Engineering Statement

1 Introduction

Intelsat License LLC, as debtor in possession ("Intelsat"), seeks authority in this application to launch and operate the Galaxy 31 satellite at the 121.0° W.L orbital location. This satellite will replace Galaxy 23 (S2592),[1] currently operating at the same orbital location. The characteristics of the satellite, as well as its compliance with the various provisions of Part 25 of the Federal Communications Commission's ("FCC" or "Commission") rules,[2] are provided in the remainder of this Engineering Statement.

2 Spacecraft Overview

Galaxy 31 has the capability to operate in the frequencies listed in the table below. Intelsat is only seeking authority in this application, however, to operate in C-band at the 121.0° W.L. orbital location.

Direction	Frequency
Uplink	5925-6425 MHz
	12750-13250 MHz
	13750-14500 MHz
	27500-30000 MHz
Downlink	3700-4200 MHz[3]

[1] The Ku- and Ka-band transponders of Galaxy 23—known as EchoStar 9—are licensed by the United States to EchoStar Satellite Services L.L.C. *See* Policy Branch Information; Actions Taken, Report No. SAT-01444, File No. SAT-MOD-20191108-00128 (Jan. 31, 2020) (Public Notice).

[2] Unless otherwise stated, all references to rule sections in this document refer to sections in Title 47 of the Code of Federal Regulations.

[3] In the contiguous United States, Intelsat is only seeking authority to operate in the 4000-4200 MHz downlink band. Outside of the contiguous United States—and at the two consolidated TT&C/Gateway locations in Brewster, Washington and Andover, Maine—Intelsat is seeking to operate in the entire 3700-4200 MHz band. Intelsat understands that, at present, such operations in 3700-4000 MHz at the two consolidated telemetry, tracking, and control ("TT&C")/Gateway locations are on a non-protected basis only. *See Expanding Flexible Use of*

	10700-11200 MHz
	11700-12450 MHz
	17700-20200 MHz

The spacecraft provides the following coverage:

Frequency band	Beam	Coverage
C-band	Wide fixed	North America including Alaska and Hawaii; Central America; and the Caribbean

2.1 Spacecraft Characteristics

Galaxy 31 is a Maxar FS 1300-122 three-axis stabilized type spacecraft that has a rectangular outer body structure. Galaxy 31 utilizes two deployable solar array wings and a number of deployable and non-deployable antennas.

The Galaxy 31 satellite is composed of the following subsystems:

- Thermal;
- Power;
- Attitude Control;
- Propulsion;
- Telemetry, Command and Ranging ("TC&R");
- Uplink Power Control ("ULPC"); and
- 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 for all the various subsystems in order to avoid single-point failures.

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the 3.7 to 4.2 GHz Band, Report and Order and Order of Proposed Modification, FCC 20-22, 35 FCC Rcd 2343, ¶ 152, ¶ 134 (2020); 47 C.F.R. § 2.106, NG182.

The structural design of Galaxy 31 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

The Galaxy 31 C-band payload employs channels with bandwidth of 36 MHz, 43 MHz, and 126 MHz. The C-band frequencies, polarization, and channel plan as well as the coverage contours and performance characteristics are provided in Schedule S. Exhibits 1 and 2 provide the beam parameters for the C-band uplink and downlink beams, respectively, and Exhibit 4 provides the Schedule S beam designations.

2.3 Telemetry, Command and Ranging ("TC&R") Subsystem

The 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.

Galaxy 31 is also equipped with a tunable command receiver with center frequency selectable via ground command in 100 kHz steps.

The satellite's command and telemetry channel frequencies are shown 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 Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A), contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S. The satellite's command and telemetry subsystem performance are summarized in Exhibit 3.

2.4 Uplink Power Control Subsystem

Galaxy 31 utilizes one C-band channel for 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), contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S. Galaxy 31's ULPC frequencies and subsystem performance are summarized in Exhibit 3.

2.5 Satellite Station-Keeping

The satellite will be maintained within 0.05° of its nominal longitudinal position in the east-west direction in compliance with Section 25.210(j).

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

Galaxy 31 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 Galaxy 31 can provide a range of communications services, including compressed digital video, high speed digital data, and digital single channel per carrier data channels.

4 Power Flux Density

The power flux density limits for space stations operating in the 3700-4200 MHz band is specified in Section 25.208. As provided in Schedule S, the Galaxy 31 transmissions do not exceed these limits.

5 Emission Compliance

Section 25.202(e) requires that the carrier frequency of each space station transmitter be maintained within 0.002% of the reference frequency. Galaxy 31 is designed to be compliant with this rule.

Galaxy 31 will comply with the provisions of Section 25.202(f) with regard to its emissions.

6 Orbital Location

Galaxy 23 is currently licensed and operating at the 121.0° W.L. orbital location. Intelsat requests that Galaxy 31 be assigned the 121.0° W.L. orbital location as a replacement satellite for Galaxy 23.

7 International Telecommunication Union ("ITU") Filings

Galaxy 31 operations in the 3700-4200 MHz and 5925-6425 MHz bands will rely on the PACSTAR-L4 ITU filing of the Administration of Papua New Guinea.

8 Coordination Statement and Certifications

The downlink effective isotropic 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 the associated uplink transmissions will not exceed the applicable EIRP density envelope in Section 25.218 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 Galaxy 31 at 121.0° W.L.

9 Orbital Debris Mitigation Plan

Intelsat is proactive in ensuring safe operation and disposal of this and all spacecraft under its control. The four elements of debris mitigation are addressed below.

9.1 Spacecraft Hardware Design

Galaxy 31 is designed such that no debris will be released during normal operations. Intelsat has assessed the probability of collision with meteoroids and small debris. In order to limit the effects of such unlikely collisions critical satellite components are located inside the protective body of the satellite and are properly shielded. The satellite does not use any subsystems for end-of-life disposal that are not used for normal operations.

As calculated using the NASA Debris Assessment Software, the Galaxy 31 satellite's probability of a collision with large objects is less than 0.01, and with small objects is less than 0.01.

9.2 Minimizing Accidental Explosions

Intelsat has assessed the probability of 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 spacecraft, 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 assessed and limited the probability of the space station becoming a source of debris as a result of collisions with large debris or other operational space stations.

With the exception of a short period of co-location during and after traffic transition,[4] Galaxy 31 will not be located at the same orbital location as another satellite or at an orbital location that has an overlapping station keeping volume with another satellite.

Galaxy 31 will replace Galaxy 23 at 121.0° W.L. These satellites may be nominally collocated during transfer of traffic and Intelsat will ensure that sufficient spatial separation is achieved between these two satellites through the use of orbit eccentricity and inclination offsets and thus minimize the risk of collision. Intelsat is not aware of any other FCC licensed system, or any other system applied for and under consideration by the FCC, having an overlapping station-keeping volume with Galaxy 31. Intelsat is also not aware of any system with an overlapping station-keeping volume with the satellite that is the subject of an ITU filing and that is either in orbit or progressing towards launch.

9.4 Post Mission Disposal

At the end of the mission, Intelsat will dispose of the spacecraft by moving it to an altitude of at least 290 kilometers above the geostationary arc. Intelsat has reserved 55.0 kilograms of bi-propellant for that purpose.

In calculating the disposal orbit, Intelsat has used simplifying assumptions as permitted under the Commission's Orbital Debris Report and Order.[5] The effective area to mass ratio (Cr*A/M) of the satellite is 0.046 m^2/kg, resulting in a minimum perigee disposal altitude under the Inter-Agency Space Debris Coordination Committee formula of 290 kilometers above the geostationary arc. Accordingly, Galaxy 31's planned disposal orbit complies with the FCC's rules.

The reserved propellant figure is an estimate. This figure is 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.

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4 Bases on end of maneuver life calculations, Intelsat expects Galaxy 23/EchoStar 9 (EchoStar 9 is the Ku- and Ka-band portion of the satellite) to be deorbited soon after the arrival of Galaxy 31. Intelsat is responsible for the operation of Galaxy 23/EchoStar 9's TT&C.

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

10 TC&R Control Earth Stations

Intelsat will conduct TC&R operations through earth stations at one or more of the following teleports: Napa, California; Hagerstown, Maryland; Fillmore, California; Riverside, California; Castle Rock, Colorado; Brewster, Washington; Andover, Maine; Paumalu, Hawaii; and Ellenwood, Georgia. Additionally, Intelsat is capable of remotely controlling Galaxy 31 from its facilities in McLean, Virginia and Long Beach, California.

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	November 6, 2020
Giselle Creeser Intelsat Director, Spectrum Policy and Engineering	Date

EXHIBIT 1

COMMUNICATION SUBSYSTEM UPLINK BEAM PARAMETERS

Beam Name	C-Band North America	C-Band North America
Schedule S Beam ID	CAHU	CAVU
Frequency Band (MHz)	5925-6425	5925-6425
Polarization	Horizontal	Vertical
G/T (dB/K)	4.5	4.5
Minimum SFD-- (dBW/m^2)	-102.0	-102.0
Maximum SFD-- (dBW/m^2)	-77.0	-77.0

EXHIBIT 2

COMMUNICATION SUBSYSTEM DOWNLINK BEAM PARAMETERS

Beam Name	C-Band North America	C-Band North America
Schedule S Beam ID	CAHD	CAVD
Frequency Band (MHz)	3700-4200	3700-4200
Polarization	Horizontal	Vertical
Maximum Beam Peak EIRP (dBW)	47.0	47.0
Maximum Beam Peak EIRP Density (dBW/4kHz)	7.5	7.5
Maximum Beam Peak EIRP Density (dBW/Hz)	-28.6	-28.6

EXHIBIT 3

TC&R SUBSYSTEM CHARACTERISTICS

Beam Name	Command 1 Dish	Command 1 Omni	Command 2 Dish	Command 2 Omni
Schedule S Beam ID	CMD1	CMD2	CMD3	CMD4
Frequencies (MHz)	6422.0*	6422.0*	6424.5*	6424.5*
Polarization	Horizontal	RHCP	Horizontal	RHCP
Peak Flux Density at Command Threshold (dBW/m^2-Hz)	-80.0	-80.0	-80.0	-80.0

*Tunable with 100 kHz step (5925-6425 MHz)

Beam Name	Telemetry 1 Dish	Telemetry 1 Omni	Telemetry 2 Dish	Telemetry 2 Omni	ULPC Dish
Schedule S Beam ID	TLMD	TLMO	TLMP	TLMM	UPC1
Frequencies (MHz)	4197.25**	4197.25**	4197.75**	4197.75**	4199.95
Polarization	Vertical	LHCP	Vertical	LHCP	RHCP
Maximum Channel EIRP (dBW)	7.5	7.5	7.5	7.5	7.5
Maximum Beam Peak EIRP Density (dBW/4kHz)	-13.5	-13.5	-13.5	-13.5	-13.5
Maximum Beam Peak EIRP Density (dBW/Hz)	-49.5	-49.5	-49.5	-49.5	-49.5

**Tunable with 100 kHz step (3700-4200 MHz)

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**	**Uplink**	**Downlink**	**Downlink**	**Uplink**	**Uplink**	**Downlink**	**Downlink**
	(H-Pol.)	**(V-Pol.)**	**(H-Pol.)**	**(V-Pol.)**	**(LHCP)**	**(RHCP)**	**(LHCP)**	**(RHCP)**
C-Band Beams								
C band North America, Alaska, Hawaii & Caribbean	CAHU	CAVU	CAHD	CAVD	----	----	----	----
Telemetry 1	----	----	----	TLMD*	----	----	TLMO*	----
Telemetry 2	----	----	----	TLMP*	----	----	TLMM*	----
Command 1	CMD1*	----	----	----	----	CMD2*	----	----
Command 2	CMD3*	----	----	----	----	CMD4*	----	----
ULPC	----	----	----	----	----	----	----	UPC1*

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