COMMENTS OF AT&T SERVICES, INC. ON A NATIONAL SPECTRUM STRATEGY

AT&T welcomes the opportunity to provide these comments on the National Telecommunications and Information Administration's (NTIA's) proposal to develop a National Spectrum Strategy (NSS). NTIA accurately observes that our national security, critical infrastructure, transportation, emergency response, public safety, scientific discovery, economic growth, competitive next-generation communications, and diversity, equity and inclusion all depend on spectrum availability. Indeed, NTIA might have gone farther, to observe that most of the items on this list are partly or wholly dependent on the achievement and continuation of just one of the listed objectives—world-leading, next generation mobile broadband networks – the foundation of the wireless ecosystem. Indeed, virtually all Americans access spectrum resources every day via the computer in their pocket, with mobile network operators running sophisticated spectrum sharing systems that allow hundreds of millions of users to simultaneously access spectrum, on demand, while reassigning frequencies and resource blocks dynamically, in real time, to maintain data sessions, accommodate higher density applications, maintain voice quality, and, when necessary, route emergency communications to appropriate local authorities together with location information for first responders.

Moreover, most of the "spectrum reliant services and missions" listed in the request for information, including "advanced transportation technologies, industrial and commercial applications, wireless medical devices and telemedicine, internet of things and smart cities, securing the Nation's critical infrastructure, and even many national defense and homeland

security uses," can best be accommodated on the world's finest and most secure mobile broadband networks—U.S. mobile broadband networks powered by full-power spectrum licenses. With their high capacity, very low latency, network slicing and other capabilities, 5G mobile broadband networks can and do support these "spectrum reliant services and missions" today.

To be sure, a National Spectrum Strategy will need to account for more than just mobile broadband networks. A successful NSS will need to incent innovation and continued technological leadership in national defense operations that are spectrum dependent, in commercial and federal satellite systems and in network edge products and services that are spectrum dependent. But a National Spectrum Strategy will fail to meet these objectives if it does not allocate and auction sufficient "network grade" spectrum for mobile broadband networks to ensure continued U.S. leadership in this area. Allocating and auctioning full power, licensed mid-band spectrum for mobile broadband networks drives enormous investment into national infrastructure and provides consumers, businesses, and government users with a robust, efficient, interference-free managed quality of service experience, and ensures that the U.S. will continue to enjoy a world-leading mobile broadband platform to support the wider wireless ecosystem. Failing to allocate and auction enough of this network grade spectrum would ensure that the NSS falls short of virtually all of the other goals noted in the paragraphs above. Moreover, because advanced 5G networks are capable, adaptable and secure, and unlicensed spectrum is so plentiful[1], those who seek limited purpose spectrum allocations for proprietary

[1] Accenture found that in the bands between 3.0 and 8.5 GHz, which are ideal for mobile broadband network use, there is *7 times as much spectrum limited to unlicensed uses*, and 12 *times as much spectrum limited to federal government use*, than the *total* amount of licensed spectrum suitable for broadband network deployment. *Spectrum Allocation in the United States, Accenture (Sept. 2022)* https://www.ctia.org/news/spectrum-allocation-in-the-united-states.

uses, including Federal government use cases, should be required to demonstrate that their needs cannot be met with the spectrum and network platforms already available to them before any "single use" allocation is considered.

I. The Vital Interest in Maintaining Mobile Broadband Network Leadership.

The United States has long been at the center of the wireless ecosystem. Enlighted spectrum policies, including long term, exclusive licenses assigned through competitive bidding in open auctions, competition in the provision of network services, and light-handed regulation have combined to create the conditions for success. The U.S. leads the world in investing in wireless networks[2] and this has led to incredible leaps in network capabilities and capacity, an explosion in usage, and a cascade of innovation at the network's edge – all to the benefit of U.S. consumers, businesses, and government.[3] U.S. leadership in mobile broadband networks has had profound ramifications for the economy, for consumers, and for national security. Given the pace of technological advancement in mobile broadband,—today's networks are roughly 85 times faster than they were in 2010, for example[4]—the U.S. will need a focused National Spectrum Strategy to maintain this leadership. One only has to consider the benefits such leadership conveys to appreciate the importance of this objective.

Economic Impact

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[2] Investment Heroes 2022: Flighting Inflation with Capital Investment, Michael Mandel & Jordan Shapiro, July 2022. Available at https://www.progressivepolicy.org/publication/investment-heroes-2022-fighting-inflation-with-capital-investment/.

[3] *Building the U.S. 5G Economy, Boston Consulting Group (Sept. 2020)* https://www.ctia.org/news/report-building-the-united-states-5g-economy.

[4] CTIA, *2022 Annual Survey Highlights* (Sept. 13, 2022), *at* https://www.ctia.org/news/2022-annual-survey-highlights.

Mobile broadband network leadership disproportionately contributes to economic growth, job growth, internet adoption, and private capital investment in the U.S. For example, during the "LTE" decade just past, the proportionate contribution was staggering:

> *In 2011, the wireless industry and the companies it powers contributed $195.5 billion to GDP. Based on historical 3G trends, the industry's GDP contribution was projected to grow by 126%, to $441.8 billion by 2019. In reality, 4G blew past all expectations. The industry's contribution grew to a staggering $690.5 billion in 2019, $248.7 billion more than projected. This expansion reflects the monumental impact of America's 4G leadership and the American-designed mobile devices, mobile advertising, apps and content created.*[5]

This incredible growth also had an impact on employment. More than 1/3 of U.S. job growth between 2011 and 2019 was due to wireless industry growth. And by 2019, one of every six U.S. jobs depended on the wireless industry.[6]

If anything, the importance of maintaining mobile broadband leadership has only increased in the 5G era.[7] Fortunately, U.S. mobile network operators have been doing their part, investing at a world-beating rate of over $121 billion over the last five years in spectrum acquisition and network upgrades and expansions.[8] The 5G era has begun. And it promises to continue to keep

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[5] The 4G Decade: Quantifying the Benefits, Recon Analytics and CTIA, *available at* The-4G-Decade.pdf (reconanalytics.com).

[6] *Id.*

[7] In 2020 alone, the wireless industry contributed over $1.3 trillion in gross output, $825 billion in GDP and nearly 4.5 million jobs to the U.S. economy. *The Importance of Licensed Spectrum and Wireless Telecommunications to the American Economy, Compass Lexecon (Dec. 2022)* https://www.ctia.org/news/the-importance-of-licensed-spectrum-and-wireless-telecommunications-to-the-american-economy.

[8] *2022 Annual Survey Highlights (Sept. 2022)* https://www.ctia.org/news/2022-annual-survey-highlights.

U.S. mobile broadband at the forefront of economic growth in the U.S., contributing an estimated $1.5 trillion to U.S. GDP and over 4.5 million new jobs over the next decade.[9]

One of the best parts of this story is that this boost in GDP and job growth also provides consumers with profound benefits. More than 307 million Americans access broadband internet services via their mobile broadband connection.[10] For many Americans it is their only form of broadband access.[11] Yet, the price of this broadband access, whether expressed in terms of monthly bills or cost per megabyte, has steadily declined, even as usage has skyrocketed along with the capabilities of U.S. mobile broadband networks.[12] In fact, a recent study concluded that U.S. consumers get more for their money than mobile broadband users anywhere else among OECD countries.[13] Indeed, mobile broadband networks are the primary broadband access services

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AT&T alone has invested over $140 billion over the last five years, the single largest capital investor in the U.S. over that time frame, with the vast majority of this capital invested in its mobile and fixed networks.

[9] *5G Promises Massive Job and GDP Growth in the U.S., Boston Consulting Group (Feb. 2021)* https://www.ctia.org/news/report-5g-promises-massive-job-and-gdp-growth-in-the-u-s.

[10] *Number of Smartphone Users in the United States* https://www.statista.com.

[11] Pew Research Center data indicates that at least 85 percent of Americans use mobile broadband, and 15 percent of Americans are "mobile broadband only" users. *Mobile Fact Sheet—Pew Research Center,* https://www.pewresearch.org/internet/fact-sheet/mob.

[12] The average price of an unlimited mobile broadband data plan has decreased by more than 43% since 2010. Meanwhile, mobile broadband network traffic leapt to 53 trillion MBs by 2021, more data traffic than 2010 through 2017 *combined*. *2022 Annual Survey Highlights (Sept. 2022)* https://www.ctia.org/news/2022-annual-survey-highlights.

[13] *U.S. Wireless Consumers Get the Most Value for their Money, NERA Economic Consulting (Mar. 2020)* https://www.ctia.org/news/report-united-states-wireless-consumers-get-the-most-value-for-their-money.

in the U.S.[14] And this should come as no surprise. The capabilities of mobile broadband networks have increased at a staggering rate. Mobile networks in 2021 were over 85 times faster than in 2010.[15] And latency has decreased dramatically[16], making close-to-real-time applications like VR possible.

Innovation Impact.

The investments that America's mobile network builders continue to make, in essential spectrum resources, coverage, infrastructure, technology upgrades and innovations, have created the conditions for a hugely successful wireless ecosystem. And because the U.S. has the leading mobile broadband platforms, it also leads in edge innovations. From chipsets, to devices, to applications, U.S. innovators like Qualcomm, AMD, Intel, Apple, Meta, Alphabet, Uber, and others have led a wave of innovation at the network's edge that multiplies the benefits of U.S. mobile broadband leadership.

The importance of having the most advanced mobile broadband networks and broadest adoption is well understood.[17] Led by AT&T, the U.S. wireless industry pioneered the Internet of Things (IoT) in the 3G era, and still leads the world in this area. U.S. leadership in the 4G era brought a bounty of innovation and tremendous economic growth.[18] As the 5G era gathers

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[14] *Mobile Fact Sheet—Pew Research Center,* https//www.pewresearch.org/internet/fact-sheet/mob.

[15] *See* note 4, *supra.*

[16] 5G Latency: Why Speeding Up Networks Matters (cnet.com) (July 1, 2021).

[17] *Building the U.S. 5G Economy, Boston Consulting Group (Sept. 2020)* https://www.ctia.org/news/report-building-the-united-states-5g-economy.

[18] *The 4G Decade: Quantifying the Benefits, Recon Analytics (July 2020)* https://www.ctia.org/news/report-the-4g-decade-quantifying-the-benefits.

momentum, we already are seeing benefits from the huge investments made by mobile network operators in 5G mobile broadband networks, in the form of innovations in agriculture, education, health care, manufacturing, public safety, smart cities and transportation.[19]

All of this innovation, all of this economic activity, all of these products and services, and all of the new jobs they enabled, happened here, in the U.S., because the U.S. stayed in the lead in the advancement of mobile broadband network technology and deployment. But it might not have happened, or it might have happened elsewhere, without spectrum policies that provided needed, network grade spectrum in time to ensure that U.S. mobile broadband network operators could continue to expand and upgrade their networks, from 3G to LTE, and now to 5G. Indeed, the only thing that threatens this continued success is spectrum scarcity – insufficient spectrum being allocated and auctioned, in terms of amount and bandwidth, to mobile broadband network operators.

Equity and Inclusion Impact

U.S. spectrum policies have helped with the digital divide and allow all Americans to participate in the information age. Today over 307 million Americans are connected to broadband via America's mobile broadband networks.[20] Many Americans also have a fixed broadband connection, but the numbers clearly show that for American consumers, mobile broadband is the first, and for many, the only choice. The reasons for this are many.

- **Mobile is virtually omnipresent** – over 315 million Americans have 5G mobile broadband coverage.[21]

[19] *The 5G Innovators, CTIA (Feb. 2023)* https://www.ctia.org/news/the-5g-innovators.

[20] *Number of Smartphone Users in the United States* https://www.statista.com.

[21] www.ctia.org/news/2022-annual-survey-highlights.

- **Mobile is mobile** - broadband can be accessed wherever you are and while you are in motion.

- **Mobile enables WiFi** - most smartphones, tablets, connected vehicles, and dedicated hotspot devices can be used as WiFi access points to connect WiFi dependent devices to mobile broadband networks where fixed broadband service is unavailable or undesirable.

- **Mobile can use WiFi** - your mobile device can also access fixed broadband over WiFi in addition to mobile broadband in places where fixed broadband is also available.

- **Mobile is affordable** - the combination of forward- thinking spectrum policy, light-handed regulation and market forces have combined to make mobile broadband available to more people in more places, and at steadily declining costs, even as network capabilities and usage have skyrocketed.[22]

In light of these facts, a core objective of any coherent spectrum strategy, or any coherent *broadband* policy for that matter, should be to ensure that sufficient network grade spectrum is allocated and auctioned to grow the capabilities and capacity of the nation's primary broadband networks—mobile broadband networks. This would ensure that the U.S. mobile industry and U.S. mobile network operators continue to pay the U.S. Treasury tens of billions of dollars in auction revenue, continue to invest hundreds of billions in U.S. infrastructure, and continue to offer the most technologically advanced mobile broadband networks in the world. All to the benefit to consumers, businesses, government, innovators and the economy. It would also ensure that the primary, most affordable, most indispensable and most universally available form of broadband network access for U.S. consumers is continually upgraded and expanded. It would ensure that the computers 307 million Americans carry in their pockets have access to mobile

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[22] *2022 Annual Survey Highlights (Sept. 2022)* https://www.ctia.org/news/2022-annual-survey-highlights. See also, *Oxford Economics: Unpacking the Cost of Mobile Broadband Across Countries, Oxford Economics (Nov. 2022)* https://www.ctia.org/news/oxford-economics-unpacking-the-cost-of-mobile-broadband-across-countries. ; and *U.S. Wireless Consumers Get the Most Value for their Money, NERA Economic Consulting (Mar. 2020)* https://www.ctia.org/news/report-united-states-wireless-consumers-get-the-most-value-for-their-money.

broadband networks everywhere with more capabilities and more capacity than networks anywhere else in the world.[23] And that the cutting-edge wireless ecosystem that Americans have come to depend on (including telehealth, accessing government services, agriculture) and enjoy continues to flourish with its foundation and applications residing here in the U.S.

If we have a spectrum policy enlightened enough to allow markets to continue to deliver world leading mobile networks, if we have a spectrum policy enlightened enough to deliver the network grade spectrum resources necessary to innovate and expand, to continue to stay ahead of skyrocketing demand and provide a platform for edge innovations, then Americans can continue to enjoy the dramatic increases in output and declines in prices that have long characterized mobile networks. In short, the U.S. can maintain and extend its leadership in 5G, 6G and beyond, and consumers can continue to get more and pay less. If we lose this mobile broadband network leadership to other countries due to a lack of sufficient spectrum resources, then we risk losing these other benefits as well. Innovators and investment will seek out a more capable mobile broadband platform elsewhere, and the economic growth, jobs, and consumer benefits that flow from being the leader of this vibrant wireless ecosystem will go with them.

II. Mobile Broadband Leadership Requires Sufficient Allocations of Network Grade Spectrum.

"*Network Grade" spectrum defined*:

[23] Providing more network grade spectrum to maintain the U.S.' world-leading technology position in mobile and more robust mobile broadband networks to ensure that U.S. consumers continue to enjoy first rate mobile broadband services would not come at the expense of the other pillar of U.S. broadband strategy---incenting the deployment of fiber. In fact, it would come at no government expense, but would generate hundreds of billions in capital investment, billions more in direct government revenues in the form of auction receipts and increases in GDP that would lead to increases in tax revenues. Innovation, investment, economic growth, better broadband and deficit reduction. Sound spectrum strategy pays dividends.

As demonstrated above, a central goal of any successful National Spectrum Strategy will be to ensure that the U.S. maintains its lead in mobile broadband network advancements and the consumer benefits and broader wireless ecosystem innovations that leadership engenders. The way spectrum is allocated and assigned is critical to achieving this objective.[24] Mobile networks require spectrum to operate. Moreover, to incent investment and allow for stable network management, that spectrum should ideally be allocated by:

- *exclusive licensing*, to provide certainty of interference-free access necessary to secure the infrastructure investment;
- *flexible use rights,* to allow it to be "refarmed" for more advanced technologies over time;
- *full-power and good propagation characteristics (8.5GHz and below),* to allow wide coverage, "macro" network use, not just "small cells";
- *large, contiguous channel sizes,* to allow for higher data rates and TDD operations to increase efficiencies in 5G;
- *Internationally harmonized to the greatest extent possible*, to capture economies of scale and scope in the provision of both network provider and user equipment.

Spectrum allocations with these ideal characteristics can be thought of as "network grade." As the recent C Band auctions have shown, there is high demand for network grade spectrum.

Of course, in an era of competing spectrum priorities and the necessity for rapid progress toward 5G deployments, it might be necessary to share spectrum with a federal incumbent, for example. So long as the other attributes of "network grade" spectrum are present—exclusive as to all others, flexible use, full power, good propagation, and large contiguous channels—and there is a well-defined and transparent sharing mechanism that allows both licensees to

[24] *5G Mid-Band Spectrum: The Benefits of Full-Power, Wide Channels, and Exclusive Licensing, Rysavy Research (Nov. 2022)* https://www.ctia.org/news/5g-mid-band-spectrum-the-benefits-of-full-power-wide-channels-and-exclusive-licensing.

maximize their use and provides sufficient certainty as to where and when it may be used, the spectrum will still attract investment, as the recent 3.45 GHz auction has shown, and it will still contribute to enhancing U.S. leadership in 5G.

By contrast, spectrum allocations that do not include these characteristics, like unlicensed spectrum (which by definition is non-exclusive use with no protection from interference), allocations that are power limited (like CBRS and unlicensed), allocations of frequencies that have very limited propagation (like millimeter wave) or very small channel/license sizes, may be very useful for many purposes, but they are not "network grade."[25] They are typically used for small private LANs, home WiFi access, Bluetooth devices, or in the case of mmWave, very high performance network nodes covering very small areas.

The reasons why these types of spectrum allocations don't make the network grade cut are well known. Without primary, exclusive license rights, a network cannot offer service that is certain to be free of interference and interruption. Lack of full power makes it uneconomical to cover large areas. Aside from the challenges of obtaining real estate leases and site approvals, the network would need 5-7 CBRS sites to cover the area served by a single full power site.[26]

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[25] For these reasons unlicensed, CBRS, and mmWave are not included in the screen used by the FCC to evaluate whether any one network operator may be acquiring too large a share of the "network grade" available spectrum. *Policies Regarding Mobile Spectrum Holdings,* Report and Order, 29 FCC Rcd 6133, (2014); *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band,* Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959, n. 276 (2015) (citations omitted) ("[W]e do not find that PALs are suitable and available for the provision of mobile telephony/broadband services in the same manner as other spectrum bands that currently are included in the Commission's spectrum screen as applied to secondary market transactions. Accordingly, we do not include 3.5 GHz spectrum in the spectrum screen...").

[26] *5G Mid-Band Spectrum: The Benefits of Full-Power, Wide Channels, and Exclusive Licensing, Rysavy Research (Nov. 2022)* at 12. https://www.ctia.org/news/5g-mid-band-spectrum-the-benefits-of-full-power-wide-channels-and-exclusive-licensing.

Millimeter wave has most of the attributes of network grade—flexible use, exclusive licensing, full power and large contiguous channels—but its propagation is quite limited. CBRS has excellent propagation—it is right in the middle of prime "network grade" real estate, between 3.55 GHz and 3.7 GHz. But the spectrum rights are granted "by rule," meaning non-exclusive—like unlicensed in almost every way –and the use rights are secondary and interruptible, meaning CBRS operators must yield to licensed incumbents—federal radar systems. These drawbacks can be ameliorated somewhat by purchasing a "priority access license," or PAL, which puts one ahead of other CBRS users in terms of how this spectrum gets allocated by the third-party Spectrum Access System (There are no permanent block assignments). Moreover, the blocks are only 10 MHz, not the 80 to 100 MHz channels optimal for 5G use. However, despite occupying 150 MHz of prime mid-band spectrum, CBRS is driving no significant network investments. [27]

To be sure, the wireless ecosystem needs an adequate supply of unlicensed spectrum to support edge innovation and peripheral use cases in static small coverage areas, and the U.S. has already made vast and world-leading amounts of unlicensed spectrum available.[28] But without

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[27] Recent studies have found that CBRS is unused in many areas and when used, it typically is used like WiFi hot spots, to provide connectivity in indoor spaces like arenas, or in confined, high network congestion areas. *CBRS: An Unproven Spectrum Sharing Framework, Recon Analytics (Nov. 2022)* https://www.ctia.org/news/cbrs-an-unproven-spectrum-sharing-framework; *CBRS Spectrum Occupancy Measurements, CTIA (Jan. 2022)* https://www.ctia.org/news/cbrs-spectrum-occupancy-measurements. In short, CBRS shares more characteristics with unlicensed than with network grade spectrum and is not suitable for network deployments. Not surprisingly, neither unlicensed nor CBRS are included in the FCC's spectrum aggregation analysis as "available spectrum." Neither is a substitute for network grade spectrum.

[28] While there is no equivalence here—unlicensed spectrum is wholly inadequate for mobile broadband network deployment, except to enhance existing networks at the margins—it should be noted here that compared with other nations, the U.S. is awash in unlicensed spectrum, and it has continued to allocate more unlicensed than network grade spectrum. In the bands between 3.0 and 8.5 GHz, which are ideal for mobile broadband network use, there is *7 times as much spectrum available for unlicensed uses*, than the *total* amount of licensed spectrum suitable for broadband

enough "network grade" spectrum, the benefits of GDP boosts, job creation and edge innovation that are driven by network investment and innovation, are more likely to accrue to some other country. Perhaps one like China, that doesn't stint on network grade spectrum.

The U.S. Now Lags the World on Network Grade Spectrum

As successful as the U.S. has been at leading the world in technology advances and deployments in mobile from the development of cellular technology at AT&T, and from analog through 4G LTE, that leadership is under serious threat. Previous technology advances in wireless achieved huge increases in performance chiefly through changes in air interface technologies, from TDMA, to GSM, to CDMA to UMTS, to LTE. The advances 5G makes possible are based on other factors. But the advancements are breathtaking.

The chief advantages of 5G are very low latency, blazing speeds, and the ability to use network slicing to customize bandwidth. These breakthroughs are achieved in a number of ways. Latency is reduced by moving network intelligence closer to the edge, speed is increased by the use of massive MIMO, broad channels (optimally 80-100 MHz wide) and TDD technology. This puts a premium on the availability of network grade mid-band spectrum in the 2.5 GHz to 8.5GHz range, as it has the right propagation characteristics for macro network deployments, the right antenna size requirements to support massive MIMO, is not subject to rain fade, as higher

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network deployment. *Spectrum Allocation in the United States, Accenture (Sept. 2022)* https://www.ctia.org/news/spectrum-allocation-in-the-united-states. While this surfeit of free spectrum has many benefits, they can only be achieved if there are highly advanced mobile broadband platforms to support the edge products and services that use unlicensed frequencies. While unlicensed spectrum may allow one to utilize broadband more creatively or productively, or even enhance broadband network performance at the margin, it is not a substitute for network grade spectrum.

frequencies are, and is not allocated in narrow, paired allocations designed for legacy FDD technologies, as is most mobile spectrum below 2.5 GHz.[29]

Accordingly, ensuring that the U.S. mobile broadband market has an adequate supply of this contiguous mid-band spectrum will be crucial to maintain U.S. leadership. Yet a recent study by Analysys Mason makes clear that the U.S. already lags most of the world in the allocation of mid-band and the situation is only going to worsen over the next five years.[30] As of September 2022, the U.S. already trailed the three leading countries in midband by hundreds of MHz on average.[31] Moreover, unlike the U.S., which relegated 1200 MHz of midband in the 6 GHz band to unlicensed use, China plans to allocate this band as network grade, exclusive licensed spectrum, which in five years will leave them with roughly three times the network grade mid-band spectrum that will be available in the U.S.[32] Ceding mobile broadband

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[29] The suitability of such contiguous mid-band spectrum for 5G, which ideally would work over channels 80-100 MHz wide is generally acknowledged. See, e.g., *5G Mid-Band Spectrum: The Benefits of Full-Power, Wide Channels, and Exclusive Licensing, Rysavy Research (Nov. 2022)* https://www.ctia.org/news/5g-mid-band-spectrum-the-benefits-of-full-power-wide-channels-and-exclusive-licensing. Given its relative scarcity, and the dangers to competition that would result from a single carrier controlling too high a share of it, AT&T has proposed that the FCC adopt a separate spectrum screen to analyze holdings of these mid-band frequencies separately. AT&T Petition for a Rulemaking to Establish a Mid-Band Spectrum Screen (filed September 1, 2021). A successful NSS would ensure that this scarcity is remedied, and in time to maintain U.S. leadership.

[30] *Comparison of Total Mobile Spectrum in Different Markets, Analysys Mason (Sept. 2022)* https://www.ctia.org/news/comparison-of-total-mobile-spectrum-in-different-markets.

[31] The Analysys Mason study is inaccurate in a few ways. CBRS is improperly included in the U.S. midband total (although for the reasons noted above, neither the FCC nor the industry counts it as "network grade,"). Similarly, 2.5 GHz spectrum, which is approximately 200 MHz of network grade spectrum ideally suited for 5G, is inexplicably left out. Correcting these errors in the data, however, would not change the fact that the U.S. is well behind.

[32] The current study of the 3.1-3.45 GHz band could eventually affect the U.S. total, but even if all of it were allocated to mobile for exclusive use, this would not close the gap, especially given constraints likely to emanate from a framework of shared usage with DoD incumbents. Policy makers should take another look at the 6 GHz band as a candidate. Notwithstanding the current

leadership not only threatens U.S. economic well-being, but could have profound negative consequences for U.S. interests in supporting human rights and democracy globally.[33]

III. A Recipe for a Sensible NSS

1. Start With a Mobile Broadband Policy—Maintain U.S. Leadership.

As shown above, ensuring that U.S. mobile broadband networks have the mobile broadband network grade spectrum needed to maintain U.S. leadership will benefit the economy, ensure that the U.S. continues to be the center of wireless innovation, and will benefit U.S. consumers, businesses, governments, and edge providers, who will continue to get more and pay less.

The specific targets for this should be:

- **Reallocate and auction at least 1500 MHz of network grade mid-band spectrum** – *i.e.*, full-power, licensed, flexible use spectrum. The target should be at least 1500 MHz to be reallocated and auctioned, **not just identified for study.** Propagation characteristics and capacity are important and should play a significant role in determining these targets which should be:
    - Short term target: Reallocate and auction at least 150 MHz in the 3.1-3.45 GHz range within 4-5 years;[34]

allocation of 6 GHz for unlicensed in the U.S., there are no DoD systems in the 6 GHz band. Auctioning even half of the 1200 MHz for exclusive licensed, full power use for 5G networks would be easier to do in 6 GHz than clearing even half of that amount in the 3 GHz range. Auction revenues could be used to relocate incumbent point to point networks with unlicensed devices opportunistically operating in the band using database or sensing capabilities.

[33] *The Strategic Imperative of U.S. Leadership in Next-Generation Networks,* CSIS (Jan. 2023) https://csis-website-prod.s3.amazonaws.com/s3fs-public/2023-01/230120_Johnson_U.S._Leadership.pdf?VersionId=YVAIuGmCH6KlQ9zg9npcOHlg5dluhRZS.

[34] Any auction of frequencies in this band that are subject to sharing requirements must take full stock of the lessons being learned from Auction 110 in the 3.45 GHz band. These include the need for greater clarity, specificity, and detail about incumbent DoD operations—including at the classified level with appropriately qualified auction participants—as well as industry-DoD concurrence on key analytical methodologies undergirding sharing analysis, *prior to the auction*.

- Mid-term target: Reallocate and auction at least 200 MHz in the 4.4-4.94; GHz range and at least 600 MHz in the 7125-8500 MHz range in the next 5-7 years;

- Longer-term target: at least 600 MHz in the 12.7 GHz-13.25 GHz range in the next 7-9 years.

While it might be easier to move forward with the 12.7-13.25 GHz band first, it should be lower on the priority list. Spectrum in this range is important and will likely be even more important for 6G and beyond, but it is above the prime mid-band range (3-8.5 GHz) and its more limited propagation and vulnerability to rain fade makes it less useful for 5G network construction. Spectrum in the 3-8.5 GHz range is the spectrum most crucial for 5G, and therefore what is needed first allowing the U.S. to be at the forefront of the wireless ecosystem.

2. Improve DoD Processes and Systems.

The DoD is, and should remain, a user of large amounts of spectrum. But it should change its approach in certain ways. For example, the DoD should rely more heavily on commercially available communications services, customized with enhanced capabilities and security, where possible. Maximizing the use of available networks would reduce competition between DoD and commercial broadband providers for scarce spectrum resources, while safeguarding more sensitive DoD connectivity options.[35] Discussed further below, DoD also should be incented to develop enhanced radar and electronic warfare (EW) systems capable of operating in the presence of full power, co-channel 5G operators for example, by becoming more robust, resilient, and frequency agile.

Accordingly, the timeline to auction of these frequencies must permit this more extensive pre-auction process in order to speed deployment of networks in this band post-auction.

[35] AT&T, "Response to Defense Information Systems Agency (DISA) Next-Generation Electromagnetic Spectrum (EMS) Strategic Roadmap Request for Information," 17 February 2023.

Current spectrum policies tend to discourage such innovation in a number of ways. For example, when DoD systems are relocated out of spectrum reallocated for commercial use, their relocation is funded from auction proceeds, via the Spectrum Relocation Fund (SRF). But DoD is not allowed to apply these funds toward system improvements or upgrades beyond those incidental to relocating or enabling sharing—*i.e.*, they are limited to using the old gear on new frequencies because that is all the SRF will allow.

Similarly, when DoD systems share spectrum with others, such as in the 3.45 GHz band, DoD is obliged to divert funds and human resources away from R&D. Rather than use scarce funds, spectrum experts, and other resources to develop new, more robust, frequency agile systems that can operate in the presence of full power 5G networks, for example, they are forced to expend these resources on coordination systems that essentially are designed to fence off their old gear from new commercial operations to protect the old gear.

Governments in other nations, including places where our armed forces might have to operate in the future to defend our nation, have assigned mid-band spectrum for 5G and other commercial services in spectrum ranges that in the U.S. are fenced off to protect DoD systems (e.g., radars). During routine training operations abroad, DoD's usage of these frequencies is constrained by host nation agreements that DoD prefers to not have imposed at home. But when used in these foreign theaters operationally, will DoD radar and EW systems be able to function properly in the presence of these full power 5G network operations? It is quite likely that DoD is already developing improved radar signal processing capabilities to filter out the most predictable and recognizable source of interference in the mid-band range: full power transmissions from 3GPP-standards based mobile networks. Doing so would clearly align with Objective 1.1 of the DoD's Electromagnetic Spectrum (EMS) Superiority Strategy, "Improve

Technologies to Enable Systems to Sense, Asses, Share, Maneuver, and Survive in Complex [Electromagnetic Operating Environments]."[36] If DoD is *not* already developing such technology, then it is being grossly negligent in failing to provide its warfighters a key capability they need to conduct electromagnetic spectrum operations overseas with agility. Such a *warfighting* capability would have the tremendous ancillary benefit of greatly simplifying the task of sharing mid-band spectrum domestically with full power 5G network operations—and thereby provide the additional economic benefits to the nation outlined above. This benefit, in fact, is one of the five guiding principles of the DoD's EMS Superiority Strategy: "Economic growth, which includes the need for commercial EMS access, is in the national security interest of the United States."[37]

A rational NSS should encourage this DoD pivot by pushing to reform the SRF rules to allow funds to be used to develop more capable, interference resistant, and agile systems, rather than limiting the DoD options to either putting the old gear on a new frequency or fencing the old gear off from commercial uses using coordination systems.[38] The NSS also should consider

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[36] Department of Defense, Electromagnetic Spectrum Superiority Strategy, October 2020, p.7. In describing the concept of "EMS Maneuver," this strategy also notes that "DoD will update its EMS-related policies, enhance cooperative processes, pursue emerging technologies, and incorporate commercial innovations to adapt its EMS-dependent systems. This will make systems operating in the EMS more maneuverable and able to operate in complex EMOEs. To support EMS maneuver, the Department, with emphasis on the Services, will need to evolve and harmonize their requirements for new acquisitions, **perhaps incorporating major modifications to existing systems.**" (p. 6, **emphasis added**).

[37] Department of Defense, Electromagnetic Spectrum Superiority Strategy, October 2020, p. 3.

[38] One of the most pernicious and wasteful suggestions in the context of commercial operations operating co-channel with DoD operations is to limit the commercial users to low power. Supporters claim this would allow more use on the commercial side because the DoD systems could better tolerate low power transmissions. The reality is that any sharing rubric with DoD, *whether low power or high power*, will be required to protect DoD systems to precisely the same interference protection criteria. Thus, the only effect of high versus low power levels on the

a new policy on co-channel sharing that would encourage the DoD to work around the commercial co-channel operations. It would be more spectrally efficient to have DoD plan around commercial systems where the specifications and operations are transparent, as opposed to having commercial operators seek to avoid DoD systems, the specifications and employment of which are opaque at best and more often classified. The latter approach—fencing off DoD systems—results in suboptimal spectrum utilization and runs counter to the tenets of EMS maneuver espoused in DoD's EMS Superiority Strategy.

3. Embrace Spectrum Auctions.

Since Congress first granted the FCC auction authority during the 1990s, the wireless industry has taken off, with innovation, investment, and vigorous competition as its hallmarks. The cornerstone of this success has been the spectrum auction, which led to investment in spectrum licenses with the certainty of access needed to induce investments in network deployment. Other nations have emulated the U.S.' spectrum auction model, understanding how spectrum auctions can unlock investment, incent deployment and breed competition, all to the benefit of their citizens and economies. While the FCC has occasionally neglected to use its auction authority (gifting AWS-4 to DISH and the PCS G Block to Sprint, for example), for the most part the FCC has used its auction authority creatively and successfully to ensure that commercial spectrum is distributed according to expressed demand, and the results have been an unqualified success.

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commercial users operating co-channel with DoD is on the scope of the geographic areas requiring coordination and/or mitigation. But as discussed above, cripplingly low power limits can make the spectrum unsuitable for mobile broadband network deployments. The lack of any significant use of the low power CBRS band should serve as a cautionary tale.

A proper NSS would ensure that auctions were used to assign spectrum licenses, encourage two-way auctions where appropriate[39], and would extend auctions beyond wireless to satellite. Auctions are a proven way to ensure that spectrum is allocated efficiently. There is increasing demand for spectrum from satellite providers. Auctions would put satellite licenses in the hands of those most likely to use them to benefit the public. It's time.

4. Use Sensible Receiver Policies.

While prescriptive receiver standards would likely inhibit innovation, waste regulatory resources, and generate enormous controversy, a sensible policy would set reasonable expectations and result in more efficient sharing among spectrum dependent industries. The NSS should adopt a sensible policy, like "use only the spectrum you are authorized to use." In other words, receivers should be designed to receive signals in the band they are authorized to use, and ordinarily should be capable of rejecting radio energy in frequencies outside their licensed band. Accordingly, out of band energy will not ordinarily be deemed as a cause of harmful interference. Such a policy would maximize spectrum usage.

5. Use Spectrum Neighborhoods.

Try to group like uses together. For example, keep satellite with satellite. Like the receiver policy, it will allow policy makers to maximize usage by avoiding the need for large guard bands. It would also help inform reasonable expectations when applying the receiver policy. The nature of your neighbors' operations will inform how much adjacent signal rejection capability should be designed into your receivers.

[39] When the FCC has chosen to use two-way auctions, in the 600 MHz and millimeter wave auctions, for example, they have proven to be as examples. While it missed an opportunity to use an incentive auction to create real competition and opportunity in the recent 2.5 GHz auction, the FCC has been successful in efficiently and successfully reallocating spectrum by putting market forces to work.

6. Work for International Harmonization and Open Standards.

Harmonization creates efficiencies globally, but especially along the borders with Canada and Mexico. Harmonization and open standards also increase interoperability and reduce costs. Open standards also help to disseminate innovation and open markets to U.S. products.

7. Sharing is a Tool, not a Strategic Objective.

The over-arching objective of any spectrum strategy is to ensure that spectrum is used for its best and highest purposes to benefit the public. When early spectrum users proved unable to share and share alike, Congress established the RCC, and later the FCC, to impose some order. Early sharing mechanisms included assigning frequencies in a given geography to a given user-*i.e.*, licensing. But the point was to make sure that spectrum dependent uses, like AM radio, ship to shore, later television, and of course defense operations like radar, could work without interference. Later sharing mechanisms, like listen-before-talk, allowed for unlicensed use. Perhaps the most successful models of spectrum sharing are cellular networks, which allow multiple users to access the same spectrum at the same time and reuse the same spectrum across the network. Today's advanced mobile broadband networks are perhaps the most elegant spectrum sharing/spectrum access systems in existence. Each of over 100 million AT&T end users are assigned spectrum resources on demand, in real time. These spectrum access assignments change on a dynamic, real-time basis as users move around the network, change the applications they are running, and as other users enter or exit a given sector. On a mobile network everyone gets spectrum access, everyone shares spectrum access.

Somewhere along the line, much like the way Enron once entranced energy regulators with their innovative ideas for spot energy markets and distributive efficiencies, some spectrum regulators became attracted to the idea that a goal of spectrum policy should be to develop real

time spectrum "markets" that would allow opportunistic, temporary use of spectrum on a spot basis. In other words, if we could treat spectrum access as a commodity, and allow individuals to opportunistically bid for and access any licensed spectrum not currently in use, you could maximize spectrum use. Indeed, it was hoped this would ensure that no MHz would go unused, even for a minute. Ever.[40] That is an interesting idea, but only if it serves a purpose, and only if it works.

To understand the folly of prioritizing innovation in spectrum sharing as an objective of spectrum policy, rather than recognizing it as a tool to achieve an appropriate objective, like enhancing the public interest benefits of spectrum dependent services, we need look no further than CBRS. If maintaining U.S. leadership in mobile broadband were the objective, what is now CBRS would have been auctioned and would already constitute an important part of burgeoning 5G network deployments. As it is, we have 150 MHz of prime, contiguous mid-band, otherwise perfectly suited for 5G deployments, consigned to low-power, unlicensed-like rules, with a third-party SAS assigning frequencies, all users secondary to the federal incumbents, and some users paying for priority over the other secondary users. Unsurprisingly, studies indicate its utilization, when it is utilized at all, has been underwhelming. While the CBRS experience likely has some value to academics as an experiment in spectrum sharing, relegating 150 MHz of prime, contiguous mid-band to this power limited, unlicensed-like use can now be seen, in retrospect, as a missed opportunity to allocate network grade spectrum to maintain U.S. mobile broadband leadership.

[40] It should be noted here that unlicensed spectrum is available to anyone, at any time—that is the nature of unlicensed spectrum. Not only is it available in larger quantities than auctioned, licensed spectrum, but the vast majority of these frequencies lie fallow at any given place and time. This is also true of license by rule bands like CBRS.

The irony, of course, is that auctioning exclusive use licenses would have achieved more efficient spectrum sharing in addition to 5G network investment. Mobile broadband networks may be the most elegant, efficient spectrum sharing mechanisms in use. Mobile broadband networks afford spectrum access to hundreds of millions, with each user accessing spectrum resources on demand, with frequencies and resources assigned and reassigned dynamically on a real-time basis. But sharing was never the object--the purpose is to provide highly capable, secure mobile broadband connectivity with the highest possible quality to the largest possible number of users, rather than sharing for sharing's sake. This is an efficient use of spectrum that cannot be matched. But it requires that the network's spectrum be under the control of the network operator, rather than operated independently by over 100 million users.

That is not to say that we should not continue to work on more innovative sharing methods. Studying innovative sharing methods is important. But a sharing mechanism should be viewed as a tool used to help achieve an NSS objective, not as an end in itself.

CONCLUSION

AT&T recognizes that maintaining U.S. leadership in the wireless technology ecosystem cannot be the only objective of a National Spectrum Strategy, but it should be among the top two or three, along with national security and satellite leadership. A further object of the NSS should be to ensure that the U.S. acts in accordance with it. And of course, it the NSS should be updated on a regular basis. The pace of technological advancement in spectrum dependent industries is rapid. Our strategies need to keep pace.

The benefits from adopting and adhering to an appropriate NSS are obvious. It would allow the U.S. to set the agenda at the ITU, rather than merely react to the agendas of others. It would permit us to ensure that we maintain leadership in space and in terrestrial industries that

are dependent on the availability of adequate spectrum resources. Maintaining leadership in mobile broadband network technology and deployments will continue to spawn innovation, generate jobs economic growth and provide Americans with broadband services that are more capable, affordable and more broadly available. Americans will continue to benefit from getting spectrum access on demand through the most efficient spectrum sharing mechanisms ever devised—America's world leading mobile broadband networks. And we can close the gap in the availability of network grade mid-band needed to keep all of these benefits flowing and growing.