Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services	)	GN Docket No. 14-177
	)	
Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands	)	IB Docket No. 15-256
	)	
Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band	)	RM-11664
	)	
Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services	)	WT Docket No. 10-112
	)	IB Docket No. 97-95
Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations	)	

REPLY COMMENTS OF THE
NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

The National Academy of Sciences, through its Committee on Radio Frequencies (hereinafter, CORF),[1] hereby submits its reply comments in response to the Commission's July 14, 2016, *Further Notice of Proposed Rulemaking* (FNPRM) in the

[1] See the Appendix for the membership of the Committee on Radio Frequencies.

above-captioned dockets.

II. Protection of Passive Scientific Use of Specific Frequency Bands.

In response to certain comments filed pursuant to the FNPRM, CORF notes the following:

A. 32 GHz Band

In the FNPRM, the Commission proposes to add primary fixed and mobile service allocations at 31.8-33.4 GHz. The 31.8-32.3 GHz portion of the band is currently allocated to the Space Research Service (SRS) (space-to-Earth), although use of that band for the SRS is limited to Goldstone, California. There are also Earth Exploration Satellite Service (EESS) and Radio Astronomy Service (RAS) primary allocations at 31.3-31.8 GHz. Observations in these allocations are used to gather data for weather forecasting (EESS) and for continuum observations of galactic and extragalactic objects (RAS). Footnote US246 prohibits transmission at 31.3-31.8 GHz. The band is also protected by Footnote 5.340 (all emissions in the band are prohibited). In the original NPRM in this proceeding, the Commission noted the "difficult challenges" in allocating 31.8-33.0 GHz for mobile uses, specifically including the need to protect the RAS at 31.3-31.8 GHz.

In its Comments filed September 30, 2016, the Telecommunications Information Association (TIA) supports fixed and mobile operations in this band. It recommended a particular band plan, at pages 9-10 of their Comments, with the suggestion of "more stringent protection for radio astronomy if necessary."

CORF supports spectrum-sharing technologies that continue to protect primary allocations for EESS and RAS from aggregate interference due to in-band and out-of-

band emissions. Prior to the implementation of any guard-band plan such as that recommended by TIA, detailed, peer reviewed studies by TIA or the Commission would be required on the potential for harmful interference from out-of-band emissions, and on the size of guard bands needed to provide adequate protection.

B. 42 GHz Band

In the NPRM in this proceeding, the Commission declined to propose service rules for the 42.0-42.5 GHz band due in part to concerns that operators would be unable to adequately protect radio astronomy observations in the adjacent 42.5-43.5 GHz band. CORF appreciates the Commission's recognition of the need to protect RAS in that band. Nevertheless, the FNPRM sought comments on a proposal to authorize fixed and mobile service operations at 42.0-42.5 GHz.

In its Comments (filed September 30, 2016, at page 14), T-Mobile states that interference from terrestrial transmitters to RAS receivers is almost always received through the antenna side lobes:

> Moreover, current analyses regarding interference to RAS receivers in the high frequency range have focused on satellite services, concluding that satellite transmissions and airborne terrestrial operations have the greatest potential to cause severe interference to the RAS. Ground-based terrestrial interference sources are usually in the far side-lobe region of the radio telescope antenna, and possibly further attenuated by the topography and clutter of the surroundings of the radio observatory. In contrast, interference by satellite transmitters is likely to be received via the main beam and inner side lobes, with considerably higher gain. Because interference from terrestrial transmitters to RAS receivers is almost always received through the antenna side lobes, the main beam response to interference need not be considered.

CORF agrees that interference is almost always received through antenna side lobes, but points out that the text and calculations of ITU-R RA.769 explicitly take this

into account. The thresholds for interference are calculated assuming that the interference is only received through the 0 dBi side lobes of the radio telescope. These side lobes only have the gain of an isotropic antenna but cover most directions in the sky.

C. 50 GHz Band

The FNPRM proposes to authorize fixed and mobile operations at 50.4-52.6 GHz. There is a primary allocation for EESS at 50.2-50.4 GHz, with additional protection (transmissions prohibited) for that allocation from Footnote US246. It should be noted that when combined with the FNPRM's proposal to authorize services at 47.2-50.2 GHz, the EESS allocation would be completely surrounded by active transmissions.

TIA's Comments supports authorizing fixed and mobile operations in the 50 GHz band. They state (at page 16) that

> "with 2200 MHz of spectrum available, the Commission should create five blocks of 400 MHz each plus one block of 200 MHz, consistent with the approach described in Section II-A above. Guard bands to protect passive services on either side of this band are unnecessary, but to the extent that any special operating restrictions in certain blocks are deemed necessary to protect either the lower adjacent or upper adjacent bands, the 200 MHz block should be placed at that end of the 50 GHz band (or two 100 MHz blocks on either end) to ensure that the larger 400 MHz blocks can operate without restrictions."

In response, CORF notes that in light of recent work indicating the potential for more than 100,000 active cell phone users within a single footprint of weather satellites operating near 52.6 GHz,[2] further analysis of the guard-band parameters needed to satisfy a maximum aggregate interference level of −166 dBW mandated by ITU-R RS.2017 is needed.

[2] Louail, T. et al., "From mobile phone data to the spatial structure of cities," Sci. Rep. 4, 5276; DOI:10.1038/srep05276, 2014.

D. 57-71 GHz

In Comments and Reply Comments earlier in this proceeding, CORF discussed in detail its concerns regarding the Commission's proposal to unify rules in the 64-71 GHz band with those for operations at 57-64 GHz, and the negative impact that aeronautical transmissions would have on EESS observations at 57-59.3 GHz, which are vitally important for weather forecasting. CORF strongly urged the Commission to use great caution before authorizing aeronautical transmissions at 57-59.3 GHz, and recommended the following instead: (1) further study of real-world transmission scenarios in aircraft prior to authorizing unlicensed airborne use of this band, (2) making any service at 57-59.3 GHz licensed and requiring aircraft operator licensees to retain responsibility for ensuring that radio frequency (RF) leakage levels are below required threshold levels (for the aggregate transmissions from the aircraft) if aeronautical operations are permitted, or (3) in the absence of better data, prohibiting airborne use of WiGig Channel 1 (57.24-59.4 GHz).

In light of CORF's detailed and documented discussion, the Report and Order (R&O) in this proceeding prohibited unlicensed operations at 60 GHz on aircraft. Specifically, the R&O extended the restriction on on-board aircraft operation in Section 15.255(a)(1) to cover the entire 57-71 GHz band.[3] CORF commends Commission actions designed to enhance the public interest by protecting data collection critical to weather forecasting, and thus to public safety and to the U.S. economy.

[3] R&O at para. 333.

In its recent Comments (at pages 9-10), the Wi-Fi Alliance states that the Commission should take a "two-step approach" in addressing aeronautical use of this band:

> "First it should remove the prohibition against unlicensed operations on WiGig Channels 2 and 3 (*i.e.*, 59.4-63.72 GHz) on board aircraft. … Eliminating transmissions at the top of the band strikes a balance between Wi-Fi Alliance's earlier concerns that use of the upper WiGig channels would cause harmful interference to [EESS and RAS]. Excluding WiGig channel 1 will also address the Committee on Radio Frequencies ("CORF")'s primary concern regarding potential interference from WiGig operations to EESS remote sensing at 57.0-59.3GHz. In order to prevent the use of WiGig channels 1, 4, 5 and 6 on board aircraft, WiGig-enabled access points installed on planes could be set to disable those channels. In addition, WiGig-enabled devices could be equipped with a special "airplane mode" function that would prevent any communications, including peer-to-peer communication on WiGig channels 1,4, 5, and 6 while in flight. These solutions, proposed by CORF, will address the issues raised by CORF, the IEEE Committee on Frequency Allocations in Remote Sensing, and the Commission."
>
> "Second, the Commission and industry should continue to conduct analyses and peer studies on the use of WiGig channels 1, 4, 5, and 6. Wi-Fi Alliance is interested in contributing to those sharing studies to address coexistence concerns on the remaining channels."

In response, CORF notes that it does not oppose the Alliance's first suggestion. It appears to be consistent with CORF's proposal. In regards to the Alliance's discussion of further analyses, CORF looks forward to any *specific* studies regarding various types of on-board aircraft provision of service (direct transmission to computers vs. bouncing the signal inside the aircraft), variations of aircraft fuselages, and signal leakage through unshielded windows. Studies should also account for variations due to aircraft roll. As the R&O noted (at para. 331), any studies should be based on transmissions specifically at 59-60 GHz, as opposed to references to ITU documents

based on much lower frequencies. Lastly, special consideration should be given to peer-peer communications, which would be uncontrolled upon the authorization of airborne unlicensed use. Until such studies are completed and conclusively predict minimal impact (<0.01% loss of data) to the protected band, airborne use of the 57-59.3 GHz band should remain prohibited.

E. Bands Above 95 GHz

As noted in the FNPRM, many of the existing frequency allocations above 95 GHz are allocated for passive services—the RAS and EESS. CORF generally supports the shared use of frequency bands where the avoidance of interference from such sharing is practicable, and while the transmission characteristics of the millimeter wave bands support some productive uses by active services with the ability to protect passive users from harmful interference, attention will need to be paid to such protection.

Maximum power levels and the percentage sensor viewing area that in-band interference can occupy for EESS passive satellite sensors are found in ITU-R RS.2017. The bands of interest to RAS for 95 GHz and above, with the corresponding calculations of detrimental thresholds for interference, are found in ITU-R RA.769.

The RAS thresholds are based on far out side lobes having the collecting area of an isotropic antenna, which decreases as the inverse square of frequency. CORF notes that ITU-R RA.2189 specifies values for atmospheric attenuation at 275 GHz (5 dB/km), 1,000 GHz (300 dB/km), and 3,000 GHz (4,000 dB/km). Because of the *extreme* dependence of both atmospheric attenuation and side lobe collecting area on frequency, it is not appropriate to extrapolate statements about the likelihood of mutual

interference above 1,000 GHz, found in RA.2189, to the region between 95 and 275 GHz.[4] This similarly holds true for EESS nadir-looking sensors and is exacerbated by the fact that the atmospheric attenuation reduces with increasing altitude.

III. Conclusion.

In the R&O in this proceeding, the Commission took a number of steps to protect important passive scientific observation of the spectrum. Such protections serve the public interest, and CORF appreciates the Commission's recognition of the importance of such observations in the FNPRM. CORF generally supports the sharing of frequency allocations, where practical, but protection of passive scientific observations, as discussed herein and in its Comments, must be addressed.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

By: 
_____
Marcia McNutt
President, National Academy of Sciences

15 November, 2016
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DATE

[4] 300 dB/km, the attenuation at 1000 GHz, is huge: a factor of 1,000,000,000,000,000,000,000,000,000,000 to 1, compared to 5 dB/km at 275 GHz, which is only about 3 to 1.

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