

The background features a composite image of Earth and the Moon. The Earth is shown in the upper half, with its blue oceans and white clouds. The Moon is in the lower half, showing its grey, cratered surface. A network of glowing green and blue lines and dots is overlaid on the scene, representing a futuristic orbital or communication network. The lines are curved, suggesting orbits or signal paths, and the dots are bright, representing nodes or satellites. The overall color palette is dark, with the green and blue of the network providing a high-contrast, futuristic feel.

CSMAC Subcommittee 2: 6G

September 21, 2023

Subcommittee Members

- Reza Arefi, Co-Chair
- Carolyn Kahn, Co-Chair
- Michael Calabrese
- Thomas S. Dombrowsky Jr.
- Mark Gibson
- Dale Hatfield
- Jennifer Manner
- Jennifer McCarthy
- Danielle Piñeres
- Glenn Reynolds
- Dennis Roberson
- Jesse Russell
- Steve Sharkey
- Mariam Sorond
- Rikin Thakker
- Jennifer Warren
- Kevin Holmes, FCC Observer
- Richard Orsulak, NTIA Liaison
- Jessica Quinley, FCC Liaison
- Antonio Richardson, Designated Federal Officer

Mandate

- NTIA seeks input on what sort of use cases 6G may entail
 - Importantly, NTIA would like the CSMAC to consider use cases beyond traditional wireless communications including safety, sensor, radar, space and other scientific applications and address 6G's potential impact on federal government users
- When considering spectrum bands that could be used to support 6G, NTIA observes that the THz bands have been identified for potential use
 - How would such use impact government users in that range and what recommendations could be made to help prepare for this
 - Are there other spectrum bands that may be appropriate for 6G and beyond use?

NTIA Clarification: The scope should concentrate on 6G services only. This effort should consider generally the benefits to federal government user, the positives for the federal government as a user or federal equities, and how federal agencies can benefit broadly from 6G.

Approach

- Scoped the work and developed a study plan and report outline
- Collected key reference materials
- Conducted about 40 interviews with federal agencies, service providers, equipment manufacturers, and academia and other non-profit organizations
- Held over 20 subcommittee meetings to foster ongoing cross-sectional analysis, inputs, and discussion
- Developed a 6G vision, findings, and recommendations addressing the mandate given to the subcommittee by NTIA

Schedule

- Kicked off subcommittee: August 2022
- Holding regular subcommittee meetings
- Conducted interviews: December 2022 – June 2023
- Analyzed information and developed a draft report: September 2022 – August/September 2023
- Delivered draft paper and recommendations: September 2023
- Iterate interim findings and conduct follow-on work: September 2023 – December 2023
- Deliver final paper and recommendations: December 2023

Surveys & Interviews*

- Federal agencies
 - AF, Army, **DHS S&T, DISA DSO**, DoD CIO, **DoE, DoI, DoJ, DoS, DoT**, FAA, FCC (TAC), FDA, NASA, Navy, **NSC, NTIA ITS**, NOAA, NSF, NIST, **Treasury, OUSD R&E, USAGM**, USDA, USCG, USPS, VA
- Industry
 - Service providers: AT&T, BlackSky, **CTIA, EchoStar**, HawkEye360, **Intelsat**, Kuiper, Maxar, Planet, OneWeb, **SES, SpaceX**, T-Mobile, Verizon, Viasat
 - Cable companies: **CableLabs, Charter**, Comcast
 - Equipment manufacturers: **Cisco, Ericsson, Nokia, Samsung**
 - Chip manufacturers: **Broadcom, Intel, Qualcomm**
 - Hyperscalers: **AWS, Google, Meta, Microsoft**
 - Virtualization companies: **VMWare**
- Academia and other non-profit organizations
 - Non-profit organizations: IEEE (Future Networks Initiative), **Next G Alliance, O-RAN Alliance Policy Consortium**
 - Academia: **SpectrumX**
 - International: **6G Flagship, 6GIA, B5GPC (Japan), 5GForum (Korea), Hexa-X, Networld Europe**

* Surveys & interviews received/completed are denoted in bold font.

Draft Report Outline

- Mandate
- Approach
- 6G vision
- Overview of organizations involved in 6G development
- Key application drivers
- 6G use cases
- Potential use of 6G by federal government users
- Technologies and technical capabilities of 6G
- Potential spectrum bands to support 6G and potential implications to government users
- International considerations
- Findings
- Recommendations to help prepare for impact to government users
- CSMAC recommendations

Draft Findings: Technology Development and Migration

- Carriers are still focused on deploying 5G and moving on to 5G-Advanced, which will take a few years
- On the other hand, RAN vendors are aggressively defining 6G technology elements and spectrum for 6G
- Carriers and network infrastructure vendors see open networks and ORAN as dominant in the 6G era

Draft Findings: Use Cases

- Clash between visionary ideas and practical realism
- Currently equipment providers and researchers driving 6G vision, until service providers develop requirements
- Need to address challenges of 6G (and fill gaps of 5G)
 - Business case/ROI, economies of scale, convergence of vision and path forward, risk of fragmentation and regional divergence
 - Tradeoffs between economies of scale, economies of specialization, and economies of scope
 - Tradeoffs between open architectures and diverse specialized systems
- Indicators of use case viability: R&D, technology readiness level (TRL) progression, proven business case and economic impact, convergence, low barriers to entry, demonstrated impact

Draft Findings: Spectrum

- Most of focus for TN use is now on mid-bands and extending them up to around 15 GHz (vs. MMW or THz); other bands are being considered for NTN
- Interest in sub-THz limited to research areas for mostly short-range communications with a longer associated timeframe for commercial use
- Lack of suitable dedicated or shared spectrum for 6G
- Potential use of spectrum ranges for 6G (including both TN and NTN)
 - Low-band: Not focus for terrestrial 6G; under-utilized spectrum, particularly in large geographic areas with relatively few users, could be pieced together via carrier aggregation and multi-radio connectivity for increased coverage; recent activities around the world for augmenting terrestrial coverage through space (MSS) by utilizing some low-band spectrum to provide connectivity directly to user devices
 - Mid-band: Sweet spot between coverage, capacity, and contiguity; widespread interest for supporting 6G applications and use cases; most, if not all, of IMT spectrum proposals under consideration in ITU-R Regions for study toward WRC-27 are in mid-bands
 - MMW: "Information showers" via wireless local and personal area networks for home, office, transportation center, and city hotspot access; portions of these bands remain critical for satellite communications to support 6G
 - Sub-THz/THz: fixed wireless and backhaul, high bandwidth applications if feasible, and passive services

CSMAC Draft Recommendations to Help Prepare for Impact to Government Users

Caveat, and in line with the mandate from NTIA: our report does not include operational impacts to federal government users

1. NTIA should work with the FCC and federal agencies to develop more spectrum sharing-friendly plans and designs across government and commercial systems
 - a. NTIA should engage early with federal incumbents with assignments in bands of particular interest for 6G, including mid-bands and above 95 GHz, to understand the type and degree of uses and ability to share
 - b. NTIA should work with FCC to leverage more data-driven, automated, and dynamic methods into its plans, such as developing the incumbent informing capability (IIC) vision and use of schedulers
2. NTIA should work with the FCC, federal agencies, the White House, and Congress to consider acquisition reform and incentives for federal agencies and commercial industry to use spectrum as efficiently and effectively as possible to increase spectrum sharing and/or facilitate relocation, as appropriate

CSMAC Draft Recommendations

1. NTIA should work with federal agencies to identify, if and when, commercial 6G services would benefit their missions, characterize any expected differentiated requirements (such as related to standards, security, and technical performance criteria) in alignment with the ITU-R timeline, and coordinate with industry to address federal agencies requirements
2. NTIA should work with the FCC, federal agencies, the White House, and Congress to proactively help prepare for the impact of 6G to government users (*previous slide*)
3. NTIA should work with federal agencies to update the spectrum compendium more frequently, adding additional, more detailed and granular data, e.g., location and time of use, describing federal spectrum uses and extending its compendium above 7.125 GHz to at least the THz range
4. NTIA should adopt a “toolbox” approach to spectrum sharing to best match sharing approaches to specific conditions by customizing sharing techniques to frequency band and range of incumbent systems (including commercial incumbents) and consider the requirements of commercial services in the process of devising and implementing new sharing methods. Also, less management may be required in the sub-THz or THz ranges where propagation, including building losses, are helpful in enabling sharing
5. NTIA should collaborate with the FCC to facilitate innovation in THz spectrum for 6G on an exploratory basis (e.g., waivers, possible additional unlicensed spectrum), considering that operations tend to be localized based on the propagation characteristics of this range



Discussion