Engineering Statement

1 Introduction

Intelsat License LLC ("Intelsat") seeks authority in this application to modify the C- and Ku-band coverage of the Intelsat 10 satellite (Call Sign S2382), which operates at 47.5° E.L. (312.5° W.L.). The characteristics of the Intelsat 10 spacecraft and its compliance with the various provisions of the Federal Communications Commission's ("FCC" or "Commission") rules are provided in this Engineering Statement. This engineering statement updates the satellite's Ku- and C band coverage areas. In all other respects, the characteristics of Intelsat 10 remain unchanged from those described in SAT-MOD-20130322-00052.[1]

2 Spacecraft Overview

Intelsat 10 is capable of operating in the C- and Ku-band frequencies listed below:

Direction	Frequency
Uplink	5925-6425 MHz
	14000-14500 MHz
Downlink	3700-4200 MHz
	11450-11700 MHz
	12250-12500 MHz
	12500-12750 MHz

[1] Intelsat extended the license term for Intelsat 10 in 2016 but did not provide a Schedule S with that application. *See Satellite Policy Branch Information, Actions Taken*, Report No. SAT-01173, SAT-MOD-20160422-00038 (July 8, 2016).

The spacecraft provides the following coverage:

Beam Name	Coverage Area	Frequency Band
Europe/Stans	Europe and Stans Countries	Ku-band
Europe/ME	Europe and Middle East	Ku-band
India	India	Ku-band
Europe/Africa	Europe and Africa	Ku-band
Asia	India and North East Asia	Ku-band
Global	Global	C-band

2.1 Spacecraft Characteristics

Intelsat 10 is a Boeing BS-601HP three-axis stabilized spacecraft with a rectangular outer-body structure. Intelsat 10 utilizes two deployable solar array wings and four mechanically adjustable reflectors (East, West, North, and South).

The Intelsat 10 spacecraft is composed of the following subsystems:

- Thermal
- Power
- Attitude Control
- Propulsion
- Telemetry, Command, and Ranging
- Uplink Power Control
- Communications

These subsystems maintain the correct position and attitude of the spacecraft; ensure that all internal units are maintained within the required temperature range; and ensure that the spacecraft can be commanded and controlled with a high level of reliability from launch to the end of its useful life. The spacecraft design incorporates redundancy in all subsystems in order to avoid single-point failures.

The structural design of Intelsat 10 provides mechanical support for all subsystems. The structure supports the communication antennas, solar arrays, and thrusters. It also provides a stable platform for preserving the alignment of critical elements of the spacecraft.

2.2 Communication Subsystem

Intelsat 10 provides active communication channels in C- and Ku-band. In C-band, active communication channels have a bandwidth of 27 MHz and 54 MHz. In Ku-band, active communication channels have a bandwidth of 36 MHz. The Intelsat 10 frequencies, polarization, and channel plan are provided in the Schedule S that accompanies this application.

The coverage contours and performance characteristics of all Intelsat 10 beams are provided in Schedule S. Exhibits 1 and 2 provide the beam parameters for the Intelsat 10 uplink and downlink beams, respectively.

Currently Intelsat 10 is authorized to operate each of the four mechanically adjustable reflectors only when pointed to a specific boresight. The current beam boresights were selected to meet customer needs at the time. However, in order to meet new and evolving customer requirements Intelsat requests authority to fully utilize the Intelsat 10 capability to steer the four reflectors within the satellite service area shown in the figure below. This will allow Intelsat to meet on-going and future customer requirements in an expeditious manner without the need to modify the Intelsat 10 license each time a new requirement is identified.

2.3 Telemetry, Command, and Ranging Subsystem

The telemetry, command, and ranging ("TC&R") subsystem provides the following functions:

1) Acquisition, processing, and transmission of spacecraft telemetry data;

2) Reception and retransmission of ground station generated ranging signals; and

3) Reception, processing, and distribution of telecommands.

The command and telemetry channel frequencies are provided in Exhibit 3. The coverage patterns of the command and telemetry beams have gain contours that vary by less than 8 dB across the surface of the Earth, and accordingly the gain at 8 dB below the peak falls beyond the edge of the visible Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A) of the FCC's rules, contours for these beams are not required to be provided and the associated GXT files are not included in Schedule S. The command and telemetry subsystem performance for Intelsat 10 is summarized in Exhibit 3.

2.4 Uplink Power Control Subsystem

Intelsat 10 utilizes two Ku-band channels for uplink power control ("ULPC"), antenna tracking, and ranging. The coverage patterns of the ULPC beams have gain contours that vary by less than 8 dB across the surface of the Earth, and accordingly the gain at 8 dB below the peak falls beyond the edge of the Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A) of the FCC's rules, contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S. The ULPC frequencies and subsystem performance for Intelsat 10 are summarized in Exhibit 3.

2.5 Satellite Station-Keeping

In compliance with Section 25.210(j) of the Commission's rule, the spacecraft will be maintained within 0.05° of its nominal longitudinal position in the east-west direction.

The attitude of the spacecraft will be maintained with accuracy consistent with the achievement of the specified communications performance, after taking into account all error sources (i.e., attitude perturbations, thermal distortions, misalignments, orbital tolerances, and thruster perturbations, etc.).

3 Services

Intelsat 10 is a general-purpose communications satellite and has been designed to support various services offered within the Intelsat satellite system. Depending upon the needs of the users, the transponders on Intelsat 10 can accommodate digital and analog communications. Typical communication services include:

a) Compressed digital video;

b) High speed digital data; and

c) Digital single channel per carrier ("SCPC") data channels.

4 Power Flux Density

The power flux density ("PFD") limits for space stations operating in the 3700-4200 MHz and 11450-11700 MHz frequency bands are specified in Section 25.208 of the Commission's rules. The PFD limits for space stations operating in the 12250-12500 MHz and 12500-12750 MHz frequency bands are specified in No. 21.16 of the International Telecommunications Union's ("ITU") Radio Regulations.

The maximum PFD levels for the Intelsat 10 transmissions were calculated for the 3700-4200 MHz, 11450-11700 MHz, 12250-12500 MHz, and 12500-12750 MHz bands. The results are provided in Schedule S and show that the downlink PFD levels of the Intelsat 10 carriers do not exceed the limits specified in Section 25.208 of the Commission's rules or those specified in No. 21.16 of the Radio Regulations.

5 Emission Compliance

Section 25.202(e) of the Commission's rules requires that the carrier frequency of each space station transmitter be maintained within 0.002% of the reference frequency. Intelsat 10 is designed to be compliant with the provisions of this rule.

Intelsat will comply with the provisions of Section 25.202(f) of the Commission's rules with regard to Intelsat 10 emissions.

6 Orbital Location

Intelsat requests that its assigned 47.5° E.L. orbital location remain unchanged. The 47.5° E.L. location satisfies Intelsat 10 requirements for optimizing coverage, elevation angles, and service availability. Additionally, the location also ensures that the maximum operational, economic, and public interest benefits will be derived. Although 47.5° E.L. was entered into Schedule S, the Schedule S software rounded it to 48.0° E.L.

7 ITU Filing

Intelsat 10 operations in the 3700-4200 MHz, 5925-6425 MHz, 11450-11700 MHz, 12250-12500 MHz, 12500-12750 MHz, and 14000-14500 MHz frequency bands will continue to be under the Administration of Germany's ITU filings EUROPE*STAR-3 and EUROPESTAR-47.5E.

8 Coordination with Co-frequency Space Stations

Intelsat 10 will continue to operate under existing ITU filings of the German Administration, as noted above. The downlink equivalent isotropically radiated power ("EIRP") density of the satellite's transmissions in the conventional C-band will not exceed 3 dBW/4kHz for digital transmissions or 8 dBW/4kHz for analog transmissions, and associated uplink transmissions will

not exceed applicable EIRP density envelopes in Sections 25.218 or 25.221(a)(1) unless the non-routine uplink and/or downlink operation is coordinated with operators of authorized co-frequency space stations at assigned locations within six degrees of Intelsat 10's assigned location of 47.5°E.L.

The downlink EIRP density of the satellite's transmissions in the conventional or extended Ku-bands will not exceed 14 dBW/4kHz for digital transmissions or 17 dBW/4kHz for analog transmissions, and associated uplink transmissions will not exceed applicable EIRP density envelopes in §25.218, 25.222(a)(1), 25.226(a)(1), or 25.227(a)(1) unless the non-routine uplink and/or downlink operation is coordinated with operators of authorized co-frequency space stations at assigned locations within six degrees of Intelsat 10 at 47.5° E.L.

Given the above, the 5925-6425 MHz and 14000-14500 MHz uplink frequency bands and the 3700-4200 MHz and 11450-11700 MHz downlink frequency bands do not require any interference analysis under the Commission's rules. The required interference analysis for 12250-12750 MHz is attached in Exhibit 5. In all cases, Intelsat will comply with the applicable coordination agreements for 47.5° E.L.

9 Orbital Debris Mitigation Plan

9.1 Spacecraft Hardware Design

The spacecraft is designed such that no debris will be released during normal operations Steps are taken to reduce the probability of collision with meteoroids and other small debris (<1 cm diameter). Such steps include a spacecraft design where critical spacecraft components are located inside the protective body of the spacecraft and properly shielded, and all spacecraft subsystems have redundant components to ensure no single-point failures. The spacecraft does not use any subsystems for end-of-life disposal that are not used for normal operations.

9.2 Minimizing Accidental Explosions

The manufacturer has assessed the probability of a catastrophic failure including accidental explosions during and after completion of mission operations. The satellite is designed in a manner to minimize the potential for such explosions. Propellant tanks and thrusters are isolated using redundant valves and electrical power systems are shielded in accordance with standard industry practices. At the completion of the mission and upon disposal of the satellite, Intelsat will ensure the removal of all stored energy on the spacecraft by depleting all propellant tanks, venting all pressurized systems, and by leaving the batteries in a permanent discharge state.

9.3 Safe Flight Profiles

Intelsat has implemented operation processes and best work practices to limit the probability of the satellite becoming a source of debris as a result of collisions with space debris and/or other operational space stations.

Intelsat signed a user agreement with the Combined Space Operation Center ("CSpOC") with the United States government and routinely receives close approach alerts for the Intelsat fleet. Intelsat is also a founding member of the Space Data Association ("SDA") that was established to improve safety of flight by routinely exchange ephemeris data with other operators.

9.4 Post Mission Disposal

At the end of the mission, Intelsat intends to dispose of the spacecraft by moving it to an altitude of at least 150 kilometers above the geostationary arc. Intelsat has reserved 30.1 kilograms of propellant for this purpose. In its *Second Report and Order* in IB Docket 02-54, Mitigation of Orbital Debris,[2] the FCC declared that satellites launched prior to March 18, 2002, such as the Intelsat 10 satellite, would be designated as grandfathered satellites not subject to a specific disposal altitude. Therefore, the planned disposal orbit for Intelsat 10 complies with the FCC's rules.

The reserved fuel figure was determined by the spacecraft manufacturer and provided for in the propellant budget. This figure was calculated taking into account the expected mass of the satellite at the end of life and the required delta-velocity to achieve the desired orbit. The fuel gauging uncertainty has been taken into account in these calculations.

10 TC&R Control Earth Stations

Intelsat will conduct TC&R operations through one or more of the following earth stations: Fuchsstadt, Germany; Hartebeeshoek, South Africa; or Fucino, Italy. Additionally, Intelsat is capable of remotely controlling Intelsat 10 from its facilities in McLean, Virginia or in Long Beach, California.

[2] Mitigation of Orbital Debris, *Second Report and Order*, 19 FCC Rcd 11567 (2004).

Certification Statement

I hereby certify that I am a technically qualified person and am familiar with Part 25 of the Commission's rules. The contents of this engineering statement were prepared by me or under my direct supervision and to the best of my knowledge are complete and accurate.

/s/ Giselle Creeser	September 26, 2019
Giselle Creeser Intelsat US LLC Director, Spectrum Policy and Engineering	Date

EXHIBIT 1

COMMUNICATION SUBSYSTEM UPLINK BEAM PARAMETERS

Beam Name	C-Band Global	C-Band Global	Europe/Africa	Europe/Africa
Schedule S Beam ID	GCVU	GCHU	AFHU	AFVU
Frequency Band (MHz)	5925-6425	5925-6425	14250-14500	14250-14500
Polarization	Vertical	Horizontal	Horizontal	Vertical
G/T (dB/K)	-0.4	0.4	2.1	2.3
Minimum SFD-- (dBW/m^2)	-103.6	-104.4	-97.1	-97.3
Maximum SFD-- (dBW/m^2)	-78.6	-79.4	-72.1	-72.3

Beam Name	Europe/Middle East	Europe/Stans	Asia
Schedule S Beam ID	MKVU	EKHU	AKVU
Frequency Band (MHz)	14000-14250	14000-14250	14250-14500
Polarization	Vertical	Horizontal	Vertical
G/T (dB/K)	4.8	6.4	4.4
Minimum SFD-- (dBW/m^2)	-99.8	-101.4	-99.4
Maximum SFD-- (dBW/m^2)	-74.8	-76.4	-74.4

EXHIBIT 2

COMMUNICATION SUBSYSTEM DOWNLINK BEAM PARAMETERS

Beam Name	C-Band Global	C-Band Global	Asia	Europe/Africa
Schedule S Beam ID	GCHD	GCVD	AKVD	AFHD
Frequency Band (MHz)	3700-4200	3700-4200	12500-12750	12500-12750
Polarization	Horizontal	Vertical	Vertical	Horizontal
Maximum Beam Peak EIRP Density (dBW/Hz)	-32.9	-32.5	-26.6	-28.2
Maximum Beam Peak EIRP (dBW)	41.4	41.8	49	47.4
Maximum Beam Peak EIRP Density (dBW/4kHz)	3.1	3.5	9.5	7.9

Beam Name	Europe/Africa	Europe/ Middle East	Europe/Stans	India
Schedule S Beam ID	AFVD	MKVD	EKHD	IKHD
Frequency Band (MHz)	12500-12750	11450-11700	11450-11700	12250-12500
Polarization	Vertical	Vertical	Horizontal	Horizontal
Maximum Beam Peak EIRP Density (dBW/Hz)	-28.0	-26.3	-26.5	-23.6
Maximum Beam Peak EIRP (dBW)	47.6	49.3	49.1	52
Maximum Beam Peak EIRP Density (dBW/4kHz)	8.1	9.8	9.6	12.5

EXHIBIT 3

TC&R SUBSYSTEM CHARACTERISTICS

Beam Name	Command Global	Command Bicone	Command Global
Schedule S Beam ID	CMDG	CMDB	CMDH
Frequencies (MHz)	14000.5	14499.5	14499.5
Polarization	RHCP	Horizontal	Horizontal
Peak Flux Density at Command Threshold (dBW/m^2)	-90	-90	-90

Beam Name	Telemetry Global	Telemetry Global	Telemetry Pipe	Telemetry Pipe	Telemetry Bicone	Telemetry Bicone	ULPC	ULPC
Schedule S Beam ID	TLMG	TLMB	TLMP	TLMQ	TLM1	TLM2	ULP1	ULP2
Frequencies (MHz)	12747.5	12748.5	12747.5	12748.5	12747.5	12748.5	11699.0	12749.5
Polarization	Horizontal	Horizontal	RHCP	RHCP	Horizontal	Horizontal	Vertical	Horizontal
Maximum Channel EIRP (dBW)	8	8	8	8	8	8	13	13
Maximum Beam Peak EIRP Density (dBW/4kHz)	-11.4	-11.4	-11.4	-11.4	-11.4	-11.4	-6.4	-6.4
Maximum Beam Peak EIRP Density (dBW/Hz)	-47.4	-47.4	-47.4	-47.4	-47.4	-47.4	-42.4	-42.4

Note: *RHCP: Right Hand Circular Polarization, LHCP: Left Hand Circular Polarization*

EXHIBIT 4
Beam Polarizations and GXT File Names

	Schedule S Beam Names							
	Linear Polarization				Circular Polarization			
Beam Designation	**Uplink (H-Pol.)**	**Uplink (V-Pol.)**	**Downlink (H-Pol.)**	**Downlink (V-Pol.)**	**Uplink (LHCP)**	**Uplink (RHCP)**	**Downlink (LHCP)**	**Downlink (RHCP)**
C-Band Beams								
Global Beam	GCHU	GCVU	GCHD	GCVD	----	----	----	----
Ku-Band Beams								
Europe Middle East	----	MKVU	MKVD	----	----	----	----	----
Europe Africa	AFHU	AFVU	AFHD	AFVD	----	----	----	----
Europe Stans	EKHU	----	EKHD	----	----	----	----	----
Asia	----	AKVU	AKVD	----	----	----	----	----
India	----	----	IKHD	----	----	----	----	----
Telemetry Global	TLMG* TLMB*	----	----	----	----	----	----	----
Telemetry Bicone	TLM1* TLM2*	----	----	----	----	----	----	----
Telemetry Pipe	----	----	----	----	----	----	----	TLMP* TLMQ*
Command Global	CMDH*	----	----	----	----	CMDG*	----	----
Command Bicone	CMDB*	----	----	----	----	----	----	----
Ku-band ULPC	ULP2*	ULP1*	----	----	----	----	----	----

** GXT files are not provided for the indicated beams because their -8 dB gain contours extend beyond the edge of the Earth.*

EXHIBIT 5
INTERFERENCE ANALYSIS

Effect of Hypothetical Satellite at 45.5 and 49.5°E.L on Intelsat 10
Band: 12250-12750 MHz
Beams: Europe Africa (AFHU, AFHD), Asia (AKVU), and India (IKHD) beams

UPLINK BEAM INFORMATION								
Uplink Beam Name	AFHU	AKVU	AFHU	AKVU	AFHU	AKVU	AFHU	AKVU
Uplink Frequency (MHz)	14250-14500	14000-14250	14250-14500	14000-14250	14250-14500	14000-14250	14250-14500	14000-14250
Uplink Beam Polarization	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear
Uplink Relative Contour Level (dB)	-4	-4	-4	-4	-4	-4	-4	-4
Uplink Contour G/T (dB/K)	2.3	4.4	2.3	4.4	2.3	4.4	2.3	4.4
Uplink SFD (dBW/m²)	-84	-84	-84	-84	-84	-84	-84	-84
Rain Rate (mm/hr)	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
DOWNLINK BEAM INFORMATION								
Downlink Beam Name	AFHD	IKHD	AFHD	IKHD	AFHD	IKHD	AFHD	IKHD
Downlink Frequency (MHz)	12500-12750	12250-12500	12500-12750	12250-12500	12500-12750	12250-12500	12500-12750	12250-12500
Downlink Beam Polarization	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear
Downlink Relative Contour Level (dB)	-1	-1	-1	-1	-1	-1	-1	-1
Downlink Contour EIRP (dBW)	47.4	52.0	47.4	52.0	47.4	52.0	47.4	52.0
Rain Rate (mm/hr)	48.2	48.2	48.2	48.2	48.2	48.2	48.2	48.2
ADJACENT SATELLITE								
Orbital Locations	45.5°E,49.5°E	45.5°E,49.5°E	45.5°E,49.5°E	45.5°E,49.5°E	45.5°E,49.5°E	45.5°E,49.5°E	45.5°E,49.5°E	45.5°E,49.5°E
Uplink Power Density (dBW/Hz)	-38.7	-38.7	-38.7	-38.7	-38.7	-38.7	-38.7	-38.7
Downlink EIRP Density (dBW/Hz)	-32	-32	-32	-32	-32	-32	-32	-32
CARRIER INFORMATION								
Emission Designation	36M0G7W	36M0G7W	8M25G7W	8M25G7W	1M73G7W	1M73G7W	382KG7W	382KG7W
Information Rate (kbps)	36860.0	36860.0	8448	8448	1024	1024	256	256
Carrier Modulation	QPSK	QPSK	QPSK	QPSK	BPSK	BPSK	BPSK	BPSK
Code Rate	0.75	0.8	0.75	0.75	0.5	0.5	0.5	0.5
Occupied Bandwidth (kHz)	26665	26665	6111.3	6111.3	1283.9	1283.9	273.2	273.2
Allocated Bandwidth (kHz)	36000	36000	8250.5	8250.5	1733	1733	382	382
Minimum C/N (dB)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3

UPLINK EARTH STATION								
Earth Station Diameter (meters)	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Earth Station Gain (dBi)	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2
Earth Station Elevation Angle	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
DOWNLINK EARTH STATION								
Earth Station Diameter (meters)	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Earth Station Gain (dBi)	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3
Earth Station G/T (dB/K)	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6
Earth Station Elevation Angle	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
LINK FADE TYPE	Clear Sky	Clear Sky	Clear Sky	Clear Sky	Clear Sky	Clear Sky	Clear Sky	Clear Sky
UPLINK PERFORMANCE								
Uplink Earth Station EIRP (dBW)	84.80	84.80	78.36	78.36	71.58	71.58	64.86	64.86
Uplink Path Loss, Clear Sky (dB)	-206.7	-206.7	-206.7	-206.7	-206.7	-206.7	-206.7	-206.7
Uplink Rain Attenuation (dB)	0	0	0	0	0	0	0	0
Satellite G/T (dB/K)	2.3	4.4	2.3	4.4	2.3	4.4	2.3	4.4
Boltzman Constant (dBW/K-Hz)	228.6	228.6	228.6	228.6	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	74.3	74.3	67.9	67.9	61.1	61.1	54.4	54.4
Uplink C/N (dB)	30.7	30.7	40.4	40.4	27.9	40.4	40.4	40.4
DOWNLINK PERFORMANCE								
Downlink EIRP per Carrier (dBW)	44.3	44.3	37.9	37.9	30.1	30.1	24.1	24.1
Antenna Pointing Error (dB)	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Downlink Path Loss, Clear Sky (dB)	-204.8	-204.8	-204.8	-204.8	-204.8	-204.8	-204.8	-204.8
Downlink Rain Attenuation (dB)	0	0	0	0	0	0	0	0
Earth Station G/T (dB/K)	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6
Boltzman Constant (dBW/K-Hz)	228.6	228.6	228.6	228.6	228.6	228.6	228.6	228.6
Carrier Noise Bandwidth (dB-Hz)	74.3	74.3	67.9	67.9	61.1	61.1	54.4	54.4
Downlink C/N (dB)	18.9	13.0	18.9	13.0	17.9	12.0	18.6	12.7
COMPOSITE LINK PERFORMANCE								
C/N Uplink (dB)	30.7	30.7	40.4	40.4	27.9	40.4	40.4	40.4
C/N Downlink (dB)	18.9	13.0	18.9	13.0	17.9	12.0	18.6	12.7
C/I Other links (Co-channel & IM)	16	16	16	16	16	16	16	16
C/I Uplink Adjacent Satellites (dB)	40.5	40.5	40.5	40.5	40.5	40.5	40.5	40.5
C/I Downlink Adjacent Satellites (dB)	37.2	37.2	37.2	37.2	37.2	37.2	37.2	37.2
C/(N+I) Composite (dB)	14.0	11.1	14.1	11.2	13.6	10.5	14.0	11.0
Required System Margin (dB)	1.0	1.0	1	1	1	1	1	1
Minimum Required C/N (dB)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
CARRIER DENSITY LEVELS								
Uplink Power Density (dBW/Hz)	-38.7	-38.7	-38.7	-38.7	-38.7	-38.7	-38.7	-38.7
Downlink EIRP Density at Beam Peak	-30	-30	-30	-30	-30	-30	-30	-30