

## EXHIBIT A

### Modification of Ka band Aeronautical Antennas

By this application, Viasat, Inc. (“Viasat”) seeks to modify its authorization to operate two transmit/receive earth station antenna models mounted on aircraft to provide service in the United States using the ViaSat-2 satellite at 69.9° W.L.<sup>1</sup> Viasat seeks to:

- (i) add the 18.8-19.3 GHz and 28.6-29.1 GHz band segments designated as primary for NGSO FSS and secondary for GSO FSS;
- (ii) add the 27.5-28.35 GHz band segment designated as primary for Upper Microwave Flexible Use (“UMFU”) services, but limited to operations for earth stations at altitudes of 10,000 feet or more above ground level; and
- (iii) correct the license by adding the 18.1-18.3 GHz band segment allocated primarily for terrestrial fixed service and on a secondary basis for FSS downlinks, which inadvertently was left off of the Form 312 associated with the current license, but otherwise was addressed in that application.

No other modifications to the license are proposed by this application.

#### **1. Request for Additional Frequencies and Waivers of the U.S. Table and Ka-band Band Plan**

Viasat currently is authorized to operate two earth station antenna models mounted on aircraft to provide service in the United States using the ViaSat-2 satellite at 69.9° W.L., which operates under the authority of the United Kingdom:<sup>2</sup> (i) the Mantarray M40 antenna, and (ii) the Global Mantarray GM40 antenna. The earth stations are authorized to operate using the 17.7-18.1 GHz, 18.3-18.8 GHz and 19.7-20.2 GHz portions of the Ka band for downlinks, and 28.35-28.6 GHz and 29.5-30 GHz for uplinks.

In order to meet increasing consumer demand for aeronautical broadband services and to maintain the quality of these services, Viasat seeks to increase the amount of spectrum available for use by its Ka band aeronautical earth stations operating with ViaSat-2. Specifically, Viasat seeks to operate the currently authorized earth stations in the following additional frequencies: (i) the 18.8-19.3 GHz and 28.6-29.1 GHz band segments designated as primary for NGSO FSS and secondary for GSO FSS; (ii) the 27.5-28.35 GHz band segment designated as primary for UMFU;<sup>3</sup> and (iii) 18.1-8.3 GHz band segment allocated primarily for terrestrial fixed service and on a secondary basis for FSS downlinks. The ViaSat-2 satellite is authorized to use each of these frequency bands to serve the United States. The earth stations will operate in these bands

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<sup>1</sup> See Viasat, Inc., File No. SES-LIC-20180123-00055, Call Sign E180006 (granted Apr. 17, 2018) (“ViaSat-2 Aeronautical License”)

<sup>2</sup> Viasat, Inc., Call Sign S2902, File Nos. SAT-LOI-20130319-00040 (granted Dec. 12, 2013); SAT-MOD-20141105-00121; SAT-AMD-20150105-00002 (granted Apr. 15, 2015); SAT-MOD-20160527-00053 (granted Jan. 12, 2017) (“ViaSat-2 Authorization”).

<sup>3</sup> The M-40 antenna will operate only in the 28.1-28.35 GHz portion of this band segment.

throughout the coverage area of the ViaSat-2 satellite and can be operated with each of the gateway earth stations for ViaSat-2.<sup>4</sup>

In connection with this request, Viasat seeks a waiver of the U.S. Table of Frequency Allocations, and the Commission's Ka-band band plan, to operate mobile earth stations in these bands. The Commission has granted such waivers to allow Viasat to operate aeronautical earth stations with ViaSat-2, as well as Viasat's other spacecraft,<sup>5</sup> and has granted authority to other licensees to operate earth stations on mobile platforms in the Ka band.<sup>6</sup> "Good cause" exists for such a waiver,<sup>7</sup> which would serve the public interest by providing access to greater bandwidth and capacity for aeronautical broadband services, and thereby meeting consumer demand, and otherwise would be fully consistent with Commission precedent.

As an initial matter, it is now well-established in the industry and in Commission precedent that GSO FSS uplink spectrum resources can be used for service from mobile platforms without causing any more interference than a traditional FSS antenna. The Commission recently has adopted rules that authorize earth stations in motion in the 18.3-18.8 GHz, 19.7-20.2 GHz, 28.35-28.6 GHz and 29.25-30 GHz portions of the Ka-band.<sup>8</sup> Based on the Commission's conclusion that FSS earth stations in motion ("ESIMs") are no more interfering than operations in a fixed installation, the Commission has adopted a footnote to the U.S. Table to recognize the operation of ESIMs as an application of the FSS with primary status.<sup>9</sup>

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<sup>4</sup> See 47 C.F.R. § 25.115(e).

<sup>5</sup> See ViaSat-2 Aeronautical License; Viasat, Inc., File No. SES-MOD-20160108-00029, Call Sign E120075 (granted June 29, 2016).

<sup>6</sup> See, e.g., ISAT US Inc., File No. SES-LIC-20141030-00832, Call Sign E140114 (granted Aug. 11, 2015) (granting waiver for aeronautical earth stations at 19.7-20.2 GHz and 29.5-30 GHz); ISAT US Inc., File No. SES-LIC-20140224-00098, Call Sign E140029 (granted Sept. 29, 2015) (granting waiver for maritime earth stations at 19.7-20.2 GHz and 29.5-30 GHz); see also O3b Limited, File No. SES-MS-20151021-00760 (granted Jan. 29, 2016) (granting a waiver to provide service to 30 foreign-flagged ships using earth stations at 27.6-28.35 GHz).

<sup>7</sup> See 47 C.F.R. § 1.3; see also *WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969) (granting waiver where such grant "would better serve the public interest than strict adherence to the general rule"); *Northeast Cellular Tel. Co. v. FCC*, 897 F.2d 1166 (D.C. Cir. 1990) (grant of a waiver is warranted where the requested waiver "would not undermine the policy objective of the rule in question and would otherwise serve the public interest"); *Fugro-Chance, Inc.*, 10 FCC Rcd 2860 ¶ 2 (1995) (waiver of U.S. Table of Frequency Allocations appropriate "when there is little potential for interference into any service authorized under the Table of Frequency Allocations and when the non-conforming operator accepts any interference from authorized services.").

<sup>8</sup> See *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*, IB Docket No. 17-95, Report and Order and Further Notice of Proposed Rulemaking, FCC 17-56 ¶¶ 17-18, 51 n.118 (rel. May 19, 2017).

<sup>9</sup> *Id.* at ¶ 66.

In addition, the Commission is considering expanding ESIMs into other bands in which GSO FSS earth stations may be operated. The Commission also issued a further notice of proposed rulemaking accompanying its ESIM ruling proposing to allow GSO FSS ESIMs to operate in the 28.6-29.1 GHz and 18.8-19.3 GHz band segments on secondary basis with respect to NGSO FSS systems, and to receive signals from GSO FSS spacecraft in the 17.8-18.3 GHz band segment on a secondary basis with respect to fixed services.<sup>10</sup> To the extent the Commission adopts these proposed ESIM rules, Viasat requests that the proposed modification be authorized on that basis.

As detailed below and in the attached Technical Description, the proposed operations in the 18.8-19.3 GHz and 28.6-29.1 GHz band segments, would be compatible with and would not cause harmful interference into any primary NGSO FSS operations or the operations of other GSO FSS operations in those bands. Moreover, Viasat's proposed ESIM operations in the 27.5-28.35 GHz band segment would be limited to operations above 10,000 feet above ground level, and thus would not cause harmful interference into UMFU services. Finally, adding the 18.1-18.3 GHz portion of the 17.7-18.3 GHz band segment to the license is consistent with the demonstrations in the original license application that primary fixed services would not be impacted by the receive operations of ESIMs in that band.

## **2. Grant of this Application and the Associated Waiver Requests Is in the Public Interest**

Grant of this application would promote the public interest by enabling the provision of expanded broadband service to passengers and crew on board commercial and private aircraft using the ViaSat-2 satellite. Since Viasat first began providing Ka-band satellite broadband service on airplanes, demand for in-flight connectivity has increased dramatically. Today, passengers and crew not only expect broadband connectivity everywhere, including while on board aircraft, but also have come to expect a level of service quality while on board that matches their broadband experience within the home. A recent study by the London School of Economics predicts exponential growth of Wi-Fi service to airplanes in the coming decade, thus further confirming the need for access to spectrum for ESIMs to respond to this market demand: "By 2035, it is likely that inflight connectivity will be ubiquitous across the world."<sup>11</sup> Indeed, Viasat is currently connecting approximately 90 million personal devices per year on airplanes.

And, as mobile data and Wi-Fi networks on board aircraft have become more prevalent, consumers increasingly demand support for video streaming services, significantly increasing the need for greater network capacity. The Commission has acknowledged that this need for increased capacity requires additional spectrum resources. In granting access for satellite to additional spectrum in the Spectrum Frontiers proceeding, the Commission cited comments from major U.S. airlines that are Viasat customers "argu[ing] that as demand for in-flight broadband

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<sup>10</sup> See *id.* at ¶ 91.

<sup>11</sup> Dr. Alexander Grous, London School of Economics and Political Science, Sky High Economics, "Chapter One: Quantifying the commercial opportunities of passenger connectivity for the global airline industry" at 3, available at <http://www.lse.ac.uk/business-and-consultancy/consulting/assets/documents/sky-high-economics-chapter-one.pdf>.

grows, airlines and their satellite broadband partners will need access to more spectrum to meet consumer demand.”<sup>12</sup>

Significantly, the vast majority of Viasat’s current broadband capacity (and the portion of the Ka band it currently uses) is used to provide broadband service to customers in their homes. ESIMs operate within the same satellite network as fixed user terminals. Therefore, the vast majority of Viasat’s potential Ka band spectral capacity simply is not available to provide in-flight connectivity. In order to expand the spectrum available for these services, Viasat now seeks to modify its aeronautical earth station license to include the additional frequencies discussed here.

### **3. Compatibility with GSO FSS Operations in the 27.5-28.35 GHz, 18.8-19.3 GHz and 28.6-29.1 GHz Band Segments**

The attached Technical Description in Attachment 1 describes the antenna specifications, network architecture, and antenna pointing mechanism for the GM40 and M40 antennas. The antenna patterns for the authorized M40 and GM40 antennas were provided in the original application and are incorporated here by reference.<sup>13</sup> As demonstrated in the original application, both antennas are consistent with the existing regulatory framework for the Ka band and are compatible with other GSO satellite networks. The same demonstrations of compatibility previously provided apply equally to any GSO satellite networks that operate using the 27.5-28.35 GHz, 18.8-19.3 GHz and 28.6-29.1 GHz band segments.

As explained in the original application, the GM40 and M40 antennas comply with the EIRP spectral density limits in Section 25.138(a) in the GSO plane, but exceed to a limited degree the Section 25.138(a)(2) limits in the elevation plane. Specifically, the antenna patterns show off-axis exceedances for the main lobe in the elevation plane. In order to avoid a scenario where the main-beam exceedances would impact the GSO arc, Viasat has accepted as conditions to the license that transmissions would cease if the antenna-to-GSO skew angle exceeds 60 degrees and the off-axis EIRP spectral density emissions risk harmful interference to a GSO space station.<sup>14</sup> These conditions also would protect any GSO spacecraft operating in the additional proposed frequencies.

The antenna patterns also show off-axis exceedances for four grating lobes along the elevation axis that occur around a 25-degree skew angle. These grating lobes are located well outside of the GSO arc and could intersect the GSO arc only when the earth station is skewed by approximately 25 degrees relative to the GSO arc. Because the grating lobes occur well outside of the GSO arc, they could intersect the GSO arc only when the aircraft is traveling within certain geographic locations in which the GSO arc appears skewed with respect to the local

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<sup>12</sup> *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, GN Docket No. 14-177, Second Report and Order, FCC 17-152, at ¶ 188 (rel. Nov. 22, 2017); *see also* American Airlines *Ex Parte* Presentation, GN Docket No. 14-177, *et al.*, at 1 (Nov. 9, 2017); JetBlue Airways, *Ex Parte* Presentation, GN Docket No. 14-177, *et al.*, at 1 (Nov. 9, 2017).

<sup>13</sup> Viasat, Inc., File No. SES-LIC-20180123-00055, Call Sign E180006, at Exhibit B (filed Jan. 23, 2018)

<sup>14</sup> *See* ViaSat-2 Aeronautical License, Conditions 90254, 90465 (granted Apr. 17, 2018).

horizon of the antenna, or when the aircraft is banking at certain angles while in flight. Due to the high speeds at which aircraft travel, any intersection of a grating lobe with the GSO arc likely would be fleeting. Moreover, due to the large off-axis angles from the main lobe where these grating lobes occur, the level of any actual impact to any GSO satellite is extremely low.

In addition, the only GSO satellites that could potentially be impacted are those located at off-axis angles where the grating lobes could radiate toward the GSO arc when the earth stations are operated in certain geographic locations and at certain skew angles. Moreover, the satellite networks at these off-axis locations potentially could be impacted only if they operate co-frequency and have overlapping coverage with ViaSat-2. As explained in the Technical Description, DirecTV's satellites operating in the range of 99° W.L. to 103° W.L. are the only networks that potentially could be impacted by the grating lobes due to their position on the GSO arc. However, these satellites do not operate in the 18.8-19.3 GHz, 28.6-29.1 GHz or 27.5-28.35 GHz band segments, and thus, the proposed modification does not have any impact on these networks, nor does it change the coordination that Viasat already has completed with DirecTV.

#### **4. Compatibility with NGSO FSS Operations in the 18.8-19.3 GHz and 28.6-29.1 GHz Band Segments**

In the 18.8-19.3 GHz and 28.6-29.1 GHz band segments, the Commission's band plan designates NGSO FSS as primary, and GSO FSS as secondary, and as discussed above, the Commission is contemplating rules allowing GSO FSS ESIMs as secondary to NGSO FSS. Viasat requests a waiver for the operation of GSO FSS ESIMs in the 18.8-19.3 GHz and 28.6-29.1 GHz band segments on a non-interference, unprotected basis with respect to NGSO FSS while that rulemaking is pending.

As demonstrated in the Technical Description, the proposed ESIM operations in these bands are compatible with and will not cause harmful interference into NGSO FSS operations. Specifically, the Technical Description includes an analysis of the off-axis EIRP density in the plane perpendicular to the GSO with respect to the NGSO FSS systems in the Commission's Ka-band processing round. Based on simulations conducted using the technical characteristics of Viasat's proposed earth stations under typical operating conditions and the information in the NGSO FSS applications, the proposed operations are unlikely to cause harmful interference into NGSO systems.

Moreover, Viasat has a long history of successfully operating earth stations in the 18.8-19.3 GHz and 28.6-29.1 GHz band segments while protecting NGSO FSS operations, including through operations of aeronautical earth stations in these bands with ViaSat-1. The Commission has approved ViaSat-1 and ViaSat-2 based on Viasat's demonstrated ability to protect primary NGSO FSS operations in these bands. Specifically, the Commission has approved Viasat's demonstrated capability to cease operations in these bands in the event of an in-line event between Viasat's communications and the NGSO system's communications. As with all other Viasat terminals operating within the ViaSat-1 and ViaSat-2 networks, each earth station is dynamically controlled and can shut down operations in the bands in which NGSO systems have priority when an NGSO satellite is within the minimum line-of-sight separation angle established either through coordination or calculated based on the system characteristics of each NGSO system operating, or expected to operate, in these bands. The Technical Description details the analysis of the predicted harmful interference from the proposed operations into each of the potentially affected NGSO systems and any separation angle necessary to protect those systems.

As that analysis demonstrates and as discussed above, even without maintaining any angular separation, harmful interference would not reasonably be expected to occur.

Notably, Viasat has coordinated its aeronautical earth station operations for ViaSat-2 with OneWeb and will continue these coordinations with any future potentially affected NGSO applicants.

## **5. Compatibility with UMFU Services in the 27.5-28.35 GHz Band Segment**

In the 27.5-28.35 GHz band segment, UMFU is designated as primary with protections for certain FSS earth stations pursuant to Section 25.136 of the Commission's rules. Those protections extend to a maximum of three individually-licensed earth stations per county, and that are sited in accordance with the requirements of Section 25.136.<sup>15</sup> The area around the earth station in which it generates a PFD, at 10 meters above ground level, of greater than or equal to  $-77.6 \text{ dBm/m}^2/\text{MHz}$  may not cover certain population thresholds or certain roadways or venues, and must coordinate with any UMFU operations within the covered area.

By this modification, Viasat seeks to use the 27.5-28.35 GHz band to operate aeronautical earth stations on aircraft flying at 10,000 feet or more above ground level. Viasat does not seek to operate these earth stations while on the ground or at altitudes lower than 10,000 feet. Viasat seeks a waiver of Section 25.136 and the U.S. Table as needed to allow ESIM operations at 27.5-28.35 GHz on a blanket basis and without regard to the number of authorized earth stations.

The Commission has previously authorized ESIMs in the 28.1-28.35 GHz portion of this band based on a technical showing that such operations at 10,000 feet or more above ground level would not cause harmful interference into primary terrestrial wireless services in the band.<sup>16</sup> The attached Technical Description demonstrates that earth station transmissions at 27.5-28.35 GHz on aircraft flying 10,000 feet or more above the ground, which are pointed upward toward the satellite, will have a PFD measured 10 meters above the ground that is far below the protection level for UMFU stations. Because the PFD measured at 10 meters above ground level would not exceed  $-77.6 \text{ dBm/m}^2/\text{MHz}$  anywhere, the proposed operations would not cover any population or any restricted site, and does not require coordination with any licensed UMFU operations.<sup>17</sup> Further, as a non-conforming user of this band segment, Viasat accepts the risk of interference from conforming spectrum uses.

In addition, to the extent necessary to authorize the operation of the earth stations at 27.5-28.35 GHz without specifying their locations, Viasat seeks a waiver of Section 25.115(e)(2) of the Commission's rules.<sup>18</sup> Licensing multiple earth stations through a single authorization serves the public interest by reducing administrative costs and delays and by accelerating system deployment, and thereby facilitating the delivery of expanded services to end users. The

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<sup>15</sup> 47 C.F.R. § 25.136(a)

<sup>16</sup> See Viasat, Inc., File No. SES-MOD-20160108-00029, Call Sign E120075 (granted June 29, 2016).

<sup>17</sup> See 47 C.F.R. § 25.136(a)(ii)-(iv).

<sup>18</sup> See 47 C.F.R. § 25.115(e)(2).

Commission has previously issued licenses for GSO earth stations in segments of the Ka band other than those identified in Section 25.114(e) without specifying the locations of the earth stations in advance, including aeronautical earth stations operating in the 28.1-28.35 GHz portion of the spectrum requested in this application.<sup>19</sup> Therefore, grant of the waiver request would be consistent with Commission precedent.

## **6. Compatibility with Fixed Services in the 18.1-18.3 GHz Band Segment**

The 18.1-18.3 GHz band segment is allocated primarily for FS, with a secondary allocation for FSS downlinks. Viasat's request to add the 18.1-18.3 GHz band segment is merely a correction to the frequencies identified on the license. In the original application, Viasat requested authority to operate the earth stations in receive mode across the entire 17.7-18.3 GHz band segment, and demonstrated that downlink transmissions from ViaSat-2 are within the power-flux density limits at the earth's surface set forth in Article 21 of the ITU Radio Regulations and thus, would not cause harmful interference into primary fixed service operations throughout this band. However, the frequencies identified in the Form 312 inadvertently excluded the 18.1-18.3 GHz portion of this band, and the resulting license identifies only the 17.7-18.1 GHz portion of this band. Based on the same demonstration originally provided for compatibility of FSS downlinks in the 17.7-18.3 GHz band, Viasat seeks to correct the license to include the 18.1-18.3 GHz frequencies.<sup>20</sup>

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<sup>19</sup> See Viasat, Inc., File No. SES-MOD-20160108-00029, Call Sign E120075 (granted June 29, 2016).

<sup>20</sup> See Viasat, Inc., File No. SES-LIC-20180123-00055, Exhibit A at 5 (filed Jan. 23, 2018); see also ViaSat-2 Authorization, File No. SAT-MOD-20160527-00053, Att. to Grant at ¶ 12 (granted Jan. 12, 2017) (authorizing downlinks on ViaSat-2 in the 17.7-18.3 GHz band).