11 July 2018

Ex Parte

Marlene H. Dortch
Secretary, Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: 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

Dear Ms. Dortch:

Iridium Communications, Inc. ("Iridium") submits this letter to follow up on its 14 June 2018 discussion with the Office of Engineering and Technology ("OET") about interference from earth stations in motion ("ESIMs") into Iridium's feeder-link operations.[1]

As previously noted, in that meeting, Iridium and OET staff discussed the challenges of managing the interference that would be produced by aeronautical and other ESIMs communicating with satellites in geostationary-satellite orbit ("GSO") in the 29.25-29.3 GHz band. As discussed below, although managing interference from ESIMs of all types would be extraordinarily difficult, coordinating with aeronautical ESIMs would be orders of magnitude more complex and much less predictable—and thus pose needless risks to the Iridium network and its more than one million subscribers.

All ESIMs—terrestrial, maritime, and aeronautical—pose risks to Iridium's network in the 29.25-29.3 GHz band. Iridium uses the 29.25-29.3 GHz band for Earth-to-space communications from its feeder-link earth stations. Currently, Iridium coordinates its use of the 29.25-29.3 GHz band with GSO satellite operators that use the band for transmissions from *fixed* earth stations to their respective GSO satellites. Notwithstanding the dynamic geometry of Iridium's feeder links, which must track Iridium's satellites at all possible azimuth angles and all elevation angles down to five degrees above horizon, these coordinations are generally possible. The potential for interference from these GSO earth stations occurs as Iridium satellites pass through the GSO earth station uplink transmissions. Because the interfering GSO earth stations are fixed, the number and duration of these interference events can be determined *a priori* using computer-aided analyses in order to establish whether the summation of all of interference events in the aggregate will be acceptable. This allows Iridium and GSO operators to define exclusion zones knowing with some confidence that transmissions beyond those exclusion zone boundaries will not cause unacceptable levels of interference to the Iridium network.

[1] *See* Letter from Scott Blake Harris, Counsel to Iridium, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 17-95 (June 18, 2018).

The same kind of coordination is not possible for ESIMs communicating with a GSO network. The aggregate interference received by an Iridium satellite from multiple ESIMs cannot practically be determined *a priori* since the number and locations of these ESIMs with respect to Iridium satellites moving in space are unknown. As Iridium has previously explained, "aggregate interference" in this case does not primarily refer to *simultaneous* interference from multiple ESIMs that combine in interference power.[2] Rather, "aggregate interference" in this case refers to the summation of the multiple, independent interference events generated by each ESIM over time, each of which contributes to periods during which the Iridium feeder link becomes unavailable. Thus, while it is certainly the case that the more transmitting ESIMs there are in the region surrounding the Iridium gateway, the higher the total unavailability of Iridium's feeder links, it is not possible to predict how much link unavailability Iridium will suffer just by assuming a maximum number of ESIMs transmitting simultaneously. Iridium and GSO operators also must know the locations of each transmitting ESIM terminal at every point in time and the relationships at every point in time between those locations and Iridium's satellites. Obviously, this information cannot be determined in advance of ESIM deployment such that reliable exclusion zones might be developed.

Nor can ESIM interference realistically be managed in real time. Because each ESIM operates independently of the rest, there is no obvious way—and certainly none described on the record—to detect and limit the aggregate interference from multiple ESIMs post deployment. When multiple ESIMs in the vicinity of an Iridium gateway transmit to a GSO satellite, no single ESIM terminal would be aware of how much interference the other ESIMs are contributing and have contributed towards the threshold of acceptable interference at the Iridium satellites. The fact that the interference produced by each ESIM depends on the location of the ESIM relative to Iridium satellites that *also* are in constant motion further compounds the problem. Even if an ESIM operator's Network Control and Monitoring Center ("NCMC") could track how many ESIMs are transmitting and where they are, the ESIM operator would not be able to develop knowledge of *how much interference* each ESIM contributes at the Iridium satellite, and thus the amount and duration of aggregate interference received by Iridium's continuously moving satellite receivers. Moreover, while Iridium certainly will notice the unavailability of its feeder links, it would be unable to identify the ESIMs responsible for breaching its network's protection criteria—or even confirm that the cause is an ESIM at all.

Aeronautical ESIMs magnify these risks exponentially. Aeronautical ESIMs by far generate the greatest amount of interference uncertainty—and therefore risk—to the Iridium system.

- Unlike land and maritime ESIMs, *aeronautical ESIMs have the ability to be situated directly in-line with the Iridium feeder-link main beam to the Iridium satellite, as the ESIM is flying over the Iridium gateway*. Land and maritime ESIMs could certainly be located in close proximity to the Iridium gateway, but aeronautical ESIMs will always have the potential to produce greater levels of interference into the Iridium satellites.

---

[2] *See, e.g.*, Letter from Scott Blake Harris, Counsel to Iridium, to Marlene H. Dortch, Secretary, FCC, at 1-2, IB Docket No. 17-95 (Mar. 22, 2018); Comments of Iridium at 14-16, IB Docket No. 17-95 (July 31, 2017); Reply Comments of Iridium at 5-7, IB Docket No. 17-95 (Aug. 30, 2017).

- Aeronautical ESIMs also create a much more dynamic interference environment that is even harder to define *a priori* or manage in real time. *Aeronautical platforms inherently move at faster speeds, and over a very large number of flight paths, resulting in a greater number of possible ESIMs moving in and out of a region near Iridium's feeder-link earth stations.* These challenges cannot be overcome by assuming that ESIMs fly along defined routes. Not only do the times and flight paths of airliners change frequently—and even midflight—but ESIM operators do not know at the time of coordination which flights will be equipped with ESIM terminals. Moreover, many general aviation and military aircraft do not operate pursuant to scheduled flights at all.

- *Aeronautical ESIMs introduce a third dimension to the interference environment*. As discussed, the interference from an ESIM into an Iridium feeder link depends on the location of the ESIM relative to continuously moving Iridium satellites. For aeronautical ESIMs, that location would change continuously in three dimensions based on the altitude of the plane. As explained, developing a two-dimensional interference exclusion zone around each Iridium feeder-link earth station for land or maritime ESIMs would be difficult enough. But a three-dimensional exclusion zone that is a function of aeronautical ESIM latitude, longitude, *and* altitude clearly would be prohibitively complex to define and implement—and no one has even attempted to provide a method for doing so on this record.[3] Indeed, as shown in the attached slide previously submitted by Iridium, the three-dimensional exclusion zone would not simply extend vertically from the Earth's surface.[4] It would extend along a continually changing slant path toward each Iridium victim satellite at numerous azimuth and elevation angle pairs—of which the slide depicts just one.

Example interference scenarios illustrate the exceptional risks of ESIMs, and especially aeronautical ESIMs, to the Iridium network:

- ***Case 1:*** Consider a single ESIM producing interference that just barely meets Iridium's feeder-link short-term percentage of time protection criterion (*i.e.*, interference falls below a specified power level for a given percentage of time). This single ESIM may be a small aircraft that is primarily flying in proximity to an Iridium gateway, or it may be a passenger

3 Inmarsat filed the results of a simulation purporting to show that if one shifts GSO terminals from the ground to a known higher altitude, the size of the two-dimensional exclusion zone projected on the Earth's surface would remain relatively unchanged. *See* Letter from Jack Wengryniuk, Inmarsat, to Marlene H. Dortch, Secretary, FCC, IB Docket No. 17-95 (June 28, 2018); John P. Janka and Elizabeth R. Park, Counsel to Viasat, Inc., and M. Ethan Lucarelli and Giselle Creeser, Inmarsat, Inc., to Marlene H. Dortch, Secretary, FCC, at Attachment pp. 16-18, IB Docket No. 17-95 (Nov. 6, 2017). Whatever the merits of Inmarsat's simulation, it bears no relevance to the feasibility of deploying aeronautical ESIMs in the 29.25-29.3 GHz band. First, aeronautical ESIMs flying *outside* a two-dimensional exclusion zone projected on the Earth's surface could nevertheless be located *inside* the three-dimensional exclusion zone that Inmarsat never bothered to calculate. *See* Letter from Scott Blake Harris, Counsel to Iridium, to Marlene H. Dortch, Secretary, FCC, at 7-8, IB Docket No. 17-95 (Jan. 18, 2018). Second, Inmarsat bizarrely assumed that the interfering terminals were operating at *fixed* locations above the Earth, with no movement in *any* dimension over time—even though this proceeding clearly is focused on ESIMs and not fixed earth stations. *Id.*

4 *See* Attachment A; Letter from Scott Blake Harris, Counsel to Iridium, to Marlene H. Dortch, Secretary, FCC, at Attachment p.8, IB Docket No. 17-95 (Sept. 25, 2017).

jet that routinely flys over the Iridium gateway several times a day. Now consider a second, or third or fourth, ESIM flying near the same Iridium gateway, but not quite as close. Even though this additional ESIM does not produce as much interference as the first ESIM, the interference from both ESIMs in the aggregate could exceed Iridium's protection criterion, regardless whether both ESIMs transmit at the same time. Unfortunately, neither of these two ESIMs, nor the operator's NCMC, has any idea how much interference all system terminals are producing to Iridium's satellites, and the ESIM network operator thus cannot know to shut down either ESIM's emissions in the 29.25-29.3 GHz band.

- ***Case 2:*** Assume that a single ESIM is operating in the region of an Iridium gateway in such a way and with such a high duty cycle that it, by itself, is in violation of Iridium's protection criterion. Because this interference is intermittent, other ESIMs and the NCMC would be unaware of this situation, and the other ESIMs would unknowingly produce unacceptable interference any time they transmit near the Iridium gateway.

Both scenarios demonstrate the enormous difficulty of managing the risk of aggregate ESIM interference as applied to aeronautical terminals. The prospect that a large number of aeronautical platforms will move in and out of regions around Iridium gateways unpredictably, at high rates of speed, and along three dimensions makes these interference scenarios both likely to occur, and virtually impossible to define and guard against *a priori* or to detect and mitigate in real time.

Importantly, both scenarios also describe variations within a *single GSO network's ESIM operations*. Other GSO ESIM operators will have no knowledge of how much interference the other GSO networks are producing and will be unable to manage the overall interference to Iridium's satellites. Furthermore, as explained, because all of this interference will be occurring within Iridium's very large satellite footprint, the particular offending ESIM(s) will be unknown by Iridium as well, further contributing to the unmanageable nature of the interference.

* * *

Allowing satellite networks to generate unmanageable interference to other satellite networks contradicts core spectrum management principles and is contrary to the public interest. Yet the Commission risks doing just that by permitting ESIMs in the 29.25-29.3 GHz band. Aeronautical ESIMs in particular pose extraordinary risks of interference that cannot be managed by ESIM operators, who would have no way of determining how much interference they are producing or developing and enforcing three-dimensional exclusion zones. Iridium urges the Commission to consider these issues as it finalizes rules for ESIMs in the Ka-band.

Sincerely,

Scott Harris

Scott Blake Harris
Counsel to Iridium Communications, Inc.

Enclosure

ATTACHMENT

ADDITIONAL AERONAUTICAL ESIM COORDINATION PROBLEMS

- Aeronautical ESIMs pose an additional problem when addressing protection of Iridium feeder links
- The standard interference protection zone needed around an Iridium feeder link earth station is defined as a two-dimensional region on the Earth's surface in which an interfering GSO earth station is not allowed to operate co-frequency if it won't meet Iridium protection criteria
- Even if a protection zone could be determined for terrestrial ESIMs, it's obvious that aeronautical ESIMs at altitude force the need for a three-dimensional protection zone that extends up into the national air space
- The required protection zone does not merely extend vertically from the Earth's surface – it extends along the (continually changing) slant path towards the victim Iridium satellite (see figure), making the definition and enforcement of this protection zone challenging