

S Commerce Hearing On The Commercial Satellite Ind., sked FINAL

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COMMITTEE HEARING

SEN. JOHN THUNE

CHAIRMAN

S COMMERCE

WASHINGTON, D.C.

S COMMERCE HEARING ON THE COMMERCIAL SATELLITE INDUSTRY

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S Commerce Hearing on Commercial Satellite Industry

OCTOBER 25, 2017

SPEAKERS:

SEN. JOHN THUNE, R-S.D.

CHAIRMAN

SEN. ROGER WICKER, R-MISS.

SEN. ROY BLUNT, R-MO.

SEN. DEAN HELLER, R-NEV.

SEN. TED CRUZ, R-TEXAS

SEN. DEB FISCHER, R-NEB.

SEN. RON JOHNSON, R-WIS.

SEN. CORY GARDNER, R-COLO.

SEN. JERRY MORAN, R-KAN.

SEN. DAN SULLIVAN, R-ALASKA

SEN. JIM INHOFE, R-OKLA.

SEN. SHELLEY MOORE CAPITO, R-W.VA.

SEN. MIKE LEE, R-UTAH

SEN. TODD YOUNG, R-IND.

SEN. BILL NELSON, D-FLA.

RANKING MEMBER

SEN. MARIA CANTWELL, D-WASH.

SEN. AMY KLOBUCHAR, D-MINN.

SEN. RICHARD BLUMENTHAL, D-CONN.

SEN. BRIAN SCHATZ, D-HAWAII

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SEN. TAMMY BALDWIN, D-WIS.

SEN. TAMMY DUCKWORTH, D-ILL.

SEN. MAGGIE HASSAN, D-N.H.

SEN. CATHERINE CORTEZ MASTO, D-NEV.

WITNESSES:

PATRICIA COOPER,

VICE PRESIDENT OF SATELLITE GOVERNMENT AFFAIRS,

SPACE X

MARK DANKBERG,

CHIEF EXECUTIVE OFFICER,

VIASAT

STEPHEN SPENGLER,

CHIEF EXECUTIVE OFFICER,

INTELSAT

GREG WYLER,

FOUNDER AND EXECUTIVE CHAIRMAN,

ONEWEB

THUNE: Welcome to today's hearing on the State of Commercial Satellite Industry and the promises of next-generation satellite technology to improve the lives of Americans.

I believe we're at a critical moment of the development of satellite capability and I'm excited to hear from our panel of distinguished witnesses today.

Satellite services available today offer residential broadband at speeds substantially greater than those available just a few years ago. Download speeds that meet the Federal Communication Commission's definition of advanced telecommunications capability and in some cases without the strict data cap limits that have vexed users of satellite broadband in the past.

Much of our television broadcast programming is delivered to broadcasters by satellite with extraordinary reliability and millions of Americans receive their video service through direct broadcast satellite.

This summer, the FCC for the first time authorized access to the U.S. market to a provider using a proposed constellation of 720 satellites. OneWeb received approval to enter the U.S. market with an array of satellites to provide global high-speed broadband including in remote and hard to serve areas.

For comparison, there are about 1,000 satellites total in operation today. This new type of service would place satellites in a much lower orbit than many of the satellites currently in operation.

Similarly, SpaceX seeks to bring its satellite expertise to bear with a proposal to deploy a constellation of thousands of satellites to provide high-speed broadband. If realized, these ambitious proposals could completely change consumer access to broadband in rural areas as well as cities across the country and around the world.

Satellite capability can also play a critical role in establishing communication after natural disasters and has been used by the Red Cross and others as part of the effort to reconnect the residents of Puerto Rico after the devastation caused by Hurricane Maria, as well as those affected by hurricanes in Texas in Florida.

As with the wireless services, this Committee has examined, had numerous hearings, spectrum is critical to satellite services. As the value of spectrum skyrocket with America's increasing demand for broadband, spectrum that previously had little value for mobile broadband use now faces competing demands. It is essential that any evaluation of these competing demands accurately consider the full range of spectrum uses and how best to deliver broadband and other services to the American people.

The specifics of how to balance such demands in the public interest: things like allocating spectrum between services and between licensed and unlicensed use, setting appropriate interference levels between terrestrial and satellite uses and determining the size, number and location of exclusion zones are as important as they are complex. However they are not the subject of today's hearing as the FCC is addressing those matters in the ongoing spectrum frontiers proceeding and elsewhere, but it is important to set the broad parameters of this discussion.

We must ensure that next generation technologies rise or fall on their merits including their efficiency in the use of spectrum in ultimately their ability to meet the demands of American households for reliable high-speed broadband.

Today, will have an opportunity to hear from some of the leaders and innovators in the field who are redefining satellite capability and who can explain what satellite services can offer to ongoing efforts to make broadband more available to all parts of the country and the world.

Wireline service fixed and mobile wireless service and satellite service all have a role to play in connecting Americans to next- generation broadband service. Understanding satellite capability and the potential of next generation satellite deployments will help inform this Committee regarding the costs and benefits of spectrum allocations, spectrum sharing and related technology neutral policies among other things.

So I am pleased that we have such a distinguished panel to address these matters today and I look forward to hearing their thoughts.

I recognize Senator Nelson for his opening statement.

NELSON: Thank you, Mr. Chairman. Well, this is an exciting time because communication satellites are essential links in our globally connected world. They bounce television signals all over the planet, provide voice communication and Internet access to remote areas and in a recognition of satellites resiliency and reliability, First Responders and those in disaster areas like Florida after hurricane, Texas, Puerto Rico, the Virgin Islands -- they rely on satellite systems as their lifeline when other communication systems are down.

So the next generation of satellite-based communication systems holds even more promise large constellations, thousands of satellites will provide broadband communications that rival the terrestrial counterparts and is going to make access even more affordable for broadband Internet. It's going to become a reality that broadband Internet in rural areas and remote areas that the terrestrial networks don't reach.

Other constellations promise imaging services that could advance key earth and climate science initiatives and that's just the beginning of it. Much of this new interest and investment in space is coming from the private sector. In fact, some have begun to call this the Second Great Space Age and as it was for the First Great Space Age, the epicenter and I hate to be parochial here, the epicenter is going to be the Cape.

So goes -- well, we'll let you do all your manufacturing out there.

CANTWELL: We'll take it. We'll take it. We'll take it.

NELSON: Senator Cantwell, but as it was in the First Grade Space Age, so it now is in the commercial launch business and thanks in no small part to the efforts of some of the companies here today and to our commitment to an ambitious Civil and National Security Space Program, the Cape is coming alive.

The space industry has brought millions of dollars of investment to this country along with thousands and thousands of jobs, lots of economic benefits and a lot of spin-offs from the technology that is developed for the Space Program and so as we have been working with NASA, the FAA and the Air Force and our colleagues here in Congress, we are paving the way to a dramatic increase in commercial space activity at the Cape.

And when I say the Cape, that's the generic term not just the physical Cape Canaveral which is the Air Force Station, but it also includes the Kennedy Space Center and the commercial activities that are going on there, which are very significant.

So take for example the Commanding General of the 45th Space Wing, General Monteith, he told me recently that they now have the capability of supporting two launches in one day. Now in the past, that could have never happened in large part that in fact is due -- that they now have the Autonomous Destruct and you don't have to have an Air Force lieutenant sticking there with his finger on the destruct button, but you have the autonomous -- if a rocket were to go off the trajectory that it's supposed to be on threatening populated areas.

And over the coming years, these launches are going to be able to deliver thousands of new satellites to orbit, cargo and cruise to the International Space Station and eventually new technologies like in space manufacturing and on top of all that, we're building the vehicles that will return humanity to deep space and ladies and gentlemen, we're going to Mars and the beginning of that is in two years with the launch of the largest rocket, most powerful rocket ever -- the SLS with its spacecraft Orion, and that's just two years away.

So suffice it to say this in fact is not only an exciting time, it's a critical time for the Space Program and space commercialization as well; and that's why it's such an important time to have our space agency led by an experienced and competent professional. The agency has not faced this critical of an inflection point since the Apollo Program. If we stumble now, the impacts of our civil, commercial and national space capabilities could be felt for decades to come.

And I want to thank the witnesses for being here this is going to be an exciting discussion. Thank you, Mr. Chairman.

THUNE: Thank You Senator Nelson and we have lots of wide open space and uncongested airspace in South Dakota too so if you want to bring any of that technology our way, we welcome it.

So we have a great panel as you pointed out today and we have Ms. Patricia Cooper who's the Vice President of Satellite Government Affairs at SpaceX.

Mr. Mark Dankberg, who is the Chief Executive Officer of ViaSat.

Mr. Stephen Spengler who is the CEO of Intelsat and Mr. Greg Wyler, who is the Founder and Executive Chairman of OneWeb, so thank you all for being here.

We'll start on my left and your right with Ms. Cooper and then proceed and if you would all, if you can limit your oral remarks to about five minutes, it'll give us an optimum time to ask questions and we'll make sure that all of your remarks get made part of the written record of this hearing, so thank you being here. Ms. Cooper?

COOPER: Mr. Chairman, Ranking Member Nelson and members of the Committee. I'm pleased to be back today representing SpaceX and my more than 6,000 colleagues who are revolutionizing space technologies.

Mr. Chairman, there's a space Renaissance underway and SpaceX is proud to be at the forefront of innovation. My testimony today will outline SpaceX's plans to harness the platform of space for a new approach to broadband delivery. I will also recommend actions that the Committee can take to foster innovation by streamlining regulations driving efficient spectrum use and protecting the safety of space.

SpaceX is designing, developing, building and launching a constellation of over 4,000 satellites operating close to the earth. We have designed our constellation to achieve an ambitious and compelling goal, connecting the hundreds of millions of Americans and billions of global citizens to high-speed broadband.

Our direct-to-consumer focus drives the large scale of our system featuring substantial on-orbit capacity and to keep pace as broadband demand grows and sophisticated techniques for frequency reuse.

From the outset our constellation planning aim to push the edge of innovation so that we can groom our coverage to match the peaks and valleys of broadband demand, interoperate flexibly with other users and protect the space environment.

Underlying these plans are the credentials that SpaceX has built over 15 years that demonstrate our capability to manufacture and operate complex space systems with unprecedented innovation efficiency scale and affordability.

Unlike many other aerospace firms, SpaceX is heavily vertically integrated. We build our Falcon rockets and our Dragon spacecraft in-house from tip to toe including propulsion systems, structures, avionics and launch all within the U.S.

Our space and launch heritage and our drive to innovate gives us a distinct edge in deploying our ambitious satellite project. SpaceX has successfully launched 42 flights of the Falcon IX including 15 this year alone, landed 18 first stages and reused three and flown 13 supply missions to the International Space Station using our Dragon spacecraft.

We will bring this experience to bear in our satellite project.

In space, our constellation will use dynamic antennas and optical links between the satellites to form an efficient mesh network. These advancements will allow us to reuse frequencies many times over to ultimately deliver far greater broadband capacity to consumers.

As a company, we are deeply committed to maintaining a debris-free environment in space and our satellite system has been thoughtfully designed to meet or exceed all existing requirements for safety of operations in space and upon deorbit.

On the ground, we're producing affordable, easy to install end user terminals that all but remove the incremental cost of new users joining our network. Here, we avoid the dollars per mile terrestrial build-out costs and other obstacles that have made terrestrial broadband connections cost prohibitive for so many American communities.

The coming low orbiting constellations hold enormous potential to finally bring broadband connectivity to all corners of America at speeds and latencies that today are available really only in the most populated areas.

Mr. Chairman, we lay out an ambitious goal and we could use the Committee's help. To summarize my written statement, we urge the Committee to continue its work to modernize the regulatory framework for commercial launch operations both at the FAA and at the FCC.

Launch is the critical path to deploying satellite constellations and licensing rules and spectrum allocations must be updated to reflect that new pace and number of launches. SpaceX is proud to launch our constellation from U.S. soil on American-made SpaceX rockets.

The Committee should endorse rules that foster spectrum sharing and technology advancement to make the best use of the airwaves. The FCC has already taken an important step by updating its rules for such satellite constellations rightfully expecting operators to negotiate among themselves for spectrum sharing.

Unfortunately, not all operators are -- have chosen to invest in available technologies for spectrum efficiency. The Committee has an important oversight function to ensure that the rules of the road incentivize and support smart technology that can interoperate with other users on orbit and on the ground.

To protect the space environment, the Committee should encourage closer coordination among the many Federal agencies responsible for orbital safety policies and regulation. Congress should also consider additional investments in the nation's infrastructure to track orbital objects even more precisely.

Finally, we ask for the Committee's vigilance to assure tech neutrality in any and all legislation or Federal programs designed to expand broadband infrastructure. blanket exclusions of any qualifying technology from existing programs like the Connect America Fund should be rescinded so that new satellite constellations can be harnessed for high-quality broadband connectivity in every corner of America.

This is an exciting and dynamic time in the satellite industry. I thank the Committee for the opportunity to be here today and look forward to any questions. Thank you.

THUNE: Thank you, Ms. Cooper. Mr. Dankberg.

DANKBERG: Chairman Thune, Ranking Member Nelson and Members of the Committee, I'm Mark Dankberg, co-founder and CEO of ViaSat. Thank you for the chance to testify on the U.S. satellite industry and the critical role it plays in closing the digital divide in connecting millions of mobile devices and in our national defense.

ViaSat is an American success story. It started in my house 31 years ago and we've generated billions in revenue, become public and created almost 5,000 high-paying jobs. Six years ago, we launched our first satellite to deliver truly competitive broadband services directly to rural America to Airlines and even to Air Force One.

Though a space newcomer, we're redefining satellite. Our first one had a hundred times the bandwidth of a typical satellite. Our second doubled that and we're building one now a thousand times better than the typical satellite still in use today.

The global satellite industry is valued at \$260 billion a year. The U.S. has the largest share satellite service, it is the biggest segment and the economic engine for commercial space. Advances in spacecraft and rockets depend on demand for satellite services. Communication is the largest piece of services and broadband is the fastest-growing part of communications.

Broadband satellite demand has skyrocketed as media and entertainment evolves from broadcast to Internet enabled on-demand service. If you are seeing a frozen Internet video stream, you know the pain of slow broadband.

Today, we deliver faster Internet to hundreds of thousands of American homes. We've grown without subsidies competing against much larger companies. We see the market work. When our service is faster, people choose ViaSat.

In 2012, our download speed was 12 megabits per second, above average back then. Our second generation satellite reach is a hundred megabits per second; again, above average for all U.S. broadband. We've invested heavily. We've built our own payload factory employing hundreds of people. In five years, we've invented three generations of satellites aiming to bring fiber-like speeds to Americans left behind by other technologies. We're still designing even faster versions.

We're disrupting in-flight Wi-Fi too. Not long ago, airborne Wi-Fi meant a terrestrial wireless link so slow and expensive, hardly anyone used it. We now bring satellite Wi-Fi to every JetBlue flight free to every passenger and with enough bandwidth to stream video. It's so popular there's often more connected devices than passengers.

We've expanded to large portions of United and American Airlines too. We're exporting to international airlines, the global airline industry sees satellite Wi-Fi as the future with over three billion global passengers a year and over 800 million in the U.S. We believe competition works.

ViaSat embraces an entrepreneurial spirit and competes with the largest companies in the world. Now, there are dozens of startups and satellite in space and we believe our success helped inspire others, but there's a threat to American satellite growth.

Broadband needs spectrum. Our technology uses spectrum extremely efficiently and we help the FCC open the 28 gigahertz band for 5G while still enabling growth in satellite broadband by sharing the same band. Yet sadly, the FCC's most recent NPRM would take spectrum long allocated for satellite growth and designated almost exclusively to terrestrial wireless. This is the 47 to 52 gigahertz band.

We've been investing heavily in the technology that allows us to use the spectrum in the next five years. Such a policy decision would pick winners and losers and stifle competition. The problem is not in accommodating 5G, it's in taking spectrum away from competitive satellite services and creating exclusivity by regulation. It need not be a zero-sum game.

There's no technical argument against spectrum sharing. ViaSat has put extensive technical studies on the record in spectrum frontiers from independent experts showing satellite terrestrial spectrum sharing can work. There's no policy or reason to limit competition that can bring the best broadband services to American consumers, businesses and government users.

In summary, demand for satellite broadband is at an all-time high. We're providing a service that is competitive with the urban offerings and we are uniquely suited to serving the rural Americans other technologies have left behind. There's much more innovation to come. Technology markets are dynamic and evolve in unexpected ways.

ViaSat is committed to serving all of America. We just need the spectrum tools to do so. Thank you again for the opportunity to appear before you today on these important issues and I'll be happy to answer questions that you may have.

THUNE: Thank you, Mr. Dankberg and before turn to Mr. Spengler, we'll just say we're going have a vote at 10:30. We'll try and rotate members so that we have people here to cover and we'll just keep right on rolling, but thank you. Mr. Spengler?

SPENGLER: Thank You, Chairman Thune, Ranking Member Nelson, Members of the Committee. I'm proud to lead Intelsat, the world's leading provider of satellite services. We have a fleet of 50 satellites - a sophisticated terrestrial infrastructure.

We operate the first truly global network for video broadband that covers 99 percent of the world's populated regions. Our ultimate goal is a world with ubiquitous connectivity and no communications boundaries. To make that a reality, we've invested billions in high- speed satellite technology.

We've been pioneering satellite communication since 1965 when we launched the first commercial communication satellite Early-Bird at the dawn of the Space Age. Four years later, we transmitted the pictures of Neil Armstrong's first step on the moon to the world. Today, 50 years later, we're a public company listed on the New York Stock Exchange with over \$2 billion in annual revenues and we employ a thousand people here in the U.S. with the majority based in McLean, Virginia.

We're committed to taking the next giant leap forward for satellite technology in the 21st Century whether that's launching next-generation satellites or preparing for innovative smaller, lighter ground antennae.

While Intelsat is largely a business to business company, our customers are in media, maritime, aviation, telecom and enterprise networking, the U.S. military and emergency services. They rely on Intelsat to provide broadband video, secure satellite communications and mobility services. In media, we distribute video programming for most of the U.S. broadcasters and programmers including CBS, NBC, Disney, ABC, Fox, Discovery Channel, Turner and HBO.

In the air, we're a major supplier of Wi-Fi broadband connectivity for airlines such as United, Southwest and Delta. And on the oceans, to major cruise ship companies.

In rural America, satellite bridge is the last mile where cell towers and fiber don't reach. In Alaska for example, we help provide connections to enable telemedicine for residents and distance education for K through 12 students and in the US military, we're proud to bring the nation's soldiers, sailors, airmen and Marines the critical communications capabilities they need to carry out successful missions around the globe.

Satellite solutions are uniquely sustainable during natural disasters when fibers cut, cell towers washed away, the electricity is out and other means of communications are down, satellites remain in place in outer space. We provided disaster recovery and emergency services to locations such as Puerto Rico and the U.S. Virgin Islands after the recent devastating hurricanes.

We announced this week that in Puerto Rico, Intelsat is working with U.S. antennae manufacturer, Kymeta and telecom operator, Liberty to deliver necessities and Internet connectivity to residents.

This is an exciting time for the satellite industry given the insatiable demand for affordable connectivity everywhere and of all times, satellite is converging with other telecommunications technologies to build one common telecommunications infrastructure.

Intelsat designed and now has in service a high-performance, next-generation satellite platform, Intelsat Epic. Intelsat Epic offers greater efficiency in the use of spectrum and more powerful and affordable services for customers.

We all know about the connected car, Intelsat is leading the way with a satellite solution for the future where software will be as important to our transportation as the latest design features.

Satellites will work seamlessly with terrestrial networks in a connected car environment. Some applications will run over the wireless network, but cars will get their software updates over satellite.

The broadcast ability of satellite from point-to-multipoint is highly efficient. Car companies can update thousands of cars at once and these connections are more secure. Satellite networks can operate fully separate from the public network, dramatically reducing the cyber threat entry points making automated cars safer for all citizens.

Intelsat is also invested in and partnered with OneWeb to utilize the power of a combined multiple constellation solution that will enhance the worldwide connectivity for mobility, wireless extensions and military services.

Finally, in response to a recent FCC proceeding, Intelsat is leading with a creative market-based approach in proposal that will pave the way for joint use of C-band radio spectrum in the United States without risking significant reliability issues in interference for American television viewers. This spectrum is highly prized for both satellite television distribution and 5G wireless services to millions of American homes and consumers and we've proposed a solution that allows for both sectors to flourish.

At a time when access to secure and reliable communications impacts everything from the economy to national security, Intelsat is playing a major role innovating for our nation's infrastructure. Thank you.

WICKER: Thank you very much, Mr. Spengler. Mr. Wyler?

WYLER: Thank you, Senator Wicker, Ranking Member Nelson and Members of the Committee. Thank you for the opportunity to testify before the United States Senate about OneWeb's mission to bridge the digital divide.

We will spend billions to build the world's first large-scale constellation and launch our fleet in the coming months. We will begin bridging the American digital divide in 2019 by enabling low latency broadband coverage for every home, school and hospital in Alaska.

In 2020, we will reach every square mile of America. This means a brighter future for the nearly half of Americans with substandard Internet access primarily in rural areas. This will be a foundation for ubiquitous 5G service, the Internet of Things, connected vehicles, telemedicine and online education.

Our initial system with peak speeds of 500 megabits per second is just the beginning. Our second constellation plan for 2021 will enable ultra-high speeds beyond two and a half gigabits per second, faster than fiber, direct to every rural home using a small lightweight antenna.

We have a third constellation plan for 2023, which will continue to increase our total capacity until we can support one billion consumers globally by 2025. In total, we look to invest nearly \$30 billion to achieve our mission of fully bridging the global digital divide by 2027 and this will start right here in the United States.

Today, total satellite capacity is a few terabytes per second. OneWeb will add seven terabits per second in its first constellation; over 120 terabits per second in its second and has achievable plans to reach nearly 1,000 terabytes per second -- that's one petabyte per second by 2025.

Over the past few years, we have raised nearly \$2 billion from caring shareholders with industry and distribution expertise including Softbank, Qualcomm, Hughes, Intelsat, Coca-Cola, the Airbus Group and the Virgin Group. To build this system, we needed to break new ground in satellite development.

In March, we began construction of the world's largest purpose-built satellite manufacturing facility in Exploration Park, Florida. This \$85 million project will soon produce 15 satellites per week.

This factory is creating 250 high-paying jobs -- high-paying engineering jobs with multiplier effects for the regional economy. With thousands of satellites to manufacture, hundreds of rockets to order and launch and billions of people to connect to our system, this is not easy, but today OneWeb satellites are under construction, the rockets are in place and our first launch is in May.

OneWeb was founded with the mission of enabling affordable access for everyone and we must do so while protecting our precious spacious environment. I spent the past 15 years on this mission. It's a life's mission and one deeply held by all of us.

In 2003, I began connecting hundreds of schools and communities in Rwanda, building the first fiber in the home and the first 3G network in Africa. With each connection, I saw the impact on individuals and communities. I also saw the potential of small ISPs and telecom operators, which is why OneWeb will partner with rather than displace local operators and aspiring entrepreneurs.

In 2007 I founded O3b Networks which has launched 12 satellites. O3b has the distinction of not only being the fastest and lowest latency satellite system to date, but also the only NGO cell broadband system to not have gone bankrupt, which illustrates the challenges and fragility of this industry. This is hard, but we must overcome these challenges responsibly.

Together, we must lead in setting the global standards for protecting our fragile space environment because the consequences if we do not are dire. Space debris, re-entry casualties -- these are serious risks which come from substandard components and a lack of an adequate regulatory environment.

We know that a single impact between satellites can cost thousands of debris fragments. At OneWeb we recognize the responsibility of being on the leading edge and has the first to launch a large constellation, we have taken great care not to physically overlap our orbit altitude with prior filed systems to reduce the risk of inter-constellation debris creation.

These best practices have been adopted by others as there remain many altitudes for safe space operations.

Ranking Member Nelson, Senator Wicker and the Members of the Committee, thank you for the opportunity to testify today. We know you understand the moral urgency of this mission. We know you see the issues as you visit rural townships and populations where millions of Americans live without access.

We are not here to ask you to get behind us with CAF or other government subsidies, we are here to stand by your side and bring connectivity, jobs and economic prosperity by connecting people in rural America to their opportunities.

WICKER: Thank you very much and thank you to all of our witnesses. Mr. Dankberg, let me begin with you. As you know, I'm from a rural state and many members of this Committee are from rural States and we are very much interested in bridging the digital broadband divide in those areas.

Recently, Senator Cortez Masto and I introduced the Streamlining Permitting to Enable Efficient Deployment of Broadband Infrastructure Act, the SPEED Act and it deals with the permitting process for deployment of broadband. This will give -- this will help accelerate deployment in rural America in such areas as 5G.

As you know, Congress and the President are working on infrastructure and we'd like to deal with that as soon as we get through with the tax package as our next big issue. What are your thoughts on how Congress can ensure that satellite providers can be included in any broadband infrastructure proposal?

DANKBERG: Thank you, Senator Wicker for your question. We are very anxious to participate in delivering broadband more to rural America. The thing that we would find the most useful would be to have a technology neutral policy, which would allow whatever infrastructure investment is made to deliver the greatest amount of broadband service to the greatest number of people with the best service at the lowest prices.

Now, that would be our suggestion for getting the most value out of investment that we make.

WICKER: Well, okay. Technology neutral -- in terms of where we put the, investment should this be done at the FCC level or according to the statute?

DANKBERG: One of the opportunities in the CAF program that connect Americans on program has been listed -- mentioned already. The Connect America Fund program has a concept of a reverse option where different providers using different technologies could make bids to say how much would it cost to deliver this broadband to this area with these features? And there are different technology attributes that the FCC has looked at.

One of the dominant ones is speed. Another one is bandwidth. Third one is latency. Fourth one is price. What we see in the market and our experience in the in-flight connectivity business is a good example of this is that the things that really dominate users' perception of the quality of broadband is the speed of service that they get and the amount of bandwidth that they get. That is not having to have usage caps that would limit the amount of bandwidth that they use and the next one would be -- it's tied to both of those would be price.

So our recommendation would be to use something like a reverse auction process, but to use market-based factors that would reflect the desires of subscribers for getting the best service that they can and that would also allow the government to achieve the greatest penetration of subscribers that is possible given that amount of money.

WICKER: Are you -- we are going to need to amend the statute on that or does the agency already have?

DANKBERG: This so far, our perception is that the FCC has not weighted it in a market reflective way that the weighting that they've put on latency is so high that a satellite service -- I'm going to give you an example, a satellite service that would deliver 100 or 200 megabits per second at a given price and too more people would be penalized so severely that a lower latency service of even 10 or 25 five megabits per second may be selected in the auction.

We don't think that those weighting factors accurately reflect what subscribers really want in a broadband service.

WICKER: Ms. Cooper, were you wishing to weigh in on that issue?

COOPER: Yes, thank you, Senator. We agree that there's some review needed of any program that's looking at broadband partly because you want every tool available to you as you try and reach every citizen in your state.

For the Connect America Fund, we've found for us the latency issue is not our chief concern because we believe our low earth system will have latencies in 25 to 35 milliseconds, but we've found an area where satellites have simply been precluded from bidding because the last generation of satellites didn't meet some of those speed and latency requirements.

So instead of a wholesale exclusion of an entire category of technology, we would just recommend that the Committee look at any of the programs or Federal incentive or infrastructure programs to ensure that anything that qualifies, any technology that meets those requirements can bid.

I would just say that satellites are sort of structured differently in that the incentive is not to build the infrastructure. All the companies here are investing and building in the connectivity. The infrastructure on the ground, whether it's to an end location, a terminal for the consumer or potentially some gateways to manage traffic is where that sort of scale is going to come in and we may end up coming back to you with some recommendations to make sure those elements can be captured as well, but none of us here, certainly not SpaceX are counting on that investment in our space constellation to come to fruition.

WICKER: Thank you. Ms. Cortez Masto, it appears you are next. The last shall be first.

CORTEZ MASTO: Thank you, Mr. Chair. I know my colleague, Senator Sullivan has to preside, so I defer to him.

SULLIVAN: Thank You, Senator Cortez Masto and Mr. Chairman, if this cannot come out of her five minutes, I just have one quick question before I go preside and it's to Mr. Wyler. You talked about space debris and Senator Booker and I have had some concerns about this.

The Department of Defense Space Surveillance Network currently tracks 22,000 pieces of orbital debris that no longer serve a useful purpose. Can you and perhaps Ms. Cooper, if you want to weigh in on this, can you talk about what your concerns are and who do you think in the kind of constellation of Federal agencies we have -- nobody seems to be in charge -- who should be in charge?

WYLER: Thank you for the question. It's very important, Senator Sullivan. One -- if there is a collision of satellites, we will -- all the opportunities you heard today, all the wonderful things we could do for humanity and rural populations will vanish in the blink of an eye.

We cannot have that.

We can we have to make sure that all of the satellite systems have their own altitudes, that they're not all at the same place physically at the same time and so, while we're tracking 22,000 space debris, a huge number of space debris was created at about 800 kilometers a few years ago when Iridium and Kosmos satellites hit each other creating thousands of new fragments to track.

These fragments then hit each other again and created new fragments, creating more and more space debris. The space debris numbers rise and they will impact and have impacted many other satellites.

So the important thing to do first of all is to just keep things separated, make sure everybody's at their own altitudes like airplanes or cars driving on either sides of the roads. This is a physical issue.

Now, who should oversee this? That's a very interesting question. Right now, the FCC does not have the tools to do it. NASA is studying this at great length and the FAA is looking into it. It's really up to you in Congress and the House to determine what we should be doing next and form some sort of a Committee and oversight and take the lead for America in what needs to be done because we will lead this for the rest of the world, which is asking the exact same questions.

SULLIVAN: Thank you and Mr. Chairman, I'd like to yield back fulltime to Senator Cortez Masto who was kind enough to let me skip in line, so I can go preside. Thank you.

THUNE: Thank you, Senator Sullivan and we'll go to Senator Cortez Masto.

CORTEZ MASTO: Thank you. Thank you, Mr. Chair. Thank you all first of all. Great conversation today.

As you know, I'm from Nevada -- 17 counties, 15 of which are rural and rural broadband is so important so I think this conversation is incredible, very excited about the future.

I want to follow up on the line of discussion that we've had though, about the use of reverse auctions and the process that should be allowed to reflect the consumers wants and I appreciate you bringing up speed, bandwidth, latency and price.

Can you talk a little bit about how proposed satellite Internet offerings and what they provide to consumers? Do your proposed satellite Internet offerings provide consumers with unlimited broadband access or are there going to be data usage caps imposed to manage that capacity.

I'll ask all of you, whoever yes. Thank you.

DANKBERG: Yes, I'll start with that. Yes, so we have plans of both types. We have both effectively unlimited plans and we have plans that have usage caps. The plans that have the usage caps, we try to set the usage caps at levels that most people would not hit.

What we have found in the market is that hitting the usage caps is basically the greatest source of dissatisfaction for users. So in our new satellites, what we've done as we've put -- and I mentioned this in my testimony -- we've put more than double the bandwidth that we had in our first generation satellite and in our second one, and we have the third generation that we're building is 10 times and the upshot of all that is that we're working on plans that will eliminate usage caps for more and more of our subscribers that will be able to go to market with competitively priced plans without usage caps.

CORTEZ MASTO: Thank you and that was -- my follow-up was, is it going to be cost-competitive and that's the intent is to be cost- competitive and do away with users caps?

DANKBERG: Yes, yes. That's is exactly right.

CORTEZ MASTO: Okay, I'm happy to hear from you...

COOPER: Thank you for that question. I think like Viasat, SpaceX is an engineering company. We love solving difficult problems and the limiting factor here is the amount of capacity that you have on orbit that you can share among your consumers and customers.

For our part, we are looking at pushing the boundaries of the capacity of each satellite and then of course having many of them over 20 and viewed from any spot in the U.S. so that customers can aggregate capacity where there's a concentration of demand and diffuse capacity where those end-users are in different more widely geographically dispersed locations.

By building more capacity on orbit, will be able to manage our network and groom our capacity in a different way. We're still several years away from providing customer service, so we can't answer with the kind of specificity that Viasat can with their existing customers, but the real trick that we're focused on now is removing the upper limit of capacity constraints that drive those kinds of network management questions.

CORTEZ MASTO: Thank you. I didn't know if the other...

SPENGLER: Yes, Intelsat is a bit different than others on the panel today. We are a business-to-business provider. We're providing infrastructure to operators. It could be a wireless operator that's looking to extend services into remote and rural areas. It could be a provider of Wi-Fi in-flight broadband or they use our network.

So our responsibility and our focus is developing that infrastructure that is extremely efficient, very cost effective, delivering the speeds that those providers need.

CORTEZ MASTO: Okay.

SPENGLER: And so the end-user customers are really the customers of our customers and partners.

CORTEZ MASTO: Okay.

WYLER: So all this talk of subsidies is confusing for me as an entrepreneur. We've raised billions of dollars and are raising billions more because we're building a system that can operate and meet the needs of the people -- not meet the needs only if the government gives us money to help it meet the needs.

Now I cut my teeth in Africa building systems for people who made, you know \$2.00 a day, you know, so they of course couldn't afford subsidies, but we had to build a system that could meet their needs, right?

Because in those countries, they don't have anybody giving them anything. So if we were to raise this kind of money to build a system, it really needs to be able to operate without subsidies. It needs be able to provide services at affordable rates for the people in these communities, so that's for all the subsidy conversation.

I think we're in this point where it's like subsidies are given, "Now, let's figure out how to dish it out." Well, why don't we invent technologies that doesn't need -- that don't need subsidies like most every consumer product people in this room today buy?

So this is where I'm sort of trying to figure out, I think we're taking the subsidy as a given as opposed to saying, "Maybe we should have technologies that don't need it and focus on that."

CORTEZ MASTO: And your technology is one that will address the consumers and even the consumers...

WYLER: We're addressing where the hardest hit -- this is this is where I spent my time. We're just we're addressing the system to focus on the people that are in most need and to do it in a profitable way to meet their needs and provide broadband that gives them oxygen- like capacity.

They wake up in the morning, they have it. They don't think about it just like we take every breath every day.

CORTEZ MASTO: Thank you. I know that my time is up. Thank you very much, appreciate you being here. Thank you, Mr. Chair.

THUNE: Thank you for Senator Cortez Masto. Senator Hassan.

HASSAN: Thank you, Mr. Chair and thank you and the Ranking Member for holding this hearing. To our witnesses today, thank you so much for being here and for the work you do.

Mr. Wyler and Ms. Cooper, I just wanted to start with a question for the two of you and first of all thank you for your testimony. I come from a very rural and geographically diverse state. We're small, but we've got mountains, we've got seacoast and just a few weeks ago, thanks to the Chairman and Ranking Member, we had a field hearing in New Hampshire to explore the issue my constituents face when it comes to connectivity and one of the more humorous parts of the hearing was when one of the providers said we have to be careful not to build duplicative capacity and my constituents are like we just would like capacity you know we're not worried about duplication yet.

So I guess the question is how can satellite provide a broadband solution for states like mine and what's the role of satellite in a 5G America especially with so many of our places even though the maps may say we've got connectivity, but in reality our citizens will tell us they don't.

So Ms. Cooper, why don't we start with you?

COOPER: Thank you, that's a terrific question. I think it's the problem that all of us here are geared to solve using different architectures and different technology approaches, but I think it underlies the goal that all these companies here on the panel have.

For us, we are looking at these constellations of satellites with multiple satellites in view so that you're not bound to one single path to reach a specific satellite. You would have multiple paths and multiple satellites, which we think will allow some currently blocked customers to have access to an infrastructure of high speed capability and reliability.

And then the next step is to make sure that the customer can afford a service that it is appropriate to what their demands are and that's the next step of ensuring that you drive the cost down of making lots of satellites, which is I think a strong suit of SpaceX and using our manufacturing and innovation history to drive the costs of other complex satellite and launch systems downward.

And also then, the cost of deploying those systems has to be driven down. Certainly, a factor of our launch heritage -- reusability.

So all those pieces bring to bear these two problems. One of them is making sure you actually can reach the customer and the second is making sure that the infrastructure that you're building that will be available always on is cost effective and easily deployed from an architecture perspective. That's I think our approach is.

HASSAN: Thank you and Mr. Wyler, did you want to comment?

WYLER: Sure, sure. Growing up in Boston on the border of New Hampshire and spending all the weekends there, I know your state well and understand the issues and the challenges especially when you get in the White Mountains where you actually can't see through the mountain hit satellites and so lots of people and this is sort of the same problem in Alaska and a lot of the northern states with a lot of satellites, you can't see -- you literally just can't see them.

So our satellites remain very high in altitude, just almost straight up at all times. You always have a vision of one or two or multiple more satellites at a time. The key is the terminal. The key is to have something small, lightweight, inexpensive and it's -- the size is actually less important than the weight and the cost and that's where people get...

No one in rural New Hampshire, they're not going to care whether it's one foot, two foot or ten feet. They're going to care -- is it cheap? Can I install it easily? And do I get really good Internet access?

So what we're doing is bridging towards flipping rural on its head. We're making rural faster than suburban and so there's no reason that we're all to have that penalty.

HASSAN: Okay. Thank you and yes, Mr. Spengler.

SPENGLER: Yes, I just wanted to add to that. I think we all believe that to bridge the digital divide, it's going to take a combination of a lot of different technologies to get there. It may be direct-to-consumer by satellite. It may be enabling terrestrial networks in new ways, but I think people don't realize today that satellite is currently in the backbone of a lot of wireless networks around the world who are providing 2G and 3G services and in lesser developed countries and Intelsat today is providing 4G services, helping wireless companies extend their network in 4G in the U.S.

So 5G is an extension of that and we firmly believe that when it comes to rolling out 5G across the country, it is not going to get everywhere without the support of satellite and satellite solutions are going to be essential to reaching those hard-to-reach locations and extending those capabilities out there in the future.

HASSAN: Thank you. Mr. Dankberg, did you have anything to add?

DANKBERG: I think that satellite today -- if you look at -- we think a great model of satellite TV where over 30 million people have satellite TV and our ability to provide satellite Internet basically corresponds exactly to satellite TV -- a competitive service.

HASSAN: Well, thank you. I see my time is up. I have two other questions that I'll submit to you for the record. One about planning for resiliency in the light of natural disasters and the other, about debris in space and I look forward to your answers. Thanks.

THUNE: Thank you Senator Hassan. Senator Nelson?

NELSON: I saw firsthand what satellite communication does in a place like Puerto Rico since so much of it was you couldn't communicate because there wasn't primarily electricity even though they were bringing in temporary cell towers, so I was provided a satellite phone when I went.

I'm curious as we're going forward, talk about the role that your satellites will play with regard to something like autonomous vehicles.

SPENGLER: I could start, so as I mentioned in my opening remarks, we see satellite as playing A -- important role in the connected vehicle and again, the connected car is not just going to be connected by satellite, it is going to be connected by all sorts of wireless technologies as it is today and we know that the cars are getting more and more sophisticated.

So it's leveraging each communications technology for its particular role and leveraging its strength to provide a safe environment for cars and safe environments on the roads that will ultimately lead to the fully autonomous vehicle.

What we're working on is a technology partnership with an antenna company that will shrink satellite antennas so that they're small enough to fit into the roof of a car, the company is called Kymeta and this will enable software downloads, mapping downloads on a point-to- multipoint basis to thousands and thousands of cars at one time, keeping that data up to date is going to be essential for safety and enabling those future features in cars.

NELSON: And how does that integrate with the GPS system?

SPENGLER: Well, GPS of course is connecting cars today and it already exists and so, it is all going to be tied together through software and systems in the car at one point in time to make sure that they're all working together to enable a safe environment for passengers and on the roadways.

NELSON: And as you answer Mr. Wyler, also bring in spectrum. There's a real competition for spectrum by terrestrial based broadband services, as well as satellite. So what's the right balance?

WYLER: Excellent question and I like that you started this off with First Responder because this was actually an initial focus we put a lot of resources into developing an antenna that would go on a top of a car or be built in which also includes LTE and 3G connectivity for the passengers and the surrounding area and a unique feature of this for a First Responder -- so imagine a fire vehicle, a fire truck and you put the antenna on it and wherever you go, when the AT&T or Verizon signal falls down, it's listening to the signal strength and it turns on in milliseconds maintaining your call.

It tells your phone, "Hey, I'm here. I'm your local antenna." When the signal strength is low and then when the signal strength comes back up it, automatically shuts off. A unique feature of this is as the vehicles come together, they actually know where each other are and form their own network.

So you could walk among the vehicles with your normal cell phone and be using your current cellular operator whichever you have in any country of the world, so this would be unique and important for places like Puerto Rico for instance and Florida where hurricane comes and every police officer and every fire vehicle on every emergency vehicle will actually be its own cell system with the resiliency that satellite brings it.

NELSON: So Ms. Cooper, now there are a dozen applications in front of the FCC for various new satellite constellations, so what does the challenge posed to your company and how are we going to have coordination and spectrum sharing protocols in the future?

COOPER: Thank you, Senator. Part of that space Renaissance that I referenced is an excitement about using this concept of low earth orbiting satellites to solve complex problems on earth. There were 32 different proposals filed at the ITU and 11 of those companies have filed either to ask for a U.S. license for their constellation such as ours or a license to provide a foreign system with service to the U.S.

Not all of those will succeed. This is a complex set of problems. There's an engineering and design and investment and concept and bring to market problems that all need to be kind of brought to bear.

Companies like SpaceX love to solve these kinds of difficult complex problems and we think we have a real edge because we can draw through our design and manufacturing techniques and our launch capability to deploy this kind of system.

The FCC has done a terrific first step to review and update the rules for this kind of satellite constellation, which hadn't been updated in about 15 years and they rightfully put the onus on sharing spectrum on the operators to share and negotiate and coordinate and if they can't come to agreement, the FCC will designate and split the bands.

Every applicant in the round said that is the least effective outcome -- is to have the FCC dictate and divide and designate spectrum. So the best outcome will be between smart systems that are incentivized to continue to innovate and incentivize to continue to coordinate and this is also true internationally. The ITU has similar encouragements internationally for other governments to apply, for systems to coordinate operator to operator and make the best use of the airwaves by applying those negotiations and smart technologies. Thank you.

THUNE: Thank you, Senator Nelson. Senator Gardner?

GARDNER: Thank you, Mr. Chairman. Thank you all for your testimony and time today. This is an incredibly exciting technology that we continue to develop and you continue to deploy and I thank you for it.

It used to be when I was growing up that satellite communications had sort of a James Bond feel to it. If you saw a satellite phone, it was the size of a cinder block and it was really amazing that you could see that and we've advanced then to, you know, cell phone technologies in the bag that dimmed the headlights on the car when you plugged it in.

So then you know we see this -- what I think you've done is sort of a democratization of satellite technology through broadband deployment and it's incredible particularly for a state like mine where we have vast swathes of rural areas from sort of the high plains in the east side to the beauty of the mountains and the valleys as a result and some of the challenging terrain when it comes to communication in the western part of Colorado.

And so Mr. Dankberg, obviously I greatly appreciate your presence in Colorado, the work you do, the hundreds of employees that you have there, I appreciate what you do to help connect all of us.

My staff informs me they are not pleased with your connections on in-flight satellite efforts because I can send them e-mails and articles, and they're very upset at that, but I appreciate it so thank you.

In the 1980s, your business was started -- grown dramatically since then, you talked about in-flight satellite. We have had talk on autonomous vehicles, vehicle to vehicle communication, and what satellites can do in terms of that. What other areas can satellites provide for that unique niche to, as well as satellite technologies that may be preferred and certain circumstances, if you talk about those two ideas?

DANKBERG: Yes. Thank you, Senator Gardner and also thank you for your leadership on the airways bill and your recognition of the importance of satellite. One of the areas that we haven't talked about very much is our national defense and Homeland Security and satellite provides capability to connect people anywhere and to protect them and there are many applications that we do for the Defense Department with satellite communications, we identify the locations of friendly troops and avoid fratricide is a very important application.

One of the things I mentioned in my testimony is that we provide Internet connectivity to the entire U.S. VIP fleet including Air Force One, Air Force Two so that that the leaders of our country can remain in contact them with the ground no matter what's going on and get up- to-date information over the Internet.

Another really, really important one is for our troops overseas and so one of the big advantages of the satellites that we've developed that have so much more bandwidth and conventional satellites is that we can make very, very small terminals and put them on platforms like helicopters and so V-22 Marine Corps now have the ability to remain in contact with their troops while in flight at broadband speeds.

We also provide support for Border Patrol as well whether it's in the oceans or over deserted areas. All of these areas are very uniquely suited for satellite and then the other point is the types of satellites that we're making are so new that the amount of bandwidth we provide is on the order of a hundred times that which is available through organic DoD satellites.

So the Department of Defense is a very heavy user of commercial satellite systems especially ours and the networks that we provide.

GARDNER: Do you think about the advancements if you go through some of the documentation of September 11, 2001, you talked about the experience that President Bush was having on Air Force One while they were watching what was happening on that day. They were relying on over-the-air transmission, right? They didn't have a feed that can give them consistent reliable communications to watch the news to see what was unfolding.

Now, of course you can provide that, so I think again, just the national security component of this is so critical and shouldn't be overlooked and Ms. Cooper, you talked a little bit about the constellation efforts that you've that you're making at SpaceX. So you mentioned in your testimony that there would be prototype launches over the next several months and if you need, you know, the space for launch, we certainly have plenty of space for launch in Colorado.

With the launch campaign beginning in 2019, with phases of satellites launching through 2024, I mentioned the wide swathes of Colorado. If low latency, high-speed satellite constellations were an option for rural constituents in Colorado, it would mean obviously a big step in -- sorry -- a big step in overcoming the digital divide. When do you think constituencies like mine in rural Colorado -- rural America can benefit from this? Would they see it in 2019? How long would it take? Would they be the first to benefit from this? How would that look?

COOPER: So our current deployment plans have us sending up two test satellites within the next few months, so we can verify the technology we've been designing and building from scratch and then starting our launch campaign in about 2019 and launching the entire constellation over the course of about five years.

So we would expect to provide commercial service as early as 800 satellites deployed, which is probably in the 2020 -- 2021 timeframe. Certainly, it would be available throughout the United States including in Colorado. As a Kansan, we'd like to help you out.

GARDNER: Well, just don't take our water. That's all I ask. So just the final thing and I don't want to wrap our time here is -- the CAF2, you mention tech neutral language for things like CAF2 funding, I think it's very important. I didn't get a chance to ask. I'd ask you and Mr. Dankberg for the same question, but I think that's very important that we have to make sure that tech neutrality remains a central element of the work that we do. Thank you for your time.

THUNE: Thank you, Senator Gardner. Senator Inhofe?

INHOFE: Yes, thank you, Mr. Chairman. You know being new on the Committee, I'm not as familiar on some of the rest of my -- with these issues however, Mr. Dankberg, I have been the Ranking Member on the Senate Armed Services Committee, we're very interested in the applications that we have that we enjoy.

How are we with our competition over there? Tell me who else is out there that that we're competing with in this room?

DANKBERG: Which other nations?

INHOFE: Yes, yes. Well, adversaries. I won't ask you to make you that determination who our adversaries, but go ahead.

DANKBERG: Yes, so satellites have been very, very instrumental and used in the Middle East and in Africa in dealing with ISIS and terrorists in terms of surveillance reconnaissance. The issue is that now we're dealing with potential and more near pure adversaries and we have a number of issues and vulnerabilities.

And so the things that I've described that provide more bandwidth to end-users also provide more resilience and jam protection to our forces in the field. The good thing is that largely because of the American system and the opportunities in the U.S., the U.S. -- it is really important, I think this is an area -- the types of technology that you've heard from everybody in the panel is an area where the United States has clear technology leadership over pretty much every country.

And we do work internationally including all of the countries including some that may eventually be adversaries. I think that making spectrum available and providing a supportive environment for satellite will keep us in the lead relative to all of our adversaries.

I think we do have a strong lead now in satellite communications.

INHOFE: Yes, where are we with Russia right now?

DANKBERG: Again, so the Russians in terms -- the underlying technology that we've described and all of us are describing is what's called spot beam satellites. So the spot beam satellites basically reuse frequencies extremely efficiently. You've heard about that at both LEO and GEO. No other country has the technology yet that we do for spot beam technology. Probably a factor of 10 behind what we've been doing in the United States, but I can tell you that Russia, China, India, Brazil -- all of the spacefaring nations are very, very interested in this and if we don't support our satellite industry, I fear that we could fall behind.

INHOFE: Yes, Mr. Spengler, did you want to make a comment?

SPENGLER: I just want to add just something to that and I agree with everything that Mr. Dankberg said about the importance -- the tactical importance of satellite communications to military missions for our military, but just maybe to take his last thought a little bit further.

It is vitally important that the commercial satellite industry is integrated into the strategy and planning of military SATCOM as well and what we've seen over the time period of recent conflicts is how critical the commercial industry has been to those missions and we think that it needs to be sustained in a very resilient way that we can integrate strategies commercially and with MIL SATCOM to provide this leadership well into the future.

INHOFE: Okay, appreciate that. Mr. Dankberg, we -- I appreciate also what you're doing in my state of Oklahoma. We've got some 20,000 homes with you and of course when you put this on American Airlines, all that installation takes place in my home city in Tulsa and I know that some of the rest of you are actually launching satellites right now to reach some of the rural areas, which I'm concerned about in Oklahoma.

But Mr. Wyler, I know that you're not -- it's not the same company you had when you and I talked before when you talked about your activities in Africa and it's a different company now. Are you still involved in Africa and I'd like to use the rest of my time having you explaining to me. I just got back from Tanzania going through to Burundi, Ethiopia and I've kind of specialized in Africa now for 20 years. So I'm interested in the problems they're having over there, how I can be of help to some of these countries because they look to me and as one who might be able to help them, so would you comment on that?

WYLER: Sure. Thank you. Thank you. Africa, obviously I spent a great deal of time there and the challenges if you look at the 17 STGs and the United Nations, all these challenges about gender equality and water and education -- every single one of those challenges, the underlying requirement is connectivity. You can't measure it. You can't manage it without connectivity.

And so Africa is just like America in our rural areas. There is no ability to bring broadband because the terrestrial infrastructure is too expensive. We still spend a lot of our energy with Africa. I've been working with a lot of African nations and the government of Rwanda is an investor in OneWeb as well as many other places around the world.

So we're -- they're counting on us to help solve this problem, help to bridge this divide because the cost structure of other technologies is just too hot.

INHOFE: Well since you mentioned Rwanda because I had dinner with Paul Kagame just less than a week ago and he brought this up and this is a great concern there, but go ahead.

WYLER: Yes and he's becoming a Chairman of the African Union and leading the technological revolution of Africa. So Africa is going to have more youth than any other continent in the world over the next 10 years. It's growing a very fast in population but, it's also growing in economy. The economics of each country is growing really fast and they're using -- needing and utilizing more broadband.

If we stranglehold that broadband in any way that continent will have trouble growing. It will have trouble allowing the youth who are hungering for information to experiment and understand.

INHOFE: Yes, well my time is expired, but maybe for the record because a couple of other countries have brought this up to me. One being the Prime Minister of Ethiopia that has a great deal of interest. Thank you, Mr. Chairman.

THUNE: Thank you, Senator Inhofe. Senator Peters?

PETERS: Thank you, Mr. Chairman and thank you to our panelists. Very great testimony here today, certainly an important topic, an exciting topic for the future. We appreciate you sharing your thoughts here today. This industry has been around a while and we've been in space a while and now we have thousands of active satellites orbiting the Earth with thousands more rocket bodies and hundreds of thousands of pieces of debris cluttering near-earth space as well.

On top of that, the companies that are here before us, you're going to be putting more stuff up into space as well and we've been very fortunate I think so far, we haven't seen any high speed collisions or limited number of those at least, but certainly each collision as you know exponentially increases the odds of having other collisions as a result of the debris that's thrown out there.

So Mr. Wyler, my question to you is that your testimony provided some detail about your debris mitigation strategy and how it exceeds U.S. government's best standards which you cited as being outdated that we currently have, would you propose that the mitigation strategies your company is following namely the 125-kilometer minimum altitude spacing and five-year limit for deorbit could be followed as a best practice for the whole industry?

WYLER: For sure. Space debris as you mentioned is a critical component and everything we're talking about doing for Africa, it will be gone if we end up with a space debris problem because our orbital altitudes will be gone.

So the 125 kilometers which was actually adopted as well by Boeing and others have been keeping orbital separation is really, really critical to making sure that if there is an intra-constellation collision where one operator might have failures of satellites and smash into their own satellites that those debris will have a limited limitation on how much debris they cast into other altitudes and your own University of Michigan students who now work at OneWeb have done a lot of calculations on this to show the tail and the falling off, so you have -- of looking at both debris greater than 10 centimeters and greater than -- or less than 10 centimeters and if you look at that, it really starts to dive off around 125 and 150 kilometers.

The total amount of debris that makes it -- if you -- when you model two satellites hitting each other using the NASA debris orbiting models, so that's the space -- that separation is critical. It's just like lanes in a highway. I mean, you have you can't be going in the same place at the same time.

PETERS: Well, certainly we don't -- the benefits are pretty clear as you just articulated. What are some of the challenges for us to be able to accomplish that? Well, I think it's really a regulatory question because it's really -- it's very easy to do and there's plenty of altitudes for people to be in and everyone knows where everyone else is.

So we filed and put our satellite constellation out there years before everybody else in terms of this Renaissance and the people before us, the Global Star and Iridium. We kept a good distance between them and so most everybody usually respects the filing systems and says, "Okay," there's where these are I'm going to be away from them so I don't have a chance of any erroneous issues causing a catastrophe.

Right now, there are no rules. I mean, no substantive rules. That's why we don't even quote the current rules because it's really not relevant. They were done in 1967, so the Outer Space Act, right?

So the big challenge is for America to take a leadership position in this and then call in other nations and say, "Other nations, this is what we're doing. Would you join us in this? Can we talk about this?" But we're already taking these constraints upon our self and other nations will follow the yearning too.

I saw at the FCC because of all these different constellations and ideas and concepts have been sort of put to them. The FCC has gotten letters from other nations and other European Space Agency and other space agencies saying, "Please don't -- you know -- be very careful. It's not just your space, right?" So we have to be careful, but we have to -- and it's a global world, but we have to take a leadership position and have every -- all of these other nations follow us and we have that opportunity today.

PETERS: I see the other panelists shaking their heads, so I want to give them an opportunity to weigh in as well. Ms. Cooper, you want to start?

COOPER: Absolutely, I think you'd be hard-pressed to find a company with more invested in the future of space than SpaceX. We certainly count on a space environment that allows for future inventiveness and exploration and we've approached our constellation with that responsibility in mind.

I would just add there are a couple of other elements to this. We absolutely will participate and continue to drive forward the caliber of operations and expectations for space operations. There are a couple of other elements I wanted to add. The first is, you know, the design of the spacecraft itself is important, the materials you choose that the spacecraft burns up on re-entry, the compartmentalization of systems that you can maintain control even if you happen to get dinged by the harsh environment of space, your survivability and your resilience in space is important, your concept for how you operate on orbit is also important, the ability to maneuver in that in that sort of sandstorm of space, your plan for how to respond if there's a collision and how to deorbit at the end of your operations are all critical.

Finally, you have to know what's on orbit, not just the other spacecraft, but the debris and we would really like to continue our conversations that we've been having with the Department of Defense and with NASA on how to continue to improve the quality of inputs about our understanding of the space environments that we can maneuver smartly when there is (inaudible).

SpaceX is designing our satellites to be able to maneuver thousands of times in their lifespan and we're bringing to bear the reliability that NASA entrusts for us to take human NASA astronauts to the space station to bear in that responsibility of operating in space.

I know that the FCC is about to issue some new rules for very small satellites, cube SATs, micro SATs particularly the kinds that are used for experimentation and we think that's the kind of leadership role that the U.S. needs to take not just for the U.S. environment, but for the global space environment to balance the role that space can take for research and inspiration and also preserving that environment for future activity.

PETERS: I appreciate that. My time is expiring, but Mr. Spengler you've been -- if you could be brief your concurrence...

SPENGLER: Sure...

PETERS: With what you heard.

SPENGLER: We've been operating in the geostationary orbit for decades and that's an orbit with hundreds of satellites, not thousands but -- and there's been defined rules on how to operate there and this has required a lot of cooperation between satellite operators to share that space well.

We took the initiative with several other operators to create the Space Data Association to enhance that engagement with each other, so that in that arc, the industry itself is taking ownership and responsibility for sharing information and making sure that it's safe and secure for the long term, but now when you're talking about thousands of satellites in the lower earth or mid earth orbit, it gets more complex and I agree with Mr. Wyler.

I don't think we can just leave that up to industry cooperation, we're going to need some help and leadership from government to help make that a safe and secure environment for well into the future as well.

PETERS: All right, thank you for your testimony. I appreciate it.

THUNE: Senator Blumenthal?

BLUMENTHAL Thank you, Mr. Chairman. I'm concerned about some of the reports that we've seen from the intelligence community and other sources that Russia and China and perhaps even terrorist organizations are pursuing a range of anti-satellite technology. In fact, efforts designed to threaten our military effectiveness and the satellites that may be used for civilian purposes.

Other countries are aggressively developing the jamming and hacking capabilities that could cripple our military technology and surveillance -- our navigation systems and communication networks, these technologies can be unleashed on civilian capabilities as well including commercial satellites.

So my question to each of you is how concerned are you by the potential hacking capabilities of other countries or other hazards that may come from them or from non-governmental threats.

COOPER: Thank you, it's an excellent question and as a company that operates one of the most technologically sensitive activities, launch capability, we take this very seriously and have deep experience and heritage in the protection of those systems that we will bring to bear to this satellite system.

I would also note that the supply chain has a particular vulnerability for Space Systems and we have chosen to bring a high percentage of our manufacturing in-house and maintain U.S. control of that and we're proud that our satellites will not only be built in the U.S., have a high U.S. content, they'll also be launched on U.S. rockets from U.S. soil without any involvement from foreign launchers or certainly Russian capability. Thank you.

DANKBERG: Yes, I think -- thank you, Senator, I think it's a very, very important question because we work with the military and the Defense Department, we do get support from them on dealing with especially cybersecurity and we also provide cybersecurity for defense satellites.

So we have a good understanding of what the threat environment is, but I do believe that for a privately held company to deal with state actors is probably more -- asking more than those private kind of held companies are capable of.

I think the U.S. has taken -- has had dominance in space for so long that in some sense we may take that for granted and I think it's not a not something that we should take lightly. One of the solutions that we think is definitely possible is the types of satellites that we're talking about for commercial are so much less expensive and so much -- so easy to replicate that that's one of the ways that we at least, from a national defense perspective can obtain some amount of assurance that we'll have a reliable capability in space is to use whether in the geosynchronous arc or in the low orbit arc, multiple satellites that provide the capabilities that we need, so we can make the economics of damaging our capability in space overwhelmingly expensive.

SPENGLER: As a provider to U.S. military DoD and other applications, we have built our network with the highest level of cybersecurity for those specific customer sets and have a regular engagement and dialogue with that sector. So we're very familiar with their issues and the challenges that has even led us to design our current generation -- next generation satellite Central Side Epic with some very specific feature sets that manage and deal with intentional jamming and hacking that can occur on tactical missions that could be absolutely devastating if they're not dealt with quite quickly.

So it is it is critically important. There's no question about this and it's where we have continued focus in these areas.

WYLER: So cybersecurity is obviously very important, but I'll bring up something else. China not that long ago shot a satellite at a thousand kilometers from the ground. They're not the only ones that can do it. If you put all these satellites in the same orbital altitude, you're literally shooting two birds with one bullet.

Orbital spacing allows one satellite constellation to have a calamity without involving the other satellite constellations. So as the U.S. government which has been very actively looking at how installations can provide very high speed low latency connectivity for its troops in the field. It should want -- I assume it will want that with resiliency and that capability and that assurance of continued service and not make it really easy for a competitor or another nation to take out the entire thing at one shot.

BLUMENTHAL: I think these answers have been very illuminating. My time is expired and even if I had another power, probably we would not have enough time to exhaust all of the important ramifications of this area, but essentially space is lawless right now. Space is the Wild West and it's vulnerable to cyber, to physical interference as you've just suggested with missiles launched either from space or from ground and we need to be prepared for the threats to our commercial and civilian satellites as well as to the military satellites that we have there so, thank you, Mr. Chairman.

THUNE: Thank you, Senator Blumenthal. Senator Markey.

MARKEY: Thank you, Mr. Chairman very much. We have come a long way since Intelsat and Inmarsat had a monopoly and I always enjoyed back in the 1980s and 1990s helping to break up the monopolies and to make it possible for there to be more competition and we have come now to a new era and this requires a lot of thought in order to unleash all of the potential for good which is out there. So Mr. Wyler, if I can begin with you, you've raised a lot of money. You're going to deploy a lot of satellites and I guess my big question to you is the softball right across home plate for you. What's the difference between you and all these preceding companies that have tried to achieve the very same result in space in terms of providing low-cost access to the Internet to citizens not only in rural parts of America, but around the planet?

WYLER: Thank you for the question, Senator Markey. I get asked this a lot of times and why now? Why can we do it now that we couldn't go before? Because a lot of people have tried. We've known the potential, but we haven't had the technology to accomplish it.

I think it starts -- our system as you had me testify ten years ago maybe 15 about deploying fiber-to-the-home in Africa. It starts with understanding who needs what and the needs of those consumers and those people in these rural populations and designing for the lowest common denominator of customer. How do you build something that's affordable?

We had an earlier conversation about CAF funding and all these subsidies were -- why are we talking with subsidies? We should be building something that's affordable in the first place for the GDP adjusted cost structure of the environment that we're going to be serving.

So what's happened now is that we're able to provide a service that is very low latency, which is key to the 30 very low latency...

MARKEY: Low latency means what?

WYLER: Latency is the round-trip time between you and the server on the other side. So you send the signal up to the satellite down to some gateway some server and then back.

MARKEY: You mean it's fast?

WYLER: It's fast.

MARKEY: Okay yes. It's another way of saying low latency...

WYLER: Fast.

MARKEY: Okay, fast.

WYLER: When you click, it shows up.

MARKEY: Okay, yes, I got it.

WYLER: And there are a lot of standards for this, for instance...

MARKEY: Our job is to translate it to English all acronyms, okay that our constituents understand what we're talking about.

WYLER: It's super critical for things like AR and VR which...

MARKEY: For what?

WYLER: Sorry, virtual reality, okay and augmented reality so the ability to create a video game on this table while you watch with your new iPhone, this requires very low latency. This need...

MARKEY: Very -- it can move very fast...

WYLER: Very fast.

MARKEY: For reality and for augmented reality.

WYLER: And for augmented reality...

MARKEY: And people can decide which is better.

WYLER: Yes.

MARKEY: Reality or augmented.

WYLER: Exactly and in...

MARKEY: We're actually living in that area right now.

WYLER: 5G services demand low latency.

MARKEY: Yes.

WYLER: So we've been able to create a system that is like -- it is designed for 5G services so that you can roll out 5G anywhere.

MARKEY: So when can the first person on the planet be expected to be able to subscribe to your service and have it delivered? When do you expect that to happen?

WYLER: Two thousand and nineteen.

MARKEY: Two thousand and nineteen and where will that customer be do you expect?

WYLER: Sitting in Alaska. Hopefully in Barrow or some other -- not in Anchorage.

MARKEY: Yes, so you think it'll be an American.

WYLER: It will be in America.

MARKEY: Okay, where will the first customer outside of the United States be who will be able to subscribe?

WYLER: We'll be covering Europe and we'll be covering as Africa -- South Africa and other areas around there, also Argentina and all around a lot of emerging rural markets.

MARKEY: So we'll all of that be in 2019?

WYLER: Twenty nineteen will be the beginning customers, 2020 they will all be covered.

MARKEY: So all of Europe will be covered?

WYLER: Twenty twenty, yes.

MARKEY: And not all of Africa, but South Africa...

WYLER: Most of Africa...

MARKEY: Most of Africa will be covered.

WYLER: Yes.

MARKEY: Will it be all of South America or just Argentina and...

WYLER: A big chunk in 2020, most of it -- most of South America will be covered in 2020.

MARKEY: Okay, and again this is your commercial and what will it cost the average customer to be able to purchase this?

WYLER: Well there's two things, the acquisition cost and the cost of service.

MARKEY: So the acquisition cost, if your antenna and your terminal is in the \$100.00 to \$150.00 range, you can have a real trouble in communities of enabling community infrastructure to be there. If your cost -- when I started this company based upon my work in Africa, I shot for how do we get -- make affordable Internet access for someone who has \$2.00 a day income? Which means \$0.10 a day.

MARKEY: Okay, so in 2019...

WYLER: Yes.

MARKEY: In 2020 at the latest, you're on track to get this done.

WYLER: Yes.

MARKEY: And you're all going to accomplish it. Your investors are prepared to run the risk that you won't be just a repetition of what's happening.

WYLER: We have a lot of investors and a lot of eyes watching us, yes.

MARKEY: Okay and how many total satellites will you have up there?

WYLER: In 2020 we should be able to hit about 800 or 900.

MARKEY: In 2020.

WYLER: And then it'll climb to probably another -- about 2,000 or 2200 in 2021.

MARKEY: So 2,200 satellites. When Motorola was doing Iridium, they named it after the 77 elements of Mendeleev's chart of elements. They had 77 and so you all just vastly expanded it with smaller satellites to ensure that there is ubiquitous coverage.

WYLER: The key is making these satellites smaller and smaller than...

MARKEY: Okay and I think the key question I think for Americans is going to be, will the price that you're offering in Alaska or rural South Dakota or Massachusetts, will that be on a scale that is equivalent to what you're going to be offering in Africa or in South America?

WYLER: So we partner with the local providers -- the ISPs and the local -- and let them -- work with them to help them set the prices and let them set the prices for the hyperlocal environments.

So the prices will change around the world, but it will be dealt with -- the prices will be managed by the local internet service providers.

MARKEY: So you're now saying you will be partnering with Comcast and AT&T in the United States in order to set the price for American consumers?

WYLER: It's a great question. They don't cover most of the United States, so there will be -- we'll be partnering with a lot of other people and we're happy to also partner with them, but there will be competition between the partners.

MARKEY: So you're saying, in the parts of America where you are going to target, it will be mostly those areas unserved by those large ISPs and as a result, you'll be partnering with those smaller companies.

WYLER: Yes.

MARKEY: In smaller towns all across the country and trying to devise a price point that will bring a profit to the ISP and to you?

WYLER: Correct and to hopefully spur new ISPs and new entrepreneurship in those regions.

MARKEY: Right so that very -- do you mind, Mr. Chairman just so I can understand. I appreciate it. So this very low price point that you mentioned earlier for let's say Africa or South America, is that also going to be something that you're seeking to achieve that is to be the lowest cost provider comparatively speaking across the United States?

WYLER: Yes, we're seeking to be an affordable for everybody in every state and so, we will hopefully be the lowest cost provider. The price will change. It may not be that low in some states, but it will be affordable to the people with their local GDP.

MARKEY: Yes. Do you have already existing contracts with those ISPs or are they to be negotiated in...

WYLER: We have a number of MOUs already with them that were set up and ready to go. If you look at our investor base, which includes Hughes and include Softbank, which has a number of telecom companies including Sprint, we're working very closely to make sure we can get rural coverage. It's a passion and a drive in what we're going to succeed.

MARKEY: So do you already know what that price point is going to be because of the already negotiated contracts?

WYLER: We know that we have the flexibility for that price point to move to what is affordable within the regions.

MARKEY: Yes.

WYLER: So we actually took a very unique approach to this rather than saying, "Okay, it's \$30.00 a month or \$50.00 a month," we've said, "Okay, let's work together in your region for your area and let you set the price because you're the expert about what's going on in rural South Dakota. You know what the farmers there can afford and what they can pay and what the competitive prices are."

MARKEY: Yes, and so and -- finally is the service which these people are going to receive comparable to the service that people receive in Boston?

WYLER: Speaking as a customer of someone in Boston I don't want to achieve that. Better. So watching the circle go around.

So we've designed a system that really uses the spectrum very efficiently. We're actually asking the question. "Why can't rural be faster?" So we're shooting for 2021 to achieve two-and-a-half gigabits per second of capacity direct to a rural home.

So should be no -- in the new technological age, there should be no penalty for being in rural populations. Those people who want to stay there and want to be educated want to stay with their parents and build businesses should be able to and that's what we're trying to achieve and I think we are.

MARKEY: Well, I saw what you did in Rwanda. You came in and we had you testify, it was an incredible concept. You executed and it transformed Rwanda. Okay, no one would have ever thought broadband in Rwanda would work so successfully. It's really transformed their future.

Hopefully here, this concept also is executed because I think the potential is unlimited in terms of transforming information and competition not just in the United States, but around the planet, so thank you. Thank you, Mr. Chairman.

THUNE: Thank you, Senator Markey and I'm glad you settled once and for all what latency actually is. It will give a whole new way of explaining speeding tickets in this country using high latency low latency.

Let me just ask a couple of general questions as we wrap up here. To all of you and feel free to jump in here, but what are the what are the major factors right now that are affecting the investment in next-generation satellite technology? Ms. Cooper?

COOPER: So it's basic. We're not at this point going out to seek outside investment for this project, but I would say the capability to undertake a complex problem is definitely a differentiating factor. The ability to not only conceive of it, but actually deploy the manufacturing design that's responsible and undertake the space operations in a way that preserves the space environment.

I think we are going to be rewarded. I think the work that my colleagues here on the panel have done in terms of advancing the caliber of satellite services continuously over the last few years has also generated an enormous amount of investment interest and an excitement about what the space environment and what the satellite sector can do. Thank you.

DANKBERG: I think there's really two factors. One is this notion of space Renaissance where there's been a large increase in investment in space I think is absolutely true. You see a lot of startups. One of the big reasons is because there are companies working on reducing the cost of access to space and that's basically democratizing the environment, but there are I would say two issues. The number one issue is access to spectrum.

For communications, no communication system can really achieve the level of cost effectiveness and performance that we want and the level of competition Senator Markey has raised without access to spectrum and I think that the real issue here is not dedicating spectrum only to satellite at the detriment of some other, it's really working on sharing because there's a finite amount of spectrum and that is a very, very important area.

I would say at the next level down and it's not quite as important is the one that we've touched on a little bit here which is the question of subsidies and the real issue of subsidies is -- I kind of agree with Gregg is that we work on a free market basis. We don't expect subsidies in order to be to be able to provide a good broadband product at a competitive price anywhere in the U.S.

We can do that without subsidies. I do think that we should think about what the effect is of subsidies on market distortion and how that reflects what it is that the market really wants and I think that's -- I wouldn't put that at the level of a spectrum issue, but it's something I think for the government to consider.

SPENGLER: What we've encountered in recent years and it's been said many times today is this Renaissance in space and satellite communications and as a result, there is robust investment. There's robust investment and innovation. There's sources of capital that are supporting investment and I think that all ties to the recognition that the future network is an integrated network. It's a single network. It is a telecom network that will have many parts to it -- satellite, wireless, fiber and so, it is really driving a lot of this innovation that's happening.

I think the next big area for enhanced investment in free market investment is really in the ground technologies. It has been referenced a few times today, investments have been made on satellites and enhancing the performance, the cost, but we also have to continue to invest on the ground -- the terminals, the user devices that customers have -- to make them smaller, cheaper, simpler to install and easy. In that way, we will be fully integrated.

WYLER: So as the only sort of startup in the room, we've had to go out and raise our share of capital and we have a very wide and broad base of investors.

I'll say sort of the two big things. Spectrum certainty, spectrum certainty, spectrum certainty and I repeat that so we know it. We should not play with spectrum. We should not play with people's foundations.

If you went to Verizon and said, "We're thinking about taking back the 700 megahertz or whatever or the 1.9, you know, maybe it would just halt investment overnight," Don't play with the spectrum.

This stuff that we're doing takes seven years to build and tens of billions of dollars to do it at the scale we're talking about. If you just play with the spectrum, you play with the investors' understanding and viewpoint of the solidity of your project, which already has many other dynamics.

The second thing is, space debris. If there's an accident in space, you will see a halt to investment, so unless we take a leading position on this -- and it's not just from the U.S., lots of people can launch satellites. We need to take a leading position in the U.S. and I have all other countries work with us and are eager to do so, so that we can keep satellites in in their own lanes because if they hit, the whole thing's gone.

So these are the places where you on your bench in your position are speaking not just for investment for the future, but you're the voice of the people with no way to speak. The people in the future generations who also want to have access to space, the people in the rural populations who know that this is the only way they're going to get broadband that's equivalent or better than that in the suburbs and be part of the rest of the world and be part of the rest of America economically and socially.

So those are the two things -- spectrum certainty and space debris certainty.

THUNE: All of you have talked about the satellite constellations that you've proposed or raising a number of issues for the FCC and for various other international entities, but do you feel that the FCC has the tools currently that it needs to properly address the issues that are raised by satellite constellations along the lines of what you proposed today?

COOPER: I would just say, I think the FCC has done a laudable job in a very complex issue area. They've just undertaken an update of the rules for these kinds of constellations that had been sort of dormant since the last generation of low Earth orbiting satellites.

Those rules will give us a much better platform to kind of pivot to this next newer unfolding generation. They did things like extending the milestones by which you need to deploy a constellation which is especially important if you have larger constellations and as advice that's noted, the ability to be able to deploy those is contingent on launch capability which is something we feel very strongly about our capabilities there.

They've also really laid the expectations in terms of sharing spectrum to be firmly on the operators to try and figure out how to interoperate with each other, interoperate with and protect the satellites that are above us and also make sure that we can work with the terrestrial operators.

The thing that I would say that that would be most useful I think from the Committee in terms of the Commission is to make sure that there's a reflection of this opportunity with space-based systems in the expectations of spectrum that there are two kind of key underlying principles, one is you should use -- avail every technology that's available that's possible to try and be a more efficient user of the spectrum and also be incentivized for any group of parties whether it's terrestrial and satellite or within the satellite sector at different orbital hierarchies to try to apply technology for spectrum sharing.

That's going to serve the American consumer better because you'll get better services through the same amount of frequency bands. I think those are the two principles that the FCC is going to benefit from in terms of direction from this Committee.

On space debris, I think the recommendation for the agencies to work together and pool their common and diverse experiences to continue to evolve that sort of foremost role of the U.S. in terms of maintaining a safe environment that's a successful next step.

We were pleased to see the formation of the National Space Council. We're pleased to have participation in the first meeting and expect to be involved in every one of the agencies that's active in space policy. Thank you.

THUNE: Yes, go ahead, quickly.

DANKBERG: Thanks, yes, I think the FCC certainly has the skills and the resources to manage spectrum and one of the things that's helped us is the FCC's willingness to entertain new spectrum sharing strategies within the satellite sector itself. That was part of what made our satellites more effective and then also recently with the 28 gigahertz spectrum frontiers, the FCC -- and we did reach agreement on spectrum sharing between terrestrial 5G and satellite. So we know that's possible.

I think that especially recently, there's been a very strong focus on 5G wireless in the FCC possibly to the detriment of other technologies, satellite being one. The other one that I would put in a plug for and this really goes to some of Senator Markey's questions is what we're a little bit unique because we are a direct retailer.

So we not only drive down the cost of delivering broadband, but we then set the prices to our subscribers and in dealing with -- we also deal in Mexico where we can provide broadband at the price points today that Mr. Wyler is talking about in Africa. The thing that makes that possible is unlicensed spectrum because when we deliver bandwidth through other carriers, they're the ones as Mr. Wyler said that are setting the price points.

With the access to unlicensed spectrum, we can go to Native Americans, Indian reservations, national parks and deliver services directly to people's phones with unlicensed spectrum and that's an area that there's really not a very strong advocacy within the FCC.

I think that that's one area that could use more support.

SPENGLER: I think the FCC like a lot of regulators that are dealing in the digital world have challenges because things are moving so fast, there's so much change and I think that's where industry and the private sector and the market can be of benefit to in terms of helping solve some of these challenges.

We're coming to the FCC with all kinds of new models that we haven't gone to before where we're talking about partnering with different satellite operators, different kinds of arrangements and it's all to develop new services for different parts of the world and in the U.S. in particular.

We recently responded to a notice of inquiry from the FCC on the C-band and the C-band right now, in fact since some of the comments have been made is being sought after by the wireless industry. Currently, it's being used by satellite broadcasters to distribute programming to cable head-ends to re-transmitters all around the country and millions of Americans get their television through the C-band distribution.

What we've done is we said, "Look, we don't believe that sharing can work in the traditional sense," and we proposed a new solution and we proposed a solution with Intel saying, "Let the industry work on this together. Let the market decide how we can free up spectrum in that band to allow the growth of 5G wireless, which we believe in, we all want that to happen, but also gives some certainty and surety to the broadcasters and the television viewers around the country a scheme where there's joint use. That the market can decide the best way to clear that spectrum in that we can bring a solution to the FCC."

They have a lot of things on their plate and this is one that the industry could potentially solve together in this particular case.

WYLER: I actually slightly disagree with Mr. Dankberg, the FCC is probably under resources, just a slight disagreement there. Generally, they've been doing an excellent job. There are places where they're just overwhelmed with new technologies, new ideas and in this digital age that changes so fast.

Certainly, I'll just you know, in the latest proceeding, the ability for NGOs to interfere with GSOS, they've just given us sort of a hall pass and said, "Go ahead and work it out later."

It's kind of interesting because we're supposed to protect the GSOs, now being on the beneficial side of that, I shouldn't be saying anything bad about it, but I think it's a bit -- it was generous, let's say and unexpected to let us do that.

I think in terms of space debris, they are trying. They really are. They're putting out questions to people with their kind of everybody's got these different ideas and some with -- how they're going to put their -- where they're going to put their satellites and whether they're going to crash into each other or not and people and they're asking them for more data, but they're not equipped for that. They're not designed for space debris because they are spectrum focused, right?

They are in electrons, not in physical objects hitting each other. So some Committee, some way of giving them some tool with NASA, with the FAA with others, maybe a Presidential Commission, may be a congressional or Senate Commission, I don't know, but some way of giving them some oversight and some support in dealing with this because right now, since if -- basically their arms are tied. They're frozen and they don't know what to do with it because there is no good answer with the current -- if you launched all these satellites, you definitely have space debris. So now what do they do? And who's in charge of that?

THUNE: All right, well thank you all and we appreciate very much, yes...

MARKEY: Can I just ask one question? Your questions have been great, so it just prompted one question which goes back to Mr. Dankberg on the historic role of unlicensed spectrum and what you think that role should be in this space right now, can you talk about that just for a minute, please?

DANKBERG: Yes, well -- so thank you. Yes, one of the things -- if we look at some of the things that are really different in the satellite industry compared to say five or ten years ago, there are two that are big ones.

One is -- the history of Intelsat shows most of the time, satellite companies had to work through other telecom providers because their customers were the telephone companies or the wireless carriers.

The other one is if you wanted to provide video transmission, you had to work with a content owner or a TV station for distribution. What's really different now and is very liberating in the satellite industry is that you have million -- you have billions of phones going around, which have Wi-Fi capability.

So now a satellite operator, if they can deliver the transmission at lower cost, then a terrestrial operator, you can create real competition by going to them through unlicensed spectrum, but only if that unlicensed spectrum is truly available and has the ability to reach those people.

The other big, big change is that now, you're seeing these over-the-top video services where an individual subscriber can basically make an arrangement directly with a service provider like it could be Disney, it could be Netflix, Hulu and that now transmission is really a commodity that you can just deliver to that subscriber, greatly reduce their costs without having to go through someone else.

So for the first time, satellite is no longer just a cost input to somebody else, but it has the ability to compete in two-way transmission.

MARKEY: If I may, I just want to put it into my consumer perspective, you're saying that these multiple satellite competitors in an unlicensed spectrum world down below has more potential for identifying markets that they could move into and provide services at even lower cost because that spectrum is unlicensed and that the company terrestrially doesn't need a return on investment because it's unlicensed at that point.

It's a very it's a much lower cost...

DANKBERG: Yes.

MARKEY: ... overall and it puts a pressure on the market that otherwise would not be there because some consumers will be opting out and heading in that direction.

DANKBERG: Yes and in fact, just to elaborate just for a second, we are doing services in Mexico and in Africa.

In Africa, we work with an organization called Ascon, which is an organization of all the African states. We need to go through cellular operators, then a cellular operator will need to go into a village and invest \$50,000.00 to \$100,000.00 to put a cell tower.

In Mexico, we can do it directly using our own satellites and for \$1,000.00 put in a Wi-Fi hotspot, so that -- we've talked a lot about technology which is exciting, but the business model changes are very important in seeing regulations that support those would be very, very helpful.

THUNE: Thank you, Senator Markey. Well, great panel, great questions, great answers and it's a fascinating field and one that we obviously want to do everything we can to support encourage and see that we are doing everything we can to make sure that people all over the country and all over the world and South Dakotas of this country and other places around the world have access to everything that comes with technologies and broadband and the opportunities associated with it.

So we appreciate the good work that you all are already doing and we look forward to working with you and encourage you as you encounter issues and challenges that you think we ought to be attending to and you know, articulating policy about to share that with us and -- but this I think has been very, very helpful this morning and we will look forward to other opportunities to hear from you again.

I will just say to who our panelists that if you could respond to any questions that are submitted by members of this Committee, we'll try our best to ensure that we close the record out in a matter of a couple of weeks, so we'll try and get our members to get their questions for the record to you and then if you could as promptly as possible, get those responses back, it would be most appreciated.

So with that we will conclude. Thank you all very much.

END

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