Fletcher, Heald & Hildreth

FEDERAL SPECTRUM DEVELOPMENTS

October 2018 – May 2019

CORF Meeting
May 2019

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I. Satellite Uplinks at 50 GHz

June 2018 Further Notice of Proposed Rulemaking

-FCC proposes to permit FSS earth station uplinks at 50.4-51.4 GHz.

>EESS allocation at 50.2-50.4 GHz with FN US 246 protection (no transmissions)
> BUT, FN to FN 246: "The allocation to the Earth exploration-satellite service (passive) and the space research service (passive) in the band 50.2-50.4 GHz should not impose undue constraints on the use of the adjacent bands by the primary allocated services in those bands."

-Prior FCC NPRM acknowledged that this EESS band is vital to weather prediction.

I. Satellite Uplinks at 50 GHz

-In June 2018 Audacy Satellite Order, FCC acknowledged concerns of NASA, NOAA and NSF re OOBE into EESS 50.2-50.4 GHz band.

>NTIA had requested OOBE limits stricter than US156, but FCC orders use of US156.

-The FCC also has pending proposal to authorize terrestrial fixed and mobile operations as part of "Upper Microwave Flexible Use Service ("UMFUS")"

CORF Comments in response to June 2018 NPRM:

>FCC should *prohibit all OOBE* into 50.2-50.4 GHz, or limit it to *-33 dBW/100MHz* (US157)

I. Satellite Uplinks at 50 GHz

-April 2019 Letter from NTIA to FCC: *Slow down and protect EESS!!*

"The … issue of protection of adjacent passive services from mobile services remains outstanding and NTIA reminds the Commission that protection of passive services has not been resolved internationally … to protect vital government space-based assets in these bands. *The Commission must not prematurely reach an outcome that does not adequately protect them and may jeopardize essential federal systems that provide critical government services without adequate scientific justifications.* We note that current levels proposed by the Commission for the *protection of passive systems from mobile wireless services in other bands have not proven sufficient to protect such systems* and NTIA and the Commission are working collaboratively on studies to establish the needed protection limits. Critically, 50.2-50.4 GHz is a calibration band for space-based weather and atmospheric measurements, making it *especially vital that the U.S. ensure that mobile systems do not cause interference into this band*."

I. Satellite Uplinks at 50 GHz

Nevertheless, FCC issues April 2019 Order:

-Permits licensing of individual FSS earth stations in the 50.4-51.4 GHz band based on geographical density:

>no more than three earth stations in a county and no more than 15 earth stations in any larger PEA.

>limit on the area in which the earth station generates a power flux density (PFD), at 10 meters above ground level, of greater than or equal to -77.6 dBm/m2/MHz.

I. Satellite Uplinks at 50 GHz

FCC April 2019 Order:

Apply existing OOBE limit from Section 25.202(f) of FCC Rules:

"(f) *Emission limitations.* …. the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section….

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by *more than 50 percent up to and including 100 percent* of the authorized bandwidth: *25 dB*;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by *more than 100 percent up to and including 250 percent* of the authorized bandwidth: *35 dB*;

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by *more than 250 percent* of the authorized bandwidth: An amount equal to *43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts*; [Spurious Emissions]

(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the *Commission may, at its discretion, require greater attenuation* than specified in paragraphs (f) (1), (2) and (3) of this section."

I. Satellite Uplinks at 50 GHz

More to Come on this Issue:

-WRC-19 Agenda Item 1.6:

> *to consider the development of a regulatory framework for non-GSO FSS satellite systems that may operate in the frequency bands 37.5-39.5GHz (space-to-Earth), 39.5-42.5GHz (space-to-Earth), 47.2-50.2GHz (Earth-to-space) and 50.4-51.4GHz (Earth-to-space), in accordance with Resolution 159 (WRC-15)*

-FCC terrestrial UMFUS rules & OOBE standard

-Pending FCC NPRM on Satellite OOBE standards

II. Proposed Revision to Satellite OOBE Rules

November 2018 FCC NPRM to "Streamline" Satellite licensing rules

-One proposal is to revise Section 25.202(f) of the rules (OOBE limits)

>FCC: Current rule "is outdated and has led to confusion among some [satellite] operators." Operators "reference the in-band power spectral density of the emission, which would make a significant portion of the assigned frequency band unusable because it would require an *abrupt 25 dB attenuation at band edge*."

>FCC proposes use of ITU-R SM.1541-6 "Unwanted Emissions in the out-of-band domain" -- resulting in "*smooth transition starting at band edge.*"

II. Proposed Revision to Satellite OOBE Rules

CORF Comments filed March 2019:

> Provisions of ITU-R SM.1541-6 *unlikely to provide a mask sufficient* to provide the protection that passive services need or are entitled to.

> SM.1541-6 acknowledges that its *generic minimum limits/safety net* is "intended for use in bands where tighter limits are not otherwise required to protect specific applications."

>Numerous international and domestic footnotes *already specifically prohibit* the transmission of OOBE into passive bands, or provide *specific OOBE limits* into passive bands.

>Any new FCC rule should use the *band-specific ITU limits*, or default to ITU-R RA.769 or ITU-R RS.2017.

II. Proposed Revision to Satellite OOBE Rules

CORF Comments filed March 2019:

> FCC proposal also removes reference in rule to *unwanted spurious emissions* (current Section 25.202(f)(3)), and removes the ability of the Commission, at its discretion, to *require greater attenuation* in order to prevent harmful interference (current Section 25.202(f)(4)).

>FCC should retain these provisions or include reference to ITU-R SM.329-12 ("Unwanted Emissions in the Spurious Domain").

-Satellite operator reply comments:

> SM.1541-6 discusses spurious limits in Annex 5
> International FNs *operative on their own* -- no need to put into FCC Rule
> Issue of protection standards for passive bands is *outside the scope* of this rulemaking.
> No need to address in rule, since FCC always has the authority to impose additional conditions on licenses.

III. Proposed GSO/NGSO-ESIM Up/Downlink Rules

"Earth Stations in Motion" ("*ESIMs*"):

Previously called ESVs, VMEs, ESAA's: satellite transmit/receive stations mounted on vehicles, boats, aircraft.

September 2018 FCC Order – unify coordination requirements for 14.47-14.50 GHz ESIM uplinks with RAS

September 2018 NPRM on GSO-ESIM Uplinks/Downlinks *and* November 2018 NPRM on NGSO-ESIM Up/Downlinks

PROPOSED DOWNLINKS:

-10.70-10.95 GHz (already allocated for downlinks, next to 10.68-10.7 RAS band, in RAS coord band)
-11.7-12.2 GHz (already allocated for downlinks, next to 10.7-11.7 GHz RAS coordination band)
-18.3-18.6 GHz (already allocated for downlinks, next to EESS allocation at 18.6-18.8 GHz)

[EESS allocation at 18.6-18.8 GHz]
-18.8-19.3 GHz (already allocated for downlinks, next to EESS allocation at 18.6-18.8 GHz)

-19.7-20.2 GHz (already allocated for downlinks)

III. Proposed GSO/NGSO-ESIM Up/Downlink Rules

November 2018 NPRM on NGSO-ESIM Up/Downlinks

PROPOSED UPLINKS:

-14.0-14.5 GHz (already allocated for uplinks, but there are Footnote protections for RAS)

-28.35-28.6/28.6-29.1/29.5-29.9 GHz (already allocated for uplinks, but international FN secondary protection for EESS data uplink at 28.5-30.0)

CORF Comments filed 2/2019:

"… because of their *constant motion*, constellations of NGSO satellites have the potential for being *particularly disruptive* to the passive services because of their constantly changing configuration, their near-constant coverage of Earth's surface, and the potential for multiple satellites being *visible simultaneously* from a radio astronomy facility, resulting in *aggregate interference*."

III. Proposed GSO/NGSO-ESIM Up/Downlink Rules

CORF NGSO Comments filed 2/2019, GSO Comments filed 4/2019:

-RAS observations in the 10.6-11.7 GHz band are subject to protection:

>US246 and Int'l 5.340 (no authorized transmissions/all emissions prohibited at 10.68-10.70 GHz)
>US211 (airborne/space stations – "all practicable steps" to protect RAS)
>US131 (GSO downlinks must coordinate with RAS)

-Therefore FCC rules should provide:

>no emissions/OOBE into 10.68-10.70 GHz observations
>NGSO operators transmitting at 10.7-11.7 GHz must coordinate (through NSF)

III. Proposed GSO/NGSO-ESIM Up/Downlink Rules

CORF Comments:

-For NGSO ESIM uplinks at 14.0-14.5 GHz:

>Footnote US133(b) requires coordination to protect RAS observations at 14.47-14.50 GHz at certain facilities.

- Protection of EESS at 10.6-10.7 GHz:

>US246 and Int'l 5.340 (no authorized transmissions/all emissions prohibited at 10.68-10.70 GHz)

>suggest use of a guard band of 25 MHz, so that the lowest frequency of this ESIM downlink band would be 10.725 GHz.

- Protection of EESS at 18.6-18.8 GHz:

>FCC must be mindful of OOBE from ESIM links

IV. Kepler NGSO Authorization Order

In November 2018 Order, FCC authorized Kepler to launch and operate an NGSO satellite system:

-140 satellites in 7 orbital planes, approximate altitude of 500-600 kilometers.

-Transmit at 10.7-12.7 (s-E), 14.0-14.5 GHz (E-s)

Two elements of the order are notable for radio astronomy:

>Order has a condition requiring Kepler to *coordinate* 10.7-11.7 GHz (through NSF) with RAS observations at 10.6-10.7 GHz at US 131 observatories (Arecibo, GBT, VLA, VLBA).

>For uplinks that include 14.47-14.5, Kepler must take "all practicable steps" to protect RAS from harmful interference.

V. Theia Satellite Authorization Order

May 10, 2019 FCC Order authorized construction and operation of NGSO satellite operated by Theia.

-*Commercial active* EESS at 1215-1300 MHz (SAR imaging)
-*Commercial passive* EESS
-commercial imaging
-broadband data communications services

-112 satellites in 8 planes at 800 km altitude

"Theia proposes to capture *continuous visible and broad infrared video* of the entire Earth, near continuous high-resolution *hyperspectral and active radar data*, and *microwave radiometer data* and provide this data to individuals and institutions around the world. Theia states that data derived from its constellation will be used to provide a range of services, including precision agriculture analytics, surveying and monitoring of infrastructure, and real-time geophysical information and first responder support."

-Ownership by Thai govt.?

V. Theia Satellite Authorization Order

Active Remote Sensing -- 1215-1300 MHz (SAR)

Passive Remote Sensing -- 1420-1427 MHz, 1660.5-1668.4 MHz, 2655-2690 MHz, 8.55-8.65 GHz, 9.3-9.9 GHz, and 10.6-10.7 GHz

Gateways	17.8-18.6 GHz (space-to-Earth)
	18.8-19.4 GHz (space-to-Earth)
	19.3-19.7 GHz (space-to-Earth)
	19.7-20.2 GHz (space-to-Earth)
	25.5-27.0 GHz (space-to-Earth) [subject to future FCC action]
	27.5-30.0 GHz (Earth-to-space)
	37.5-42.0 GHz (space-to-Earth)
	47.2-50.2 GHz (Earth-to-space)
	50.4-51.4 GHz (Earth-to-space)
Users	10.7-12.7 GHz (space-to-Earth)
	14.0-14.2 GHz (Earth-to-space)

V. Theia Satellite Authorization Order

Active remote sensing will have *secondary status* vis a vis GPS, surveillance radar

Order *does not provide for coordination with RAS at 10.7-11.7 GHz*, but provides for protection vis a vis *other* RAS bands:

> -take *all practicable steps* to protect radio astronomy observations in the adjacent bands from harmful interference from its operations in the *40.5-42.0 GHz band*.
>
> -for *48.94-49.04 GHz, Earth station operations must be coordinated* with radio astronomy stations operating on a co-primary basis in this band, and "Theia is urged to take all practicable steps to protect radio astronomy observations from harmful interference from its operations in [this] band."

But FCC also alerts Theia to problem of *OOBE into RAS bands* (10.68-10.70?), and to *RAS observation outside of RAS bands*, and suggests coordination through NSF.

VI. Above 95 GHz – Unlicensed and Experimental Order

-March 2019 Order enacts rules for unlicensed devices and experimental licenses operating above 95 GHz.

>Fixed licensed terrestrial to be addressed in future.

A. EXPERIMENTAL LICENSES

-FCC created a new category of experimental licenses for *any frequencies* in the 95 GHz to 3 THz range (a "Spectrum Horizons License").

-Spectrum Horizons Licenses would have a longer, *10 year license term*, and the ability to *sell transmitter equipment on a commercial basis*.

-Required to operate in a manner that does *not cause harmful interference* to authorized services at the same frequencies, including passive services in bands that have been allocated for passive services.

VI. Above 95 GHz – Unlicensed and Experimental Order

A. EXPERIMENTAL LICENSES

-Proposals to operate on passive band allocations:

>must make a *showing* that *non*-passive band frequencies are *not adequate* for the experiment;
>must acknowledge that they *intend to transition* any potential long-term use to a band with "appropriate allocations."

Such applications will be submitted to the IRAC process, where other federal agencies could lodge objections, or demand revisions or conditions such as coordination, geographical limitations, indoor use, etc.

VI. Above 95 GHz – Unlicensed and Experimental Order

B. UNLICENSED OPERATIONS

-FCC made 21.2 gigahertz of spectrum available for unlicensed use at: 116-123 GHz, 174.8-182 GHz, 185-190 GHz, and 244-246 GHz. (Wings around 183 GHz band)

>FCC: No more allocations for mmW unlicensed, for now.

-Like all unlicensed operations, they must operate on *non-interference basis*, including protecting passive services.

-This unlicensed use is *limited to terrestrial transmissions* – airborne and satellite are prohibited. This is presented as a concession to CORF's concerns.

-*Maximum EIRP* of 40 dBm (average) and 43 dBm (peak), but *outdoor fixed point-to-point* has maximum EIRP of 82 dBm (average) and 85 dBm (peak)

-*OOBE Limit* – 90 picowatts per sq. cm at 3 meters, up to the third harmonic or 750 GHz, whichever lower.

VI. Above 95 GHz – Unlicensed and Experimental Order

C. FCC Response to CORF Arguments

Order contains extensive and detailed technical argument as to why the FCC's new rules will protect RAS and EESS, including a detailed response to many of CORF's arguments.

RAS

FCC: Only one new unlicensed band overlaps RAS – 244-246 GHz
>that band *already designated for ISM devices with higher power*
>for other unlicensed bands, "stringent" OOBE limit will protect RAS

CORF: Analysis shows need for significant protection zones or indoor limitation

FCC: *invalid assumption re power* – FCC orders peak power of 43 dBm rather than 25 dbW/MHz, then add terrain shielding, clutter, lack of LOS, and isolation of RAS sites.

VI. Above 95 GHz – Unlicensed and Experimental Order

C. FCC Response to CORF Arguments

EESS

CORF: Standard atmospheric model does not account for *variations* in humidity and altitude – which impact *attenuation*.

FCC: -Remote sensing scans over *broad areas*; ITU-R RA.2189 uses standard model.

-Up to 42,000 devices per sq. km still meets standard in ITU-R RS.2017 for vertical scan; up to 96 million for angle scan – *no problem with aggregate interference*

Concessions to CORF:

-Limit unlicensed power levels to the proposed maximum peak of *43 dBm*

-Limit to terrestrial use

-"Stringent" OOBE limit

-"*recognize* that the bands above 95 GHz are *largely uncharted territory*" and will "*revisit the rules, if warranted,* in the future as technology and applications develop in this region of the spectrum." Promise to require protection from harmful interference, and *address promptly any complaints* of harmful interference.

-Reject proposal to modify US246

VII. Google Waiver Request – 57-64 GHz

-March 2018 -- Google requested *waiver* of the FCC's rules to:

-operate fixed and mobile *radar-based field disturbance sensors* at 57-64 GHz

-at a *conducted power, mean power spectral density (PSD) and mean Equivalent Isotropically Radiated Power (EIRP)* at levels *higher* than allowed under FCC rules, but consistent with ETSI standard EN 305 550.1.

Technology to be used for motion sensors to enable *touchless control of mobile device* functions or features.

VII. Google Waiver Request – 57-64 GHz

-Section 15.255(c)(3) of the Commission's rules for short-range devices for interactive motion sensing:

-*peak transmitter conducted output power* limit of −10 dBm and
-peak *EIRP* limit of +10 dBm

Google originally requested ETSI limits of +10 dBm transmitter conducted output power, +20 dBm mean EIRP level, and +13 dBm/MHz mean power spectral density.

The engineering study attached to the waiver request *did not address possible interference to passive users*, particularly use on airplanes. Impact on EESS?

VII. Google Waiver Request – 57-64 GHz

-CORF Comments (filed 4/20):

-57-59.3 GHz is vitally important to weather forecasting.

-*Distinguished* this from prior recent order on aeronautical use of 57-71 GHz:

> *technical premises* of AVSI study are not applicable to the Google proposal—architecture of access point stations affixed to the *interior ceiling* in aircraft to deliver to travelers' laptops/tablets or to in-seat display monitors on the aircraft vs. Google proposal where emissions come from *consumer devices* (next to windows)

VII. Google Waiver Request – 57-64 GHz

-CORF Comments:

- In prior Order, FCC *limited* transmission power levels to those in Section 15. 255(c)(3). Google proposes to significantly *increase* those power levels.

-Also note concerns re OOBE into RAS bands: 114-116 GHz, 182-185 GHz, 226-231.5 GHz, 241-248 GHz and 250-252 GHz. All but 114.0-114.25 and 241-248 GHz are protected by Footnote 5.340 -- all emissions are prohibited.

CORF Recommendation: prohibit *waiver-based transmissions at 57-59.3 GHz.* (prohibition on aeronautical use of devices unenforceable)

-CORF discussions with Google/Google files study purporting to show no harm to EESS.

VII. Google Waiver Request – 57-64 GHz

FCC Order 12/2018 – Grants Google Waiver request, and allow use in aircraft:

"operat[ion] at the requested power levels *will not materially change the operating environment* in the 57-64 GHz band such that there would be an *increase* in potential harmful interference to other users in the band …"

-FCC had previously authorized airborne use of other devices in this band, based on industry study regarding attenuation from aircraft body.

-CORF participation nevertheless had *positive impact*:

Google *reduced the power level it sought by 7 dB:*

>originally sought +20 dBm peak EIRP

>FCC grants revised request to +13 dBm peak EIRP; +10 dBm output power; +13 dBm/MHz power spectral density

VIII. Proposed Rules for 6 GHz Unlicensed Use

October 2018 NPRM proposes new bands for unlicensed use from *5.925-7.125 GHz*.

-*Proposed unlicensed Sub-bands*:

5.925 – 6.425/6.525 – 6.875 GHz "Standard" Power *outdoor* use with automated frequency coordination ("AFC")

6.425-6.525/6.875 – 7.125 "Low Power" *indoor* use

-Some attempt to parallel *current* unlicensed rules for 5.150 – 5.250/5.725 – 5.850 GHz

-Significant *opposition from incumbents*:

-Fixed point-to-point terrestrial (carriers, railroads, broadcasters)

-Fixed satellite use for uplinks (paired with 4 GHz downlinks for "C-Band")

VIII. Proposed Rules for 6 GHz Unlicensed Use

Proposed Power Limits:

"Standard" (outdoor) Access Points: The *maximum conducted output power is 1 watt* and *maximum power spectral density is 17 dBm* in any 1 megahertz band.

"Low Power" (indoor) Access Points: The *maximum conducted output power is 250 milliwatts* and *maximum power spectral density is 11 dBm* in any 1 megahertz band.

Client Devices: The *maximum conducted output power is 63 milliwatts* and *maximum power spectral density is 5 dBm* in any 1 megahertz band.

FOR ALL THREE CATEGORIES: If a transmitting *antenna with directional gain greater than 6 dBi* is used, the maximum power and power spectral density shall be *reduced* by the amount in dBi that the directional gain is greater than 6 dBi.

Unwanted Emission Limit: All emissions below 5.925 GHz and above 7.125 GHz shall not exceed an *EIRP of -27 dBm/MHz.*

Prohibition on use from moving vehicles: *No access point* operating from cars, trains, aircraft. No operations (including *client devices*) on *drones*.

VIII. Proposed Rules for 6 GHz Unlicensed Use

CORF Comments Filed Feb. 2019:

-NPRM states that rules are designed to protect "incumbents", but makes no mention of passive services. Per US342, *RAS is an "incumbent" at 6.650-6.675 GHz, entitled to protection.*

>*Observatory locations should be included* in the Automated Frequency Control (AFC) regime, to create RAS exclusion zones.

> Even indoor devices should be required to use the AFC system to identify exclusion zones.

-Client devices should *not* be allowed to transmit probe requests, as a means for joining a network prior to receiving a frequency assignment.

-Support prohibition on airborne uses.

-FCC should prevent interference to *EESS at 6.425-7.250 GHz:*

>support indoor use
>*add "ships and boats"* to prohibition on moving uses

IX. Proposed Commercial Use of 1675-1680 MHz

May 2019 – FCC releases an NPRM - shared use in the 1675-1680 MHz band between incumbent federal operations and new, *commercial terrestrial fixed and mobile wireless operations*.

-Part of the 1675-1695 MHz band allocated on a co-primary basis to the *Meteorological Aids* (MetAids) (radiosondes) and the *Meteorological Satellite* (MetSat) (space-to-Earth).

>Important band for *NOAA weather data transmission, including GOES-N/R downlinks* to Federal agencies and other users: 1673.4-1678.6, 1679.7-1680, 1680.5-1694.5, and other downlinks up to 1694.8 GHz.

> 1675-1683 MHz currently *used widely by NOAA for radiosondes*. These radiosondes are scheduled to be *relocated to the 401-406 MHz band by February 19, 2021*.

- U.S. administrations have for years discussed implementing commercial use of the 1675-1680 MHz band.

>federal legislation has included provisions to compensate federal users for the costs of sharing or relocating from their federal allocations, in order to promote commercial use.

-Ligado/LightSquared -- 2012 Petition for RM -- 1675-80 for terrestrial mobile
1670-75 allocated to fixed and terrestrial mobile, and used by Ligado

IX. Proposed Commercial Use of 1675-1680 MHz

FCC PROPOSAL:

-Reallocate the 1675-1680 MHz band to make commercial fixed and terrestrial mobile services co-primary with MetSat and MetAids.

>*Entire* 5 MHz band be used as a *downlink*.
>Licenses would be assigned by *auction*.
>Fixed and base stations to operate up to *2000 watts* peak equivalent isotropically radiated power (EIRP), with their standard OOBE limit for fixed and base stations of 43 + 10 log10 (P) dB, where P is the transmit power in watts.

- NPRM: Does fixed nature of these federal data transmission services "leave large geographic areas in which spectrum may *feasibly be shared* with new commercial uses *without "significantly affecting incumbent users"*? NPRM states an *intention to work collaboratively with NOAA and the NTIA* "to study how these goals can be accomplished."

How to protect:
(1) *current federal earth stations* in, and adjacent to, the band;
(2) *planned/future* federal earth stations; and
(3) *non-federal* earth stations that receive NOAA data

IX. Proposed Commercial Use of 1675-1680 MHz

CONSIDERATIONS RE CORF PARTICIPATION:

-1675-1680 MHz is used for *data transmission*, rather than for scientific observation.

-Radiosondes scheduled to *move out of this band by 2021*, though satellite earth stations will be using it at least through *2036*.

-Impacted *federal agencies are actively engaged with the FCC* on this matter, though not clear how much the FCC is listening.

-Much of the *weather community* (WMO, AGU, AMS) *has been actively engaged* at the FCC on this band in the past, and already Canada and a few of these entities have already filed *ex parte* notices in the docket for this NPRM, expressing concerns about interference to transmission of critical weather data.

QUESTIONS?

Fletcher, Heald & Hildreth

THANKS!

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