

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

In the Matter of)	
)	
Amendment of Parts 2 and 25 of the Commission's Rules)	IB Docket No. 17-95
to Facilitate the Use of Earth Stations in Motion)	
Communicating with Geostationary Orbit Space Stations in)	
Frequency Bands Allocated to the Fixed Satellite Service)	

COMMENTS OF SES S.A. AND O3B LIMITED

SES S.A. (“SES”) and its subsidiary O3b Limited (“O3b”), hereby submit these comments in response to the Notice of Proposed Rulemaking in the above-captioned proceeding.¹ SES and O3b strongly agree that the Commission should facilitate the deployment of Earth Stations in Motion (“ESIMs”) and reduce regulatory burdens on ESIM operators.² Consistent with those goals, SES and O3b support expanding the scope of this proceeding to address ESIMs using non-geostationary orbit (“NGSO”) satellites and permit ESIM operations in additional spectrum. The Commission should also take steps to ensure that ESIM operations in conventional Ka-band frequencies are not subject to unnecessary constraints.

BACKGROUND

SES, one of the world’s largest commercial communications satellite operators, is uniquely positioned to address issues raised by the Notice because its facilities include both geostationary orbit (“GSO”) and NGSO satellites used to provide ESIM services today. The SES fleet of more than 50 GSO satellites supplies C-, Ku-, and Ka-band capacity to numerous

¹ *Amendment of Parts 2 and 25 of the Commission's Rules to Facilitate the Use of Earth Stations in Motion Communicating with Geostationary Orbit Space Stations in Frequency Bands Allocated to the Fixed Satellite Service*, Notice of Proposed Rulemaking, IB Docket No. 17-95 (rel. May 19, 2017) (the “Notice”).

² *Id.* at ¶ 1.

providers of aeronautical, maritime, and land-based mobile services in U.S. territory and around the globe.³ SES subsidiary O3b uses its Ka-band NGSO system to serve maritime customers pursuant to Commission earth stations on vessels (“ESV”) authority.⁴ O3b maritime offerings include services tailored to providing connectivity to large cruise ships, using a beam that tracks a vessel as it navigates through the oceans and allowing O3b to provide cruise ship passengers and crew with a level of connectivity similar to what they can experience on land.⁵

As active participants in ESIMs markets, SES and O3b have seen first-hand the rapidly increasing demand for FSS capacity to serve mobile terminals.⁶ As the Notice points out, the International Telecommunication Union (“ITU”) has highlighted the need for mobile broadband satellite communications and determined that some of this need can be met by FSS satellite networks.⁷ The Commission must ensure that its regulatory framework is capable of supporting expanded ESIM service in response to significantly rising demand.

³ See, e.g., Space News, “SES Enters Ka-Band Airline Connectivity Market with Thales Avionics As Customer,” Sept. 12, 2016, available at <http://spacenews.com/ses-enters-ka-band-airline-connectivity-market-with-thales-avionics-as-customer/>; SES and Gilat Join Forces to Make Connectivity at Sea More Accessible, Press Release, Feb. 15, 2017, available at: <https://www.ses.com/press-release/ses-and-gilat-join-forces-make-connectivity-sea-more-accessible>; KVH Industries, Inc., Call Sign E110078, File No. SES-LIC-20110429-00528, Narrative at 1 (proposing use of SES satellites for VMES operations), granted Aug. 29, 2011).

⁴ See, e.g., File No. SES-LIC-20130528-00455, Call Sign E130098 (granted May 13, 2014) (authorizing maritime service in the 28.6-29.1 GHz and 18.8-19.3 GHz frequencies to U.S.-flagged vessels); File No. SES-MSC-20151021-00760 (granted Jan. 29, 2016) (permitting maritime service to non- U.S.-flagged vessels in and near U.S. territorial waters).

⁵ See The Maritime Executive, “Cruise Ship Connectivity,” Nov. 1, 2015, available at <http://www.maritime-executive.com/editorials/the-week-in-review-cruise-ship-connectivity>.

⁶ See *id.* (global maritime broadband satellite communications is “one of the fastest-growing segments of the global satellite services industry”); SES: The Big Beam Boom - The Growth in Aeronautical and Maritime Services, June 12, 2015, available at: <https://www.ses.com/press-release/ses-big-beam-boom-growth-aeronautical-and-maritime-services>.

⁷ Notice at ¶ 3, *citing* ITU Resolutions 156 and 158, Final Acts WRC-15 at 245-249 & 254-257. As discussed below, European regulators have also focused on this growing market segment.

The Notice proposes to reorganize the ESIMs rules and codify the ability to provide ESIM services in Ka-band spectrum in order to “promote innovative and flexible use of satellite technology, and provide new opportunities for a variety of uses.”⁸ SES and O3b support this objective but urge the Commission to use this opportunity to conduct a more complete review of both existing and future ESIMs offerings. In particular, the Commission should propose rules for ESIM operations with NGSO as well as GSO satellites and include a wider range of frequencies for ESIM operations. The Commission should also ensure that the new rules for ESIM operations in conventional Ka-band spectrum are not unduly limiting.

I. THE COMMISSION SHOULD BROADEN THE RULEMAKING TO ADDRESS USE OF NGSO SYSTEMS FOR ESIM OPERATIONS

In order to comprehensively respond to demand for use of FSS capacity to provide services to satellite terminals in motion, the Commission should invite comment in this rulemaking on issues relating to ESIM use of NGSO as well as GSO satellite systems. SES and O3b urged the Commission to make this change prior to issuing the Notice,⁹ but the Commission declined to do so at that stage. However, the public interest benefits and administrative efficiency advantages of exploring the regulatory framework for NGSO ESIM operations in the near term are clear and support beginning that process now.

In particular, as SES and O3b have previously explained, deferring consideration of rules for ESIMs operating with NGSO satellites threatens to unreasonably delay Commission licensing of state-of-the-art terminals and place U.S. customers at a disadvantage when other countries are moving ahead on these matters. Equipment manufacturers are designing combined

⁸ Notice at ¶ 2.

⁹ See Letter from Suzanne Malloy of O3b and Petra A. Vorwig of SES to Marlene H. Dortch, Secretary, FCC, IB Docket No. 17-95 (filed May 12, 2017) (“SES/O3b Letter”).

multi-band, multi-orbit antennas to allow users to take advantage of a wide range of options for satellite capacity in support of their operations.¹⁰ These technological advances are in high demand in the marketplace and will proceed even if the Commission defers consideration of the associated regulatory implications. Antenna manufacturers, ESIM operators, and ultimately U.S. consumers would all benefit from development of Commission rules that define operating parameters for ESIM communications with both NGSO and GSO satellites.

The European Electronic Communications Committee (“ECC”) and European Telecommunications Standards Institute (“ETSI”) have completed extensive technical analyses to define rules and standards for mobile terminals using Ka-band NGSO FSS systems.¹¹ The ECC has also begun studies to develop appropriate regulations for NGSO ESIMs operating in the 10.7–14.5 GHz band.¹² These European actions can serve as a useful reference as the Commission considers a regulatory framework for U.S.-licensed ESIMs using NGSO FSS

¹⁰ See SES/O3b Letter at 1 & n.2., *citing* ORBIT, “Ocean TRx 7 Maritime Stabilized VSAT System,” available at <http://orbit-cs-usa.com/?product=oceantrx-7> (describing a dual GSO/NGSO-capable antenna available for commercial use) and Alan Boyle, “Kymeta and Intelsat Debut Kalo Satellite Service and Antennas at ‘Coming-out Party,’” GeekWire (May 7, 2017) available at <https://www.geekwire.com/2017/kymeta-intelsat-unveil-kalo-satellite-service-antennas/> (describing antennas designed to seamlessly switch from GSO to NGSO satellites).

¹¹ See SES/O3b Letter at 1 & n.1., *citing* ECC Decision 15(04), “The harmonised use, free circulation and exemption from individual licensing of Land and Maritime Earth Stations on Mobile Platforms (ESOMPs) operating with NGSO FSS satellite systems in the frequency ranges 17.3-20.2 GHz, 27.5-29.1 GHz and 29.5-30.0 GHz” (approved July 3, 2015). See also ETSI Standard EN 303 979, “Harmonised EN for Earth Stations on Mobile Platforms (ESOMP) Transmitting towards Satellites in Non-Geostationary Orbit in the 27,5 GHz to 29,1 GHz and 29,5 GHz to 30.0 GHz Frequency Bands Covering the Essential Requirements of Article 3.2 of the R&TTE Directive,” Version 2.1.2, published October 2016.

¹² See ETSI EN 303 980, “Harmonized EN for fixed and in-motion Earth Stations communicating with non-geostationary orbiting systems (NEST) in the 11 GHz to 14 GHz frequency bands covering essential requirements under article 3.2 of the Directive 2014,” published for final approval on June 26, 2017.

systems. If the Commission does not engage on these issues, however, users and manufacturers in other markets will reap the benefits of new service options while U.S. offerings lag behind.

There is no valid reason for the Commission to put off inviting comment on NGSO ESIM matters. Although the Notice points to the pendency of the NGSO rulemaking as supporting delay,¹³ the Commission does not identify any specific issues in that proceeding that must be resolved before the Commission can begin to consider rules for ESIM operations with NGSO systems. SES and O3b recognize that there will necessarily be some overlap between the two proceedings, but the comment cycle in the NGSO NPRM was completed in early April, so the Commission has a full record on which to base its decisions in that rulemaking. Given the more advanced stage of the NGSO NPRM proceeding, the Commission should be able to start considering how to regulate NGSO ESIMs now, even if final decisions cannot be made until the NGSO NPRM rulemaking is concluded.

At a minimum, the Commission should expand this proceeding to specify that ESIMs operating in the 18.8-19.3 GHz (space-to-Earth), and 28.6-29.1 GHz (Earth-to-space) bands where NGSO systems have sole primary status are an application of the FSS and to seek input on appropriate licensing rules for ESIMs using NGSO satellites in these frequencies. Treatment of ESIMs operating in NGSO-primary spectrum as authorized FSS terminals is consistent with the Commission's proposal to authorize ESIMs operating with GSO satellites in the conventional Ka-band spectrum where GSO networks are primary. The NGSO-primary bands are designated for blanket licensing both internationally and in the U.S.,¹⁴ and, like the

¹³ Notice at 2 n.4, *citing Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Notice of Proposed Rulemaking, 31 FCC Rcd 13651 (2016) ("NGSO NPRM").

¹⁴ See 47 C.F.R. § 2.106, Footnote 5.516B (identifying bands including 18.8-19.3 GHz and 28.6-29.1 GHz as available for high-density applications in the fixed-satellite service); 47 C.F.R.

GSO-primary Ka-band frequencies, the spectrum is not shared with terrestrial services under the Commission's Ka-band plan.¹⁵ O3b is already authorized to offer ESIM services using its NGSO system, so the Commission has experience with the operating environment for NGSO ESIM terminals. As with ESIMs communicating with GSO satellites, the Commission can adopt rules to ensure that ESIM terminals using NGSO capacity would not pose more of a risk of interference to, nor require more interference protection from, other systems than would fixed earth stations operating in these bands.¹⁶

Adding NGSO ESIMs would not require extensive changes to the regulatory framework proposed in the Notice. SES and O3b have provided in Annex 1 to these comments specific proposals for some of the rule revisions needed for NGSO ESIM operations.

II. ESIMS SHOULD BE PERMITTED TO USE ADDITIONAL SPECTRUM

The Commission should also authorize ESIM operations in Ku- and Ka-band frequencies beyond those addressed in the Notice. As the Commission has recognized, ESIM networks operating outside the U.S. require access to spectrum designated for FSS use in those areas. For example, in the aeronautical context, the Commission acknowledged that “terminals on U.S.-registered aircraft may need to access foreign satellites while traveling outside of the United States (*e.g.*, over international waters),” and therefore may need to use additional downlink spectrum.¹⁷ Moreover, as long as adequate protections are in place for primary

§ 25.115(e) (permitting licensing of user terminals in the 18.8-19.3 GHz and 28.6-29.1 GHz bands without specifying their locations).

¹⁵ See NGSO NPRM, Appendix B (depiction of Commission's Ka-band plan).

¹⁶ Notice at ¶ 53.

¹⁷ *Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service*, IB Docket No. 05-20, Notice of Proposed Rulemaking, 20 FCC Rcd 2906 (2005) at ¶ 18 (footnote omitted).

services, ESIMs should be permitted to use spectrum in which terrestrial services are operating. Accordingly, the Commission should allow ESIM operations in the bands discussed below.

Appendix 30B Extended Ku-band Downlink Spectrum: Under the proposals in the Notice, the Commission identifies the extended Ku-band as it is defined in Section 25.103, which currently excludes the 10.7-10.95 GHz and 11.2-11.45 GHz band downlink segments that are subject to an international plan under Appendix 30B.¹⁸ Prior to its December 2015 decision in the Part 25 proceeding,¹⁹ these band segments were within the extended Ku-band definition in Section 25.103, but that order revised the extended Ku-band definition to remove these bands.²⁰

The considerations underlying the Part 25 Order do not, however, justify making the 10.7-10.95 GHz and 11.2-11.45 GHz band downlink segments unavailable for ESIM operations. The changes made in that decision reflected concerns that applying two-degree spacing rules to those frequencies could undercut the protection rights of U.S. filings under Appendix 30B.²¹ But simply allowing ESIMs to receive signals in these band segments will have no effect on U.S. Appendix 30B filings.²² In fact, the Commission has authorized U.S. licensees to operate mobile terminals in these band segments under the existing rules.²³

¹⁸ Notice at ¶ 2 & n.5.

¹⁹ *Comprehensive Review of Licensing and Operating Rules for Satellite Services*, Second Report and Order, FCC 15-167, 30 FCC Rcd 14713 (2015) (the “Part 25 Order”).

²⁰ *See id.* at ¶ 243.

²¹ *See id.* at ¶ 116.

²² Nor will terrestrial use of the band be affected, as ITU power flux density limits are in place to protect terrestrial operations throughout the 10.7-11.7 GHz band. *See* ITU Radio Regulations, Article 21, Table 21-4. These limits on downlink transmissions apply to satellite operations regardless of the type of terminal that is receiving the signal, and therefore reception of the downlink signal by ESIM terminals presents no risks to terrestrial fixed services.

²³ *See, e.g., Panasonic Avionics Corp.*, Call Sign E100089 (ESAA license authorizing use of 10.7-12.75 GHz downlink frequencies); *Blue Marble Network, LLC*, Call Sign E100102 (ESV license authorizing use of 11.2-11.7 GHz downlink frequencies).

As part of this proceeding, the Commission should expressly permit ESIMs to operate in the 10.7-10.95 GHz and 11.2-11.45 GHz band segments. Because routine licensing is not available in these frequencies, SES and O3b recognize that ESIM applicants would not be able to designate the Permitted Space Station List as a point of communication, but the rules should allow ESIM use of this spectrum on a satellite-specific basis.

17.8-18.3 GHz Ka-Band Downlink Spectrum: The NGSO NPRM proposes changes to allow FSS use of the 17.8-18.3 GHz band, which is currently allocated for terrestrial fixed service, for downlinks by both GSO and NGSO systems.²⁴ The record in that proceeding strongly supports the Commission's proposal.²⁵ Assuming those changes are adopted, the Commission should expressly permit ESIM use of this spectrum with GSO and NGSO satellites.

As the NGSO NPRM observes, the ITU has adopted power flux density limits to protect primary terrestrial uses of the 17.7-18.3 GHz frequencies.²⁶ To avoid constraining future growth of terrestrial networks, ESIM use of this spectrum should be on an unprotected basis with respect to terrestrial operations. Under these conditions, the same rationale that led the Commission to permit domestic use by ESAA and other mobile operations in extended Ku-band spectrum where terrestrial fixed services are primary supports allowing ESIM reception in the 17.8-18.3 GHz Ka-band segment.²⁷

²⁴ NGSO NPRM at ¶ 9.

²⁵ See Reply Comments of SES S.A. and O3b Limited in IB Docket No. 16-408, filed Apr. 10, 2017 ("SES/O3b NGSO NPRM Reply") at 2-3 & n.5 (citing other comments endorsing proposals to allow FSS downlinks in the 17.8-18.3 GHz band).

²⁶ NGSO NPRM at ¶ 9 & n.26.

²⁷ *Revisions to Parts 2 and 25 of the Commission's Rules to Govern the Use of Earth Stations Aboard Aircraft Communicating with Fixed-Satellite Service Geostationary-Orbit Space Stations Operating in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14-14.5 GHz Frequency Bands*, Notice of Proposed Rulemaking and Report and Order, IB Docket Nos. 12-376 & 05-20,

To implement these changes, the Commission should revise its rules to make clear that ESIMs operating in the 10.7-10.95 GHz, 11.2-11.45 GHz, and 17.8-18.3 GHz band segments are an application of the FSS and can operate in these bands domestically on an unprotected basis vis-à-vis terrestrial fixed services. Proposed language is provided in Annex 1.

III. THE COMMISSION SHOULD ADOPT RULES TO ENCOURAGE ROBUST ESIM USE OF CONVENTIONAL KA-BAND SPECTRUM

SES and O3b fully support the Commission's proposal to explicitly permit ESIM operations in the conventional Ka-band.²⁸ We urge the Commission to ensure that its regulatory framework facilitates ESIM access to this important spectrum.

In this regard, the Commission should reject any suggestion that constraints should be imposed on ESIM use of the conventional Ka-band frequencies in order to protect terrestrial fixed or mobile operations.²⁹ In the conventional Ka-band, there are no terrestrial fixed or mobile services that are currently entitled to protection from satellite operations under the Commission's Ka-band plan and associated rules.³⁰ Accordingly, there is no justification for hampering satellite services' use of this spectrum.

Furthermore, the Commission should reject Iridium's arguments that the 29.25-29.3 GHz segment of the conventional Ka-band should be excluded from the frequencies available for ESIM use.³¹ As other satellite operators have observed, this band segment is

27 FCC Rcd 16510 (2012) at ¶¶ 20-21 (unprotected ESAA downlink use of extended Ku-band spectrum "will not interfere with or restrict current or future [terrestrial fixed] operations").

²⁸ Notice at ¶ 2.

²⁹ *See id.* at ¶ 52.

³⁰ The periods during which grandfathered terrestrial fixed service stations were entitled to co-primary status with FSS operations have expired. *See* 47 C.F.R. § 101.147(r).

³¹ Notice at ¶ 54.

designated for blanket licensing under Section 25.258(b) of the Commission's rules and is therefore suitable for ESIM use as well.³² Coordination with Iridium is appropriate under that rule provision for earth stations "in the vicinity of" operational Iridium feeder link facilities.³³ To provide greater certainty for ESIM applicants, the Commission should define a perimeter around Iridium earth stations within which coordination is necessary.³⁴ This will expedite consideration of ESIM applications and avoid coordination-related delays for operations in areas sufficiently distant from the handful of Iridium feeder link sites operating in this band segment.

IV. CONCLUSION

For the reasons discussed herein, the Commission should expand the scope of this proceeding and adopt rules to facilitate ESIM operations with both GSO and NGSO systems in spectrum available for FSS.

Respectfully submitted,

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³² See *id.* at n.58, *citing* Letter from Giselle Creeser and M. Ethan Lucarelli of Inmarsat, Inc. and Jennifer Manner of EchoStar Satellite Operating Corp. and Hughes Network Systems, LLC., to Marlene H. Dortch, Secretary, FCC, IB Docket No. 17-95 (filed May 11, 2017) and Letter from John Janka and Elizabeth R. Park, Counsel, ViaSat Inc., to Marlene H. Dortch, Secretary, FCC, IB Docket No. 17-95 (filed May 11, 2017).

³³ 47 C.F.R. § 25.258(b).

³⁴ See SES/O3b NGSO NPRM Reply at 11-12 and nn.47 & 50 (discussing commenters' support for defining zones beyond which coordination with Iridium should not be required). Such an approach would be consistent with Commission requirements specifying coordination zones around radio astronomy and NASA TDRSS sites. See, e.g., 47 C.F.R. § 25.226(c) and (d).

ANNEX 1: Proposed Rule Revisions

This annex contains suggested rule revisions to implement some of the policy changes discussed in the foregoing comments of SES and O3b. The SES and O3b proposals for alteration of the rules currently in effect or proposed in Appendix A of the Notice are marked in red.

1. Changes to the Table of Allocations:

Revise footnote NG52 as follows:

NG52 Except as otherwise provided for herein, use of the bands 10.7-11.7 GHz (space-to-Earth) and 12.75-13.25 GHz (Earth-to-space) by geostationary satellites in the fixed-satellite service (FSS) shall be limited to international systems, i.e., other than domestic systems. In the ~~sub-bands 10.95-11.2 GHz and 11.45~~ 10.7-11.7 GHz ~~band~~, Earth Stations in Motion (ESIMs), as regulated under 47 CFR part 25, may be authorized for the reception of FSS emissions from geostationary satellites, subject to the condition that these earth stations shall not claim protection from transmissions of non-Federal stations in the fixed service.

Add new footnote NGxx as follows and add a reference to the footnote in the Non-Federal column of the United States Table, in the rows relating to the 18.8-19.3 GHz and 28.6-29.1 GHz bands:

NGxx In the bands 18.8-19.3 GHz (space-to-Earth), and 28.6-29.1 GHz (Earth-to-space), Earth Stations in Motion (ESIMs), as regulated under 47 CFR part 25, are applications of the fixed-satellite service and may be authorized to communicate with non-geostationary satellites in the fixed-satellite service on a primary basis.

Add new footnote NGyy as follows and add a reference to the footnote in the Non-Federal column of the United States Table, in the row relating to the 17.8-18.3 GHz band:

NGyy In the 17.8-18.3 GHz band, Earth Stations in Motion (ESIMs), as regulated under 47 CFR part 25, may be authorized for the reception of FSS emissions from geostationary and non-geostationary satellites, subject to the condition that these earth stations shall not claim protection from transmissions of non-Federal stations in the fixed service.

2. Changes to Section 25.103:

Revise the definitions of Earth Station on Vessel, Earth Stations aboard Aircraft, and Vehicle-Mounted Earth Station, as shown below.

Earth Station on Vessel (ESV). An earth station onboard a craft designed for traveling on water, receiving from and transmitting to geostationary-orbit or non-geostationary-orbit Fixed-Satellite Service space stations.

Earth Station Aboard Aircraft (ESAA). An earth station operating aboard an aircraft that receives from and transmits to geostationary-orbit ~~or non-geostationary-orbit~~ Fixed-Satellite Service space stations.

Vehicle-Mounted Earth Station (VMES). An earth station, operating from a motorized vehicle that travels primarily on land, that receives from and transmits to geostationary orbit ~~or non-geostationary-orbit~~ Fixed-Satellite Service space stations and operates within the United States.

3. Changes to Section 25.202(a):

§25.202 Frequencies, frequency tolerance, and emission limits.

(a) * * *

(a)(8) The following frequencies are available for use by ESVs:

3700-4200 MHz (space-to-Earth)

5925-6425 MHz (Earth-to-space)

~~10.95-11.2 GHz (space-to-Earth)~~

~~11.45~~10.7-11.7 GHz (space-to-Earth)

11.7-12.2 GHz (space-to-Earth)

14.0-14.5 GHz (Earth-to-space)

~~17.8-18.3 GHz (space-to-Earth)~~

18.3-18.8 GHz (space-to-Earth)

~~18.8-19.3 GHz (space-to-Earth)~~

19.7-20.2 GHz (space-to-Earth)

28.35-28.6 GHz (Earth-to-space)

~~28.6-29.1 GHz (Earth-to-space)~~

29.25-30.0 GHz (Earth-to-space)

(a)(10) The following frequencies are available for use by Vehicle-Mounted Earth Stations (VMESs):

~~10.95-11.2 GHz (space-to-Earth)~~

~~11.45~~10.7-11.7 GHz (space-to-Earth)

11.7-12.2 GHz (space-to-Earth)

14.0-14.5 GHz (Earth-to-space)

~~17.8-18.3 GHz (space-to-Earth)~~

18.3-18.8 GHz (space-to-Earth)

~~18.8-19.3 GHz (space-to-Earth)~~

19.7-20.2 GHz (space-to-Earth)

28.35-28.6 GHz (Earth-to-space)

~~28.6-29.1 GHz (Earth-to-space)~~

29.25-30.0 GHz (Earth-to-space)

(a)(11) The following frequencies are available for use by Earth Stations Aboard Aircraft (ESAAs):

~~10.95-11.2 GHz (space-to-Earth)~~

~~11.45~~10.7-11.7 GHz (space-to-Earth)

11.7-12.2 GHz (space-to-Earth)

14.0-14.5 GHz (Earth-to-space)

~~17.8-18.3 GHz (space-to-Earth)~~

18.3-18.8 GHz (space-to-Earth)

~~18.8-19.3 GHz (space-to-Earth)~~

19.7-20.2 GHz (space-to-Earth)

28.35-28.6 GHz (Earth-to-space)

~~28.6-29.1 GHz (Earth-to-space)~~

29.25-30.0 GHz (Earth-to-space)