairman Thune, thank you again for holding this hearing and for the invitation to testify. I welcome your questions.

The CHAIRMAN. Thank you, Commissioner Carr. Again thank you for the time you've invested in understanding South Dakota, what our needs are, and for everything you're doing on the FCC. I couldn't applaud more the steps that you and your fellow Commissioners have taken in this to prepare and get us ready to win that race.

Mayor TenHaken, who is a tech entrepreneur as well, so understands these things really well and is working aggressively I know here in the City of Sioux Falls to do everything possible to help speed up and enable us to take full advantage of some of these technologies. So thank you for the leadership that you're taking, and I look forward to hearing from you.

**STATEMENT OF HON. PAUL TENHAKEN, MAYOR,
CITY OF SIOUX FALLS**

Mr. TENHAKEN. Thank you.

Chairman Thune, thank you for holding this hearing today in what you already know as the greatest city in the world, Sioux Falls, South Dakota.

I appreciate the opportunity to address you today on the importance of Internet connectivity in Sioux Falls and how fifth generation of Internet connectivity is incredibly important to South Dakota and to the Upper Midwest.

Sioux Falls is a growing city in the heart of America. Continued investment in connectivity like 5G helps ensure that South Dakota remains a technological player in the national and international market.

With the dawn of the digital age and Internet, we've seen a new wave of business fueled by entrepreneurs, like myself. In 2008, I founded the marketing technology firm Click Rain here in Sioux Falls. Thanks to the explosive growth of the Internet and digital commerce, our company quickly found our way onto the Inc 5000

list 5 years in a row as one of America's fastest growing private companies, and soon became one of the largest marketing technology firms in the Upper Midwest. My background in this space gives me a heightened level of interest and expertise on the subject, of which I am quite passionate about.

Today, nearly every sector of Sioux Falls' economy counts on a fast and reliable Internet connection. Organizations like Avera Health are operating one of the most robust eCARE backends in the country, right here in Sioux Falls. CarsForSale.com is a dot-com success story that has created hundreds of jobs here in Sioux Falls. DocuTAP, just up the street, provides hundreds of tech careers delivering EMR software to urgent care clinics all over the world. The common thread of success amongst all these companies: fast, reliable connectivity.

As the United States strives to be one of the first nations with a fully functional 5G network, the city of Sioux Falls strives to be the first mid-market city with a 5G infrastructure. Right now, wireless carriers are negotiating small cell tower location review fees and easement fees with local governments to install 5G infrastructure, and that's happening right here in Sioux Falls.

As Mayor, it's not my intent to profit off carriers to deploy 5G infrastructure. We seek fair and reasonable compensation for city staff time to review applications from carriers. And, in turn, we offer a reasonable time-frame to approve or deny these applications, or work with the carrier on an alternative site. Last, we want easement fees that cover the inflationary costs we incur with carriers locating their technology on our city assets. It's a very basic ask: make the city whole on our costs to review and house the infrastructure that carriers need to deliver this connectivity.

It is critical that Federal regulations protect local governments and allow them to set reasonable fees that cover costs. Giving carriers authority to set fees that are unfair to local governments is, in essence, an unfunded Federal mandate that will cost local governments tens of millions of dollars when you consider the thousands and thousands of small cells that will be deployed across the Nation in the coming years.

5G plays a pivotal role in the future of economic development, workforce development, and innovation in this city. For autonomous vehicles to be safe and viable, we need 5G. For enhanced public safety with high-definition feeds for police officer cameras, we need 5G. The opportunities 5G brings to our community are endless, and I look forward to working with this Committee, the FCC, and the carriers to successfully and expeditiously deploy 5G in Sioux Falls.

So in closing, I want to thank Chairman Thune for your leadership in this area. Your vision for streamlining 5G deployment across the U.S. that is fair to communities, consumers, and carriers is a step in the right direction.

I am excited to foster and support 5G in Sioux Falls as we seek to grow our technological footprint in this city and remove unnecessary barriers for entry for this critical infrastructure. We're ready to help you lead this effort.

Thank you.

[The prepared statement of Mr. TenHaken follows:]

PREPARED STATEMENT OF PAUL TENHAKEN, MAYOR,
CITY OF SIOUX FALLS, SOUTH DAKOTA

Chairman Thune, thank you for holding this and hearing, and welcome to the great City of Sioux Falls, South Dakota. I appreciate the opportunity to address you today on the importance of Internet connectivity in Sioux Falls and how the fifth generation of Internet connectivity is incredibly important to South Dakota and the Upper Midwest.

Sioux Falls was incorporated in 1876, around the same time in history when communication in the United States was transformed by the telegraph system, and the same year Alexander Graham Bell sent the first human voice over an electric telegraph wire. Fast forward to today, Sioux Falls is a growing city in the heart of America. Our geographic distance from larger cities is immaterial for access information and communication. Today, the city and its citizens are data-driven, we are information creators and consumers, and we are mobile in a global economy. South Dakotans can work remotely for any global company, talk with clients around the world and read news from Washington, D.C., and other capitols throughout the world. Continued investment in connectivity, like 5G, helps ensure that South Dakota is a member of the national and international market.

With the dawn of the digital age and the internet, once again, communication and information channels were revolutionized for rural America, and birthed new businesses and fueled entrepreneurs, like myself. In 2008, I founded the marketing technology firm, Click Rain, in Sioux Falls. Thanks to the explosive growth of the Internet and digital commerce, our company quickly became our way onto the Inc 5000 list for five straight years as one of America's Fastest Growing Private Companies and one of the largest marketing technology firms in the Upper Midwest.

Today, nearly every sector of Sioux Falls' economy relies on a fast and reliable Internet connection. As an essential part of personal and professional life, our mobile devices and the infrastructure supporting the connection of these devices is an economic and quality of life driver for Sioux Falls, South Dakota and the entire region. Organizations like Avera Health are operating one of the most robust eCARE backends in the country, right here in Sioux Falls. CarsForSale.com is a dot-com success story that has created hundreds of jobs in Sioux Falls. DocuTAP provides EMR software to urgent care clinics across the globe. The common thread of success amongst all these companies: fast, reliable connectivity.

In particular, the future of telemedicine from providers like Avera will be revolutionized as the prevalence of 5G grows. Avera's eCARE launched in 1993 focused on telemedicine care, and today it provides a wide continuum of care including emergency, ICU, pharmacy, senior care and behavioral health. This team has touched 1.4 million patients across 18 states and has saved \$200 million in health care dollars over the past 25 years. 5G will no doubt increase the capability of patients to receive care from wherever they have access to a computer, tablet or phone.

Imagine the ability of a doctor in Sioux Falls to consult with a doctor and patient in Pierre while sharing a 3D CAT scan that is several gigabytes in size and at a 4K resolution. Traditional connections today would prohibit that type of communication on a routine or on demand basis and require that same patient to travel to Sioux Falls to see the Sioux Falls Specialist and the 4k 3D image. 5G technology would allow this interaction to occur in milliseconds. This technology could also provide telemedicine for simple and complex medical needs from a patient's home or in an ambulance while being transported to the nearest hospital. The potential is great and the benefits are tremendous.

The deployment of 5G is of great importance to the continued evolution of connecting rural America to the rest of the world. As the United States strives to be the first nation with a fully functional 5G network, the City of Sioux Falls strives to be the first mid-market city with 5G infrastructure.

Right now, wireless carriers are negotiating small-cell tower location review fees and easement fees with local governments to install 5G infrastructure, cities with outdated ordinances are faced with updating regulations that allow small cell towers.

As mayor, it is not my intent to profit off carriers to deploy 5G infrastructure. We seek fair and reasonable compensation for city staff time to review applications from carriers. In kind, we offer a reasonable time frame to approve or deny applications, or work with the carrier on an alternative site. Lastly, we want easement fees that covers the inflationary costs we incur with carriers locating their technology on city assets. It's a very basic ask—make the city whole on our costs to review and house the infrastructure you need to earn your profits.

Recent guidance from the Federal Communications Commission and the proposed legislation before this Committee seeks to standardize negotiations for cities and

carriers, and in many cases is aligned with my philosophy of rapid deployment in Sioux Falls. It is critical that Federal regulations protect local governments and allow them to set reasonable fees that cover costs. Giving carriers authority to set fees that are unfair to local governments is in essence an unfunded Federal mandate that will cost local governments tens of millions of dollars when you consider the thousands of small cells that will be deployed across the Nation in the coming years.

Cutting-edge technology, innovation, forward thinking and proactive planning are crucial to preparing Sioux Falls and the region for quality of life improvements driven by technology advancements, and 5G plays a pivotal role in the equation. For autonomous vehicles to be viable, we need 5G. For enhanced public safety with high-definition feeds for police officer body cameras and surveillance equipment, we need 5G. The opportunities 5G brings to our community are endless, and I look forward to working with this Committee, the FCC and carriers to successfully and expeditiously deploy 5G in Sioux Falls.

In closing, I want to thank Chairman Thune's leadership in his area. His vision for streamlined 5G deployment across the United States that is fair to communities, consumers and carriers is a step in the right direction. The Chairman understands the importance of connecting rural states with the rest of the world as well as the economic opportunities 5G offers to states like South Dakota. I am excited to foster and support 5G in Sioux Falls as we seek to grow our technological footprint and remove unnecessary barriers to entry for this critical infrastructure.

The CHAIRMAN. Thank you, Mayor. Again thank you for everything you're doing, and the bold vision that you've articulated for Sioux Falls. I hope it can be replicated all across our state and across our country. It's moving the ball in the right direction, and the sky is the limit in terms of what we can do, but it takes the right kind of leadership. So thank you.

Dr. José-Marie Griffiths, is the, as I said, President of Dakota State University. I think everybody is well aware of the terrific work that she and Dakota State University are doing in cybersecurity, and the young, bright, talented people that they are producing that are leading the way on a lot of these technological fronts. So thank you for being here, and I look forward to hearing from you.

**STATEMENT OF DR. JOSÉ-MARIE GRIFFITHS, PRESIDENT,
DAKOTA STATE UNIVERSITY**

Dr. GRIFFITHS. Thank you, Chairman Thune, for the opportunity to testify today on this important topic of next-generation communications infrastructure, services, and applications. I'm especially pleased that you chose to hold this hearing in Sioux Falls, South Dakota, not only because it brings you home, Senator, but because I strongly believe that South Dakota represents the 68 percent of country's "tweener" population that live between the East Coast and the West Coast.

I'm passionate about ensuring that more than two-thirds of the country are not bypassed by the next technological revolution along with its need to connect not just the last mile, but what one of my colleagues calls the "last inch."

I believe the best way to address the three issues that you asked of us is to start with a coordinated effort to develop widespread understanding and knowledge of what 5G and the cyber universe, what I call the Cyberverses, are and why they're so important to the economic health, security, and quality of life for the United States in both the near—and far-term future.

As impressive as today's Internet is, it's clear that our present telecommunications and cyber environment have major problems

with limited bandwidth, unacceptably long latency, slow speeds, and inadequate reliability, inappropriate dependencies on users for security and maintenance, and interoperability chaos.

At the same time as we're hitting a brick wall with our existing technology and networking approach, users are increasingly demanding far more than simply access to information. The complex problems of our 21st century world require a more complex and fluid ecosystem of participants, machine and human. People don't want to just access or give information, they want to interact with it, to be immersed in the process of its creation as much as its use, analysis, extension and dissemination. And they don't just need to interact with it by themselves, they need to collaborate with multiple others in a 3-dimensional environment where they can tap into people-to-people, machine-to-machine, and people-to-machine interactions, more like an ocean than a highway.

I believe to make the greatest progress most rapidly, we should create a public-private partnership to build and deploy a real-world 5G and Cyberverses testbed. Two years ago, Dakota State University developed the idea of South Dakota 5G, we call it SD5G, as one, if not the first, 5G ready straight. We believe that our state has the characteristics and resources that make it the ideal place for such a project. We're eager to move forward to create for the Nation a model of how to address the various challenges of this transformative approach to the delivery and use of technology.

South Dakota is a geographic area in the United States that contains a cross-section of the types of population clusters and organizations, geography, climate, industries, and existing technologies to explore, troubleshoot, and establish best practice models for the technology, as well as for the policies and governance required to support 5G deployment and development across the country.

Those who think of South Dakota as home to vast farms on the plains, buffalo and cattle ranches stretched across the buttes, and the lifestyle of "Little House on the Prairie" and Native American heritage should be aware that these days the state is also home to impressively sophisticated technology development and cyber innovation. Silicon Valley or Boston's metropolis are rapidly being matched by a technology revolution in the center of the United States. DSU cybersecurity and Raven's Loon system are matched by multiple enterprises across South Dakota working at the vanguard of precision agriculture, cutting-edge and distance-delivery health care, and robotic manufacturing, among others. To develop and deploy these new technologies in a manner consistent with the country's democratic values and concerns, we must engage cybersecurity professionals in every aspect of this testbed.

With great power comes great responsibility, and that's never been more true than with the development and deployment of 5G and migration into the Cyberverses. 5G is what will make it possible for us to move into the Internet of Everything; however, every time we connect a new device to the network, we also potentially open up a new set of vulnerabilities. The U.S. is sorely lacking right now in standards and best practices for security to build into Internet of Everything devices or the software that can easily be installed as part of the basic features of any device.

The U.S. is presently seriously underresourced in cybersecurity professionals, and the vast majority of cybersecurity professionals that we do have are overextended, working to mitigate and remediate existing Internet attacks, which multiple faster than the proverbial rabbits. However, it's critical that the U.S. ensure that a network upon which every activity in this country is dependent is developed in such a way that vulnerabilities are reduced as much as possible and that the U.S.'s 5G and Cybaverse cybersecurity expertise proceeds in step with the development of our national 5G networking capability. And this is one area that's of such common concern and serves every individual and enterprise in the country that it would be appropriate and maybe necessary for the Federal Government to help provide the upfront investment in the recruitment, education, and deployment of cybersecurity professionals in 5G development.

5G and the resulting Cybaverse are a common good whose availability and operability will be critical to every endeavor across the United States. As such, it's important that the Federal Government provide leadership and corral support for those efforts that will move development and deployment of this vital national resource.

It's also the case that we'll only have one chance to do this first. According to a study released by Deloitte Consulting, the United States is losing the race against China to develop and deploy a nationwide 5G network. And there's more at stake here than just prestige. The National Security Agency has stated that if China dominates the telecommunications network industry, it will win politically, economically, and militarily.

In addition to the concerns of national security, there's no question that the first country to effectively deploy 5G will also reap enormous macroeconomic gains. The first to deploy 5G in the Cybaverse in a real-world setting will also be the country to understand the strengths, weaknesses, opportunities, and threats related to the new technology.

The United States was the first country to develop and implement the comprehensive Internet, initially building on the foundation and integrating multiple federally developed networks. The results have been clear and impressive. Despite all of the concerns about cybersecurity issues and technology dependencies, there is no question that the United States' lead in developing and deploying the Internet has had profound economic and societal impacts. There is a need once again for the Federal Government to step forward and take the lead in investment and organizational support for the development and deployment of 5G and the Cybaverse.

In summary, we need a coordinated effort to develop widespread understanding of the benefits and implications of 5G capabilities accompanied by the creation of a public-private partnership to build and deploy real-world 5G Cybaverse testbed, preferably across South Dakota—of course, I'm biased now—and engage cyber professionals in all aspects of testbed development and deployment.

Thank you for your attention.

[The prepared statement of Dr. Griffiths follows:]

PREPARED STATEMENT OF DR. JOSÉ-MARIE GRIFFITHS, PRESIDENT,
DAKOTA STATE UNIVERSITY

5G NETWORKING—FROM THE INTERNET TO THE CYBER UNIVERSE—THE CYBERVERSE
FROM THE INFORMATION SUPERHIGHWAY TO AN OCEAN OF COLLABORATIONS

A SHIFT FROM DRIVING DATA LOCATION TO LOCATION TO LIVING, WORKING, AND PLAYING IN AN ENVIRONMENT OF TECHNOLOGY-INFUSED INTERACTIONS AND COLLABORATIONS

INTRODUCTION

This hearing is asking those of us testifying to address three topics:

- 1) Existing barriers to broadband deployment on the horizon of next generation wireless technology deployment,
- 2) ways to encourage investment in next generation communications services, and
- 3) ways to streamline broadband deployment siting.

I believe the best way to address all three of these issues is as follows:

- 1) Invest the resources necessary to *build widespread understanding and knowledge* of what 5G and the Cyber Universe are and why they are so important to the economy, security, and quality of life for the United States in both the near and far future;
- 2) *Engage cyber security professionals* in every aspect, from the ground up, of the creation of a 5G and Cyber Universe testbed such that the model U.S. 5G environment is not only effective and efficient, it is also safe and ensures the privacy and democratic values to which we in the U.S. are committed; and
- 3) *Rapidly create a publicly/privately-funded partnership to build and deploy a real-world 5G and Cyberverses testbed* across a geographic area in the U.S. that contains a cross-section of U.S. population clusters and organizations, geography, climate, industries, and existing technologies, to explore, troubleshoot, and establish best-practice models for the technology as well as the policies and governance required to support 5G development and deployment across the country.

I. BUILDING KNOWLEDGE AND UNDERSTANDING OF 5G AND THE NEW CYBER UNIVERSE—What are 5G and the Cyberverses and why should anyone care?

In order to build widespread understanding and knowledge of what 5G is and why it is so important to the economy, security, and quality of life for the United States and its citizens in both the near and far future, we must first be clear about what is 5G and what is the new Cyber Universe—the Cyberverses—it will enable.

We have become accustomed to our technology becoming, ever rapidly, faster and more capable. We understand that most of our computers or smart phones or networks have a half-life shorter than most pro football coaches (their average is about 3 years). It's hard to be excited or very energized by—or put a lot of investment into—some new technology that we anticipate will lose its “wow” factor predictably and soon. The “yawn factor” runs deep these days in the general public's—and even much of leadership's—reaction to calls from techies to embrace yet another supposed new breakthrough technology with some new strange name, like “5G and the “Cyberverses.”

5G is NOT just another iteration of what has come before. In reality, calling 5G the fifth generation, just as 1G was first generation, 2G was second generation, etc. is a misnomer. 5G is a totally new and radical approach, not just to telecommunications and networking, but to how we live, work, and play in the cyber universe.

A) THERE IS TROUBLE ON THE INFORMATION SUPERHIGHWAY

As amazing as the Internet is, there is trouble on the Information Superhighway. We are facing multiple problems in our present cyber environment, including availability/capacity, reliability, speed, responsiveness, interoperability, security, energy efficiency, expandability, and the flexibility to support the complex problem-solving processes that the complex problems of the 21st century require.

i) Travel on the Internet is not optional—network connectivity and technology access are essential community goods

Today, the technology an organization uses—and how effectively it uses it—is just as essential to its success as its reason for existence—the service or product it generates. There is really no significant activity in this country that does not

depend heavily, and often for its very existence, on technology, telecommunications, and computer networking. From finance to agriculture to manufacturing to healthcare to government to entertainment, the cogs of our modern society move by the power of cyber.

All this cyber use means that the traffic on the Information Superhighway is increasing at a rate that is difficult to grasp. According to a study by Cisco, Internet traffic is on target to increase by 25 percent every year between 2016 and 2021. We are also on trend that by 2021 the number of devices connected to IP networks will be more than three times the global population, at the equivalent/per capita of 3.5 networked devices for every man, woman, and child on the planet. Between 2016 and 2021 we will have added 10 billion devices online, from 17.1 billion in 2016 to 27.1 billion in 2021. It would take more than 5 million years for one person to watch the amount of video that will cross global IP networks each *month* in 2021.¹

ii) Traffic jams are increasingly common—capacity constraints are creating availability, reliability, speed, and responsiveness problems

All this traffic is causing global-sized traffic jams. The bottom line is that we don't have enough lanes on the Information Superhighway to accommodate everyone and everything that wants to use it. And we don't have enough available real estate on the present routes, *i.e.*, the presently used radio spectrum bands, to add more lanes, technically called bandwidth. The result is the cyber world matches L.A. traffic at rush hour in the physical world. And without the required capacity on the Highway, availability, reliability, speed, and responsiveness fall off exponentially.

Practically, at the busiest times of the day cyber users may find that they are totally unable to even get on the Internet—there are simply no lanes available for them, there is no more bandwidth available for their transmissions. We have all had the experience of watching the spinning ball on our monitors with increasing frustration as we try to get on the virtual Highway. If the traffic jam and lack of bandwidth is really bad, the system may just give up trying. An error message will pop up on our screens saying that the connection “timed out” and we have to click our mouse or enter a command to try afresh to connect. Once we do connect, depending on how our connection is routed, if we hit a place where the traffic overwhelms the available lanes, the available bandwidth, we may be knocked off the virtual highway altogether and, from our virtual ‘ditch,’ have to try yet again to get back on the highway into a lane.

All this congestion means that we cannot rely on how long any transmission will take. Latency, the delay between an action taken on my computer and being received at another device, is critical in more and more applications. In the early days of the Internet, trying to ‘crystal ball’ the future, developers attempted to guess at what might be possible if we had this ubiquitous resource to move information around. At the outer edges of that imagining, people suggested things like remote surgery with a physician able to operate robots in an operating room in a rural area, providing life-saving care to patients who do not have access to that specialized surgeon's skill and expertise. They envisioned collaborations involving real-time meetings with hundreds of thousands of people interacting with each other using the same application on their various devices, all at one time, for example following a natural disaster or in a military operation. The reality is that we do now have the technology to do these tasks and many more. However, the increasingly crowded bandwidth of the Internet and the resulting traffic jams not only impact availability and reliability, speed and responsiveness have also deteriorated. The movement of the surgeon's hand tying off a bleeding blood vessel must be transmitted in milliseconds to the robot device actually carrying out the action inside the patient's body. Network latency cannot be an issue.

And the amount of information to be transmitted is more and more extensive and detailed, which also is going to require more lanes of the highway. A less dramatic but economically significant example is with supply chain management. U.S. manufacturers are dependent on supplies coming from around the world on a predictable schedule. Being able to prepare for a shortage, for example, of the raw materials to make a car's dashboard, can save or cost an automaker thousands of dollars, enabling them to shut down or repurpose a factory line. It's not enough for the ship carrying those materials to have a system with

¹ <https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/vni-hyperconnectivity-wp.html>

sensors that lets the captain know that a part has broken down inside the engine. Now it is possible and economically necessary for that engine to have sensors that can predict that a part is close to breaking down, which sends a message to a system that figures out when it will fail entirely, which then sends back a message to shut down the engine to save damage to other parts while sending an alert to the repairman as to what needs to be fixed and, simultaneously, notifying a supplier thousands of miles away and multiple steps down the supply chain that the car dashboard factory line is not going to have the parts on time. This scenario is entirely possible, but the present telecommunications system does not have the bandwidth to accommodate this and the other millions of scenarios in multiple industries.

iii) Too many people have keys—and they’re all different—maintenance, security, and interoperability in the present technology environment are dependent on millions of (non-techie) people being technologically savvy and responsible

We are also now struggling with a high level of technology knowledge required of even the most casual user. It’s one thing when you only have very smart technology people using the network and sharing information. It is another thing when you have millions of people doing that, an enormous number of whom have no interest or ability to, for example, keep their passwords private and change them often, or upgrade software on their multiple devices every time another security vulnerability is identified or a company has decided to upgrade or expand the features available in their applications. In addition, the responsibility for getting all of our various devices connected to the Information Superhighway falls on each of us individually. And often the way to do so is different for each device—smartphone, computer, tablet, gaming console, etc.

In addition, I think most of us without thinking about it, have all taken on an enormous time-drain of overhead in obtain, maintain, and use our ever-increasing number of devices—a smartphone, a tablet, a laptop computer, a desktop computer, now rapidly being joined by a TV, various kitchen appliances and/or a smart speaker like Alexa. There is at present a serious contrast between, for example, electricity and technology networking.

Electricity is generally pretty invisible. Except when it goes out, most of us, I don’t believe, spend much time thinking or dealing with electricity. We push a light switch—in our kitchen, in our office, in the restroom at the restaurant—the electricity connects and the light goes on.

This is not the case with our “smart” phones. In order for my phone to work in my kitchen, I have a cable coming into my house connected to a cable modem, which I have to set up with a user name and a password. If the network goes down or becomes disconnected, I will have to reset and re-enter the cable modem user name and password.

The cable modem talks to a Wi-Fi router sitting on a bookshelf in my living room, which also has a network name and password. When the cat knocks that device over and it becomes unplugged, I will also have to plug it back in and re-enter that network name and password. When I brought my cell phone home for the first time (or when I get a new one) I have to go into settings on that phone, have it find my home network (out of an amusing list of network names of my neighbors’ Wi-Fi networks), and use the correct user id and password to get it connected to my Wi-Fi and, ultimately, to the Internet, where I likely also have to use various different user ids and passwords to get into various sites to access any information I might have online, like my bank account, or be able to purchase something from an online store.

Going to check my balance in my bank account first thing in the morning, I discover that the before-school teen crowd in my neighborhood has taken over the network bandwidth to check in with their friends as to what they’re going to wear that day. It takes so long for my typed-in request to get to the bank website that they consider I’ve been on my account so long that it’s a security risk and they have logged me out. Network latency has hit again. And I haven’t even left the house yet. . . .

Heading out for work, I lose my home Wi-Fi connection by the time I’m in the garage, where I have to wait for my phone to (hopefully) connect to my cell network (which also initially required a user id and password) and then via bluetooth to my car’s audio system. On the way to work, depending on the coverage of my provider’s network, my phone may or may not stay connected during the conversations I’m trying to have while enroute. When I arrive at work and go up to my office, my phone once again has to switch to the office Wi-Fi

(which at some point—and perhaps now and again must be repeated—requires yet another user id and password). I get to the office and login in to my computer (yes, another user id and password) and an alert comes up telling me that someone has discovered yet another security vulnerability in my operating system and I must install an update immediately. Installing that update requires my going to a website (where I have to login with—yes—another user name and password), download the software and install it, which takes three attempts because everyone else just got to the office and they are also trying to download the software and so I keep getting logged off the software download site. Once logged on, I send to a coworker a copy of a file that I worked on last night on my home computer. He sends me an e-mail back saying he can't read it, because I have a different version of the software on my computer than he has on his.

The present networking and computing configuration has put the maintenance, interoperability and most concerning, security of our cyber endeavors in the hands of millions of individuals with minimal knowledge, understanding, and unknown values.

iv) People no longer want to ride only in their own vehicles—21st century problems require fluid multiple interactions for people and technology

At the same time as we're hitting a brick wall with our existing technology and networking approach, users are increasingly demanding far more than just access to information. The complex problems of our 21st century world require a more complex and fluid ecosystem of participants, machine and human. People don't want to just access or give information, they want to interact with it, to be immersed in the process of its creation as much as its dissemination and extension. And they don't just need to interact with it by themselves, they need to collaborate with multiple others in a three-dimensional environment where they can tap into people to people, machine to machine, and people to machine interactions—more like an ocean than a highway.

In addition, the machines are becoming smarter and smarter. The last 10 to 20 years have seen phenomenal growth in artificial intelligence and machine learning functionality. Computers are now able to take millions of pieces of data, identify predictive patterns and knowledge, and then use those results to inform and direct further processing and analysis. This is allowing humans to leapfrog over literally years of research to ask new questions in new ways, leading to the creation of new tasks for AI and machine learning machines to work on. However, AI and machine learning require almost instantaneous access to enormous amounts of data and need to transmit enormous amounts of data. Today's crowded Internet cannot accommodate the speed or density of communication that are required for these new functions to work effectively.

B) 5G AND THE CYBER UNIVERSE—the Internet is fixable

As impressive as today's Internet is, it is clear that our present telecommunications and cyber environment has major problems in

- limited bandwidth;
- unacceptably long latency, slow speeds, and inadequate reliability;
- inappropriate dependencies on users for security and maintenance,
- interoperability chaos, and
- inability to accommodate the multidisciplinary, multi-agent processes required of people to people, people to machine, and machine to machine interactions for 21st century endeavors.

i) How 5G will move us from the Information Superhighway to the Cyber Universe

Bandwidth, latency, speed reliability

5G deals with bandwidth and latency in a new way, resulting in orders of magnitude improvements in cyber speed and reliability.

The radio spectrum is broken up into bands, each with different features as you move up into higher frequencies. Our existing telecommunications systems work on certain bands of frequencies. 5G will run on a new "high-spectrum band", which uses higher frequency signals than previous generations of telecommunications. The new band will be much less congested than at present because there are many more frequencies available in higher ranges. These high frequencies are great for a number of reasons, one of the most important being that they support a huge capacity for fast data. Not only are they less cluttered with existing cellular data, and so can be used in the future for increasing bandwidth demands, they're also highly direc-

tional and can be used right next to other wireless signals without causing interference or crossover.

This is very different from 4G towers that fire data in all directions, potentially wasting both energy and power to beam radio waves at locations that aren't even requesting access to the Internet. 5G also uses shorter wavelengths, which means that antennas can be much smaller than existing antennas while still providing precise directional control. Since one base station can utilize even more directional antennas, it means that 5G will support over 1,000 more devices per meter than what's supported by 4G. Traffic jams, and the resulting crashes and slowdowns that contribute to today's lack of connection reliability will be a thing of the past once 5G is deployed. Given that the Internet of Things is going to move us into an almost unimaginable number of devices on the network, we need that capacity and speed yesterday.

With 5G, for example, when a user makes a request from their phone, the network will respond about 10 times faster than the blink of an eye. (That is, network response times will be approximately 1 millisecond.) Importantly, this is below the human threshold to even detect a delay! To the physician's hands sending signals to the remote robot, it will seem to the doctor that he and the robot are moving the scalpel at exactly the same time.

Security, maintenance, interoperability

One of the goals of 5G is to make our networking connections as invisible and requiring as little of our attention as electricity does now. 5G is designed to have everything connected to everything else, and to have all that connectivity taken care of and managed not by each individual user but by systems and processes in the Cloud.

For example, with 5G, the network follows a user through "cells"—geographic areas of connectivity. That cell of connectivity will no longer depend on a certain type of connection, for example Wi-Fi or cable. The network will seamlessly connect together all of the various cells provided by various technologies. Whether connectivity is being provided by a cellular network or a cable modem or a "small cell" device on the telephone pole outside their window will be of no concern to the user and will require no action on their part. In this heterogeneous but cohesive network, cells will assess the needs of each user's device and route it to the most efficient services regardless of where location. There will continue to be larger cells, with broad coverage, but other areas, for example, a college campus, will be covered by small cell technology hung on lamp posts or the roofs of building, and, in new buildings, possibly even inside the bricks in the wall. But none of these different connections will require every individual user to enter a user id and password as their connection is moved from cell to cell.

For example, algorithms in the network will determine how fast a moving device is travelling and what its networking needs might be because of that. An autonomous vehicle might be connected to a large or macro-cell, such as a large cellular tower, so that it stays connected without having to be shifted from cell to cell as it travels over a long distance. However, students walking across campus, texting on their smart phones can connect to smaller cells with less coverage, as the connections can easily be transferred to the next small cell as needed, so quickly that the student won't even notice.

Everything will be connected to everything all the time, just like electricity. Once the connection is there it stays connected. And if it goes down, when it comes back up, once again everything will be connected to everything else without any intervention on the part of users.

An example of the difference in this approach can already be seen in our K–12 schools, many of which have moved from tablets or laptops for their students to Chromebooks. What is the difference? For schools, which often need to have many hundreds of devices to serve their students, teachers, and staff, a huge difference is in tech support. A tablet or laptop has an operating system (OS) on it, as well as applications. When there is an update to either the OS or any of the apps, that update has to be installed on each device. While school networks often do have programs that will update multiple machines at the same time, some IT support person still has to ensure that all the devices are charged or plugged in and on the network and not being used at the time to run that program and that no one happened to take their machine home the night tech person is installing the upgrade. And that some user didn't go rogue and install some out-of-the-ordinary app on their machine that collides with the new OS or software upgrade.

Chromebooks update themselves automatically both for OS upgrades and application upgrades. There are no applications on Chromebooks—they connect to the Internet and use applications in the cloud. If an application needs updating, it is

updated in the Cloud and the next time the students go to that app, they are automatically connected into the new version.

One of the features of 5G is to move to the Chromebook model rather than the tablet or laptop computer model. It is a shift away from our devices—hardware and what is included and runs on a particular device—to having all the technology we need to use running in the Cloud. The device we use to connect to the Cloud becomes almost unimportant. Incompatible files caused by only having access to a certain old version of a software application would be a thing of the past. How many times have we gone to show someone something on our phone and say “oh, I can’t get that on my phone—I’ll have to show it to you on my computer.” It used to be that children would say “my dog ate my homework.” Today it is “my computer crashed and I couldn’t print it out” or “my brother spilled orange juice on my laptop and fried my file.” New excuses will be required with 5G—that homework will live in the cloud and be available from anywhere on any device.

With zero perceived delay in access, even for those large files, 5G will change the economics of technology expense within an organization. The faster, low latency, reliable connections will make it more sensible to move expensive cyber storage and processing into the Cloud, which will require much simpler, less expensive, lower-maintenance devices in the hands of users.

In addition, by moving the bulk of processing and storage into the Cloud, the energy demands of user devices will drop as well. It will be possible for smartphones, for example, to have batteries that last weeks or even months, given that the only processing required on that device is to make a connection to the network and then the Cloud. Medical implants will be able to function for decades without having to be removed or upgraded, since only maintaining a connection to the network will require very little battery use.

ii) An immersive efficient cyber universe of interactions

When bandwidth, reliability, latency, security, maintenance and interoperability are no longer constraints, it will be possible to migrate to a fluid immersive cyber universe of the people to people, people to machine, and machine to machine interactions required for 21st century endeavors.

Analysts predict that by 2020, each person in a developed country will own and use about 27 connected devices. These will range from existing technology, such as smartphones, tablets and smartwatches, to refrigerators, cars, augmented reality glasses, and even smart clothes. Some of these devices will require significant data to be shifted back and forth, while others might just need tiny packets of information sent and received. The 5G system itself will understand and recognize this and allocate bandwidth respectively, thereby not putting unnecessary strain on individual connection points.

II. CYBER SECURITY MUST BE BUILT IN FROM THE GROUND UP—and why it is important the U.S. get to 5G first

A) Cyber Security Professionals

We must engage cyber security professionals in every aspect of the development of the U.S.’s 5G system. Such that this country’s 5G environment is not only effective and efficient, it is also safe and ensures the privacy and democratic values to which we in the U.S. are committed.

With great power comes great responsibility, and that has never been more true than with the development and deployment of 5G and migration into the Cyberverse. 5G is what will make it possible for us to move into the Internet of Everything (IoE). However, every time we connect a new device to the network we also potentially open up a new set of vulnerabilities. Presently companies are racing to make their devices, from crock pots to lawn mowers, IoE-ready. In the absence of instructions and requirements, cyber security tends to be the last consideration of most of these manufacturers. The U.S. is sorely lacking right now in standards and best practices for security to be built into IoT devices, or the software that can easily be installed as part of the basic features of any device.

The U.S. is presently seriously under-resourced in cyber security professionals. The vast majority of the cyber security professionals we do have are over-extended trying working to mitigate and remediate existing Internet attacks, which multiply faster than the proverbial rabbits. However, it is critical that the U.S. ensure that a network upon which every activity in this country is dependent is developed in such a way that vulnerabilities are reduced as much as possible, and that the U.S.’s 5G and Cyberverse cyber security expertise proceeds in step with the development of our national 5G networking capability. This is one area that is of such common concern and serves every individual and enterprise in the country that it would be appropriate and likely necessary for the Federal Government to provide the upfront

investment in the recruitment, education, and deployment of cyber security professionals in 5G development.

B) Why we must get to 5G first—and why we are falling behind China

According to a study released by Deloitte Consulting, a top industry consulting firm, this past August 2018, the United States is losing the race against China to develop and deploy a nationwide 5G network. For a long time, the U.S. led in telecommunications and networking. As FCC Commissioner Jessica Rosenworcel has said, the U.S. has 5 percent of the world's population but we have over 50 percent of the world's 4G deployment. The smart phone revolution and the application economy started in the U.S. and we have reaped the rewards of that leadership position. Other countries have decided they are not going to let that happen with 5G.

There is more at stake here than just prestige. The National Security Agency has stated that if China dominates the telecommunications network industry it “will win politically, economically, and militarily.” Michael O'Reilly, one of the U.S. FCC commissioners has stated that he believes if the U.S. loses the race to 5G it will mean that the Nation will be dictated to by foreign powers, many of which can't be fully trusted, don't believe in capitalism, don't believe in freedom, don't believe in fair play, don't believe in the role of the individual over the government, and rebuke American leadership.”

Deloitte's report also states that since 2015 China has outspent the U.S. by \$24 billion in 5G infrastructure. China has built 350,000 new cell sites, while the U.S. has built fewer than 30,000 in the same time-frame. The U.S. mobile carriers' industry association, CTIA, estimates that the number of cell sites in the U.S. must more than double from about 325,000 to 800,000 for 5G to be deployed. Deloitte's report noted that China plans hundreds of billions of dollars in 5G-related spend and suggests that “China and other countries may be creating a 5G tsunami, making it near impossible [for the U.S.] to catch up.”

In addition to the concerns of national security, there is no question that the first country to effectively deploy 5G and the Cyber Universe will also reap enormous macroeconomic gains. Given the increased capabilities of 5G and the Cyberverse, companies that develop and are designed to take advantage of those capabilities will quickly become global leaders. There is also something called the “data-network effect,” in which early leadership in new markets translates into more users who generate more data that, in turn, helps improve services and attracts more users. The first to deploy 5G and the Cyberverse in a real-world setting will also be the country to understand the strengths, weaknesses, opportunities, and threats related to the new technology.

III. WE NEED A PUBLIC/PRIVATE PARTNERSHIP TO BUILD AND DEPLOY A REAL-WORLD 5G AND CYBERVERSE

A) What we need

The United States needs to rapidly create a publicly/privately-funded partnership to build and deploy a real-world 5G and Cyberverse testbed across a geographic area in the U.S. that contains a diverse cross-section of population clusters and organizations, geography, climate, industries, and existing technologies. This entity will make it possible to explore, troubleshoot, and establish best-practice models and tools for 5G and the new Cyberverse, as well as the policies and governance required to support similar development and deployment across the United States.

5G and the new Cyberverse is clearly critical to the economic, safety, and quality of life future for this country. But there is a lot we still don't know and won't know until we actually fully deploy and use a 5G network and a Cyberverse. And we need to do it quickly.

A big issue in the U.S. is finding a workable model for municipalities, states, and the nation, along with private industry, to work together to integrate the multiple networking components and resources it is going to take to achieve 5G. In an authoritarian country such as China, those are nonissues, and so they are moving very rapidly through that process. We can be successful in this work in the United States, still maintaining our respect for the rule of law and regional rights, but we need a model to do so. To develop that model, we need to develop and deploy a test 5G network in an area that has multiple types of communities. A model that will work in a large city will likely not work the same way in a rural area or a small town. More than 85 percent of cities in the U.S. are small, under 10,000 people. If we are going to reach ubiquitous 5G, we have to develop a model that works in more than just urban areas along the two coasts. However, at present the telecom companies are concentrating only on those two areas, seeing them as the “low hanging fruit” where they can make the most money quickly. Only 15 percent of the U.S. population lives on the west coast, and only 17 percent in the northeast, which

means that 68 percent of the country does not live in the areas where U.S. telecoms are working to develop 5G. It is going to take Federal leadership and investment to ensure that more than two-thirds of the country are not bypassed by the next technological revolution.

B) SD5G and the SD CYBERVERSE

South Dakota is now working to become the first state in the Nation to develop and deploy a state-wide 5G network and Cyberverse. We believe that our state has the characteristics and resources that make it the ideal place for such a project. We are eager to move forward to create for the Nation a model of how to address the various challenges of this transformative approach to the delivery and use of technology.

An American model for 5G and Cyberverse development and deployment must develop best practices that integrate the needs and particular characteristics of multiple:

1. Cyber security demands, software to hardware, end user through the Cloud
2. Technologies—small cell, large cell, fiber, etc.
3. Enterprises—education, government, agriculture, manufacturing, health care, transportation, etc.
4. Population clusters and types—from urban to rural, with special focus on making sure the “last mile” and the “last inch” are as connected as the first and reviving “main street” through migration to ‘smart cities’
5. Governmental organizational structures and concerns—city, county, state
6. Geographies and climates

1) Cyber security demands, software to hardware, end user through the Cloud

South Dakota is home to Dakota State University (DSU) in Madison, South Dakota. DSU is part of a state-wide regental system of six public universities. The DSU started in 1881 as a teachers’ college to serve the growing educational needs of the Dakota Territories and over time grew into a comprehensive university. In 1986, a remarkably prescient South Dakota state legislature re-missioned DSU to add to these roles an augmented and specific focus on technology-infused and technology-intensive degree programs and R&D.

Today DSU is one of the leading cyber security universities in the country, with four Center of Academic Excellence designations by the U.S. National Security Agency and Department of Homeland Security, in cyber education, operations, and research. The Beacom College of Computer and Cyber Sciences has a breadth and depth of cyber degrees, associates through doctoral, unmatched by any university in the country, its graduates at 100 percent placement, either in a professional position or a top graduate school. DSU also has the largest cohort in the country of the National Science Foundation’s CyberCorps Scholarship for Service program, where in exchange for scholarship support after graduation individuals serve in a state, federal, or tribal organization for the same number of years they received the scholarship. Dakota State is also home to the Madison Cyber Labs. The MadLabs is a prolific collection of public/private partnerships in research, scholarship, economic development, and policy development clusters organized around expertise and technology application in specific enterprises. DSU has experts exploring and working with leading edge technologies in a wide range of disciplines, from health care to adaptive technology for individuals with disabilities, from digital forensics to cyber security for the financial sector, and more. There are presently 14 clusters, and a new facility, funded by a private/public partnership, will open in 2019 to provide centralized and collaborative space for the MadLabs. Because DSU is part of the state-wide comprehensive regental university system, it is integrated into a rich fabric of disciplinary experts and exploration at the other five universities with their various emphases, from agriculture to law, from the medical school to mining.

South Dakota is thus developing and will be deploying our 5G and Cyberverse solutions with the professionals and resources of DSU’s robust cyber security environment interwoven into every decision and solution. We continue to see the enormous cost to public and private safety and security when cyber security issues are ignored or left out of technology solutions. One only needs to consider the recent issues facing Facebook over the last few years to understand that we must never again consider cyber security a lower level “add on” to our technology innovations and solutions.

2) Technologies—small cell, large cell, fiber, etc.

South Dakota has been remarkably energized and diversified in pursuing and taking advantage of networking and cyber innovations and technologies. One of the rea-

sons for this is that with a smaller population, the state can be remarkably agile in making decisions and implementing change.

In addition, the state has a wide cross-section of needs in its population that are representative of the wide cross-section of needs across the country. South Dakota has urban (*e.g.*, Sioux Falls) and rural populations, and a large collection of typical “small town U.S.A.” communities. The state continues to have strong concerns and is constantly looking for quality-of-life improvements for its Native American population, which for the most part continues to face poverty, physical and mental health illness, and a lack of socio-economic opportunities. Because of the wide geographical distribution of population, many physical solutions to issues in education, healthcare, transportation, business, development, etc. turn out to be cost-prohibitive and impractical. Early on, as the State legislature’s 1986 commissioning of DSU illustrates, South Dakotans recognized that computing and cyber had more potential to provide solutions to its challenges than the models developed and implemented in more geographically dense areas of the country. South Dakota is by no means alone in this respect. As mentioned before, 85 percent of U.S. towns have populations under 10,000 people, and 68 percent of the country’s population does not live in the primarily urban or population-intense northeast or west coast.

Thus South Dakota has already taken initiatives to create the foundation of multiple networking technologies that will require integration to deploy 5G and the Cyberspace. The state already has a number of areas that have deployed small cells, and a number are under development. Sioux Falls and Brookings, two of the state’s larger cities already have some small cells deployed. Dakota State University is working in collaboration with the City of Madison to deploy a city-wide small cell system in the next year. The state is connected to the Internet2 high-speed fiber backbone through the REED Network.

One of the most innovative new networking technologies has emerged from Google’s Project Loon, an effort to find a new way to provide Internet access to rural and remote areas. The company that emerged from the R&D project uses high-altitude balloons placed in the stratosphere at an altitude of about 18 km (11 mi) to create an aerial wireless network. The balloons use patch antennas—which are directional antennas—to transmit signals to ground stations or LTE users. Some smartphones with Google SIM cards can use Google Internet services. The equivalent of the “base station” that talks directly to devices is carried in the balloon (adding new meaning to the idea of technology in the “cloud”). Users of the service connect to the balloon network using a special Internet antenna attached to their building. The signal travels through the balloon network from balloon to balloon, then to a ground-based station connected to an Internet service provider (ISP), then onto the global Internet. The system aims to bring Internet access to remote and rural areas poorly served by existing provisions, and to improve communication during natural disasters to affected regions. It was named Project Loon for 2 reasons: one was that even Google itself found the idea of providing Internet access to the remaining 5 billion unconnected people in the world an unprecedented and “loony” idea, and ‘loon was a short-hand for the “balloons.”

It turns out that South Dakota is a significant partner in the Loon technology, through the company that makes the highly sophisticated balloons, Raven Industries, Inc. Established in 1956 to make high-altitude balloons, Raven was launched by a group of General Mills employees, including General Mills High Altitude Research division employee Ed Yost. Yost picked Sioux Falls for its favorable wind conditions and over the years the company has focused in on its precision agriculture, engineered films, and Aerostar divisions. The U.S. military and other government agencies are among its clients. The balloons are superpressure balloons filled with helium and stand 49 feet across and 39 feet tall when fully inflated. They carry a custom air pump system that pumps in or releases air to ballast the balloon and control its elevation. A small box weighing about 22 lb containing each balloon’s electronic equipment hangs underneath the inflated envelope. This box contains circuit boards that control the system, radio antennas and a system to communicate with other balloons and with Internet antennas on the ground, and batteries to store solar power so the balloons can operate during the night. Each balloon’s electronics are powered by an array of solar panels that sit between the envelope and the hardware. In full sun, the panels produce 100 watts of power, which is sufficient to keep the unit running while also charging a battery for use at night. A parachute attached to the top of the envelope allows for a controlled descent and landing when a balloon is ready to be taken out of service. In the case of an unexpected failure, the parachute deploys automatically. When taken out of service, the balloon is guided to an easily reached location, and the helium is vented into the atmosphere. The ground stations use a Ubiquiti Networks Rocket M5 radio and a custom patch antennae to connect to the balloons at a height of 12 miles. The balloons are equipped

with automatic dependent surveillance broadcast and so can be publicly tracked along with other hot air and weather balloons.

Those who think of South Dakota as home to vast farms on the Plains, buffalo and cattle ranches stretched across the buttes, the lifestyle of Little House on the Prairie, and Native American heritage should be aware that these days the state is also home to impressively sophisticated technology development and cyber innovation. Silicon Valley or Boston's metropolis are rapidly being matched by a technology revolution in the center of the United States. DSU's cyber security and Raven's Loon system are matched by multiple enterprises across South Dakota working at the vanguard of precision agriculture, robotic manufacturing, and distance-delivery health care, among others.

This multifaceted foundation of expertise and deployed technologies is making it possible for South Dakota to move rapidly in the development and deployment of SD5G and the SD Cyberverse. The only constraints at present are garnering the investment needed to move as rapidly as we are able to. We understand the national security and economic impacts of the United States achieving working and workable 5G and Cyberverse models before those countries whose development of these technologies will likely not be in our best interest or to our profit. South Dakotans long learned how to overcome obstacles and turn dry ground into fertile fields, and our efforts in cyber are determined to be comparably fruitful.

3) *Enterprises—education, agriculture, manufacturing, health care, etc.*

South Dakota, especially over the last century, has developed a remarkably diverse business and industry environment. In every area, often due to the particular challenges of rural areas and difficult geographies, technology development and use is key to the state's economic development and health.

a) Education

5G and the Cyberverse will be especially transformative in terms of education. The South Dakota university system launched some of the very first online courses, and, for example, DSU's Internet-based degree programs reach students across the country and around the world.

Technological advances have already moved many rich digital resources far beyond the physical confines of the classroom and into the hands of learners. 5G and the Cyberverse will enable a learning model that will be an international, immediate, virtual, and interactive environment. It will make it possible for teachers and students to learn and interact in much different ways that we do today. The new model will be learner-centric, skill-centric, on-demand and personalised, which will in turn improve student development in the areas of critical-thinking and collaborative learning.

5G and the Cyberverse will create a network capable of transferring our tactile communication from one location to another, from one device to another. This will make it possible to move beyond today's online teaching focus of content and information delivery to the ability to train students in hands-on skills, what some are calling manual handskill delivery.

Virtual reality (VR) has initially been developed primarily by the entertainment industry, but with 5G networking in the Cyberverse VR has tremendous potential and relevance for education and training. For example, with a VR application, students could not just learn about the seven wonders of the world, they could visit them and explore on their own, at their own pace and direction the sights and sounds that make those locations especially remarkable. They could stop and examine those things of greater interest to them, and immediately access additional information or locations that would further enhance their understanding and experience. Instead of just studying about the various systems of the human body, VR applications can be developed to allow them to virtually enter a body and follow the bloodflow through the heart and lungs, or perch themselves inside an ear to watch what happens to the ear drum when sound waves hit it.

Combining tactile and VR communication, it will be possible for students to develop hands-on skills by using simulations of highly sensitive expensive equipment without potentially damaging the real equipment. And medical students can perfect the precise hand motions and pressure required to carry out surgical procedures with applications that even can provide them virtual but realistic feedback on the damage they can do if they do not perform correctly. Students in elementary schools may see the tops of their desks turned into touch-sensitive screens, able to assess their progress as they complete assignments and providing them corrections and directions to increase their success.

One of the populations that has been profoundly impacted by 21st century technology developments are individuals with disabilities. At present, with the model of assistive technology that is device-dependent, where applications have to be within the hardware accessed by the user, many assistive and adaptive technologies are far too costly to be available in schools. However, with 5G and the Cyberverse, where the applications will live in the Cloud and users will access them via a device in their hands or on their wheelchair, expensive speech and language technologies, for example, will be made far more widely available for those children who are unable to speak without such assistance. The impact on the ability of those children to participate in a regular educational setting with their peers will expand exponentially.

Cloud-based robots can be considered as a full-time assistants for students with disabilities, helping them to interact with the standard classroom environment and their peers. Rather than having to call a teacher over for help (which can cost both the student and the teacher time they could be using more productively) the students can take care of the issue with the help of their robot.

At the college level, we look forward to many applications that can improve today's teaching, learning, and campus experience. Being automatically logged into the classroom as soon as entering the classroom, being alerted by a tactile signal as soon as losing concentration during a lecture, or real-time feedback to a lecturer about areas that students still have problem based on the real-time analyses of their notes are all innovations well within reach with 5G and the Cyberverse.

Dakota State University began as a teacher's college, and its education degree programs are still central to its mission. In recent years the university has significantly expanded its collaborations with K-12 schools in South Dakota, focusing on two needs in cyber education: a general cyber literacy for all students, and accelerated education and opportunities for those who are interested in pursuing cyber careers. These programs will provide a foundation and structure within which SD5G and the SD Cyberverse can begin to develop, test, and implement some of the many exciting teaching/learning innovations that will be enabled by these new technologies.

b) Agriculture

Agriculture is an industry in every state in the union, and in many areas remains a key employer. The United States is a net exporter of food to the world, which has often strengthened both our economic and national security. South Dakota is located in the middle of the country's most agriculturally rich region, and the state's traditional expertise and success in agriculture has continued to move forward. South Dakota is now a leader in technology-based precision agriculture. South Dakota farms are heavily invested in the development and use of automated driving technology, computer vision, telematics, and cloud-based mobile applications to help farmers double or triple their yields—a feat that will be key to keeping up with global food demands as the Earth's population grows over the next thirty years.

It is a known fact that food sufficiency plays a major role in the peace and prosperity of any country. Predictions are that by 2050 there will be nine billion people on the planet. To feed all those people, experts believe globally agriculture will need to increase current production by 70 percent. It is a race to develop and deploy the technologies to get there, and certainly the first country to do so will reap enormous benefits, not only in its ability to feed its own population but economically to be the preferred marketplace for other countries.

In the early 1800s, it took about 300 hours of labor to produce 100 bushels of wheat. Today in South Dakota, through the application of leading-edge technologies, it takes less than an hour of labor to produce 100 bushels of wheat. However, in the state as around the world, climate change, soil degradation, and water shortages are all challenges that are increasing. Sensors are already available that can be put out in crop fields to collect information such as soil moisture, fertilization, and recent weather impacts. With 5G and the Cyberverse, once the processing is done in the Cloud, these will be able to be simpler and less expensive. The information from the sensors will be able to be transmitted to a central hub, providing farmers real-time access to information and analysis of their land and crop. This information can then be used to logistically plan for the most effective use of their resources like water and machinery.

Cattle farmers in the west to be profitable have to have herds of thousands of animals distributed over thousands of acres of land. The growth, health, and

location of those herds is critical information for the rancher. Cattle and sheep often wander into terrain that is inaccessible by motor vehicles, still requiring location and monitoring by horseback, challenging and slow, especially in winter blizzards, when the livestock often need the most support to survive. GPS devices, passive systems requiring only small units with little energy draw, are already available that can be attached to each animal, which would make it possible for real-time monitoring of the location of one animal or a thousand. In addition, biomedical sensors are now available and shrinking in cost and size that will be able to provide real-time biomedical data on livestock, such as body temperature, pulse, growth, and even tissue resistivity, a significant measure of productivity and market value. Today, neither the bandwidth nor the capacity to accommodate thousands of simultaneous users make this application practical. However, with 5G it will be just one of many that will transform livestock farming.

South Dakota's vigorous agricultural industries, illustrative of agriculture across the United States, are providing expertise and enthusiasm toward the development of 5G and the Cyberverse across the state.

c) Manufacturing

Supplying the needs of the United States through a strong domestic manufacturing sector protects the country from international economic and political disruptions. 5G and the Cyberverse has the responsiveness, concurrency and reach that will transform manufacturing.

One in every ten jobs in South Dakota is in manufacturing. In 2016 the state's manufacturing industry generated more than \$4.5 billion of output and accounted for 9 percent of South Dakota's GDP. The state's manufacturing sector has eagerly sought out technology-based innovations to increase productivity, expand markets, and develop new products. South Dakota's Manufacturing and Technology Solutions (MTS) organization is part of the National Institute of Standards and Technology's Manufacturing Extension Partnership (NIST MEP). MTS is one of many organizations supporting South Dakota manufacturing in its drive for what is being called Industry 4.0, or the next industrial revolution. NIST is advancing 'smart manufacturing' as systems that are "fully-integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the factory, in the supply network, and in customer needs." For example, South Dakota manufacturers are heavily engaged in deploying Collaborative Robots (Cobots) and Autonomous Guided Vehicles (AGVs) on factory floors. South Dakota companies have discovered that implementing these robotic systems improves efficiency, reduces errors, increases safety by relieving humans from dangerous tasks, and reduces machine downtime. Compared to traditional industrial robots, the latest collaborative robots are better suited to high mix, low volume production, meaning they can be used to meet variable demand and for just-in-time inventory processes. However, they also require a more sophisticated technological infrastructure, and large-scale multi-site deployment will require the capabilities of 5G and the Cyberverse.

South Dakota's manufacturing companies will provide the testing ground for how 5G and the Cyberverse need to be configured to support their activities.

d) Health Care

5G and the Cyberverse will have a profound impact on health care delivery in this country, especially for those populations who have historically been underserved. A fast, reliable, high-capacity network will make it possible to truly implement telemedicine, and enable providers, first responders, and even civilians to provide medical aid faster, more efficiently and safely.

The Center for the Advancement of Health Information Technology (CAHIT) is one of the DSU MadLabs and the home of HealthPoint, the non-profit federally-designated health information technology (HIT) resource and support center for all South Dakota healthcare providers. HealthPoint is part of a national network of 60 regional extension centers with a pipeline of key information on health IT. The organization supports medical practices with technology tools and support needed to improve quality of care, increase patients' access to information, utilize health data to determine gaps and interventions, and spend dollars more wisely. As a result of their work, South Dakota leads the Nation in percentage (90.4 percent) of office-based physicians that have adopted certified Electronic Health Records. SD5G and the SD Cyberverse will use this existing strong network of already-connected medical practices to explore how best to configure the new technologies to enhance and expand medical care delivery.

4) *Population clusters and types*

South Dakota has a range of population clusters and types and is committed to economic development improvement through the use of technology for all of them. From urban to rural, the state has special focus on making sure the “last mile” and the “last inch” are as connected as the first. South Dakota is also taking the lead in efforts to “revive main street” through migration to ‘smart cities,’ harnessing the power of technological innovation to improve economic health and the quality of life in our small and medium-sized cities.

South Dakota has the third highest proportion of Native Americans of any state, behind Alaska and New Mexico. Five of the state’s counties lie entirely within Indian reservations. South Dakota is also a refugee resettlement state, and its university system has a significant enrollment from international students.

South Dakota is the 11th-fastest growing state in the country, and Sioux Falls is the sixth fastest-growing city in the country. This growth has been significantly fueled by a young (the median age in the state is 36) entrepreneurial culture that is highly tech savvy.

At the same time, the state has a vast land mass and much of the population is distributed in rural areas. In this regard South Dakota is representative of much of the center of the United States, which is often resource-rich but connectivity poor. 5G and the Cyberverse must include innovative ways to connect every U.S. citizen, regardless of their location in the country. SD5G and the SD Cyberverse will develop models to do so.

5) *Governmental organizational structures and concerns—city, county, state*

The smaller population of South Dakota, and the distributed population, have required that cities, counties, and the state work together collaboratively to meet the needs of the state’s citizens. One of the challenges in deploying 5G and the Cyberverse is the complicated, interwoven, and often mutually exclusive regulations, policies, practices, and laws of different municipalities.

One of the greatest needs at the Federal level is for new radio spectrum bands to be made available for 5G and the Cyberverse. Senator Thune took the lead toward action on this almost two years ago in the Mobile Now Act proposing reforms that would ensure more spectrum is made available for commercial use and by reducing the red tape associated with building wireless networks. His leadership and interest in moving U.S. technology and networking forward is matched by leadership across South Dakota, and thus the state is a receptive area for developing, deploying, and creating best practices for leading edge technologies.

6) *Geographies and climates*

The United States is a country which, because of its size, has a vast assortment of geographic configurations and climates. A range of 5G and Cyberverse hardware must be developed and deployed that can accommodate the differences in geographic configurations (*e.g.*, mountains) and extremes of temperature (*e.g.*, hot summers and sub-zero winters), wind, and precipitation. Because of its considerable size—the state is 380 miles long and 210 miles wide—it covers several geographic areas, each with a different weather pattern. The eastern half of the state has a humid continental climate while the western half of the state falls into the semiarid steppe category. South Dakotans face extremes in temperature: blazing heat waves in the summer and bitter Arctic incursions in winter. In July and August, the mercury can soar above 100 degrees Fahrenheit, while in winter, it regularly dips below zero. Record-setting temperatures in the state include readings above 115 degrees and colder than minus 40. This makes it an ideal setting to test the weatherability of various technologies, and most especially the ability to maintain the network of connectivity under extreme conditions.

CONCLUSION

It is exceedingly important to do what we can to remove the existing barriers to broadband deployment on the horizon of next generation wireless technology deployment, to encourage investment in next generation communications services, and find ways to streamline broadband deployment siting.

I believe the best way to address all three of these issues will start with a coordinated effort to develop widespread understanding and knowledge of what 5G and the Cyber Universe are and why it is so important to the economic, security, and quality of life health for the United States in both the near and far future. To develop and deploy these new technologies in a manner consistent with the country’s

democratic values and concerns, we must engage cyber security professionals in every aspect of this testbed. I believe the way to make the greatest progress most rapidly is to create a public/private partnership to build and deploy a real-world 5G and Cyberverspace testbed. We are eager to do so in South Dakota, as a geographic area in the U.S. that contains a cross-section of the types of population clusters and organizations, geography, climate, industries, and existing technologies, to explore, troubleshoot, and establish best-practice models for the technology as well as the policies and governance required to support 5G development and deployment across the country.

5G and the new Cyberverspace is a common good whose availability and operability will be critical to every endeavor across the United States. As such, it is important that the Federal Government provide leadership and support for those efforts that will move development and deployment of this vital national resource.

It is also the case that we will only get one chance to do this first. The United States was the first country to develop and implement the comprehensive Internet, initially building on the foundation and integrating multiple federally-developed networks. The results have been clear and impressive. Despite all of the concerns about cyber security issues and technology dependencies, there is no question that the United States lead in developing and deploying the Internet has had profound economic and societal impacts. There is a need once again for the Federal Government to step forward and take the lead in investment and organizational support for the development and deployment of 5G and the Cyberverspace.

The CHAIRMAN. Thank you, Dr. Griffiths for the great work that you and Dak State are doing in this space. It's going to take a lot of very trained, skilled professionals to protect and safeguard these networks, too, as we develop new technologies. So it's exciting stuff that you're involved with.

Next up is Mr. Robert Fisher, who, as I said, is Senior Vice President at Verizon, Senior Vice President of Federal Government Affairs. He is here today. We welcome him to South Dakota and hope that Verizon is looking at investing heavily in these types of technologies in our state. So thank you for being here, Mr. Fisher.

**STATEMENT OF ROBERT FISHER, SENIOR VICE PRESIDENT,
FEDERAL GOVERNMENT AFFAIRS, VERIZON**

Mr. FISHER. Yes. Thank you, Mr. Chairman. I appreciate the opportunity to be here.

My name is Robert Fisher, and I am Senior Vice President of Federal Government Affairs for Verizon. I appreciate the opportunity to be here to discuss 5G and the policies that the United States needs to adopt to win the global race on 5G.

On a personal note, Mr. Chairman, I just want to thank you. As a former staffer of the Senate Commerce Committee many years ago under then Chairman John McCain. It's a real honor and a pleasure for me to be here today.

Earlier this decade, Verizon led the way in deploying the Nation's first 4G network. Mr. Chairman, here in South Dakota, from 2013 to 2018, Verizon alone has invested more than \$119 million in private capital. Today, our 4G network covers more than 98 percent of the U.S. population, and now we are leading the way on 5G. For example, Verizon created the 5G Technology Forum, led the way with a number of technology firsts on 5G, built innovation labs to help create next-generation applications, and we were the first in the world to launch a commercial 5G service called Verizon 5G Home, which is currently available in Houston, Indianapolis, Los Angeles, and Sacramento. Verizon plans for rapid expansion of 5G Home and the launch of 5G mobility service going into 2019 and

beyond. But it's helpful to begin our conversation by looking at what came before 5G.

The first generation of mobile technology 1G was about voice. 2G introduced text messaging. The move to 3G provided the essential network speeds for accessing the Internet through smartphones. 4G, with faster data transfer rates, gave rise to many of the connected devices and services that we rely upon today. Ultimately, 5G will be even faster, allowing greater network capacity, more opportunities for connectivity, and improved reliability. 5G also represents the potential for up to 1,000 times the network capacity of today's 4G LTE network and 20 times faster download speeds, and the network latency will become even faster than a blink of an eye.

We believe the economic and social impacts will be transformative, and 5G will usher in a true "Fourth Industrial Revolution," which will fundamentally change how we live, work, and play. It will be the foundation for other technologies, such as artificial intelligence, autonomous cars, robotics, and biotechnology. In addition to providing a long-sought competitive alternative to cable broadband, as Verizon's 5G Home Service does, 5G will provide for an enhanced mobile broadband, such as new and immersive virtual reality experiences, mission-critical communications, the connections that are required for the full capabilities of self-driving cars, and the connecting of the Internet of Things.

It's critically important for the U.S. to lead the way in 5G. The wireless industry's impact on the State of South Dakota due to the evolution of 4G technology already accounts for \$587 million in gross domestic product and 6,700 related wireless jobs in the state. We want 5G to build on that success of 4G.

Commissioner Carr said it best earlier this year, "The stakes are high. Winning the race to 5G could mean 3 million new jobs, a half trillion dollars in GDP, \$275 billion of private sector investment, all without a penny of new taxes. We want that, but our friends and competitors in Europe and Asia want that, too."

To underscore the Commissioner's point, all of this is being done with private investment. Fortunately, the FCC and Congress have both made great strides to win the race to 5G with a focus on infrastructure and spectrum policy.

Two weeks ago, under Commissioner Carr's leadership, the FCC issued a ruling that adopted commonsense guidelines that reduced the time and cost of deploying next-generation wireless infrastructure while accounting for legitimate local interests. The FCC's ruling built on the momentum established over the past few years in numerous States and communities to reform infrastructure siting.

In terms of spectrum policy, the FCC has moved fast to open up more spectrum and frequency bands that not have traditionally been used for cellular communications but are critical for 5G. Last week, Commissioner O'Rielly outlined a plan for moving forward on the 3.5 gigahertz spectrum to be considered at the FCC's meeting later this month.

Likewise, Mr. Chairman, you have been leading the way to advance 5G infrastructure policy in Congress. You and Brian Schatz, a Senator from Hawaii, have introduced the STREAMLINE Small Cell Deployment Act, or the STREAMLINE Act, to help promote the deployment of small cell equipment. The STREAMLINE Act

modernizes deployment policies while ensuring states and localities have the ability to recover their costs. You've led the way in ensuring to critical mid-band spectrum, which is a critical component of 5G deployment. Mid-band spectrum provides a good mix of coverage and capacity and is essential for a broad nationwide rollout of 5G technologies.

Verizon has always worked well with policymakers at all levels and hope to do that around the country, and ensure that we are building our country's biggest and best network is accomplished with the cooperation and support of our government partners. While some municipalities have expressed concern about having a standardized framework for governing antenna siting, I can assure you that Verizon believes in dialogue and compromises between providers and localities are more important than ever, and we remain committed to that goal.

The U.S. needs to win the race to 5G, and while Verizon is investing and innovating to help us get there, it is critical for Federal, State, local governments all to be rowing in the same direction. We have to get this policy framework right. With your leadership, Mr. Chairman, and working with the members of the Senate Commerce Committee, the FCC, and other policymakers, we're making great progress, and I have high hopes the U.S. will lead the world on 5G network deployment.

I thank you again for being here today and look forward to answering your questions.

[The prepared statement of Mr. Fisher follows:]

PREPARED STATEMENT OF ROBERT FISHER, SENIOR VICE PRESIDENT,
FEDERAL GOVERNMENT RELATIONS, VERIZON

My name is Robert Fisher, and I am Senior Vice President, Federal Government Relations for Verizon. Thank you for inviting me to discuss 5G—the fifth generation of wireless networks—and the policies that the United States needs to adopt to win the global race to 5G.

What 5G Means

To understand 5G, it's helpful to understand what came before it. Broadly, the first generation of mobile technology, 1G, was about voice. 2G introduced short-messaging (*i.e.*, text messaging) and the move to 3G provided the essential network speeds for accessing the Internet through smartphones. Then 4G, with faster data-transfer rates, gave rise to many of the connected devices and services that we rely on today. According to CTIA, the wireless industry's impact on the state of South Dakota, due largely to the roll out of 4G, accounts for \$587 million in GDP and 6,761 wireless-related jobs. Verizon has invested more than \$119 million in private capital in the state of South Dakota since 2013.

Ultimately, 5G will be even faster, with an exponential growth in network capacity, greater opportunities for connectivity and improved network reliability. 5G presents the potential for up to 1000 times the network capacity of today's 4G LTE network and 20 times faster download speeds than 4G. Additionally, network latency—or lag—of less than 10 milliseconds is many times faster than the blink of an eye. The economic and social impacts of this next generation will be transformative.

With 5G, we are on the cusp of the "Fourth Industrial Revolution," which will fundamentally change how we live, work and play. The Fourth Industrial Revolution is blurring the lines between the physical and digital worlds. Everything that can be connected will be. Some call it the "Cyber Physical" era, building on such technologies as artificial intelligence, autonomous cars, robotics and biotechnology to prime a fresh wave of innovation—all of it enabled by the low latency, lightning-fast speeds, and continuous connectivity of 5G wireless technology. And Verizon is leading the way in deploying 5G.

Verizon's 5G Leadership

Verizon's 4G LTE network covers more than 98 percent of the U.S. population today, and we plan to quickly expand our 5G service, using a wide variety of spectrum frequencies—low band; mid-band; and Ultra Wideband (which is what we're using first for Verizon 5G Home). We have been the leader in 5G from the start. This has required a lot of important steps to get us to where we are today and where we are going. We created the 5G Technology Forum (5GTF) in 2015, with partners like Ericsson, Intel, Samsung and Qualcomm. As a result of these efforts, the first international technical standard for 5G debuted in December 2017—ahead of expectations. Verizon also led the way with a number of technology firsts on 5G, including the first “in the wild 5G data transmission,” and we have built 5G innovation labs to help create the 5G applications that will change how we live, work and play. We were also proud to recently announce the world's first commercial 5G service, Verizon 5G Home, which launched on October 1st and is available for order in Houston, Indianapolis, Los Angeles and Sacramento. Moving forward, Verizon plans for rapid expansion of 5G Home and the launch of 5G mobility service going into 2019 and beyond.

What 5G Will Enable

What capabilities will 5G enable? Ed Chan, Verizon Senior Vice President and Chief Technology Architect, recently said at CTIA's Race to the 5G Summit, “5G will only be limited by our imagination.” Looking back at the predictions of how 4G LTE would be used, no one predicted the smartphone and app economy revolution, and it may be that the most earth-shattering uses of 5G are things that no one is thinking of today—or maybe some young entrepreneur is inventing in her garage in Silicon Valley or right here in Sioux Falls?

Nevertheless, CTIA has described some of the ways that 5G will impact the U.S. economy: “Entire industries, from agriculture to transportation, will be transformed to be more capable, efficient, and intelligent. That's the promise of 5G.” In addition to providing a long-sought competitive alternative to cable broadband—as Verizon's 5G Home service does—5G also will provide for Enhanced Mobile Broadband, such as new immersive virtual reality experiences; Mission-Critical communications, such as the connections needed for the full capabilities of self-driving cars; and connecting the “Internet of Things.”

Policies to Win the Global Race to 5G

The U.S. winning the race to 5G is not a guarantee. Research by CTIA earlier this year found China has a narrow lead over the U.S. and South Korea in the race to 5G. It is imperative that we take the lead as we did with 4G. Why is it so important? Commissioner Carr said it best earlier this year: “The stakes are high. Winning the race to 5G could mean three million new jobs, half a trillion dollars in GDP, and \$275 billion of private sector investment, all without a penny of new taxes. We want that. But our friends and competitors in Europe and Asia want that too.” To underscore the Commissioner's point, all of this is being done with private capital. Fortunately, we know what needs to be done. Commissioner Carr hit on the winning playbook: focus on spectrum and infrastructure. Congress and the FCC have made great strides on both parts of this playbook.

Under Commissioner Carr's leadership, the FCC recently issued a ruling that adopted common-sense guidelines that reduce the time and cost of deploying next generation wireless infrastructure while accounting for legitimate local interests. This ruling built on the momentum established over the past few years in numerous states and communities to reform infrastructure siting policies. In terms of spectrum policy, the FCC has moved fast to open up more spectrum in frequency bands that have not traditionally been used for cellular communications but are critical for 5G.

But FCC and state action is not enough. We need help from Congress, too, and that effort has been led by Chairman Thune, who, together with Senator Brian Schatz, introduced the “Streamline Small Cell Deployment Act” to help promote the deployment of small cell equipment. This bipartisan legislation is an important and thoughtful kickoff to a conversation about how best to modernize small cell deployment policy. The Streamline Act would add significant provisions to the national policy framework that the FCC's recent decision just could not cover. As just one example, the Streamline Act would provide that small cell applications are “deemed granted” at the end of the allowed timetable for state and municipal authorities to act on an application. The FCC found that the remedy for inaction on an application is in the judicial system, and decided not to apply a “deemed granted” remedy, though it provided substantial guidance that should expedite judicial review. How-

ever, even expedited judicial review involves delay and uncertainty, so a “deemed granted” remedy is a critical component to promote investment.

In addition, while the FCC correctly noted that state and local governments are entitled to recover all reasonable costs related to the building of small cell antennas, this provision of the FCC’s new rules is opposed by some jurisdictions and likely will be challenged in court. Codifying the cost-based fee standard—as the Streamline Act would do—provides additional certainty and legitimacy behind this important principle, which simply ensures that states and localities have the ability to recover their costs, but not to tax infrastructure investment for additional revenues and for spending on unrelated purposes.

Chairman Thune also has led the way on ensuring access to critical “mid-band” spectrum, which is a crucial component of 5G deployment. Mid-band spectrum provides a good mix of coverage and capacity and is essential for a broad, nationwide roll-out of 5G technologies. And there are other bipartisan efforts underway to ensure adequate spectrum resources. Of particular note is the Airwaves Act, which would help to create a spectrum pipeline, encourage rural wireless deployment, and reallocate underused spectrum. The Airwaves Act will help to encourage rural wireless investment by setting aside 10 percent of proceeds from the spectrum auctions required by the Act to deploy wireless in underserved, often rural areas. The Act also requires the FCC to study the impact of unlicensed spectrum on rural healthcare, education, agriculture, and broadband access. In addition, FCC Commissioner O’Rielly recently outlined a plan for moving forward on 3.5 GHz spectrum to be considered at the FCC’s October meeting. We encourage the FCC to ensure the 3.5 GHz band plays a critical role in delivering 5G services to American consumers.

Verizon has always worked with policymakers at all levels to ensure that the building of our country’s biggest and best network is accomplished with the cooperation and support of our government partners. While there are some municipalities that have expressed concerns about having a standardized framework governing antenna siting, I can assure you that Verizon believes that dialogue and compromises between providers and localities are more important than ever. Under the FCC’s new rules and the provisions of the Streamline Act, there is still a great deal of leeway and oversight for localities to manage their rights of way. It will be most productive if providers work together with localities on comprehensive plans for small cell deployment. Verizon remains committed to that goal.

Conclusion

To sum up: the U.S. needs to win the race to 5G, and while Verizon is investing and innovating to help get us there, it is critical for the federal, state, and local governments to all be rowing in the same direction to get to the right policy framework. With the leadership of Chairman Thune and Commissioner Carr, and many other policymakers, we are making great progress, and I have high hopes that the U.S. will lead the world on 5G network deployment.

The CHAIRMAN. Thank you, Mr. Fisher.

Mr. FISHER. Oh, yes, sure. Here’s a—I won’t say what company it is, but it’s a—

[Laughter.]

Mr. FISHER.—it’s a sample of a 5G small cell. This is approximately the size of things that we’re looking at deploying in places all around the United States.

The CHAIRMAN. Compared to fourth generation technology, which is much larger.

Mr. FISHER. Much larger. 200-foot macro cells, yes.

The CHAIRMAN. So that’s the next generation, and what cities like Sioux Falls and other cities around the country will need to deploy to benefit from this.

So thank you, sir, for being here and for your comments.

Mr. FISHER. Thank you.

The CHAIRMAN. Next up is Mr. Justin Forde, who is the Senior Director of Government Relations for Midcontinent Communications, which has a big footprint here in South Dakota and all across this region of the country.

So thank you and look forward to hearing from you.

**STATEMENT OF JUSTIN FORDE, SENIOR DIRECTOR,
GOVERNMENT RELATIONS,
MIDCONTINENT COMMUNICATIONS**

Mr. FORDE. Thank you. There's a lot of talk about how to address the digital divide in rural America, but at Midco, we are currently solving and closing the digital divide through our fiber and fixed wireless broadband solutions. And 5G technology will continue to expand Midco's opportunities to provide more fiber and fixed wireless here in South Dakota and across our footprint.

Chairman Thune, thank you again for inviting me here today to discuss Midco's view on 5G from the field in the Upper Midwest.

Midco is the leading provider of Internet, networking, cable TV, phone, data center, home security, and advertising services in the Upper Midwest. We serve more than 400,000 residential and business customers in South Dakota, North Dakota, Minnesota, Kansas, and Wisconsin, and communities ranging in size from less than 100 people to more than 180,000.

Midco has almost 10,000 miles of fiber, and in 2017, we launched our Midco Gig Initiative, a commitment to bring gigabit Internet speeds to our entire service area. To date, we have invested over \$56 million in our Gig Initiative, and that's over and above the millions of dollars we invest in our network annually. Today, Midco Gig is available to more than 80 percent of our customers, and it's affordable and accessible at every address here in Sioux Falls and communities large and small with more to come in 2018.

We also recognize that fiber is not the only solution to solve the digital divide. Many of our most rural and remote residents do not have access to broadband or have access to speeds that are so slow that the service is essentially nonexistent. This digital divide is devastating to our friends and rural residents and businesses and in smart agriculture. So in 2018, Midco acquired InvisiMax, and we have begun to expand broadband wireless service more broadly in most rural areas within our footprint. Fixed wireless allows us to reach rural areas that are up to 50 miles away from our fiber network.

I myself am a Midco fixed wireless customer. I get my Internet from the top of a grain elevator 8 miles away to my small farmstead. On a normal day, my three kids are streaming video, and my wife is using that Internet to run a small business. The service has been a great asset to our family.

My fixed wireless broadband ultimately connects to Midco's fiber backbone, and fiber will continue to be the backbone of any connectivity solution, including small cell 5G technology for urban areas like Sioux Falls or Fargo. And given our deep fiber network, we are able to partner with the mobile carriers to provide the necessary connectivity link from small cell towers to the Internet.

The discussion about emerging small cell technology for urban areas is continuing to gain momentum, and Midco is here to support mobile carriers by providing that connectivity. Small cell will create deeper fiber penetration in our communities, and we are excited for that possibility.

Small cell technology, however, is not the likely solution to close the digital divide due to the density of towers needed. For example, we estimate that 350 small cell towers would be needed to provide 5G service to Sioux Falls with an area of only 74 square miles. While technology requires end users to be in such close proximity to a tower as a possibility in our more urban areas, it is not realistic in some of our more rural areas. But fixed wireless has been, and will continue to be, a solution. Instead of hundreds of feet between a tower and a consumer, our fixed wireless network can beam speeds, high-speed broadband, 5 to 28 miles between a tower and consumer.

Midco currently provides fixed wireless broadband to large portions of the Red River Valley, with approximately 14,000 square miles using 140 cell towers, water towers, and grain elevators. Fixed wireless is closing the digital divide today.

As Congress and the FCC continue to support emerging 5G technology, we, at Midco, are excited for the possibilities that that next generation of technology spectrum will bring for our fixed wireless network.

In the race to 5G, Midco has two suggestions for Congress and the FCC to ensure that 5G discussions include opportunities for rural America.

First is Congress and the FCC work to free up additional spectrum and drive the use of that spectrum in rural America. It's vital that fixed wireless providers, like Midco, have both access to the spectrum and the financial ability to purchase licensed spectrum. As more spectrum is made available, we ask that the rules regarding spectrum also consider the technology needs for fixed wireless, such as higher power allowances. Large rural providers that desire to purchase licensed spectrum should have the ability to compete with large mobile carriers in spectrum auctions. To that end, the FCC and Congress should revise the rural bidding credits to allow larger rural companies, like Midco, to take advantage of such credits to build out their networks.

Second, it is vital that fixed wireless providers have access to new laws and to advancing small cell technology so we can also benefit from those reduced regulations. This Committee's STREAMLINE Act contains similar provisions to the FCC's recent ruling on small cells, and we encourage lawmakers to continue considering fixed wireless when revising rules at the request of small cell operators.

Chairman Thune, thank you again for inviting me here today. And we look forward to working with you all to continue advancing 5G technology while also closing the digital divide.

[The prepared statement of Mr. Forde follows:]

PREPARED STATEMENT OF JUSTIN FORDE, SENIOR DIRECTOR,
GOVERNMENT RELATIONS, MIDCONTINENT COMMUNICATIONS

Chairman Thune and Members of the Committee, thank you for inviting me here today to discuss Midco's view from the field on the impact of 5G in our footprint. We at Midco have developed innovative approaches to help us get high speed and reliable broadband to all of our customers, and I'm excited to share them with you today and our thoughts on the impact of mobile 5G technology.

My name is Justin Forde, and I am the Senior Director of Government Relations for Midcontinent Communications ("Midco"). Midco is the leading provider of Inter-

net and connectivity, cable TV, phone, data center, home security and advertising services in the Upper Midwest. We also operate a regional sports network, Midco Sports Network, which broadcasts live, local high school and regional college sports.

Over 400,000 residential and business customers count on Midco services in 342 communities in South Dakota, North Dakota, Minnesota, Kansas, and Wisconsin. Midco community populations range from less than 100 in places like Dodge, North Dakota, to our largest community, Sioux Falls, South Dakota, which has a population of approximately 180,000.

Innovation and foresight have shaped Midco's course for more than 85 years. In particular, we have made it our mission to ensure that our most rural communities are at the leading edge of technology. Our goal throughout our footprint is to continue to find ways not only to meet, but to exceed, the communications needs of our customers.

Midco's History of Innovation

Midco has a history of innovation in the Upper Midwest. Founded in 1931, Midco began by operating movie theatres, with a vision of always staying one-step ahead of ever-changing technology. Midco then entered the radio business, and in 1954, became the owners of the first television station in South Dakota. We continued to innovate with the introduction of cable television and phone service, and on April 15, 1996, in Aberdeen, South Dakota, launched our broadband Internet service, which today is the largest portion of our business.

Our commitment to innovation continues to motivate our business initiatives today. We own and operate four data centers in North Dakota and South Dakota to give local businesses a cost-effective way to secure critical data and their IT infrastructure. We provide solutions for regional and national banking, healthcare, energy, and government customers, among many other industries. We combine our data center services with powerful network solutions through our wholly-owned, operated and engineered Midco fiber network. Our data centers are directly connected to our fiber backbone, giving businesses access to some of the fastest Internet speeds in the country.

In 2017, we launched the Midco Gig Initiative—a commitment to bring Gigabit Internet speeds to our entire service area—from the region's smallest towns to its largest cities. Today, Midco Gig is now available to more than 80 percent of our customers—with more communities to come in 2018—while the rest of our customers have a choice to receive speeds anywhere from 50 Mbps to 250 Mbps. It is important to remember that the majority of the communities we serve are very rural—nearly all of the 342 communities we serve have less than 50,000 people, with most having a population closer to 500 than to 5,000.

To date, we have invested over \$56 million to upgrade our network to deliver Gigabit speeds to some of the most rural areas in America—in addition to the millions of dollars we invest in our network annually. In 2017 alone, we invested more than \$125 million in capital projects in our service area.

Our continuing investment and almost 10,000 miles of fiber also serve as the connectivity source for mobile operators to connect their mobile customers to the internet. As mobile carriers advance their 5G initiative, local fiber and cable companies, like Midco, will continue to be an indispensable partner to connect consumers from small cell towers to the Internet.

Midco's innovation and continuing capital investment in our fiber stems from our desire to serve the communities where we live and raise our families. While the national push for 5G technology may yield a benefit to urban areas within our footprint, such as Sioux Falls or Rapid City, fiber and fixed wireless companies will continue to be the primary source of broadband in the more rural and remote areas. For example, last year, we extended our fiber-optic network to Littlefork, Canby, Porter, Tauton, Minneota and Ghent, Minnesota—six small communities that now have access to Midco's fiber network, Gig speeds, and our data centers. Not only do we invest in our fiber and fixed wireless infrastructures, but we are also a Midwestern company and are deeply committed to giving back to the communities we serve. To date, the Midco Foundation has contributed more than \$3.8 million in grants to the work of non-profits, local governments, and schools.

Midco's Innovative Use of Fixed Wireless to Reach More Communities with Broadband

While extending the Midco network and bringing our service to rural communities has always been part of Midco's culture and priorities, there are still folks out there who lack access to our network, or to any reliable and affordable Internet source. There are challenges and high costs associated with building fiber in many commu-

nities in our area, due to difficult terrain or sparse population in the vast farmland of the Upper Midwest.

Fixed wireless services can be part of the solution for rural America. In March of 2018, we acquired InvisiMax, Inc., a fixed wireless company operating in the Red River Valley with more than 10 years of innovative spectrum use.

I can personally speak to the benefits of the fixed wireless approach, as I myself am a Midco fixed wireless customer. I get my Internet from the top of the grain elevator in Prosper, North Dakota to my small farmstead six miles west of Argusville, North Dakota. On a normal day, my three kids are streaming video or other content, while my wife is using the Internet to run a small business, so this service has been a great asset for our family.

Our extensive fiber network is the connectivity backbone for our fixed wireless business and other fixed wireless businesses through bandwidth wholesale agreements. We use our fiber network as the backbone and edge out our broadband services by using fixed wireless to reach more remote locations.

A fixed wireless option is a huge benefit to our friends and neighbors who are not on Midco's wired network. Fixed wireless allows us to reach remote, rural areas that are up to 50 miles away from our fiber network, and we can implement this solution relatively quickly and without the effort or expense of constructing fiber networks. We can also deploy new fixed wireless networks during the winter months, when harsh weather makes fiber construction impossible.

Through innovative spectrum use, Midco is currently testing residential fixed wireless speeds of 100 Mbps download and 20 Mbps upload using our 3.65 GHz nationwide non-exclusive and 3.5 GHz Citizens Broadband Radio Service band licenses. Once Midco is able to access spectrum in the 3.5 GHz band, we can offer 100/20 speeds more widely in our fixed wireless footprint.

Midco's fixed wireless innovation extends to the millimeter wave, where we are beginning testing. Using shorter distances from towers to consumers, we can use the 70 and 80 GHz bands for our point-to-point connections and the 50 and 60 GHz bands for our point-to-multipoint connections. A new meshing technology will increase redundancy and reliability, and we will be testing Gigabit fixed wireless services. Millimeter wave technology can be an additional tool in the toolbox to offer high-speed and reliable broadband to rural America.

How Congress Can Support Broadband Deployment in Rural America

Midco supports your efforts to ensure all Americans have access to broadband services, and we have invested many millions of dollars to help make that goal a reality. We greatly appreciate the bipartisan commitment of this Committee to produce bills that include and reflect the key components of a broadband deployment-friendly atmosphere—prioritizing unserved areas, instituting competitive principles for awarding broadband dollars, and embracing technological neutrality. Your efforts in the RAY BAUM'S Act and MOBILE NOW Act to include broadband deployment provisions like the Dig Once policy and a spectrum policy balancing licensed and unlicensed uses, and your thoughtful consideration of the ACCESS Broadband Act, have contributed to an environment in which we are able to more easily invest, expand, and deploy. This Committee is leading the way in Congressional efforts to close the Digital Divide and should be commended for its efforts.

Midco also respects your efforts to identify barriers to broadband deployment, including in the STREAMLINE Small Cell Deployment Act, introduced by Chairman Thune and Senator Schatz. As broadband providers develop new ways to deliver connectivity to their customers, it is appropriate to examine the regulatory landscape to ensure that obligations placed on providers—whether they offer wireless or wireline service—are reasonable, lawful, competitively neutral, and not unduly burdensome, while respecting legitimate interests of local communities. Fortunately, given Midco's deep connections to the communities we serve, we have been able to work effectively and collaboratively with the great majority of our local officials to advance our shared interest in extending the benefits of broadband to our customers.

We recognize that there is a great deal of interest these days in 5G, which is expected to enhance competition in cities like Sioux Falls and Rapid City. Like other fiber and cable providers, given our deep fiber network and partnership with municipalities across our footprint, we are able to partner with these mobile carriers to provide the necessary connectivity link from their small cell towers to the Internet.

In the race to 5G, which will benefit more highly populated areas with dense networks, Midco hopes that Congress and the Federal Communications Commission ("FCC") will not neglect rural America. Therefore, today, I would like to offer three suggestions for how you might help us further advance rural broadband.

First, as Congress and the FCC work to free up additional spectrum, it is vital that companies like Midco that provide high-speed and reliable broadband to the most rural areas of our country have equal access to spectrum.

It would be detrimental to rural America if valuable and limited spectrum was allocated only to 5G, especially as 5G requires a high concentration of small cells to operate. Using current mobile 5G technology, it would take an estimated 350 small cell towers to provide 5G to Sioux Falls, with a square footage of only 74 miles. While technology that requires end users to be in such close proximity to a tower is a possibility in Sioux Falls, Rapid City, and other urban areas, mobile 5G it is not currently a realistic solution to close the Digital Divide in rural areas.

But fixed wireless has been and will continue to be a solution. South Dakota is the fourth least densely populated state in the country, with about 11 people per square mile; and we all know that there is far less population density in our rural and farming communities. Instead of hundreds of feet between a tower and a consumer, our fixed wireless system can beam high-speed broadband 5–28 miles between a tower and a consumer. For example, Midco currently provides fixed wireless broadband to large portions of the Red River Valley with a square footage of approximately 14,000 miles using 140 cell towers, water towers and grain elevators. This partnership of fiber and fixed wireless is a viable, and long-term, solution to closing the Digital Divide.

On behalf of our friends and neighbors who still lack access to broadband, we ask that Congress and the FCC allow fixed wireless providers like Midco to have equal access to spectrum as that valuable resource is freed up for commercial use. We know from field testing that the 3.5 GHz band is key spectrum for us to provide speeds of 100/20 and higher to homes that are over 8 miles away from the tower. The FCC is currently changing the rules for the 3.5 GHz band. However, under those rules, after 2020, we will lose our interference protection in the 3.65 GHz band, and we will then need to either use general authorized access spectrum, in which case our operations would not be entitled to interference protection, or bid on priority access licenses in the 3550–3650 MHz range that will be auctioned. Moreover, only 70 MHz of spectrum will be auctioned, and there is no guarantee Midco will be able to gain access to that spectrum.

In addition, the FCC's priority access licenses in the 3.5 GHz range will only be truly effective in helping rural areas if they are offered in small enough geographic areas that companies like Midco that want to provide broadband via fixed wireless in rural markets can compete for their purchase. Midco supports the FCC's adoption of county-sized priority access licenses in the draft order released last week. County-sized licenses strike the right balance to enable auction participation by new entrants, including rural providers, and Midco urges the FCC to adopt this aspect of the order at its October open meeting. Midco also encourages the FCC to expand its definition of rural provider for rural bidding credits to be any provider with 250,000 broadband subscribers or less in each state in which the provider seeks a priority access license for the 3.5 GHz band. By measuring and limiting the number of broadband subscribers on a state-by-state basis, mid-sized regional companies that focus their service on rural communities can benefit from the rural bidding credits and the FCC's ultimate purpose for the credits remains intact. Given the push for 5G and need for spectrum for mobile carriers, robust rural bidding credits would allow long-standing rural community providers like Midco to have the ability to compete for priority access licenses.

Beyond the 3.5 GHz band, the FCC is also considering how to more effectively use the 2.5 GHz, or Educational Broadband Spectrum, band. The licensed spectrum in the 2.5 GHz band is attractive because the propagation characteristics and high power allowance allows the broadband signal to penetrate through multiple shelter belts and forests to provide broadband and an Internet solution for precision agriculture and cutting-edge farm technology. Currently, however, the 2.5 GHz band can only be licensed to educational institutions or other entities dedicated to educational purposes, who may then lease the spectrum to others. This is true even though much of the spectrum remains unused. Indeed, the FCC estimates that current licensees only cover about half of the geographic area of the United States today, with significant amounts of spectrum going unused in rural areas. Opening the 2.5 GHz band for licensing by other, non-educational entities would allow Midco to provide fixed wireless service to even more rural residents.

Specifically, we encourage the FCC to open as much of the 2.5 GHz band for commercial auction as possible by doing the following: rationalizing the current, 35-mile wide circular licensees (Government Service Area or GSA) to county-sized licenses if the GSA covers at least 75 percent of the county's geography; instituting the performance requirements contemplated by the FCC in its May 10, 2018 Notice of Pro-

posed Rulemaking;¹ auctioning all remaining 2.5 GHz whitespace in county-sized licenses through a competitive auction with a defined channel plan and a limit on the amount of spectrum that one competitor could acquire;² and creating robust rural bidding credits as suggested by Midco in the 3.5 GHz band.

It is important that rural Americans have access to broadband of a sufficient speed, so that they can stream video on multiple devices, attend webinars and virtual meetings, operate a home security system, and, importantly in Midco's service areas, use the Internet for a variety of precision agriculture needs. We need access to more spectrum so that our customers can engage in all of these activities.

Second, we recognize that government help may be needed to bring broadband to areas that are beyond the reach of private risk capital. In areas where it is not financially viable to build—because they are too difficult to reach, geographically remote, or are otherwise very hard to serve—broadband deployment grants can alter the financial calculation, making serving an area possible. It is critical, however, that such help and government resources used for this purpose are directed to bring service only to areas that are truly unserved and not to overbuild existing networks.

In the past, some government broadband funding programs have allowed funding to be used in places that already have broadband service. Midco has been overbuilt with our own tax dollars in places like Mitchell and Yankton, South Dakota, as have others in our region. In Yankton, South Dakota, for example, government dollars were used by a fiber company to overbuild two existing providers; and the new provider used those government funds to “cherry pick” a few business customers. We believe that scarce government resources should be targeted to those who will build out areas that do not yet have *any* access to broadband.

We were a participant in the Connect America Fund Phase II Auction hosted by the FCC this year. This was a competitive, reverse auction, and we believe a fair and economical method to fund those last mile technologies. Midco was awarded approximately \$38.9 million in the auction, and we will use the proceeds to extend our fiber and fixed wireless services deeper into rural areas in our service area. We were also encouraged to see that the pilot broadband funding program in the Omnibus Appropriations Act directed that funds be used in areas that are at least 90 percent unserved, and that the Senate Farm Bill similarly limits funding to areas that are at least 90 percent unserved. These approaches, implemented in a technology-neutral manner and with appropriate guardrails to ensure areas targeted are truly unserved, can complement the work of this Committee to make a meaningful impact in reducing the number of Americans lacking broadband access.

Third, it is vital that fixed wireless—a service squarely aimed at rural areas—has access to new laws and orders designed to advance 5G technology, as fixed wireless, not mobile 5G, is the solution here and now to solve the Digital Divide. We were encouraged, therefore, to see the definition of “Small Wireless Facilities” in the FCC’s recent *Declaratory Ruling and Third Report & Order on Small Cells* as being structures that are 50 feet or less in height with antennas no more than three cubic feet in volume. This Committee’s STREAMLINE Act contains similar provisions, and we encourage this Committee, Congress, and the FCC to not neglect fixed wireless in revising rules and regulations at the request of 5G operators. We ask only for equal access to benefit from new laws and regulations.

I commend the Committee for its focus on ensuring that all Americans—including those in rural America—receive the full potential of America’s broadband networks. Thank you again for inviting me here today, and we look forward to working with all of you on these important issues.

The CHAIRMAN. Thank you, Mr. Forde. We appreciate you being here and look forward to have the opportunity to ask some questions about the things that your company is involved with here in South Dakota and across the region as well.

¹“For mobile and fixed point-to-multipoint services, we propose an interim benchmark of 50 percent population coverage and a final benchmark of 80 percent population coverage. . . . For educational broadcast services, we seek comment on an interim benchmark of 50 percent population coverage and a final benchmark of 80 percent population coverage.” *Notice of Proposed Rulemaking*, WT Docket No. 18–120 (May 10, 2018) at ¶54.

²“Midco also discussed and endorsed the channel plan and associated spectrum limitation of no more than 63 MHz advanced . . . specifically: A1–A3 and B1–B3—33 MHz of contiguous spectrum in lower band segment; C1–C3 and D1–D3—33 MHz of contiguous spectrum in lower band segment; A4, B4, C4, D4, and G4—30 MHz of contiguous spectrum in middle band segment; and G1–G3—16.5 MHz of contiguous spectrum in upper band segment[.]” *Midco Ex Parte to Wireless Telecommunications Bureau*, WT Docket No. 18–120 (Sept. 26, 2018) at 1–2 (adopting the proposal from the Wireless Internet Service Provider Association).

Mr. FORDE. Thank you.

The CHAIRMAN. So last up is Mr. Mark Shlanta, who is the Chief Executive Officer of SDN Communications here in South Dakota. He has been at this for a long time, and has a lot of perspective and background I think that can be very useful as we head into this new frontier.

So, Mark, welcome. It's good to have you here.

**STATEMENT OF MARK SHLANTA, CHIEF EXECUTIVE OFFICER,
SDN COMMUNICATIONS**

Mr. SHLANTA. Chairman Thune, thank you. And thank you for inviting SDN to participate in today's hearing.

The prospect of 5G in South Dakota excites me. South Dakota has long been at the leading edge of broadband, especially in rural markets, thanks to the progressive approach of SDN's owner companies, the independent telephone companies of South Dakota. Our companies cover 80 percent of South Dakota's geography, and they aggressively combat the digital divide. In fact, SDN and the South Dakota Telecommunications Association recently commissioned a broadband benchmark report.

Three things I wanted to highlight. First, 65 percent of the SDTA members, their customers are connected by fiber. 76 percent of their customers have high-speed broadband speeds that meet or exceed the FCC's broadband definition. And third, in the 5 years from 2013 to 2017, our members have invested over \$400 million in networks that now total 45,000 miles of fiber in South Dakota. That's enough to circle—enough fiber to circle the Earth twice.

This leads me to my primary point: small cells and five generation networks, fifth generation networks. In the end, it's still all about the wires, that I will refer to as the 6G fiber optic networks that support such advances.

When I use my smartphone to send a message to my mother across town or to my sister, who lives in South Korea, nearly all of that communication will travel through the fiber in the ground or under the ocean. It's only the very last part of the connection, from the handset to the tower, that is wireless. Today's 4G and tomorrow's 5G wireless do not exist without the 6G fiber that empowers them.

SDN has extensive experience in the field. We partner with all the wireless providers in the region to provide backhaul from the towers and fronthaul to the small cells.

SDN played a key role in deploying some of the first small cells in the region. We helped deploy dozens of small cells in places like Aberdeen, Brookings, Sioux Falls, Sioux City, Sturgis, and Yankton. One of the best examples is the new SDSU Dana J. Dykhouse Stadium in Brookings, which holds 19,000 people. Even a—even a few thousand fans had previously overloaded the mobile data capacity, making it impossible to text and pull up a web page or post to social media. That could paralyze a university and drive away fans, especially younger ones. SDN worked with a wireless carrier to secure locations, permit, and construct the poles. Fans now have a better digital experience there.

More importantly, these and other small cells will play a role in public safety. These small cells represent the precursor to 5G. We

will need many of these to make 5G work, and all of them will have to connect to our 6G fiber.

Chairman Thune and Commissioner Carr, I want to thank you for the lighter regulatory touches that you've allowed, especially the shot clocks encouraging local governments to act. In the past, it could take months, and in some cases, the regulatory and siting expenses exceeded \$25,000 per pole. This did not include the monthly fees to cities, campuses, and other property owners.

I encourage continued streamlining; however, I also believe the Federal and State governments should find a balance for local control. We work cooperatively with the governments in Aberdeen, Brookings, and Sioux Falls to make positive local ordinance changes. I am pleased to say the South Dakota Municipal League is aggressively working to create model ordinances for cities large and small to attract 5G services to South Dakota.

An additional reminder, network security is critical as we advance faster wireless services. 5G will expand the Internet of Things and the IoT devices we all use, but network security should not be overlooked. Our state's academic resources can assist to discover vulnerabilities and develop security measures.

In conclusion, our fiber assets run deep into the rural landscape, and our early experience in small cells, along with the combination of local—local governments ready to embrace 5G, not to mention Dakota State University's technical expertise, make South Dakota the perfect test site for everything from driverless vehicles to wearable devices, which are the applications of 5G. All of it will improve rural quality of life and offer our strikingly independent South Dakotans the opportunity to live, work, and create wherever they please. The diverse weather, culture, and geographic conditions will offer the best test of 5G and leverage the promise of our 6G fiber optic services.

Thank you, Chairman Thune.

[The prepared statement of Mr. Shlanta follows:]

SUMMARY OF TESTIMONY OF MARK SHLANTA, CHIEF EXECUTIVE OFFICER,
SDN COMMUNICATIONS

SDN Communications ("SDN") is a leading provider of Internet and other networking services in the Upper Midwest. SDN is owned by 17 ILECs in South Dakota and works with dozens of additional ILECs, which collectively serve over 200,000 residential and business customers in over 400 communities in South Dakota, Minnesota, and Iowa. SDN has a history of centralizing services for ILECs and supporting complex solutions for large enterprise customers.

Nearly a decade ago, SDN's members started delivering fiber to the premise and, in doing so, moved into the Gig era. SDN's Members have invested nearly \$500 million into the fiber projects since 2013. That includes 2018's investment of \$100 million in fiber and other capital projects by SDN and the ILECs that own SDN. These efforts have also included expanding service into unserved and underserved communities. There are challenges and high costs associated with building fiber in some rural communities. However, the schools, clinics, businesses, and consumers all benefit when our 6G fiber optic networks are deployed at the core of the broadband infrastructure.

SDN supports the efforts of the wireless carriers, local governments, and the FCC to bring next generation 5G wireless services to the population centers. Larger communities in South Dakota can be outstanding test beds as this technology develops. Consumers will benefit from the enhanced access to faster wireless services and computing power being deployed to support new applications in the Internet of Things (IoT) era. Network security will play an ever-increasing role for consumers and SDN encourages all governments to encourage the development and deployment

of secure network assets and services during the growth and deployment of the new 5G wireless networks.

PREPARED STATEMENT OF MARK SHLANTA, CHIEF EXECUTIVE OFFICER,
SDN COMMUNICATIONS

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Our companies cover 80 percent of South Dakota's geography, and we're not talking about the population centers. Yet they aggressively combat the digital divide. In fact, SDN and the South Dakota Telecommunications Association recently commissioned a benchmark report. Three things to highlight:

1. 65 percent of SDTA Members' customers are connected by fiber.
2. 76 percent of them have high-speed broadband that meets or exceeds the FCC's broadband definition.
3. In the five years from 2013 to 2017, our members have invested \$400 million in networks that now total 45,000 miles of fiber in South Dakota—enough fiber to circle Earth twice!

That leads me to my primary point: Small cells or 5G—it's still all about the wires and what I refer to as the 6G fiber optic networks that support such advances.

If I'm going to use my smart phone to send a message to my mother across town or my sister, who lives in South Korea, nearly all that communication will travel fiber in the ground or under the ocean; it's only the very last part of the connection—from the handset to the tower—that is wireless. Today's 4G and tomorrow's 5G wireless do not exist without the 6G fiber that empowers them.

SDN has extensive experience in this field. We partner with all the wireless providers here to provide backhaul from the towers and fronthaul to the small cells. SDN played a key role in deploying some of the first small cells in the region. We helped deploy dozens of small cells in places like Aberdeen, Brookings, Sioux City, Sioux Falls, Sturgis and Yankton.

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Dana J Dykhouse Stadium
Brookings, SD



 SDN COMMUNICATIONS.

SDN worked with a wireless carrier to secure locations, permit and construct the poles. Fans now have a better digital experience there. More importantly, these and other small cells will play a role in public safety.

Western Mall
Sioux Falls, SD



 SDN COMMUNICATIONS.
nsf

Kiwanis Avenue
Sioux Falls, SD



 SDN COMMUNICATIONS.

These small cells represent the pre-cursor to 5G. We will need many of these to make 5G work. And all of them will have to connect to our 6G fiber.

Buffalo Chip Sturgis, SD



SDN COMMUNICATIONS.

I want to thank you for a lighter regulatory touch, especially shot clocks encouraging local governments to act. In the past, it could take months, and in some cases, the regulatory expenses exceeded \$25,000 per pole. That does not include the monthly fees to cities, campuses or other property owners.

I encourage continued streamlining. However, I also believe the Federal and state governments should find balance for local control.

We worked cooperatively with governments in Aberdeen, Brookings, and Sioux Falls to make positive local ordinance changes. I'm pleased to say South Dakota Municipal League is aggressively working to create model ordinances for cities, large and small, to attract 5G services to South Dakota.

One reminder: network security is critical as we advance faster wireless services. 5G will expand the Internet of Things and the IOT devices we will all use, but network security should not be overlooked. Our state's academic resources can assist to discovery vulnerabilities and develop security measures.

In conclusion, our fiber assets run deep into the rural landscape and our early experience in small cells, along with the combination of local governments ready to embrace 5G not to mention Dakota State University's technical expertise, make South Dakota the perfect test site for everything from driverless vehicles to wearable devices—the applications of 5G. All of it will improve rural quality of life and offer our strikingly independent South Dakotans the opportunity to live, work, and create wherever they please. The diverse weather, culture, and geographic conditions will offer the best test of 5G and leverage the promise of our 6G fiber optic network services.

Thank you.

The CHAIRMAN. Thank you, Mr. Shlanta.

Let me just follow up with you while it's fresh in my mind here, but with the passage of the MOBILE NOW Act, we did make a downpayment on the spectrum and infrastructure needs to secure American leadership in 5G, and the STREAMLINE Small Cell Deployment Act represents sort of the next step on that infrastructure list. We recently held a hearing focused on ensuring that we have the additional spectrum necessary for 5G.

From your perspective, as a provider of services to wireless carriers, what else should we be doing to support the deployment of 5G, particularly in states like South Dakota?

Mr. SHLANTA. Thank you. You know, states like South Dakota in the—I'll say in the urban centers, you know, we all have reasonable fiber optic networks to help with the deployment. Coordination at the local effort in terms of working with the local governments

for placement of fiber optic facilities will be key. But in the rural markets, if 5G were to ever long term extend into those rural markets, we must maintain I'll say the support aspects of developing more fiber optic networks across the rural networks. The cost to deploy a rural network far exceed the cost per mile to—and the cost per customer to support—that is used to support an urban customer. So I would just make sure the Federal Government doesn't overlook the needs of rural as we deploy 5G across the urban environments and extend those into the neighboring rural environments.

The CHAIRMAN. In your experience, do you think that the siting policies for small cells should be different than policies for larger sort of macro towers, like what we see today?

Mr. SHLANTA. Well, I do because they are far less intrusive. I think some of the pictures that were showing during my testimony, you know, indicate they are really similar to a municipal light pole, and I know that's many of the collocation efforts that the wireless carriers are looking to work with the communities on, is to collocate on those types of infrastructure.

The early poles that we deployed largely were a standalone facility, and those could be used in places where maybe a light pole or just the traffic volumes really wouldn't allow us to get that type of infrastructure close to the communications or to the transportation systems, but they have that separate facility. So a lighter touch on those smaller facilities is important.

The CHAIRMAN. Yes. Thanks.

Mr. Forde, Midco has been particularly resourceful in deploying both fixed and wireless services to the people of South Dakota; for example, as you point out, deploying antennas on grain silos to provide wireless broadband. Could you discuss maybe how Midco has overcome some of the challenges to deployment in rural areas and some of the lessons that you have learned?

Mr. FORDE. Absolutely, yes. Absolutely. Thank you, Mr. Chairman. And we were also lucky to have Chairman Carr with us earlier this week as we climbed some elevators across the footprint. So it was very exciting to be up there.

Obviously, when you look at, you know, deploying those networks, as Mr. Shlanta said, that cost can be very high. And when you look at our highly rural areas, and obviously as the temperatures dip, there's only a limited amount of time when you can deploy some of those—those fiber networks. The fixed wireless solution, the speed, reliability, and throughput, that has continued to improve with the improvement of technology. So deploying that fixed wireless from our rich, you know, fiber networks in the cities that we do serve really allows us to reach those rural farmsteads and allows us to reach that 25 to 30 miles around there for precision ag, all those tough-to-reach places.

Also, we have a very diverse geography here in our state and across the region, whether it's badlands, granite cliffs, you know, lakes, you just can't get the fiber through that. So this is a really unique way to continue to close the digital divide and reach those hard-to-reach areas. And it can be deployed relatively quickly. I mean, you can call and just within a few hours in some of those

rural areas we can have that technology out to you at very high speeds.

The CHAIRMAN. You talked about the need for spectrum being available to fixed—people who are providing fixed wireless services, too. So what else do you think we could be doing to make it easier for you and others that are serving rural America to get access to that spectrum? You talked about it needed to be accessible and affordable.

Mr. FORDE. Yes. I think obviously as spectrum is made available, it needs to be available in a way that we can have access to it. We like county size license sizes for spectrum, so that's something that we can feel is a good fit for us to afford. Access to some of the bands of spectrum. The 2.5 gigahertz can get through some trees and get through some denser areas, which allows us to ultimately serve that customer better. So, you know, making sure that we have access to that will be helpful. Of course, we also provide video services as well through satellite, and we've got to make sure that there isn't any interference with some of that spectrum as that's made available for more fixed wireless. So there's a good balance that needs to be found there as we make more spectrum available.

The CHAIRMAN. I understand 5G is going to require different types of infrastructure in rural areas, some of which may be impractical in rural areas. But what other connectivity solutions can Midco offer?

Mr. FORDE. Well, it's, you know, that advancement of 5G technology, you know, the fixed wireless is a way—is similar to that, and some of those technology advancements are also advancing that fixed wireless technology. So obviously, you know, working with both in advancing those technologies will allow us to continue to have better 5G technology in our cities and also reach some of those hard-to-reach last areas.

The CHAIRMAN. OK. Mayor, I think we're all well aware that you understand what's at stake here and are working hard to make it easier to build out some of these networks in the City of Sioux Falls. But could you talk a little bit about maybe what the implications are for economic growth and job creation if 5G deployment is slowed down by a delay in the approval by local, you know, zoning and siting applications?

Mr. TENHAKEN. Yes. You know, I—me and my administration look at 5G as much as an economic driver and a workforce driver as anything. And in South Dakota, like a lot of places, we have a workforce challenge. We have a hard time recruiting people to come to Sioux Falls to put down roots here and work, even though we know the secret of this place, and it's a great place to be. And so being able to offer advanced technology, like 5G, as a point of differentiation to whether that's new college grads or whether that's people pivoting in their career, and using 5G as a point of differentiation for Sioux Falls in addition to our favorable tax climate and our safe community and our great quality of life, it would be a tremendous win for us in helping to fill the workforce shortage that we have and helping to recruit businesses here.

We recently invested in a biotech research park called the USD Discovery District, which we hope will someday house a couple thousand jobs centered around ag, pharma, and biotech, and those

jobs are going to require 5G connectivity to be done. They're going to be jobs that rely on a good—good access. And so a slowed down 5G rollout is only going to slow down some of those advancements we want to make as a city in terms of looking at biopharma jobs and bringing in new jobs to our city.

The CHAIRMAN. In your experiences, do you think Sioux Falls is properly equipped right now to be a leader in 5G adoption?

Mr. TENHAKEN. I think there's—you know, this is one topic, just because of my background, that I am really passionate about, and I've talked a lot about this. And there is a hunger and an appetite in this city to be a leader in this space. And so we've seen that in our negotiations with the carriers. When we're talking with them, we're saying, "Listen, we're not trying to make money on the deployment of these cells. We want to cover our costs, and that's it, because we don't see this as a revenue source for the city, and we're not looking at it that way. We're looking at it the win is going to happen once we have the network, that's when the money will come in, through those jobs, through the economic development, and so forth." So most of our community leaders are thinking that way as well. So the time is really right in terms of the mindset in Sioux Falls to be a real early adopter in this and a leader in this.

The CHAIRMAN. Dr. Griffiths, I was interested in listening to your testimony and then reading it earlier, too. You talked about an interesting comparison. It's not a super highway, it's more of a super ocean in terms of the way that the connectivity that will exist as a result of this when it's deployed. But could you talk about how 5G will improve education tools both for students and faculty at a university like Dakota State?

Dr. GRIFFITHS. Yes, certainly. It will do a lot of things. First of all, it's—it's like the Mayor said, if you have the advanced technologies, the advanced infrastructure, people will come to work in it because we'll have it and other places won't, so that's one thing that will help.

In terms of our ability to reach out to work with K–12 education and with our own remote students—half our students are remote—we will be able to extend out virtual—virtual reality experiences for our students. We can train them in what we call hand skills. The ability to convey tactile information with a 5G network is going to be very strong so that we'll be able to train them to do certain things.

On Friday, I had an interesting conversation about robotic—a robotic dairy farm, which I happen to know about, which is strange, you know, self-milking cows. And we were talking about—they were talking about potentially locating this dairy outside Madison, South Dakota, and they were very interested in Dakota State because they were interested in the students and the graduates we have because a robotic farm is going to need people who can take care of the robots as well as taking care of the cows. I mean, it's not just the cows anymore, the robots also need certain care and feeding as well.

So—but I think the biggest thing that 5G in this area would do is to keep many of our graduates in this State. As you know, we are very technologically advanced with our graduates. 57 percent of our high-tech graduates leave the state. We want to provide

them opportunities to stay in-state. Many of them would prefer to stay in-state. And so I think with—by putting the infrastructure in place that will enable 5G services, we will attract the industries and the jobs and the innovation and entrepreneurship to occur within South Dakota to bring people in, to bring people back, and to keep our graduates here.

The CHAIRMAN. And among the subjects that you've studied is how the digital revolution has affected research.

Dr. GRIFFITHS. Yes.

The CHAIRMAN. So what do you see as the impact of 5G on the ability to collect and use information and what that might mean for the economy and for how we live our lives?

Dr. GRIFFITHS. Well, information is power, so, you know, there is this ability to collect a lot of information about how technology is used, how people are mobilizing, new applications, and all of that data can be gathered and analyzed in interesting ways. So, for example, we are looking now at law enforcement information, the number of cyber attacks that people have seen. Analyzing the data on who is attacked, where, by whom, what kind of attacks, et cetera, where the vulnerabilities lie, allow us to take those patterns and project out into industries so that we can be more proactive in preventing those kinds of attacks.

So there's a tremendous opportunity. If you have the information and you gather the information, that pool of information gives you the ability to know more than anyone else and to go out and help people fix the kinds of problems that they're having. So it's a huge advantage. And we believe that, plus the specialized resources that we're building in Madison, South Dakota, at DSU will attract people in so that we'll be able to attract new faculty who might not otherwise be attracted, we'll be able to attract students who might not otherwise come, and we'll be able to attract partners to come and work alongside us in this part of the country rather than staying out on the fringes, as it were.

The CHAIRMAN. Yes. Good. A magnet. Yes.

Commissioner Carr, I mentioned earlier some of the things the FCC is doing, which I give you great credit, you and your fellow Commissioners, because I think you're very forward-looking, and many of the ideas that are incorporated I think as has been pointed out by several of the panelists in the STREAMLINE Act legislation, the FCC has been moving forward with, or at least moving forward in areas that are consistent with the goals that are outlined in the legislation. And so I just think you guys are really, really hitting it, and hitting it on all cylinders, in terms of what we need to be doing. But could you speak a little bit further to some of these recent FCC rulings, and particularly about wireless infrastructure and what it means for 5G deployment?

Commissioner CARR. Sure. And thank you, Senator, for your leadership on these issues. We benefited a lot at the FCC from the legislation that you've introduced, the ideas that you've put together, as well as local leaders, including the mayor. There have been 20 states around the country that adopted updated procedures to account for these new small cell deployments. And if you think back, a lot of our regulations were written in an era of almost exclusively 200-foot towers with a large footprint. There were envi-

ronmental reviews, historic reviews, costs, timelines, that maybe made sense given that massive construction project. But when you have a small cell the size of a backpack or smaller, like the one we have now, when it can go on an existing light pole, those outdated approaches didn't make sense and were holding us back.

So in March, we reached a decision that excluded these small cells, but only the small cells, from the environmental and historic reviews that apply to those 200-foot towers, and there's an economic study put into the record that showed that the March decision cut about \$1.5 billion in red tape. And we saw situations, for instance, where you can put a 30-foot tower in a parking lot where the ground was disturbed, new pavement put down, but nonetheless, you had to get a historic preservation review as if you were turning the ground over anew, and you could have a deployment costing \$30,000, where the environmental review would cost \$27,000. So it was out of step with the technology, and that's why we reached the decision in March.

And then two weeks ago, we reached another decision that really builds on a lot of the ideas that we heard the mayor just talk about. Cities absolutely need to be compensated for their costs in reviewing these deployments. They can't be going underwater reviewing the private sector's investments. They need to be made whole, as the mayor made clear. And that's what we did in our decision. We made sure that cities get their reasonable costs compensated, but that this is not a revenue-generating opportunity, as the Mayor said, because we need to move forward on a scope and scale of small cells that we've never done before. So we have to clear out the red tape that has been holding it back.

The CHAIRMAN. Yes. I'm glad that South Dakota is leading the way on that, too and you heard earlier that the South Dakota Municipal League here in South Dakota is coming up with a draft ordinance for cities to adopt that would enable these infrastructures to be in place and to be built out. What you and the Commissioner are doing I think dovetail nicely with all of those activities. So we want to continue to encourage that. And, honestly, as we look at these issues, obviously we want to be respectful of the prerogatives of local governments and authorities and do it in a way that strikes a balance, but also in a way that's reasonable and doesn't stand in the way of what I think is going to be an enormous economic opportunity for our cities and our states and our country.

What are the implications, to follow up on your point about siting policies, that go beyond cost-based recovery?

Commissioner CARR. We saw evidence in our record that small cells are particularly sensitive to excessive regulatory fees, and we saw in the record where providers were looking to deploy in relatively small communities across the Midwest, and excessive fees resulted in pulling back and investing that deployment in the areas where the fees were a lot more reasonable. We saw record evidence of excessive fees in big coastal cities that would suck up the capital needed to deploy small cells in surrounding communities. So we saw real impacts in terms of the regulatory fees impacting where deployment takes place and whether deployment is going to take place.

The CHAIRMAN. Yes. Thank you.

Mr. Fisher, we had Meredith Baker, who is the CEO of the CTIA, testify before the Commerce Committee earlier this year, and she said, and I quote, a small cell often can be installed in about an hour. The challenge we face is that governmental approval processes can take more than a year, and the application and fee structures are often mismatched with the smaller footprint of tomorrow's networks, end quote.

So could you kind of expand on this concept for us and explain how we can remove red tape and get infrastructure deployed to spur jobs and growth and get broadband competition more quickly?

Mr. FISHER. Yes. Thank you, Mr. Chairman. I think I agree a lot with what Commissioner Carr just kind of pointed out, which is I think historically when you've looked at the way that we've had red tape around expanding cell coverage, we thought of cell coverage, especially in 2G all the way up to 4G about large macro towers and, you know, historical preservation reviews and NEPA regulations. There are a lot of things that went into that process. And I'm not saying that that wasn't incorrect maybe at the time given the size of some of those things. But as we move to really taking 5G—and the way I like to describe it to folks like I think about my parents and trying to explain what we're doing on 5G, when you're taking the network out closer to the consumer and trying to make a service that is going to be, 1,000 times faster than we have today, you need to realize that when we're deploying something like this, the same things that Commissioner Carr pointed out and the regulations that surrounded large towers applying to this really don't make sense. And the time, the amount of money, that go to that definitely do get more exercise towards that process and really take away, you know, potential investment in other surrounding areas.

So I think continuing to encourage, and I hope that the Senate will take up the STREAMLINE Act and pass it because I think it's a perfect complement to what Commissioner Carr and the rest of the FCC have done, which is really getting some of that underburden out so that we can get out there and quickly deploy because I think it's crucial that we do it because we know that China and others are working very fast to do this, and I think it's critical that, just as we led the world in 4G deployment, the U.S. should lead in 5G deployment.

The CHAIRMAN. I want to follow up on the point you made about the steps. What steps do we need to take to win the 5G race when you have other countries like China, South Korea, Japan and Europe heading in the same direction here, but are deploying communications networks at a faster rate? And in a lot of cases they don't have to deal with, the regulatory issues that we have in our country.

So say we want to win that race, what are the steps that we need to be taking, that you think are necessary?

Mr. FISHER. Well, I think we've taken a critical first step with what the FCC has done, and I think that's good. I think building upon what they have done in passing the STREAMLINE Act would be critical. I do agree with what Mr. Forde said, too, you know, we need to identify mid-band spectrum, which is critically important. I agree with a lot of what he said on the mid-band side. It's important to get more spectrum out there as quickly as possible. A lot

of other countries have been doing that for many years and have been rushing to do that.

The CHAIRMAN. Can you talk just a minute and follow up why mid-band spectrum is important?

Mr. FISHER. Yes. Well, I think as we move to—as we’ve thought about cell service, cell service was always about big towers, low-band frequencies that can penetrate through walls, really cover big distances. As we move into 5G we’re looking and deploying right now using what they call millimeter-wave spectrum, which is high frequency. And the higher you go up, the shorter distance it travels, but it has the ability to carry massive amounts of data.

But in order to have all these things work, mid-band spectrum is going to be very complementary with high-frequency spectrum and low-frequency spectrum, quite frankly, because as you push the network out further distances, you’re going to need a combination of short-travel-distance spectrum to longer distance traveled spectrum to be able to cover larger areas.

So all of those things are going to be very complementary to one another, and it’s going to be very critical for those things to happen, I think, in a very thoughtful but speedy way so that we don’t fall behind the rest of the world, because I—I think the most—the most damaging thing that we could do is take longer—take a longer amount of time to do this because we would be missing out on billions and billions of dollars of global economic cost to the U.S. because we’ve led in 4G, and we saw the benefits from it. It’s how the app economy exploded in this country.

And probably a lot to what the mayor and the businesses that he ran, that—that was—that was really largely because of the—of the way we did networks here in the United States. If we continue to do that here in 5G, we will continue to develop things that we can’t even know or understand, things that students at Dakota State are trying to develop today.

So it’s just vitally important that we—that we move forward quickly.

The CHAIRMAN. And with all—it sounds like all the various bands of spectrum play into that.

Mr. FISHER. Correct.

The CHAIRMAN. But mid-band is especially valuable in terms of—

Mr. FISHER. Very valuable, yes.

The CHAIRMAN. OK. Dr. Griffiths, I would be remiss if I didn’t ask this question because it’s kind of what you and your folks do. But 5G does offer the ability to connect many more devices to the Internet than we currently have at a higher level of connectivity, lower latency, tremendous increases in speed. But what challenges does this raise for cybersecurity?

Dr. GRIFFITHS. Oh, I think, as I mentioned, every time you connect a new device to the network, you create potential for new vulnerabilities, not just in the devices—in hardware, coded in hardware is particular a problem. In software, it’s a little bit easier to detect.

The other challenge I think that we have in this environment, as it moves so rapidly, is—is making sure we pay attention to the privacy concerns of the public that, you know, now people are becom-

ing more aware of devices that are actually recording them, and they—you know, we take it for granted that things will work the way we think they're going to work, but, again, bad actors are always in play, and we need to always be mindful of that.

So we do—we do educate some of our young people to—to think like that. It's a different way of thinking, to be more proactive in looking at the cybersecurity environment to actually test things out in a proactive way to ensure that they can find potential vulnerabilities.

And I think it's a concern as we shift generations. So I'm afraid I'm a generation that saw the birth of the modern Internet, so, you know, my mind works in certain ways, and I'm glad I won't have to deal with the waves of innovation that will come. But young people today have a totally different approach to the way they interact with technology, the way they think about privacy, the way they deal with data, et cetera. So it's a totally different world.

So I think there are going to be some social strains and stresses on the system that are going to actually eventually have to be worked out through governance structures and policy, et cetera.

The CHAIRMAN. OK. I'm glad you're training people to understand the bad guys, but getting them to work for the good guys. That's what we want to have.

Dr. GRIFFITHS. And make sure they put their white hats on.

The CHAIRMAN. Right. And I would just say, too, if anybody else on any of these questions wants to jump in, feel free to do that.

Mr. FISHER. Mr. Chairman, I was actually just going to follow up on something that Dr. Griffiths said because I think it's important on the privacy front. And I agree, there's a lot of work being done on the cybersecurity front as it relates to 5G and privacy. But in particular, this Committee has been very engaged in the privacy debate. You've held a series of hearings over the last couple weeks on privacy and what we should do, and as you know, Verizon has been pushing for comprehensive privacy reform for the last 6 years, and we believe it's well past our time to update those laws, primarily for some of the reasons that Dr. Griffiths brought up. But it's critically important that consumers have a sense of their privacy, and I think a lot of what we've seen over the last couple of years is certainly putting a lot of pause into people and the Americans across the country who are trying to figure out how their data is being used. So while I know it's somewhat relevant to this hearing, I think it's an important topic and something that the Committee hopefully and that the Senate and the House can pass legislation in 2019 to update our Nation's privacy laws.

The CHAIRMAN. I couldn't agree more with that.

Mr. Shlanta, obviously we're all talking about swift action on 5G spectrum and deployment and how critical that is, but much of that massive amount of data is going to travel over 5G networks that will travel over SDN and the thousands of miles of fiber that you and your members currently operate. How is this increase in data traffic going to affect your business?

Mr. SHLANTA. Well, first of all, thank you. You know, I would say the change in consumer behavior that we've seen especially in the 4G world is things really moved to the handset in terms of how transactions started to take place. You know, we'll see that double,

triple, 10 times, in terms of the number of transactions that will take place over the next decade across those—those handsets. All of that, of course, gets gathered up across those wireless networks and then transmitted across the fiber networks.

You know, one of the things that we are planning for and have been continuing to invest in is the expansion, not just the reach of our fiber network, but the capacity of the fiber network, the optical network behind the glass that not every one sees. And so we're already laying the, I'll say, groundwork to upgrade those aspects of our network. Some of those are already in place as we're seeing the deployments that the wireless carriers are bringing forward. But the, I'll say, opportunities and challenges it brings, some of the opportunities are I'll say staying current with the technology and finding the right workforce and being able to hire them and attract them to a state like South Dakota. And, you know, that's one of the—I'll say one of the challenges, one of opportunities, is just being able to meet those challenges. It may be somewhat cliché, but those are the kind of things that drive I know largely my technical team to the office every day that work and discover on those types of activities.

But if I could, I'd like to build on one other statement that—or a couple of statements that were made here today, and I wanted to build on one that the mayor was speaking earlier, that it was hitting me. And I think if you go back and look at the record today, you're going to find people who talk about all of us, in terms of witnesses, talk about, you know, 5G and what's coming and what's coming to South Dakota.

But, you know, I want to make sure the carriers and the people who are here recognize that South Dakota has, first of all, a willing government environment. You've heard the mayor talk about that. You've heard the Municipal League talk about that. You know, we want to attract the 5G deployments to our state. You've heard different speakers talk about really the diversity of our climate, the diversity of our populations, the diversity of our environment. So there are great testbed opportunities to come here. And we talk about really the technical resources that not only SDN, but Mr. Forde, at Midcontinent, offer to the carriers as we come.

And I would say, last, and it's the thing that I think people overlook at times, it's the network security. We want to push this forward, but we cannot overlook the network security aspects.

I ran into you earlier this week in Washington. You were headed to the White House, and I was headed to a cybersecurity briefing, and just to hear those business leaders talk about the needs for security in their transmissions, you know, was driving the point home. So I just want to make sure that as a government official who helps drive legislation, that you don't overlook the security aspects, so we bring that along at the same time we bring along all the other aspects of our—of our networks.

The CHAIRMAN. OK. Good.

Mr. TENHAKEN. Mr. Chairman.

The CHAIRMAN. Yes, sir.

Mr. TENHAKEN. Somewhat of a pivot from what Mark just talked about, but I want to make sure we get this out before the hearing ends. And, you know, the one “wet blanket” piece of this that I feel

we need to also address is what health impacts micro-millimeter waves have because it's so new. And as a mayor, and as a mayor who is sitting on this panel, and the media is here, I'm going to get asked this 20 times yet this evening about the health ramifications of 5G and small cell deployment and mmW. And I've been getting asked it a lot already.

And I know there are no documented studies because the technology is so new. And it reminds me a little bit of when microwaves came into our home, and people were concerned about the microwaves, and holding a cell phone to your head is going to fry your brain, and these things, and I'm hearing this more and more.

And so while the concern I think is very inflated, it is something that we, as municipalities, are going to need help addressing. If we want to be excited and push this forward, which we are, we also need to have very clear direction, talking points, studies that have been done that show that there is no harm to our constituents and to the taxpayers on putting these small cells on towers close to libraries, close to schools, close to their homes.

And so I, for one, have been researching this and have not seen any damaging effects of this, but I do think it's something that this group, you know, will have to just consider to look at and continue to study so that as we push the legislation forward, we can do so with not only a clear conscience, but also have the right answers for people who express that concern.

The CHAIRMAN. Yes. Good point, that is something that you do hear. We hear about it and I'm sure the FCC hears about it, too.

Commissioner CARR. Yes, I'm happy to step in real quick on that. So the FCC, as well as other agencies that are experts in health and safety issues, are always looking very closely at these issues, staying up to date on the latest science. They've looked at all of the studies and all of the information, and they've reached the determination that these are safe, and that's a determination that is constantly undergoing review, and any new information that comes up is taken into account. And, in fact, given the position of the Federal agencies on this, Federal law actually says that State and local governments can't take RF concerns into account given how much work has already gone into this issue at the Federal level. And that's not to say that you don't hear about these concerns. And we have community meetings where people raise the concerns. All I can say is that both the FCC and other expert health agencies in Washington, they stay very much up to speed on these issues and have reached the determination that these are safe.

The CHAIRMAN. I appreciate that. And you're right Mayor, there is a lot of research that has been done, but it's always important that efforts be made to educate your constituents, my constituents, the people across this country, who have that concern, and make sure we understand exactly what, if any, those health risks are. But as I have studied the literature that you and the FCC have, most of it comes to the same conclusion in terms of the impacts, but it's something certainly that we need to be able to explain and be aware of.

Between the auctions that are scheduled for this year and next, there will be a lot of new high-band spectrum coming into the market, but we were talking about mid-band spectrum and how desir-

able that is. I want to ask Commissioner Carr, are the FCC's allocations of mid-band spectrum keeping pace with such allocations for high-band spectrum? Can you talk a little bit about the auctions and what you guys are doing over there?

Commissioner CARR. Happy to do so, Senator. Thanks for the question.

I think to start, obviously the MOBILE NOW Act, which you got across the finish line, has put a lot more spectrum on the table, which is going to be key for deploying 5G networks. We've heard a lot about what we call at the FCC high-band spectrum, and that's going to be a key part of some of the initial 5G deployments, but ultimately, we need to push 5G down the spectrum band, including mid-band. And if you look at all the spectrum globally, the U.S. is leading the world in terms of allocating and freeing up more spectrum for mobile, but a lot of that is in the high-millimeter-wave band. So right now, we are turning our focus very closely to what we call "mid-band spectrum." We have a number of proceedings underway, and we need to keep pushing forward, to your point, to get that mid-band spectrum out there.

The CHAIRMAN. OK. We're kind of getting to the time when we need to wrap up, but I just wanted, for any of our panelists today, to respond to kind of a couple of wrap-up questions or any closing remarks that you would like to make, or anything that you feel we didn't touch on that we need to touch on.

But just one question to think about, and that is, What can we do at the Federal level to help speed up deployment in South Dakota and around the country? My goal is to have South Dakota have the fastest Internet speeds in the Nation, in the world, for that matter. But, so, obviously I'm greatly interested in that as it pertains to our state here.

And then how is this next-generation technology that we talked about today going to change what you do every day, and how is it going to change what we all do? I mean, I know it's kind of a broad question, but if—and maybe it gets to a little bit some of the benefits and potential attributes and virtues of this technology.

But what can the Federal Government be doing to speed it up? And, second, how does it change what we do every day and how is it going to change how we all live every day? Think about that for a minute. Anybody who wants to chime in, feel free.

Mayor.

Mr. TENHAKEN. Yes. You know, I think there is still so much unknown because it's—it's going to be the "Wild West" again. And so there's—there are innovations that haven't even been thought of yet which will bubble up as a result of 5G deployment. So I think that's why it's so important to keep the foot on the gas on this, because there are things we haven't even thought of yet, but—and there are things we have thought of.

For instance, I—I was talking with our police force today and was sharing with them the fact that with 5G, we would be able to have HD live feed body camera footage going back to Metro, so rather than them having to call in when an officer is down or a shot's been fired, they're seeing it in real time in HD, and the response times would improve, and they hadn't even thought of that as an application to what would help them better serve the public.

So I think there are so many things and so many doors that would be opened, which is why I think most of us up here are really excited at the opportunity. With Dr. Griffiths, we've talked about between a partnership with Madison and Dakota State and Sioux Falls, they are, you know, the "Cadillac" of cybersecurity colleges, and they're cranking out amazing grads. But they also know they have challenges being in Madison, South Dakota, and—or in Sioux Falls. And if we can create a 5G network and a 5G kind of pathway between Madison and Sioux Falls, we could really be known as a cybersecurity—it could be the next industry that this state is known for. But it's going to take that technology before we can—we can make that a reality.

So I guess my closing statement is just things like the STREAMLINE Act and MOBILE NOW, keep the foot on the gas on it. I think you have a lot of municipalities that want to be supportive and want to help. They also want to make sure it's fair to the taxpayer on the deployment. But there's a lot of excitement and energy for what could be.

The CHAIRMAN. OK. Great.

Dr. GRIFFITHS. If I could just add to that, it's—it's ultimately going to be all about the services and applications, but you can't get them until you've got the infrastructure in place. And if you delay on putting the basic infrastructure in place when the services come out, it will take you longer to get that infrastructure there.

It reminds me very much of Internet 1 to Internet 2, and a group of academic institutions wanted to put in the next generation of Internet so that we can experiment with it and see how it worked. We didn't switch our regular Internet use to that Internet 2, it was purely a research network, and a number of my colleagues at the time were reluctant to sign up. So I was the first one to sign up for Internet 2. We're now talking academically about Internet 3. But it's the same—it's the same environment.

My feeling was, how could I sit and not have my faculty and students have access to the best resources available to them? I'm sure you think the same about your constituents. How can we not make available the potential of all this capability once those services come available? We can't think of what those services would be. I don't think anyone would have imagined Amazon to have grown to be the behemoth that it is in all the different areas it's doing business, but, you know, the business, the applications, the innovations will come, but if the infrastructure is not in place, then you're behind, and once you're behind, it's hard to catch up.

Mr. FISHER. And, Mr. Chairman, I think that this discussion today has been extremely helpful. I think all the work that's being done at all levels of government there's a real effort by a lot of folks at the Federal side and legislation that you are championing that we remain committed to hopefully try to get that—that bill passed. I think the mayor brings up, you know, excellent points.

I mentioned in my testimony, I'd like to underscore it again, we're working very hard at a local level to talk to cities all across the country and have these discussions about getting our—our investment, you know, out there as quickly as possible. So I think just keeping a foot on the gas pedal is the theme that we're using here on the Federal side.

And I would say to your last question, the capabilities of 5G right now is basically wherever your mind can take you at this point. And I think that whether it's students that are currently enrolled at Dakota State or universities across the country. I bet if we sat here even 10, 15 years ago and talked about the app economy today and what it blew up to, none of us would have ever guessed what would have happened, and 4G took us there.

I think 5G leads us to a whole different level of virtual reality, augmented reality, and even applications that we don't know of. The latency—one thing that we didn't talk about that I'll just mention quickly, the latency as we go to 5G, that is the time, that devices can talk back and forth on the network.

Just an example would be that today if you take an autonomous car, and it's traveling at 60 miles an hour, and it's communicating over a 4G network, and it has to signal that it's about to break, the processing time right today on a 4G network is about 4 feet. When it's going 60 miles an hour, about 4 feet is the processing time to go back and forth. I think as we have autonomous vehicles, we can all safely assume that we want to make sure that things are happening very quickly and very rapidly. In a 5G world latency, the same example, a car traveling 60—it goes from 4 feet to 1 inch of compute power, and the latency will be quicker than a blink of an eye.

And so that really gives us unlimited potential as it relates to robotic surgery. You know, think about the things that we can do to take STEM education to the next level. You know, here, I think in many parts of South Dakota, what that means to ag tech and farmers across the country.

So let our imaginations take us where 5G is possible, but I think maybe 10 years from now, we could be sitting around here imagining all these things that we couldn't believe here today.

At Verizon, we're very excited about this. We have five labs, 5G labs, that we're opening across the country. We have one open in New York right now. We're going to have some open in Palo Alto and Washington, D.C., Boston, and L.A. by the end of 2018. So these will really be testbeds for people to come and test out technologies.

The CHAIRMAN. The mayor was waiting to hear you say "Sioux Falls."

Mr. SHLANTA. I was ready to chime in—

Mr. FISHER. My understanding is that we've had some initial discussions and conversations continue, so we look forward to that.

The CHAIRMAN. Great.

Mr. FORDE. Mr. Chairman, thank you so much for bringing this hearing to South Dakota and for your leadership and your staff and all the hard work they've put in to keeping us a technology leader here in South Dakota. You know, we're just so blessed to have all these companies together working so hard on this issue, and I think that are fiber networks and our data center, our Gig Initiative, our fixed wireless, just making all these things a part of this process leads to the great environment that we have here in this community. And we're blessed to be able to work with everyone here at the table and to continue move things forward in our state.

Mr. SHLANTA. One last thing I'd just like to say is we've heard a lot today about 5G wireless. So much will happen, especially in the—probably the urban centers as we get started. But I just wanted to also say thank you, Chairman Thune and Commissioner Carr, for all the work that you do in the rural networks as well. The needs of rural are different than we see in the urban areas. So I just wanted to say thank you for all your efforts there as well.

Commissioner CARR. Also, real quick, I think there are still a number of great ideas in the STREAMLINE Small Cell Deployment Act that's in Congress right now. And I'll also say today we were with the really talented crews of Sioux Falls Tower, and if you think about having about 15- to 20,000 cell sites in the country going up a year, well, next year we need to see about 60,000 a year increasing from there. So it's actually a good jobs story, but we're at a point where we need to make sure we have the trained workforce that can do that massive increase in infrastructure deployment. I think there's work we can do on the apprenticeship side. I think there's work we can do on the community college side as well to get very quickly the skill sets into the community.

The CHAIRMAN. All right. Thank you.

Well, listen, thanks to all of you. Appreciate your input, your thoughts, your suggestions. And I think it's really exciting. And we've had a number of hearings in the Commerce Committee dealing with some of these new technologies, like artificial intelligence and quantum computing and blockchain and other things, all of which I think become increasingly more possible.

And I've used the example, Mr. Fisher, that you use with autonomous vehicles because, you know, one of the things that we—and the reason I'm interested in autonomous vehicles is that we lose 37,000 people every year on America's highways. 94 percent of those accidents are human error. And if we can eliminate just some of that, we can save a lot of lives. It needs to be done in a safe way, and obviously it's much safer if an autonomous vehicle can stop at an inch rather than in—what was it? 4 feet? Yes. So, you know, these are the dimensions of difference and dimensions of benefit that happen when this kind of technology and the infrastructure and everything that supports it is put into place.

So we want to encourage that investment. I'm excited to see the things that are happening already here in South Dakota and the great work that's already being done. But I really do believe the sky is the limit, and so we want to continue to partner and work with everybody here at the table as we, as a State and a country, win this race.

So thank you all very much. With that, this hearing is adjourned.
[Whereupon, at 4:38 p.m., the hearing was adjourned.]

A P P E N D I X

NTCA—THE RURAL BROADBAND ASSOCIATION
Arlington, VA, September 27, 2018

Hon. JOHN THUNE,
United States Senate,
Washington, DC.

Hon. BRIAN SCHATZ,
United States Senate,
Washington, DC.

Dear Senator Thune and Senator Schatz,

On behalf of NTCA—The Rural Broadband Association, I write to reinforce our support for S. 3157, The Rapid Evolution And Modernization of Leading-edge Infrastructure Necessary to Enhance Small Cell Deployment (the STREAMLINE Small Cell Deployment) Act, and our gratitude for your ongoing interest in improving conditions for broadband deployment throughout the United States.

Having served on several of the FCC's Broadband Deployment Advisory Committee working groups, after reviewing many of the infrastructure questions and challenges presented there, and knowing well the obstacles NTCA members often face in seeking to build broadband networks across rural America, NTCA appreciates your bipartisan effort to reduce barriers to deployment of communications networks that are needed to meet the growing demands of consumers.

Applications based on objective engineering standards, reasonable shot clocks, and more transparent permitting processes are common sense solutions that continue to respect local authority while also seeking to modernize infrastructure rules and promote *both* advanced wireless services *and* the robust wireline networks that serve as their essential foundation.

NTCA looks forward to continuing to work with Congress to identify and address barriers to deployment and expansion of broadband facilities of all technologies. Thank you for your bipartisan efforts and we look forward to working with you on this important bill.

Sincerely,

SHIRLEY BLOOMFIELD,
Chief Executive Officer.

October 3, 2018

The Honorable John Thune
United States Senate
Washington, DC 20510

The Honorable Brian Schatz
United States Senate
Washington, DC, 20510

Dear Senator Thune and Senator Schatz,

On behalf of a diverse group of associations, we write to express our support for S. 3157, Streamlining The Rapid Evolution And Modernization of Leading-edge Infrastructure Necessary to Enhance Small Cell Deployment (the STREAMLINE Small Cell Deployment) Act.

This balanced and forward-looking bipartisan legislation will modernize wireless infrastructure regulations for next-generation 5G wireless networks, unlocking significant consumer and economic benefits. 5G networks will be up to 100 times faster than 4G, five times more responsive, and able to support 100 times more devices. These capabilities make 5G key to enabling the potential of the Internet of Things and supporting consumer demand for all things wireless.

For example, the deployment of 5G networks across the country will enable a myriad of new and advanced telehealth capabilities and applications. These advancements will result in real-time disease diagnosis, population analytics, patient outcomes, and remote access capabilities – all leading to more efficient, higher quality technology-enabled care. 5G is poised to transform the transportation sector through smart buses, trains, and cars that cut travel times and emissions, while improving access to transportation options and keeping Americans safe while on the road. 5G will also improve agricultural productivity by employing 5G-powered autonomous vehicles for field tasks, sensors to predict maintenance needs for farming equipment, augmented reality for learning purposes, and sensors, tracking and data for efficient logistics.

To make these 5G-powered advancements a reality, hundreds of thousands of small cells will need to be deployed in the next few years. Small cell deployments will escalate rapidly – from roughly 13,000 deployed in 2017 to over 800,000 deployed by 2026, according to Accenture. These small cells can be installed in as little as an hour or two, but under rules designed decades ago for 200-foot cell towers, it can take more than a year to get the necessary government approvals. We applaud the STREAMLINE Small Cell Deployment Act for updating decades-old rules to reflect this new technology by setting reasonable timeframes for localities to act on siting applications, eliminating the need for costly and time-consuming litigation if an application has not been processed in that time frame, and clarifying that siting fees for access to public property are reasonable and based on actual costs.

Winning the Global Race to 5G. Today, there is a global race for 5G leadership and superiority, with China, South Korea, and other countries focusing on the infrastructure and spectrum policies to ensure they lead the world in this technology. The U.S. won the race to 4G, which boosted the U.S. economy by nearly \$100 billion and sparked an 84 percent increase in wireless-related jobs.

Being first to 5G will also have major economic benefits, from keeping the next generation of developers focused on innovation for and in the U.S., to creating new 5G jobs, to adding billions of dollars in investment to the U.S. GDP.

Preserving Local Authority. The STREAMLINE Small Cell Deployment Act appropriately balances the need to modernize the rules with the rights of state and local governments. The bill creates reasonable timeframes for acting on siting requests, but retains local authority to regulate structural engineering standards, safety requirements, and aesthetic or concealment requirements. The bill also provides small municipalities additional time to process applications, recognizing that that smaller entities may need more flexibility. Finally, the bill allows a one-time FCC waiver of the timelines for state and local governments should additional time be needed.

Driving Economic Growth and Innovation. With new rules for new 5G networks, the wireless industry will invest \$275 billion to build out 5G networks, generating \$500 billion in economic growth and three million new American jobs. Underscoring the economic impact of reforms like the STREAMLINE Small Cell Deployment Act, a recent study found that reducing the current timelines for 5G wireless infrastructure by 12 months would unleash an additional \$100 billion to the U.S. economy¹. Not only will 5G networks transform our economy, but 5G networks will prompt significant innovation and advancements for every sector including consumer tech, transportation, energy, agriculture, manufacturing, and healthcare. The STREAMLINE Small Cell Deployment Act will help make that investment and future innovations a reality by fostering the growth of 5G right here in the U.S. We need to ensure that tomorrow's advancements in healthcare, transportation, energy, and various other industries are not exported overseas by ceding 5G leadership to other countries.

We support the STREAMLINE Small Cell Deployment Act that will help ensure the U.S. leads the world in 5G and spur economic growth in industries of the future and in communities of all sizes across the country. Thank you for your bipartisan leadership and we look forward to working with you to advance and pass this important bill.

Sincerely,



¹ Accelerating Future Economic Value From the Wireless Industry, Accenture, July 19, 2018 at <https://api.ctia.org/wp-content/uploads/2018/07/Accenture-Strategy-Wireless-5G-Accelerating-Economic-Value-POV-July-2018.pdf>





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October 15, 2018

The Honorable John Thune
Chairman
Senate Committee on Commerce,
Science, and Transportation
512 Dirksen Senate Office Building
Washington, DC 20510

The Honorable Bill Nelson
Ranking Member
Senate Committee on Commerce,
Science, and Transportation
512 Dirksen Senate Office Building
Washington, DC 20510

Dear Chairman Thune and Ranking Member Nelson:

On behalf of the National Governors Association, National Conference of State Legislatures, National Association of Counties, National League of Cities, Government Finance Officers Association and The United States Conference of Mayors, I am writing to request that the enclosed letter be included in the record of the October 12 hearing, "Race to 5G: A View from the Field." As you will note, the enclosed July 27, 2018 letter, which is signed by the leading national associations of state and local government officials, expresses the groups' opposition to the pending Thune-Schatz legislation, S. 1357, as currently crafted.

In addition, at the committee's field hearing, growing local concerns about the effects of RF emissions as new 5G networks are deployed was also discussed. I am also requesting that the enclosed October 2, 2017 letter from the National Association of Counties, National League of Cities, National Association of Telecommunications Officers and Advisors, and The United States Conference of Mayors to the Federal Communications Commission be included in the hearing record as well. This letter sets forth the concerns of local officials about the need for a "comprehensive review of the current RF emission rules" and urges the agency to undertake such a review, which the letter indicates last occurred more than 20 years ago when the current RF rules were issued in 1996.

Sincerely,

Handwritten signature of Tom Cochran in black ink.

Tom Cochran
CEO and Executive Director

Enclosures: State and Local Government Associations' July 27, 2018 Letter on S. 1357
Local Government Associations' October 2, 2017 Letter to FCC on RF Rules

July 27, 2018



The Honorable John Thune
 Chairman
 Senate Committee on Commerce,
 Science, and Transportation
 512 Dirksen Senate Office Building
 Washington, DC 20510

The Honorable Bill Nelson
 Ranking Member
 Senate Committee on Commerce,
 Science, and Transportation
 512 Dirksen Senate Office Building
 Washington, DC 20510

Dear Chairman Thune and Ranking Member Nelson:

On behalf of the National Governors Association, National Conference of State Legislatures, National Association of Counties, National League of Cities, The United States Conference of Mayors, and the Government Finance Officers Association, we write to share our concerns with the "Streamlining The Rapid Evolution And Modernization of Leading-edge Infrastructure Necessary to Enhance (STREAMLINE) Small Cell Deployment Act" (S. 3157). As currently written, the bill would directly impact traditionally-held state and local regulatory authority and may complicate, rather than simplify, national and other efforts to expedite infrastructure deployment by prolonging state and local processes.

S. 3157 will complicate ongoing efforts by state and local governments to deploy small cell infrastructure. While State and local governments share Congress's goal of ensuring efficient, safe, and appropriate deployment of new broadband technology, this bill as currently written does not represent the best way to achieve that shared goal. In major telecommunications markets throughout the nation, we are seeing how major public and private sector entities are collaborating to adjust rules and take other actions to facilitate the deployment of small cell networks. Currently, nearly half of all U.S. states have passed legislation specifically addressing the deployment of small cell wireless structures, and local governments in those states are now implementing new ordinances and procedures to comply with those changes and are negotiating with industry partners on these deployments.

The STREAMLINE Small Cell Deployment Act as currently written not only threatens and potentially preempts these ongoing efforts of states and local governments to streamline the deployment of small cell infrastructure, but also introduces an unnecessary, one-size-fits-all federal mandate, when little data now exists to determine what is most effective and what is really needed to advance the deployment of small cell networks. Under current rules and practices, significant progress is being made in deploying these networks, with a recent industry report estimating that this year the number of small cell deployments will increase by 550 percent over 2017 levels.

In pending state and local efforts, the bill does nothing to ensure deployment will occur ubiquitously in all of our communities, sharing the fruits of new technology state, city, and county-wide. Rural areas and underserved communities in denser areas may still see profound coverage gaps despite the loss of state and local authority.

Chairman Thune and Ranking Member Nelson
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Next, the bill imposes unfair and inappropriate timelines on state and local governments. The shot clocks proposed by S. 3157 are considerably shorter than those the federal government applied to itself in the bipartisan MOBILE NOW Act. The reduced size per installation of small cell infrastructure does not directly translate to an accordingly reduced procedural burden on state or local governments. State and local governments must still review each site individually to ensure that it meets the jurisdiction's requirements. Further, the limited extension for small jurisdictions and bulk requests of over fifty applications included in the bill does not address the resource challenges before states and localities. In some areas today, companies are already working with local governments to develop new methods to facilitate the timely review and local action on these applications, innovations that will be compromised or set aside by the bill's one-size-fits-all directives.

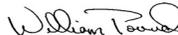
Finally, limiting what state and local governments can charge for access to rights-of-way and other state and local government property to direct and actual costs is an overreach by the federal government. The federal government should not grant private businesses favored access to property that it does not own, nor should it regulate the rates that state or local governments charge for use of their property. State laws governing what state and local governments may charge for use of their property should be respected under our system of federalism.

For these reasons, we are opposed to S. 3157 as currently written. We look forward to working with you and others on the Committee and in the Senate to develop better solutions to expand broadband access through new small cell networks in our urban and rural areas and better serve all Americans.

Sincerely,



Scott D. Pattison
Executive Director & Chief Executive Officer
National Governors Association



William T. Pound
Executive Director
National Conference of State Legislatures



Matthew D. Chase
Executive Director
National Association of Counties



Clarence E. Anthony
CEO/Executive Director
National League of Cities



Tom Cochran
CEO and Executive Director
The United States Conference of Mayors



Christopher P. Morrill
Executive Director/CEO
Government Finance Officers Association

cc. The Honorable Brian Schatz
Other Members, Senate Committee on Commerce, Science, and Transportation



October 2, 2017

Ajit Pai, Chairman
Mignon Clyburn, Commissioner
Michael O’Rielly, Commissioner
Brendan Carr, Commissioner
Jessica Rosenworcel, Commissioner

Federal Communications Commission
445 12th Street SW
Washington, DC 20554

RE: Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies (ET Docket No. 13-84)

Dear Chairman Pai, Commissioner Clyburn, Commissioner O’Rielly, Commissioner Carr, and Commissioner Rosenworcel:

On behalf of the National Association of Telecommunications Officers and Advisors (NATOA), the National League of Cities (NLC), the National Association of Counties (NACo), the U.S. Conference of Mayors (USCM) and all of the respective constituencies that we represent, we respectfully write to request that the Federal Communications Commission (FCC) undertake a comprehensive review of its current radio frequency (RF) emission rules.

As a background, nearly four years ago, local government commenters urged the Commission to undertake a comprehensive review of its RF emission rules and work to provide timely updates in light of the best, independent scientific research from around the world. This position was not premised on any belief that the current rules are obsolete, too strict, or too lenient. Rather, it was based on the fact that the current rules were adopted in 1996. At that time, “cell phone use by children was rare, smart phones did not exist, cell phone cases were virtually unheard of, and the FCC assumed consumers would use belt clips or holsters to carry their phones.”¹

In addition, the deployment of new technologies – especially small cells – in our communities has raised new concerns with the current standards. While local governments may not regulate the siting of personal wireless service facilities on the basis of the environmental effects of RF emissions, local government officials are often faced with residents raising RF concerns with the siting of new wireless facilities in the public rights-of-way. While a comprehensive review of the current rules may not alleviate all consumer concerns, we believe it would go a long way in

¹ City and County of San Francisco Comments at 4.

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providing badly needed assistance to local government officials when faced with questions regarding RF emissions and the public's health and safety.

The time for the Commission to take action in this proceeding is NOW.

Respectfully submitted,



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