IRIDIUM NEXT ENGINEERING STATEMENT

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The following Engineering Statement and electronically filed FCC Form 312, Main Form and Schedule S[1] respond to the requirements specified in Sections 25.114, 25.143 and other FCC rules that address the frequency bands that are to be used by the Iridium NEXT Satellite System.

A. APPLICANT

§25.114(c)(1) and (2): Name and address and telephone number of the applicant:

Iridium Constellation LLC
1750 Tysons Boulevard
Suite 400
Mclean, Virginia 22102
Phone 703-287-7400
Fax 703-287-7459
Attention: Donna Bethea Murphy

Name, address and telephone number of the person(s), including counsel, to whom inquiries or correspondence should be directed:

Donna Bethea Murphy above should receive inquiries and correspondence for the Iridium NEXT system, with a copy to:

Wiley Rein LLP
1776 K Street, NW
Washington, DC 20006
Phone 202-719-4975
Attention: Jennifer D. Hindin

B. AUTHORIZATION REQUESTED

§25.114(c)(3): Type of authorization requested (e.g. launch authority, station license, modification of authorization).

Iridium Constellation LLC hereby seeks authority to modify Iridium's non-geostationary satellite orbit Big LEO Mobile Satellite Service (MSS) license (FCC Call sign S2110). The modification requests authority to launch and operate up to 66 second generation replacement

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[1] The term "transponder" is used herein as a convenience to correspond to Schedule S. The Iridium NEXT Space Vehicle (SV) uses on board processing and does not have transponders per se.

satellites to replenish, augment and enhance Iridium's currently authorized first generation MSS system. Iridium's second generation satellite system is called Iridium NEXT. Iridium is also requesting authority to launch up to an additional 15 second generation satellites as in orbit spare satellites. Initially, six of these spare satellites will be deployed with the launch of the 66 replacement satellites; one spare satellite to correspond to each of the orbital planes. The remaining nine satellites will be ground spares to be deployed into orbit as the future needs of the Iridium NEXT constellation dictate.

§25.114(e): Applicants requesting authority to launch and operate a system comprised of technically identical, non-geostationary satellite orbit space stations may file a single "blanket" application containing the information specified in paragraphs (c) and (d) of this section for each representative space station.

The instant application is requesting a blanket authorization for the Iridium NEXT second generation satellite system and is providing responses to the various elements of Section 25.114(c) and (d) in the following information.

§25.165(e): A replacement satellite is one that is:

(1) Authorized to be operated at the same orbit location, in the same frequency bands, and with the same coverage area as one of the licensee's existing satellites, and

(2) Scheduled to be launched so that it will be brought into use at approximately the same time as, but no later than, the existing satellite is retired.

The Iridium NEXT satellite system complies with the replacement satellite requirements in 25.165(e). Iridium NEXT uses the same orbital parameters to provide the same orbital coverage using the same frequency bands as the current ("Block 1") Iridium satellite constellation. The Iridium NEXT constellation schedule is to place the Iridium NEXT satellites into the current Iridium constellation in order to provide a seamless transition to the Iridium NEXT satellite network from the Iridium Block 1 satellite network. Therefore Iridium is not required to post a bond pursuant to Section 25.165 for the Iridium NEXT second generation satellite system.

C. IRIDIUM NEXT DESCRIPTION

§25.114(d): The following information in narrative form shall be contained in each application:**§25.114(d)(1): General description of overall system facilities, operations and services;**

Iridium's second generation constellation, known as Iridium NEXT, will be comprised of 66 low earth orbiting satellites that will serve as replacements for the first generation satellites. The general configuration of the NEXT constellation is described in the response to 25.114(c)(6). The NEXT satellites will have the same configuration as the first generation (Iridium Block 1) satellites with 48 Mobile Satellite Service (MSS) L band beams per satellite to be used in a Time Division Duplex manner for the forward and return service links and two beams per satellite in both the forward and return direction for the feeder links. There are also four intersatellite link beams for communication with the Iridium NEXT (or Block 1) satellites forward and aft of the reference satellite in the same orbital plane and with two Iridium NEXT (or Block 1) satellites that are in each of the two adjacent orbital planes. The satellites will be deployed in near polar orbits in 6 orbital planes with 11 satellites per orbital plane.

The Iridium NEXT satellite system has a hosted payload for its Aireon LLC joint venture. The hosted payload currently is planned to be authorized by another administration and is described in Exhibit D for informational purposes only.

The technical design and orbital parameters of the Iridium NEXT satellite system are described in greater detail in the FCC Form 312, Main Form and Schedule S and Application Narrative.

§25.143(b): *Qualification Requirements*—(1) *General Requirements*. Each application for a space station system authorization in the 1.6/2.4 GHz Mobile-Satellite Service or 2 GHz

Mobile-Satellite Service shall describe in detail the proposed satellite system, setting forth all pertinent technical and operational aspects of the system, and the technical and legal qualifications of the applicant. In particular, each application shall include the information specified in § 25.114. Non-U.S. licensed systems shall comply with the provisions of § 25.137.

(2) *Technical qualifications.* In addition to providing the information specified in paragraph (b)(1) of this section, each applicant and letter of intent filer shall demonstrate the following:

(i) That a proposed system in the 1.6/2.4 GHz MSS frequency bands employs a non-geostationary constellation or constellations of satellites;

(ii) That a system proposed to operate using non-geostationary satellites be capable of providing Mobile-Satellite Service to all locations as far north as 70° North latitude and as far south as 55° South latitude for at least 75% of every 24-hour period, i.e., that at least one satellite will be visible above the horizon at an elevation angle of at least 5° for at least 18 hours each day within the described geographic area;

(iii) That a system proposed to operate using non-geostationary satellites be capable of providing Mobile-Satellite Service on a continuous basis throughout the fifty states, Puerto Rico and the U.S. Virgin Islands, i.e., that at least one satellite will be visible above the horizon at an elevation angle of at least 5° at all times within the described geographic areas; and

The Iridium NEXT constellation's coverage is global and is available on a continuous basis from 90°N to 90°S. Consequently, the Iridium NEXT constellation will fulfill the coverage requirements of 25.143(b) by being capable of providing service as far north as 70 North Latitude and as far south as 55 South Latitude for at least 75 percent of every 24 hour period and on a continuous basis throughout the fifty US states, Puerto Rico and US Virgin Islands.

D. ORBITAL INFORMATION

§25.114(c)(6):. For satellites in non-geostationary satellite orbits

(i) the number of space stations and applicable information relating to the number of orbital planes

(ii) the inclination of the orbital planes

(iii) the orbital period

(iv) the apogee

(v) the perigee

(vi) the arguments of Perigee.

(vii) actual service arcs and

(viii) the right ascension of the ascending node(s).

The Iridium NEXT satellite constellation consists of 66 satellites that will replace, one for one, the first generation Iridium satellites. Iridium NEXT will have the same orbital characteristics as the first-generation constellation; 6 near-polar orbital planes with 11 satellites per plane at a nominal circular altitude of 780km. The precise positions of the satellites are described as follows:

66 NEXT SVs, 11 equally spaced SV/Plane, 6 Planes

Nodal period = 6028 sec (SMA: 7155.804 km based on GEMT3 18X18)

Inclination = 86.4° (as of June 01, 1996; currently 86.398°)

Eccentricity = 0.001260

Argument of Perigee = 90°

Ascending Node/Plane Spacing: 31.6°;

Seam (between planes 1 & 6 ascending/descending nodes) = 22°

dfps = -(360/11) * (((1+(-1)^p)/4) + s - 1) + (p-1) * fphase

Where

dfps is the nominal short period mean argument of latitude of a satellite in a given plane and slot relative to a satellite in plane 1 and slot 1

f phase is the in-track phase offset between neighboring planes having the value of -1.3 degrees

p is the plane number (i.e., 1, 2, 3, 4, 5 or 6)

s is the slot number (i.e., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 11)

This orbit topology has been selected to provide full global coverage, ranging from equatorial to both the north and south poles, so that the service "arc" for each satellite covers the entire globe. The constellation is flown with relative position between the satellites precisely maintained. The -1.3 degree "stagger" between slot locations (the "fphase" parameter above) serves to maximize the intersatellite miss distance at the polar crossing while minimizing the impact on equatorial coverage.

The service area is the entire globe so that the active service arc for each satellite to provide MSS Services in L band can be the entire Earth's surface. Actual MSS service can be geographically restricted to regions where service has been appropriately authorized by the relevant administration. The Ka band subsystem is also capable of providing service anywhere in the world, but these are practically limited to those areas where appropriate ground stations (teleports) are located. The ISS beams do not intersect the Earth's surface. The fore and aft ISS beams are fixed to the satellite body in the direction of the forward or aft "sister" satellite. The left and right ISS beams are steerable to connect with the adjacent left forward or right aft sister in the adjacent plane. The left/right links are not used across the counter-rotating seam in the constellation. They are also shut down at high latitudes when the range between satellites drops below a configurable minimum distance (nominally 2880 km) and re-acquire on the other side of the pole when the range increases. See the Figure C below for a polar view of the constellation that illustrates a number of these features. In this figure, satellites to the right of the seam are travelling into the page, and satellites to the left of the seam are travelling up out of the page.

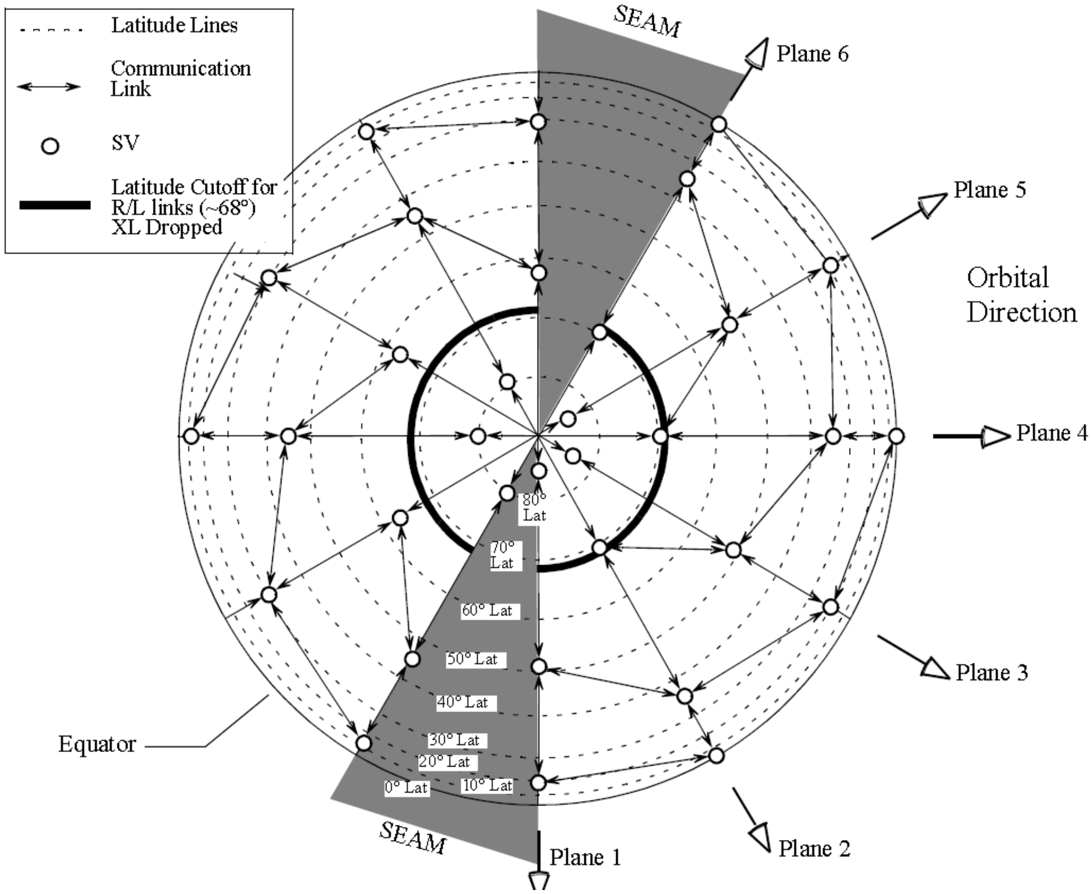

FIGURE C: Polar View of the Iridium NEXT Constellation

Orbital information is provided in Schedule S for the six in orbit spare satellites that will be deployed with the 66 satellite Iridium NEXT constellation.

E. CONSTRUCTION AND LAUNCH SCHEDULE

§25.114 (c)(12): Dates by which construction will be commenced and completed, launch date, and estimated date of placement into service.

Iridium is building 81 satellites for the Iridium NEXT satellite constellation; 66 operational replacement and 15 spare satellites. The first two satellites will be ready for launch Feb. 2015 and the remaining satellites will be launched during 2015 through 2017. The Iridium NEXT satellites will replace existing Iridium Block 1 satellites incrementally throughout this period. The proposed date of operation of the complete Iridium NEXT constellation is approximately mid 2017 pursuant to the launch plan provided below. In any event the complete Iridium NEXT constellation will be phased into the first generation satellite constellation to ensure that the Iridium NEXT satellite constellation is operational before the anticipated end of life of the first generation satellites.

1. *Launch Plan Overview*

Iridium plans to launch NEXT over a period of approximately two years, using two launch vehicles. The primary launch vehicle will be the Falcon 9 from SpaceX, a US company headquartered in California. The Falcon 9 is a new launch vehicle, and will be capable of launching 10 Iridium NEXT satellites on each launch from Vandenburg AFB in California. The other launch vehicle, used for the first launch and possibly later contingency launches, is the Dnepr operated by ISC Kosmotras, a joint venture between Russia, Ukraine, and Kazakhstan. The Dnepr is capable of launching two Iridium NEXT satellites on each attempt from a base in Yasny, Russia.

The current launch plan is represented in the following Table 1:

Date	Vehicle	# Sats
Feb 2015	Dnepr	2
Jul 2015	Falcon 9	10
Oct 2015	Falcon 9	10
Jan 2016	Falcon 9	10
May 2016	Falcon 9	10
Sep 2016	Falcon 9	10
Jan 2017	Falcon 9	10
May 2017	Falcon 9	10

TABLE 1: Iridium NEXT SATELLITE LAUNCH PLAN

Note that these dates should be regarded as nominal launch dates that can potentially be delayed for a number of reasons outside of Iridium's direct control.

The target plane for the first launch will be determined approximately 6 months before launch, and will depend on the health of the existing constellation at that time. An engineering and business decision will be made at that time to determine which plane is the optimal target, based on existing satellite health, constellation traffic loading, and priorities for later deployment (since the subsequent launch strategy is strongly affected by the target plane for first launch). The plan is to replace the existing satellites one by one, in place, as replacements reach their target orbit and complete early checkout. Iridium requests to reserve the option to retain some of the existing satellites in the sparing orbit as potential spares. Full replacement of the existing constellation is to be completed shortly after final launch in May of 2017.

2. *Orbit Insertion, Ascent, Drifting, Overview*

The launch rocket will deploy the Iridium NEXT satellites into a 625km altitude circular orbit with an inclination of 86.66°. This combination of altitude and inclination produces a plane precession rate that matches the rate at the mission orbit of 780km altitude and 86.4° inclination. From this insertion orbit the satellites, under ground control, will utilize their onboard propulsion system to ascend to an initial storage orbit at 700km altitude and 86.53° inclination. When this storage orbit is reached, the satellites will start initial on-orbit checkout (IOT) of all subsystems, but will not support commercial service.

At completion of on orbit checkout, a satellite will proceed to one of 4 possible destinations: ascent to mission at 780km altitude and 86.4° inclination; eastward drift at 700km altitude and 85.91° inclination; westward drift at 750km altitude and 87.08° inclination; or on orbit storage at 750km altitude and 86.44° inclination.

F. SATELLITE NETWORK CONTROL

§25.272: General inter-system coordination procedures.

(a) Each space station licensee in the Fixed-Satellite Service shall establish a satellite network control center which will have the responsibility to do the following:

(1) Monitor space-to-Earth transmissions in its system (thus indirectly monitoring uplink earth station transmissions in its system) and

(2) Coordinate transmissions in its satellite system with those of other systems to prevent harmful interference incidents or, in the event of a harmful interference incident, to identify the source of the interference and correct the problem promptly.

(b) Each space station licensee shall maintain on file with the Commission and with its Columbia Operations Center in Columbia, Maryland, a current listing of the names, titles, addresses and telephone numbers of the points of contact for resolution of interference problems. Contact personnel should include those responsible for resolution of short term, immediate interference problems at the system control center, and those responsible for long term engineering and technical design issues.

The Iridium NEXT satellite system uses the same Network Management and Control center as the first generation satellite system.

Iridium's primary control center is the Space Network Operations Center (SNOC) located in Leesburg, Virginia. All satellite command and control is generated there, and all telemetry is retrieved and archived there. Network operations, feederlink antenna contact plans, and global resource allocation are also controlled from this location.

§25.114(c)(9): Arrangement for Tracking, Telemetry and Control

The TT&C ground station antenna sites are at Chandler, AZ, Fairbanks, AK, Yellowknife Canada, Iqaluit Canada, and Svalbard Norway. This does not include other commercial and government traffic Ka band earth stations. The TT&C ground stations are all connected to the SNOC using commercial high-availability, secure leased network capabilities.

The TT&C frequencies are described in **Section G. FREQUENCY and POLARIZATION.**

§25.207: Cessation of Emissions

Space stations shall be made capable of ceasing radio emissions by the use of appropriate devices (battery life, timing devices, ground command, etc.) that will ensure definite cessation of emissions

All downlink and intersatellite link transmissions from each satellite can be turned on and off by ground telecommand, thereby causing cessation of emissions from the satellite, as required.

G. FREQUENCY and POLARIZATION

§25.114(c)(4)(i): Radio frequencies and polarization plan (including beacon, telemetry, and telecommand functions) center frequency and polarization of transponders (both transmitting and receiving frequencies)

The Iridium NEXT satellite constellation has the capability in its L-band service links to provide mobile satellite service in 1616.0-1626.5 GHz using Time Division Duplex (TDD) between the uplink and the downlink signals.

There are 252 carriers in the 1616-1626.5 MHz band in both the uplink and downlink with carrier spacings of 41.667 KHz. The necessary bandwidth for each of these carriers is 35 or 36 kHz.[2] These carriers can be combined to provide wider bandwidth signals with necessary bandwidth up to 288 KHz as indicated in Schedule S. These 252 carrier frequencies can be grouped into sub bands of 8 carriers. The 32nd sub group has 4 carriers. These carriers are for both uplink and downlinks and each uplink carrier can be assigned independently of the downlink carrier. Table 2 provides a listing of the carriers for subbands 1 through 6 (1616- 1618 MHz) and subband 30-32 (1625.66667- 1626.5 MHz). Iridium will use the appropriate carrier to maintain signals within the assigned bandwidth. Sub Bands 7 through 29 (carriers 49 through

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2 In this discussion, we show necessary channel bandwidth for clarity. The assigned bandwidth for each carrier type, including Doppler correction, is listed in Schedule S table S11.

232) can be developed by repeating the same pattern of frequencies for the 2 MHz between 1616 and 1618 MHz until carriers 233 – 252 which are listed below as subbands 30 through 32.

TABLE 2.

Duplex subbands 1-6 (1616-1618 MHz) and 30-32 (1625.666667- 1626.5 MHz)

Subband	Freq. Access	absolute	Lower Edge (MHZ)	Center (MHz)	Upper Edge (MHZ)
1	1	1	1616.000000	1616.020833	1616.041667
	2	2	1616.041667	1616.062500	1616.083333
	3	3	1616.083333	1616.104167	1616.125000
	4	4	1616.125000	1616.145833	1616.166667
	5	5	1616.166667	1616.187500	1616.208333
	6	6	1616.208333	1616.229167	1616.250000
	7	7	1616.250000	1616.270833	1616.291667
	8	8	1616.291667	1616.312500	1616.333333
2	1	9	1616.333333	1616.354167	1616.375000
	2	10	1616.375000	1616.395833	1616.416667
	3	11	1616.416667	1616.437500	1616.458333
	4	12	1616.458333	1616.479167	1616.500000
	5	13	1616.500000	1616.520833	1616.541667
	6	14	1616.541667	1616.562500	1616.583333
	7	15	1616.583333	1616.604167	1616.625000
	8	16	1616.625000	1616.645833	1616.666667

3	**1**	**17**	1616.666667	1616.687500	1616.708333
	2	**18**	1616.708333	1616.729167	1616.750000
	3	**19**	1616.750000	1616.770833	1616.791667
	4	**20**	1616.791667	1616.812500	1616.833333
	5	**21**	1616.833333	1616.854167	1616.875000
	6	**22**	1616.875000	1616.895833	1616.916667
	7	**23**	1616.916667	1616.937500	1616.958333
	8	**24**	1616.958333	1616.979167	1617.000000
4	**1**	**25**	1617.000000	1617.020833	1617.041667
	2	**26**	1617.041667	1617.062500	1617.083333
	3	**27**	1617.083333	1617.104167	1617.125000
	4	**28**	1617.125000	1617.145833	1617.166667
	5	**29**	1617.166667	1617.187500	1617.208333
	6	**30**	1617.208333	1617.229167	1617.250000
	7	**31**	1617.250000	1617.270833	1617.291667
	8	**32**	1617.291667	1617.312500	1617.333333
5	**1**	**33**	1617.333333	1617.354167	1617.375000
	2	**34**	1617.375000	1617.395833	1617.416667
	3	**35**	1617.416667	1617.437500	1617.458333
	4	**36**	1617.458333	1617.479167	1617.500000
	5	**37**	1617.500000	1617.520833	1617.541667
	6	**38**	1617.541667	1617.562500	1617.583333
	7	**39**	1617.583333	1617.604167	1617.625000

	8	40	1617.625000	1617.645833	1617.666667
6	1	41	1617.666667	1617.687500	1617.708333
	2	42	1617.708333	1617.729167	1617.750000
	3	43	1617.750000	1617.770833	1617.791667
	4	44	1617.791667	1617.812500	1617.833333
	5	45	1617.833333	1617.854167	1617.875000
	6	46	1617.875000	1617.895833	1617.916667
	7	47	1617.916667	1617.937500	1617.958333
	8	48	1617.958333	1617.979167	1618.000000

The Subbands 7 through 29 repeat this pattern for every 2MHz until the following subband 30

30	1	233	1625.666667	1625.687500	1625.708333
	2	234	1625.708333	1625.729167	1625.750000
	3	235	1625.750000	1625.770833	1625.791667
	4	236	1625.791667	1625.812500	1625.833333
	5	237	1625.833333	1625.854167	1625.875000
	6	238	1625.875000	1625.895833	1625.916667
	7	239	1625.916667	1625.937500	1625.958333
	8	240	1625.958333	1625.979167	1626.000000
31	1	241	1626.000000	1626.020833	1626.041667
	2	242	1626.041667	1626.062500	1626.083333
	3	243	1626.083333	1626.104167	1626.125000
	4	244	1626.125000	1626.145833	1626.166667
	5	245	1626.166667	1626.187500	1626.208333

6	246	1626.208333	1626.229167	1626.250000
7	247	1626.250000	1626.270833	1626.291667
8	248	1626.291667	1626.312500	1626.333333
32 1	249	1626.333333	1626.354167	1626.375000
2	250	1626.375000	1626.395833	1626.416667
3	251	1626.416667	1626.437500	1626.458333
4	252	1626.458333	1626.479167	1626.500000

There are five simplex carriers in the 1626-1626.5 GHz band; each having a 35 kHz necessary bandwidth on the following downlink frequencies:

1626.1042 MHz

1626.1458 MHz

1626.2708 MHz

1626.3958 MHz

1626.4375 MHz

These simplex carriers also employ spacings of 41.667 kHz. The ring alert carrier is 1626.2708 MHz and the other 4 carriers are messaging carriers for paging and acquisition. There are 7 other 41.667 kHz carrier locations that are unused in 1626-1626.5 MHz and remain as guardbands amongst these simplex carriers.

The polarization is Right Hand Circular (RHC) in both the uplink 1616-1626.5 MHz and downlink 1616-1626.5 MHz band.

The Iridium NEXT feeder links, which are in the Ka-band, operate in 19.4 GHz – 19.6 GHz for the downlink and 29.1- 29.3 GHz for the uplink. There are 13 transponders /channels each in the uplink and downlink spaced at 15 MHz with a necessary bandwidth of 14 MHz. The specific center frequencies for these transponders/channels are provided in Schedule S.[3] The feeder uplink transponders can be assigned independently of the feeder downlink transponders. The polarization for these feeder link transponders is RHC in the uplink (29.1- 29.3 GHz) and Left Hand Circular (LHC) in the downlink (19.4- 19.6 GHz).

The Iridium NEXT satellites also have four intersatellite links on each satellite that communicate with the Iridium NEXT satellites that are forward and aft in the same orbit and to Iridium NEXT satellites that are in the adjacent orbits. There are eight transmit and receive intersatellite link transponders/channels in the 22.18- 22.38 GHz band. The center frequencies of these transponders are spaced at 25 MHz and each transponder has a necessary bandwidth of 21.6 MHz. Each transmit and receive intersatellite link can be assigned independently of the other links. The intersatellite link frequencies use horizontal polarization for both transmit and receive. These links are half duplex using transmit and receive time slots on the same carrier frequency. The center frequencies for these transponders are provided in Schedule S.

The TT&C links provide information regarding the attitude, status and performance of the satellite. There are two telecommand carriers that use RHC polarization. These telecommand carriers have a necessary bandwidth of one MHz and operate on center frequencies 29102 MHz and 29298 MHz. There are 13 telemetry carriers each with a necessary bandwidth of 200 kHz and channel spacing of 400 kHz that use LHC polarization and that use center frequencies between 19400.2 MHz and 19405.2 MHz. The specific center frequencies are listed in Schedule S. In addition, the normal feeder link communication channels of the Iridium NEXT constellation accomplish TT&C functions during normal operations (See Figure D).

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[3] *See infra, n.1.*

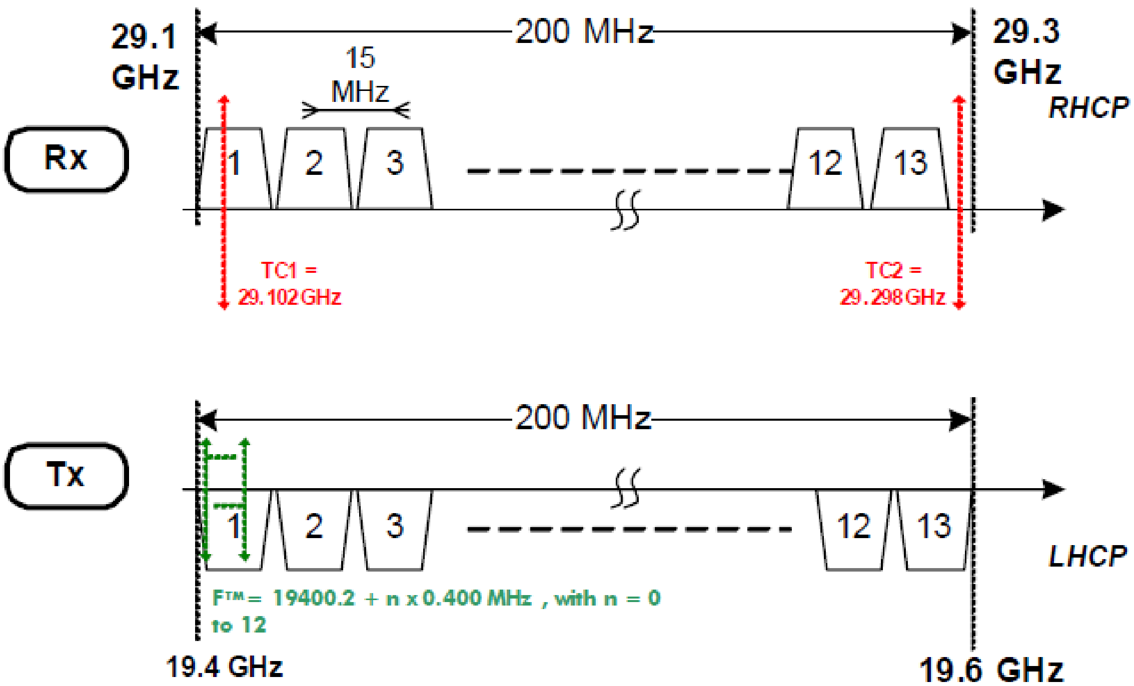

Figure D. Iridium NEXT Ka band Frequency and Polarization

The Iridium NEXT satellites utilize on board processors for the L band MSS carriers, the Ka band feeder links and Intersatellite Service (ISS) links. Any of the 252 L band carrier frequencies can be assigned to any of the 48 L band beams at any time. The five simplex carriers/channels in 1626-1626.5 GHz can and will also be assigned to all 48 L band beams dynamically. The on board processors are capable of dynamically routing traffic among any combination of L band user carriers through any of the intersatellite link transponders and through any of the feeder uplink/downlink transponders. Therefore, any of the 252 L band transmit/receive user traffic carriers may be routed through any of the 4 transmit/receive intersatellite link transponders/channels and then transmitted (or received) through any of the 13 downlink (or uplink) feeder link transponders/channels on each feeder link. Each Ka band feeder uplink/downlink transponder on a given satellite can support all of the traffic routed through that satellite. Each feeder link earth station gateway is assigned two pairs of uplink/downlink 15 MHz transponders. Two pairs are required in order to support hand off of the feeder links between satellites.

H. BAND FREQUENCY REUSE

Frequency reuse in the Iridium NEXT system is possible at L Band:

- At the constellation level, i.e. between the beams of satellites which are sufficiently isolated to avoid unacceptable interference between the satellites in case of frequency reuse;
- At the individual satellite level, i.e. between two beams of the same satellite which have sufficient isolation to avoid unacceptable interference for co frequency operation.

Frequency reuse depends on the traffic to be handled by the constellation or part of the constellation. The general scheme is to compare the various possibilities of frequency resource allocations and to choose the option with the lowest interference cost. It is not possible to assign an L band carrier to all 48 beams simultaneously on the same spacecraft. Each satellite can assign only 32 out of the 48 beams in any one time slot.

The near-polar orbits of Iridium satellites cause the satellites to be closer together as the subsatellite latitude increases. This orbital motion, in turn, causes the coverage of neighboring satellites to increasingly overlap as the satellites approach the poles. A consistent sharing of load among satellites is maintained at high latitudes by selectively deactivating outer-ring spot beams in each satellite. This beam control also results in reduced inter-satellite interference and also minimizes satellite power consumption, while maintaining Earth coverage.

An L band beam can be switched OFF when it is totally covered by one or several other beams.

The following criteria are considered for the switch off protocol:

- Complete L Band beam switch OFF above poles
  - o Switch OFF of all L band beams on planes 1,3,5 above ~70°N
  - o Switch OFF of all L Band beams on planes 2,4,6 under ~70°S
- Progressive switch OFF of L Band beams on satellites in
  - o Odd planes in Northern hemisphere
  - o Even planes in Southern hemisphere

The complete L band beam shutdown above the poles is consistent with Block 1 Iridium system approach.

This strategy allows the system to concentrate the traffic on the same satellites depending upon whether it is in Northern or Southern hemisphere, and as a result the system manages the intrasatellite and intersatellite interference situations. The following Figure E provides an illustration of beams being shut off on some satellites when there are overlapping beams from other satellites in an adjacent plane.

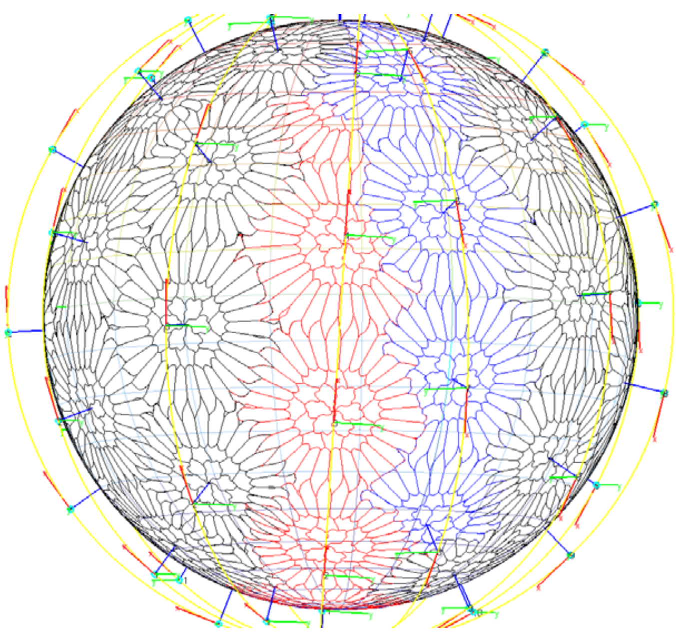

Figure E. Active L band beams

1. *SUB BANDS*

The L band also uses sub bands of 8 contiguous carriers. A sub band/carrier assignment to any L band beam is dynamically performed and a frequency reuse among the L band beams is maintained to avoid inter beam interference and intersatellite interference.

Each sub band contains 8 L band carriers and up to four uplink and four downlink duplex time slots. Any sub band up to and including all 32 sub bands (252 carriers) can be assigned to any L Band beam depending upon the traffic demand. Also a partial sub band or any L band carrier can be assigned to a specific L band beam to meet an increase in traffic demand in that beam.

2. *TDMA FRAME STRUCTURE*

Iridium NEXT uses a TDMA Frame structure where a frame is 90 milliseconds with time slots that are assigned to the simplex channels and the duplex uplink and downlink carriers as follows in Figure F:

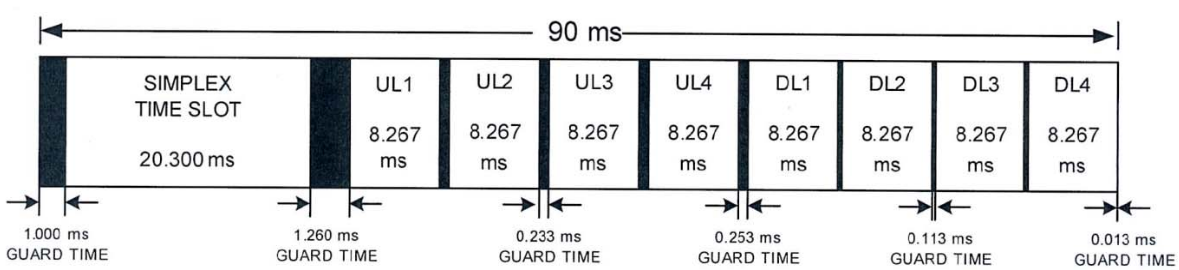

FIGURE F: TDMA Frame Structure

The simplex time slot is 20.300ms and each of the four uplink and downlink time slots is 8.267ms. The frame also provides for guard times as described in the Figure F. Each Ka Band feeder link transponder can carry all the traffic from the L band carriers from any of the L band beams.

The traffic from the intersatellite links can be assigned to any Ka band transponder or any L Band carrier and assigned to any L band beam as required to complete the circuit to the user.

§25.114(c)(13): The polarization information specified in §§ 25.210(a)(1), (a)(3), and (i), to the extent applicable.

Section 25.210 (a)(1) and (a)(3) are not applicable since these provisions apply only to 4/6GHz. Other provisions of Section 25.210 address frequency reuse and polarization for the FSS feeder links. Specifically, Section 25.210(i)(1) states:

"Space station antennas in the Fixed-Satellite Service, other than antennas in the 17/24 GHz BSS, must be designed to provide a cross-polarization isolation such that the ratio of the on axis co-polar gain to the cross-polar gain of the antenna in the assigned frequency band shall be at least 30 dB within its primary coverage area."

§25.210 (b) All space stations in the Fixed-Satellite Service in the 20/30 GHz band shall use either orthogonal linear or orthogonal circular polarization. Those space stations utilizing orthogonal linear polarization shall also comply with paragraph (a) of this section.

§25.210(f) All space stations in the Fixed-Satellite Service operating in any portion of the 3600-4200 MHz, 5091-5250 MHz, 5850-7025 MHz, 10.7-12.7 GHz, 12.75-13.25 GHz, 13.75-14.5 GHz, 15.43-15.63 GHz, 18.3-20.2 GHz, 24.75-25.25 GHz, or 27.5-30.0 GHz bands, including feeder links for other space services, and in the Broadcasting-Satellite Service in the 17.3-17.8 GHz band (space-to-Earth), shall employ state-of-the-art full frequency reuse, either through the use of orthogonal polarizations within the same beam and/or the use of spatially independent beams.

The Ka band feeder link beams operate with a single circular polarization in each direction. As indicated in Schedule S, the cross-polarization isolation is 19 dB for these beams which is the same cross-polarization isolation for the Iridium Block 1 satellites. The cross-polarization patterns for each Ka band feeder link are provided for informational purposes only in Exhibit A. These cross-polarization beams will not be used, but patterns have been created based on predicted values. These satellites do not use orthogonal polarization to provide frequency reuse for feeder links.

Each Iridium NEXT satellite has two spatially independent feeder link beams using the same polarization which provide frequency reuse in compliance with 25.210(d) and (f). One beam is the primary beam to provide communications to a specific gateway. A second stand by beam is provided to switch the traffic as needed and is used specifically to transition the traffic between gateways where the traffic being provided to one gateway using one beam is switched to a second gateway and satellite beam. The Iridium NEXT system uses one polarization in the feeder uplink and downlink. There is no self interference that has occurred with Iridium Block 1 or will occur in Iridium NEXT because of the cross polarization.

The TT&C links provided at these Ka band frequencies also use RHC polarization in the Telecommand uplink and LHC polarization in the Telemetry downlinks. The telemetry and telecommand co- pol and cross pol beams are provided in Exhibit A and have an isolation of 15 dB as indicated in Schedule S.

To the extent a waiver of 25.210 (i)(1) is required since the 30 dB cross polarization isolation is not achieved, Iridium requests a waiver of 25.210(i)(l). The Iridium NEXT system does not use the cross polarization for the feeder links nor the TT&C links and therefore there is no need to have 30 dB of isolation. The TT&C links use omni directional antennas and the Earth is seen with a wide view angle from the Iridium orbit (+/- 62.7°) making control of the cross-polarization over this solid angle very difficult. The feeder links use two spatially independent beams to accomplish full frequency reuse in accordance with 25. 210(d) and (f) and therefore there is no need to use the cross-polarization for these links.

The issue of cross polarization interference from the Iridium NEXT feeder links to other satellite networks is addressed in the normal course of satellite coordination if the operators of the other satellite networks consider it an interference issue that needs to be addressed.

§25.202(g): Telemetry, tracking and telecommand functions for U.S. domestic satellites shall be conducted at either or both edges of the allocated band(s). Frequencies, polarization and coding shall be selected to minimize interference into other satellite networks and within their own satellite system.

The Iridium NEXT satellites have band-edge TT&C functions. The telecommand carrier frequencies are 29102 MHz and 29298 MHz and the 13 telemetry carrier center frequencies are within 19402.2 to 19406.2 MHz. These TT&C operations are for communication with individual satellites that are within view of the Teleport network. They use omnidirectional antennas for transmit and receive on the satellites. The Iridium NEXT SV omnidirectional telecommand receivers at Ka band are always on. TT&C functions are also conducted on the normal feeder link frequencies used during normal communications during specified time slots.

To the extent necessary, Iridium requests a waiver of Section 25.202(g) for its TT&C operations, which are digitally multiplexed into the feeder link data stream and can be used on any Ka band carrier. This approach is fundamental to Iridium's management of its constellation as a network and has always been a feature of the Iridium system. By embedding telecommand and telemetry data into feeder link data streams and using its intersatellite links to transport the data, Iridium is able to maintain connectivity in real time with every satellite in its constellation.[4]

§25.114(d)(2): If applicable, the feeder link and inter-satellite service frequencies requested for the satellite, together with any demonstration otherwise required by this chapter for use of those frequencies (see, *e.g.* , §§ 25.203(j) and (k));

The Iridium NEXT satellites will operate feeder links in the frequency bands 29.1- 29.3 GHz Earth-to-space and in 19.4-19.6 GHz space-to-Earth. The feeder link transponders/channels

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[4] The dedicated frequencies that are used for TT&C, by way of contrast, can only be used to communicate with a single satellite at any point in time.

will have 15 MHz spacing with 14 MHz necessary bandwidth for each transponder. The Iridium NEXT satellites have two feeder link antennas.

The intersatellite links will operate on the same frequencies in 22.18 GHz – 22.38 GHz as the Iridium Block 1 satellites for transmit and receive directions with the same channelization of eight 25 MHz transponders/channels to serve the same number (four) of intersatellite beams as the Iridium Block 1 satellites.

The responses to 25.203(j) and (k) are provided in Section **R COORDINATION**.

I. EMISSION INFORMATION

§25.114(c)(4)(ii): Emission designators and allocated bandwidth of emission, final amplifier output power (identify any net losses between the output of the final amplifier and input of the antenna) and specify the maximum EIRP for each antenna beam

The maximum EIRP, transmit amplifier output power, power losses between the output of the final amplifier and input of the antenna and emission designators for each carrier and emission type are provided in Schedule S for the L band carriers, the Ka band transponders, the ISS links and the dedicated telecommand and telemetry carriers. The assigned bandwidth and carrier spacing for each carrier emission is provided in Schedule S.

1. *POWER CONTROL*

Closed loop power control is implemented on the L band uplink. The subscriber terminals are able to vary the EIRP on the uplink over a minimum range of 8 dB in response to maintenance messages received from the spacecraft. The system employs independent power control on the uplink and the downlink. The L band downlink power control is only applied to traffic bursts: other types of bursts (ring, broadcast, acquisition, maintenance) are transmitted at a constant power with configurable power backoff. The subscriber downlink power control has a minimum range of 12 dB.

The feeder links also employ power control. The feeder downlink EIRP can vary from a 3 dB increase in EIRP to a 1.5 dB decrease in EIRP. The EIRP is controlled in 6 steps of 0.5 dB and one step of 1.5 dB for an increase in EIRP from 1.5 to 3dB. The uplink feeder link power dynamic range is 38 dB with a maximum EIRP of 67dBW.

2. *DOPPLER FREQUENCY SHIFT COMPENSATION*

The Iridium NEXT constellation compensates for the Doppler frequency shift due to the motion of the orbiting satellites in the subscriber links and the feeder links. The subscriber terminals compensate for both downlink Doppler and time-of-arrival variations, and pre-correct the uplink signal to minimize time-of-arrival and Doppler variations at the Iridium NEXT SV. The subscriber terminals compensate for a maximum carrier frequency Doppler shift of up to +/- 45 KHz.

The feeder link earth stations compensate for Doppler frequency shifts on the uplink and downlink. The uplink telecommand precompensates within a range of +/- 750 kHz around the reference frequency. For the telemetry downlink, the Doppler shift characteristics are +/- 470 kHz.

For cross links the receiving satellite receiver post corrects for Doppler frequency shifts. Each crosslink is able to compensate for an input frequency offset up to +/- 200 kHz from nominal due to Doppler shifts.

§25.202(e): *Frequency tolerance, space stations.* The carrier frequency of each space station transmitter authorized in these services shall be maintained within 0.002 percent of the reference frequency.

In Schedule S, Iridium certifies that the satellite transmitters in each frequency band meet this reference frequency tolerance requirement.

All Iridium NEXT SV frequencies are derived from a Master Local Oscillator (MLO) which enables the space stations to meet the frequency tolerance requirement in each frequency band. The MLO stability will not be less than $1.2x\ 10^{-8}$ at any time. The reference frequency in each frequency band corresponds to the channel center frequency and the Doppler frequency effect is excluded from this tolerance.

§25.202(f): *Emission limitations.* Except for SDARS terrestrial repeaters, 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. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) 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;

(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.

In Schedule S, Iridium certifies that the NEXT satellite emissions meet this requirement in each frequency band.

J. ANTENNAS

§25.114(d)(3): Predicted space station antenna gain contour(s) for each transmit and each receive antenna beam and nominal orbital location requested. These contour(s) should be plotted on an area map at 2 dB intervals down to 10 dB below the peak value of the parameter and at 5 dB intervals between 10 dB and 20 dB below the peak values, with the peak value and sense of polarization clearly specified on each plotted contour. For applications for geostationary orbit satellites, this information must be provided in the .gxt format.

The Iridium NEXT system is a low earth orbit non geostationary satellite constellation; Iridium is not requesting a geostationary satellite orbit location and therefore this application is not providing information in a .gxt format pursuant to 25.114(d)(3). The Iridium NEXT antenna gain contours for all satellite antennas for L band, Ka band feeder links, the TT&C links and the cross links are provided in Exhibit A.

The predicted space station antenna gain contour(s) for the 48 transmit and receive L band beams are provided in Exhibit A. Since the Iridium NEXT satellites operate in a Time Division Duplex mode on the same frequencies for transmit and receive service links, the satellite transmit beams are identical to the satellite receive beams and have the same gain contours as the satellite receive beams. These space station contours are provided on a satellite projection of the Earth centered on Tempe, Arizona as the nadir of the satellite. These L band space station beam contours are globally applicable as depicted in Figure E. Exhibit A also depicts the Iridium NEXT satellite "footprint" layout and numbering scheme of the 48 L band beams from the satellite. The L band beam cross pol patterns in Exhibit A are provided for informational purposes only since the Iridium NEXT satellites use a single polarization for all L band communications, and do not depend on cross polarization for frequency reuse. These cross polarization beams have been created based on predicted values.

The predicted space station antenna gain contour(s) for the transmit feeder links beam at 19.4- 19.6 GHz is provided in Exhibit A. The satellite receive feeder link beam at 29.1-29.3GHz is also provided in Exhibit A. These antenna beams contours are provided on a satellite projection of the Earth centered on Tempe, Arizona as the nadir of the satellite. Although the satellite has two beams in the forward feeder link and two beams in the return feeder link, only one beam in each direction is provided because in each case the two beams are identical when the satellite projection is at the nadir to the location of the satellite. These space station feeder link antenna beam contours are applicable at each gateway and teleport antenna site.

The intersatellite links operate at 22.18- 22.38 GHz. The predicted space station antenna gain contour(s) for transmit and receive beams are provided in Exhibit A. These satellite beams are provided from a satellite perspective without a projection on a geographic area since these beams are pointing at other satellites.

§25.114(c)(4)(iii): Identification of which antenna beams are connected and switchable to each transponder and TT&C function.

The response to Section 25.114(c)(4)(i) in Section **G. FREQUENCY and POLARIZATION** describes the switching capability of the satellite on board processor. Any L band channel can be assigned to any of the 48 L band beams. These channels are demodulated on board the spacecraft, where the data can be routed to any feederlink, crosslink, or L-band channel and remodulated for transmission. Data received on a feederlink or crosslink channel are also demodulated on board and routed to the appropriate destination, which may be an L band channel, another crosslink or feederlink, or the spacecraft's local TT&C function. The only exceptions are that TT&C cannot be routed to/from any L band channel, and that the dedicated omnidirectional TT&C channels cannot be routed at all, and must be used by the spacecraft's local TT&C function.

J. SERVICES and TRANSMISSON CHARACTERISTICS

§25.114(d)(4): A description of the types of services to be provided, and the areas to be served, including a description of the transmission characteristics and performance objectives for each type of proposed service, details of the link noise budget, typical or baseline earth station parameters, modulation parameters, and overall link performance analysis (including an analysis of the effects of each contributing noise and interference source);

§25.140(b)(2): Except as set forth in paragraphs (b)(3), (b)(4), (b)(5), and (b)(6) of this section, all applicants must provide an interference analysis to demonstrate the compatibility of their proposed system two degrees from any authorized space station. An applicant should provide details of its proposed r.f. carriers which it believes should be taken into account in this analysis. At a minimum, the applicant must include, for each type of r.f. carrier, the link noise budget, modulation parameters, and overall link performance analysis. *See, e.g.* , appendices B and C to Licensing of Space Stations in the Domestic Fixed-Satellite Service (available at address in Sec. 0.445)).

The Iridium NEXT satellite constellation will continue to provide the services globally as provided by the Iridium Block 1 first generation satellites.

The Iridium NEXT satellite system will offer two way voice, data and one way messaging services although there will be more capacity and higher data rate transmissions. See **Section L. PUBLIC INTEREST and COMMON CARRIER CONSIDERATIONS** and the Application Narrative for more information regarding the Iridium NEXT services. Schedule S provides the emission designators, modulation information, the base line earth station parameters, the total carrier to noise objective and the single entry C/I objective for each of these emissions.

The Section 25.140(b)(2) requirement for a 2 degree analysis applies to geostationary FSS satellites and does not apply to non-geostationary FSS satellite systems. Iridium is providing link budgets for its rf carriers as supporting information for Schedule S and Section 25.114(d)(4) above. These link budgets are in Exhibit B.

§25.114(c)(4)(iv): Receiving system noise temperature

The receiving system noise temperature for each L band, Ka band, ISS and telecommand receiver for each type of emission is provided in Schedule S.

§25.114(c)(4)(v): The relationship between satellite receive antenna gain pattern and gain-to-temperature ratio and saturation flux density for each antenna beam (may be identified on antenna gain plot)

The gain to temperature ratio and saturation flux density for each satellite antenna receive beam are identified in Schedule S.

§25.114(c)(4)(vi): The gain of each transponder channel (between output or receiving antenna and input of transmitting antenna) including any adjustable gain step capabilities.

The Iridium NEXT satellites do not have any adjustable gain steps for its receivers since the satellites employ on board processors. There are also no transponder gains since the satellites employ regenerative payloads and do not have transponders. Such information is not applicable to regenerative payloads.

To the extent that a waiver is required, Iridium hereby requests a waiver of Section 25.114(c)(4)(vi).

§25.114(c)(4)(vii): Predicted receiver and transmitter channel filter response characteristics

Predicted receiver and transmitter channel filter response characteristics information is not applicable to regenerative payloads which are used on Iridium NEXT satellites. To the extent that a waiver may be required for not providing this information, Iridium hereby requests a waiver of Section 25.114(c)(4)(vii).

§25.210(c): All space stations in the Fixed-Satellite Service shall have a minimum capability to change transponder saturation flux densities by ground command in 4 dB steps over a range of 12 dB.

The Iridium NEXT satellites do not have any adjustable gain steps for its receivers since the satellites employ on board processors. There are also no transponder gains since the NEXT satellites employ regenerative payloads and do not have transponders. Such information is not applicable to regenerative payloads.

K. PFD REQUIREMENTS

§25.114(d)(5): Calculation of power flux density levels within each coverage area and of the energy dispersal, if any, needed for compliance with § 25.208; Calculation of power flux density levels within each coverage area and of the energy dispersal, if any, needed for compliance with § 25.208, for angles of arrival other than 5°, 10°, 15°, 20°, and 25° above the horizontal.

Iridium NEXT satellites will operate with the same power flux density (PFD) levels in each geographic coverage area as the Iridium Block 1 satellites. The downlink service links in 1616-1626.5 GHz will provide the same PFD on the Earth's surface as the first generation satellites. The feeder downlinks in 19.4 – 19.6 GHz and the ISS Links in 23.18 – 23.38 GHz comply with the requirements of §25.208(c) and the corresponding International Telecommunication Union (ITU) limits with substantial margins. The supporting calculations are provided in response to Section 25.114(c)(8) as follows:

§25.114(c)(8): Calculation of power flux density levels within each coverage area and of the energy dispersal, if any, needed for compliance with §25.208, for angles of arrival of 5°, 10°, 15°, 20° and 25° above the horizontal.

Section 25.208(c) specifies the power flux density requirements for satellites transmitting in the 19.3- 19.7 GHz and the 23.0-23.55 GHz bands that Iridium NEXT uses for its Ka Band downlink feeder links and ISS links respectively. Specifically, these requirements are:

(c) In the 17.7-17.8 GHz, 18.3-18.8 GHz, 19.3-19.7 GHz, 22.55-23.00 GHz, 23.00-23.55 GHz, and 24.45-24.75 GHz frequency bands, the power flux density at the Earth's surface produced by emissions from a space station for all conditions for all methods of modulation shall not exceed the following values:

(1) −115 dB (W/m^2) in any 1 MHz band for angles of arrival between 0 and 5 degrees above the horizontal plane.

(2) −115 + 0.5 (δ-5) dB (W/m^2) in any 1 MHz band for angles of arrival d (in degrees) between 5 and 25 degrees above the horizontal plane.

(3) −105 dB (W/m^2) in any 1 MHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

Schedule S Section S8 provides the PFD values for the three angles of arrival arcs specified in 25.208(c) for NEXT's Ka band feeder downlink, the ISS links and the TT&C links. The calculated PFD values are less than the PFD requirements of 25.208(c) with considerable margin.

The calculations to support these PFD values for the Iridium NEXT satellite feeder links and the ISS Links and TT&C links are as follows:

1. *FEEDER LINK PFD ANALYSIS*

The maximum value of Iridium NEXT SV EIRP that is needed to reach the FCC PFD requirements of 25.208(c) for the worst-case link budget under clear-sky) conditions:

ANGLES OF ARRIVAL (°)	FCC PFD (dBW/m2)	Slant Range (km)	Free Space Loss (dB)	MAX NEXT SVEIRP (dBW) ALLOWED
90	-105	780	0.35	38.5
25	-105	1560	3.81	44.3
20	-107.5	1730	3.80	42.9
15	-110	1990	3.79	41.7
10	-112.5	2320	3.78	40.5
5	-115	2740	3.9	39.4

Table 3 – Maximum Space Vehicle Feeder downlink EIRP to comply with 25.208(c).

The satellites are designed to operate such that each feeder-link shall not provide an effective isoflux EIRP higher than the following profile for downlink communication:

32 dBW for an off-nadir angle lower than 53.9°

32 - 0.5 * (arcos(sin(a)*r/Re)-25) dBW for an off-nadir angle between 53.9° and 62.6°

Where a is the satellite off-nadir angle, Re is the Earth radius (6378.12km) and r is the SV altitude including Earth altitude (7158.12km).

Therefore, the satellite downlinks PFD does not exceed the requirements of 25.208(c).

2. *CROSSLINK ANALYSIS*

The Iridium NEXT SV cross-link never points to Earth. Therefore the cross link side lobe performance determines the cross link compliance with 25.208(c).

For E/W and N/S cross-link communications, the Iridium NEXT SV will not provide an off-axis EIRP higher than the following profile (off-axis is positive if towards Earth):

34.5 dBW	if $a\ 10° \leq a < 40°$
34.5 - 0.05 * (a-40) dBW	if $40° \leq a < 60°$
33.5 dBW	if $60° \leq a < 140°$

where a is the off-axis angle with respect to antenna boresight.

Therefore the Iridium NEXT satellite cross links do not exceed the PFD requirements of 25.208(c).

In summary, the Iridium NEXT satellite feeder links and cross links operations comply with the PFD requirements of 25.208(c).

L. <u>PUBLIC INTEREST and COMMON CARRIER CONSIDERATIONS</u>

§25.114(d)(6): Public interest considerations in support of grant;

See Application Narrative.

§25.114(c)(11): A clear and detailed statement of whether the space station is to be operated on a common carrier basis, or whether non-common carrier transactions are proposed. If non-common carrier transactions are proposed, describe the nature of the transactions and specify the number of transponders to be offered on a non-common carrier basis;

All transponders on the NEXT satellite constellation at L band, Ka band and in the ISS links are operated on a non-common carrier basis.

§25.114(d)(7): Applicants for authorizations for space stations in the fixed-satellite service must also include the information specified in §§ 25.140(b)(1) and (2) of this part.

§25.140(b): Each applicant for a space station authorization in the fixed-satellite service must demonstrate, on the basis of the documentation contained in its application, that it is legally, technically, and otherwise qualified to proceed expeditiously with the construction, launch and/or operation of each proposed space station facility immediately upon grant of the requested authorization. Each applicant must provide the following information:

IRIDIUM IS LEGALLY QUALIFIED.

See Application Narrative.

IRIDIUM IS TECHNICALLY QUALIFIED

See Application Narrative.

§25.140(b)(1): The information specified in § 25.114;

This information is provided herein as specified for the relevant provisions of Section 25.114(c) and (d).

§25.140 (b)(2):

The response to Section 25.140(b)(2) is in **Section J. SERVICES and TRANSMISSION CHARACTERISTICS.**

M. SPACE STATION PHYSICAL CHARACTERISTICS

§25.114(c)(10): Physical characteristics of the space station including weight and dimensions of spacecraft, detailed mass (on ground and in-orbit) and power (beginning and end of life) budgets, and estimated operational lifetime and reliability of the space station and the basis for that estimate;

The Iridium NEXT physical characteristics are provided in Schedule S. The Iridium NEXT satellite constellation is expected to remain operational at least 15 years. The probability of survival for the operational lifetime for each satellite is provided in Schedule S. These lifetime estimates are based upon the reliability of the various components in each satellite. Mass of each Iridium NEXT satellite on the ground and on orbit is contained in Schedule S. The power budget for each Iridium NEXT satellite at beginning and end of life is listed in Schedule S.

1. *FUEL*

There is not one fuel budget that is applicable to all Iridium NEXT satellites. However, a nominal fuel budget of an Iridium NEXT satellite is as follows:

Mission Phase	Fuel Mass (kg)
Insertion – Mission Orbit	38.0
Drift	71.6
Mission Station Keeping (including Collision Avoidance)	5.6
Deorbit	39.6
Residuals	9.3
Total	164.0

2. *Attitude Control*

The Iridium NEXT satellite is three-axis stabilized during normal operations, with the attitude fixed in the local orbit frame so that the antenna panel is always pointed at Earth, and the fixed ISS antennas on the fore and aft ends of the satellite are pointed at the sister satellite in orbit. The satellite utilizes a combination of reaction wheels (in 4-3 redundancy) and redundant magnetic torque rods to control the attitude. Attitude is sensed with a multi-head star tracker (in 3-2 redundancy) and a redundant magnetometer. Attitude control during normal operations is maintained at less than 0.3° along the satellite-earth vector, and 0.45° along the satellite-satellite (intersatellite link) vector.

Additional attitude sensing capability is provided by 8 simple sun sensors for early deployment and anomalous operations. The satellite has a built in Safe Mode where it spins at a slow rate about its normally Earth-pointed axis, pointing that axis at the Sun. In this mode, the satellite can survive with minimal attention for extended durations if needed. Safe Mode can be entered and maintained with any two reaction wheels and 6 of the 8 sun sensors, with no need for star trackers, magnetometers, or torque rods.

N. ORBITAL DEBRIS MITIGATION and REENTRY INFORMATION

§25.114(d)(14): A description of the design and operational strategies that will be used to mitigate orbital debris, including the following information:

(i) A statement that the space station operator has assessed and limited the amount of debris released in a planned manner during normal operations, and has assessed and limited the probability of the space station becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal;

(ii) A statement that the space station operator has assessed and limited the probability of accidental explosions during and after completion of mission operations. This statement must include a demonstration that debris generation will not result from the conversion of energy sources on board the spacecraft into energy that fragments the spacecraft. Energy sources include chemical, pressure, and kinetic energy. This demonstration should address whether stored energy will be removed at the spacecraft's end of life, by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in a permanent discharge state, and removing any remaining source of stored energy, or through other equivalent procedures specifically disclosed in the application;

(iii) A statement that the space station operator has assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. Where a space station will be launched into a low-Earth orbit that is identical, or very similar, to an orbit used by other space stations, the statement must include an analysis of the potential risk of collision and a description of what measures the space station operator plans to take to avoid in-orbit collisions. If the space station operator is relying on coordination with another system, the statement must indicate what steps have been taken to contact, and ascertain the likelihood of successful coordination of physical operations with, the other system. The statement must disclose the accuracy—if any—with which orbital parameters of non-geostationary satellite orbit space stations will be maintained, including apogee, perigee, inclination, and the right ascension of the ascending node(s). In the event that a system is not able to maintain orbital tolerances, *i.e.* , it lacks a propulsion system for orbital maintenance, that fact should be included in the debris mitigation disclosure. Such systems must also indicate the anticipated evolution over time of the orbit of the proposed satellite or satellites. Where a space station requests the assignment of a geostationary-Earth orbit location, it must assess whether there are any known satellites located at, or reasonably expected to be located at, the requested orbital location, or assigned in the vicinity of that location, such that the station keeping volumes of the respective satellites might overlap. If so, the statement must include a statement as to the identities of those parties and the measures that will be taken to prevent collisions;

(iv) A statement detailing the post-mission disposal plans for the space station at end of life, including the quantity of fuel—if any—that will be reserved for post-mission disposal maneuvers. For geostationary-Earth orbit space stations, the statement must disclose the altitude selected for a post-mission disposal orbit and the calculations that are used in deriving the disposal altitude. The statement must also include a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the space station. In general, an assessment should include an estimate as to whether portions of the spacecraft will survive re-entry and reach the surface of the Earth, as well as an estimate of the resulting probability of human casualty.

See Exhibit C.

O. LICENSING REQUIREMENTS

§25.145: Licensing conditions for the Fixed Satellite Service in the 20/30 GHz band

(a) Except as provided in § 25.210(b), in general all rules contained in this part apply to Fixed-Satellite Service in the 20/30 GHz bands.

(b) *System License.* Applicants authorized to construct and launch a system of technically identical non-geostationary satellite orbit satellites will be awarded a single "blanket" license covering a specified number of space stations to operate in a specified number of orbital planes.

The instant application is requesting a blanket license to launch and operate 66 satellites in 11 near polar orbital planes of 780 Km altitude with 6 satellites per orbital plane. The application is requesting authority for the satellites to operate on frequencies 1617.775 -1626.5 MHz for MSS uplinks and downlinks consistent with the operational authority for the first generation authority. The instant application is also requesting authority to operate on 29.1- 29.3 GHz for feeder uplinks, 19.4-19.6 GHz for feeder downlinks, 23.18- 23.28 GHz for crosslinks and 29.102 and 29.298 GHz for Telecommand and 19.4002-19.4052 GHz for Telemetry links. The application is also requesting blanket authority to launch and operate 6 in orbit spares at an altitude of 700- 750 km with an in orbit spare to correspond to each of the 6 orbital planes. Iridium is requesting authority to operate its TT&C carriers for these in orbit spare satellites.

Iridium will also have 9 spares on the ground until such time as they are needed to be deployed to satisfy NEXT system requirements.

§25.145(c): In addition to providing the information specified in § 25.114, each non-geostationary satellite orbit applicant shall demonstrate the following (1) That the proposed system is capable of providing Fixed-Satellite Service to all locations as far north as 70° North Latitude and as far south as 55° South Latitude for at least 75% of every 24-hour period; and

(2) That the proposed system is capable of providing Fixed-Satellite Service on a continuous basis throughout the fifty states, Puerto Rico and the U.S. Virgin Islands.

The Iridium NEXT satellite system has the same orbital parameters as the Iridium Block 1 satellites. Each Iridium NEXT satellite has the capability to provide service to the entire Earth's surface. The Iridium NEXT satellite system uses the 29.1-29.3 GHz and 19.4- 19.6 GHz bands for MSS feeder links with gateways and teleports at specified authorized locations.

§25.145(e): Prohibition of certain agreements. No license shall be granted to any applicant for a space station in the Fixed-Satellite Service operating in the 20/30 GHz band if that applicant, or any persons or companies controlling or controlled by the applicant, shall acquire or enjoy any right, for the purpose of handling traffic to or from the United States, its territories or possession, to construct or operate space segment or earth stations, or to interchange traffic, which is denied to any other United States company by reason of any concession, contract, understanding, or working arrangement to which the Licensee or any persons or companies controlling or controlled by the Licensee are parties.

Iridium does not have exclusive agreements of the kind described in Section 25.145(e).

§25.143 (h): Prohibition of certain agreements. No license shall be granted to any applicant for a space station in the Mobile-Satellite Service operating at 1610-1626.5 MHz/2483.5-2500 MHz if that applicant, or any persons or companies controlling or controlled by the applicant, shall acquire or enjoy any right, for the purpose of handling traffic to or from the United States, its territories or possession, to construct or operate space segment or earth stations, or to interchange traffic, which is denied to any other United States company by reason of any concession, contract, understanding, or working arrangement to which the Licensee or any persons or companies controlling or controlled by the Licensee are parties.

Iridium does not have exclusive agreements of the kind described in Section 25.143(h).

P. IN-ORBIT SPARES

§25.113(h): Licensees of Non-Geostationary Satellite Orbit (NGSO) satellite systems need not file separate applications to operate technically identical in-orbit spares authorized as part of a blanket license pursuant to § 25.114(e) or any other satellite blanket licensing provision in this part. However, the licensee shall notify the Commission within 30 days of bringing the in-orbit spare into operation, and certify that operation of this space station did not cause the licensee to exceed the total number of operating space stations authorized by the Commission, and that the licensee will operate the space station within the applicable terms and conditions of its license. These notifications must be filed electronically on FCC Form 312.

§25.143(d): *In-Orbit Spares.* Licensees need not file separate applications to operate technically identical in-orbit spares authorized as part of the blanket license pursuant to paragraph (a) of this section. However, the licensee shall certify to the Commission, within 10 days of bringing the in-orbit spare into operation, that operation of this space station did not cause the licensee to exceed the total number of operating space stations authorized by the Commission.

§25.145(i): *In-Orbit Spares.* Licensees need not file separate applications to operate technically identical in-orbit spares authorized as part of the blanket license pursuant to paragraph (b) of this section. However, the licensee shall certify to the Commission, within 10 days of bringing the in-orbit spare into operation, that operation of this space station did not cause the licensee to exceed the total number of operating space stations authorized by the Commission.

Iridium is seeking to launch up to 6 in orbit spares and to have 9 additional spare satellites on the ground to be deployed in the future as the needs of the Iridium NEXT system dictate. At no time will the operating satellites exceed the total number of operating space stations authorized by the Commission. The instant application is requesting that the in orbit spares be also authorized. See also response to Section 25.114(c)(3) in Section **B. AUTHORIZATION REQUESTED, Section E. CONSTRUCTION and LAUNCH SCHEDULE** and Schedule S for additional information about in orbit spare satellites. The Schedule S Table S4 provides orbital parameters for 6 orbits at 700 kms and 6 orbits at 750 kms. These altitudes represent the boundary altitudes for the location of the 6 in orbit spares. The final altitude and exact orbit at that altitude will be determined when the satellites are launched.

Q. ITU INFORMATION

§25.111(b):

b) Applicants, permittees and licensees of radio stations governed by this part shall provide the Commission with all information it requires for the Advance Publication, Coordination and Notification of frequency assignments pursuant to the international Radio Regulations. No protection from interference caused by radio stations authorized by other Administrations is guaranteed unless coordination procedures are timely completed or, with respect to individual administrations, by successfully completing coordination agreements. Any radio station authorization for which coordination has not been completed may be subject to additional terms and conditions as required to effect coordination of the frequency assignments with other Administrations.

Iridium NEXT is designed to support legacy services, and so will operate as closely as possible to the existing characteristics of the current Iridium Block 1 network. The ITU filings supplied are intended to supplement the HIBLEO-2 / HIBLEO-2FL / HIBLEO-2FL2 which are already filed with the ITU, and retain the priority which those filings currently hold.

Consequently, Iridium is submitting separately: 1) an ITU request for coordination that adds information to the HIBLEO-2 filing and 2) a new Advance Publication for TT&C operation and a Coordination Request for the HIBLEO-2FL2 filing. Iridium is requesting that these ITU filings be submitted to the ITU Radiocommunication Bureau.

R. COORDINATION

1616-1626.5 MHZ

There are several ITU and FCC rules specifically addressing the protection of other authorized services in or near the band 1610-1626.5 GHz. Protection of Radio Astronomy observations by space stations is specifically addressed in RR 5.372, 25.213(a)(1) and (2). The protection of other radio services are addressed in US 208 and Section 25.143(b)(2)(v).

§25.114(d)(10): Applications for authorizations in the 1.6/2.4 GHz Mobile-Satellite Service shall also provide all information specified in § 25.143.

The information required by Section 25.143(a) and (b)(1) through (4) is provided in the previous pages. See Section **C. IRIDIUM NEXT DESCRIPTION**. With respect to Sections 25.143(b)(2)(v), 25.213, RR5.372, the following responses are provided.

§25.143(b)(2)(v): That operations will not cause unacceptable interference to other authorized users of the spectrum. In particular, each application in the 1.6/2.4 GHz frequency bands shall demonstrate that the space station(s) comply with the requirements specified in § 25.213.

1. *RADIO ASTRONOMY*

Section 25.213 addresses the protection of Radio Astronomy in1610.6-1613.8 MHz by mobile satellite systems. In addition RR5.372 indicates that harmful interference shall not be caused to stations of the radio astronomy service using the band 1610-6-1613.8 MHz by MSS stations. This applies to the MSS in the bands 1613.8-1626.5 MHz.

RR 5.372. Harmful interference shall not be caused to stations of the radio astronomy service using the band 1610.6-1613.8 MHz by stations of the radiodetermination-satellite and mobile-satellite services (No. 29.13 applies).

§25.213: Inter-Service coordination requirements for the 1.6/2.4 GHz Mobile-Satellite Service.

(a) Protection of the radio astronomy service in the 1610.6-1613.8 MHz band against interference from 1.6/2.4 GHz Mobile-Satellite Service systems.

(1) *Protection zones.* All 1.6/2.4 GHz Mobile-Satellite Service systems shall be capable of determining the position of the user transceivers accessing the space segment through either internal radiodetermination calculations or external sources such as LORAN-C or the Global Positioning System.

(i) In the band 1610.6-1613.8 MHz, within a 160 km radius of the following radio astronomy sites:

Observatory	Latitude (DMS)	Longitude (DMS)
Arecibo, PR	18 20 46	66 45 11
Green Bank Telescope, WV	38 25 59 38 26 09	79 50 24 79 49 42
Very Large Array, NM	34 04 43	107 37 04

Owens Valley, CA	37 13 54	118 17 36
Ohio State, OH	40 15 06	83 02 54

(ii) In the band 1610.6-1613.8 MHz, within a 50 km radius of the following sites:

Observatory	Latitude (DMS)	Longitude (DMS)
Pile Town, NM	34 18 04	108 07 07
Los Alamos, NM	35 46 30	106 14 42
Kitt Peak, AZ	31 57 22	111 36 42
Ft. Davis, TX	30 38 06	103 56 39
N. Liberty, IA	41 46 17	91 34 26
Brewster, WA	48 07 53	119 40 55
Owens Valley, CA	37 13 54	118 16 34
St. Croix, VI	17 45 31	64 35 03
Mauna Kea, HI	19 48 16	155 27 29
Hancock, NH	42 56 01	71 59 12

§ 25.213(a)(2) states

2) Mobile-Satellite Service space stations transmitting in the 1613.8-1626.5 MHz band shall take whatever steps necessary to avoid causing harmful interference to the radio astronomy facilities listed in paragraphs (a)(1)(i) and (ii) of this section during periods of observation.

Iridium is implementing a Radio Astronomy Spectrum Protection (RASP) approach on the Iridium NEXT constellation that meets the Radio Astronomy (RA) band SV emission requirements during RA data collection events. The techniques used to limit out-of-band (OOB) intermodulation (IM) products and noise floor power levels in the RA bands are part of the Iridium NEXT baseline design.

Iridium has defined RASP features required for Iridium NEXT SV software and ground operations that are initiated to limit Iridium NEXT SV OOB emissions during an RA site data collection event when an Iridium NEXT SV transmit beam is in the vicinity of the RA site. The RASP controls are applied dynamically to any point on a 2º global grid in 30 second steps. The

Iridium NEXT SV controls are time-tagged parameter settings that configure the Iridium NEXT SV to reduce supported traffic during the conjunction of an active Iridium NEXT SV beam and an RA collection event.

During these conjunctions, the ground software will evaluate the RASP event requirements and direct the Iridium NEXT SV software to invoke some, and if necessary, all of the following Iridium NEXT SV configuration changes:

1. Increase the transmit beam power amplifier bias to improve linearity and reduce IM product power level (at the expense of SV power consumption);
2. Force the frequency assignment of the higher power services to the high end of the Iridium band;
3. Force user frequency assignments to the higher end of the Iridium band;
4. Limit user access;
5. Back-off the transmitted signal power;
6. Mute all transmit carriers in the beam.

In addition, Iridium has added a filter on the Iridium NEXT SV transmit signal path to further limit OOB emissions.

Iridium is requesting mutual coordination of RA data collection events with the RA community to minimize the Iridium quality of service impacts. This collaboration would require the RA community to supply to Iridium ground operations their data collection plan information. Iridium ground operations would convert the RA site plan data into the temporal based Iridium NEXT SV configurations in preparation for the RA collection event.

Analysis will be performed by Iridium to estimate performance during an RASP event given different combinations of Iridium NEXT SV configurations. In addition, further characterization measurements may be required on Iridium NEXT SVs for a final tailoring of the RASP parameter settings for each SV configuration.

2. *OTHER AUTHORIZED SERVICES*

In addition to Section 25.143(b)(2)(v), US 208 indicates:

> **US 208 Planning and use of the band 1559-1626.5GHz necessitate the development of technical and/or operational sharing criteria to ensure maximum degree of electromagnetic compatibility with existing and planned systems within the band**

MSS and Global Navigation Satellite Systems (GNSS) are the other two authorized systems in these bands between 1559 – 1626.5 MHz in the United States.

3. *MSS SATELLITE SYSTEMS*

The only other authorized MSS satellite system operating in any portion of the 1616-1626.5 MHz band is Globalstar. The Iridium NEXT satellites will operate consistent with the Commission's decisions establishing the frequency plan for the Big LEO band.[5] In accordance with these decisions, Iridium will operate on 1617.775 – 1618.725 MHz shared with Globalstar and on 1618.725-1626.5 MHz not shared with Globalstar. Iridium has petitioned the Commission for access to 1616-1626.5 MHz.[6] If the Commission grants this petition, Iridium requests that this application be granted consistent with that decision.

1. *GLOBAL NAVIGATION SATELLITE SYSTEMS*

The Global Navigation Satellite System (GNSS) service uses frequencies in the band that is adjacent to the 1610-1626.5 MHz Big LEO band. The Iridium Block 1 space stations have

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[5] *See In re Globalstar LLC, GUSA Licensee LLC (Call Signs S2115 and E970381) and Iridium Constellation LLC Iridium Satellite LLC Iridium Carrier Services LLC (Call Signs S2110, E960132, E960622) Modification of Authority to Operate a Mobile Satellite System in the 1.6 GHz Band,* Modification Order, 23 FCC Rcd 15207, 15222 (Rel. Oct. 15, 2008).

[6] *See Iridium Constellation LLC Petition for Rulemaking to Promote Expanded Mobile Satellite Service in the Big LEO MSS Bands, RM 11697* (Filed Feb 11, 2013).

been operating compatibly with the GNSS systems. Iridium NEXT space stations, meet the out of band emission (OOBE) requirements of Section 25.202(f), and the Iridium NEXT space station OOBE do not exceed the Block 1 space station OOBE. Therefore the Iridium NEXT system space station emissions also will be compatible with GNSS.

2. *FEEDER LINKS*

§25.203(j): Applicants for non-geostationary 1.6/2.4 GHz Mobile-Satellite Service/ Radiodetermination satellite service feeder links in the bands 17.7-20.2 GHz and 27.5-30.0 GHz shall indicate the frequencies and spacecraft antenna gain contours towards each feeder-link earth station location and will coordinate with licensees of other fixed-satellite service and terrestrial-service systems sharing the band to determine geographic protection areas around each non-geostationary mobile-satellite service/radiodetermination satellite service feeder-link earth station.

Iridium is coordinating its satellites with other US-authorized GSO Fixed Satellite systems in the 29.25- 29.3 GHz band. These same coordination agreements will also provide the necessary protection to the gateway and teleport earth stations for the Iridium NEXT satellite system. With respect to the 19.4- 19.6 GHz downlink and the 29.1- 29.25 GHz uplink band, there are no other primary or secondary satellite services that are allocated or assigned in the USA and no further action is necessary. International coordination with respect to other fixed satellite service networks in the 29.1- 29.3 GHz band and 19.4-19.6 GHz band is being conducted in accordance with the relevant ITU Radio Regulations and FCC rules.

Iridium is providing modifications to the HIBLEO-2FL2 filing for TT&C links and additional emissions. These will be coordinated in due course with the other satellite operators to the extent that modifications are needed to address any potential increase in interference to or protection from other satellite networks. Until that coordination is completed, Iridium's operation of these TT&C links will comply with the current coordination agreements.

The bands 19.4-19.6 GHz and 29.1-29.25 GHz are also allocated on a co-primary basis to the fixed service and LMDS respectively in the United States and Iridium coordinates its gateways with these terrestrial services.

§ 25.203(k) provides requirements for earth stations applications which is not the subject of this application and therefore is not addressed herein.

US 334: In the band 17.8-20.2 GHz, Federal space stations in both geostationary (GSO) and non-geostationary satellite orbits (NGSO) and associated earth stations in the fixed-satellite service (space-to-Earth) may be authorized on a primary basis. For a Federal geostationary satellite network to operate on a primary basis, the space station shall be located outside the arc, measured from east to west, 70° West longitude to 120° West longitude. Coordination between Federal fixed-satellite systems and non-Federal space and terrestrial systems operating in accordance with the United States Table of Frequency Allocations is required.

Iridium has coordinated its Iridium Block 1 feeder links with Federal space stations in 19.4-19.6 GHz. The Iridium NEXT operations will comply with these coordination agreements with the US Government agencies responsible for these Federal space stations.

S. INTERSATELLITE SERVICE LINKS

§25.279: Inter-satellite service.

(a) Any satellite communicating with other space stations may use frequencies in the inter-satellite service as indicated in § 2.106 of this chapter. This does not preclude the use of other frequencies for such purposes as provided for in several service definitions, *e.g.*, FSS. The technical details of the proposed inter-satellite link shall be provided in accordance with § 25.114(c).

(b) *Operating conditions.* In order to ensure compatible operations with authorized users in the frequency bands to be utilized for operations in the inter-satellite service, these inter-satellite service systems must operate in accordance with the conditions specified in this section.

(1) *Coordination requirements with federal government users.*

(i) In frequency bands allocated for use by the inter-satellite service that are also authorized for use by agencies of the federal government, the federal use of frequencies in the inter-satellite service frequency bands is under the regulatory jurisdiction of the National Telecommunications and Information Administration (NTIA).

(ii) The Commission will use its existing procedures to reach agreement with NTIA to achieve compatible operations between federal government users under the jurisdiction of NTIA and inter-satellite service systems through frequency assignment and coordination practice established by NTIA and the Interdepartment Radio Advisory Committee (IRAC). In order to facilitate such frequency assignment and coordination, applicants shall provide the Commission with sufficient information to evaluate electromagnetic compatibility with the federal government users of the spectrum, and any additional information requested by the Commission. As part of the coordination process, applicants shall show that they will not cause interference to authorized federal government users, based upon existing system information provided by the government. The frequency assignment and coordination of the satellite system shall be completed prior to grant of construction authorization.

(2) ***Coordination among inter-satellite service systems.*** **Applicants for authority to establish inter-satellite service are encouraged to coordinate their proposed frequency usage with existing permittees and licensees in the inter-satellite service whose facilities could be affected by the new proposal in terms of frequency interference or restricted system capacity. All affected applicants, permittees, and licensees, shall at the direction of the Commission, cooperate fully and make every reasonable effort to resolve technical problems and conflicts that may inhibit effective and efficient use of the radio spectrum; however, the permittee or licensee being coordinated with is not obligated to suggest changes or re-engineer an applicant's proposal in cases involving conflicts.**

The Iridium NEXT satellites will operate their Inter satellite links on the same frequencies and in the same manner as the Iridium Block 1 satellites. They will comply with any Iridium Block 1 coordination agreements that apply to the operation of these inter satellite links.

ENGINEERING CERTIFICATION

The undersigned hereby certifies to the Federal Communications Commission as follows:

(i) I am the technically qualified person responsible for the engineering information contained in the foregoing Application for Modification of Non-Geostationary Mobile Satellite Service System Authorization (S2110) To Launch and Operate Replacement Satellites,

(ii) I am familiar with Part 25 of the Commission's Rules, and

(iii) I have either prepared or reviewed the engineering information contained in the foregoing Application for Modification of Non-Geostationary Mobile Satellite Service System Authorization (S2110) To Launch and Operate Replacement Satellites, and it is complete and accurate to the best of my knowledge and belief.

Signed: *<u>/s/ Frank Buntschuh</u>*

Frank Buntschuh
Chief Systems Engineer
Iridium Satellite LLC

Dated: December 27, 2013