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FILED VIA IBFS

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

Re: Supplement to Application of Intelsat License LLC to Launch and Operate Galaxy 14R, a Replacement Satellite with New Frequencies, at 125.0° W.L. (235.0° E.L.), File No. SAT-LOA-20170524-00079 (Call Sign S3016)

Dear Ms. Dortch:

Intelsat License LLC ("Intelsat"), by counsel, hereby supplements its above-referenced pending application to launch and operate a C-band replacement satellite with new Ku- and Ka-band frequencies, to be known as Galaxy 14R (Call Sign S3016), at the 125.0° W.L. orbital location.

Intelsat submits this supplement to provide an updated Engineering Statement that includes an interference analysis pursuant to Rule 25.140(a)(3)(v).[1] In the attached Engineering Statement, Intelsat demonstrates that the Galaxy 14R satellite system is compatible with co-frequency, geostationary satellite networks at orbital locations two degrees from 125.0° W.L. in certain Ka-band frequencies.

Please contact the undersigned with any questions.

Respectfully submitted,

/s/ Jennifer D. Hindin

Jennifer D. Hindin
Counsel to Intelsat License LLC

Attachment

[1] 47 C.F.R. § 25.140(a)(3)(v).

CERTIFICATE OF SERVICE

I, Randy Pannell, hereby certify that on this 8th day of January 2018, a copy of the foregoing Supplement to Application of Intelsat License LLC to Launch and Operate Galaxy 14R, a Replacement Satellite with New Frequencies, at 125.0° W.L. (235.0° E.L.) is being sent via first class, U.S. Mail, postage paid, to the following:

Maureen C. McLaughlin
Vice President, Public Policy
Iridium Satellite LLC
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/s/ Randy Pannell
Randy Pannell

Engineering Statement

1 Introduction

Intelsat License LLC ("Intelsat") seeks authority in this application to launch and operate the Galaxy 14R satellite at the 125.0° W.L. orbital location. Galaxy 14R will replace Galaxy 14, currently operating at 125.0° W.L. The characteristics of the Galaxy 14R spacecraft, as well as its compliance with the various provisions of Part 25 of the Federal Communication Commission's ("FCC or "Commission") rules, are provided in the remainder of this Engineering Statement.

2 Spacecraft Overview

Galaxy 14R is a Boeing model 702MP spacecraft that is capable of operating in the C-band, Ku-band, and Ka-band frequencies listed in the table below.

Direction	Frequency
Uplink	5925–6725 MHz
	13750–14000 MHz
	27500–29100 MHz[1]
	29250–30000 MHz[2]
Downlink	3700–4200 MHz
	10950–11200 MHz
	11450–11700 MHz
	17800–19300 MHz
	19700–20200 MHz

[1] Intelsat is also aware that frequencies in the 27.5-28.35 GHz and 28.6-29.1 GHz band are secondary for GSO FSS. *See* 47 C.F.R. § 25.202(a)(1), fn. 3, 7.

[2] The band 29250-29300 MHz is allocated to MSS feeder links and FSS on a co-primary basis. Earth station uplink operation in this band will require coordination with the incumbent MSS feeder link operator.

The spacecraft provides the following coverage:

Frequency band	Beam	Coverage
C-Band	Wide Beam	United States including Alaska and Hawaii
Ku-Band	K1–K57	United States including Alaska and Hawaii
Ka-Band	A1-A57	United States including Alaska and Hawaii

2.1 Spacecraft Characteristics

Galaxy 14R is a three-axis stabilized type spacecraft that has a rectangular outer body structure. Galaxy 14R utilizes two deployable solar array wings and a number of deployable and non-deployable antennas.

The Galaxy 14R spacecraft is composed of the following subsystems:

1) Thermal
2) Power
3) Attitude Control
4) Propulsion
5) Telemetry, Command and Ranging ("TC&R")
6) Uplink Power Control ("ULPC")
7) 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 each of the various subsystems in order to avoid single point failures.

The structural design of Galaxy 14R provides mechanical support for all subsystems. The structure supports the communication antennas, solar arrays, and the thrusters. It also provides a stable platform for preserving the alignment of critical elements of the spacecraft.

2.2 Communication Subsystem

Galaxy 14R provides active communication channels at C-band, Ku-band, and Ka-band frequencies. The C-band payload employs channels with bandwidths of 36 MHz. The Ku-band payload employs channels having bandwidths of 36 MHz, 54 MHz, 72 MHz, 84 MHz, and 96 MHz. The Ka-band payload employs channels having bandwidth of 36 MHz, 72 MHz, 96 MHz, and 125 MHz. The Galaxy 14R frequency and polarization plan is provided in Schedule S.

Galaxy 14R utilizes a combination of wide-beam and multiple spot-beam architecture. A wide beam that covers the United States, including Alaska and Hawaii, operates in C-band. In both Ku-band and Ka-band, there are 57 identical spot beams that collectively cover the United States, including Alaska and Hawaii. The coverage contours and performance characteristics for only a single representative Ku-band spot beam and a single representative Ka-band spot beam are provided in Schedule S. The latitude and longitude of each Ku-band and Ka-band spot beam's maximum gain point on the Earth are provided in Exhibits 1 and 2 in conformance with Section 25.114(c)(4)(vii)(B) of the Commission's rules. Additionally, in Exhibit 3, Intelsat has included the Schedule S beam designation for all beams.

The performance characteristics of all Galaxy 14R beams are provided in Schedule S. The coverage contours of all Galaxy 14R beams, except for those with their -8.0 dB contour extending beyond the edge of the Earth, are provided with Schedule S.

Exhibits 4 and 5 provide the beam parameters for the Galaxy 14R uplink and downlink beams, respectively.

All C-band, Ku-band, and Ka-band communication subsystems are inter-connected, which allows for any frequency combination for the uplink and downlink connectivity at sub-beam level. Additionally, a beam can have multiple connections to several other beams by splitting the channels into sub-channels with variable sizes. The expected dominant application for Galaxy 14R will comprise of hub and spoke networks wherein one earth station serves as the hub or gateway for a number of other earth stations. The earth stations' predominant communication links will be with the hub. All Galaxy 14R beams can be used for both gateway and service links.[3]

2.3 Telemetry, Command and Ranging 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.

The Galaxy 14R command and telemetry subsystem performance is summarized in Exhibit 6 and in Schedule S. The beams used for orbital maneuvers and on-station emergencies as well as the on-station 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

[3] Use of the band 27500 MHz-28350 MHz by earth stations will be subject to Section 25.136.

Commission's rules, contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S.

2.4 Uplink Power Control Subsystem

Galaxy 14R utilizes one C-band channel, one Ku-band channel, and one Ka-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) of the Commission'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 Galaxy 14R ULPC subsystem performance is summarized in Exhibit 6.

2.5 Satellite Station-Keeping

The spacecraft will be maintained within 0.05° of its nominal longitudinal position in the east-west direction. Accordingly, it will comply with Section 25.210(j) of the Commission's rules.

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 14R will be a general purpose communications satellite and has been designed to support various services offered within Intelsat's satellite system. Depending upon the needs of the users, the transponders on Galaxy 14R can accommodate television, radio, voice, and data communications. Typical communication services include:

a) Compressed digital video

b) High speed digital data

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

4 Power Flux Density ("PFD")

The power flux density ("PFD") limits for space stations operating in the 3700–4200 MHz, 10950–11200 MHz, 11450–11700 MHz, and 18300–18800 MHz are specified in Section 25.208 of the Commission's rules. Also, Section 25.138(a)(6) of the Commission's rules specify a PFD limit of -118 dBW/m^2/MHz for space stations

operating in the 18300-18800[4] MHz and 19700–20200 MHz bands. The Commission's rules do not specify a PFD limit in the 17800–18300 MHz or 18800–19300 MHz bands; however, there are PFD limits specified in rule No. 21.16 of the International Telecommunication Union ("ITU") Radio Regulations.

The maximum PFD levels for the Galaxy 14R transmissions were calculated for the bands 3700–4200 MHz, 10850–11700 MHz, 17800–18300 MHz, 18300–18800 MHz, 18800–19300 MHz, and 19700–20200 MHz. The results are provided in Schedule S and show that the downlink power flux density levels of the Galaxy 14R carriers do not exceed the limits specified in Sections 25.208 and 25.138 of the Commission's rules, nor those in rule No. 21.16 of the ITU Radio Regulations, as applicable.

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. Galaxy 14R 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 Galaxy 14R emissions.

6 Orbital Location

Intelsat requests that it be assigned the 125.0° W.L. orbital location for Galaxy 14R. The 125.0° W.L. location satisfies Galaxy 14R's 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.

7 ITU Filings

Galaxy 14R's operations in the 3700–4200 MHz, 5925–6425 MHz bands have been coordinated under the Administration of the United States' ITU filings USASAT-22B, USASAT-35D, and USASAT-50C.

For the operation of Galaxy 14R in the frequencies 6425-6725 MHz, 13750–14000 MHz, 10950–11200 MHz, 11450–11700 MHz, 27500–29100 MHz, 29250–30000 MHz, 17800–19300 MHz, and 19700–20200 MHz, Intelsat will be submitting as part of this application the corresponding Appendix 4 information for the new satellite network to be forwarded by the FCC to the ITU.

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[4] Section 2.106, footnote US255 further limits the PFD at the surface of the earth in the 200 MHz wide band 18600-18800 MHz to -95 dBW/m^2 for all arrival angles. That level is equivalent to -118 dBW/m^2/MHz.

8 Coordination Statement and Certifications

The downlink EIRP density of Galaxy 14R's transmissions in the conventional and extended 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 Galaxy 14R at 125.0° W.L.

The downlink EIRP density of Galaxy 14R's transmissions in the conventional and extended Ku-band 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 Sections 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 Galaxy 14R at 125.0° W.L.

PFD at the Earth's surface produced by emissions from a space station in the conventional Ka-band, 18300–18000 MHz and 19700–20200 MHz for all conditions, including clear sky, and for all methods of modulation shall not exceed a level of -118 dBW/m^2/MHz, and in addition will not exceed the limits specified in § 25.208(d). The associated uplink transmissions will not exceed applicable EIRP density envelopes in Section 25.138 unless the non-routine operation is coordinated with operators of authorized co-frequency space stations at assigned locations within six degrees of Galaxy 14R at 125.0° W.L.

Galaxy 14R will also operate in several bands addressed by Section 25.140(a)(3)(v). Because there are no previously authorized co-frequency space stations at a location two degrees away, Section 9 provides an interference analysis demonstrating compatibility with a hypothetical co-frequency space station two degrees away with the same receiving and transmitting characteristics as the proposed space station.

Further, Intelsat will operate Galaxy 14R in compliance with all existing or future coordination agreements for 125.0° W.L.

9 Interference Analysis

The compatibility of the proposed Galaxy 14R emissions in the, 17800-18300 MHz, 18800-19700 MHz, 27500-28350 MHz, and 28600-29250 MHz bands with adjacent satellites located at 123.0° W.L. and 127.0° W.L. was analyzed. The interference analysis was conducted for a representative carrier in each beam type.

Other assumptions made for the interference analysis were as follows:

a) In the plane of the geostationary satellite orbit, all transmitting and receiving earth station antennas have off-axis co-polar gains that are compliant with the limits specified in section 25.209(a) of the FCC's rules.
b) All transmitting and receiving earth stations have a cross-polarization isolation value of at least 30 dB within their main beam lobe.
c) Rain attenuation predictions are derived using Recommendation ITU-R P.618.
d) Increase in noise temperature of the receiving earth station due to rain is taken into account.
e) For the cases where the transponder operates in a multi-carrier mode, the effects due to intermodulation interference are taken into account.

All assumptions and the results of the analysis are documented in Exhibit 7. Each of the link budgets demonstrate positive link margin for the representative carrier in the presence of an identical carrier operating via a satellite two degrees away.

10 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.

10.1 Spacecraft Hardware Design

The spacecraft is designed such that no debris will be released during normal operations. Intelsat has assessed the probability of collision with meteoroids and other small debris (<1 cm diameter) and has taken the following steps to limit the effects of such collisions: (1) critical spacecraft components are located inside the protective body of the spacecraft and properly shielded; and (2) 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.

10.2 Minimizing Accidental Explosions

Intelsat has assessed the probability of accidental explosions during and after completion of mission operations. The spacecraft 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.

10.3 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 potential exception of co-location during a traffic transition period, Galaxy 14R 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 14R will replace Galaxy 14 at 125.0° 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 14R. Intelsat is also not aware of any system with an overlapping station-keeping volume with Galaxy 14R that is the subject of an ITU filing and that is either in orbit or progressing towards launch.

10.4 Post Mission Disposal

At the end of the mission, Intelsat will dispose of the spacecraft by moving it to an altitude of at least 280 kilometers above the geostationary arc. Intelsat has reserved 2.0 kilograms of xenon 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 Galaxy 14R spacecraft is 0.045 m^2/kg, resulting in a minimum perigee disposal altitude under the Inter-Agency Space Debris Coordination Committee formula of 280 kilometers above the geostationary arc. Accordingly, the Galaxy 14R planned disposal orbit 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.

11 TC&R Control Earth Stations

Intelsat will conduct TC&R operations through one or more of the following earth stations: Napa, CA, Hagerstown, MD, and Ellenwood, GA. Additionally, Intelsat is capable of remotely controlling Galaxy 14R from its facilities in McLean, VA or Long Beach, CA.

[5] *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/ Alexander Gerdenitsch	January 8, 2018
Alexander Gerdenitsch Intelsat Manager, Spectrum Policy, Americas	Date

EXHIBIT 1
Ku-band SPOT BEAM BORESIGHT LOCATIONS

Beam Designation	Latitude (°N)	Longitude (°E)	Beam Designation	Latitude (°N)	Longitude (°E)
Ku-band Beams			**Ku-band Beams**		
K1	19.31	-68.32	K30	47.7	-82.63
K2	18.63	-82.34	K31	46.42	-95.95
K3	24.27	-71.48	K32	45.66	-105.85
K4	23.5	-84.59	K33	45.18	-114.3
K5	23.03	-93.67	K34	44.88	-122.03
K6	29.55	-72.89	K35	44.74	-129.38
K7	28.63	-86.08	K36	59.06	-59.98
K8	28.07	-95.29	K37	55.25	-91.6
K9	27.69	-102.91	K38	54.01	-104.72
K10	27.4	-109.65	K39	53.32	-115.06
K11	27.2	-115.86	K40	52.95	-124.26
K12	27.07	-121.74	K41	52.84	-133
K13	35.34	-72.37	K42	52.95	-141.74
K14	34.17	-86.71	K43	53.32	-150.94
K15	33.49	-96.4	K44	54.01	-161.28
K16	33.03	-104.36	K45	55.25	-174.4
K17	32.7	-111.4	K46	64.65	-139.32
K18	32.47	-117.89	K47	65.33	-152.9
K19	32.33	-124.05	K48	67.22	-171.38
K20	32.26	-130.03	K49	24.29	-153.21
K21	42.1	-67.93	K50	27.07	-144.26
K22	40.36	-86.04	K51	27.2	-150.14
K23	39.48	-96.81	K52	32.26	-135.97
K24	38.91	-105.43	K53	32.33	-141.95
K25	38.52	-112.98	K54	32.47	-148.11
K26	38.27	-119.93	K55	38.12	-139.46
K27	38.12	-126.54	K56	38.27	-146.07
K28	38.07	-133	K57	21.32	-156.83
K29	49.59	-56.41			

EXHIBIT 2
Ka-band SPOT BEAM BORESIGHT LOCATIONS

Beam Designation	Latitude (°N)	Longitude (°E)	Beam Designation	Latitude (°N)	Longitude (°E)
Ka-band Beams			Ka-band Beams		
A1	19.31	-68.32	A30	47.7	-82.63
A2	18.63	-82.34	A31	46.42	-95.95
A3	24.27	-71.48	A32	45.66	-105.85
A4	23.5	-84.59	A33	45.18	-114.3
A5	23.03	-93.67	A34	44.88	-122.03
A6	29.55	-72.89	A35	44.74	-129.38
A7	28.63	-86.08	A36	59.06	-59.98
A8	28.07	-95.29	A37	55.25	-91.6
A9	27.69	-102.91	A38	54.01	-104.72
A10	27.4	-109.65	A39	53.32	-115.06
A11	27.2	-115.86	A40	52.95	-124.26
A12	27.07	-121.74	A41	52.84	-133
A13	35.34	-72.37	A42	52.95	-141.74
A14	34.17	-86.71	A43	53.32	-150.94
A15	33.49	-96.4	A44	54.01	-161.28
A16	33.03	-104.36	A45	55.25	-174.4
A17	32.7	-111.4	A46	64.65	-139.32
A18	32.47	-117.89	A47	65.33	-152.9
A19	32.33	-124.05	A48	67.22	-171.38
A20	32.26	-130.03	A49	24.29	-153.21
A21	42.1	-67.93	A50	27.07	-144.26
A22	40.36	-86.04	A51	27.2	-150.14
A23	39.48	-96.81	A52	32.26	-135.97
A24	38.91	-105.43	A53	32.33	-141.95
A25	38.52	-112.98	A54	32.47	-148.11
A26	38.27	-119.93	A55	38.12	-139.46
A27	38.12	-126.54	A56	38.27	-146.07
A28	38.07	-133	A57	21.32	-156.83
A29	49.59	-56.41			

EXHIBIT 3
Beam Polarizations and GXT File Names

	Schedule S Beam GXT File Names							
	Linear Polarization				Circular Polarization			
Beam Description	**Uplink (H-Pol.)**	**Uplink (V-Pol.)**	**Downlink (H-Pol.)**	**Downlink (V-Pol.)**	**Uplink (LHCP)**	**Uplink (RHCP)**	**Downlink (LHCP)**	**Downlink (RHCP)**
C-Band Beams								
United States	CAHU	CAVU	CAHD	CAVD	----	----	----	----
ULPC1	----	----	CLHD*	----	----	----	----	----
Telemetry Global	----	----	TGHD*	----	----	----	----	----
Command Global	----	CMD*	----	----	----	----	----	----
Telemetry Pipe	----	----	----	----	----	----	TPLD*	----
Telemetry Hemi	----	----	----	----	----	----	THLD*	----
Command Pipe	----	----	----	----	CPLU*	----	----	----
Command Hemi	----	----	----	----	CHLU*	----	----	----
Ku-Band Beams								
Spot K1-K57	KSHU	KSVU	KSHD KSHE	KSVD KSVE	----	----	----	----
ULPC2	----	----	----	----	----	----	----	KLRD*
Ka-Band Beams								
Spot A1-A57	----	----	----	----	ASLU ASLV	ASRU ASRV	ASLD ASLE	ASRD ASRE
ULPC3	----	----	----	ALVD*	----	----	----	----

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

EXHIBIT 4
COMMUNICATION SUBSYSTEM UPLINK BEAM PARAMETERS

Beam Name	C-Band Wide	C-Band Wide	Ku-Band Spot	Ku-Band Spot
Schedule S Beam ID	CAHU	CAVU	KSHU	KSVU
Frequency Band (MHz)	5927.0-6703.0		13754.0-13996.0	
Polarization	Horizontal	Vertical	Horizontal	Vertical
G/T (dB/K)	4.8	4.8	18.1	18.1
Minimum SFD--(dBW/m^2)	**-106.1**	**-106.1**	-100.9	-100.9
Maximum SFD--(dBW/m^2)	**-78.1**	**-78.1**	-75.9	-75.9

Beam Name	Ka-Band Spot	Ka-Band Spot	Ka-Band Spot	Ka-Band Spot
Schedule S Beam ID	ASRU	ASLU	ASRV	ASLV
Frequency Band (MHz)	27504.0-29088.0		29254.0-29995.0	
Polarization	RHCP	LHCP	RHCP	LHCP
G/T (dB/K)	19.0	19.0	19.0	19.0
Minimum SFD--(dBW/m^2)	-101.9	-101.9	-101.9	-101.9
Maximum SFD--(dBW/m^2)	-76.9	-76.9	-76.9	-76.9

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

EXHIBIT 5

COMMUNICATION SUBSYSTEM DOWNLINK BEAM PARAMETERS

Beam Name	C-Band Spot	C-Band Spot
Schedule S Beam ID	CAHD	CAVD
Frequency Band (MHz)	3702.0-4178.0	
Polarization	Horizontal	Vertical
Maximum Beam Peak EIRP (dBW)	49.5	49.5
Maximum Beam Peak EIRP Density (dBW/4kHz)	6.1	6.1
Maximum Beam Peak EIRP Density (dBW/Hz)	-29.9	-29.9

Beam Name	Ku-Band Spot	Ku-Band Spot	Ku-Band Spot	Ku-Band Spot
Schedule S Beam ID	KSHD	KSVD	KSHE	KSVE
Frequency Band (MHz)	10950.0-11198.0		11454.0-11690.0	
Polarization	Horizontal	Vertical	Horizontal	Vertical
Maximum Beam Peak EIRP (dBW)	62.0	62.0	62.0	62.0
Maximum Beam Peak EIRP Density (dBW/4kHz)	20.4	20.4	20.0	20.0
Maximum Beam Peak EIRP Density (dBW/Hz)	-15.6	-15.6	-15.6	-15.6

Beam Name	Ka-Band Spot	Ka-Band Spot	Ka-Band Spot	Ka-Band Spot
Schedule S Beam ID	ASLD	ASRD	ASLE	ASRE
Frequency Band (MHz)	17804.0-19295.0		19704.0-20187.0	
Polarization	LHCP	RHCP	LHCP	RHCP
Maximum Beam Peak EIRP (dBW)	64.0	64.0	64.0	64.0
Maximum Beam Peak EIRP Density (dBW/4kHz)	20.0	20.0	20.0	20.0
Maximum Beam Peak EIRP Density (dBW/Hz)	-16.0	-16.0	-16.0	-16.0

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

EXHIBIT 6
TC&R SUBSYSTEM CHARACTERISTICS

Beam Name	Command Global	Command Pipe	Command Hemi
Schedule S Beam ID	CMD	CPLU	CHLU
Center Frequencies (MHz)	6424.5	6424.5	5926.75
Command Carrier Bandwidth (MHz)	1.0	1.0	1.0
Polarization	Vertical	LHCP	LHCP
Peak Flux Density at Command Threshold (dBW/m^2-Hz)	-90	-80	-80

Beam Name	**Telemetry Global**	**Telemetry Pipe**	**Telemetry Bicone**
Schedule S Beam ID	TGHD	TPLD	THLD
Frequencies (MHz)	4197.75, 4198.25, 4198.75, & 4199.25	4197.75, 4198.25, 4198.75, & 4199.25	4197.75, 4198.25, 4198.75, & 4199.25
Polarization	Horizontal	LHCP	LHCP
Maximum Channel EIRP (dBW)	13.7	15.4	11.9
Maximum Beam Peak EIRP Density (dBW/4kHz)	-7.3	-5.6	-9.1
Maximum Beam Peak EIRP Density (dBW/Hz)	-43.3	-41.6	-45.1

Beam Name	**C-band Global**	**Ku-band Global**	**Ka-band Global**
Schedule S Beam ID	CLHD	KLRD	ALVD
Frequencies (MHz)	4199.75	11451.0	19702.0
Polarization	Horizontal	RHCP	Vertical
Maximum Channel EIRP (dBW)	6.2	11	12.0
Maximum Beam Peak EIRP Density (dBW/4kHz)	-1.8	3	4.0
Maximum Beam Peak EIRP Density (dBW/Hz)	-37.8	-33	-32.0

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

EXHIBIT 7
Interference Analysis
Effect of Hypothetical Satellites at 123°W.L and 127°W.L on Galaxy 14R

UPLINK BEAM INFORMATION				
Uplink Beam Name	**ASLU & ASRU**	**ASLU & ASRU**	**ASLU & ASRU**	**ASLU & ASRU**
Uplink Frequency (MHz)	27500-28350 & 28600-29100	27500-28350 & 28600-29100	27500-28350 & 28600-29100	27500-28350 & 28600-29100
Uplink Beam Polarization	Circular	Circular	Circular	Circular
Uplink Relative Contour Level (dB)	-3.0	-3.0	-3.0	-3.0
Uplink Contour G/T (dB/K)	19.0	19.0	19.0	19.0
Uplink SFD (dBW/m²)	-89.6	-89.6	-89.6	-89.6
DOWNLINK BEAM INFORMATION				
Downlink Beam Name	**ASLD & ASRD**	**ASLD & ASRD**	**ASLD & ASRD**	**ASLD & ASRD**
Downlink Frequency (MHz)	17800-18300 & 18800-19300	17800-18300 & 18800-19300	17800-18300 & 18800-19300	17800-18300 & 18800-19300
Downlink Beam Polarization	Circular	Circular	Circular	Circular
Downlink Relative Contour Level (dB)	-3.0	-3.0	-3.0	-3.0
Downlink Contour EIRP (dBW)	64.0	64.0	64.0	64.0
Rain Rate (mm/hr)	48.2	48.2	48.2	48.2
ADJACENT SATELLITE				
Orbital Locations	123°W,127°W	123°W,127°W	123°W,127°W	123°W,127°W
Uplink Power Density (dBW/Hz)	-57.0	-57.0	-57.0	-57.0
Downlink EIRP Density (dBWHz)	-16.0	-16.0	-16.0	-16.0
CARRIER INFORMATION				
Emission Designation	**36M0G7W**	**8M25G7W**	**1M73G7W**	**382KG7W**
Information Rate (kbps)	36860.0	8448.0	1024.0	256.0
Carrier Modulation	QPSK	QPSK	BPSK	BPSK
Code Rate	0.8	0.8	0.5	0.5
Occupied Bandwidth (kHz)	26665	6111	1284	273
Allocated Bandwidth (kHz)	36000	8251	1733	382
Minimum C/N (dB)	7.30	7.30	1.80	1.20
UPLINK EARTH STATION				
Earth Station Diameter (meters)	2.4	2.4	2.4	2.4
Earth Station Gain (dBi)	55.8	55.8	55.8	55.8
Earth Station Elevation Angle	20.0	20.0	20.0	20.0
DOWNLINK EARTH STATION				
Earth Station Diameter (meters)	0.97	0.97	0.60	0.60
Earth Station Gain (dBi)	44.5	44.5	40.3	40.3
Earth Station G/T (dB/K)	22.7	22.7	18.5	18.5
Earth Station Elevation Angle	20.0	20.0	20.0	20.0
COMPOSITE LINK PERFORMANCE				
C/N Uplink (dB)	17.6	17.6	30.1	30.1
C/N Downlink (dB)	25.0	25.0	13.9	14.6
C/I Other links (Co-channel & IM)	16.0	16.0	16.0	16.0
C/I Uplink Adjacent Satellites (dB)	34.3	34.3	34.3	34.3
C/I Downlink Adjacent Satellites (dB)	19.5	19.5	15.3	15.3
C/(N+I) Composite (dB)	11.6	11.6	9.0	9.2
Required System Margin (dB)	1.0	1.0	1.0	1.0
Minimum Required C/N (dB)	7.3	7.3	7.3	7.3
CARRIER DENSITY LEVELS				
Uplink Power Density (dBW/Hz)	-57.0	-57.0	-57.0	-57.0
Downlink EIRP Density at Beam Peak	-16.0	-16.0	-16.0	-16.0