NTIA Request for Public Input	)
on an Implementation Plan	)
for the	)
National Spectrum Strategy	)
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Comments of ATIS' Next G Alliance
On the
National Spectrum Strategy

ATIS' Next G Alliance, an initiative to promote North American leadership in 6G, takes this opportunity to provide input on NTIA's development of an Implementation Plan for the National Spectrum Strategy. The Next G Alliance and its members have developed a roadmap for 6G that will ensure economic and national security and deliver North American leadership. Spectrum is ultimately the lifeblood of such efforts.

Bold efforts to make more spectrum available and to drive the efficient usage of all spectrum resources is imperative to U.S. leadership in future generations of wireless technologies and the vertical industries that rely on these technologies. Commercial mobile broadband over its various generations has and will continue to rely heavily on readily available and usable spectrum. Given that the demand for spectrum has grown with every generation of commercial mobile cellular, harnessing 6G's full potential requires a comprehensive examination of all potential spectrum. Accordingly, the Next G Alliance urges NTIA to set forth an ambitious Implementation Plan for the National Spectrum Strategy and move as expeditiously as possible in executing its key pillars. The Next G Alliance is eager to continue partnering with the Administration in pursuit of these objectives.

I. Background

ATIS' Next G Alliance, which was established in November 2020, brings together the private sector, academia, and government interests to drive North American leadership in 6G. It has grown to over 100 members and represents North America's collective interests and market development priorities for next-generation communications systems from research to marketplace realization. Next G Alliance members are united in promoting North American leadership in 6G technologies across key consumer and industrial sectors to strengthen the region's economic interests, both locally and globally. Over the past three years, the Next G Alliance has brought together hundreds of subject matter experts to define 6G research drivers, technologies, use cases, and societal needs.[1] This includes extensive, ongoing efforts focused on 6G spectrum needs and radio technologies to promote more efficient spectrum utilization. Additionally, the Next G Alliance Research Council brings together some of North America's top academics and industry members to identify research and development priorities needed for North American 6G leadership.

International engagement on 6G has recently accelerated, reflecting the competitive global race to lead the next generation of critical and emerging technologies. The International Telecommunication Union Radiocommunication Sector (ITU-R) published a framework in December 2023 for the development of standards and radio interface technologies for IMT-2030, which is the term it uses for 6G. The ITU's World Radiocommunication Conference also just concluded its meeting and set its agenda for WRC-27, which will have critical implications for determining spectrum that will enable 6G/IMT-2030. A related activity is 3GPP, on which ATIS serves as the North American Organizational Partner. 3GPP announced that it will develop 6G communications specifications, reprising the role it has served in prior generations of mobile communications technology. A bold U.S. commitment and Implementation Plan to increase spectrum availability for 6G will be critical to ensuring that the country can be a leader in these international engagements.

[1] To date, the Next G Alliance has produced more than 20 white papers aimed at driving North American 6G leadership. Available at https://www.nextgalliance.org/6g-library.

ATIS and the Next G Alliance are working closely with the U.S. Government to promote international collaboration for 6G and are eager to extend that partnership toward implementing the National Spectrum Strategy. At the behest of the U.S.-E.U. Technology and Trade Council, the Next G Alliance has worked with 6G-IA to provide the governments with a joint roadmap for future E.U. and U.S. collaboration opportunities to promote 6G development. This includes discussing the importance of internationally harmonized spectrum for 6G and the need for significant research efforts in areas such as spectrum sharing, interference management, and sensing. The Next G Alliance has also entered into arrangements and is in active dialogue with other regional organizations — including the Beyond 5G Promotion Consortium in Japan, 6G Forum in Korea, and Bharat 6G in India — to advance a North American perspective on the global development of 6G.[2]

II. Discussion

Commercial mobile broadband, over its various generations, has and will continue to rely heavily on readily available and usable spectrum. Spectrum access depends on many technical and regulatory factors, often resulting in a holistic combination of exclusive licensing, shared, or unlicensed allocations. New 6G use cases — such as extended reality applications used for digital world experiences, AI for automation, computing capabilities of distributed cloud systems, and sensing capabilities integrated into communication equipment — will help meld the internet into human senses and automation systems. Ensuring spectrum availability across different frequency ranges that are appropriate, given the underlying performance requirements of the services, will be critical to ensure that mobile technologies can deliver on these innovative opportunities, as well as address issues such as bridging the digital divide and promoting security and sustainability.

A. Pillar One: A Spectrum Pipeline to Ensure U.S. Leadership in Advanced and Emerging Technologies

[2] The Administration recently acknowledged with approval the Next G Alliance's Memorandum of Understanding with India's Bharat 6G to explore collaboration opportunities for research and development priorities that support a common 6G vision.

A spectrum pipeline for 5G, 6G, and beyond is critical to U.S. wireless leadership, bringing economic benefits and technological security. Spectrum demand has grown with every generation of commercial mobile cellular. Thus, harnessing the full potential of 6G requires a comprehensive examination of all potential spectrum bands and all spectrum access regimes, including licensed, shared licensed, and unlicensed.

The Next G Alliance Spectrum Working Group's white paper, *6G Spectrum Considerations*,[3] details the Next G Alliance's efforts in support of a data-driven process for assessing potential 6G suitable spectrum bands based on applications and technology requirements. This initial paper focuses on a summary status of current band usage and characteristics for existing allocations in Canada, Mexico, and the U.S. for 3G/4G/5G spectrum and a study of suitable bands for 6G. The Next G Alliance is currently working on a companion paper, *Derivation of Spectrum Needs for 6G*, with expected publication in early 2024, that aims to establish the methodology and derive 6G spectrum needs based on application-specific key performance indicators (KPIs) and technical performance requirements (TPRs).

The *6G Spectrum Considerations* paper identifies various spectrum characteristics for evaluating spectrum to support a variety of 6G use cases: coverage requirements, channel bandwidth requirements, contiguity of spectrum, harmonization, and spectrum access.

- **Coverage requirements:** 6G will likely require spectrum allocations across a wide range of frequencies. The guiding principle should be that the spectrum allocation satisfies the requirements of the corresponding deployments. 6G spectrum utilized for wide-area coverage of a cellular mobile network needs to allow the reuse of the existing 5G macro cell sites to make 6G economically viable.

- **Channel bandwidth requirements:** To support a variety of 6G use cases, spectrum characteristics (amount, frequency ranges) should allow efficient operation in **multiple** frequency bands. Support for 6G use cases would require availability of a variety of channel bandwidths.

[3] The Next G Alliance. *6G Spectrum Consideration*. https://www.nextgalliance.org/white_papers/6g-spectrum-considerations/

- **Contiguity of spectrum:** Although intra-band carrier aggregation technology enabled the use of non-contiguous spectrum blocks, this method introduces latency and signaling overhead (especially as more carriers in additional spectrum bands are combined). For 6G systems, the availability of spectrum resources will likely require broader, contiguous channel bandwidths to satisfy the various envisaged 6G technology and application use cases.

Many use cases, especially those associated with critical societal and industrial needs, will require spectrum allocations that can guarantee high availability of capacity and interference protection. Not all these use cases can be confined to local or limited geographical fencing of availability requirements. For example, a utility company like an electricity provider might benefit from automation of control systems that demand high visibility into system performance with millisecond-level response times to automatic control systems. Similarly, autonomous ground vehicles in industrial parks, mines, and farms will benefit from reliable coverage for network-based processing of sensor-aided workflows involving complex tasks. Reliable coverage and capacity are also required to deliver extended reality to citizens across wider areas, such as across a park, venue, or even a city.

Based on the spectrum characteristics for the key 6G use cases, the *6G Spectrum Considerations* paper recommends that the following spectrum bands be prioritized for further studies, with the goal of making additional spectrum available for mobile services: 3.1-3.45 GHz, 4.4-5.0 GHz, 7.125-9.3 GHz, 10-10.5 GHz, 12.7-13.25 GHz, 25.25-27.5 GHz, 37.0-37.6 GHz, 42-42.5 GHz, and 42.5-43.5 GHz. [4] [5] [6] There is also interest in mmWave and sub-THz bands in the range of 94.1-150 GHz for research. As noted above, these bands will be the focus of the Next G Alliance's upcoming *Derivation of Spectrum Needs for 6G* paper, which will be based partly on simulations intended to capture North American conditions.

[4] The 3.1-3.45 GHz, 7.125-8.4 GHz and 37-37.5 GHz bands are common between the NSS and the Next G Alliance list of prioritized bands for study. We encourage study of those bands and further consideration of the additional bands the Next G Alliance has identified.
[5] Additional bands for study toward WRC-27 were concluded during WRC-23; these should be considered in the National Spectrum Strategy, as well.
[6] WRC -23 identified 3.3-3.4 GHz, 3.6-3.8 GHz, 4.8-4.99 GHz, and 10-10.5 GHz for terrestrial component of IMT in some regions/countries

Finally, it is also critically important to ensure global harmonization on bands of interest, preferably in a substantial number of markets to fully realize the benefits of economies of scale for American consumers.

B. Pillar Two: Collaborative Long-Term Planning to Support the Nation's Evolving Spectrum Needs

The National Spectrum Strategy appropriately recognizes the need for a "long-term planning process in which stakeholders work together openly, consistently, and transparently…to address users' current and future spectrum requirements."[7] In this regard, the Next G Alliance wishes to highlight the importance of government working in partnership with industry and academia in an open and transparent manner.

The Implementation Plan and its deliverables should provide early clarity regarding the study processes and principles for the bands under study, including timing, inputs, and outputs. Such processes should be data-driven — consistent with the Administration's focus on data-based decision making — and increase transparency into current and future federal and non-federal spectrum use. Incumbent agency systems should be as transparent as possible in providing information to ensure the greatest ability to evaluate the spectrum for repurposed, exclusive use or for any sharing mechanism that might be necessary to accommodate commercial access to the band.

NTIA should also prioritize ways to incentivize federal users to upgrade equipment. The Spectrum Relocation Fund, including improvements to the fund that may be considered by Congress, uses spectrum auction revenues to fund updated federal systems resulting from repurposing and can be an important part of this process. Ultimately, incumbent spectrum occupancy should be evaluated with the stated intent of improving efficiency of use.

The Next G Alliance was created as a venue where government, industry, and academia collaborate to drive 6G leadership. As the Administration moves forward with implementing the

[7] National Telecommunications and Information Administration. *National Spectrum Strategy*, p. 9. https://www.ntia.gov/sites/default/files/publications/national_spectrum_strategy_final.pdf

National Spectrum Strategy, we encourage NTIA to continue to look to the Next G Alliance as a vehicle for open and transparent engagement between the public and private sectors.

C. Pillar Three: Unprecedented Spectrum Innovation, Access, and Management through Technology Development

The Next G Alliance Technology Working Group's *6G Radio Technology Part I: Basic Radio Technologies*[8] white paper addresses key technologies including Waveform, Coding and Multiple Access Schemes, Joint Communications and Sensing, and Advanced Duplexing Technology, etc. This paper also includes a section on spectrum sharing technology (Section 3.2) that, among other things, addresses the challenges and research directions such as the complexity of ensuring fairness in the dynamic spectrum access decisions that maximize the chosen KPIs while providing reasonable protection to primary users.

The Memorandum on Modernizing United States Spectrum Policy and Establishing a National Spectrum Strategy[9] seeks to develop a spectrum strategy by "considering different types of spectrum governance models, including exclusive licensing, unlicensed use, shared use, and combinations of these approaches." Finding new spectrum for each successive generation of cellular technology has become increasingly difficult because each has required wider spectrum bandwidths to support increasingly demanding use cases. It is also no surprise that diverse services compete for use of the more attractive spectrum bands, often pitting incumbent agency services against commercial needs for new spectrum. This means that exclusive licensing is not always feasible. As such, the National Spectrum Strategy appropriately identifies spectrum sharing as an approach that must be part of the toolbox to alleviate future bandwidth availability constraints.

Technology that efficiently shares spectrum can provide economical and societal benefits, such as reduced cost, and new use cases and deployment scenarios. The main challenges for shared-spectrum deployments include (but are not limited to):

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[8] Next G Alliance. *6G Radio Technology Part I: Basic Radio Technologies.* https://www.nextgalliance.org/white_papers/6g-radio-technology-part-i-basic-radio-technologies/

[9] The White House. *Memorandum on Modernizing United States Spectrum Policy and Establishing a National Spectrum Strategy*. https://www.whitehouse.gov/briefing-room/presidential-actions/2023/11/13/memorandum-on-modernizing-united-states-spectrum-policy-and-establishing-a-national-spectrum-strategy/

- Predictability of available resources.
- Efficient system performance measurement.
- Real-time spectrum sensing in complex RF environments such as mixed RF signals and heterogeneous systems.
- Management of mutual interference between networks of the same technology or across different technologies.
- Interference detection and mitigation techniques.

New research is needed to improve spectrum sharing efficiency and predictability to a degree comparable to single-use spectrum. For efficient utilization of limited available spectrum, 6G must natively support technology for sharing, including static, semi-static, and dynamic sharing in time, frequency, and spatial domains. Research areas include the study of a variety of scenarios, use cases, and spectrum-sharing and system-measurement techniques. Further research is also needed to ensure that these spectrum sharing techniques do not lead to unacceptable degradation of service for the existing primary deployments or unacceptable service quality for new secondary or co-primary deployments.

New channel-access procedures, with or without channel sensing, may be needed to enable efficient sharing with a high degree of predictability of resources among multiple authorized co-primary users or sharing among secondary services and primary users. Sharing may be applicable to different network topologies (e.g., co-located or distributed, homogeneous or heterogeneous) and may include interference detection, localization, mitigation, or cancellation. Spectrum sharing procedures should also be considered in conjunction with new system architectures that reduce deployment costs and meet stringent carbon footprint targets for 6G deployments.

To achieve high spectrum utilization for sharing, efficient mechanisms will be critical. Innovative coexistence techniques could be considered between 6G systems and incumbents, with an eye on protecting passive services. Efficient spectrum sharing can help mitigate interference among overlaid deployments to enable spectrum re-use among licensees. As the radio coexistence environment becomes increasingly complicated from both a device and

network perspective, 6G spectrum-sharing native design is anticipated to accommodate a wide variety of use cases.

The *6G Radio Technology Part I: Basic Radio Technologies* paper refers to various spectrum types, including exclusively licensed, non-exclusively licensed (i.e., shared licensed), and unlicensed (see Figure 10). New and innovative techniques are considered for spectrum access, particularly for non-exclusively licensed spectrum. The paper refers to the following innovative techniques for consideration:

- **Dynamic temporal sharing** is useful, but it helps if 6G networks and devices can modify their operational parameters (frequency, bandwidth, power, beamforming, etc.) to minimize end user impact. One example of temporal sharing involves government radar systems, which may use the band relatively infrequently but require high degrees of protection and in some instances quick reaction time. This will require intelligent control of the radio resource parameters to enable dynamic techniques to address interference susceptibilities for incumbents while maximizing 6G spectrum utilization.
- **Spatial techniques** that exploit a large number of antenna elements may also be utilized to enable concurrent use of spectrum in the same geographical location, without the need to overly rely on dynamic temporal sharing.
- **RAN sharing** could be utilized for spectrum sharing among co-licensees, but more research is needed to identify RAN architecture and procedures that give operators full flexibility to differentiate their services and share spectrum.

National Spectrum Research and Development Plan. The Next G Alliance has developed a set of Research Priorities, that include Spectrum Sharing and Enhanced Spectrum Access and Radio Access Technologies. These two areas, out of 10, focus on various aspects of spectrum utilization and optimization for 6G PHY and MAC designs to optimize coverage and capacity tradeoffs. The Next G Alliance would like to offer our collaboration in the development of the Spectrum R&D Plan called out in the strategy to work with the U.S. Government to address these and related items.[10]

[10] Next G Alliance. *Research Priorities – Technology.* https://www.nextgalliance.org/research-priorities/technology/

D. Pillar Four: Expanded Spectrum Expertise and Elevated National Awareness

We agree with NTIA that "making decisions for our Nation about the allocation and authorized uses of spectrum is a heavy responsibility" that requires "complex, cross-cutting understanding and knowledge of the technical aspects of spectrum use." Leaders at all levels of government need to understand spectrum issues holistically and have access to spectrum managers and professionals that understand the complexities relative to their interests.[11]

The Next G Alliance has significant resources[12] that can support government officials interested in learning more about spectrum and the benefits that can flow from a robust 6G future. The Next G Alliance has expertise in electromagnetic propagation, spectrum science, spectrum engineering, spectrum management, spectrum management techniques, and a wide range of related topics.

The National Spectrum Strategy also suggests that the public needs a better understanding of the importance of spectrum and the role it plays in their everyday lives. The Next G Alliance stands ready to assist with this important role. For example, the Next G Alliance recently released a white paper, *Shaping Tomorrow: The Evolution of Personalized Digital Experiences Through 6G Technologies,*[13] that delves into the capabilities of personalized user experiences driven by 6G technologies. The paper uses a narrative structured around "A Day in the Life" of a multi-generational family in 2035, highlighting four core areas: shopping, health care and wellness, travel, and education. Each domain showcases tailored scenarios for the elderly, working parents, and young students, and elucidates the cutting-edge technologies facilitating these services.

III. Conclusion

The National Spectrum Strategy is an important step toward ensuring that access to essential spectrum resources is not a roadblock to continued U.S. leadership in critical and

[11] *National Spectrum Strategy*, p. 20, Strategic Objective 4.2.
[12] Next G Alliance. *6G Library*. https://www.nextgalliance.org/6g-library/
[13] Next G Alliance. *Shaping Tomorrow: The Evolution of Personalized Digital Experiences Through 6G Technologies.* https://www.nextgalliance.org/white_papers/shaping-tomorrow-evolution-personalized-digital-experiences/

emerging technologies, including 6G. ATIS' Next G Alliance urges NTIA and the Administration to adopt a bold implementation plan that expeditiously drives increased availability and efficient usage of spectrum to meet the timelines envisioned for deployment of 6G. We look forward to continuing our support as a trusted partner with the U.S. Government to deliver on that critical goal.

Respectfully Submitted,

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