**Before the**
**National Telecommunications and Information Administration**
**U.S. Department of Commerce**
**Washington, D.C. 20230**

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| In the Matter of | ) | |
| | ) | |
| Developing a Sustainable Spectrum | ) | Docket No. 181130999–8999–01 |
| Strategy for America's Future | ) | |
| | ) | |

**COMMENTS OF VIASAT**

Viasat, a leading global broadband services and technology company, is pleased to submit its comments in response to the National Telecommunications and Information Administration ("NTIA") Request for Comments ("RFC") on its development of a comprehensive, long-term national spectrum strategy, as required by the Presidential Memorandum, *Developing a Sustainable Spectrum Strategy for America's Future* (Spectrum PM), issued on October 25, 2018.[1]

In just seven years after beginning to operate its own satellites, Viasat has become a leading provider of communications solutions across a wide variety of technologies (both terrestrial and satellite). Viasat uses a fleet of spacecraft and an extensive ground network to provide fixed and mobile broadband service to residential, enterprise and government customers. Viasat has revolutionized the satellite industry by reducing the "cost per bit" of delivering broadband service, providing a high-quality service to end users, and affording millions of Americans an effective competitive alternative to wired and wireless terrestrial services. Today, Viasat connects over ninety million devices per year on more than 1,000 commercial aircraft[2] and offers services currently meeting and exceeding the 25/3 Mbit/s speed threshold, including providing the first satellite-delivered 100 Mbit/s broadband service. Viasat also is a provider of satellite broadband service to government and military users around the world for their essential missions and communications needs. None of this would be possible without access to spectrum.

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[1] Memorandum for the Heads of Executive Departments and Agencies, Developing a Sustainable Spectrum Strategy for America's Future, 83 FR 54513 (Oct. 30, 2018), available at https://www.gpo.gov/fdsys/pkg/FR-2018-10-30/pdf/2018-23839.pdf.

[2] *Viasat Hits 1,000 Commercial Aircraft Flying with its In-Flight Connectivity System*, Press Release, Dec. 10, 2018 (https://www.viasat.com/news/viasat-hits-1000-commercial-aircraft-flying-its-flight-connectivity-system).

Viasat applauds the Administration for its leadership in reinvigorating U.S. space leadership,[3] for helping foster a vibrant commercial space industry[4], and for the steps it is now taking to advance a sustainable spectrum strategy for America's future. Whether it is Commerce Secretary Wilbur Ross[5], NTIA Administrator David Redl[6], White House Space Council Executive Secretary Scott Pace[7], or FCC Chairman Ajit Pai[8], there is a growing recognition among Administration leaders that we are on the verge of a new era of space commerce in which satellite broadband technologies are driving critical needs today and enabling transformative benefits tomorrow.

We likewise see enormous spectrum-enabled satellite broadband opportunities on the horizon enabling us to reach people in places and ways that are often simply unachievable using any other technology platform. But we also see a potential looming satellite spectrum crunch that threatens to stall, stifle, or even stop the full promise and potential of commercial satellite broadband from being realized, unless it is addressed soon.

It is for this reason that we support the Administration's effort to take a comprehensive look at spectrum policy, needs, and solutions. And this is why it is essential that the U.S. strategy include a comprehensive view of spectrum needs over the next 15 years that ensures sufficient long-term access

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[3] White House Fact Sheet. President Unveiling an America First National Space Strategy. March 23, 2018 https://www.whitehouse.gov/briefings-statements/president-donald-j-trump-unveiling-america-first-national-space-strategy/.

[4] Scott Pace: "*I'd like to see a stronger and more vibrant commercial space community that has been able to take advantage of regulatory reform and relief. I'd like to see the U.S. capitalizing on a lot of those newly opened opportunities and leading the world in commercial space industry growth."* https://www.scientificamerican.com/article/q-a-plotting-u-s-space-policy-with-white-house-adviser-scott-pace/.

[5] Commerce Secretary Wilbur Ross, asks the important question of "*how do we get to the $1 Trillion space economy?*" and notes that *"[g]etting to $1 Trillion is going to take the entire government working together to create a commercial space environment that allows business to do what it does best.*" Remarks to the U.S. Chamber of Commerce Space Summit: Industry Taking Off, December 6, 2018. https://www.commerce.gov/news/speeches/2018/12/remarks-us-commerce-secretary-wilbur-l-ross-us-chamber-commerce-space-summit.

[6] NTIA Administrator David Redl: "*There is no doubt that the United States needs a vibrant satellite sector. This industry creates tens of thousands of high-paying jobs and enables millions more in the larger economy. In the next few years, a new era in satellite coverage will strengthen our nation's broadband infrastructure and power advanced services that will improve people's lives*" *https://www.ntia.doc.gov/speechtestimony/2018/remarks-assistant-secretary-redl-satellite-2018.*

[7] Scott Pace, Executive Secretary, National Space Council: *"The United States has a strong and entrepreneurial satellite communications industry, available to engage in global competition. To ensure we retain the strategic advantages afforded by space services, the United States needs to continue to open and promote competitive markets and protect spectrum allocation for space services to compete." https://www.satellitetoday.com/government-military/2018/05/02/national-space-council-on-competitiveness-and-spectrum-in-the-new-space-era/.*

[8] FCC Chairman Ajit Pai: *"I've often said that in order to bring digital opportunity to all Americans, we need to use all of the tools in the toolbox. Satellite broadband service is one of those tools. Next-generation satellites are bringing new competition to the broadband marketplace and new opportunities for rural Americans who have had no access to high-speed Internet access for far too long."* Remarks to Satellite Industry Association https://docs.fcc.gov/public/attachments/DOC-349676A1.pdf

to satellite spectrum to expand digital opportunities to meet consumer, business, government, and national security requirements, and ensure digital inclusion of everyone---no matter where they may reside.

**SATELLITES PLAY A CRITICAL ROLE IN ENABLING TODAY'S DIGITAL ECOSYSTEM AND WILL PLAY AN EVEN MORE ESSENTIAL ROLE OVER THE NEXT 15 YEARS**

**Already today, we maximize the use of satellite spectrum and innovative technology to provide critical connectivity in unique ways.**

- **Delivering lightning fast broadband.** Enabled by Ka-band spectrum certainty, last year Viasat reached a new milestone, providing up to 100 Mbit/s download speeds over its second-generation broadband satellite, Viasat-2. As a result, across the country broadband customers are already taking advantage of Ka band satellite systems that provide services that are competitive with, and in many cases superior to, terrestrial service.

- **Providing mission-critical connectivity to our warfighters.** Spectrum-enabled satellite connectivity has become a cornerstone of our national security capabilities -- enabling our warfighters to protect us by land, sea or air, providing agencies with state-of-the-art technologies to protect our national security, and connecting our embassies and government leaders with secure communication options.

- **Enabling communications on the move.** Satellite spectrum is making it possible for us to deliver high-speed Wi-Fi connectivity to aircraft passengers whether they are waiting to take off, or are cruising at 35,000 feet. Already more than a thousand Viasat-equipped airplanes flying billions of air miles are providing passengers at their seats with access to satellite-enabled high-speed Wi-Fi capable of streaming Internet and movies. This service has become so popular that there are often more connected devices than passengers on planes.

- **Closing the digital divide.** Satellite spectrum is also enabling us to extend high-speed broadband to reach the increasingly underserved. The Federal Communication Commission recently awarded $1.5 Billion of support over the next ten years in its CAF II program to extend broadband service to about 700,000 locations that the incumbent telephone providers declined to continue to serve.[9] As part of this Commission's effort to close the digital divide, over the next 10 years Viasat will be expanding broadband access for consumers in 20 states where consumers have been without high-speed broadband access for too long.[10] As FCC Chairman Ajit Pai has explained: "*I've often said that in order to bring digital opportunity to all Americans, we need to use all of the tools in the toolbox. Satellite broadband service is one of those tools. Next-generation satellites are bringing new competition to the broadband marketplace and new*

[9] FCC Connect America Fund Phase II Auction results: https://www.fcc.gov/auction/903.

[10] FCC Connect America Fund to expand broadband access to over 700,000 rural homes and businesses. https://docs.fcc.gov/public/attachments/DOC-353840A1.pdf.

*opportunities for rural Americans who have had no access to high-speed Internet access for far too long*."[11]

Moving forward, the best is yet ahead. Satellite services like Viasat's are poised to deliver revolutionary new capabilities at near exponential growth rates. When ViaSat-1 entered into operation in 2011 it enabled throughput of approximately 140 Gbit/s. When it was launched, ViaSat-1 had more than 10 times the throughput of any of the other Ka-band satellites in orbit at that time.[12] Viasat's second-generation high-capacity Ka Band satellite has doubled this capability -- supporting speeds well over 100 Mbit/s.[13] The planned deployment of multiple third-generation Viasat high-capacity Ka Band satellites will enable even higher capacities of over 1 Terabit per second (1,000 Gbit/s). These revolutionary advances in throughput are made possible by pushing the frontiers of new technologies as we build our satellites which is enabled by predictable access to Ka Band and other key satellite spectrum bands.

**Over the next 15 years, satellite spectrum needs will continue to grow commensurately with the size of the societal benefits satellites are poised to deliver.**

- **Providing near ubiquitous global broadband connectivity that enables game-changing new opportunities.** Over the next 15 years, satellite spectrum can enable near ubiquitous global broadband coverage to connect the unconnected, expand markets for US digital industries, and enable policymakers to help solve critical global problems in ways not possible without connectivity. Today some 3.9 billion people do not have access to the Internet, and around one-third of the world's inhabitants still do not own a personal mobile phone.[14] As multiple satellite systems with over one terabit per second of capacity now under construction are deployed, hundreds of millions of businesses and consumers everywhere will be able to take advantage of satellite's geographically independent cost structure to do things never before possible or imagined, whether in areas that are not adequately connected via terrestrial networks, and will never be within reach of mobile networks, or in underserved parts of urban areas that have long been neglected by telcos. Expanding access to high speed broadband is an opportunity equalizer, competition enhancer, and economic accelerator. A mere 10% increase in broadband penetration is estimated to raise global economic growth by as much as 1.4%.[15]

- **Extending communications to moving platforms including planes, trains, cars and ships.** Spectrum enabled satellite broadband services are poised to expand economic opportunity

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[11] FCC Chairman Ajit Pai remarks to the Satellite Industry Association, https://docs.fcc.gov/public/attachments/DOC-349676A1.pdf.

[12] See ViaSat-1 FAQ, available at https://www.viasat.com/sites/default/files/legacy/web/ViaSat-1_FAQ_3_09_V3.pdf.

[13] See Viasat Q2 2016 Viasat Earnings Conference Call (Nov. 9, 2015), available at http://investors.viasat.com/events.cfm.

[14] https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.18-2017-PDF-E.pdf.

[15] BroadbandCommission, Working Together to Connect the World by 2020, January 2016 https://www.broadbandcommission.org/Documents/publications/davos-discussion-paper-jan2016.pdf.

everywhere – on the ground, in the air, across the seas, and around the globe. With well over 90 million electronic devices already connect every year to satellite-enabled Wi-Fi on Viasat-equipped airplanes, U.S. consumers have already demonstrated how popular broadband can be on platforms that can often never be served in any other way. For example, the number of connected devices on airlines is expected to increase exponentially to hundreds of millions of devices in just the next 3-5 years as more aircraft become connected. By 2035, because of high passenger demand for video content and broadband access, airline Wi-Fi connectivity will become ubiquitous, creating a $30 billion airlines access market, and generating $130 billion in ancillary revenue by 2035.[16] This type of dynamic expansion is likely to follow in other sectors as high-speed broadband makes it possible to connect consumers and businesses on the move whether on a ship in the middle of the ocean, on a tractor in a remote and rural farm, on a bus[17] or train in a city, or in an emergency vehicle speeding down the freeway or in the air on the way to a hospital.[18]

- **Extending Wi-Fi service.** Increasingly, satellite-enabled Wi-Fi services are creating high-speed hotspots that connect users in metropolitan areas as well as unserved and underserved markets within the satellite network's coverage area. Already today, nearly a million people in thousands of locations that do not have 3G or 4G services can now connect their smartphones to high speed broadband thanks to satellite-powered Community and Urban Wi-Fi hotspots.[19] These Wi-Fi services are growing quickly as satellite services create unique ways to connect urban city centers, community recreation

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[16] London School of Economic and Political Science, Sky High Economics: Quantifying the commercial opportunities of passenger connectivity for the global airline industry. September 2017. http://www.lse.ac.uk/business-and-consultancy/consulting/consulting-reports/sky-high-economics.

[17] *Saying Goodbye to Summer Vacation*, FCC Chairman Ajit Pai, Blog, Sept. 4,2018 (https://www.fcc.gov/news-events/blog/2018/09/04/saying-goodbye-summer-vacation) ("Returning to the topic of my "summer vacation": a couple of weeks ago, I found myself in the beautiful state of Utah. There, I "virtually met" the Superintendent of the Kane County School District, which has seven schools spread out over 4,000 square miles — a district twice the size of Delaware. Students who play sports routinely spend hours shuttling to and from games across vast remote areas that lack wireless service. To help the students do their homework during this time, the school buses are equipped with Wi-Fi. That Wi-Fi connection is made possible by a satellite transmitting data to a receiver on the bus — what we call an Earth Station in Motion (ESIM). That brings me to the next item on our agenda. Currently, ESIMs are regulated differently based on the type of vehicle they are attached to, whether it's ships, airplanes, or school buses. This doesn't make a lot of sense, so the FCC will be voting to consolidate and streamline these rules, eliminating burdens and adding frequencies where ESIMs can operate. If adopted, this item will enable a fast-growing segment of the satellite industry to innovate and invest in new technologies — and to deliver high-speed services like those used by the kids on those Kane County buses.").

[18] *Viasat technology behind advances in telemedicine, better en route care*, Jan. 15, 2019 (https://corpblog.viasat.com/viasat-technology-behind-advances-in-telemedicine-better-en-route-care/).

[19] *Community Wi-Fi: High-speed internet in the hardest-to-reach places* (https://www.viasat.com/services/community-wi-fi); *Viasat Introduces Viasat Urban Wi-Fi, the Fastest Satellite-Enabled Broadband Service for Urban Areas across Mexico*, Dec. 3, 2018 (https://www.viasat.com/news/viasat-introduces-viasat-urban-wi-fi-fastest-satellite-enabled-broadband-service-urban-areas).

centers, airports, stores, shops, and remote villages. By 2021, Cisco predicts that 5G cellular devices will represent only 0.2% of all connected devices in the world and only 1.5% of network traffic, while 50% of global traffic will be delivered over Wi-Fi.[20] Furthermore, Cisco predicts the number of Wi-Fi hotspots will grow a staggering four times over 5 just years.[21] Over the next 15 years, we expect the number of innovative satellite enabled Wi-Fi hotspots to continue to expand, and the data on each network to continue to expand as well.

- **Extending technological opportunities to solve challenges in ways never before possible.** Over the next 15 years, satellite broadband will become an even more central part of our future digital ecosystem in part because it is uniquely situated to solve key digital inclusion challenges by providing next-generation broadband connectivity. (*See* Attachment, "Satellite as Part of the 5G Ecosystem" CITEL PCC II Information Paper, Nov. 19, 2018, also submitted to Asia-Pacific Telecommunity WRC-19 Working Group (APG), Dec. 31, 2018). As the world is blanketed with high speed satellite broadband access, the opportunities to harness technology to solve bigger challenges becomes even greater, the technologies more transformative, and the impacts even more profound. For example, global access to broadband helps enable more intensive use of breakthrough technologies including the Internet of Things, artificial Intelligence, big data and the cloud, to help us solve challenges in ways that we simply never could before or cannot even imagine today. For example, among the UN's Sustainable Development Goals, the achievement of 38 targets (from improving health care to solving economic growth challenges) depends upon universal and affordable access to broadband and the technologies needed to access broadband.[22]

- **Meeting consumer and business appetite for ever increasing amounts of data**. At Viasat we believe everything, and everyone can be connected, whether in urban and population centers, as reflected in the Viasat subscriber map below (Figure 1. Viasat Broadband Subscriber Density) or in the hardest-to-reach places. As we expand access and the number of connections we make, we are also seeing aggregate bandwidth demand increasing driving increased bandwidth consumption. We expect consumer bandwidth demand to continue to increase across satellite networks at rates roughly on par with global Internet bandwidth growth, which is expected to increase roughly three-fold over the next 5 years.[23]

[20] CISCO: Global Mobile Data Traffic Forecast Update, 2016–2021 White Paper.

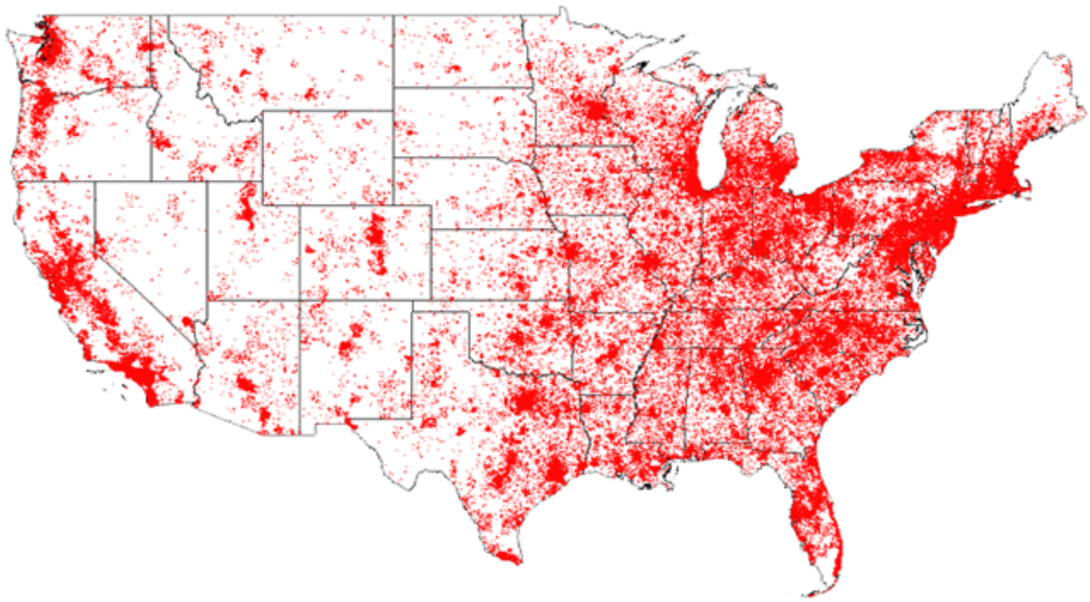
[21] https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-741490.html.

[22] Among the UN's Sustainable Development Goals (SDGs) there are no fewer than 38 targets whose achievement will depend upon universal and affordable access to ICT and Broadband. https://www.broadbandcommission.org/about/Pages/default.aspx.

[23] Global internet traffic is projected to increase threefold over the next 5 years. Cisco Visual Networking Index: Forecast and Trends, 2017–2022. https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-741490.html.

These continuously expanding demands for satellite broadband capabilities result in increasingly expanded spectrum needs over the next 15 years.

**Figure 1. ViaSat Broadband Subscriber Density**



**MEETING THE INCREASING SPECTRUM CAPACITY NEEDS FOR DELIVERING TRANSFORMATIVE SATELlITE GAINS**

The RFC asks, ***"What are the likely future needs of spectrum users, both terrestrially and for space-based applications, within the next 15 years? In particular, are present allocations of spectrum sufficient to provide next generation services like Fifth Generation (5G) cellular services and emerging space-based applications?"***

Today's 5G vision encompasses a broad technology ecosystem – with multiple network technologies supporting a global infrastructure including traditional wired, mobile wireless networks, satellite, Wi-Fi, and small cells. It includes new cellular wireless access technologies (for the last 100 meter access), and also leverages existing fixed wireless networks, Wi-Fi and satellite networks.[24] Too often, however, the only aspect of next generation wireless technology that is discussed is the last 100 meter access link to the end user device. A myopic view of 5G from a policy perspective – especially when it comes to spectrum – can limit the potential to expand digital opportunities to meet consumer, business, government, and national security requirements, and ensure digital inclusion of everyone---no matter where they may reside. Only through a holistic view of 5G, and a broad understanding of the comprehensive nature of the entire 5G ecosystem and the network of networks that enable it, can the full power and potential of next-generation wireless opportunity be realized. That's because 5G is not a step change from 4G, nor is it just a technological shift. It's a paradigm shift in the way we think about

[24] Wireless Broadband Alliance, 5G networks. https://www.wballiance.com/wireless-broadband-alliance-calls-for-industry-cooperation-to-harmonize-the-integration-approaches-of-wi-fi-with-5g/.

high speed mobile broadband networks as a network of networks. For example, harnessing the capabilities of satellite technology maximizes the reach and capabilities of 5G networks. Doing so also maximizes the ability of the 5G ecosystem to solve bigger problems – like extending high speed access to the next billion people, improving network resiliency, and enabling ubiquitous connectivity in the air, across the seas, and around the globe. (*See* Attachment, "Satellite as Part of the 5G Ecosystem" CITEL PCC II Information Paper, Nov. 19, 2018, also submitted to Asia-Pacific Telecommunity WRC-19 Working Group (APG), Dec. 31, 2018).

Over the next 15 years, in order for our industry to continue to innovate and meet the continuous demand for more and faster satellite broadband speeds, and to power the mission critical solutions that require satellite technology, satellite providers need predictable access to more spectrum to accommodate these exponentially expanding needs. However, a potential looming satellite spectrum crunch threatens to impede progress. Insufficient and unpredictable access to adequate amounts of satellite spectrum could thwart the ability of Americans to benefit from the full promise and potential of commercial satellite broadband absent a long-term spectrum strategy that balances the needs of all users.

Spectrum is the fuel that enables satellite broadband opportunity. Twenty years ago, the 27.5 – 30 GHz uplink and 17.7-20.2 GHz downlink (Ka Band) spectrum was designated for what has become a "core" global satellite broadband band.

The Ka Band originally was allocated for satellite use when the U.S. government wisely recognized the demand for satellite-based services that could not be "fully and economically accommodated in the only frequency bands [then] available"[25] (the C and Ku Bands). For the same reason, the U.S. government invested in NASA's Advanced Communications Technology Satellite ("ACTS"), which became a successful testbed for U.S. government and industry development of the Ka Band, and by 2000 served as a proof of concept for today's broadband satellites,[26] the first of which was launched shortly thereafter.[27]

Commercial satellite networks have relied on access to the Ka Band for over two decades to provide critical connectivity around the world. This includes broadband services to a wide range of individual, business and government users, regardless whether they are in the office, in the field, on an airplane or a ship, or at home. Indeed, satellite broadband provides connectivity that no other technology can offer, both on a regular basis and in times of disaster and other crises. Satellite broadband is an essential part of the nation's defense, public safety, and disaster recovery capabilities.

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[25] *Establishment of Domestic Communication-Satellite Facilities by Non-Governmental Entities*, Further Notice of Inquiry and Proposed Rule Making, FCC 70-1015, 25 FCC 2d 718, 718 ¶ 2 (1970) (citing *Establishment of Domestic Communication-Satellite Facilities by Non-Governmental Entities*, Report and Order, 22 FCC 2d 86, 89 ¶ 11 (1970)).

[26] *See* http://www.nasa.gov/centers/glenn/about/fs13grc.html ("As early as the 1970's, Glenn researchers and their industry collaborators were aware that the demand for geosynchronous orbital slots would all too soon exceed capacity. They designed the technology, then launched ACTS to demonstrate that their new technology could meet the growing communications needs of a demanding public. Well before the end of the formal demonstration project in May 2000, the answer was a resounding yes.").

[27] WildBlue-1 was launched in 2006.

Notably, Ka Band satellite systems provide services that are competitive with, and in many cases superior to, terrestrial service. Ka band spectrum "powers" satellite broadband services that:

- Are offered at speeds of up to 100 Mbit/s.
- Can be deployed to a given location almost immediately through a small antenna that can be mobile, transportable, or fixed in place, depending on end-user requirements.
- Are extendable to anyone near that satellite antenna by using a Wi-Fi hot spot to distribute the satellite connection---whether to entire communities or everyone on an airplane.
- Meet needs that no other technology addresses, including connecting otherwise unserved populations around the world, supporting national defense and security, supporting disaster recovery and relief operations, and more generally offering always-available global communications capabilities.
- Further important policy goals, such as supporting the development of democracy and nation building, ensuring freedom of information and speech, enabling telemedicine, facilitating agriculture, monitoring critical infrastructure, extending access to education and libraries, supporting the creation of new jobs, and empowering women and minorities around the world.

Moreover, as NTIA knows well, the digital divide is a reality.[28] Terrestrial networks have been abandoning areas that they deem unprofitable to serve, which requires billions of dollars of government subsidies to fill the gaps with commitments from other service providers.[29] Many reports exist of systematic denials of service by terrestrial providers in areas with high concentrations of households they deem undesirable.[30] U.S. companies are deploying Ka band satellite networks around the world to meet this need.

Many billions of dollars have been invested in the infrastructure that enables these Ka Band broadband services. The commercial satellite industry has already deployed over 130 Ka Band satellites, and it is building even more advanced satellites like the Viasat-3 class spacecraft that will be launched starting in two years. Similarly, billions of dollars have been invested in the end user terminals that are installed on

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[28] *See* https://www.telegraph.co.uk/news/2018/10/23/global-growth-internet-access-slowing-sharply-must-act-now-get/.

[29] As noted above, the United States has recently awarded $1.5 Billion of support over the next ten years in its CAF II program to extend broadband service to about 700,000 locations that the incumbent telcos declined to continue to serve. https://www.fcc.gov/auction/903. Nevertheless, the FCC still intends to find another way to extend service to the most remote and hardest to serve locations in the United States that telcos also left behind.

[30] *See, e.g.*, https://www.digitalinclusion.org/blog/2017/03/10/atts-digital-redlining-of-cleveland/.

airplanes, that are packed and ready for deployment in times of emergency, and that are attached to offices and residences.

To meet growing demand, these satellites need to make full use of 2.5 gigahertz of Ka band uplink spectrum, and other bands because the Ka band orbital arc is becoming increasingly congested.[31]

For next generation satellites to provide high capacity connectivity, they need continued and expanded access to spectrum, just like terrestrial services, and to employ the existing technologies that allow the spectrum to be used up to its technological limit. Modern satellite technology has developed to the point where it extensively employs frequency reuse technologies in which the same frequency band is used by one satellite to provide connectivity to many diverse locations at the same time by through separate spatially isolated or orthogonal beams. Similarly, many different satellites use the same frequency band to provide connectivity to the same location from different orbital locations. This is possible because each ground-to-satellite connection is pointing in a slightly different direction/orbital location in space. The ground antenna can be a traditional parabolic dish, a horn array with mechanical steering, or an electrically-steered phased array.

As a result of these technological accomplishments, satellite technology has advanced to the point that today's satellite broadband systems are approaching "Shannon's Limit" in terms of spectral efficiency.[32] As FCC Chairman Ajit Pai has described it, "*Viasat began offering 100 Mbps broadband service in the United States with unlimited data. This was made possible by high-throughput satellites that use spot-beam technology and frequency re-use to dramatically increase capacity*." As the satellite industry has used spectrum up to its technological limit, access to adequate spectrum has now become the primary limiting factor in extending satellite broadband networks to meet the growing demand and addressing all of the unserved and underserved around the world.

Satellite broadband services are already in such high demand that satellite broadband operators need the full 2.5 gigahertz of Ka band spectrum, as well as access to the Q/V band, just to meet growing consumer and business data demand. This current demand does not reflect the additional call for Ka band spectrum resouces to serve other market segments, such as business aviation, hotspots, enterprise broadband, connected vehicles, and other planned uses of satellite broadband.

Even though highly-spectrally-efficient satellite designs are being used, they still require the full 2.5 gigahertz of Ka Band spectrum to meet today's needs, and additional spectrum to meet tomorrow's. Precluding current satellite access to 850 megahertz (or more) of Ka Band spectrum, as some have proposed, would make it particularly challenging to continue to meet these growing consumer needs.

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[31] The C and Ku Bands have also been extensively used for satellite services over the last several decades, however, C band spectrum is congested and increasingly being repurposed for terrestrial services and Ku band has few if any unused orbital slots, and offers much less contiguous spectrum than the Ka Band making it less useful for high throughput broadband.

[32] *See* https://www.gaussianwaves.com/2008/04/channel-capacity/. Today's satellite systems provide actual transmissions at near the maximum capacity that theoretically can be achieved over a given amount of spectrum. This means that making more spectrum available is the only way to increase satellite capacity and serve more end users.

Constraining current satellite access to the Ka Band also would dramatically limit the economic, and societal gains that satellite broadband is now delivering with U.S. technology and high-paying jobs.

The Q/V bands are also poised to be in heavy use over the 15-year time horizon that NTIA is contemplating for its spectrum strategy. Indeed, Q/V band networks are currently under development and construction for deployment well within that time period.[33] The throughput capacity of new Ka band satellites can be significantly expanded when both feeder and service links no longer need to be in the same band. By using the Q/V band as a feeder link to satellites, but still using the Ka band to deliver capacity to end users -- satellite networks can be designed to vastly expand satellite broadband potential. As a result, the Q/V band has become increasingly critical for enabling lightning fast broadband speeds on next generation satellite networks to meet the growing digital demand.

Given current satellite spectrum congestion in the C and Ku bands, the growing congestion in the Ka band discussed above, the many new GSO and NGSO systems being authorized and deployed, the vast increase in the number of other satellites on the horizon, and the need to deliver continuously faster speeds, satellite operators need continued access to the full Ka Band, and also must also be able to harness the Q/V bands in order to meet continuing growth in consumer demand. In the future, the satellite industry also will need access to bands above the Q/V bands for further expansion. There are already FSS allocations in spectrum bands above 51 GHz that will be important for this purpose. Just like terrestrial systems, the spectrum requirements for satellite networks will continue to expand as broadband requirements grow.

Thus, it is critical that America's spectrum strategy ensures that spectrum policy at home and abroad does not curtail or foreclose satellite access to the vital bands necessary to deliver on the satellite broadband opportunity and American leadership in space technology. For this reason, NTIA should consider advancing a spectrum policy framework that maximizes the use of limited spectrum resources, maximizes consumer digital opportunities, and ensures that spectrum policies enable the whole panoply of spectrum demands -- including those of the commercial satellite industry.

As Dr. Pace, the Executive Secretary of the National Space Council has ably put it:

> *"The United States has a strong and entrepreneurial satellite communications industry, available to engage in global competition. … To ensure we retain the strategic advantages afforded by space services, the United States needs to continue [to] open and promote competitive markets and protect spectrum allocation for space services to compete. … There's an urgent need to*

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[33] The Q/V band segments allocated for satellite use include the 37.5-42.5 GHz (downlink) and 47.2-50.2 and 50.4-51.4 GHz (uplink). *Eutelsat and Space Systems Loral test potential of Extremely High Frequencies (EHF) and Eutelsat 65 West A as Blueprint for Future Broadband Systems*, May 2, 2016, https://mdacorporation.com/news/pr/pr2016050201.html; *Alphasat's Q/V-Band Payload ready for Action*, Jan. 22, 2014 (https://artes.esa.int/news/alphasats-qv-band-payload-ready-action); Indian Department of Space, Indian Space Research Organization, GSAT-29 "also carries Q/V-band payload" launched Nov. 14, 2018, (https://www.isro.gov.in/Spacecraft/gsat-29).

*provide reasonable protections for satellite gateway earth stations in certain frequency bands, as well as protection for satellite end user terminals in core satellite bands."*[34]

**MAXIMIZING SPECTRUM OPPORTUNITY REQUIRES SPECTRUM CERTAINTY AND PREDICTABILITY**

The RFC asks, ***"In what ways could the predictability of spectrum access for all users be improved?"***

Predictability is especially important for driving satellite enabled broadband opportunities and incentivizing investment. Lack of predictability or sudden changes in U.S. spectrum policy can chill or strand investment. Given the significant investment and long lead times necessary to deploy new satellite capabilities -- from spectrum identification, spectrum allocation, satellite research and design, construction, testing, launch and operation -- satellites are constructed to have a long-term operational life span often of 15 years or more. Once launched, the ability of satellite providers to alter the way in which their hardware operates, frequencies they use, or fundamentally change the way they offer services is extremely difficult, if not impossible. Some satellite components for spectrum use require custom manufacturing that cannot be changed once created.

Given these unique dynamics, spectrum decisions need to be predictable enough in order to enable the long-term investments necessary to deliver cutting-edge satellite broadband capabilities. As National Space Council Policy Advisor Michael Beavin correctly pointed out in a recent speech, *"[r]egulatory instability is bad for business and can be especially lethal to satellites*."[35]

This regulatory predictability and spectrum certainty is essential both within the United States, and globally. One of the important ways to improve the predictability of spectrum access is to improve the predictability and certainty of U.S. positions and those coming out of World Radio Conference (WRC) decisions.

For example, at the last ITU World Radiocommunication Conference in 2015 (WRC-15), global leaders took the critical step of providing certainty for existing satellite uses in the Ka Band by declining to study the possible introduction of 5G into the 27.5-29.5 GHz portion of the Ka Band (28 GHz).[36] Instead, the Conference decided to study expanded use of satellite capabilities in the Ka Band, recognizing the expansion of residential, enterprise and earth stations in motion (ESIMs) for mobile users on in the air, on water and on land.[37]

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[34] Remarks by Dr. Pace, the Executive Secretary of the White House National Space Council. SpaceNews, Space Council seeking to protect satellite spectrum, May 1, 2018 https://spacenews.com/space-council-seeking-to-protect-satellite-spectrum/.

[35] Michael Beavin, Senior Policy Advisor, National Space Council, Remarks at the Federalist Society: Modernizing American Space Policy (July 26, 2018), https://fedsoc.org/events/modernizing-americanspace-policy

[36] ITU: "Note that WRC-15 excluded the 28GHz band from the scope of study toward the international harmonization of millimetric bands for IMT by WRC-19." Page 25, Setting the Scene for 5G; Opportunities and Challenges. https://www.itu.int/pub/D-PREF-BB.5G_01-2018.

[37] WRC-15 adoption of the WRC-19 Agenda Item 1.5 (to consider the use of the frequency bands 17.7-19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) by earth stations in motion communicating with geostationary

The WRC-15's foundational decisions to preserve the 28 GHz band for the continued deployment of essential satellite services and study the use of the band for the growing ESIMs industry was based on the recognition that the 28 GHz band is essential for delivering high-speed satellite broadband to end users; billions of dollars have been invested in these satellite networks, and the demand for this spectrum is only increasing. European leaders have built upon this framework and harmonized the 28 GHz band for broadband satellite, which makes the band unavailable globally for 5G terrestrial access.[38] Instead, WRC 15 identified 33 gigahertz of other millimeter wave spectrum for study for possible 5G deployment.

In the wake of the WRC-15 decision, the satellite industry has invested billions of dollars in deploying many new networks that operate in the 28 GHz band (as well as the adjacent 29.5-30 GHz band segment and the associated downlink across the 17.7-20.2 GHz band.) With this added spectrum certainty, Viasat launched services over a new Ka Band satellite last year, ViaSat-2, has two more Ka Band satellites under construction, and is designing even more, including an entire non-geostationary orbit satellite system that will use the Ka Band.

However, instead of maintaining this spectrum certainty and supporting the billions of investment dollars it has already enabled, some have begun efforts to re-open discussion of the 28 GHz band for possible 5G use, and are doing so without regard to existing and planned satellite services in that spectrum. Indeed, even though technical studies from both 5G and satellite interests show that the 5G terrestrial access being proposed is incompatible with existing satellite operations in the 28 GHz band, terrestrial wireless network manufacturers and carriers still have suggested reopening the debate and repurposing the 28 GHz band for 5G terrestrial access. Rather than impairing the continued deployment of these essential satellite services, the U.S., led by NTIA, should be confident that 5G can be accommodated in the low band and mid-band spectrum being slated for 5G deployment, and in 33 gigahertz of other millimeterwave spectrum that WRC has identified for possible 5G use, without revisiting the 28 GHz band, or otherwise impeding satellite broadband capabilities and the ability of satellite to close the digital divide and offer true global connectivity.

Notably, the FCC's 2016 decision to permitted 5G access in the band 27.5-28.35 GHz, had its genesis in a 1996 FCC domestic band segmentation decision that was adopted *before*:

- the Internet became what it is today;
- the digital divide existed;
- today's satellite broadband systems were a reality; and
- the spectrum needs of satellite broadband systems were established by actual demand in the market place

space stations in the fixed-satellite service and take appropriate action, in accordance with Resolution 158 (WRC-15).

[38] CEPT 5G roadmap (https://www.cept.org/Documents/ecc/47557/ecc-18-146-annex-21_cept-roadmap-5g).

- *i.e.,* the needs of millions of end users who today use satellite for individual, business and government broadband connectivity needs, and who connect over 60 million phones, tablets and computers on airplanes through satellite-powered Wi-Fi each year.

Moreover, that 2016 decision (iii) significantly *increased* satellite broadband system access to the 27.5-28.35 GHz band segment.[39] Before 2016, satellite use of the 27.5-28.35 GHz segment in the United Stated was limited to a small number of gateways operating on a non-interference-protected basis.[40] The FCC's 2016 decision allowed the deployment of over 9,000 individually-licensed "gateway-type" earth stations on an interference-protected basis.[41]

Regardless, the digital divide is even greater outside the world than it is in the United States [cite], and satellite broadband is very likely the only technology that can provide affordable connectivity to those areas, and thereby support economic development, the creation of new jobs, empower women and minorities, extend access to education and libraries, enable telemedicine, facilitate agriculture , monitor critical infrastructure, and otherwise facilitate nation building.

Whatever reasons lead to the current way that the Ka Band is used in the United States, it is apparent that approach should not be imposed on other countries as part of U.S. policy or positions for the WRC-19 or any future conferences, given the enormous investment in this band for satellite-delivered services around the world. .

The world looks to the United States for leadership in both spectrum policy, and space-based communications. Thus, it is critical that federal spectrum policy continue to advance frameworks that provide the long-term certainty -- both at home and abroad -- necessary for U.S. satellite innovators to thrive and grow.

**ACTIVELY PROMOTING GLOBAL HARMONIZATION CAN PREVENT BALKANIZED DIGITAL OPPORTUNITIES**

Spectrum policy does not stop at national borders. It requires coordination with the rest of the world. When it comes to maximizing satellite digital opportunity, policymakers should also focus on taking a holistic and harmonized approach to spectrum access to ensure that ubiquitous and consistently high-quality connectivity is spread in the broadest possible ways.

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[39] *Id.,* ¶ 4 ("In the 28 GHz . . . band[], we adopt rules that will provide various mechanisms for Fixed-Satellite Service licensees to *upgrade the status of their earth stations* without significantly impacting terrestrial operations.")(emphasis added), and ¶ 55 (explaining that there are over 3,000 counties in the United States, and up to three protected earth stations operating at 27.5-28.35 GHz could be located in each county).

[40] *1996 Order,* ¶ 10 n. 13 & ¶ 48.

[41] *2016 Order,* ¶ 55 (there are over 3,000 counties in the United States, and up to three protected earth stations operating at 27.5-28.35 GHz could be located in each county).

As FCC Chairman Pai has noted, “working together toward international radio spectrum allocation and harmonization for next-generation terrestrial mobile and satellite services… will help ensure that emerging technologies are promptly introduced into the marketplace, to the benefit of all citizens in our region.”[42]

However, when countries take unilateral spectrum approaches -- for example around the 28 GHz band as it relates to 5G -- they can severely impede opportunities everywhere particularly in neighboring countries when they aren’t harmonized. One of the major advantages of satellite communications is that the spacecraft cover large areas, across borders. By way of example, each of Viasat’s latest generation broadband satellites covers about 1/3 of the Earth’s surface. This broad coverage enables the economies of scale necessary for satellite networks to extend their unique economic cost structure to the areas that have too often been left behind by terrestrial and wireless networks, to the people living on the wrong side of the digital divide.

As Dr. Scott Pace, the Executive Secretary of the White House’s National Space Council has put it:

> *“Since radio waves, as you know, don’t stop at borders, unfettered terrestrial wireless network [like 5G] use in one country could certainly preclude the use of satellite services in neighboring countries. That would harm the global economy, and a global approach is necessary to protect U.S. space commerce.”*[43]

To maximize global satellite opportunity, and prevent the balkanization of digital opportunity, we need spectrum leadership at home and abroad. U.S. policymakers must make strides within the WRC-19 and beyond process itself, and in its work with our global partners, to speak with one voice and ensure we can foster a globally harmonized approach to spectrum. Failure to harmonize spectrum approaches could mean that the broad benefits of satellite enabled innovation will not be delivered to all the world’s population, and the vast satellite-enabled broadband opportunity would be balkanized and curtailed. Instead, policymakers can foster win-win scenarios that maximize global digital opportunity led by the U.S. commercial satellite industry.

It is also why the ITU’s recently concluded Plenipotentiary Conference in Dubai, UAE, adopted modifications to Resolution 203 on Connectivity to broadband networks (Rev. Dubai, 2018) inviting Member States “to facilitate connectivity to satellite and terrestrial broadband networks, including enabling access to spectrum, as appropriate, as one important component of access to broadband services and applications, including to remote, underserved and unserved areas.”[44] This Resolution,

[42] Ajit Pai, “Remarks of FCC Chairman Ajit Pai at Canto 2018 Fireside Chat, Panama City, Panama”, 23 July 2018, https://docs.fcc.gov/public/attachments/DOC-352845A1.pdf.

[43] Remarks by Dr. Pace, the Executive Secretary of the White House National Space Council. SpaceNews, Space Council seeking to protect satellite spectrum, May 1, 2018 https://spacenews.com/space-council-seeking-to-protect-satellite-spectrum/.

[44] Final Acts of the Plenipotentiary Conference Dubai, 2018) Page 317. https://www.itu.int/web/pp-18/uploads/finalacts-en.docx.

which the U.S. supported, along with the election of the U.S.'s Doreen Bogdan Martin to lead the ITU Development Sector, with the support of the satellite industry, including companies like Viasat[45], puts the United States and the ITU in a unique position to lead the world with satellite technology that can create an environment for digital inclusion for the billions that remain unconnected, but it requires the right domestic and global spectrum policies to allow the satellite industry to invest and deploy as it has been doing for decades.

**TAKING PROACTIVE STEPS TO PREVENT HARMFUL INTERFERENCE**

Like all networks that seek to deliver reliable performance, satellite providers and customers must be provided with consistent protection from harmful interference. To enable the satellite industry to continue to deliver upon the profound benefits being enabled today and expand upon the game-changing potential just over the horizon, policymakers must ensure that harmful interference is effectively prevented, regardless of its source.

As a National Space Council representative recently put it, *"[i]nterference prevention and management is a crucial challenge for long term sustainability of space-based systems. Powerful terrestrial systems in close proximity to bands used by incumbent satellite systems and their ground facilities are problematic."*[46] Allowing the deployment of interfering services without adequately protecting existing or planned satellite services would significantly reduce regulatory certainty for American companies, chill innovation and investment in existing technology, and threaten American jobs.

Notably, one of the goals of Space Policy Directive 3 (SPD-3) Section 4(g) is preventing unintentional radio frequency (RF) interference:

> *"Growing orbital congestion is increasing the risk to U.S. space assets from unintentional RF interference. The United States should continue to improve policies, processes, and technologies for spectrum use (including allocations and licensing) to address these challenges and ensure appropriate spectrum use for current and future operations."*[47]

As Dr. Scott Pace, the Executive Secretary of the White House's National Space Council has said with regard to the WRC-19, *"[t]here's an urgent need to provide reasonable protections for satellite gateway*

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[45] *Viasat honored to host OAS/CITEL delegates prepping for ITU Plenipot at our D.C. office. Pleased to have @DoreenBogdan, Director D Sector candidate, and others in attendance,* Aug. 24, 2018, (https://twitter.com/ViasatInc/status/1033058778952998913); *Viasat congratulates Doreen Bogdan-Martin on game-changing ITU leadership election victory. We stand ready to help Doreen achieve digital inclusion worldwide. @OEA_CITEL @ITU*, Nov. 1, 2018 (https://twitter.com/ViasatInc/status/1058114869868683264); *Great connectivity conversation today with future @ITU Development Sector member to @ViasatInc #ICT4SDG, Jan. 15, 2019*, (https://twitter.com/DoreenBogdan/status/1085188538591637508).

[46] Michael Beavin, Senior Policy Advisor, National Space Council, Remarks at the Federalist Society: Modernizing American Space Policy (July 26, 2018), https://fedsoc.org/events/modernizing-americanspace-policy.

[47] Space Policy Directive-3, National Space Traffic Management Policy, 83 FR 28969 (Jun. 21, 2018), available at https://www.gpo.gov/fdsys/pkg/FR-2018-06-21/pdf/2018-13521.pdf.

*earth stations in certain frequency bands, as well as protection for satellite end user terminals in core satellite bands."*[48]

**New Spectrum Users Must Be Able to Protect Existing Users**

When a new service seeks to enter a band and share with incumbent services, the incoming service should design equipment and communications links with the characteristics of the incumbent systems in mind in order to most effectively share the spectrum. Further, failing to consider characteristics of existing services in adjacent bands in equipment design can lead to difficulties in efficiently sharing spectrum. We are seeing issues with this today as 5G proponents seek to enter new bands. On one hand, 5G proponents complain about potential out-of-band impact from incumbents who have been longtime users of the spectrum and who are widely deployed, and on the other hand 5G proponents do not want to be required to operate with any constraints to protect existing sensitive space research services in adjacent bands.

As has long been the practice in domestic and global spectrum policy, the new spectrum user should consider all the applications of services in and adjacent to the band they seek to enter.

In addition to equipment design, use or operational frameworks for new services should also be designed to be compatible with existing services. This may mean down-tilt requirements and limitations on emissions towards space, in the case of terrestrial services being deployed in bands also used for satellite services.

With respect to protection criteria for satellite services, it bears emphasis that when Recommendation ITU-R S.1432 was developed, satellite links typically used fixed data rates and fixed margins to overcome atmospheric losses and meet system availability. The error correcting codes used decades ago had fairly gentle bit error rate vs signal to noise (BER vs S/N) slopes. For example, a 1 dB decrease in S/N typically resulted in a 10% increase in BER.

Today, modern satellite communications links using adaptive coding and modulation (ACM) operate with very little margin when compared to previous designs. Error correcting codes used today operate much closer to the Shannon limit (discussed above) and provide significantly improved spectral efficiency. The codes, however, have much higher BER vs S/N slopes and can go from quasi-error free (QEF) to out of service over the range of just a few dB.

As clear-sky conditions prevail the vast majority of the time, ACM links can run with very spectrally efficient coding and modulation sets providing very high throughput and significantly increasing the capacity of a system. When conditions degrade, however, the system adaptively selects more robust coding and modulation points to keep the link operating error-free. These changes come at the expense of less spectral efficiency and lower data rate / throughput, for short periods of time. However, when integrating throughput over time, ACM systems provide significantly more capacity than older fixed rate systems under the same conditions.

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[48] Remarks by Dr. Pace, the Executive Secretary of the White House National Space Council. SpaceNews, Space Council seeking to protect satellite spectrum, May 1, 2018 https://spacenews.com/space-council-seeking-to-protect-satellite-spectrum/.

The important takeaway is that interference, when it occurs, may act like increased attenuation from rain, and reduce system margin and accordingly reduce overall system capacity, or if the interference is bursty, the ACM system may not be able to react quickly enough and instead of a reduction of capacity a complete loss of link could occur.

Recognizing the increased use of ACM, the ITU is currently developing a Recommendation for performance objectives for satellite links using adaptive coding and modulation (ACM). When completed, this new Recommendation may be used to develop updated protection criteria for fixed-satellite services using ACM.

**MAXIMIZING SPECTRUM UTILIZATION AND IMPROVING COORDINATION THROUGH SPECTRUM SHARING TECHNIQUES**

The RFC asks, ***"To what extent would the introduction of automation facilitate assessments of spectrum use and expedite the coordination of shared access, especially among Federal and non-Federal spectrum stakeholders?"***

Automation technologies can play an important role in enabling significant improvements in spectrum utilization and efficiency, when established with the appropriate protections. Spectrum sharing techniques can make more opportunistic use scenarios possible, enable more efficient use of scarce spectrum resources and ensure that the country's growing spectrum demands can be met more sustainably, while still accounting for existing spectrum uses.

These spectrum sharing opportunities are enabled by innovative and automated technologies including cognitive radios, sense and avoid technologies, dynamic beam forming antenna technologies that create "nulls" in the direction of interference sources, and automated clearinghouse systems built upon dynamic spectrum databases. These technologies enable opportunistic reuse of the same spectrum in nearby areas -- for example by developing a dynamic spectrum clearing house that provides a simple "go" or "no-go" response to mark the availability to reuse certain spectrum. A dynamic spectrum clearinghouse set up in this way allows secondary spectrum users to query a neutral system about spectrum re-use availability, and the system would provide a simple go, no-go response to ensure that supplemental spectrum use would only occur in locations and/or during times when there would not be any adverse impact on the primary designated use of the band.

This kind of automated spectrum clearinghouse can be managed by an agency or independent third party to enable operators to maintain accurate information in a database about their own spectrum usage and base station location. By using a third-party clearinghouse, confidential, proprietary and/or national security information is never available to the requesting party thus protecting sensitive or competitive information on base station location, name of carrier, or governmental usage. These techniques can help improve coordination and sharing opportunities between federal and non-federal stakeholders, as well those between non-federal terrestrial and satellite systems.

This is not some far-off technology. Dynamic spectrum sharing database systems are technologically feasible and being developed in the tiered sharing framework developed in the 3.5 GHz band and have already been established for TV White Space operations.

However, in order for sharing to work effectively, all parties need to invest in the technology and contribute to creating an environment where spectrum can be used intensively and efficiently. One type of user should not have to bear the entire burden of sharing, particularly where other types of users in a greenfield deployment can implement reasonable measures to accommodate shared uses, including populating databases that alert other spectrum users of their operations, or employing modern antenna technology that helps eliminate the effect of sources of unwanted energy. Facilitating these types of sharing scenarios requires rules that balance the sharing burdens and obligations between both satellite and terrestrial users to avoid scenarios in which a small number of terrestrial licensees become private gatekeepers for the spectrum or unilaterally dictate the terms of sharing. When burdens are appropriately balanced, these types of technologies can help improve spectrum coordination, facilitate resolution of suspected interference events, and identify situations in which spectrum is not actively being used.

These innovative sharing techniques can facilitate an even more efficient use of spectrum by satellite networks in certain band segments in a manner that was not possible when current band plans were established. They enable policymakers to re-think the decades-old perception that broad use of shared spectrum by satellite networks necessarily would impede use of the same band by terrestrial users. As NTIA develops its spectrum strategy, it should not assume that the circumstances that led to previous approaches to spectrum management should always still apply. But it is essential that NTIA protect the reasonable expectations of existing spectrum users in these circumstances.

Given the feasibility of sharing and the opportunities for making more-intensive use of spectrum that is critically needed to increase the capacity of satellite networks and thus serve the needs of consumers, it now makes sense to move beyond mere rules based legacy sharing paradigms that have now become obsolete, and harness technologies to expand the use of shared spectrum access.

**ENSURING US GLOBAL COMPETITIVES AND ENABLING A TRILLION-DOLLAR SPACE ECONOMY REQUIRES A COMPREHENSIVE SPECTRUM APPRACH**

The RFC asks, ***"What are the risks, if any, to the global competitiveness of U.S. industries associated with spectrum management and policy actions?"***

In an age when high speed broadband is quickly becoming the most transformative technology of our time, enabling pervasive reliable high-speed access everywhere has not only become an opportunity equalizer, learning enabler, and innovation accelerator, but an economic imperative.

Spectrum policy is critical to both U.S global competitiveness, and the growing economic benefits that satellite industry is capable of delivering. In 2016, the U.S. satellite industry generated over $110 billion in revenues and supported over 210,000 American jobs.[49] On a global scale, in 2017, the satellite industry earned $269 billion, which translates to 79 percent of the total space economy ($348 billion).[50]

[49] Satellite Industry Association, 2017 State of the Satellite Industry Report, at 6 (June 2017), https://www.sia.org/wp-content/uploads/2017/07/SIA-SSIR-2017.pdf.

[50] Satellite Industry Association, 2018 State of the Satellite Industry https://www.sia.org/wp-content/uploads/2018/06/2018-SSIR-2-Pager-.pdf.

**Enabling the next trillion-dollar industry**

We are on the verge of a dynamic new commercial era in space in which commercial broadband is one of the main drivers. Morgan Stanley estimates that by 2040, global space revenue will grow to $1.1 trillion.[51] Of this, Morgan Stanley estimates that satellite broadband will represent 50% to 70% of the projected growth of the global space economy by 2040.

Citing this Morgan Stanley's assessment of a trillion-dollar space economic opportunity, Secretary Wilbur Ross has asked what may be the most important question for the developers of this national spectrum policy, "how do we get to the $1 Trillion space economy?"[52] He notes that "[g]etting to $1 Trillion is going to take the entire government working together to create a commercial space environment that allows business to do what it does best." To take advantage of this economic opportunity, policymakers need to be thinking proactively about the vitality and availability of satellite spectrum resources.

Because of huge increases in satellite connectivity capabilities that are already under construction, satellite broadband is a leading candidate to help connect the 3.5 billion people in the world left behind by terrestrial infrastructure. Because of U.S. policies, and the technological leadership of U.S. commercial satellite broadband providers, the economic benefits from connecting the next cohort of broadband consumers beyond U.S. borders could largely be driven by U.S. satellite leaders, helping build U.S. global competitiveness, and driving global digital inclusion.

Unlike a terrestrial broadband service, or a cellular wireless service (neither of which is likely to be provided by a U.S. carrier in an overseas markets) satellite broadband opens up opportunities for U.S. companies to not only provide the broadband service itself, but to also expand the online marketplace of reachable consumers beyond our borders by US companies. Expanding global broadband access, expand US market access, and the US satellite industry is uniquely poised to put a dent in the estimated 3.9 billion people now offline.[53] Not only is a mere 10% increase in global broadband penetration estimated to raise global economic growth by as much as 1.4%,[54] but each 10 percent increase in global usage of so-called "over-the-top" (OTT) services, services like Netflix, adds approximately $5.6 trillion to

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[51] Space: Investing in the Final Frontier, Morgan Stanley (Nov. 13, 2017), https://www.morganstanley.com/ideas/investing-in-space.

[52] Commerce Secretary Wilbur Ross, at the U.S. Chamber of Commerce Space Summit: Industry Taking Off, December 6, 2018. https://www.commerce.gov/news/speeches/2018/12/remarks-us-commerce-secretary-wilbur-l-ross-us-chamber-commerce-space-summit.

[53] https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.18-2017-PDF-E.pdf.

[54] BroadbandCommission, Working Together to Connect the World by 2020, January 2016 https://www.broadbandcommission.org/Documents/publications/davos-discussion-paper-jan2016.pdf.

U.S. GDP.[55] Given that 95% of the world's consumers live beyond the U.S. borders[56], the greater percentage of the global population that is able to access high speed broadband, the greater the potential of the US online industry to reach them.

As importantly, ensuring sufficient spectrum for satellite broadband to reach those left behind by terrestrial broadband providers can also help solve important global challenges -- including economic mobility, health, and education challenges. But poor spectrum management, or lackluster leadership on the world stage when it comes to spectrum policy, could impede our U.S. satellite providers ability to serve global markets, and cede the global broadband marketplace to other countries.

**Conclusion**

America's commercial satellite broadband leadership is at an inflection point. Our satellite leadership, the opportunities it can deliver, the lightning fast broadband speeds now being achieved, and the breadth of our reach is now the envy of the world. This leadership position not only helps drive our economic prosperity and expand our digital frontier, but it also helps sustain American national security leadership. Moving forward, it is critical that U.S. policy continues to foster the kind of spectrum leadership that helps unlock continued global satellite leadership through continued spectrum certainty.

As addressed in these comments above, Viasat urges NTIA to take a comprehensive view of spectrum policy.

- For Ka band, it is essential that the United States have a spectrum policy that allows the commercial satellite industry to expand to meet the high broadband demand within the U.S. and around the world. Specifically, the 27.5 – 30 GHz uplink and 17.7-20.2 GHz downlink spectrum that is a "core" global satellite broadband band, both for gateways and user terminals at fixed locations and on the move.

- The Q/V bands are also poised to be in heavy use over the 15-year time horizon that NTIA is contemplating for its spectrum strategy. Indeed, Q/V band networks are currently under development and construction for use well within that time period. The throughput capacity of new Ka band satellites can be significantly expanded when both feeder and service links no longer need to be in the same band. By using the Q/V band as a feeder link to satellites, but still using the Ka band to deliver capacity to end users -- satellite networks can be designed to vastly expand satellite broadband potential.

- In the future, the satellite industry also will need access to bands above the Q/V bands for further expansion. There are already FSS allocations in spectrum bands above 51 GHz that will be important for this purpose. Just like terrestrial systems, the spectrum requirements for satellite networks will continue to expand as broadband requirements grow.

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[55] Internet Association comments to NTIA, https://www.ntia.doc.gov/files/ntia/publications/ia_comments-international_internet_priorities.pdf and, WIK. "The Economic and Societal Value of Rich Interaction Applications (RIAs)." https://www.wik.org/fileadmin/Studien/2017/CCIA_RIA_Report.pdf.

[56] U.S Chamber of Commerce. https://www.uschamber.com/ad/95-worlds-consumers-live-outside-united-states.

Viasat encourages NTIA to develop a sustainable spectrum strategy for America's future that considers the unique global nature of satellite spectrum, the inherent opportunities satellites are now poised to deliver, and adopt meaningful strategies to ensure continued opportunities for the innovation, employment, leadership and growth of satellite broadband services for a more prosperous American future and connected globe.

Respectfully Submitted,

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**32 MEETING OF PERMANENT CONSULTATIVE COMMITTEE II: RADIOCOMMUNICATIONS**
**December 3 to 7, 2018**
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# INFORMATION DOCUMENT ON SATELLITE IN THE 5G ECOSYSTEM

**(Item on the Agenda: 3.3)**

**(Information document submitted by Viasat, Inc.)**

## Introduction

5G has been conceived as an ecosystem of many technologies – a network of networks – in which satellite plays a vital role in accelerating opportunity, maximizing network potential, and extending network reach.

The global Internet approach has been a powerful driver in providing world-changing economic opportunities. By integrating the unique benefits of every kind of network – copper, fiber, terrestrial wireless, and satellite – the Internet has become a global force that has created as much economic growth in 15 years as the industrial age created in 50 years.[1] This network of networks approach has been instrumental not only because it takes advantage of the unique capability of every available technology at the *core* of the network to extend its reach (fiber, copper, and satellite), but also through the variety of access technologies at the *edge* of the network – Wi-Fi, cable, DSL, LTE, and satellite to name a few.

This ecosystem approach has proven to be essential for leveraging the unique benefits of each type of network technology to expand the reach and capability of the Internet. The combination of cellular, Wi-Fi, satellite and other advances are enabling this same kind of ecosystem approach to be extended to the wireless world – both in the core of the network and at its edges – to expand the capabilities of mobile and fixed end user devices and the locations they operate.

At the dawn of the 5G world, advancing this 5G ecosystem architecture is even more vital. Too often, however, the only aspect of next generation wireless technology that is focused on is the last 100 meter access link to the end user device. A myopic view of 5G – especially when it comes to spectrum – can limit its potential. Only through a holistic view of 5G, and a broad understanding of the comprehensive nature of the entire 5G ecosystem, can the full power and potential of next-generation wireless opportunity be realized. That's because 5G is not a step change from 4G, nor is it just a technological shift. It's a paradigm shift in the way we think about high speed mobile broadband networks. Today's 5G vision encompasses a broad technology ecosystem – with multiple network technologies supporting a global infrastructure including traditional mobile wireless networks, satellite, Wi-Fi, and small cells.

The 5G network is envisioned as an access network-agnostic architecture that includes new cellular wireless access technologies (for the last 100 meter access), but also existing fixed wireless networks, Wi-Fi and satellite networks.[ii] These multiple access technologies are critical for optimizing the many different use cases envisioned for next generation networks. With advanced concepts of a unified user identity, users can be authenticated regardless of access technology enabling a seamless experience. The access technology and network technology are not inextricably linked but are decoupled to provide more flexibility for users and applications regardless, for example, if they are on a cellular network or Wi-Fi network. This multi-access capability can, for example, enable traffic to be offloaded from the mobile access network to other networks (for example to a satellite enabled Wi-Fi endpoint).

This 5G ecosystem approach is also essential for expanding the reach of 5G networks. By taking advantage of satellite's geographically independent cost structure to extend connectivity, for example in underserved and unserved areas, satellite systems can accelerate the commercially viable deployment of 5G networks and extend scalable and efficient 5G network solutions globally. This is especially critical in areas that may not be economically or otherwise connected via terrestrial networks. Network diversity is also essential for ensuring network resiliency and continuity of service across geographies and enabling 5G devices to connect on truly mobile platforms including onboard aircraft, high-speed trains, sea-going vessels, and land-based vehicles that are beyond the reach of a cell site.

In order to fundamentally expand what networks are capable of achieving, and the places they are capable of reaching, a holistic approach is necessary to advance the entire 5G ecosystem of technologies. Harnessing the capabilities of satellite technology maximizes the reach and capabilities of 5G networks. Doing so also maximizes the ability of the 5G ecosystem to solve bigger problems – like extending high speed access to the next billion people, improving network resiliency, and enabling ubiquitous connectivity in the air, across the seas, and around the globe.

Nowhere is this more critical than in spectrum policy decisions. Having a holistic approach to spectrum policy that takes into account the unique capabilities of each technology is essential. This paper outlines the key spectrum decisions that enable the 5G opportunity to be maximized by embracing a holistic approach to the 5G ecosystem, and a holistic approach to the spectrum policy that accompanies this network of networks.

**Next Gen Wireless Networks**

It is important to be clear on the goals for the 5G ecosystem: To enable a connected world with ubiquitous access to the Internet by providing hyper mobility on land, sea and air for *all* people *everywhere*. This is more than just about the edge devices or the radio access; it is about providing a complete global network infrastructure.


**Figure 1: The Connected World** [iii]

Clearly, this cannot be done with one wireless access technology or with one network. There will continue to be extensive use of multiple wireless technologies such as Wi-Fi, point-to- multipoint links, satellites and, of course, cellular. They all play an essential role in building an infrastructure that is adaptable to the ever-expanding new applications and environments.

Similarly, network infrastructure will continue to rely upon fiber, cable, microwave, satellite, HAPS (High Altitude Platforms) and mm-wave technologies to deliver on the ubiquitous and robustness promise. These hybrid networks must now enable greater capabilities to ensure security and accessibility and adaptive performance with simple hand-offs between peer networks.

With this more complete perspective of 5G we can now put in context a balanced roadmap to future wireless technologies which will include satellite, microwave, mm-wave, cellular and Wi-Fi networks that will collectively compete for the broadening demand for new applications. Each of these networks provides its unique value in user management, security and capabilities, yet each also connects to the global Internet in a consistent way to exchange data using compatible user authentication models.

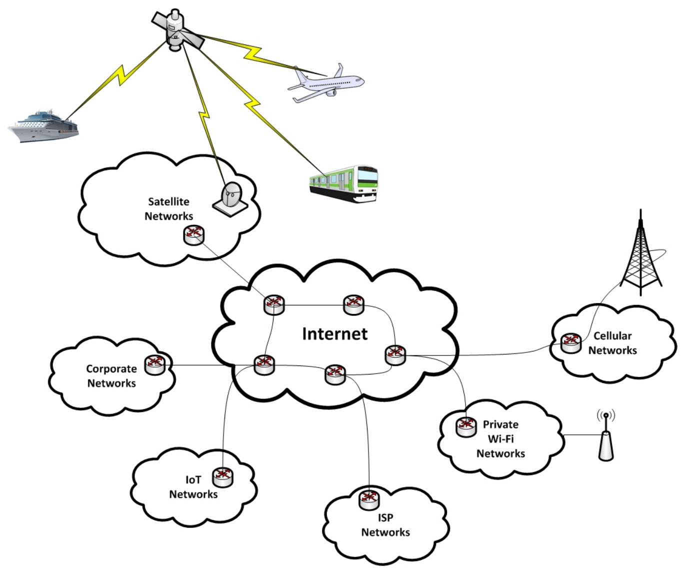


**Figure 2: 5G Ecosystem – Network of Networks**

This network infrastructure is invisible to most users but plays a critical role in delivering performance, security, value-added features, and authentication for the user. While most users rely heavily on their mobile devices, few realize that 63% of all mobile data actually is 'offloaded' to Wi-Fi and the Internet using unlicensed spectrum. As mobile data demand increases so will this offload to unlicensed spectrum. By 2021, Cisco predicts that 5G cellular devices will represent only 0.2% of all connected devices in the world and will account for only 1.5% of network traffic. Cisco also predicts that by 2021 the total of all IP Internet traffic will exceed 84 exabytes of data, 50% will be Wi-Fi, 30% will be fixed and only 20% will be mobile data. [iv]

It is this diversity of wireless access technologies as well as the inter-connectivity of network topologies that ensures a robust and resilient network ecosystem.

**Current Satellite Capabilities**

Both geostationary (GSO) and non-geostationary (NGSO) satellite networks have their specific benefits for the 5G ecosystem. Innovation is driven by development of High Throughput Satellite (HTS) systems in various types of orbits (GSO, MEO, LEO). HTS systems today deliver substantial improvements in throughput, capacity and cost, as well as provide flexible, global and high-performance services. This is done by utilizing concentrated spot beams, wideband payloads, increased frequency re-use and higher frequency bands to significantly increase capacity and speeds over wide areas. HTS networks are operating on a global basis and can provide broadband service with speeds in excess of 100 Mbit/s to the end user.

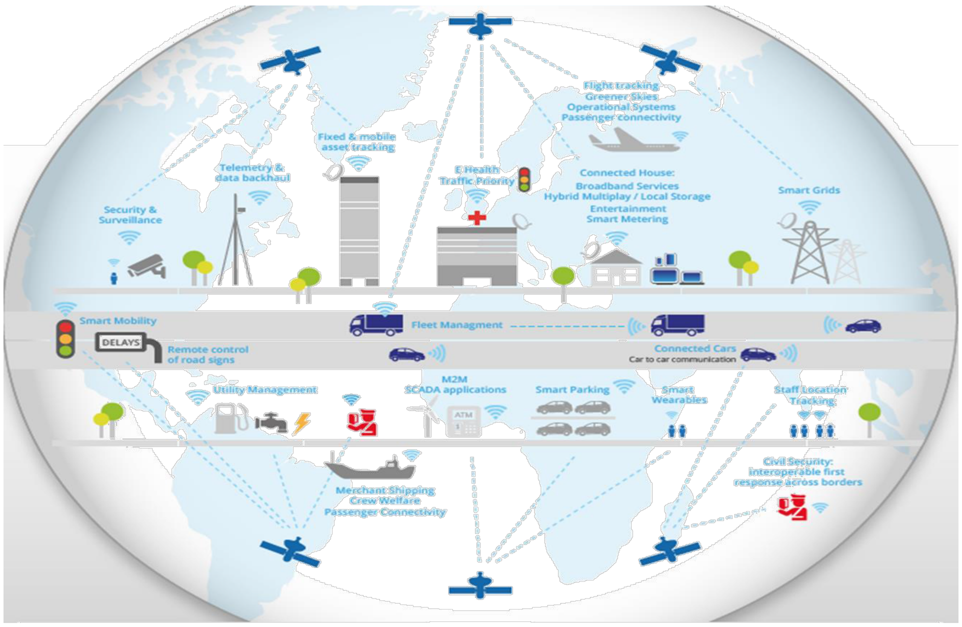


**Figure 3: Satellites in the 5G Ecosystem**

In addition to the developments in the space segment, there are technical developments in the satellite ground segment with evolutions both in the network platforms and satellite communication terminals and antennas. Satellite already has and will further adopt technologies and standards necessary to deliver the types of services needed in the 5G ecosystem, including in the areas of service delivery, network-slicing, orchestration, mobile edge computing, security, interoperability and resource virtualization in order to transparently support end-to-end service delivery to vertical applications. Furthermore, a new wave of flat panel antenna technology is emerging for satellite communications. These antennas have removed mechanical components, relying on software and electronics for steering, making them available for mobile platforms like cars, boats, planes and more.

**Advanced Satellite Network Technology**

Advanced satellite technology includes support for virtual network operators, traffic management, intelligent routing, quality of services, and other features. Some of these features are nearly unique to satellite communications, such as acceleration services to mitigate the impact of latency. Some, such as traffic enforcement, service accounting, and media services (including content rights management) are common among most access networks. Some, such as mobility services, are similar to those employed in cellular systems but are tailored to the much larger reach of satellites.

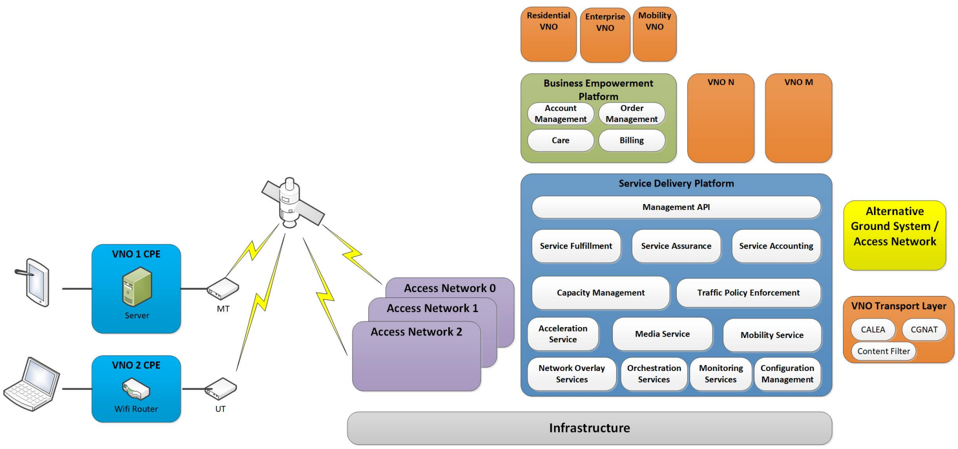


**Figure 4: Satellite Ground System Components**

Data can be routed between satellite beams within a satellite network, between satellite networks, and between satellite and terrestrial networks. This allows consistent, seamless connectivity for individual users whether they are in the air, on the water, in a vehicle or train, at home, in town, or in the office. The networks support multicast as well as unicast data efficiently.

Advanced satellite systems also include dynamic configuration management elements to enable flexible adaptation of device behavior suitable for operating across networks. This allows the networks to adapt over time and to change behavior as necessary to compensate for link dynamics.

**Satellite Spectrum Technological Advancements**

Commercial satellite networks have relied on access to the 27.5 – 30 GHz band (Ka Band) for over two decades to provide critical connectivity around the world. Today, over 130 GSO Ka band satellites are now in orbit, providing a wide range of services. Many more Ka band satellites (both GSO and NGSO) are under construction to meet the growing demand for service, and need to use the full 2.5 gigahertz of Ka band spectrum both to meet this demand, and because the Ka band orbital arc is becoming increasingly congested. While satellite use of the Ka band has grown exponentially in the past few decades, the terrestrial mobile service simply did not develop in the Ka band, even though the ITU's Table of Frequency Allocations also provided an opportunity for that to occur.

For next generation satellites to provide high capacity connectivity, they need continued access to spectrum, and to employ the existing technologies that allow the spectrum to be used up to its technological limit. Modern satellite technology has developed to the point where it extensively employs frequency reuse technologies in which the same frequency band is used by one satellite to provide connectivity to many diverse locations at the same time by creating separate spatially isolated or orthogonal beams. Similarly, many different satellites use the same frequency band to provide connectivity to the same location. This is possible because each ground-to-satellite connection is from a different direction. The ground antenna can be a traditional parabolic dish, a horn array with mechanical steering, or an electrically-steered phased array.

In fact, satellite technology has advanced to the point that today's satellite broadband systems are approaching "Shannon's Limit" in terms of spectral efficiency.[vi] Access to adequate spectrum is now the primary limiting factor in extending satellite broadband networks to address all of the unserved and underserved around the world, no matter whether they live in metropolitan areas or remote communities.[vii]

**Benefits for Consumers, Businesses, and Governments Provided by Satellite <u>Today</u>: Vertical Examples**

**As we enter a golden age of next gen satellite vast new opportunities come into view**

Satellite is a vital part of the 5G ecosystem and is uniquely situated to solve key digital inclusion challenges, and expand global digital opportunity. As the world is blanketed with high speed broadband access, the opportunities become even greater, the technologies more transformative, and the impacts even more profound. Satellite systems already offer speeds today of up to 100 Mbit/s. Satellites currently under construction are capable of offering 1 Gbit/s, lightning-fast broadband speeds.

**Connecting the unconnected:** Today, more than ever, access to high speed broadband is an opportunity equalizer and economic accelerator. What once was a luxury is a necessity today. However, 3.9 billion people around the globe still do not have access to the Internet, and around one-third of the world's inhabitants still do not own a personal mobile phone.[viii] High-quality and cost-effective satellite broadband is playing an increasingly important role in addressing this digital divide across the globe, for the unserved and underserved who exist everywhere, including in the most rural and remote areas of the world where it remains uneconomical for terrestrial or cellular services to build. The nature of satellite's wide coverage ensures that all communities within a satellite network's footprint receive the same quality of service, whether they are in metropolitan areas or remote communities.

- In many cases, the digitally disconnected are the ones who can benefit most when they gain access to the global Internet and are digitally included. Connecting these people is essential for supporting freedom of information and speech, accelerating developing economies, improving access to education, empowering women and minorities, and advancing democratic societies. This is why the UN's 2030 Agenda for Sustainable Development has recognized that "global interconnectedness has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies,"[ix] and the UN's Human Rights Council has declared Internet access to be a basic human right.[x] Satellite technology helps meet these objectives by blanketing the globe with this digital opportunity, extending access beyond the reach of terrestrial networks, and transforming the economics of global broadband reach. Indeed, among the UN's Sustainable Development Goals, the achievement of 38 targets depends upon universal and affordable access to broadband and the technologies needed to access broadband.[xi] Satellite systems not only play an essential role in extending broadband connectivity globally, they also provide the connectivity for extending scalable and efficient network solutions globally. By taking advantage of satellite's geographically independent cost structure to extend connectivity, satellite today is helping provide connectivity to tens of millions of fixed and mobile end-user devices everywhere, including areas that are not adequately connected via terrestrial networks.

- It is also why the ITU's recently concluded Plenipotentiary Conference in Dubai, UAE, adopted modifications to Resolution 203 on Connectivity to broadband networks (Rev. Dubai, 2018) inviting Member States "to facilitate connectivity to satellite and terrestrial broadband networks, including enabling access to spectrum, as appropriate, as one important component of access to broadband services and applications, including to remote, underserved and unserved areas."

**Enabling communications on the move.** Satellite broadband is helping expand economic opportunity everywhere – on the ground, in the air, across the seas, and around the globe. Advances in technology make it possible today to deliver high-speed satellite broadband communications to consumers and businesses on the move – whether on an airplane (while waiting to take off, and at 35,000 feet), on a ship in the middle of the ocean, on a tractor in a remote and rural farm, on a bus or train in a city, or in an emergency vehicle speeding down the freeway on the way to a hospital. Already more than a thousand airplanes flying billions of air miles are accessing satellite-enabled high-speed Wi-Fi capable of streaming Internet and movies right to the seat. Wi-Fi on aircraft has become so popular that there are often more connected devices than passengers on planes. Well over 60 million electronic devices already connect every year to satellite-enabled Wi-Fi on airplanes and this number is expected to increase exponentially to hundreds of millions in just the next 3-5 years as more aircraft become connected. Satellite's unique ability to provide connectivity across moving platforms is essential for enabling people with 5G devices to connect while on the move.

**Extending Wi-Fi service.** Satellite-based Wi-Fi services today connect users in metropolitan areas as well as unserved and underserved markets within the satellite network's coverage area. Satellite-based Wi-Fi is extending high-speed broadband access in unique ways to urban city centers, community recreation centers, airports, stores and shops. At the same time, large numbers of towns and villages worldwide have little to no Internet access. To address these broadband-challenged locations, satellite-powered hotspot service connects people in small villages and towns to the online world – affordably and reliably. Many people in these villages and towns have mobile smartphones, yet many do not have Internet service. By bringing a satellite-powered community 5G Wi-Fi service to these villages, made available through a shared satellite terminal, the residents gain access to high-speed connectivity. For example, today nearly one million people in thousands of locations that don't have 3G or 4G services can now connect their smartphones thanks to satellite-powered community Wi-Fi hotspots.

**Unlocking new digital health opportunities.** With too many people living in areas with only sporadic and even diminishing access to quality health care, satellite broadband technologies that span distance *today* are extending connected care *everywhere*. What was once a dream is now becoming a reality, that is, no one should be forced to put their life at risk simply because they live too far from a doctor. Satellite technology is cost-effectively overcoming a rural physician shortage, extending experts to where they are needed most, and delivering services regardless of where the doctor or patient is physically located. For example, satellites today are being used to connect ambulances in transit to doctors in hospitals to improve patient outcomes.

**Improving disaster recovery and relief**. Satellites networks provide high capacity and instantaneous connection to any place within their wide coverage areas. They are less vulnerable to physical attacks and natural disasters than terrestrial systems and satellite terminals can be rapidly deployed. Satellite networks can be especially important for improving 5G service resiliency, and for rapid deployments of high-speed wireless connectivity in emergencies and for disaster relief.

**Advancing a new era of precision agriculture**. Satellite broadband is helping enable a whole new generation of precision agriculture opportunities driven by broadband that enables remote farms – especially with livestock sensors, soil monitors, and autonomous farming equipment – far beyond where cell sites are likely to ever be deployed. Autonomous farm equipment, already enabled by satellite positioning technology, often needs connectivity far beyond the line of site of a cell site.

**Enabling competition.** Just as it has with radio and television services in the past, Ka-band enabled satellite broadband services today are providing market-based competition to terrestrial broadband services. Satellite broadband brings additional service package options, greater capacity for video downloads and streaming, competitive pricing per gigabit, and innovative services to consumers who often have few choices from terrestrial providers. It is essential that satellite networks have secured access to sufficient spectrum to meet consumer demand, without having terrestrial competitors as a gatekeeper for spectrum access.

**A holistic approach to 5G users access needs is essential**

In order to maximize 5G high-speed broadband opportunities for everyone, it is critical that a holistic approach to the 5G future be considered. This means taking a comprehensive view of spectrum policy across the 5G ecosystem to ensure secure access to the spectrum needed by all technologies to enable universally-available advanced broadband services, including to densely populated cities and underserved and unserved areas, wherever located.

1. **5G solutions must ensure global digital inclusion.** As noted above, today some 3.9 billion people do not have access to the Internet, and around one-third of the world's inhabitants still do not own a personal mobile phone.[xii] This lack of access has created a growing digital chasm between urban and rural, the wealthier and the less well off, and between developed and developing countries.[xiii] It's one of the reasons that embracing a holistic network of networks approach to 5G is essential – enabling the whole panoply of network technologies to work together to extend the reach of broadband connectivity. As satellite systems with over one terabit per second of capacity now under construction are deployed and provide affordable broadband service to everyone, they will play an even more important role in extending digital connectivity to all communities and all citizens, wherever they are located, and wherever they may travel. **Thus, to extend and project the reach of 5G broadband access, both vital satellite technologies and reliable spectrum access for satellites are essential.**

2. **A global spectrum strategy (that preserves critical Ka band spectrum for satellite) is essential for advancing digital opportunities.** Taking a holistic and harmonized approach to spectrum access is critical for ensuring that ubiquitous and consistently high-quality connectivity is spread in the broadest possible ways. At the last ITU World Radiocommunication Conference in 2015 (WRC-15), global leaders took the critical step of providing certainty for existing satellite uses in the Ka-band by declining to study the possible introduction of 5G into the 27.5-29.5 GHz portion of the Ka band (28 GHz). The WRC-15's foundational decisions to preserve the 28 GHz band for satellite growth was based on the recognition that the 28 GHz band is essential for delivering high-speed satellite broadband to end users; and the demand for this spectrum is only

increasing. European leaders have built upon this framework and harmonized the 28 GHz band for broadband satellite, which makes the band unavailable for 5G terrestrial access. In the wake of the WRC-15 decision, the satellite industry has invested billions in deploying many new networks that operate in the 28 GHz band (as well as the adjacent 29.5-30 GHz band segment), the benefits of which are described above. Technical studies from both 5G and satellite interests show that the 5G terrestrial access being proposed is incompatible with existing satellite operations in the 28 GHz band. Nevertheless, terrestrial wireless network manufacturers and carriers have suggested reopening the debate and repurposing the 28 GHz band for 5G terrestrial access. Continued certainty on use of the Ka band, including the 28 GHz band, is essential both for the continued operation of existing satellite broadband, and enabling the continued provision of satellite services as a part of the 5G network of networks, to extend the 5G opportunity. **Thus, satellite broadband must be allowed to flourish and innovate in the Ka band with the certainty that the spectrum will not be opened for incompatible services.**

3. **This is not a choice between terrestrial 5G and satellite-enabled broadband.** There is more than enough spectrum for terrestrial 5G services in other bands being explored as a part of the WRC-19 agenda without denying satellite broadband the 28 GHz band spectrum that it currently uses. In fact, as a variety of 5G interests have indicated, the low and mid-band spectrum, beyond the 33+ gigahertz that the WRC-19 will consider, is much more attractive for 5G terrestrial access. 5G can be accommodated in 33 gigahertz of spectrum that the ITU is studying for use in 5G that doesn't include the 28 GHz band or the adjacent 29.5-30 GHz part of the Ka band.[xiv]

4. **Satellite access to the 28 GHz band is essential to prevent a balkanization of digital opportunity.** Sterilizing the 28 GHz band with unilateral national 5G spectrum strategies could severely impede opportunities everywhere – particularly in neighboring countries. The coverage areas and economies of scale necessary to bridge the digital divide require satellite broadband to have a broad footprint. One of the major advantages of satellite communications is that their beams can cover large areas, across borders. The only logical solution is for countries to continue to embrace satellite broadband use of the 28 GHz band and not make it available for incompatible 5G cellular use. Failure to do so would mean that true 5G – and the broad benefits of its network of networks approach – could not be delivered to all the world's population, and the vast satellite-enabled broadband opportunity would be balkanized and curtailed.

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[i] McKinsey, The great Transformer: The impact of the Internet on economic growth and prosperity. https://www.mckinsey.com/~/media/McKinsey/Industries/High%20Tech/Our%20Insights/The%20great%20transformer/MGI_Impact_of_Internet_on_economic_growth.ashx

[ii] Wireless Broadband Alliance, 5G networks. https://www.wballiance.com/wireless-broadband-alliance-calls-for-industry-cooperation-to-harmonize-the-integration-approaches-of-wi-fi-with-5g/

[iii] ECC Report 280, Satellite Solutions for 5G, at 11, https://www.ecodocdb.dk/download/e1f5f839-ba17/ECCRep280.pdf.

[iv] CISCO: Global Mobile Data Traffic Forecast Update, 2016–2021 White Paper

[v] ECC Report 280, Satellite Solutions for 5G, at 13, https://www.ecodocdb.dk/download/e1f5f839-ba17/ECCRep280.pdf.

vi *See* https://www.gaussianwaves.com/2008/04/channel-capacity/. Today's satellite systems provide actual transmissions at near the maximum capacity that theoretically can be achieved over a given amount of spectrum. This means that making more spectrum available is the only way to increase satellite capacity and serve more end users.

vii These points were recently highlighted by Dr. Pace, the Executive Secretary of the White House National Space Council: "The United States has a strong and entrepreneurial satellite communications industry, available to engage in global competition…. The United States has a strong and entrepreneurial satellite communications industry, available to engage in global competition… There's an urgent need to provide reasonable protections for satellite gateway earth stations in certain frequency bands, as well as protection for satellite end user terminals in core satellite bands … It's for those these reasons that the National Space Council is examining how the Department of State, Commerce and the FCC can better coordinate to ensure the protection and stewardship of spectrum necessary for space commerce. https://spacenews.com/space-council-seeking-to-protect-satellite-spectrum/.

viii https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.18-2017-PDF-E.pdf

ix https://sustainabledevelopment.un.org/post2015/transformingourworld

x https://www.article19.org/data/files/Internet_Statement_Adopted.pdf

xi Among the UN's Sustainable Development Goals (SDGs) there are no fewer than 38 targets whose achievement will depend upon universal and affordable access to ICT and Broadband. https://www.broadbandcommission.org/about/Pages/default.aspx

xii https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.18-2017-PDF-E.pdf

xiii https://news.itu.int/broadband-sustainable-development/

xiv The current WRC Agenda for the 2019 Conference has identified several bands under WRC 2018 Agenda Item 1.13 for possible identification for terrestrial IMT-2020 (also known as 5G). These bands include: 24.25-27.5 GHz, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz (Proposed IMT Bands). Other bands (31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz) are being considered for co-primary allocation to the mobile service and identification as well to the terrestrial component of IMT.