January 2, 2024

Mr. John Alden
Telecommunications Specialist
Office of Spectrum Management
National Telecommunications and Information Administration
U.S. Department of Commerce
Washington, DC

RE: Notice of Opportunity for Public Input on the Implementation of the National Spectrum Strategy (federalregister.gov Document #: 2023-26810)

Dear Mr. Alden,

   Teltrium, Inc. (Teltrium) herein submits its comments to the National Telecommunications and Information Administration, U.S. Department of Commerce, Implementation of the National Spectrum Strategy notice dated 12/07/23. Further, per the notice, we are respectfully requesting a meeting as soon as practicable to discuss our comments in greater detail.

Respectfully submitted,

Jacquel R. Tomlin

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Enclosed: Attachment 1: Teltrium Inc.' s Input on the Implementation of the National
              Spectrum Strategy

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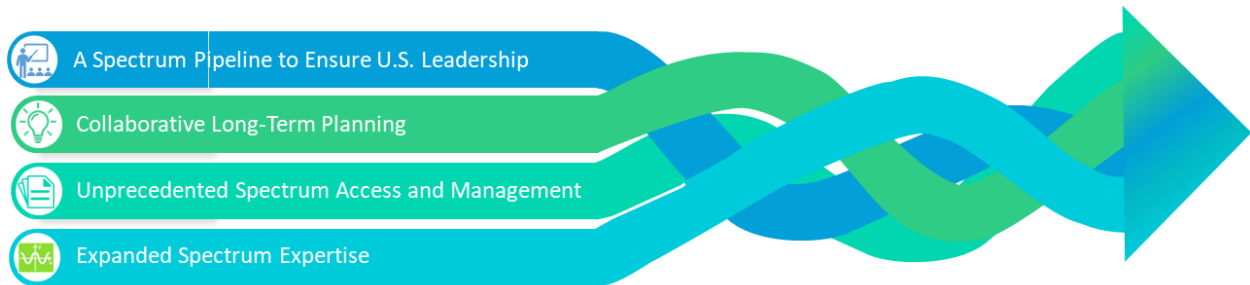
Teltrium, Inc. applauds the release of the 2023 National Spectrum Strategy (herein referred to as the Strategy) that is poised to advance U.S. innovation, economic vitality, and security, and welcomes the opportunity to provide inputs on an Implementation Plan for the Strategy. The discussion will be centered on the 4 component Pillars of the Strategy:

- Pillar 1: A Spectrum Pipeline to Ensure U.S. Leadership in Advanced and Emerging Technologies
- Pillar 2: Collaborative Long-Term Planning to Support the Nation's Evolving Spectrum Needs
- Pillar 3: Unprecedented Spectrum Access and Management Through Technology Development
- Pillar 4: Expanded Spectrum Expertise and Elevated National Awareness

Teltrium, Inc. is a designated 8A company founded in 2014 that brings together experienced subject matter experts and promising young talent to provide next-generation engineering and strategic communications services. Teltrium builds on its core heritage of technical innovation and excellence to provide best-in-class tools and processes to deliver effective solutions in the areas of radio frequency (RF) communications systems engineering, spectrum management, aerospace engineering, strategic planning and communications, and development of communications technologies. The company's staff draws on our many years of experience supporting of the National Aeronautics and Space Administration (NASA) and the Department of Defense (DoD) Defense Information Systems Agency (DISA) on technical, tactical, policy, and strategic activities related to space and terrestrial RF communications.

Teltrium believes that the Strategy can only succeed if the implementation plan takes into account that the four Pillars are fundamentally interrelated. Activities in each Pillar directly impact the execution of activities under other Pillars. For example, any lessons learned during repurposing studies for the bands identified in Pillar 1 must be accommodated in the long-term strategic planning framework developed under Pillar 2. Similarly, new spectrum sharing technologies developed under Pillar 3 will necessitate changes to the strategic planning

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framework under Pillar 2 as well as new workforce training resources created under Pillar 4. Therefore, the implementation efforts under each of these Pillars must not become siloed. To maintain U.S. spectrum leadership, these activities must instead be conducted and managed in parallel and built on a cross-cutting foundation of active collaboration.

A Spectrum Pipeline to Ensure U.S. Leadership

Collaborative Long-Term Planning

Unprecedented Spectrum Access and Management

Expanded Spectrum Expertise

Below, we describe the interconnections between the Pillars that may be leveraged to effectively implement the Strategy. With this input, Teltrium aims to offer insights – gleaned from our years of experience working in spectrum management from both a policy and technical standpoint – that we respectfully suggest the National Telecommunications and Information Administration (NTIA) consider in the course of developing an Implementation Plan for the Strategy.

Pillar 1: A Spectrum Pipeline to Ensure U.S. Leadership in Advanced and Emerging Technologies.

Pillar 1 has identified over 2,700 megahertz of spectrum in the 3 GHz to 38 GHz range for potential repurposing. Guiding principles for near-term allocation of spectrum will also be developed under this Pillar through an analysis of lessons learned from previous repurposing activities as well as the studies begun on the bands identified in the Strategy.

Pillar 1 impacts the other Pillars as follows:

- Pillar 1 activities will help define guiding principles for near-term allocation to influence spectrum allocation decisions by regulators and inform future updates to the Strategy carried out under Pillar 2.

- Spectrum Pipeline efforts under Pillar 1 have the potential to create opportunities for greater private sector participation in spectrum innovation and proceeds from future

auctions could be leveraged to fund future research and development (R&D) efforts under Pillar 3.

- Pillar 1 activities will lead to the development and refinement of educational and outreach resources such as tutorials on analysis methodologies. Proceeds from potential auctions could also be used to fund educational and outreach activities under Pillar 4.

Based on our experience from supporting spectrum sharing studies, as well as relocation efforts such the Advanced Wireless Services initiatives (AWS-1 and AWS-3), Teltrium would like to point out two pertinent issues that NTIA should consider as the spectrum pipeline is updated.

First, the work to study and possibly repurpose the spectrum bands identified in the Strategy will go much more smoothly if strong, trusting relationships exist between the stakeholders involved. In our experience, the open exchange of information, and agreement on a shared set of assumptions and methodologies is necessary to ensure a successful study process. Trust must be built to ensure that all stakeholders will productively engage with this collaborative process and be comfortable sharing key information. Without it, it is often impossible to reach outcomes that can be agreed upon by all parties. As we describe below, the efforts to involve all stakeholders in the development of the long-term strategic planning framework under Pillar 2 will be instrumental in building and strengthening these critical interpersonal and inter-organizational relationships built on mutual trust.

Second, to identify and agree on a set of guiding principles, all stakeholders must develop a shared language, follow the same best practices, and use the same tools and methods. For example, there are numerous standards and recommendations by the NTIA and FCC domestically as well as by organizations such as the International Telecommunication Union (ITU), Institute of Electrical and Electronics Engineers (IEEE), and other organizations that provide modeling guidelines and technical assumptions on various aspects of wireless communications links and networks, such as antenna radiation patterns, wireless channel models, interference thresholds, link availability metrics, and system deployment characteristics. Furthermore, it is important to implement a common method for simulating the behavior of wireless links and networks in software capabilities used for spectrum sharing studies. Without

consensus on technical resources and analysis approaches to leverage when conducting spectrum sharing assessments, there is the potential for significant differences in interference impacts findings between stakeholders.

The efforts under Pillar 4 to grow a cohesive, professional spectrum workforce can, if implemented correctly, will strengthen and accelerate the growth of a unified community of practice that operates in a mutually intelligible manner. In our experience, if stakeholders have a shared approach, they will more readily agree on the guiding principles required to conduct studies for repurposing and execute plans to help existing users move to other bands if repurposing is found to be possible and worthwhile.

Pillar 2: Collaborative Long-Term Planning to Support the Nation's Evolving Spectrum Needs.

Pillar 2 includes the identification of an evidence-based methodology for spectrum allocation decisions and regular updates to the Strategy. It is expected that these updates may include identification of additional spectrum for potential repurposing based on future spectrum demands.

Pillar 2 impacts the other Pillars as follows:

- The planning accomplished under Pillar 2 will identify updates to the set of frequency bands to be considered for repurposing and continue to feed the Spectrum Pipeline under Pillar 1. A further observation is that building stakeholder trust and consensus through the improved long-term planning framework will enhance the efficiency and effectiveness of repurposing studies and relocation efforts.

- The planning accomplished under Pillar 2 will highlight the most pressing challenges from an R&D point of view under Pillar 3 and will help guide prioritization of R&D efforts.

- The updates to the Strategy under Pillar 2 will influence the anticipated spectrum workforce requirements (e.g., size, key skills, etc.) necessary to solidify the U.S.'s preeminence in technology leadership and inform educational priorities to meet these workforce needs under Pillar 4.

Based on our experience in developing and executing strategic initiatives, particularly within the federal spectrum management community, Teltrium would like to point out three observations that NTIA should consider as plans are developed for a long-term spectrum planning framework.

First, as mentioned above, the work to involve all stakeholders in the development of this framework will pay dividends not only in the sustainability of the spectrum planning process going forward, but also to ensure the continuity of the spectrum pipeline identified under Pillar 1. A significant and dedicated level of effort will be required to maintain engagement across the various segments of the stakeholder communities and these efforts should leverage all the media formats and outlets available to a major government organization like NTIA. Sustained engagement and trust across the whole stakeholder community is critical. This includes the relationship between NTIA and the Federal Communications Commission (FCC), since close coordination between the two U.S. spectrum regulators will be essential to the efficient development and execution of this plan, and subsequent updates and revisions. Personnel with a proven track record of community building and strong interpersonal communication skills should be identified across the two regulators to lead and coordinate these efforts.

Second, the data-driven, science-based planning framework envisioned in Pillar 2 will only succeed if quality data is readily available and continues to be collected. Based on our past experiences supporting efforts to collect and analyze spectrum usage information, the quality and quantity of reliable and informative spectrum usage data varies widely across communities. The NTIA and FCC must work together with stakeholders to standardize and institutionalize a set of mutually agreed, uniform, repeatable processes for collecting data that can support the development of long-term spectrum plans and develop capabilities to store and make available data to all stakeholders to support activities under Pillars 1 and 2.

Moreover, the data collected must include information about currently licensed or authorized uses of the spectrum, as well as planned or envisioned uses informed by experts involved in the innovative R&D described under Pillar 3. To ensure accuracy, usage data must also include information about actual, current usage of the spectrum, collected via on-going monitoring of the spectrum environment across widely distributed geographical locations and time-points.

Information about the amount and severity of interference should also be collected. This environmental monitoring data can not only inform long-term planning under Pillar 1, but also serve as an important determining factor for decisions about whether a particular band is suitable for repurposing under Pillar 1.

Finaly, adopting an eight- to sixteen-year forecasting window will enable the U.S. to develop data-driven, technically sound proposals in synchrony with the typically quadrennial World Radio Conference (WRC) work cycle. Aligning this long-term planning cycle with the WRC cycle would facilitate the development of Future Agenda Items within the U.S. and the Americas ahead of each WRC. Advocating for Future Agenda Items helps the U.S. maintain its forward-looking leadership in the international spectrum regulatory realm, which in turns strengthens the U.S.'s position as a global spectrum technology leader.

Pillar 3: Unprecedented Spectrum Access and Management Through Technology Development.

Pillar 3 includes the establishment of spectrum testbeds to evaluate dynamic spectrum sharing techniques, development of a national spectrum Research and Development Plan to nurture new spectrum innovation, and collaboration with private sector R&D initiatives to further facilitate spectrum sharing.

Pillar 3 impacts the other Pillars as follows:

- As R&D yields advances in the areas of spectrum engineering and management, portions of the RF spectrum previously deemed unsuitable for repurposing could become candidates in future iterations of the Spectrum Pipeline under Pillar 1.

- Similarly, advances realized through R&D efforts will support the evolution of a collaborative framework for long-term spectrum planning and inform updates to the Strategy under Pillar 2.

- Finally, as technological advances attain higher and higher levels of technology readiness levels (TRL) through Pillar 3 efforts, guidance on implementation of these new capabilities can be developed and disseminated to the spectrum workforce under Pillar 4.

Based on our experience in software and hardware development for spectrum analysis capabilities, data management, and communications equipment, Teltrium would like to emphasize the importance of regular, bidirectional communication between the policymakers updating the long-term spectrum strategy under Pillar 2 and the research teams involved in developing the innovative new technologies under Pillar 3. Without such communication, research efforts will not be aligned with the strategy, and the policy and regulatory changes derived from the strategy and plans will not be aligned with the latest technological developments. Such misalignment could slow innovation and pose a risk to the U.S.'s technological dominance. Furthermore, it is recommended that R&D efforts under Pillar 3 follow the TRL construct used extensively by technology development activities within NASA, DoD, and other federal agencies to track progress, manage risk, control funding, and manage technology transition.

Pillar 4: Expanded Spectrum Expertise and Elevated National Awareness.

Pillar 4 includes the development of a National Spectrum Workforce Plan to expand the number of qualified candidates available for careers in spectrum-related fields. This Pillar also emphasizes the importance of educating policymakers on concepts that impact decisions involving spectrum and raising awareness amongst the general public on the role spectrum plays in their everyday lives.

Without the efforts under Pillar 4, there will likely not be enough qualified spectrum professionals to carry out the analysis, planning, and research envisioned in the other Pillars of the Strategy. Therefore, Pillar 4 is foundational to the success the other three Pillars of the Strategy.

Pillar 4 impacts the other Pillars as follows:

- Spectrum training and outreach resources developed under Pillar 4 have the potential to cover topics such as spectrum sharing analytical approaches, spectrum planning and strategy considerations, and emerging spectrum-related technological advances to support activities under Pillars 1 and 2

- The effective collection and dissemination of expert knowledge developed as part of the educational and workforce development activities under Pillar 4, such as lessons

learned from previous repurposing efforts, have the potential to help improve the effectiveness of repurposing activities under Pillar 1, and the development of guiding principles for long-term planning under Pillar 2 if they are collected and disseminated effectively. Activities under Pillar 4 must include a robust and sustainable outreach plan to ensure information flows freely between researchers and engineers engaged in activities under Pillar 3, and educators and workforce planners supporting activities under Pillar 4, via a variety of media and event formats to maximize accessibility.

- Educational information released as part of activities under Pillar 4, such as analyses and reports of future spectrum trends or forward-looking surveys of high-priority research questions modeled after the National Academies of Science's Decadal Surveys, have the potential to help inform and guide researchers and facilitate the adoption of new technologies developed under Pillar 3.

Based on our extensive experience in knowledge management and workforce training, Teltrium would like to point out several observations that NTIA should consider while developing a National Spectrum Workforce Plan and educating policymakers and members of the public on the relevance and importance of spectrum.

First and foremost, efforts under Pillar 4 will be key to building a spectrum workforce that is sufficiently qualified to ensure the success of all activities covered by the Strategy. Therefore, Pillar 4 is foundational to the success of U.S. technical leadership and must be implemented in parallel with the other Pillars, if not initiated earlier. Efforts to address spectrum workforce issues are already being undertaken by some organizations, such as NASA through their Spectrum Education Awareness (SPEARS) project, which Teltrium supports, and the National Science Foundation (NSF) through their spectrum innovation initiative, SpectrumX. Teltrium would encourage NTIA to leverage the progress of these other Agencies and help scale these efforts to a National level as they implement Pillar 4 of the Strategy.

The Strategy recognizes that widely accepted definitions of spectrum-related positions are urgently needed to drive all other aspects of Strategic Objective 4.1 of the Strategy (attract, train, and grow the current and next-generation spectrum workforce). In addition to efforts to define the federal spectrum workforce through an Office of Personnel Management (OPM)

Occupational Series, this effort should also be expanded to consider spectrum professionals beyond the federal workforce through the Department of Labor. Their Standard Occupational Codes inform everything from high school and college career counseling to labor statistics, and also crosswalk with many of the OPM's job series and job families. Such an effort would truly expand this objective to the National scale.

Professional training, education, and information campaigns will be essential to ensuring the success of the long-term strategic planning called for in Pillar 2 as well. NTIA and FCC will need to reimagine processes, adopt new information technology (IT) infrastructure, and change the way personnel across their organizations think and behave. None of this will be successful without effective training resources which foster and strengthen the relationships across agencies, and a strategic plan to manage the paradigm change. Teltrium has ample experience curating and developing knowledge resources to support and facilitate these kinds of activities, as well as other technical education efforts. The need to bolster the spectrum workforce is underscored by data showing that in some federal agencies, over half the spectrum workforce is within 5-10 years of retirement eligibility, pointing to a significant loss of spectrum knowledge and professional capability if not addressed.

Finally, it should be noted that the overall size of the current spectrum workforce, while growing, remains relatively small compared to similar technical fields such as cybersecurity or computer engineering. Colleges and universities may not yet be able to make the business case for dedicated majors or degrees. For now, the Strategy appropriately identifies alterative educational models, such as post-grad certificates at polytechnical colleges, that should be considered to meet immediate workforce needs. An emphasis on experiential learning opportunities would help new entrants to the spectrum workforce develop the practical skill set required by hiring organizations in the short- to medium-term. Like spectrum planning itself, workforce planning should be treated as a long-lead item, requiring farsighted planning on four-to-eight-year cycles to align with typical college graduation timelines.

Teltrium commends NTIA for recognizing the need for a Spectrum Workforce Development Plan, as these issues are often not given the same attention and planning resources as more technical issues. We have observed that without such efforts, the workforce will continue to grow

in the slow, haphazard way that it has historically, and it will lack the cohesiveness critical to ensuring the effective, efficient execution of the other Pillars of the Strategy. Teltrium looks forward to seeing the realization of the Strategy's objectives to ensure the Nation's leadership in spectrum and would welcome the opportunity to continue engaging with NTIA on this very important issue; please feel free to reach out to us to discuss further.