



June 2021

SPECTRUM MANAGEMENT

Agencies Should
Strengthen
Collaborative
Mechanisms and
Processes to Address
Potential Interference

GAO@100 Highlights

Highlights of [GAO-21-474](#), a report to the Committee on Science, Space, and Technology, House of Representatives

Why GAO Did This Study

Spectrum is a scarce resource that supports vital services, such as mobile communications and Earth-observing satellites. In the U.S., FCC and NTIA regulate and manage nonfederal and federal spectrum use, respectively, while the ITU sets global regulations and hosts conferences to update them. Recent U.S. and ITU activities have sought to designate spectrum for possible 5G use and to study how to do so without causing harmful interference to other uses, particularly satellites like those operated by NOAA and NASA that contribute to weather forecasting and climate science.

GAO was asked to review how agencies coordinate on and study these matters. Among other objectives, this report examines: (1) the extent that cognizant federal agencies follow leading practices in collaborating on potential interference effects on weather forecasting and (2) their processes to conduct and review technical interference studies. GAO reviewed documentation and interviewed officials from FCC, NTIA, NOAA, and NASA; analyzed how various agency mechanisms and processes were implemented during recent FCC and ITU spectrum-management activities; and compared agencies' efforts to key collaboration practices and applicable key elements of a sound research process.

What GAO Recommends

GAO is making 11 recommendations, including that FCC and NTIA collaborate to update or clarify various documents and processes related to spectrum-management coordination. The agencies generally agreed to implement the recommendations.

View [GAO-21-474](#). For more information, contact Andrew Von Ah at (202) 512-2834 or vonaha@gao.gov, or Karen L. Howard at (202) 512-6888 or howardk@gao.gov.

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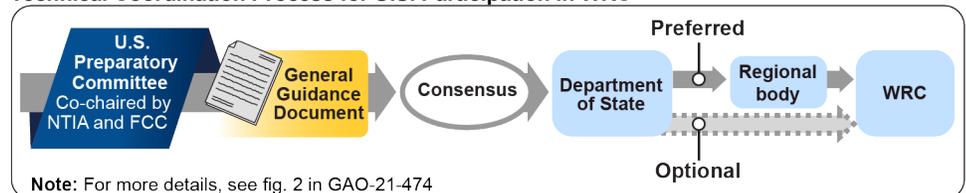
SPECTRUM MANAGEMENT

Agencies Should Strengthen Collaborative Mechanisms and Processes to Address Potential Interference

What GAO Found

The Federal Communications Commission (FCC) and National Telecommunications and Information Administration (NTIA) regulate and manage spectrum, and other agencies, such as the National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA) are among federal spectrum users. To address potential interference among proposed uses of spectrum, these agencies employ various coordination mechanisms. For domestic matters, the agencies coordinate through an NTIA-led committee that provides input to FCC's spectrum proceedings. For U.S. participation in the International Telecommunication Union's (ITU) World Radiocommunication Conferences (WRC), agencies coordinate via a preparatory committee that provides input used to develop U.S. positions that the Department of State submits to a regional body or directly to the WRC (see figure).

Technical Coordination Process for U.S. Participation in WRC



Note: For more details, see fig. 2 in [GAO-21-474](#)

Sources: GAO analysis of National Telecommunications and Information Administration (NTIA) and Federal Communications Commission (FCC) information. | [GAO-21-474](#)

These mechanisms reflect some key collaboration practices but do not fully reflect others. For example, while the documents that guide coordination between FCC and NTIA and the preparatory committee emphasize reaching consensus whenever possible, there are no clearly defined and agreed-upon processes for resolving matters when agencies cannot do so. Additionally, neither document has been updated in almost 20 years, though agency officials said conditions regarding spectrum management activities have changed in that time. GAO's review of U.S. participation in ITU's 2019 WRC shows that these issues affected collaboration. For example, disputes among the agencies and the inability to reach agreement on U.S. technical contributions challenged the U.S.'s ability to present an agreed-upon basis for decisions or a unified position.

NOAA and NASA conduct and FCC and NTIA review technical interference studies on a case-by-case basis. When originating from ITU activities, the agencies conduct or review technical interference studies through participation in international technical meetings and the preparatory committee process. However, the lack of consensus on study design and, within the U.S. process, specific procedures to guide the design of these types of studies, hampered U.S. efforts to prepare for the 2019 WRC. For example, the U.S. did not submit its studies on certain key issues to the final technical meeting, resulting in some stakeholders questioning whether the corresponding U.S. positions were technically rooted. Agreed-upon procedures could help guide U.S. efforts to design these studies and consider tradeoffs between what is desirable versus practical, to mitigate the possibility of protracted disagreements in the future.

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Abbreviations

5G	fifth-generation (mobile communications)
CITEL	Inter-American Telecommunication Commission
Commerce	Department of Commerce
FCC	Federal Communications Commission
GHz	gigahertz
IRAC	Interdepartment Radio Advisory Committee
ITU	International Telecommunication Union
MOU	memorandum of understanding
NASA	National Aeronautics and Space Administration
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NTIA	National Telecommunications and Information Administration
State	Department of State
WRC	World Radiocommunication Conference
WRC-19	2019 World Radiocommunication Conference

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June 29, 2021

The Honorable Eddie Bernice Johnson
Chairwoman
The Honorable Frank D. Lucas
Ranking Member
Committee on Science, Space, and Technology
House of Representatives

The radio-frequency spectrum is a scarce natural resource that supports a wide variety of services—from mobile voice telecommunications and broadband to scientific research and weather forecasting, among other uses—that are critical to the U.S. economy and government functions.¹ Use of spectrum is also growing exponentially, with some experts forecasting that between 25 to 50 billion devices will be competing for spectrum by 2025. Yet all of the usable spectrum has already been designated for use, and this increasing demand for spectrum cannot be met without proper planning. In managing the diverse uses of spectrum, accommodating the growing demand while protecting existing uses is a complex and challenging task. Indeed, some recent efforts within the U.S. to coordinate on managing access to spectrum near that used by weather satellites have been particularly challenging.

Spectrum use is managed and coordinated at the domestic and international levels. Within the U.S., the Federal Communications Commission (FCC) regulates and manages spectrum for nonfederal public and private uses, such as wireless services provided over commercial mobile networks (such as voice and data services offered by AT&T, T-Mobile, and Verizon) and state and local government uses. The Department of Commerce's (Commerce) National Telecommunications and Information Administration (NTIA) regulates and manages spectrum use for federal users, such as agencies operating satellites (like the National Oceanic and Atmospheric Administration [NOAA] within Commerce, and the National Aeronautics and Space Administration [NASA]).² Internationally, the International Telecommunication Union

¹Spectrum is scarce because at any given time and geographic location, one use of a portion of the spectrum precludes any other use of that portion of the spectrum.

²Generally, this report uses "manage" to refer to the regulation and management of federal and nonfederal spectrum use by NTIA and FCC, respectively.

(ITU)—a United Nations specialized agency responsible for matters related to information and communication technologies—regulates the global use of spectrum and hosts international conferences to update the global treaty establishing the international regulations. As a member state of the ITU and signatory to these regulations, the U.S. is obligated to act in conformity with these rules governing cross-border interference.³ The Department of State (State) formally leads the U.S. delegation at these conferences through an ambassador, representing the policy positions coordinated, reconciled, and provided via FCC and NTIA.

Many recent domestic and international spectrum-management activities have focused on making spectrum available for the next generation of mobile communications service, the fifth-generation (5G). Domestically, FCC has begun allocating spectrum that could be used for 5G. As part of recent international conference proceedings that concluded in late 2019, the ITU invited technical studies related to how 5G networks may operate compatibly with existing spectrum uses in certain portions of the spectrum. However, NOAA and NASA have raised concerns that if not managed properly, this use of spectrum could cause harmful interference with instruments on their satellites that operate in nearby spectrum and contribute to weather forecasting and climate science. During the U.S.'s preparatory work for the recent ITU proceedings, efforts by FCC, NTIA, NOAA, and NASA to agree on which U.S. studies and positions to present internationally on this matter were highly contentious, and disputes among agencies generated significant public attention from stakeholders, the press, and Congress. Protracted interagency disagreements surrounding the nation's technical contributions to these proceedings resulted in the U.S. not completing and reaching agreement on key technical contributions, creating challenges for the U.S.'s ability to present either a unified position to the international community or an agreed-upon technical basis for the conclusions the U.S. ultimately supported. As a result, members of Congress and other stakeholders have raised questions about federal agencies' abilities to coordinate on and study these issues.

You asked us to review how agencies coordinate on and study potential spectrum interference. This report examines (1) the extent to which the cognizant federal agencies follow leading practices in collaborating on

³The U.S. retains sovereign rights on its spectrum use, provided that use does not cause harmful interference to the use of other member states.

potential interference effects on weather forecasting, (2) how, and the extent to which, NOAA and NASA identify and raise concerns regarding potential interference to their satellite instruments, and (3) the cognizant agencies' processes, requirements, and capabilities to conduct and review technical interference studies.⁴

Due to their roles as managers of federal and nonfederal spectrum use or lead meteorological satellite operators, we focused on FCC, NTIA, NOAA, and NASA as the cognizant agencies. To assess collaboration, we reviewed documentation and interviewed officials from these agencies. For example, to determine the collaborative mechanisms they use as well as the administrative processes, we reviewed government-wide spectrum-management policies, including regulations such as NTIA's *Manual of Regulations and Procedures for Federal Radio Frequency Management* (commonly referred to as the Redbook),⁵ and agency-specific policies, procedures, and other guidance, such as spectrum-management directives and manuals. We interviewed FCC, NTIA, NOAA, and NASA officials and obtained written responses to questions we posed. To obtain additional context, we also interviewed officials from State. We assessed the agencies' collaboration mechanisms, processes, and activities against the seven leading collaboration practices identified in our prior work.⁶

To assess how NOAA and NASA identify and raise concerns regarding potential interference, we reviewed agency documentation (as described above), interviewed NOAA and NASA officials and obtained written responses to questions, and assessed NOAA's and NASA's processes and activities against applicable federal internal-control standards.⁷

To assess FCC, NTIA, NOAA, and NASA processes for conducting and reviewing technical interference studies, we reviewed agency documentation, interviewed agency officials, and obtained written responses to questions. For example, we reviewed agency

⁴Additionally, we have ongoing work examining federal spectrum management and coordination that focuses on NTIA.

⁵47 C.F.R. § 300.1.

⁶GAO, *Managing For Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, [GAO-12-1022](#) (Washington, D.C.: Sept. 27, 2012).

⁷GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.; September 2014).

documentation as described above, as well as additional technical documentation, such as NOAA- and NASA-led studies of potential interference for select bands of spectrum (described below). To obtain additional context, we also interviewed officials from Commerce's National Institute of Standards and Technology (NIST). Where appropriate, we assessed the agencies' processes against the relevant key element of a sound research process identified in our prior work.⁸

For all of our objectives, to analyze how the cognizant agencies implemented these mechanisms and processes in practice, we reviewed the agencies' recent activities surrounding select bands of spectrum that we used as case studies. Selection factors included the importance of the band to NOAA's weather-forecasting capabilities, and whether the bands were the subject of recent FCC and ITU proceedings concerning spectrum for 5G use and the potential for interference with satellite instruments that contribute to weather forecasting. Specifically, we considered FCC's Spectrum Frontiers proceeding, which began in 2014 and is ongoing as of June 2021,⁹ and the ITU's 2019 World Radiocommunication Conference (WRC-19). The three spectrum bands we selected as case studies were the 24, 32, and 37 gigahertz (GHz) bands.¹⁰ Regarding these bands, we reviewed case-specific agency documentation, such as correspondence, meeting materials, technical studies, and reports and orders. To obtain additional context, we also interviewed stakeholders representing the telecommunications, air-and-space, and meteorological communities. We selected these stakeholders to obtain a variety of viewpoints from a cross section of stakeholder interests. Appendix I describes our objectives, scope, and methodology in greater detail.

We conducted this performance audit from March 2020 to June 2021 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that

⁸GAO, *Employment and Training Administration: More Actions Needed to Improve Transparency and Accountability of Its Research Program*, [GAO-11-285](#) (Washington, D.C.: Mar. 15, 2011).

⁹*In re Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, FCC GN Dkt. No. 14-177.

¹⁰Frequencies are grouped into bands and measured in units of hertz; gigahertz refers to billions of hertz.

the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

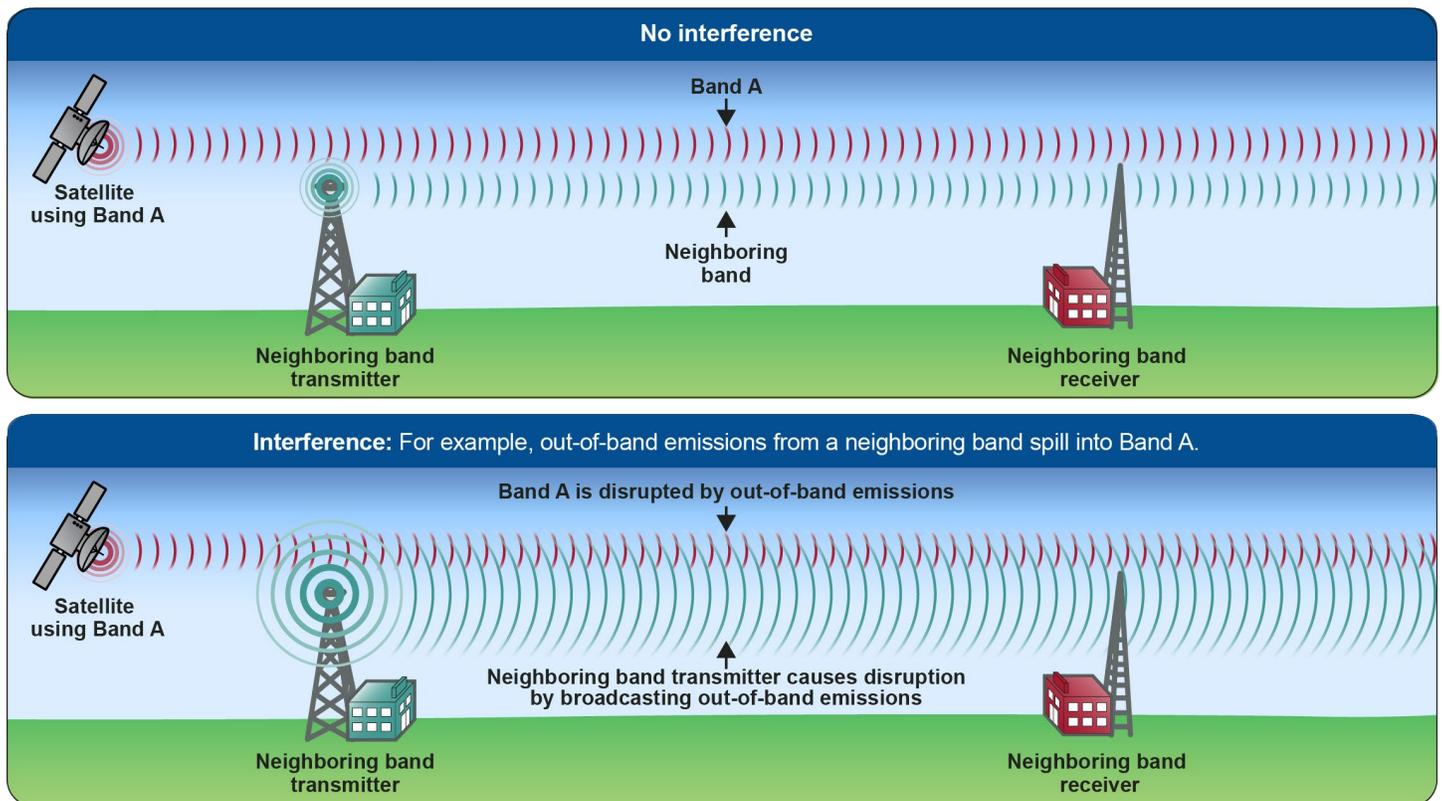
Spectrum use is managed through actions to “allocate” and “assign” it. Allocation involves segmenting spectrum into “bands” of frequencies designated for use for particular “services,” or operations (such as mobile or satellite service). Assignment, which occurs after allocation, involves providing spectrum users with a license or authorization to operate within a specific band allocated for a particular use. In allocating and assigning spectrum, spectrum managers specify service rules or regulations, including limits on the operations of equipment using the band. Depending on the allocation, use of bands may be limited to one type of user or may be shared between and among users (such as both federal and nonfederal users) for different services.

When making an allocation or assignment, spectrum managers must consider the potential for harmful interference to operations in shared bands or to operations in adjacent or neighboring bands. Harmful interference may occur when interference from one “radio” service seriously degrades, obstructs, or repeatedly interrupts another authorized service.¹¹ For example, “out-of-band” emissions may leak from a band into adjacent bands, causing interference.¹² (See fig. 1.) To help prevent harmful interference, spectrum managers may set limits on out-of-band emissions in regulations or service rules. Interference studies are one important way spectrum managers and users may assess the technical specifications around whether and how spectrum may be used by multiple users and for multiple services, and what limits on out-of-band emissions should be imposed.

¹¹47 C.F.R. § 2.1(c).

¹²Not all out-of-band emissions cause harmful interference.

Figure 1: Example of Spectrum Interference due to Out-of-Band Emissions



Source: GAO. | GAO-21-474

Note: This figure represents a simplified depiction of potential interference and is not meant to serve as a complete representation of interference scenarios. Not all interference is harmful; some interference is permissible, subject to certain conditions.

Spectrum use is managed and coordinated at both the domestic and international levels. Domestically, as noted previously, FCC regulates and manages nonfederal spectrum use and NTIA regulates and manages federal spectrum use.

- **FCC.** FCC has authority to regulate, allocate, and assign spectrum for nonfederal use through the notice-and-comment rulemaking process, a process by which FCC proposes and adopts rules with input from

the public.¹³ As part of this regulatory process, FCC starts a “rulemaking proceeding” to notify the public that it is considering adopting or modifying rules on a particular subject and to seek comments that it considers in developing final rules. FCC releases documents, which communicate actions that FCC takes as part of the proceeding, into the publicly available proceeding record and invites the public to submit comments, studies, and any other supporting documents into that record. In assigning spectrum licenses, FCC is generally required to hold an auction with a competitive-bidding process.¹⁴

For example, in October 2014, FCC formally began its Spectrum Frontiers proceeding, in which it examined the potential for the provision of mobile services (particularly 5G) in various spectrum bands, including the 24 and 37 GHz bands.¹⁵ Through this proceeding, FCC allocated certain bands at and above 24 GHz for mobile service and, in July 2016, first established service rules for this use. Among the rules that FCC established were limits on out-of-band emissions in order to protect the services and users in adjacent bands. These limits are commonly referred to in this context as protection limits. The limit established was the same standard limit FCC has historically applied for the protection of services operating in adjacent bands and was consistent with the ITU recommendations in effect at the time.¹⁶ The 24 and 37 GHz bands were among those for which FCC adopted mobile service rules in November 2017 and July

¹³The Administrative Procedure Act generally requires that agencies notify the public about, and solicit comments on, proposed regulations. 5 U.S.C. § 553. FCC has authority to “[p]rescribe the nature of the service to be rendered by each class of licensed stations and each station within any class” and to “assign bands of frequencies to the various classes of stations, and assign frequencies for each individual station and determine the power which each station shall use and the time during which it may operate.” 47 U.S.C. § 303(b)-(c). In addition, FCC has authority to allocate spectrum so as to provide flexibility of use, if— (1) such use is consistent with international agreements to which the United States is a party; and (2) the commission finds, after notice and an opportunity for public comment, that— (A) such an allocation would be in the public interest; (B) such use would not deter investment in communications services and systems, or technology development; and (C) such use would not result in harmful interference among users. 47 U.S.C. § 303(y).

¹⁴47 U.S.C. § 309(j) (requiring the FCC to use auctions to resolve mutually exclusive applications for initial licenses unless certain exemptions apply).

¹⁵*In re Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Notice of Inquiry, FCC 14-154, paras. 3, 46-55 (Oct. 17, 2014).

¹⁶This limit is -13 decibel-milliwatts/megahertz, or -20 decibel-watts/200 megahertz in ITU terms.

2016, respectively. FCC later auctioned licenses for use of the 24 GHz band and portions of the 37 GHz band from March to May 2019 and December 2019 to March 2020, respectively. FCC sought comment on the 32 GHz band in October 2015 and July 2016 but has not taken further action as of June 2021.

- **NTIA.** NTIA allocates and assigns spectrum to federal users and is responsible for overall management of federal spectrum use. The Interdepartment Radio Advisory Committee (IRAC), which NTIA chairs, is comprised of representatives from 19 federal agencies that use spectrum and advises NTIA on spectrum issues. FCC is not listed as an IRAC member, but is listed as a liaison. IRAC and its subcommittees assist NTIA in assigning frequencies and in developing policies, procedures, and technical criteria on the management and federal use of spectrum. IRAC's bylaws are incorporated into NTIA's spectrum management manual, known as the Redbook.

NOAA and NASA are among the member agencies of the IRAC that use spectrum.¹⁷ Such use includes operating satellites that contribute to the nation's ability to observe the Earth and predict weather using bands adjacent to the 24, 32, and 37 GHz bands. Instruments on the satellites passively "sense" and collect data on natural properties of the Earth that are used to improve weather prediction models, aid in weather forecasting, and contribute to research, among other uses.¹⁸ For example, these instruments measure various properties, such as water vapor. Because the signals originate from the physical properties of the Earth itself, they are fundamentally linked to specific frequencies based on the composition of the Earth's surface and atmosphere, meaning different bands cannot be used to get the same measurement. The natural signals are very faint, which makes their reception susceptible to interference that may corrupt the passive-sensing satellite instrument's measurement. Low-level interference may not be readily detectable if it results in a measurement that is still scientifically plausible but would result in inaccurate data. Aggregate interference from a number of sources may be also seen as an indistinguishable level of "noise."

¹⁷Commerce is the IRAC member agency, but NOAA represents Commerce on the IRAC.

¹⁸Throughout this report, we refer to the passive instruments on satellites that are used to collect data used in weather prediction models as "passive-sensing satellite instruments."

Internationally, the ITU maintains the treaty establishing the international regulations (known as the Radio Regulations) on use of spectrum and coordination and elimination of harmful interference between and among radio services of different countries. ITU hosts World Radiocommunication Conferences (WRC) every 3-4 years to update these regulations. As a specialized agency of the United Nations, ITU's membership is comprised of member states—that is, countries and their governments—as well as companies, universities, and international and regional organizations. Prior to the WRC, the president, acting through State, appoints an ambassador, who represents the U.S. at these international conferences. The agenda items for an upcoming WRC are developed at the preceding WRC. Regional organizations convene prior to a WRC to build consensus on agenda items. For example, the U.S. is a member of the Inter-American Telecommunication Commission (known by its Spanish acronym CITEI), which coordinates member states for the Americas region. The U.S. can present its positions and proposals on the agenda items to CITEI in order to advocate for their inclusion in the regional, inter-American proposals that CITEI submits to the WRC on behalf of the Americas group. According to FCC, NTIA, NOAA, and NASA officials, these regional proposals are an important way for countries to obtain support for their positions during WRCs. According to FCC, NTIA, and State officials, the political dynamics of WRC proceedings are complicated and, as a result, often involve negotiation and compromise. They noted that these dynamics existed leading up to and during ITU's most recent WRC.

The ITU held its most recent WRC from October-November 2019 (WRC-19). Activities for WRC-19 included studying whether the 24, 32, and 37 GHz spectrum bands (among others) could be designated for 5G use. The agenda called for spectrum sharing and potential-interference studies to help determine under what conditions 5G networks could operate compatibly with other uses (including passive-sensing satellite instruments) operating in the same or adjacent bands.¹⁹ For example, studies for the 24 GHz band sought to identify what out-of-band emissions limits would be necessary to prevent harmful interference. As a result of WRC-19, the ITU identified the 24 and 37 GHz bands for 5G use, with limits on the allowed out-of-band emissions to protect the adjacent passive-sensing satellite instruments. In the case of the 24 GHz band, these limits are more stringent than those FCC had already established in

¹⁹This was WRC-19 agenda item 1.13.

its domestic rules during the Spectrum Frontiers proceeding. The 32 GHz band was not identified for 5G use at the WRC-19.²⁰ As of June 2021, the U.S. was in the process of reviewing its domestic rules to identify what changes need to be implemented as a result of the final decisions reached at the WRC-19. For example, in April 2021, FCC sought comment on implementing the WRC-19 decisions regarding the 24 GHz band and on aligning FCC's rules (governing nonfederal spectrum use) with the emissions limits adopted at WRC-19.²¹

As noted above, some recent efforts within the U.S. to manage spectrum have been particularly challenging—most notably regarding the 24 GHz spectrum band, as discussed throughout this report. For this band, U.S. efforts to coordinate and agree on which U.S. studies and positions to present internationally in the years leading up to WRC-19 were highly contentious, and tensions and disputes among FCC, NTIA, NOAA, and NASA generated significant public attention and concern. FCC, NTIA, NOAA, and NASA did not agree on protection limits to use for purposes of WRC-19-related international negotiations for the 24 GHz band. NTIA, NOAA, and NASA supported more stringent limits based on the results of NOAA's and NASA's technical studies. FCC supported less stringent limits in line with those established during its Spectrum Frontiers proceeding; these limits were based on previously existing rules originally developed for other applications. The limits that the U.S. supported going into key pre-conference international meetings mirrored the existing FCC rules, not the more stringent limits noted by the technical studies the U.S. submitted to international technical meetings prior to the conference. Members of Congress and other stakeholders raised questions about how agencies had decided on the U.S. position.

²⁰Our prior work has reviewed a variety of key challenges with implementing 5G networks in the U.S. See, for example, GAO, *5G Deployment: FCC Needs Comprehensive Strategic Planning to Guide Its Efforts*, [GAO-20-468](#) (Washington, D.C.: June 12, 2020) and *5G Wireless: Capabilities and Challenges for an Evolving Network*, [GAO-21-26SP](#) (Washington, D.C.: Nov. 24, 2020).

²¹The request for comment was published in the federal register in May 2021. Emission Limits for the 24.25-27.5 GHz Band, 86 Fed. Reg. 28,522 (May 27, 2021).

Interagency
Collaborative
Mechanisms for
Spectrum
Management,
Including for
Addressing Potential
Interference, Reflect
Some Leading
Collaboration
Practices

Key Collaborative
Mechanisms Include
Interagency Agreements
and Groups

To coordinate and collaborate on domestic spectrum-management activities and for U.S. participation in WRCs, we identified three main collaborative mechanisms that FCC, NTIA, and, in this case, NOAA and NASA use: (1) a memorandum of understanding (MOU) between FCC and NTIA; (2) the IRAC; and (3) a U.S. international preparatory committee. These mechanisms support collaboration on various topics, including for addressing potential interference to satellite instruments used in weather forecasting.

- **FCC and NTIA MOU.** As the U.S. spectrum managers, FCC and NTIA maintain an MOU that serves as the main mechanism that guides their overall coordination on spectrum management, particularly for domestic matters. The MOU states that it establishes a framework for compliance with a statutory provision that requires the heads of FCC and NTIA (that is, the FCC Chair and the Assistant Secretary for Communications and Information) to meet at least twice

per year to conduct joint spectrum planning on various issues.²² The MOU formalizes collaboration practices between the agencies with the intention to promote efficient spectrum use, increase commercial access, and prevent harmful interference. In particular, the MOU states that FCC and NTIA are to provide each other advance notice of actions and work together to resolve technical and policy differences by consensus whenever possible. The MOU also outlines ongoing communication requirements the two agencies are to maintain.

- **IRAC.** Chaired by NTIA, IRAC is the main mechanism by which federal agencies coordinate on domestic spectrum-management activities, including when FCC is planning to allocate spectrum through a rulemaking proceeding. For example, FCC provides draft proceeding documents to NTIA, per the MOU, which NTIA distributes to the IRAC member-agency representatives for review. The member agencies may review the information and provide their comments to NTIA. According to NTIA officials, NTIA takes these comments into account as it develops the views it provides to FCC. IRAC also has subcommittees that member agencies belong to and that play a role in interagency collaboration. For example, IRAC's Radio Conference Subcommittee assists NTIA in preparing for WRCs by providing recommendations.
- **U.S. preparatory committee and the accompanying *General Guidance Document*.**²³ A U.S. preparatory committee is the main mechanism by which agencies coordinate on technical matters to prepare for U.S. participation in WRCs. Although formally the committee provides advice to State and resides under State, FCC and NTIA are vice-chairs, and the committee includes federal agency representatives (including from NOAA and NASA) as well as members from the public (such as satellite- and wireless-industry

²²Under the statute, the issues for joint spectrum planning include (a) the extent to which licenses for spectrum use can be issued pursuant to 47 U.S.C. § 309(j) to increase federal revenues; (b) the future spectrum requirements for public and private uses, including state and local government public safety agencies; (c) the spectrum allocation actions necessary to accommodate those uses; and (d) the actions necessary to promote the efficient use of the spectrum, including spectrum management techniques to promote increased shared use of the spectrum that does not cause harmful interference as a means of increasing commercial access. 47 U.S.C. § 922. NTIA is responsible for developing, in cooperation with FCC, a comprehensive long-range plan for improved management of all electromagnetic spectrum resources. 47 U.S.C. § 902(b)(2)(L)(i).

²³This committee is referred to simply as the "National Committee" in the *General Guidance Document*. Throughout this report, we refer to it as the "U.S. preparatory committee."

representatives). The committee supports the generation of U.S. technical contributions for WRC agenda items and plays a convening role for the agency and industry representatives involved in providing input used for development of the U.S. proposals and positions for CITELE and the WRCs.

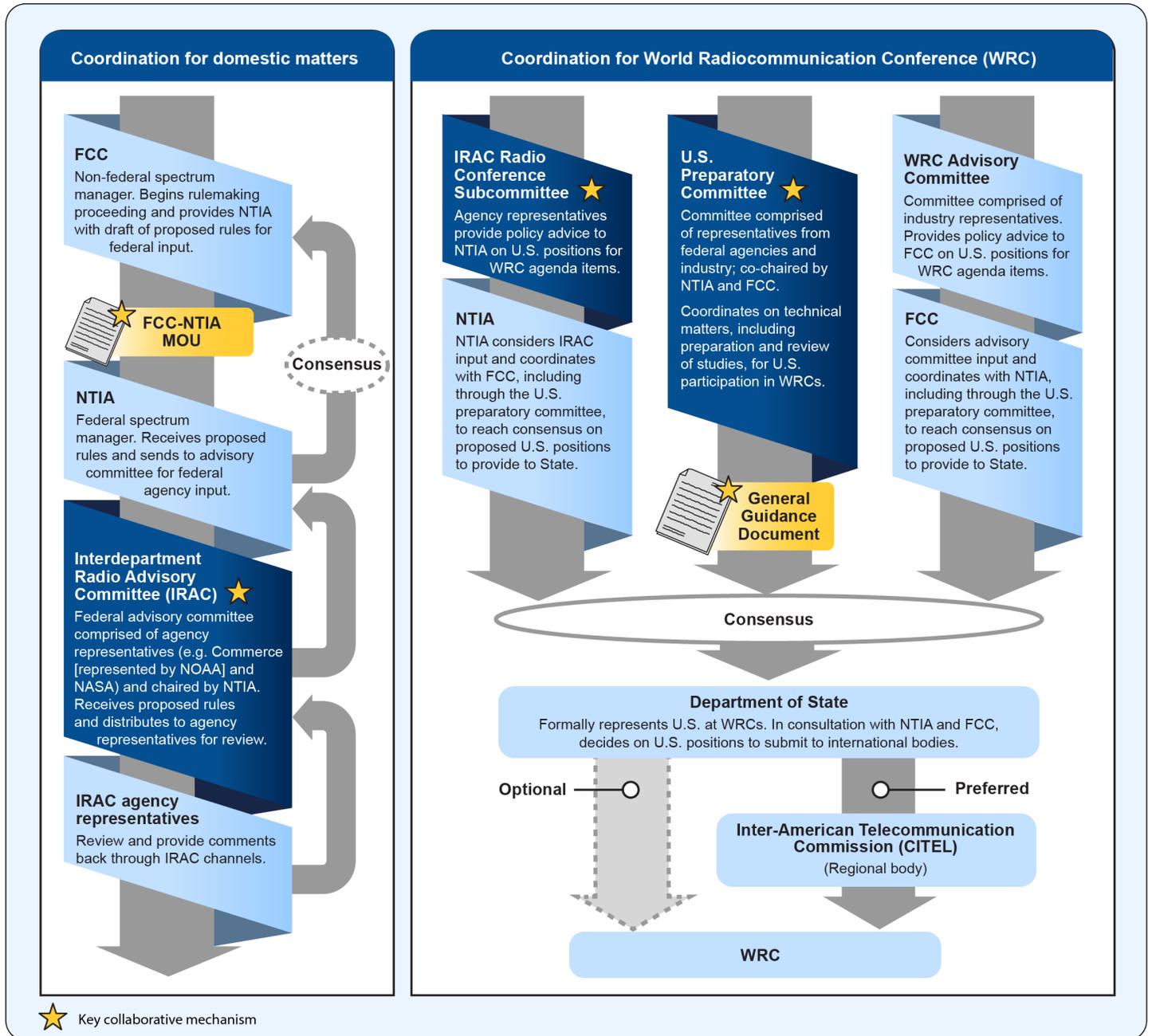
A *General Guidance Document* establishes the expectations and process by which the committee operates.²⁴ For example, participants collaborate with each other in decentralized subgroups via email, phone calls, and meetings to develop, for instance, the spectrum-sharing and potential-interference studies that serve as U.S. contributions to international meetings, and whose results will inform and may be integrated into the policy positions and proposals that the U.S. ultimately presents internationally. The contributions are circulated for U.S. preparatory committee review and to establish consensus before State submits them to international meetings. According to the *General Guidance Document*, development of consensus allows for due consideration and vetting of a U.S. position, and all efforts are to be made to achieve consensus. State, in consultation with FCC and NTIA, may ultimately decide what contributions to forward internationally.

FCC and NTIA also obtain advice from their respective advisory groups for WRC preparation. The WRC Advisory Committee, which is comprised of U.S. industry representatives, provides input to FCC, and the IRAC's Radio Conference Subcommittee provides input to NTIA. Collaboration on technical matters helps FCC and NTIA reconcile the different proposals they may receive from these groups to ensure the corresponding U.S. policy positions presented to the international community are technically sound. According to NTIA, FCC and NTIA are to reconcile their proposals and come to agreement before providing them to State for international submittal.

Figure 2 depicts the mechanisms and processes for coordination on domestic spectrum-management activities and for U.S. participation in WRCs.

²⁴*General Guidance Document: U.S. Participation in the ITU Radiocommunication Sector, and in CITELE PCC II (Radiocommunication including Broadcasting)* (Nov. 18, 2003).

Figure 2: Mechanisms and Processes for Coordination on Domestic Spectrum-Management Activities and for U.S. Participation in WRCs



Sources: GAO analysis of documentation and information from the Federal Communications Commission (FCC), Department of Commerce's (Commerce) National Telecommunications and Information Administration (NTIA) and National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA), and Department of State (State). | GAO-21-474

Collaborative Mechanisms Reflect Some Leading Practices but Do Not Fully Reflect Others

We have previously identified seven leading practices for implementing interagency collaboration that all collaborative mechanisms can benefit from.²⁵ Our prior work has shown that these practices help agencies enhance and sustain collaboration and are useful for addressing complex issues, such as spectrum management. We compared the agencies' main collaborative mechanisms (as identified above) and activities during the Spectrum Frontiers and WRC-19 proceedings against these leading practices. As shown in figure 3 and discussed further below, we found that while the agencies' collaborative mechanisms generally reflect some of these practices, they do not fully reflect others.

Figure 3: Assessment of Key Spectrum Management Collaborative Mechanisms against Leading Collaboration Practices

Leading collaboration practice	Key considerations	Do mechanisms reflect leading practice?
 Including relevant participants	Have all relevant participants been included?	Generally
 Identifying and leveraging resources	How will the collaborative mechanism be staffed?	Generally
 Identifying and sustaining leadership	If leadership is shared, have roles and responsibilities been clearly identified? How will leadership be sustained over the long-term?	Generally
 Clarifying roles and responsibilities	Have participating agencies clarified roles and responsibilities? Have they articulated and agreed to a process for making and enforcing decisions?	Not fully
 Defining outcomes and monitoring accountability	Have short-term and long-term outcomes been clearly defined? Is there a way to track and monitor progress toward these outcomes?	Not fully
 Developing written guidance and agreements	Have participating agencies documented how they will be collaborating? Have they developed ways to continually monitor and update written agreements?	Not fully
 Bridging organizational cultures	Have participating agencies developed ways for operating across agency boundaries?	Generally, but challenges remain

Generally = The mechanisms reflected most considerations of the practice.

Not fully = The mechanisms did not fully reflect most considerations of the practice.

Sources: GAO analysis of leading collaboration practices, Federal Communications Commission, National Telecommunications and Information Administration, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration and Department of State information. | GAO-21-474

Note: Key mechanisms include a memorandum of understanding between FCC and NTIA, the Interdepartment Radio Advisory Committee, and a U.S. international preparatory committee and the accompanying *General Guidance Document*.

²⁵[GAO-12-1022](#).

We found that the agencies' collaborative mechanisms and activities that we reviewed generally reflected the leading collaboration practices of: (1) including relevant participants, (2) identifying and leveraging resources, and (3) identifying and sustaining leadership.

- **Including relevant participants.** Through the IRAC and U.S. preparatory committee as noted above, all four agencies (FCC and NTIA as spectrum managers and NOAA and NASA as spectrum users) have the opportunity to participate and did participate, in some capacity, in the Spectrum Frontiers and WRC-19 proceedings. During these proceedings, each agency was routinely included in collaborative activities. For example, NOAA and NASA, through NTIA and the IRAC, had the opportunity to review and comment on FCC's draft proceeding documents during the Spectrum Frontiers proceeding, and both agencies participated in preparing potential-interference studies as part of the preparatory process in the years leading up to WRC-19. As vice chairs of the U.S. preparatory committee, FCC and NTIA both participated in reviewing the studies and, overall, participated in collaborative activities on an ongoing basis. Among potential barriers to effective coordination and collaboration that we identified, participation was the barrier that FCC, NTIA, NOAA, and NASA officials identified the least as being an issue in their work.
- **Identifying and leveraging resources, including staff.** FCC, NTIA, NOAA, and NASA leverage staff already involved in spectrum-related activities for roles related to participating in interagency collaborative efforts. In particular, each agency has various offices and positions that are responsible for monitoring or managing spectrum use, and all four agencies have leveraged staff in these offices and positions to implement or participate in both domestic and international collaborative efforts. For example, the memberships of the IRAC and U.S. preparatory committee include relevant staff from each of the agencies to carry out the committees' activities. Additionally, NTIA, NOAA, and NASA are members of the National Advanced Spectrum and Communications Test Network, a NIST-hosted multi-agency partnership that enables cross-agency technical studies. NIST, as a non-regulatory agency with spectrum-testing capabilities, may assist with data to inform spectrum management decision-making and issue resolution. NIST, NTIA, and the Department of Defense formed this partnership in 2015, and NOAA, NASA, and the National Science Foundation joined in 2018.
- **Identifying and sustaining leadership.** FCC's and NTIA's overall leadership roles with respect to regulating and managing spectrum

use are identified in statute,²⁶ and their leadership roles for international coordination are further identified in the *General Guidance Document*. Some agency officials as well as telecommunications and air-and-space stakeholders to whom we spoke noted that turnover of political appointees at NTIA or the late timing of the naming and appointment of the ambassador to lead the U.S. delegation posed challenges to WRC-19 coordination among FCC, NTIA, NOAA, and NASA. However, the agencies have generally identified leaders and sustained those positions over time, despite recent turnover.

We also found that the collaborative mechanisms and activities that we reviewed did not fully reflect the leading collaboration practices of: (1) clarifying roles and responsibilities, (2) defining outcomes and monitoring accountability, and (3) developing written guidance and agreements. In addition, while the collaborative mechanisms generally reflected features of the bridging-organizational-cultures leading practice, we found that challenges related to this practice remain.

- **Clarifying roles and responsibilities.** As part of this practice, clarity can come from agencies working together to define and agree on a process for decision-making. While FCC and NTIA (as spectrum managers) and, in this case, NOAA and NASA (as spectrum users) generally have defined roles and responsibilities through the collaborative mechanisms that we reviewed, they do not have clearly defined and agreed-upon processes for resolving matters when they cannot reach consensus to make decisions where appropriate. Although their MOU states that FCC and NTIA as managers of nonfederal and federal spectrum use, respectively, are to work together to resolve differences and reach consensus whenever possible, there is no outlined and agreed-upon process for making decisions when consensus cannot be reached between the two agencies. Instead, the MOU states that one agency's final actions do not require the approval of the other. Additionally, FCC officials we spoke to recognized the lack of an escalation process to address disagreements between the two agencies. Specifically, FCC officials told us that there is a lack of a formalized process to escalate an issue and that it may be beneficial to reflect an appropriate process in the MOU that clarifies this issue. Similarly, for collaboration on WRC participation, although consensus is emphasized, the path to escalating issues or disputes, resolving differences, and ultimately

²⁶See, e.g., 47 U.S.C. §§ 151, 152, 301, 303, 305, 309, 901(c), & 902(b)(2)(A).

making decisions when consensus cannot be reached is not clearly articulated in the *General Guidance Document*.

Our review of WRC-19 coordination activities indicates that the lack of clarity on these issues may have contributed to inconsistent understandings of how decisions are made and undermined trust. For example, during WRC-19 preparations, the agencies could not agree on technical matters or a policy position for the 24 GHz band. Shortly before the U.S. was to participate in a key international meeting to establish the positions to be considered during the conference, FCC communicated with the Executive Office of the President, requesting support for moving forward with FCC's position in the ongoing WRC-19 proceeding. Some non-FCC agency officials told us that they viewed this as outside the norm for the process. When we asked FCC, NTIA, NOAA, and NASA officials about the decision-making process and how decisions were made, responses varied. Some officials were unsure how the decision was ultimately made, which agencies or other entities not typically part of the process were involved, or which entity actually made the final decision about what U.S. position to present. Additionally, one meteorological stakeholder that we spoke to said that they believed that FCC was trying to dictate the study results that it and some industry representatives wanted without sufficient scientific support, thereby undermining stakeholders' trust in the process for making these decisions.

Both FCC and NTIA officials told us that there are no specifically defined, agreed-upon decision-making processes for when consensus cannot be reached because their coordination on routine items is largely successful, even if there are instances when more complex issues (such as spectrum allocation changes) are more controversial. We have previously identified that incorporating leading collaboration practices into collaborative mechanisms is especially useful for complex issues.²⁷ Moreover, FCC officials stated that additional clarity might not be needed because, ultimately, FCC and NTIA have separate jurisdictions, though they collaborate to the extent possible, and because, for the U.S.'s WRC preparations, State has final authority. Yet the divergent responses we received to questions about the actual processes in practice and the confusion surrounding escalating issues to a higher level suggest that additional clarity would be helpful. Additionally, State officials we spoke to stressed the importance of FCC's and NTIA's role in decision-making. For example, they noted that the development of any proposal to a WRC

²⁷[GAO-12-1022](#).

is subject to FCC's and NTIA's reconciliation processes before the proposal is provided to State, and that the *General Guidance Document* states that documents must be reviewed and approved by State "in consultation with FCC and NTIA." The State officials also noted that FCC's and NTIA's leadership is important in guiding State because the ambassador, who leads the U.S. delegation at the conference, is typically named just 6 months prior to the conference, whereas U.S. preparations for the conference last years.

Without clearly defined and agreed-upon processes for making decisions, particularly when consensus cannot be reached, collaboration can be strained in multiple ways. For example, as occurred during WRC-19 coordination, the lack of clearly defined and agreed-upon processes could prolong reaching consensus, create mistrust amongst participants, and lead to additional public disagreement in the future as spectrum becomes increasingly scarce and compatibility among different uses becomes more important.

- **Defining outcomes and monitoring accountability.** As part of this practice, clearly defining short- and long-term goals and ways to monitor and evaluate progress toward them can shape a group's vision and purpose. The collaborative mechanisms that we reviewed lack both clearly established goals tied to outcomes, as well as ways to monitor and track progress toward the goals. Neither the FCC-NTIA MOU nor the *General Guidance Document*—both key to guiding the agencies' collaborative efforts—includes clearly defined goals or ways to monitor and evaluate progress. Instead, FCC and NTIA agree in the MOU to meet together to promote increased shared use of the spectrum that does not cause harmful interference. Similarly, the *General Guidance Document* provides that the purpose of these collaborative efforts is to allow for contributions to international proceedings that are as sound as possible and that are in the best interests of the United States. Officials from FCC, NTIA, NOAA, and NASA told us that their broad, shared goal as federal agencies and participants in the U.S.'s international preparatory process is to act in the best interests of the U.S. on both domestic and international spectrum matters.

Additionally, our review of coordination activities for the Spectrum Frontiers and WRC-19 proceedings indicates that the agencies experienced difficulties related to goals. Specifically, officials from FCC, NTIA, NOAA, and NASA told us that they did not believe they were all focused on the same goal. For example, leading up to WRC-19, these agencies did not agree on protection limits to use as part of the U.S.'s international positions for the 24 GHz band. NTIA, NOAA,

and NASA supported more stringent limits based on the results of NOAA's and NASA's technical studies, and FCC supported less stringent limits in line with those established during the domestic Spectrum Frontiers proceeding. Officials from all four agencies told us they understood the need to both advance 5G deployment and protect passive-sensing satellite instruments. However, these officials also told us that it appeared that the agencies were focused on advancing their agencies' particular interests, instead of seeking to reach consensus on a shared outcome.

FCC officials further stated that a core problem was that agencies had different priorities and no common understanding of desired outcomes. The ensuing disagreements among the agencies over the 24 GHz band became public knowledge, potentially compromising the U.S.'s negotiating position for the WRC-19. For instance, the original protection limits the U.S. supported entering the conference did not align with the results of the technical studies the U.S. had previously submitted to international technical meetings held in advance of the conference. The position mirrored the existing FCC rules, though the previous studies suggested the need for much more stringent rules. FCC officials told us that supporting existing domestic rules in international negotiations is not uncommon and that they believed such support was appropriate in this case. They also noted that technical studies are not required to formulate a country's position, and countries can take into account the results of studies but are also free to negotiate and base their positions on factors other than technical studies. However, some air-and-space and meteorological stakeholders that we spoke to said that they believed that the technical basis for the U.S.'s position was unclear. NOAA officials also noted that U.S. credibility may have been hurt internationally by presenting a solution that had an unclear technical basis. FCC officials, however, noted that this was likely not a concern because of the number of divergent views presented internationally.

FCC and NTIA officials told us that they do not have specific goals or outcomes related explicitly to interagency collaboration on spectrum management because the routine way of operating works well for them. For example, FCC officials told us that most coordination items in recent years have been completed within agreed-upon timeframes in line with the FCC-NTIA MOU, and both agencies have allowed for flexibility on certain items. NTIA officials said there are no specific goals or outcomes because NTIA's coordination with FCC historically has worked well, though there are instances where disagreements occur that require more time to resolve than others do.

Nevertheless, as occurred during WRC-19 coordination, not having clear, shared goals that may be monitored and evaluated can contribute to an inability to overcome conflicting interests. We have previously identified that in a collaborative process, participants may have conflicting interests. To mitigate this, collaborative mechanisms can establish goals based on what the group shares in common, rather than where there is disagreement among missions.²⁸ Without clear goals, agencies may not be working toward a shared outcome, thus undermining collaborative efforts. Our prior work has also shown that agencies that create a means to monitor and evaluate the results of collaborative efforts can better identify areas for improvement.²⁹ Given the recurring nature of domestic and international spectrum-management activities, monitoring and evaluating progress toward shared goals may allow agencies to identify improvements for the next iteration of the process. Notably, NOAA and NASA officials told us that the U.S. preparatory committee has already begun preparing for the next WRC to be held in 2023 and that some of the coordination challenges that arose during WRC-19 preparations persist.

- **Developing written guidance and agreements.** As part of this practice, documenting collaboration agreements and developing ways to continually monitor and update these documents can strengthen agencies' commitments to working together. While the agencies have some forms of written guidance and agreements to guide their coordination activities, they have not been regularly updated, and there are no identified means to continually monitor and update them. Specifically, neither the FCC-NTIA MOU nor the *General Guidance Document* has been updated in nearly 20 years. As described above, the documents also do not reflect either clearly defined goals or agreed-upon processes for making decisions.

Our review of coordination activities for the Spectrum Frontiers and WRC-19 proceedings indicates that the existing FCC-NTIA MOU and *General Guidance Document* also do not reflect recent changes in the spectrum management landscape overall, changes that have underscored the need for clear escalation and conflict resolution procedures. For example, NOAA officials told us that while behaviors and the overarching environment have changed because of the increased need for spectrum sharing and thus, more complex decision-making, the guidance has not evolved accordingly. NOAA officials added that in the past, issues had hardly ever escalated to

²⁸[GAO-12-1022](#).

²⁹[GAO-12-1022](#).

top leadership, but recently more have been brought to top leadership. The current documents do not include guidance for participants in these cases. Additionally, some telecommunications and air-and-space stakeholders that we spoke to told us that prolonged disagreements and lack of consensus are likely to continue as spectrum demand increases in the future and that there are already examples that this situation is occurring with increased frequency.

Our review of the *General Guidance Document* in particular indicates that it is outdated, which has contributed to confusion. For example, the document links the work of the U.S. preparatory committee to an advisory committee that was dissolved in July 2020.³⁰ NOAA and NASA officials told us that they were either unaware of this change or that they understood that the advisory committee had just been renamed and reconstituted, while FCC and NTIA officials said that the other committee was renamed and now also includes an expanded scope. However, State officials told us that it had formed a new advisory committee, and that this new committee was not a replacement for the prior one and that the U.S. preparatory committee is no longer tied to it. They further told us they created an unofficial addendum to the *General Guidance Document* in 2017 to complement the document and provide additional guidance. However, we found that at least one agency is unaware of this additional document, and based on our review, all the agencies had different understandings of what is the most current and official version they are to follow, as recent changes are not currently reflected in the widely used 2003 version of the *General Guidance Document*.

FCC and NTIA officials told us that additional ways to monitor the *General Guidance Document* are not needed because although the guidance has not been formally updated, a group of principal participants from FCC, NTIA, State, and other agencies could informally review the document during quarterly meetings. Further, according to FCC officials, during these meetings, FCC and NTIA have the opportunity to recommend that State make revisions. According to NTIA officials, adjustments to the process described in the document have been made throughout the years, but the document has not been formally updated to reflect those changes. FCC and NTIA officials said that the *General Guidance Document* resides under State's control and that State would, therefore, be responsible for updating it. However, State officials we spoke to

³⁰This other committee was the International Telecommunication Advisory Committee, which advised State.

indicated that the document is not exclusively “owned” by State and that a request to initiate a review, and possible revision and update of the document, could come from any participating agency. If a request were made, State would lead such an effort in coordination with other agencies.

FCC and NTIA officials told us their MOU has not been updated because it has generally worked successfully for most of their needs. Nonetheless, the Commerce Spectrum Management Advisory Committee recommended to NTIA in July 2020 that the MOU be updated and, in January 2021, recommended additional improvements.³¹ Of particular note, the committee recommended that for non-routine FCC items (which could include rulemaking proceedings and auctions), the MOU should include specific timeframes for resolution and create an agreed-upon escalation process that considers, as appropriate, the participation of other interested agencies. The committee also recommended that the MOU provide guidelines for spectrum-management decision-making between the two agencies (including how issues will be raised and how conflicts will be resolved) and that the MOU be reviewed at least every 3 years. According to NTIA officials as of June 2021, NTIA had reviewed these recommendations but had not made any decisions on how it will act on them.³²

We have previously identified that articulating agreements reached in the areas of outcomes and roles and responsibilities (including decision-making processes) in formal, written documents is a powerful tool. These documents are most effective when they are regularly monitored and updated.³³ Additionally, federal internal control standards state that management should document policies and periodically review policies, procedures, and related control activities for continued relevance and effectiveness in achieving the entity’s objectives or addressing related risks.³⁴ Because the FCC-NTIA MOU and *General Guidance Document* have not been regularly updated, the agreements have not kept pace with the process adjustments

³¹This committee, which is comprised of spectrum policy experts from outside the federal government, advises NTIA on a broad range of spectrum policy issues.

³²There have also been previous attempts to update the FCC-NTIA MOU. For example, NTIA reported on attempts to revise the MOU in 2008. See, Commerce, *Spectrum Management for the 21st Century: The President’s Spectrum Policy Initiative Progress Report for Fiscal Year 2007* (November 2008). No changes were made at that time.

³³[GAO-12-1022](#).

³⁴[GAO-14-704G](#).

made through the years or with the changing nature of the spectrum environment, including increased use of and demand for spectrum. Thus, the two documents may not reflect the increasing pressures on agencies' collaborative efforts, particularly on FCC and NTIA as the spectrum managers. Moreover, without a way to monitor the agreements continually, agencies may not be considering their effectiveness and relevance as technology and political environments continually evolve.

- **Bridging organizational cultures.** As part of this practice, using compatible policies and procedures to address cultural organizational differences can enable a cohesive working relationship and create the mutual trust required to enhance and sustain collaborative efforts. While we found that agencies' collaborative mechanisms generally reflect features of this practice, we also found challenges. For example, while the FCC-NTIA MOU and the *General Guidance Document* establish some forms of compatible policies and procedures, we also found gaps with these documents, as described above. Namely, they have not been regularly updated, and there are no identified means to continually monitor and update them. Additionally, our review of coordination activities during the Spectrum Frontiers and WRC-19 proceedings indicates that the agencies had challenges with trust. For example, officials from all four agencies spoke to us about competing missions and priorities during the proceedings. In our interviews with officials from FCC, NTIA, NOAA, and NASA, officials also described various issues that suggested that trust was compromised. Furthermore, the agencies identified bridging organizational cultures as among the greatest barriers to collaboration. Given that establishing ways to operate across agency boundaries, including through compatible policies and procedures, can help agencies address cultural differences and create mutual trust, agencies may be able to further bridge their organizational cultures by addressing the gaps we identified in the FCC-NTIA MOU and the *General Guidance Document*.

NOAA and NASA Have Processes for Reviewing Spectrum-Management Actions for Potential Interference to Their Satellite Instruments, but NOAA Lacks Written Procedures

Both Agencies Rely on External Events to Initiate Internal Reviews about Potential Interference

As previously described, through the IRAC, federal agencies that are IRAC members receive drafts of FCC's proceeding documents for their individual review and comment. For domestic spectrum-management proceedings, both NOAA and NASA rely on these IRAC notifications to initiate review and identification of proposed FCC actions that may affect their satellite instruments. In particular, according to NOAA and NASA officials, the agencies' IRAC representatives learn of proposed actions when NTIA distributes information from FCC to IRAC members, a process that would trigger their respective internal reviews. Specifically, NOAA's and NASA's representatives would further distribute the information to the appropriate internal offices for review to identify comments and concerns (if any), including potential interference concerns. The representatives would consolidate comments to submit back to FCC through NTIA and the IRAC within FCC and NTIA's agreed timeframes. For example, each of NASA's relevant centers—such as the Goddard Space Flight Center, which operates a key meteorological satellite instrument—has a designated spectrum manager.³⁵ According to NASA officials, NASA's IRAC representative would forward the IRAC action item to these spectrum managers and consolidate their comments with those of the NASA spectrum management office for IRAC submittal. Officials from NOAA and NASA stated that this process is also what triggers their staffs to consider what, if any, spectrum-sharing or potential-interference studies they should conduct for domestic coordination efforts.

³⁵Although NASA refers to these individuals as spectrum "managers," these individuals do not regulate the use of spectrum in the manner that FCC and NTIA do.

Similarly, for WRCs, both NOAA and NASA rely on ITU actions to initiate internal review and identification of activities that may affect their satellite instruments. In particular, according to NOAA and NASA officials, their spectrum-management offices or international spectrum program managers learn of activities when the agenda for an upcoming WRC is established. The agenda triggers their internal review of whether there are agenda items of interest or concern, including ones that may require them to conduct spectrum-sharing or potential-interference studies that could serve as U.S. contributions to the international deliberations. For example, according to NOAA officials, NOAA's spectrum-management division would review the agenda items in consultation with other appropriate offices at NOAA, such as the office that operates NOAA's satellites. Once identified, staff participate directly in the U.S. process for preparing for WRCs by conducting appropriate studies and reviewing others' studies, as described above and further below.

NOAA and NASA Lacked Written Procedures That Clearly Guide Internal Processes and Delayed Raising Potential Interference Concerns during the Spectrum Frontiers Proceeding

At the time of the FCC proceeding that we examined, NOAA and NASA lacked written procedures to guide their internal processes for reviewing proposed domestic spectrum-management actions for potential interference concerns, a lack that may have contributed to delays in both agencies' providing input. Specifically, we found that they did not participate significantly in FCC's Spectrum Frontiers proceeding, although they were provided multiple opportunities to do so. For example, regarding the 24 GHz band, while FCC requested comments on actions it was considering related to the band as early as 2014, when the proceeding began, neither NOAA nor NASA submitted comments through the IRAC until several years later. By the time the two agencies provided comments—well after FCC was requesting comments on its proposed actions—FCC had already decided to take action. See table 1.

Table 1: FCC Actions on 24, 32, and 37 GHz Bands in Its Spectrum Frontiers Proceeding and NOAA's and NASA's Related Comments Submitted via the IRAC

Date	FCC Actions	NOAA Comments on Action	NASA Comments on Action
October 2014	In a Notice of Inquiry, FCC seeks comment on the advisability of allowing mobile service operations in the bands and on the corresponding technical rules for such service.	None	None
October 2015	<p>In a Notice of Proposed Rulemaking, FCC seeks comment on proposed rules for use of bands at or above 24 GHz for mobile service, including limits on out-of-band emissions.</p> <p>24 & 32 GHz: FCC requests further comment on various issues, including related to how sharing would work between mobile and incumbent uses.</p> <p>37 GHz: FCC proposes and requests further comment on various items related to developing rules for mobile service in the band, including to protect adjacent passive-sensing satellite instruments.</p>	None	None
July 2016	<p>In a Report and Order, FCC establishes rules for the use of bands at or above 24 GHz for mobile service.^a</p> <p>24 & 32 GHz: In the accompanying Further Notice of Proposed Rulemaking, FCC proposes to allow mobile service in the bands under these new rules and seeks further comment.</p> <p>37 GHz: FCC adopts rules to permit mobile service in the band.</p>	None	In response to a draft of the Report and Further Notice, NASA concurs with an NTIA conclusion stating that, with FCC's proposed limits on out-of-band emissions in the rules, fixed and mobile service in the 37 GHz band would not interfere with adjacent passive-sensing satellite instruments.

Date	FCC Actions	NOAA Comments on Action	NASA Comments on Action
November 2017	24 GHz: In a Report and Order, FCC allocates the band for mobile service under the rules it established July 2016, and indicates its intent to move forward as quickly as possible to auction licenses. 32 GHz: FCC states it will not act on this band at this time. 37 GHz: No action.	None	In response to a draft of the Report and Order, NASA suggests that FCC state it is important to protect weather satellite operations in the 24 GHz band from mobile operations and asks FCC to commit to protection. NASA notes that technical studies for the 2019 World Radiocommunication Conference (WRC-19) are being conducted on this topic, but are early on, and it is unclear what limits on out-of-band emissions will be needed to provide protection. NASA suggests that FCC state that, once the studies have been completed and agreed upon, FCC will make changes to the limits, if necessary.
June 2018	24 GHz: In a Report and Order, FCC adopts rules related to certain operability issues for the band and notes that it will auction licenses for the band following a separate auction for a different band that will begin November 2018. FCC also references studies being conducted for WRC-19. 32 GHz: No action. 37 GHz: No action related to 5G interference with adjacent passive-sensing satellite instruments.	In response to a draft of the Report and Order, NOAA raises concerns that FCC references WRC-19 studies but does not mention that the studies identified the need for limits on out-of-band emissions to protect satellite operations in the band. NOAA states that FCC must ensure protection.	None

Source: GAO analysis of Federal Communications Commission (FCC), National Oceanic and Atmospheric Administration (NOAA), and National Aeronautics and Space Administration (NASA) documents. | GAO-21-474

Note: NOAA and NASA comments were those provided through the Interdepartment Radio Advisory Committee (IRAC), which is the mechanism that the National Telecommunications and Information Administration (NTIA) uses to provide drafts of the actions FCC plans to take in a proceeding to federal agencies for the agencies' review. Dates listed correspond to when FCC published the action.

^aThe 24 GHz band is part of what is termed the Upper Microwave Flexible Use Service, a term that encompasses bands at or above 24 GHz. See 47 C.F.R. § 30.4.

Officials from NOAA and NASA told us that they did not provide comments earlier due to several complicating factors. These factors included that FCC was considering many bands at once in the proceeding, and that NOAA and NASA had no specific technical characteristics to assess for the proposed bands, had competing priorities within the agency, and were, instead, addressing the topic through the separate but simultaneous U.S. preparatory process leading up to WRC-19. Moreover, although NASA subsequently developed written procedures, at the time of the proceeding neither agency had formal written procedures to clearly guide or detail the internal processes

described above. Instead—according to NOAA and NASA officials—the procedures were generally that they did not respond to every item but, rather, provided comments via their processes on a case-by-case basis when warranted.

Relevant agency mechanisms and policy, as well as federal internal control standards, establish the importance of proper coordination, through the proper channels, on these matters. The IRAC process, not the U.S.'s international preparatory process for WRCs, is the established reporting line through which federal agencies coordinate on draft proceeding documents for domestic rulemaking. Additionally, Commerce policy establishes that NOAA is responsible for preventing interference through coordination with other agencies, and NASA policy states that NASA is to identify programs at risk due to commercial encroachment or possible interference, or both. Federal internal control standards further state that agencies should identify and respond to risks and communicate with external parties, including other government entities, using established reporting lines. Finally, while addressing issues on a case-by-case basis may be appropriate, internal control standards also state that documenting responsibilities through policies—including the policies necessary to operate a process—contributes to the effectiveness of implementing activities to achieve objectives and respond to risks.³⁶

By not providing comments in a timelier manner through the appropriate channel, the IRAC process, NOAA and NASA missed opportunities to ensure that FCC received and considered their input when it was promulgating rules.

- NASA officials told us that there was no compelling reason to comment prior to when they did due to the complicating factors noted above, as well as for various other reasons. For example, NASA officials stated that the purpose of NASA's review of the 2014 notice of inquiry was not to reply but, rather, to comment on the draft as appropriate. Later, NASA focused more on concerns it viewed as vital related to other bands in the proceeding. NASA officials further noted that, although NASA had an existing process for reviewing and providing comments through the interagency coordination process for domestic regulatory proceedings, they had previously identified the lack of internal, documented procedures as a gap.

³⁶[GAO-14-704G](#).

Accordingly, NASA developed an internal spectrum policy and regulatory tracking tool that will serve to complement and document NASA's existing process and provide increased traceability and accountability. For example, NASA's tracking tool will allow it to monitor when IRAC action items are received and comments are due, log which spectrum bands the actions involve and the NASA service potentially affected, notify internal NASA points of contact, and then track and record NASA's response, as well as the resulting FCC action, among other things. NASA presented guidance on the new tool and a tutorial on the procedures to its spectrum managers group in 2020. As of December 2020, NASA had launched the first iteration of the tracking tool, was working on enhancements, and had begun developing a corresponding tool for its international process. NASA officials noted that this approach will improve NASA's ability to manage its internal process, particularly when multiple bands are part of a proceeding and the proceeding spans several years.

- Earlier participation by NOAA in the proceeding might have revealed the potential for disagreements related to the 24 GHz band up to 2 years earlier. According to NOAA officials, when FCC began the proceeding in 2014 with a notice of inquiry, the notice sought input on general principles and there was nothing in it that would have triggered NOAA to assume the satellite instruments operating in spectrum adjacent to the 24 GHz band would be affected. However, the 2014 notice explicitly requested comment on out-of-band emissions limits and the 24 GHz band.³⁷ NOAA officials also stated that as the proceeding progressed, NOAA was focused on addressing the WRC agenda item that also included the 24 GHz band first, assuming the solution would lead to U.S. regulations once WRC decisions were made, given FCC's explicit acknowledgments of the international studies in the domestic proceeding. NOAA officials added that NOAA did not have sufficient information to provide substantive input until the WRC-19 studies were nearly complete. However, FCC proceeded with implementing U.S. regulations ahead of WRC decisions. FCC later used establishment of these domestic rules in its Spectrum Frontiers proceeding—and the lack of any NOAA (or NASA) comments or objections during the interagency

³⁷The notice sought "comment on appropriate [out-of-band emissions] limits. [The notice asked,] [w]ould an attenuation of $43 + 10\log(P)$ for out-of-band emissions be appropriate?" Furthermore, the notice sought "comment on the advisability of adding a mobile allocation and developing advanced mobile service rules in the 24 GHz band." *In re Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, Notice of Inquiry, FCC 14-154, paras. 42, 87.

coordination process—as a reason for supporting international protection limits in line with existing domestic rules.

NOAA may not have full technical information with which to comment in detail on every matter presented to it. Yet providing no level of comments earlier in the proceeding through the established reporting lines may have disadvantaged NOAA’s ability to represent itself. Clarifying internal processes through written procedures could provide NOAA with greater assurance that it is carrying out its activities in a manner that will best enable it to achieve its objectives and respond to risks. For example, it may help NOAA better consider when and how to provide comments when complicating factors exist, such as those present during the Spectrum Frontiers proceeding.

NOAA, NASA, FCC, and NTIA Conduct or Review Technical Interference Studies but Lack a Set of Guiding Procedures

NOAA and NASA Conduct Studies While FCC and NTIA Review Them

When participating in domestic and international spectrum-management activities, both NOAA and NASA have divisions or offices with the capability to conduct studies to assess spectrum sharing and potential interference with their satellite operations. NOAA’s Radio Frequency Management Division leads spectrum-management activities at NOAA, and technical experts from other NOAA offices—such as the office that operates NOAA’s satellites—may also provide support as needed. NASA’s Spectrum Management Office leads spectrum-management activities at NASA, and its Spectrum Analysis Center is tasked with ensuring technical spectrum analysis is consistent across all of NASA. Technical experts from other NASA centers may also provide support as needed.

For example, while NOAA and NASA did not prepare interference studies for FCC’s Spectrum Frontiers proceeding, both agencies were involved in preparing studies as part of the U.S.’s participation leading up to WRC-19. Regarding the Spectrum Frontiers proceeding, NASA concurred with NTIA’s conclusion that FCC’s proposed limits on out-of-band emissions for the 37 GHz band would not interfere with adjacent passive-sensing

satellite instruments. NASA told FCC (via NTIA and the IRAC) that the international community was studying potential interference issues for the 24 GHz band and, thus, decisions made at the WRC-19 on the basis of these studies might affect FCC's limits for this band. For U.S. participation leading up to WRC-19, NOAA and NASA agreed that NOAA would take the lead in conducting the studies of potential interference with passive-sensing satellite instruments; NASA would be listed as a co-author of the studies for the purposes of being included in technical discussions. NOAA's radio-frequency division led preparation of these studies with contractor support provided by the office that operates NOAA's satellites. NASA led preparation of the joint NOAA-NASA study that the agencies later prepared for the 24 GHz band, as described further below.

According to FCC and NTIA officials, in their role as spectrum managers, FCC and NTIA typically review and evaluate studies performed by others, though both agencies have offices or divisions with the capability to do their own studies. For example, a team consisting of staff from FCC's engineering office and international bureau was involved in the technical discussions and reviews of NOAA's and NASA's studies as part of the U.S. preparatory process for WRC-19. A team consisting of staff from the NTIA spectrum-management office's engineering and international divisions as well as NTIA's Institute for Telecommunications Sciences, was involved in the discussions and reviews of these studies.

NOAA, NASA, FCC, and NTIA conduct or review spectrum-sharing and potential-interference studies on a case-by-case basis, using appropriate engineering analysis, depending on the issue at hand and whether the actions requiring the study originate from domestic or international spectrum-management activities. According to NOAA, NASA, and NTIA officials, most potential interference concerns originating from domestic activities stem from spectrum-management actions taken by FCC. In this case, NOAA's and NASA's participation revolves around providing input into FCC's rulemaking through NTIA and the IRAC, as described previously. According to FCC officials, FCC reviews all studies officially submitted into the record of its proceedings. These studies are not limited to those provided by federal agencies, and may include studies submitted by other interested parties, such as nonfederal spectrum users. When interference concerns originate from ITU activities, the agencies conduct and review studies through participation in international meetings using the preparatory process for U.S. participation in these meetings.

For example, for the international meetings concerning the WRC-19 agenda item that called for the 24, 32, and 37 GHz band spectrum-

sharing and potential-interference studies, the meetings leading up to the WRC had three phases:

1. initial study meetings, where specialists established system characteristics, assumptions, and methodologies for the studies based on input from designated ITU expert bodies;
2. technical meetings, where participants presented results of their studies for review to ITU-designated study or task groups; and
3. final meetings, including meetings where countries presented policy positions and established international rules.

Several ITU expert bodies provided input for these studies, and one technical task group was designated as the body to lead the work for that item. The technical task group held five meetings leading up to WRC-19. Within the U.S., participants conducted and reviewed studies intended to be submitted as U.S. contributions to these international technical meetings through the U.S. preparatory committee process. As described previously, the U.S. process is consensus-based, with the participants in technical subgroups preparing, reviewing, and revising studies with the goal of reaching consensus within their groups, and ultimately for all of the participants to reach consensus on what contributions to present internationally. Lacking such consensus, State, in consultation with FCC and NTIA, decides whether the studies proceed to international meetings.

Inability to Reach Consensus on Study Inputs and the Lack of Guiding Procedures Hampered U.S. Efforts to Prepare Studies for the 2019 WRC

The U.S. WRC-19 proceeding activities we reviewed demonstrated that NOAA's 32 and 37 GHz band potential-interference studies did not play a significant role in the U.S. participants' decisions on actions for the bands.

- Regarding the 32 GHz band, according to FCC officials, NOAA's 32 GHz band studies were of less significance because separate Department of Defense-led 32 GHz band studies indicated that sharing of the band was incompatible with radars. According to FCC and NTIA officials, this incompatibility made the band much less attractive to the wireless industry. The results of international studies agreed with these results. Additionally, as of June 2021, FCC had not taken additional action on pursuing the 32 GHz band for mobile 5G service.
- Regarding the 37 GHz band, as part of FCC's Spectrum Frontiers proceeding, in 2016, NTIA had already indicated that interference from 5G networks with passive-sensing satellite instruments should not be a concern. NTIA concluded this because FCC's proposed out-

of-band emissions limit for the band was already lower than the allowed in-band power limit by a factor of two, meaning 5G equipment complying with the proposed limit should not cause interference.

As part of the U.S.'s participation in the ongoing technical meetings, NOAA continued to prepare and refine its studies for the 32 and 37 GHz bands, which were performed with similar system characteristics, assumptions, and methodologies as its 24 GHz studies discussed below. According to NOAA officials, the 32 and 37 GHz studies were still needed in the event the WRC went in a direction inconsistent with the U.S.'s direction. Expecting to achieve concurrence on the 24 GHz studies, NOAA planned to make corresponding changes and prepare final 32 and 37 GHz band studies. However, although the U.S. has a preparatory committee process that emphasizes reaching consensus on studies conducted and reviewed for international meetings, NOAA, NASA, FCC, and NTIA were not able to reach consensus, resulting in the U.S. not submitting final 24, 32, and 37 GHz band studies.³⁸

Between spring 2017 and summer 2018, NOAA prepared five 24 GHz band studies that were prepared for the five international task group technical meetings. The first four studies reached consensus:

- The first study was prepared for the May 2017 task group meeting. This study was largely an outline; at the time, the internationally recognized inputs (i.e., characteristics, methodologies, and assumptions) were under development.
- The second study, prepared for the September 2017 task group meeting, was the first performed using inputs provided by the expert bodies and group. However, some additional inputs were provided in November 2017.
- As such, the third study, prepared for the January 2018 task group meeting, was an update of the second study.
- The fourth study, prepared for the May 2018 task group meeting, reached consensus following compromises with FCC. FCC disagreed with the methods NOAA used for certain components of the study and advocated for different methods and assumptions to be used. Results using both FCC's and NOAA's methods were presented, with NOAA

³⁸While this report focuses on NOAA, NASA, FCC, and NTIA, the U.S. preparatory committee—as mentioned earlier in this report—includes both federal and nonfederal participants, such as industry representatives who also play a role in the U.S. preparatory process.

results in square brackets to indicate that the study was not complete, that the values were provisional, and that there would be further updates. According to NOAA officials, NOAA agreed to this approach with the understanding that the parties would continue to evaluate the methods and make changes prior to the next meeting.

However, the agencies did not reach consensus on the next study, prepared for the last task group meeting held in August 2018. This lack of consensus resulted in the U.S. not submitting any of its final studies of potential interference with passive-sensing satellite instruments to the last international task-group meeting for consideration by the international community. This circumstance meant the U.S. participated in the last technical meeting and the other key final meetings that followed without positions clearly backed by any agreed-upon U.S. technical studies of 5G interference with passive-sensing satellite instruments for the 24, 32, and 37 GHz bands.

According to NOAA, NASA, FCC, and NTIA officials, the agencies did not reach consensus on the study because they were unable to reconcile disagreements over 5G system characteristics, as well as assumptions and methodologies used in these studies. Following the final international task group meeting, NOAA, NASA, FCC, and NTIA officials further attempted to reconcile disagreements, including at a November 2018 meeting held with representatives of the U.S. wireless industry. During these exchanges, FCC and industry representatives requested results from interim steps in the NOAA studies to further explore how NOAA configured its software application code to reflect the input data, among other things. However, according to NOAA and NASA officials, it was not possible to extract the requested interim steps from the commercial software NOAA used to prepare the studies. Therefore, NOAA and NASA decided to jointly conduct a new study using NASA-developed software that, among other things, could provide the desired interim results. NTIA reviewed this new study, after which it was presented to FCC in March 2019. FCC objected to the new study and continued to raise concerns. For example, FCC disagreed with the 5G deployment and satellite sensor assumptions used, but NOAA and NASA maintained that they derived the characteristics, assumptions, and methodologies used from guidance provided by the international expert bodies and groups, which directed the international community to use these inputs. NOAA, NASA, FCC, and NTIA, with assistance from State, held several meetings between March and May 2019 but disagreements over system characteristics,

assumptions, and methodologies persisted. These meetings concluded without resolution.

According to NOAA, NASA, FCC, and NTIA officials, there are no specific procedures within the U.S. preparatory process to guide the design of studies that serve as U.S. contributions to international technical meetings. Instead, studies are prepared following the system characteristics, assumptions, and methodologies provided by others as the preparers understand them. For example, ITU expert bodies may provide guidance (as was the case for the 24, 32, and 37 GHz band studies), and a series of ITU-recommended technical standards provide technical information that may be used when preparing studies. However, according to NOAA and NASA officials, although FCC (like all involved) was a party to the international groups that developed the characteristics, assumptions, and methodologies based on guidance by ITU expert bodies, FCC later disputed the characteristics, assumptions, and methodologies NOAA and NASA used in the design and preparation of their studies—including those involving deployment of 5G networks and systems in the 24 GHz band—and there were no clear steps on how to resolve these disagreements and move forward in that scenario.

Though there is no single or ideal way for government agencies to conduct research, we previously developed a framework that identified key elements of a sound research process, using guidelines from several leading organizations.³⁹ According to this framework, agencies should establish specific procedures—including for design, during which steps to select appropriate approaches and methods should be identified. In technical analysis, analyses may evolve as additional data and information become available, and this evolution is particularly true of “first of kind” analysis when available data are particularly new and potentially incomplete. Indeed, the 24, 32, and 37 GHz band potential-interference studies prepared for WRC-19 were the first time potential interference between 5G networks and passive-sensing satellite instruments had been studied in detail. Having procedures allows agencies to consider whether appropriate tradeoffs are being made between what is desirable and what is practical and between the relative strengths and weaknesses of different methods. For example, NOAA and NASA officials noted that clarified procedures could help address how methodological objections are handled by, for example, specifying that

³⁹[GAO-11-285](#).

objections should be supported with technical details and recommended corrective actions (such as alternative parameters).

Without specific procedures to guide the design of its interference studies, the U.S. WRC preparatory process may continue to be vulnerable to protracted disagreements over study results, which may, in turn, undermine the U.S.'s positions for regional and international meetings. For example, because the U.S. did not reach consensus on its studies, the technical basis for the positions the U.S. presented to the international community was unclear, an outcome that we found allowed room for speculation regarding the motive behind the position. For example, some agency officials as well as air-and-space and meteorological stakeholders we spoke to speculated that the conclusions reached may have been motivated by political factors, rather than being based on agreed-upon studies. Specific procedures may help guide agencies' efforts to resolve disagreements like those experienced for WRC-19. Such procedures could be particularly important as future consideration is given to making additional bands—including bands that may be more critical to weather-forecasting capabilities than the 24, 32, and 37 GHz bands—available for 5G service.

Conclusions

FCC and NTIA confront complex and challenging tasks in regulating and managing the diverse uses of spectrum and accommodating the growing needs of emerging spectrum-dependent technologies while protecting existing uses from harmful interference. Indeed, the roles of FCC and NTIA in managing spectrum involve balancing the concerns of various spectrum users to promote the most efficient and effective use of the spectrum resource in the public interest. The two agencies' decisions may not always comport with the views of specific spectrum users, which may have competing priorities. Spectrum managers and users alike must coordinate on whether and how multiple users of spectrum may operate compatibly without resulting in harmful interference. While mechanisms exist that facilitate collaboration between FCC and NTIA—the U.S. spectrum managers—and federal users like NOAA and NASA, gaps also exist. The gaps that exist in decision-making processes, agreed-upon outcomes, updated guidance documents, and procedures that guide the design of interference studies all contributed to hampering the U.S.'s efforts to prepare for WRC-19. While, in this case, these gaps may have also contributed to hampering NOAA's and NASA's efforts to protect their satellite instruments from potential interference, in the future these gaps could contribute to challenges in managing spectrum for other uses. By working to address these identified gaps and weaknesses, FCC, NTIA, NOAA, and NASA will be better positioned to reach agreement on

domestic spectrum matters and present a unified U.S. position on international matters.

Recommendations for Executive Action

We are making a total of 11 recommendations, including 5 to FCC, 5 to NTIA, and 1 to NOAA.

The Chair of FCC should establish clearly defined and agreed-upon processes for making decisions on spectrum-management activities that involve other agencies, particularly when consensus cannot be reached, in consultation with NTIA and—as appropriate—State. (Recommendation 1)

The Chair of FCC should clarify and further identify shared goals or outcomes for spectrum-management activities that involve collaboration and ways to monitor and track progress, in consultation with NTIA and—as appropriate—State. (Recommendation 2)

The Chair of FCC should update the FCC-NTIA MOU to address identified gaps (such as the lack of clearly defined goals and agreed-upon processes for making decisions) and develop a means to continually monitor and update this agreement, in consultation with NTIA. (Recommendation 3)

The Chair of FCC should request that State initiate a review of the *General Guidance Document*—in consultation with FCC, NTIA, and other relevant participants—and update and develop a means to continually monitor and update this document. (Recommendation 4)

The Chair of FCC should establish procedures to help guide the design (including selection of acceptable assumptions and methodologies) of spectrum-sharing and potential-interference studies intended as U.S. contributions to WRC technical meetings, in consultation with NTIA, State, and other federal participants of the U.S. technical preparatory process. (Recommendation 5)

The NTIA Administrator should establish clearly defined and agreed-upon processes for making decisions on spectrum-management activities that involve other agencies, particularly when consensus cannot be reached, in consultation with FCC and—as appropriate—State. (Recommendation 6)

The NTIA Administrator should clarify and further identify shared goals or outcomes for spectrum-management activities that involve collaboration

and ways to monitor and track progress, in consultation with FCC and—as appropriate—State. (Recommendation 7)

The NTIA Administrator should update the FCC-NTIA MOU to address identified gaps (such as the lack of clearly defined goals and agreed-upon processes for making decisions) and develop a means to continually monitor and update this agreement, in consultation with FCC. (Recommendation 8)

The NTIA Administrator should request that State initiate a review of the *General Guidance Document*—in consultation with NTIA, FCC, and other relevant participants—and update and develop a means to continually monitor and update this document. (Recommendation 9)

The NTIA Administrator should establish procedures to help guide the design (including selection of acceptable assumptions and methodologies) of spectrum-sharing and potential-interference studies intended as U.S. contributions to WRC technical meetings, in consultation with FCC, State, and other federal participants of the U.S. technical preparatory process. (Recommendation 10)

The NOAA Administrator should clarify and document NOAA’s internal processes for identifying and raising concerns about potential interference to NOAA satellite instruments. (Recommendation 11)

Agency Comments and Our Evaluation

We provided a draft of this report to FCC, Commerce, NASA, and State for review and comment. We received written comments from FCC and Commerce (including NTIA and NOAA) that are reprinted in appendixes II and III, respectively, and summarized below. NASA and State told us that they had no comments on the draft report. FCC, NTIA, NOAA, NASA, State, and NIST also provided technical comments, which we incorporated as appropriate.

In its written comments, FCC broadly agreed to work collaboratively with NTIA and State to respond to our recommendations. For example, FCC noted that it viewed our decision to make the same recommendations to NTIA and to FCC as a compelling reason to work collaboratively to identify ways to improve the spectrum management processes while still maintaining their distinct spectrum management roles.

In its written comments, Commerce agreed with our recommendations to NTIA, agreed to implement our recommendation to NOAA, and enclosed

statements from both NTIA and NOAA that address the recommendations directed to each of them.

- In its statement, NTIA provided additional information for each recommendation, noting, for example, that it is prepared to work with FCC to update their MOU. NTIA also noted areas where actions are under way, including initiating a review of the *General Guidance Document* with State and establishing standardized procedures for the federal agencies to guide the design of spectrum-sharing studies for submission as U.S. contributions to WRC technical meetings.
- In its statement, NOAA agreed to implement the recommendation directed to it but disagreed with the findings that informed the recommendation. NOAA stated that it was not in a position to oppose FCC taking action on 5G under the Spectrum Frontiers proceeding since the action was consistent with the U.S. policy on advancing 5G deployment. Instead, NOAA stated its role was to provide input informed by engineering analysis on the necessary out-of-band emissions limits. NOAA further stated that it could not have provided this type of input until the requisite parameters were available, and they were not available until later during the proceeding. Finally, NOAA stated that providing input on out-of-band emissions limits, including the suitability of using the default level FCC proposed, is a technical issue that required analysis and that determinations on appropriate limits prior to that time would be unsupported and not based on valid engineering analysis.

As we mention in our report, we understand that NOAA may not have technical information with which to comment in detail on every matter, and we agree this was the case when the Spectrum Frontiers proceeding began. However, NOAA could have signaled earlier in the process to FCC and other stakeholders that there could be potential concerns needing study. Specifically, NOAA's statement that providing input on out-of-band emissions limits is a technical issue that requires analysis and that determinations on appropriate limits prior to that time would be unsupported and not based on valid engineering analysis, is precisely the type of comment that NOAA could have provided. Doing so could have helped ensure that its views were being formally provided and considered through the established channels for domestic proceedings. Instead, as stated in our report, FCC later used the establishment of domestic rules in its domestic proceeding—and the lack of any NOAA comments or objections during the interagency coordination process—as a reason for supporting international protection limits in line with existing domestic rules. As such, we continue to believe, as stated in our

report, that NOAA's providing no comments earlier in the proceeding may have disadvantaged NOAA's ability to represent itself.

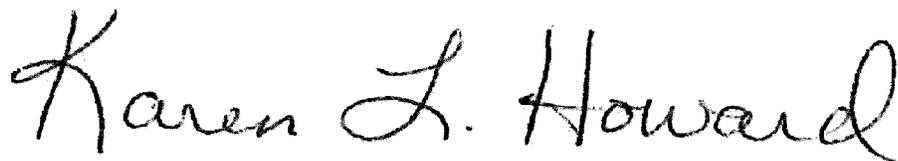
In its statement, NOAA also stated that it disagreed that additional procedures would have affected the outcome of the proceeding, noting various other factors at issue at the time, particularly factors related to interagency coordination around the separate but simultaneous U.S. preparatory process leading up to WRC-19. We understand NOAA's concerns regarding these other factors related to U.S. preparation for the WRC-19 and interagency collaboration on spectrum management overall. Indeed, we are making other recommendations to FCC and NTIA that are intended to help address these issues. Our recommendation to NOAA, on the other hand, is intended to help strengthen NOAA's internal processes, in line with relevant internal control standards. For example, as noted in our report, clarified procedures may help NOAA better consider when and how to provide comments when complicating factors exist, such as those present during the proceeding we reviewed.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the appropriate congressional committees, the FCC Chair, the NASA Administrator, the Secretaries of Commerce and State, and other interested parties. In addition, the report is available at no charge on the GAO website at <https://www.gao.gov>.

If you or your staff have any questions about this report, please contact Andrew Von Ah at (202) 512-2834 or vonaha@gao.gov, or Karen L. Howard at (202) 512-6888 or howardk@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.



Andrew Von Ah
Director, Physical Infrastructure



Karen L. Howard
Director, Science, Technology Assessment, and Analytics

Appendix I: Objectives, Scope, and Methodology

This report examines (1) the extent to which the cognizant federal agencies follow leading practices in collaborating on potential spectrum interference effects on weather forecasting, (2) how, and the extent to which, the National Oceanic and Atmospheric Administration (NOAA, within the Department of Commerce [Commerce]) and the National Aeronautics and Space Administration (NASA) identify and raise concerns regarding potential interference to their satellite instruments, and (3) the cognizant agencies' processes, requirements, and capabilities to conduct and review technical interference studies.

To assess cognizant agencies' coordination related to potential interference effects on weather forecasting, including the collaboration mechanisms and processes the agencies use, we reviewed agency documentation and interviewed agency officials. Due to their roles as regulators and managers of federal and nonfederal spectrum use or lead meteorological satellite operators, we focused on the Federal Communications Commission (FCC); National Telecommunications and Information Administration (NTIA, within Commerce); NOAA; and NASA as the cognizant agencies. We reviewed these agencies' spectrum-management policies, procedures, and other guidance, such as directives and manuals. For example, we reviewed NTIA's *Manual of Regulations and Procedures for Federal Radio Frequency Management*,¹ NASA's *Radio Frequency Spectrum Management Manual*, and Commerce's *Radio Frequency Management Department Administrative Order*. We also reviewed the 2003 memorandum of understanding between FCC and NTIA and *General Guidance Document* for U.S. participation in the United Nations' International Telecommunication Union (ITU).² We interviewed FCC, NTIA, NOAA, and NASA officials and obtained written responses to questions we posed. As part of these interviews, we administered a short questionnaire to these four agencies using a set of structured questions to obtain their views on the overall extent of coordination; quality of coordination (effectiveness and satisfaction); and barriers or opportunities for improvement, and then discussed the responses submitted with each agency. Due to the agency's role in formally representing the U.S. at ITU World Radiocommunication Conferences (WRC), we also reviewed documentation and interviewed officials from the Department of State (State).

¹47 C.F.R. § 300.1.

²*General Guidance Document: U.S. Participation in the ITU Radiocommunication Sector, and in CITELE PCC II (Radiocommunication including Broadcasting)* (Nov. 18, 2003).

To analyze how the agencies' collaboration mechanisms and processes were implemented in practice, we reviewed FCC's, NTIA's, NOAA's, and NASA's coordination activities surrounding select bands of spectrum that we used as case studies. Selection factors were the importance of the band to NOAA's weather-forecasting capabilities (as identified by NOAA); whether NOAA and NASA operate passive-sensing satellite instruments in adjacent bands; and whether the bands were the subject of FCC's Spectrum Frontiers proceeding (which began in October 2014 and is ongoing as of June 2021)³ as well as the 2019 WRC (WRC-19, held from October to November 2019). We reviewed the agencies' coordination activities concerning these bands from October 2014 to November 2019. We focused on the Spectrum Frontiers and WRC-19 proceedings because they are the most recent and major proceedings that dealt with potential interference to weather forecasting. We focused on passive-sensing satellite instruments and bands for proposed fifth-generation (5G) mobile communications use because—as relates to potential interference to satellite-based weather forecasting—they were the main subject of the proceedings. To identify what bands NOAA and NASA use to operate passive-sensing satellite instruments, we reviewed information from the World Meteorological Organization's Observing Systems Capability Analysis and Review Tool, which provides detailed information on all earth-observation satellites and instruments, and obtained additional information from NOAA and NASA. Selected bands were the 24, 32, and 37 gigahertz (GHz) bands.⁴

Regarding these bands, we reviewed documentation and interviewed officials. We reviewed case-specific agency documentation, such as correspondence between agencies, meeting materials, and reports and orders. We also reviewed Inter-American Telecommunication Commission (of which the U.S. is a member) documentation, such as the inter-American proposals developed for the WRC-19, as well as ITU documentation, such as the WRC-19 Final Acts. We interviewed FCC,

³*In re Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, FCC GN Docket No. 14-177.

⁴The 24 GHz 5G band, per the ITU, is the frequency range 24.25-27.5 GHz, or parts thereof; the adjacent band used for passive-sensing satellite instruments is 23.6-24 GHz. The 32 GHz 5G band is 31.8-33.4 GHz; the adjacent band used for passive-sensing satellite instruments is 31.3-31.8 GHz. The 37 GHz 5G band is 37-38.6 GHz; the adjacent band used for passive-sensing satellite instruments is 36-37 GHz. FCC defines the 24 GHz band as 24.25-24.45 GHz and 24.75-25.25 GHz, and refers to 25.25-27.5 GHz as the 26 GHz band.

NTIA, NOAA, and NASA officials and obtained written responses to questions we posed to better understand the coordination activities that occurred surrounding each band. For additional context, we also interviewed State officials.

We assessed the agencies' spectrum management collaborative mechanisms, processes, and activities against the seven leading collaboration practices identified in our prior work.⁵ Each of these practices contains key considerations, and we analyzed whether the mechanisms and associated processes and activities taken together reflected the relevant considerations. For example, to analyze the practice of identifying and sustaining leadership, we assessed key considerations such as how leadership is sustained over the long-term, and if leadership is shared, whether roles and responsibilities have been clearly identified and agreed upon. Based on these assessments we determined each practice to be either generally met, where the collaboration reflected most of the relevant considerations of the practice, or partially/not fully met, where the collaboration did not fully reflect most of the considerations of the practice. The control activities component of internal controls was significant to this analysis, along with the related principle that management should implement control activities (including through documentation in policies and periodic review).⁶

To assess how NOAA and NASA identify and raise concerns regarding potential interference to their satellite instruments, we also reviewed agency documentation and interviewed agency officials. For example, we reviewed policies and other guidance, as described above, to determine the processes NOAA and NASA use and, to analyze how they implemented these processes in practice, used the same case studies as identified above. For greater context on their efforts, we also interviewed NOAA and NASA officials and obtained written responses to questions we posed. We assessed NOAA's and NASA's processes and activities against applicable federal internal-control standards. The risk assessment component of internal control was significant to this assessment, along with the related principle that management should identify and respond to risks. The control activities component was also significant, along with the related principles that management should design and implement

⁵GAO, *Managing For Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, [GAO-12-1022](#) (Washington, D.C.: Sept. 27, 2012).

⁶GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.; September 2014).

(including through documentation in policies) control activities. Finally, the information and communication component was also significant, along with the related principle that management should communicate externally.

To assess the aforementioned cognizant agencies' (FCC, NTIA, NOAA, and NASA) processes for conducting and reviewing technical interference studies, we reviewed agency documentation and interviewed agency officials. We again reviewed policies and other guidance, as described above, and used the same case studies as identified above to review how the agencies conducted and reviewed studies for the specified proceedings. For example, we reviewed NOAA-led studies of potential interference between 5G mobile service and passive-sensing satellite instruments for the 24, 32, and 37 GHz bands prepared for WRC-19 technical meetings. We also reviewed the follow-up NASA-led study for the 24 GHz band. Finally, we reviewed summaries of the international studies on this topic that were documented in the WRC-19 conference preparatory meeting report.⁷ We interviewed NOAA, NASA, FCC, and NTIA officials and obtained written responses to questions we posed. We also interviewed officials from Commerce's National Institute of Standards and Technology to understand its role, if any, in these processes. We assessed the agencies' processes against the relevant key element of a sound research process identified in our prior work.⁸ Specifically, we assessed the processes against the need to establish specific procedures to guide activities—including during the design phase of the framework. Where appropriate, we assessed the processes against this element of the framework because it was the most relevant to the issues under review.

⁷ITU Radiocommunication Sector, 2nd Session of the Conference Preparatory Meeting for WRC-19, *CPM Report on Technical, Operational and Regulatory/Procedural Matters to be Considered by the World Radiocommunication Conference 2019* (Geneva, Switzerland: February 2019).

⁸GAO, *Employment and Training Administration: More Actions Needed to Improve Transparency and Accountability of Its Research Program*, [GAO-11-285](#) (Washington, D.C.: Mar. 15, 2011). In this report, we identified the key elements and phases of sound research processes based on guidelines developed by leading national organizations, including the American Evaluation Association and the National Academy of Sciences. Given the broad nature of the research framework identified in this report, the framework may be applied to a broad range of related activities, such as studies, evaluations, statistical analysis, pilots, and demonstrations, and we use the term "research" to broadly encapsulate these types of activities.

Finally, to obtain additional perspective on all of our objectives, we interviewed and reviewed documentation from stakeholders representing the telecommunications, air-and-space, and meteorological communities. To select knowledgeable stakeholder entities with a variety of viewpoints from a cross-section of interests, we considered entities that submitted comments to FCC's Spectrum Frontiers proceeding; served on relevant WRC-19-related committees or other groups; participated in FCC's auction of 24 GHz band spectrum; or otherwise had relevant interests in 5G networks, satellite instruments, and weather forecasting. Table 2 lists these stakeholders. Because stakeholders varied in their expertise with various topics, not every stakeholder provided an opinion on every topic. Accordingly, their views are not generalizable to those of all stakeholders, though they provided us with a variety of perspectives.

Table 2: List of Stakeholders Interviewed

Organization	Stakeholder Type
Aerospace Corporation	Air and space
Aerospace Industries Association	Air and space
American Meteorological Society	Meteorological
AT&T	Telecommunications
CTIA	Telecommunications
National Academy of Sciences	Varied
National Weather Association	Meteorological
Samsung	Telecommunications
Satellite Industry Association	Air and Space
T-Mobile	Telecommunications
Verizon	Telecommunications

Source: GAO. | GAO-21-474

Appendix II: Comments from the Federal Communications Commission



FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON

May 19, 2021

Andrew Von Ah
Director, Physical Infrastructure
Karen L. Howard
Director, Science, Technology Assessment and Analytics
Government Accountability Office
441 G St., NW
Washington, DC 20548

Dear Directors Von Ah and Howard:

Thank you for the opportunity to review the Government Accountability Office's (GAO) draft report, "Spectrum Management: Agencies Should Strengthen Collaborative Mechanisms and Processes to Address Potential Interference." The Federal Communications Commission (FCC or Commission) is committed to ensuring appropriate, continued coordination and collaboration with our federal partner agencies, relying on data driven processes and promoting transparency, as we carry out our spectrum management mission and duties consistent with the law.

We appreciate the recommendations you provide in the draft report as to how the Commission, as well as our federal partners, can be better positioned to reach agreement on spectrum matters involving non-federal and federal use domestically as well as improve the process to achieve consensus to present unified U.S. positions and proposals on spectrum matters in international forums. On this note, it is important to recognize the unique role the FCC plays in regulating domestic spectrum matters, as an independent multimember Commission established by Congress in the Communications Act of 1934. Section 305 of that Act established a division of authority between the Commission, with what the courts have recognized to be broad spectrum management authority over non-federal users, and the executive branch (since delegated by Congress to NTIA), responsible for managing federal use. In this role, the FCC works cooperatively with executive branch agencies consistent with the law and through agreed procedures with the National Telecommunications and Information Administration (NTIA) and the Department of State (State) on domestic rulemaking and international activities, respectively. While the Commission agrees with the general principles underlying the recommendations to improve coordination and cooperation when appropriate, in addressing non-federal and federal users' spectrum sharing and difficult questions involving the potential for harmful interference between federal and non-federal spectrum users, we note that the Commission necessarily is bound to follow its governing statutes, and to act consistently with the decisions it has made in promulgating generally applicable regulations through the public notice-and-comment rulemaking process mandated by the Administrative Procedure Act. With respect to improving coordination and collaboration on international spectrum matters, we are ready to work with State and NTIA to update the existing Department of State's guidelines,

**Appendix II: Comments from the Federal
Communications Commission**

the General Guidance Document, and continue to offer our expertise and experience in guiding the design of studies intended as U.S. contributions to future international technical meetings.

We also appreciate GAO's recognition that it can be a complex and challenging task to manage the diverse uses of spectrum in different spectrum bands in a way that accommodates the growing demand for expanded uses while protecting existing uses, and acknowledge that the outcomes will not always be consistent with what each interested spectrum user may believe to be the best approach. It is important to acknowledge that with respect to the 24 GHz interference study at issue in GAO's report, the domestic spectrum management process provided federal agencies with a full and transparent opportunity to have their concerns considered. In the 24 GHz proceeding, the FCC conducted a rulemaking proceeding to establish rules for non-federal operations in certain spectrum bands, which included collaboration with the NTIA so that the FCC could fully consider the compatibility of the proposed non-federal uses with federal operations in adjacent and nearby spectrum bands. During this rulemaking, which took place over several years and offered multiple opportunities for comment, coordination with executive branch federal agencies via NTIA was successfully completed under the existing framework established by the FCC-NTIA MOU, the rules were adopted and took effect as anticipated.

In reviewing the draft GAO report, we took particular note of the fact that GAO's recommendations offered to NTIA are analogous to the FCC's (e.g. NTIA should work to update the FCC-NTIA MOU (Recommendation 8); NTIA should request that State initiate a review of the General Guidance Document (Recommendation 9)). We view GAO's choice as a compelling reason for the FCC and NTIA to work collaboratively to identify ways to improve the spectrum management processes while still maintaining our distinct spectrum management roles, as opposed to committing to discrete and unilateral actions in this response. We broadly agree with the observation that agencies must engage in proper coordination through the proper channels and that we can work to clarify all parties' roles and responsibilities where there is confusion or misunderstanding, and look forward to working with our colleagues at NTIA to further evaluate GAO's suite of recommendations.

As GAO notes, the FCC and NTIA have relied on a version of our Memorandum of Understanding (MOU) that has been in effect for almost 20 years, and we agree that there are positive benefits in ensuring that FCC and NTIA collectively periodically review the MOU and implement appropriate mutually agreed to modifications. In doing so, we must remain cognizant that the MOU is a high-level document that has served both Federal and non-federal spectrum management well for the past two decades. This includes the coordination of countless spectrum rulemaking items, including the Spectrum Frontiers proceeding exploring the use of the 24 GHz band – and other millimeter bands – for 5G. In this proceeding, the FCC was transparent in providing pre-decisional items to NTIA for interagency coordination, and agencies were made aware of the direction that the Commission was taking and supported the technical parameters, including the out-of-band emissions limits at the time of NTIA coordination.

Similarly, the FCC sees benefit in initiating a review with the General Guidance Document, clarifying the federal and the non-federal spectrum users' and other stakeholders' roles in preparing ITU contributions towards the support of WRC studies. Federal spectrum users would continue to advise NTIA through NTIA's established processes, while non-Federal

Appendix II: Comments from the Federal Communications Commission

users and other stakeholders would continue to advise the FCC through the FCC's established processes. However, there is a need to clarify that, as it has been the case historically, the FCC, NTIA, and State each work together in managing the international preparatory processes as well as the process of determining the United States' international contributions, positions, and proposals to WRCs and other international meetings, with State in its role as the lead agency on international matters and the FCC and NTIA as the nation's expert agencies on spectrum regulatory and technical matters.

Thank you for the opportunity to review GAO's recommendations. We look forward to continuing to work with GAO in the future.

Sincerely,



Thomas P. Sullivan
Chief
International Bureau



Ronald T. Repasi
Acting Chief
Office of Engineering and Technology



Joel Taubenblatt
Acting Chief
Wireless Telecommunications Bureau

Appendix III: Comments from the Department of Commerce



UNITED STATES DEPARTMENT OF COMMERCE
Office of the Chief Financial Officer
and Assistant Secretary for Administration
Washington, D.C. 20230

June 3, 2021

Mr. Andrew Huddleston
Assistant Director
United States Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Huddleston:

Thank you for the opportunity to review the Government Accountability Office (GAO) draft report entitled *Spectrum Management: Agencies Should Strengthen Collaborative Mechanisms and Processes to Address Potential Interference* (GAO-21-474). The Department of Commerce appreciates the work the GAO has done to understand the challenges involved in developing spectrum policy in the context of evolving technology and competing priorities. While we are proud of the many accomplishments of the National Telecommunications and Information Administration (NTIA) and the Federal agencies in collaborating to improve access to spectrum and spectrum efficiency, we are always mindful that there is room for improvement. We generally concur with your recommendations to review and better document our procedures for collaboration on technical analysis and policymaking; indeed, several of the recommended actions are already underway. At the same time, however, please note that the unique nature of the electromagnetic environment for each frequency band and its incumbent and proposed new uses will raise unique challenges that cannot be fully predicted or made to fit into a fully standardized process.

NTIA is responsible for overall management of Federal spectrum use. NTIA serves as the President's principal advisor on telecommunications and information policy and manages Federally assigned spectrum, including preparing for, participating in, and implementing the results of international radio conferences, as well as conducting extensive research and technical studies through its research and engineering laboratory, the Institute for Telecommunication Sciences. NTIA has authority to issue rules and regulations as may be necessary to ensure the effective, efficient, and equitable use of spectrum both nationally and internationally. It also has authority to develop long-range spectrum plans to meet future government spectrum requirements, including those of public safety.

In carrying out its mission, NTIA constantly consults and collaborates, formally and informally, with the Federal agencies that use spectrum, as well as with the Federal Communications Commission (FCC), which manages non-Federal spectrum use, and with the Department of State (State), which represents the United States internationally. NTIA chairs the Interdepartment Radio Advisory Committee (IRAC), which is comprised of representatives from the Federal agencies that are the primary users of Federal spectrum and who advise NTIA with respect to spectrum management matters. It also chairs the Policy and Plans Steering Group (PPSG), another interagency body that advises NTIA on Federal spectrum management. These advisory bodies and their subcommittees are key elements of the collaborative process. The FCC participates in the IRAC and PPSG and also collaborates with NTIA on spectrum

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Mr. Andrew Huddleston
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management matters in accordance with a 2003 Memorandum of Understanding. In addition, NTIA collaborates formally with the FCC and the Department of State pursuant to a General Guidance document issued by the State Department.

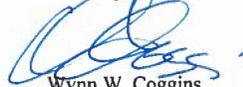
The record of successful collaboration is extensive. NTIA coordinates with the FCC on a large percentage of the roughly 90,000 frequency assignments that NTIA makes every year to Federal agencies. Over the past twenty years, we have worked with the FCC to repurpose more than 2640 MHz of Federal spectrum to enable non-Federal access. Increasingly, domestic reallocation efforts are tied to international efforts for emerging technologies, particularly in the wireless broadband and satellite fields. This requires concurrent domestic and international actions involving detailed sharing analyses weighed against international treaty text that the United States must consider in developing or changing its domestic regulations.

Your report highlights some of the challenges that can occur in the effort to identify opportunities for improving spectrum efficiency. One of these, evident in the 24 GHz case, is the complexity of agreeing on the appropriate technical analysis for determining the potential for harmful interference from new systems to incumbent systems operating on the same or nearby spectrum. Another is the difficulty in synchronizing the domestic and international processes, which often have different deadlines for inputs and milestones for decisions. And, of course, in any given case, applying our national priorities can be difficult, particularly when the decisions inevitably involve balancing equities that depend on critical technical analyses, which themselves depend upon iterative and time-intensive efforts to home in on an optimal solution.

On behalf of the Department of Commerce, I have enclosed comments to the proposed report, which include statements from the National Oceanic and Atmospheric Administration (NOAA) and the National Telecommunications and Information Administration (NTIA) that address the specific GAO recommendations for each of these Department of Commerce bureaus. The Department of Commerce agrees with the five (5) recommendations for NTIA, and agrees to implement the one recommendation for NOAA. I understand that NTIA has provided technical comments on the draft report directly to GAO.

Again, thank you for the opportunity to review the draft report. The Department is committed to working with the agencies in reviewing the recommendations and taking appropriate action. Should you have any questions, please contact MaryAnn Mausser, Commerce Audit Liaison, at 202-482-8120.

Sincerely,



Wynn W. Coggins
Acting Chief Financial Officer
and Assistant Secretary for Administration

Enclosures: (1) NTIA Response to Recommendations 6-10
(2) NOAA Response to Recommendation 11

**RESPONSE OF THE NATIONAL TELECOMMUNICATIONS AND INFORMATION
ADMINISTRATION TO RECOMMENDATIONS 6 – 10
GAO REPORT 21-474**

Recommendation 6. The NTIA Administrator should establish clearly-defined and agreed-upon processes for making decisions on spectrum-management activities that involve other agencies, particularly when consensus cannot be reached, in consultation with FCC and – as appropriate – State.

Response: The National Telecommunications and Information Administration (NTIA) recognizes there may be situations where agencies may not support the NTIA decision and, therefore, it may be escalated within the executive branch. It would be beneficial to communicate that escalation process to Federal agencies in a clear, consistent manner to improve transparency. For international regulatory decisions, NTIA interfaces with the FCC and the State Department under the General Guidance Document.

Recommendation 7. The NTIA Administrator should clarify and further identify shared goals or outcomes for spectrum-management activities that involve collaboration and ways to monitor and track progress, in consultation with FCC and – as appropriate – State.

Response: Generally, the executive branch agencies already share the broad goals of protecting key government missions and improving spectrum access for new users. In any given case, the challenge comes in balancing those goals and setting priorities, particularly when there are potential new systems with unknown characteristics and competing technical assessments of the potential for sharing to cause harmful interference to existing and planned missions. NTIA agrees that there is room for improvement in how we collaborate to better anticipate potential divergences in technical understanding and mitigations and to commit the necessary attention to reach consensus solutions.

It should be noted that the FCC is an independent agency. Although the executive branch, through NTIA, and the FCC collaborate closely, the respective decision-making processes differ for structural and statutory reasons. Thus, the executive branch can collaborate with and provide recommendations to the FCC, but final outcomes at the agency are determined by the Commissioners of the agency.

Recommendation 8. The NTIA Administrator should update the FCC-NTIA MOU to address identified gaps (such as the lack of clearly-defined goals and agreed-upon processes for making decisions) and develop a means to continually monitor and update this agreement, in consultation with FCC.

Response: Generally, NTIA and the Federal Communications Commission (FCC) work well, through both the formal process established by the 2003 Memorandum of Understanding (MOU) and informal processes (for example, by regular staff-level meetings) to collaborate on spectrum management decision. We are fully prepared, however, to work with the FCC to update the MOU and set up a process for its periodic further review.

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Recommendation 9. The NTIA Administrator should request that State initiate a review of the General Guidance Document – in consultation with NTIA, FCC, and other relevant participants – and update and develop a means to continually monitor and update this document.

Response: NTIA has already initiated an update of the General Guidance Document with the Department of State and has provided views on needed updates to provide increased transparency and to establish an escalation process for those few cases that cannot be resolved through the normal consensus process. The Department of State is reviewing the issue and will issue a revised document for consideration by all stakeholders for review and comment when completed.

Recommendation 10. The NTIA Administrator should establish procedures to help guide the design (including selection of acceptable assumptions and methodologies) of spectrum sharing and potential-interference studies intended as U.S. contributions to WRC technical meetings, in consultation with FCC, State, and other Federal participants of the U.S. technical preparatory process.

Response: NTIA has internal procedures to help guide the design of spectrum sharing and interference studies. In certain cases, as NTIA encountered in the 24 GHz band, the challenge is accurately representing technical and deployment parameters for future commercial systems used to assess potential interference to Federal systems. The estimation of potential interference from a future commercial network was a source of disagreement among the FCC and the Federal agencies. NTIA also encounters this issue domestically when establishing regulations for new technologies necessary to protect Federal systems. To address this problem NTIA has continually improved its interference modeling techniques that are used to statistically represent commercial technical and deployment parameters, such as using Monte Carlo type analyses. Statistical analyses can also be used to represent time varying parameters in a sharing analysis such as the number of active transmitters and radio wave propagation loss. Statistical analysis techniques replace deterministic analyses that generally rely on worst case assumptions when assessing potential interference. NTIA plans to establish standardized procedures for the Federal agencies using statistical analysis techniques to guide the design of spectrum sharing studies for submission as U.S. contributions to the World Radio Conference technical meetings.

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**Department of Commerce
National Oceanic and Atmospheric Administration
Spectrum Management- Agencies Should Strengthen Collaborative Mechanisms and
Processes to Address Potential Interference
(GAO-21-474, May 2021)**

The Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), reviewed the Government Accountability Office (GAO) draft report and offers the following comments for GAO's consideration.

NOAA Comments to the GAO Recommendation

GAO made one recommendation to the Department of Commerce, NOAA in the report.

- **Recommendation 11:** "The NOAA Administrator should clarify and document NOAA's internal processes for identifying and raising concerns about potential interference to NOAA satellite instruments."

NOAA Response: NOAA agrees to implement this recommendation, however, NOAA respectfully disagrees with the findings that have informed this recommendation and further disagrees that the additional procedures recommended would affect the outcome this report is intended to address. Several instances of text in pages 22 through 27 of the GAO draft report indicate that NOAA lacks proper procedures that resulted in a failure to respond to the FCC Spectrum Frontiers Proceeding at the proper time. While procedures, as a general principle, may improve an agency's spectrum management processes, the lack of NOAA procedures were neither the cause of, nor related to, the issue encountered under the 24 GHz proceeding. The Draft Report's characterization of the opportunities for influencing the 24 GHz decision process erroneously states that NOAA could have provided input in 2014. The Draft Report also does not describe how NOAA's timely efforts to inform the decision process with competent technical analysis were limited by procedures that provide other agencies the authority to determine which analyses are submitted for consideration.

NOAA was not in a position to oppose the FCC taking action on 5G under the Spectrum Frontiers proceeding since the action was consistent with U.S. policy on advancing 5G deployment in the U.S. Rather, NOAA's role was to provide engineering analysis-informed input on the necessary out-of-band emission limits once the requisite 5G technical parameters were available. GAO faults NOAA for not providing input as early as 2014. Providing input on out-of-band emission levels, including the suitability of the standard $43 + 10\log(P)$ level, is a technical issue that required analysis. A response before the requisite 5G technical parameters were available would have been speculation not based on valid engineering analysis, and simply unsupported.

GAO, in footnote 35 of the Draft Report, points to paragraphs 42 and 87 of the FCC Notice of Inquiry (NOI) as an indication that NOAA should have acted in a different manner. Paragraph 42 of the FCC NOI, 14-154, states:

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“We also seek comment on appropriate OOB limits. Would an attenuation of $43 + 10\log(P)$ for out-of-band emissions be appropriate? If not what OOB limits or range of limits would be appropriate for the mmW bands above 24 GHz?”

This question is relative to all frequency bands above 24 GHz, not a specific request for the 24.25-24.45 and 25.05-25.25 GHz frequency bands. Many frequency bands, up to 86 GHz, were under consideration. Paragraph 87 of the FCC NOI is specific to the 24.25-24.45 GHz and 25.05-25.25 GHz frequency bands, but does not request input on out-of-band emission limits. Paragraph 87 is specific to protection of Earth-to-space links of the fixed satellite service, broadcast satellite services, and with radar systems; the paragraph does not address the passive use of frequency bands by the Earth exploration satellite service (passive), and is therefore not relevant.

Paragraph 42 of the FCC NOI is the only reference relevant to out-of-band emissions. The request was not linked to 24.25-24.45 and 25.05-25.25 GHz frequency bands where no 5G parameters were available (paragraphs 83-87). As previously noted, a response on appropriate out-of-band emission limits from NOAA absent technical parameters would have been mere speculation unsupported by a valid engineering analysis.

The 5G parameters necessary for conducting the engineering studies to determine appropriate out-of-band emission limits parameters did not become available in draft form until October 2016 and in an approved form until February 2017. At that time, NOAA was fully engaged in study work with the FCC and NTIA, along with U.S. commercial companies. Study work continued up to five months prior to WRC-19, with NOAA, and then a NOAA-NASA team, modeling the 24GHz passive band mission data corruption which would result from adjacent band interference from 5G operations. This modeling employed the 5G technical parameters provided by the international process. The FCC challenged the modeling team’s use of these parameters but neither provided alternative parameters nor recommended corrective actions for the modeling. Moreover, the FCC did not provide alternative modeling results or technical data to support the out-of-band emission limits the FCC would propose for domestic use. In light of FCC objections, the Department of State did not allow the NOAA-NASA modeling results to be submitted for applicable WRC Working Party deliberations.

The international and domestic processes regarding 24 GHz were linked. The FCC states that concluding on emission limits was not possible in 2017 and 2018. In the 2017 Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order FCC 17-152, the FCC states:

“Nevertheless, acknowledging specific CORF concerns, we note that ongoing international studies include analyses to determine IMT-2020 out-of-band (OOB) emission limits necessary to protect passive sensors onboard weather satellites in the 23.6-24.0 GHz band. The Commission recognizes the need to protect these passive satellite operations that provide important data necessary for weather predictions and warnings. Once the international studies have been completed, interested parties may propose revisions to the Commission’s rules as necessary for protection of weather satellites operating in the 23.6-24.0 GHz band.”

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In the 2018 Third Report and Order, Memorandum and Order, and Third Further Notice of Proposed Rulemaking FCC 18-73 the FCC states:

“In addition, as the Commission noted in the 2nd R&O, ongoing international studies include analyses to determine IMT-2020 out-of-band emission limits necessary to protect passive sensors onboard weather satellites in the 23.6-24.0 GHz band. The Commission recognizes the need to protect these passive satellite operations that provide important data necessary for weather predictions and warnings. Given that this is a matter of interest to multiple stakeholders internationally and that we cannot predict the outcome, we find it inappropriate to adopt U.S.-only limits that may need to be modified at a later time. Once interference protection standards are agreed upon internationally we will, if necessary, consider through notice and comment whether any modification of our current out-of-band limits may be needed. We encourage non-Federal operators in the 24 GHz band to monitor these studies and to plan their systems to the extent possible, to take into account the potential for additional future protection of passive sensors in the 23.6-24.0 GHz band.”

In addition, the GAO Draft Report includes the following statement at the bottom of page 30:

“The first study was for the May 2017 task group meeting. This study was largely an outline; at the time, the internationally recognized inputs (i.e., characteristics, methodologies, and assumptions) were under development.”

The FCC proceeding is not an example of where improved procedures would have changed the outcome. Rather, NOAA presented valid input to the process once all requisite information was available to conduct the necessary engineering analyses.

Appendix IV: GAO Contacts and Staff Acknowledgments

GAO Contacts

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In addition to the contacts named above, Andrew Huddleston (Assistant Director); Nalylee Padilla (Analyst in Charge); Oluwaseun Ajayi; Sarah Amer; Frederick K. Childers; David Dornisch; Amy Pereira; Malika Rice; Krishana Routt-Jackson; Janet Temko-Blinder; Sarah Veale; and Michelle Weathers made key contributions to this report.

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