Technical Appendix

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Technical Appendix

A. Types of Authorization Requested (47 C.F.R. § 25.114(c)(3))

LightSquared Subsidiary LLC ("LightSquared") seeks authority to communicate with SkyTerra 2 in order to provide Mobile Satellite Service ("MSS"), including an Ancillary Terrestrial Component ("ATC").

B. Spacecraft Communications Subsystem (47 C.F.R. § 25.114(c)(4))

1. Transmission Characteristics

Different transmission rates may be used depending on service type. The rate chosen at the time of transmission will be a function of the terminal type, the propagation environment, and the requested service. Channel cards at the satellite feeder-link earth stations will be developed for the GMSA and GMR-3G air-interfaces for transmission and reception of control signals and user traffic between the feeder-link earth stations and the mobile terminals (MTs).

The baseline wireless protocols for the satellite system are GMSA and GMR-3G. However, other wireless protocol(s) (*e.g*. S-OFDMA; satellite adaptation of OFDMA) may be used in the future, and the requisite authority will be sought at that time.

Table 1 Satellite Service Link Transmission Characteristics

	GMSA			**GMR-3G**	
	Forward	Return	Return	Forward	Return
Access Mode	CDMA	SCPC	CDMA	TDMA	TDMA
Modulation	QPSK, 8-PSK, 16-QAM	BPSK, QPSK, 8PSK, 16-QAM, 64-QAM	BPSK, QPSK, 8PSK	BPSK, QPSK	BPSK, QPSK
Channel Rate (kbps/kcps)	Up to 1228.8	Up to 38.4	Up to 460	Up to 160	Up to 160
Carrier Bandwidth (kHz)	1250	6.4/12.8	1250	31.25 - 156.25	31.25 - 156.25
Maximum EIRP (dBW)	62.6	-11 to 15	-11 to 15	61.5	-11 to 15
Receive G/T (dB/ºK)	-31 to -15	21	21	-31 to -15	21
MT Antenna Type	Omni	Omni	Omni	Omni	Omni
MT Antenna Polarization	Linear	Linear	Linear	Linear	Linear

2. Frequency and Polarization Plan

For service links, the satellite will use the bands 1626.5-1660.5 MHz for return links and 1525-1559 MHz for forward links. Polarization will be right-hand circular in the forward service link direction and both left-hand circular and right-hand circular in the return service link direction. Forward and return service link carriers will have a bandwidth of either up to 156.25 kHz (GMR-3G) or 1.25 MHz (GMSA).

a. Gateway-to-Satellite and Satellite-to-Gateway Frequency and Polarization Plan

The satellite will use the 12.75-13.25 GHz band on each of two orthogonal circular polarizations for the forward feeder link and both the 10.70-10.95 GHz band and the 11.2-11.45 GHz band on each of two orthogonal circular polarizations for the return feeder link. Polarization will be circular with both right-hand and left-hand orthogonal components used on both transmit and receive frequencies. The use of circular rather than linear polarization enables the satellite manufacturer to achieve much improved inter-beam cross-polarization isolation that will enhance overall link performance. At the 107.3°W.L. orbital location, these bands are assigned internationally to Canada, the licensing administration for SkyTerra 2.

The total return link feeder-link bandwidth required is approximately 4000 MHz. Since only 500 MHz of spectrum is available for feeder links, LightSquared will use both polarizations at each of the four feeder-link stations to achieve the necessary 4000 MHz of spectrum. The four feeder-link earth stations have been licensed for operation with SkyTerra 1 and are located at Napa, California; Dallas, Texas; Saskatoon, Saskatchewan; and Ottawa, Ontario. SkyTerra Canada has prepared and submitted to the ITU via Industry Canada an Appendix 30B (CANSAT-23-30B) filing that provides a composite beam pattern and test points that encompass the feeder-link earth station locations.

Uplink (forward link) Ku-band feeder link signals will be amplified and translated to the L-band forward link (space-to-earth). The L-band return links (earth-to-space) will similarly be amplified and translated to feeder down links at Ku band. The flexibility of the ground-based beam forming at L band, described below, along with this flexible design, permits frequency and capacity management on a beam-by-beam basis.

b. Power Control Beacon

There will be a power control beacon, a pseudo-noise (PN) coded spread carrier with a 2.5 MHz bandwidth, generated on the spacecraft and transmitted in the feeder-link downlink. The beacon will be used to detect signal fading and guide power control of feeder uplink transmission.

3. Communications Payload

To facilitate flexibility in beam shaping and to maintain accurate spot-beam location during an inclined orbit, beam-forming will be done at the feeder-link earth stations. The communications payload subsystem will effectively have agile frequency translating transponders on the forward and return links, realized through the use of ground-based beam-forming (GBBF). Figure 1 shows a high-level block diagram of the communications subsystem. Uplink (forward link) Ku-band feeder-link signals for the L-band feed elements will be amplified and translated to the 1.5 GHz band forward link (space-to-earth) antenna feed elements through a series of amplifiers with fixed and programmable filters. The 1.6 GHz band return link (earth-to-space) signals are similarly translated to feeder downlinks at Ku band. This flexible design permits frequency and capacity management on a beam-by-beam basis and greater flexibility in producing various beam patterns.

Since beam shapes are determined by the vector sum of the signals presented to or received by the satellite feed elements, and the signal at each feed element is processed at the Ground Station Subsystem ("GSS"), the LightSquared system can form a great variety of beam shapes and sizes on the ground. The beam contours can be reconfigured via changes to the ground configuration files located at the satellite gateway.[1]

Processing at the gateway will also entail combination of signal components received by the satellite on orthogonal polarizations (polarization diversity combining),[2] combination of signal components received by spatially separated satellites (satellite diversity combining), and

[1] This feature can be used to establish an emulation mode for LightSquared's current satellite system.

[2] Some of the replacement satellite terminals transmit linearly-polarized signals. This requires the satellite to receive both RHCP and LHCP in order to capture all the signal energy.

intra-system interference cancellation to mitigate the effect of frequency reuse by the satellite network's space segment and ATC.[3]

[3] The ground-based beam forming includes an adaptive nulling capability that reduces co-channel interference from the ATC and from other satellite beams.

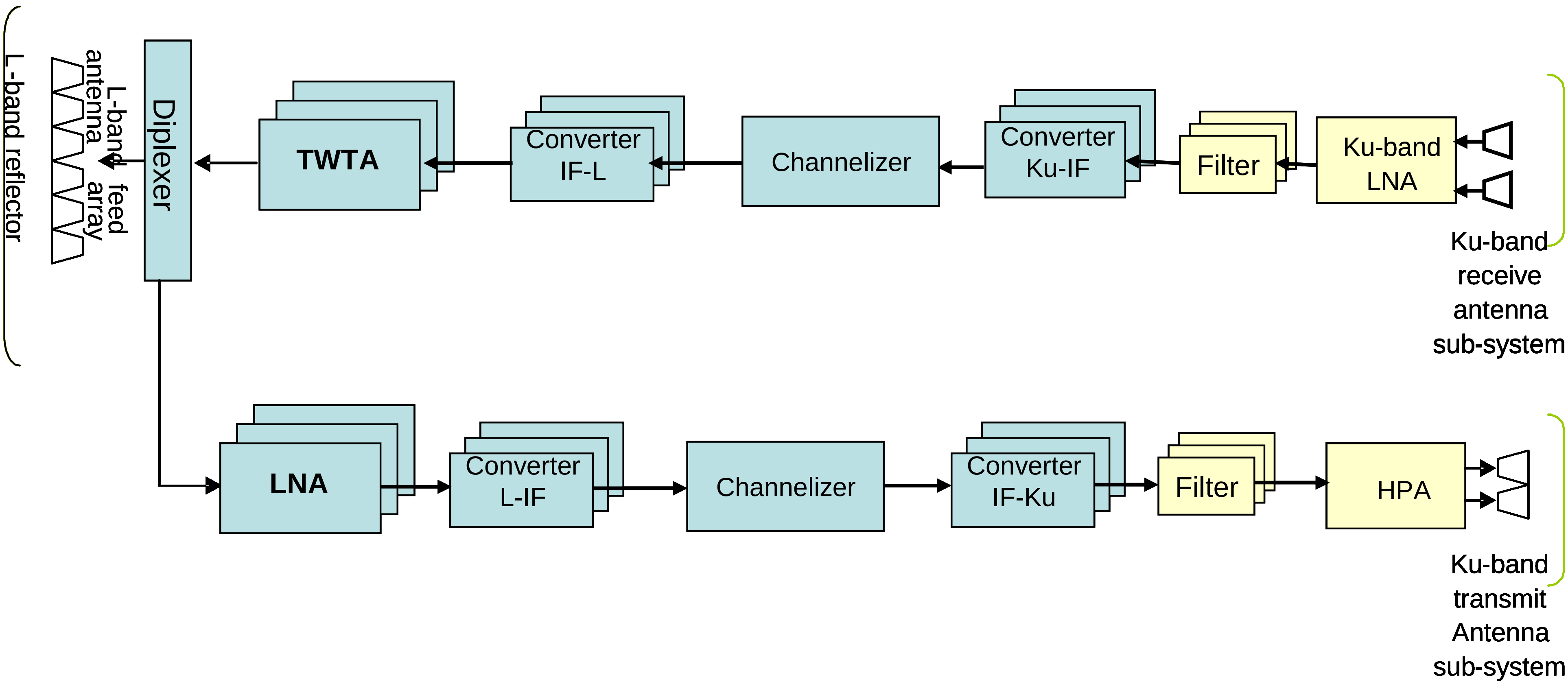


Figure 1- Communications Sub-System Block Diagram

Table 2: Communications Subsystem Characteristics

LINK DIRECTION	FEEDER to SERVICE (Forward Link)	SERVICE to FEEDER (Return Link)
Frequency band		
Receive	12.75 – 13.25 GHz	1626.5 – 1660.5 MHz
Transmit	1525 – 1559 MHz	11.20 – 11.45 GHz 10.70 – 10.95 GHz
Polarization		
Receive	LHCP & RHCP	LHCP & RHCP
Transmit	RHCP	LHCP & RHCP
Channelization	Fixed and Tunable	Fixed and Tunable
Peak Antenna Gain		
Receive	42 dBi	30 to 47 dBi
Transmit	30 to 47 dBi	42 dBi
System Temperature	780 ºK	650 to 400 ºK
Peak G/T	11 dB/ºK	2 to 21 dB/ºK
Power into Antenna	4000 W	50 W
Total EIRP @ Peak Max/beam	80 dBW	51.5 dBW Saturated
Transponder Active Gain, Nominal	132 dB	126 dB
Gain Adjustment	+/- 6 dB	+/- 6 dB
Step Size	1.5 dB	1.5 dB
Emission Designators		
CW	N0N	N0N
GMSA Forward and High-Speed Return	1M25G7W	1M25G7W
GMSA Low Bandwidth Return	6K4G1W & 12K8G1W	6K4G1W & 12K8G1W
GMR-3G	3K13G7W – 156KG7W	3K13G7W – 156KG7W
First Generation Carriers:		
	5K00G1D	5K00G1D
	6K00G1W	6K00G1W
	15K0G1W	15K0G1W
	190KG1W	190KG1W
	500KG1W	3M50G1D
Emission Limitations (% authorized bandwidth)	Attenuation per 4 kHz	Attenuation per 4 kHz
50 to 100%	> 25 dB	> 25 dB
100 to 250 %	> 35 dB	> 35 dB
> 250%	> 60 dB	> 60 dB

4. Tracking, Telemetry, and Command Payload

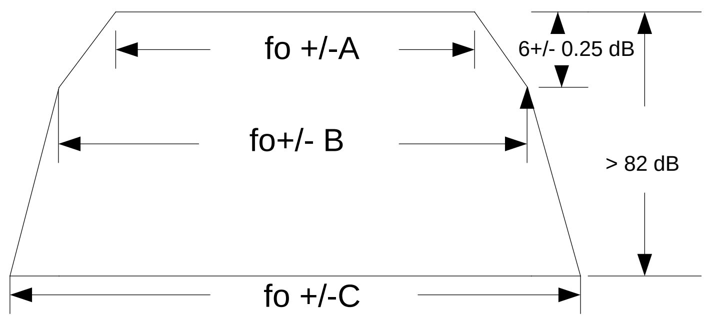
See infra Section F.

5. Predicted receiver and transmitter channel filter response characteristics

The satellite is being designed to pass all authorized frequencies while meeting all requirements for out-of-band and in-band emissions. SkyTerra 2 does not have transponders in the conventional sense, and signals are digitized on the satellite for on-board processing and switching. Analog and digital filters will be used to help control out-of-band emissions. The characteristics of the digital and analog filters have been optimized along with payload operating points to ensure that the requirements of Section 25.202(f) of the Commission's rules and all other required limits on out-of-band emissions are met.

The onboard filtering at L band is done principally through digital filters in the satellite channelizer. The channelizer can be programmed to select variable bandwidth channels up to a contiguous bandwidth of 7.5 MHz anywhere in the 1525-1559 MHz band. Since the filtering is done in digital format the passband response is very flat over the desired frequencies and the out-of-band rejection (selectivity) is very sharp. Figure 2 below describes a typical channel filter response for a specified bandwidth.

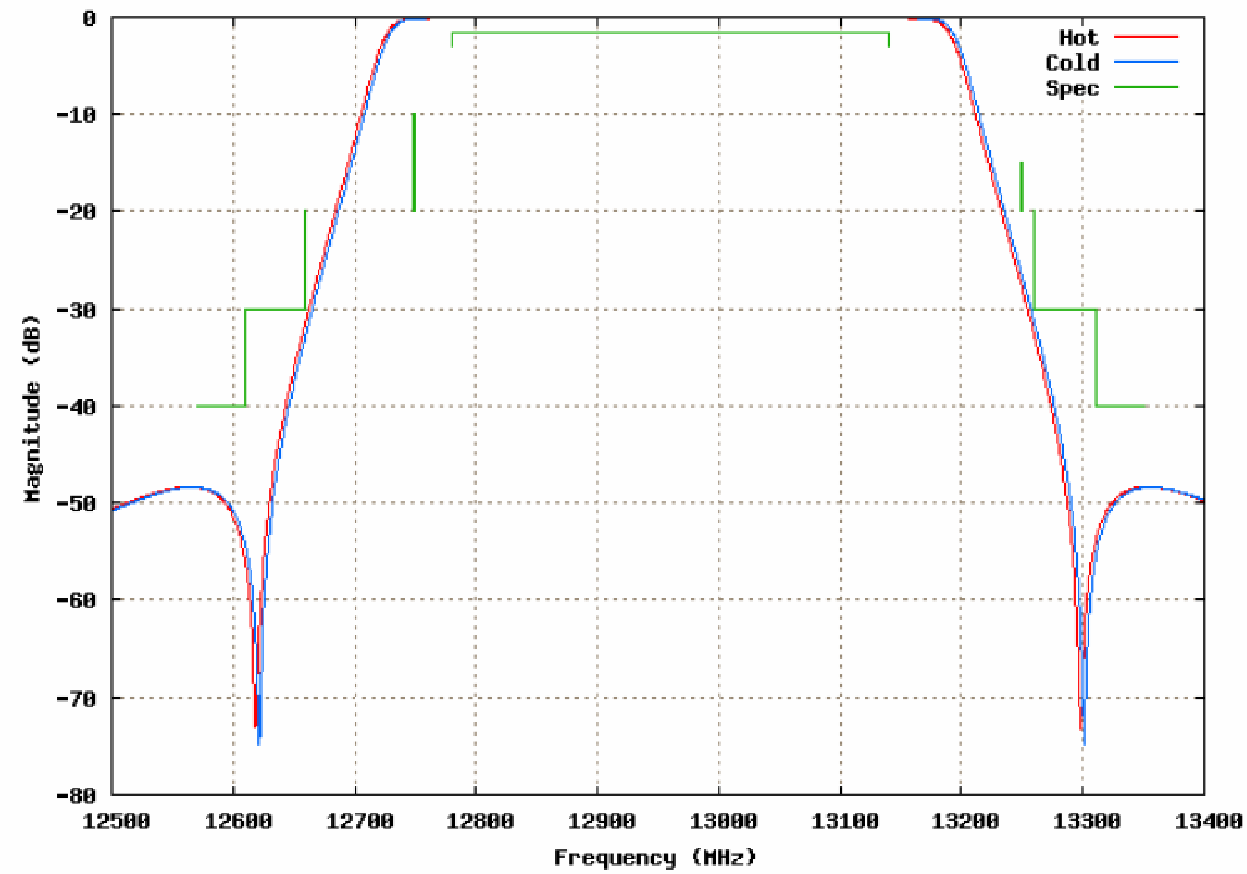
Figure 2 - Variable bandwidth L band filter



	MHz	Amplitude (dB)
A	.4 x Bandwidth	0 ± 0.25
B	.5 x Bandwidth	-6 ± 0.25
C	.63 x Bandwidth	> 82.0

Figure 3 below describes the Appendix 30B Ku-band feeder-link satellite input frequency response.

Figure 3-- Forward Feeder Link Rx Filter Rejection Response



6. Cessation of Emissions

All communications link transmissions from the satellite can be turned on and off by ground command, thereby causing cessation of emissions from the satellite, as required.

C. Orbital Locations and MSS Feeder Link Frequencies (47 C.F.R. § 25.114(c)(5))

SkyTerra 2 will operate at the 107.3° W.L. orbital location with a +/- 0.05 East-West station-keeping volume. This location provides coverage of North America and is a Canadian allotment in the ITU AP-30B plan. The satellite will operate in inclined orbit with an initial North/South inclination of as much as six degrees. This inclination would fluctuate between zero and six degrees during the expected life of the satellite as a result of celestial forces.

To maintain nearly constant beam contours on the ground as the satellite orbit changes, the GBBF will periodically update the feed-horn weight coefficient set and thus automatically adjust the satellite multiple-beam antenna pattern to maintain beam footprints over the desired service areas. SkyTerra 2 will operate in full compliance with the Commission's provisions on inclined orbit satellite operations as specified in Section 25.280 of the Commission's rules. 47 C.F.R. § 25.280. Pursuant to the Commission's rules, during those periods in which SkyTerra 2 will operate at an inclination of up to 4.5°, it will be protected fully from interference from Ku-band NGSO FSS networks.[4] During periods in which SkyTerra 2 operates with an inclination between 4.5° and 6°, the MSS feeder-link operations from gateway operations will be coordinated with any

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[4] *See Ku-band NGSO FSS Order*, 16 FCC Rcd 4096, ¶ 121 (2000).

licensed Ku-band NGSO FSS operators or operate on an unprotected and non-harmful interference basis.

D. Inclination, Antenna Axis Attitude, Longitudinal Drift (47 C.F.R. § 25.114(c)(7))

The inclination, antenna axis attitude, and longitudinal drift are provided in Table 3 below.

Table 3

Antenna Axis Attitude Accuracy – Aggregate roll, pitch, yaw, and rotation	0.1° 3-sigma half-cone error
Maintenance of Satellite Position	
East/West	± 0.05°
North/South	± 6.0°

E. Calculation of PFD Levels (47 C.F.R. § 25.114(c)(8) and § 25.114(d)(5))

The ITU maintains GSO satellite downlink power flux density ("PFD") limits across the entire 10.7 - 11.7 GHz frequency band.[5] The Commission's rules specify identical PFD limits for GSO satellites operating in the 10.95-11.2 GHz and 11.45-11.7 GHz bands, but do not specify any PFD limits for GSO satellites operating in the 10.7-10.95 GHz or 11.2-11.45 GHz bands.

Table 4 provides the power density for the feeder downlinks for each carrier type. Table 5 calculates power flux density on the ground based on the maximum density calculated in Table 4 and compares it with the limits, showing positive margin in each case.

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[5] Article 21, Table S21-4, ITU Radio Regulation (2001).

Table 4: Feeder Link (Return) EIRP Density (10.7 – 11.7 GHz)

Carrier	EIRP (dBW)	BW (kHz)	EIRP Density (dBW/4 kHz)
MSAT Voice	14.7	6	12.9
MSAT Low-Speed Data	7.2	5	6.2
GMSA	-2.7	6.4	-4.7
	0.6	6.4	-1.4
	11.0	12.8	5.9
	0.4	1250	-24.5
	14.1	1250	-10.8
GMR-3G	0.0	31.25	-9.0
	4.9	31.25	-4.1
	7.2	62.5	-4.8
	19.4	156.25	3.5
	Maximum EIRP Density =		12.9

Table 5 : Satellite Telemetry PFD Compliance (10.7 – 11.7 GHz)

Elevation Angle	Slant Range (km)	PSL (dB-m^2)	LightSquared's GSO MSS Maximum PFD (dBW/m^2/4 kHz)	Maximum PFD Limit (dBW/m^2/4 kHz)	Margin (dB)
0°	41,680	-163.4	-150.5	-150	0.5
5°	41,128	-163.3	-150.4	-150	0.4
25°	39,072	-162.8	-149.9	-140	9.9
90°	35,787	-162.1	-149.2	-140	9.2

F. Arrangement for Tracking, Telemetry, and Control (47 C.F.R. § 25.114(c)(9))

The TT&C system will perform numerous functions. The tracking function will phase-modulate onto the telemetry downlink ranging tones received by the command uplink, thereby allowing highly accurate ground determination of spacecraft range. The telemetry system will collect, format, modulate, and transmit command acknowledgments and information related to the spacecraft configuration and performance. The command system will receive, demodulate, decrypt, decode, and distribute command messages originated either internally from the attitude control subsystem or externally via the ground over the Ku-band command link. TT&C parameters are shown in Table 6.

The transfer orbit TT&C will be performed in the Appendix 30B Ku-band through an omni-directional antenna. On station, TT&C will be performed through the Ku-band feeder-link antenna. The satellite operational control will be conducted by Telesat.

TT&C will be performed via the Napa, California and Ottawa, Ontario earth stations. Each of those two locations will be able to provide the TT&C function and will serve as back-ups for each other. The satellite antenna pattern characteristics for the on-station mode of operation of the TT&C are identical to the feeder-link antenna patterns shown in Figure 13 and Figure 14. In addition to the on-station antenna beams, the TT&C subsystem also employs an omnidirectional antenna configuration comprising a biconical antenna and forward and aft pipe antennas, each of which is RHCP. The omnidirectional antenna configuration will be used during orbit-raising and will not be used in any future operation except in the event of certain operational contingencies. The gain of these antennas is relatively low (on the order of -1.8 dB for the pipes and -3.2 dB for the bicone) and the satellite antenna pattern characteristics are shown in Figure 16.

Table 6: TT&C Parameters

Antenna	Omni-directional	Directive
Command Parameters		
Frequency Band (GHz)	12751.0	13249.0
Flux Density (dBW/m2)	-85	-115
Polarization	RHCP	LHCP
Modulation	FM	FM
Peak Dev. (kHz)	300	300
Assigned Bandwidth (kHz)	800	800
Receiver Bandwidth (kHz)	1000	1000
Emission Designator	700KF9D	700KF9D
Telemetry Parameters		
Frequency Band (GHz)	11201 & 11202	11201 & 11202
Peak EIRP (dBW)	20	20
Polarization	RHCP	LHCP
Modulation	Phase, 1 Rad.	Phase, 1 Rad.
Assigned Bandwidth (kHz)	100	100
Emission Designator	50KGXD	50KGXD
Power Control Beacon		
Frequency Band (GHz)	11448.750	11448.750
Peak EIRP, dBW	20 dBW	20 dBW
Polarization	LHCP	RHCP & LHCP
Modulation	Phase	Phase
Emission Designator	2M5G1W	2M5G1W
Assigned Bandwidth	2.5 MHz	2.5 MHz

G. Physical Characteristics of Space Station (47 C.F.R. § 25.114(c)(10))

1. Overall Space Station Characteristics

The satellite bus will be the body-stabilized Boeing 702 design. The satellite payload will deliver a minimum of 4000 Watts (36 dBW) of useable power to the service-link antenna. The payload will amplify and retransmit the signals sent between the feeder-link earth station and the MTs. Table 7 lists the satellite's principal characteristics.

Figure 4 - Illustrative Spacecraft Configuration

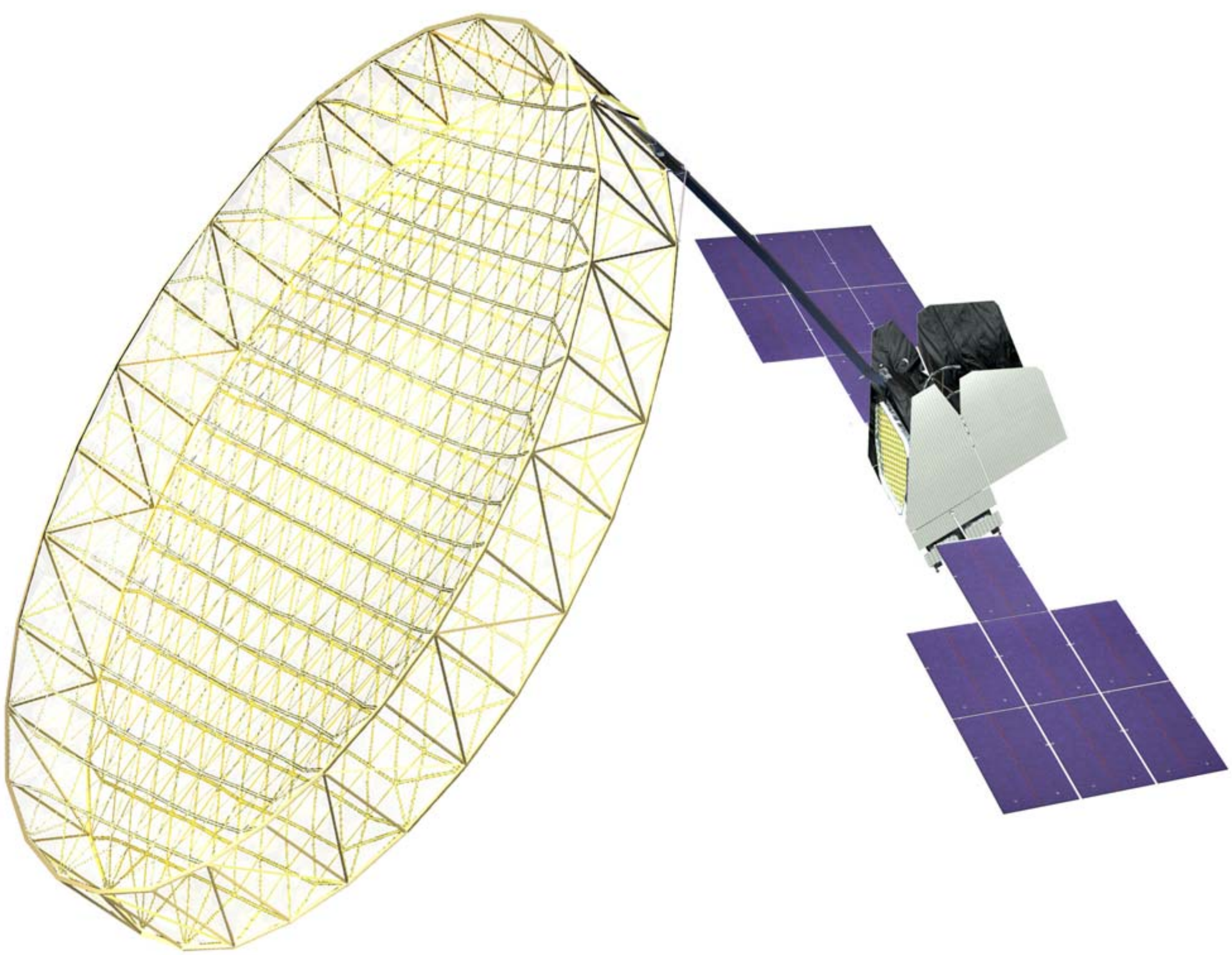

Table 7 - Satellite Principal Characteristics

Spacecraft Bus	Boeing Geo-Mobile 702
Mission	15 Years Nominal End-of-Life
Stabilization	3-Axis
Available DC Power	12 kW End of Life (approximately)
Eclipse Capability	100%
Approximate diameter of L-band Reflector	22 meters
Maintenance of Satellite Position	
East/West	± 0.05°
North/South	± 6.0°
Approximate deployed Length	40.5 meters
Approximate Weight	5433 kg with Propellant

2. Mass

Table 8 - Approximate Satellite Mass Budget

Transponder	710	kg
L band Antenna	785	kg
Ku band Antenna	40	kg
Bus	1718	kg
Spacecraft Dry Mass (Mass in Orbit)	3253	kg
Propellant	2180	kg
Total at Launch	5433	Kg

3. Power Budget

A detailed approximate power budget is shown in Table 9.

Table 9 - Satellite Power Budget

Subsystem	**Power Load, W**
Communications Payload Subsystem	10,650
Attitude Control Subsystem	168
Electrical Power Subsystem	153
Thermal Control Subsystem	226
TT&C	102
Losses and Charging	790
Total	12,089

4. Operational Lifetime

The satellite will be designed to have a service life exceeding 15 years with 85% probability.

5. Spacecraft Bus Subsystem

SkyTerra 2, like SkyTerra 1, is a Boeing 702 high-power spacecraft. The bus will support the payload power and antenna mounting area required. The TT&C subsystem will provide ample capacity for ground personnel to assess satellite health and status, and take corrective action as required. All components comprising the bus will be flight-qualified. All subsystems will be provided with direct or functional redundancy.

a. Attitude Control Subsystem

The attitude control system must be capable of controlling the spacecraft in transfer orbit and on-station. Pointing control will be accomplished by the use of reaction wheels and pulsed firing of selected thrusters. With the use of the on-board spacecraft control processor (SCP), pointing should be maintained for up to 30 days without any input from the ground control facility.

b. Propulsion Subsystem

SkyTerra 2 will use a chemical liquid propulsion system for transfer orbit control. Liquid propulsion will be used for spacecraft orbit and station keeping through its expected service life.

c. Electrical Power Subsystem

The primary components of the electrical system include two solar arrays, batteries, and power controllers that supply, regulate, store, and distribute electrical power.

d. Thermal Control Subsystem

The thermal control subsystem will use heat pipes and radiators on the spacecraft body as well as outboard radiator panels also containing heat pipes that extend beyond the body of the spacecraft for maximum thermal dissipation. Spacecraft blankets and electrical heaters will also be used to manage temperatures. Temperature sensors will feed information to the telemetry system that will send the information to the ground and to the on-board SCP. Using the SCP, temperature can be autonomously maintained for up to 30 days without any input from the ground control facility.

H. Common Carrier Status (47 C.F.R. § 25.114(c)(11))

LightSquared requests authority to offer space segment capacity on SkyTerra 2 on a non-common-carrier basis. Such regulatory treatment is consistent with the regulatory status of space segment to be provided on SkyTerra 1 and offered on other MSS satellites.[6]

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[6] *Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Non-Voice, Non-Geostationary Mobile-Satellite Service, Report and Order*, 8 FCC Rcd 8450 (1993) (non-voice, non-geostationary MSS); *Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-*

I. Polarization (47 C.F.R. § 25.114(c)(13))

Polarization will be right-hand circular in the forward service link direction and left-hand circular and right-hand circular in the return service link direction. Both forward and return feeder links will operate on each of two orthogonal polarizations, right-hand-circular-polarization (RHCP) and left-hand-circular-polarization (LHCP).

As discussed *infra* in Section Q, LightSquared requests a waiver of Section 25.210(i) of the Commission's rules to enable SkyTerra 2 to operate with less than 30B of cross-polarization isolation in the Appendix 30B Ku band within the feeder-link spot beam coverage areas.

J. General Description of Overall System Facilities, Operations, and Service (47 C.F.R. § 25.114(d)(1))

LightSquared's satellite system will consist of space segment, ground segment, and associated tracking, telemetry, command, and control facilities.

1. Ground Segment

Each of the four feeder-link earth stations will have one 11-meter Ku-band antenna to access the SkyTerra 2 satellite. Each earth station will incorporate state-of-the-art signal processing to maximize communications performance and system-wide frequency reuse. GBBF will be implemented at each gateway.

Figure 5 shows a block diagram of the Ground Station Subsystem ("GSS"). Each of the four GSS will have two 11-meter Ku-band antennae to access SkyTerra 1 and

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1626.5/2483.5-2500 MHz Frequency Bands, Report and Order, 9 FCC Rcd 5936, ¶¶ 171-181 (1994) (Big LEO MSS); *SatCom Systems, Inc.*, *Order and Authorization*, 14 FCC Rcd 20798 (1999) (foreign-licensed L band MSS); *Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band, Report and Order,* 15 FCC Rcd 16127 (2000) (2 GHz MSS); *COMSAT Corporation d/b/a COMSAT Mobile Communications et al., Memorandum Opinion, Order and Authorization,* 16 FCC Rcd 21661 (2001) (foreign-licensed L band MSS).

SkyTerra 2, respectively. On the uplink transmission path, each antenna will be connected to two HPAs, one for each polarization, RHCP and LHCP that will be used to support feeder link transmissions to the satellite. There is also one spare HPA that, in the event of HPA failure, can be switched in to replace the HPA in either the LHCP or RHCP path. Redundant Ku-band up-converters will be used to translate the GSS IF frequency to the feeder link frequencies. On the downlink transmission path, the received signal will first be amplified with one LNA for each polarization, with a third LNA that can be switched in to replaced a failed LNA. The output will be fed to a redundant set of down-converters that will translate the feeder link frequencies to the common IF frequency. The common IF is the input/output to the GBBF which then connects to the baseband channel units in digitized form. Each site will also be equipped with a 7-meter Ku-band antenna for backing-up the larger antenna during maintenance.

The channelization equipment will interface with a switching system that will be used to terminate service links on the terrestrial side of the satellite network. The GSS and the switching center will interface to convert signaling parameters as required between the satellite and the terrestrial network. Integrated control is provided for efficient system operation including the coordination of frequency reuse between the space segment and the ATC.

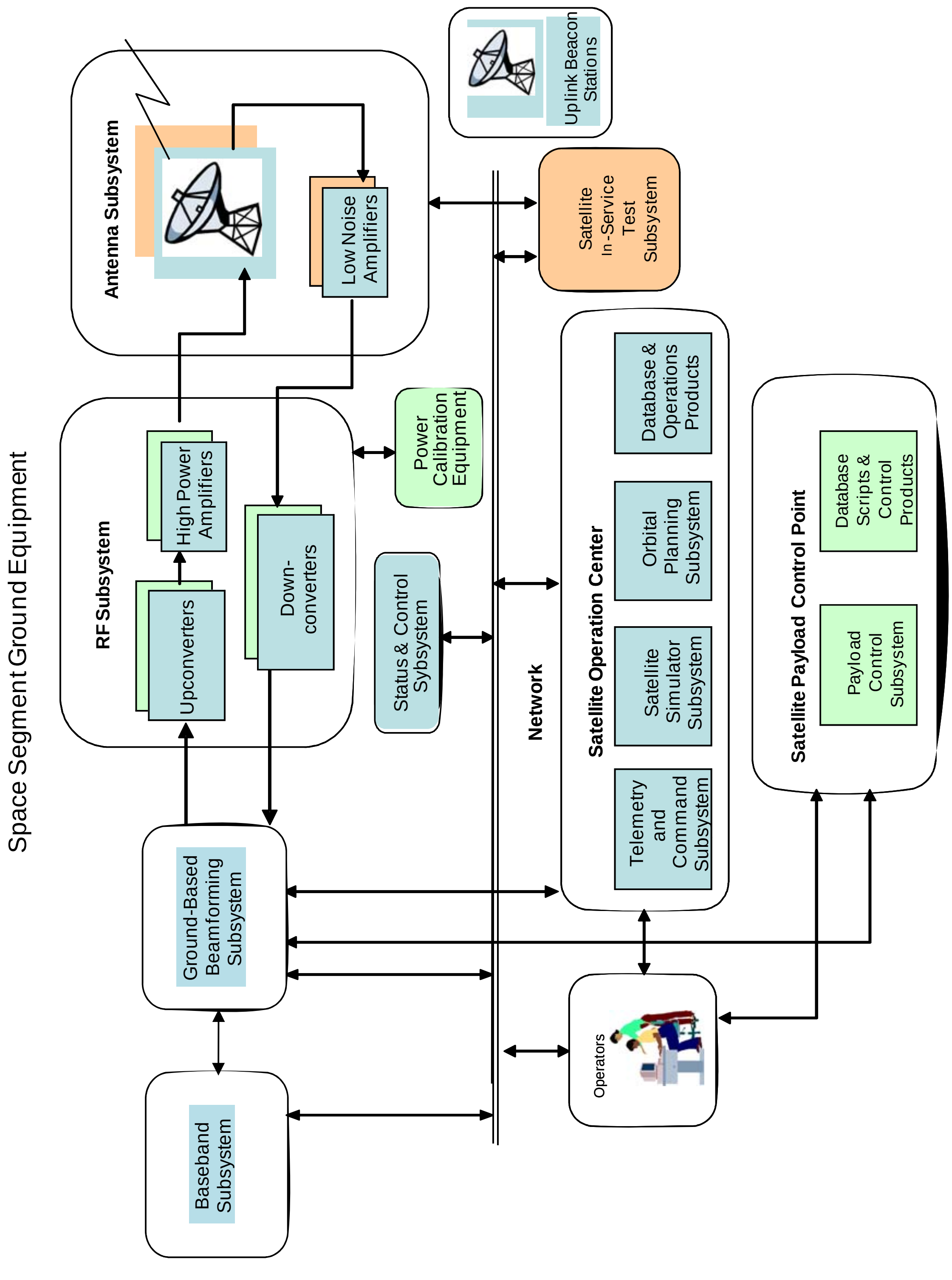

Figure 5 - Space Segment Ground Equipment

The GSS will incorporate state-of-the-art signal processing to maximize communications performance and system-wide frequency reuse. Optimum signal processing algorithms will be used on each user signal to maximize desired signal energy while minimizing noise and interference at the receiver's observation epochs.

2. System Control - Network Operational Control

Network operational control will be staffed 7 days per week, 24 hours per day, to ensure continuity of service. Personnel will provide in-house maintenance and monitoring of the transmission facilities, network facilities, and the facilities that connect the LightSquared satellite network to other networks, such as the public data network ("PDN") or public switched telephone network ("PSTN"). To ensure reliable service, system monitoring will include:

- Monitoring of all active components with switchover to redundant active units upon alarm.
- Monitoring of system power levels at critical junctions of the LightSquared signal processing chain to insure that the transmission levels remain within tolerances.
- Line monitoring to insure the continuity of the transmission lines to other networks. Upon alarm, the facility will switch to diversely routed redundant path(s) where available.
- Each of the carriers present in the satellite transponders will be continuously monitored and maintained within frequency assignment and power allocation tolerances.
- Telesat has been engaged to monitor satellite health and safety.

3. System Capacity Distribution

System-wide capacity depends on the mix of traffic types, the beam configurations used, and the geographic distribution of traffic. The capacity available to a given user group or geographic area can also be varied in response to demand or in the case of emergencies. For example, as much as 10% of the satellite's power can be reallocated to one spot beam to augment service options, increase the number of users, or increase the data rate to individual users.

K. Feeder-Link Frequencies (47 C.F.R. § 25.114(d)(2))

The satellite is capable of using 500 MHz in the 12.75-13.25 GHz band on each of two circular orthogonal polarizations (left-hand and right-hand circular polarizations) for the forward feeder link and 500 MHz in the 11.2-11.45 GHz band and the 10.70-10.95 GHz band on each of two circular orthogonal polarizations for the return feeder link. As explained in Section V of the narrative description of the application, to the extent necessary, LightSquared seeks waiver for use of these frequencies.

L. Predicated Spacecraft Antenna Gain Contours (47 C.F.R. § 25.114(d)(3))

1. Service-Link Antenna Gain Contours

The service-link antenna will use a 22-meter reflector (approximate diameter). The technical performance characteristics of the antenna are listed in Table 1-2. Approximately 500 spot beams, capable of supporting numerous carriers, will be configurable in location, shape, and size within the communications service area. Figure 6 depicts a spot beam coverage pattern spanning the current AMSC-1 coverage area.[7] Figure 7, Figure 8, and Figure 9 depict example spot beam contours for eastern, central, and western spot beams, respectively. Figure 10 illustrates how a portion of the available spectrum may be configured within larger spot beams, emulating the first-generation

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[7] All of the figures in this application assume a North-South inclination of zero degrees for SkyTerra 2. Inclination affects beam coverage more toward the north and south edges of coverage than toward the boresight, especially since the GBBF adjust phased array feed-horn gain and amplitude parameters throughout the day to compensate for inclination and other affects. Alaska will have complete full-time coverage when SkyTerra 2 inclination is zero. When inclination is greater, Alaska will have complete coverage approximately 50% of each day

satellite, to maintain compatibility with first generation user terminals and services. Figure 11 illustrates how another portion of the spectrum can be configured using a single beam covering the lower forty-eight states, Alaska, Canada, Mexico, Central America, the northern part of South America and the Caribbean. This configuration is particularly applicable to point-to-multipoint services.

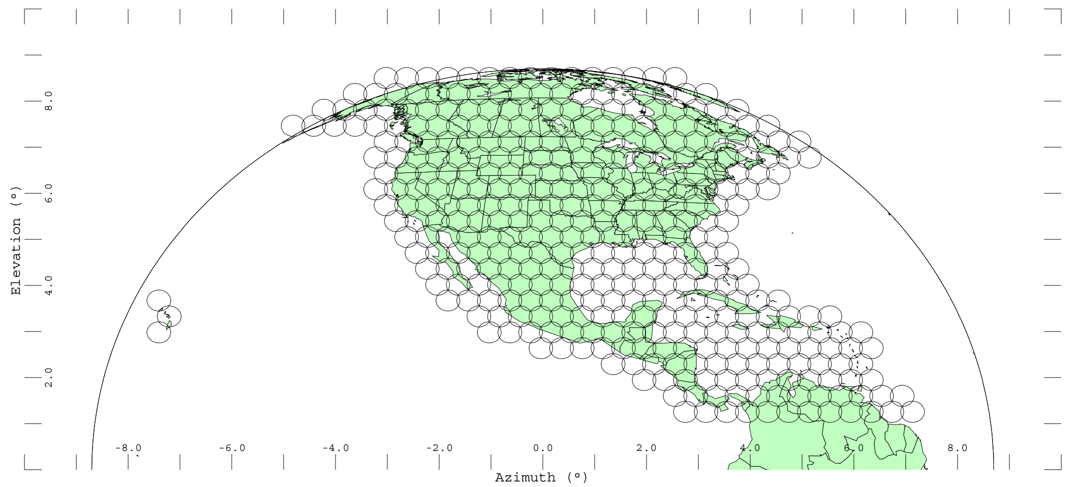


Figure 6 - Illustrative Composite Communications Service Area Served by Spot Beams

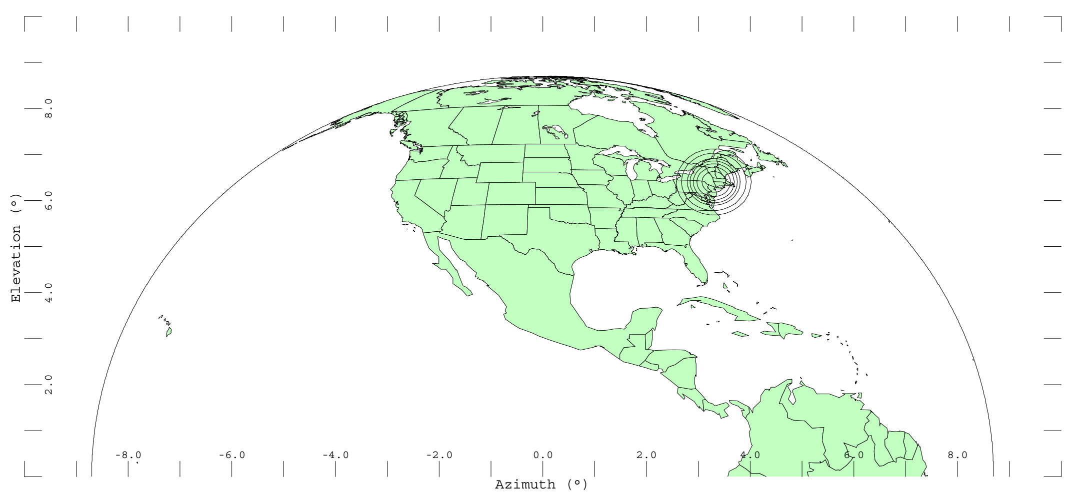


Figure 7 – Illustrative East Spot Beam Roll-Off (-2, -4, -6, -8, -10, -15, and -20 dB)

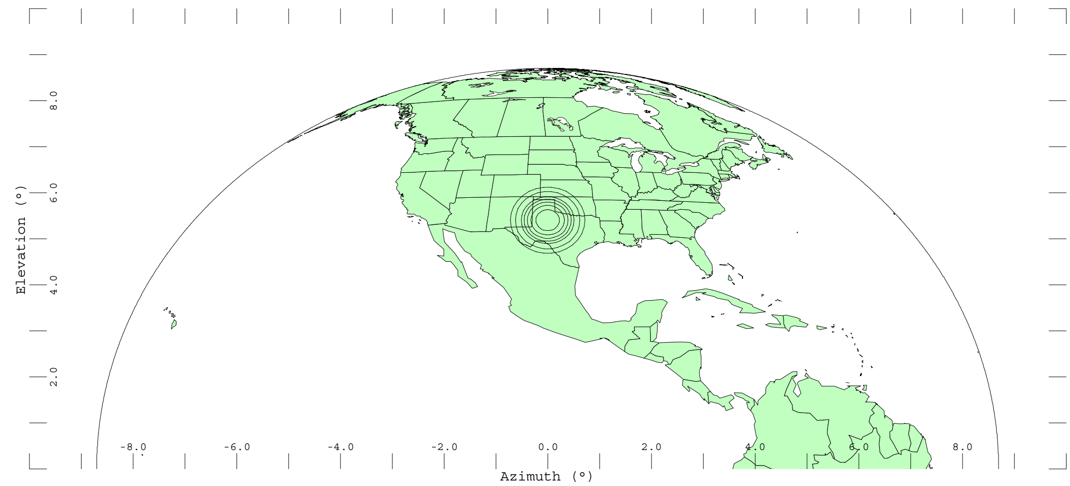


Figure 8 - Illustrative Central Spot Beam Roll-Off (-2, -4, -6, -8, -10, -15, and -20 dB)

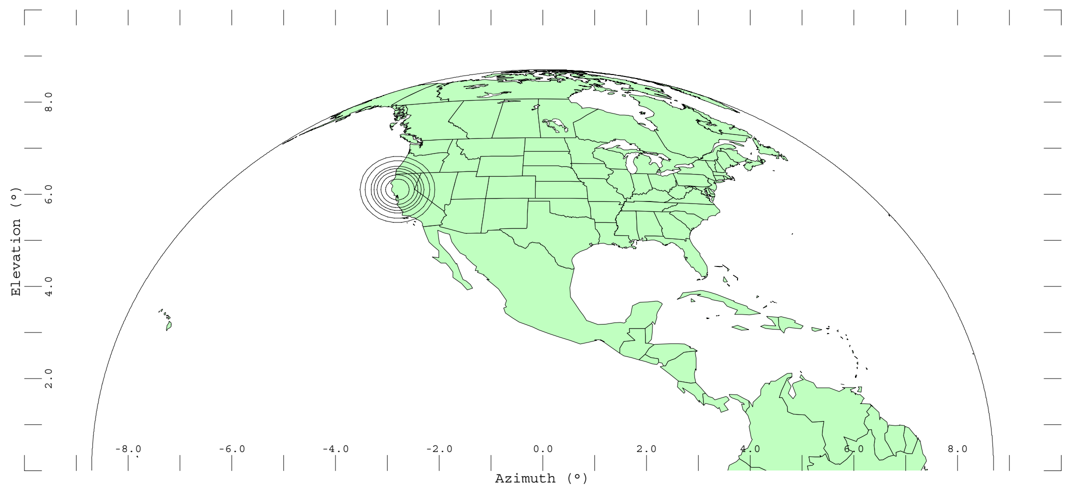


Figure 9 - Illustrative West Spot Beam Roll-Off (-2, -4, -6, -8, -10, -15, and -20 dB)

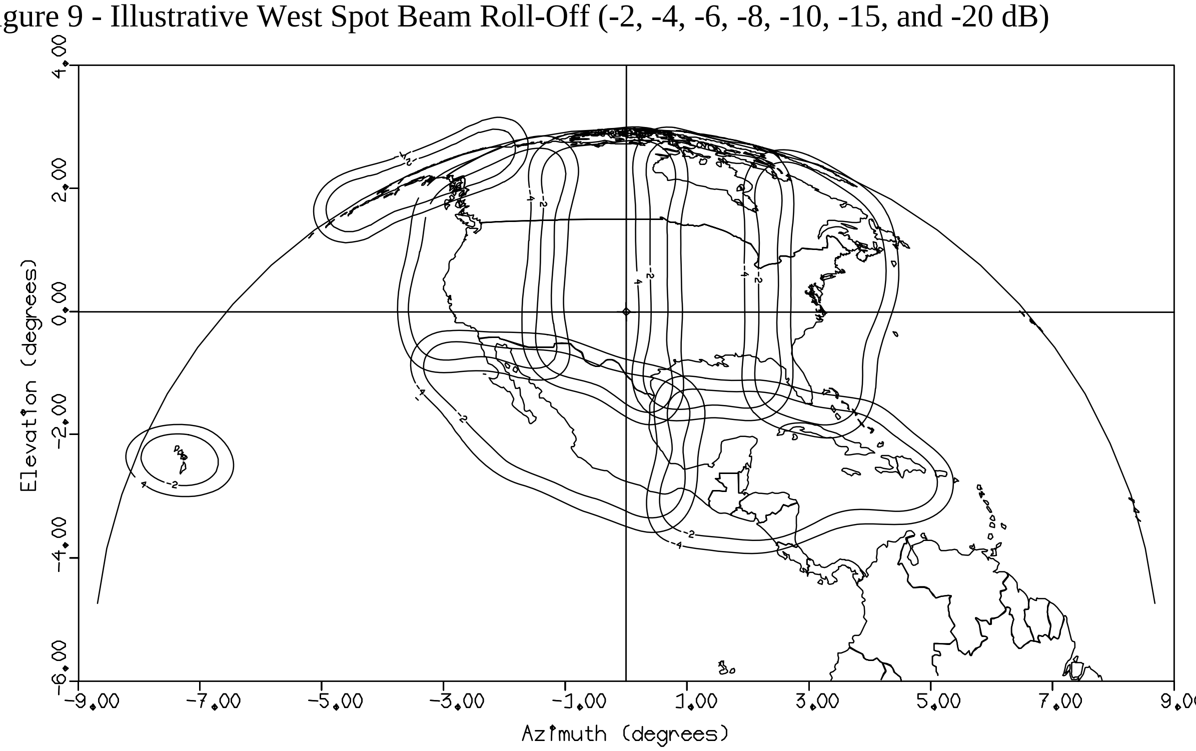


Figure 10 - Illustrative AMSC-1 Emulation Mode Beams

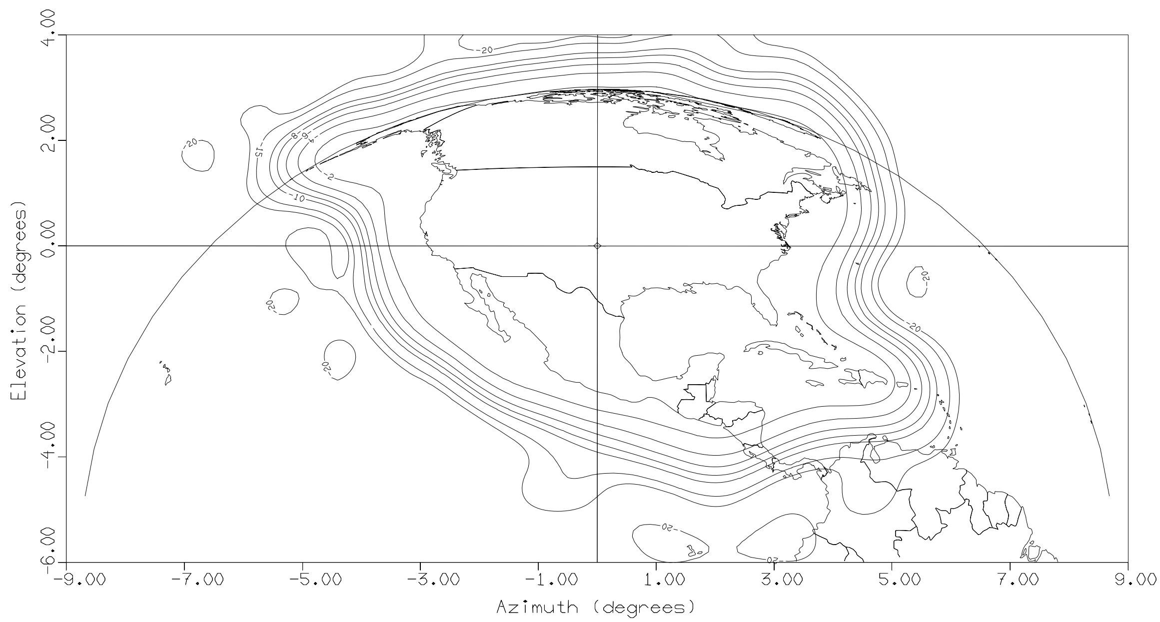


Figure 11 - Illustrative Point-to-Multipoint Service Area Beam

2. Feeder-Link Antenna Gain Contours

The feeder link will use Ku-band antenna spot beams that provide coverage to select areas of North America. Four spot beams, centered at the Napa, California; Dallas, Texas; Saskatoon, Saskatchewan; and Ottawa, Ontario feeder-link earth station sites, will be used to provide spatial frequency reuse to achieve the feeder-link bandwidth required. Depicted below are individual antenna beam contours for each of the four Ku-band spot beams. Each figure is applicable to receive and transmit beams and to RHCP and LHCP.

Figure 12 – Feeder-link Beam Dallas, TX showing beam peak and
-2, -4, -6, -8, -10, -15, and -20 dB contours.

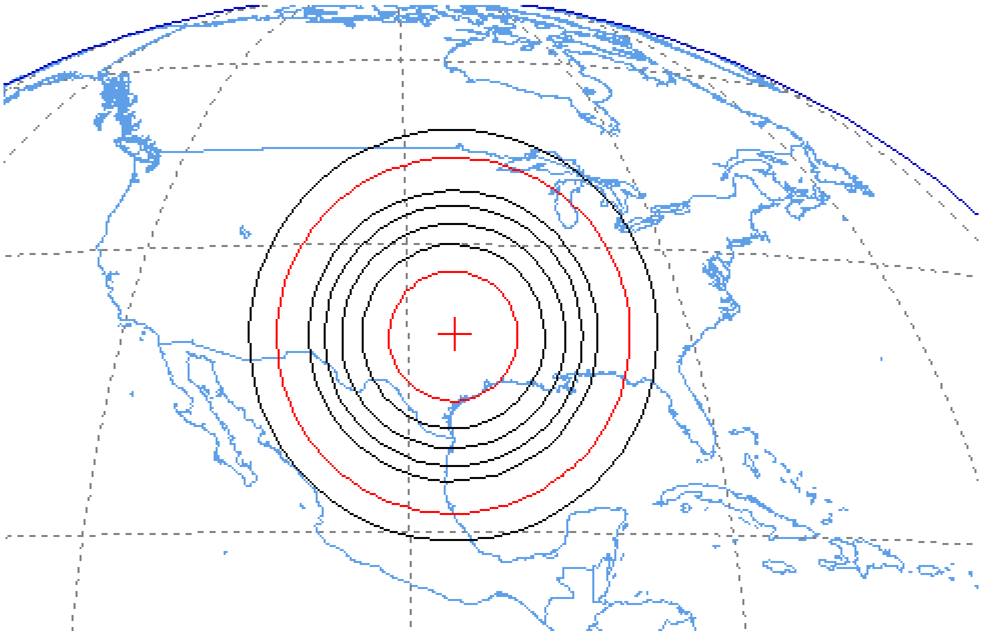


Figure 13 - Feeder-link Beam Napa, CA showing beam peak and
-2, -4, -6, -8, -10, -15, and -20 dB contours.

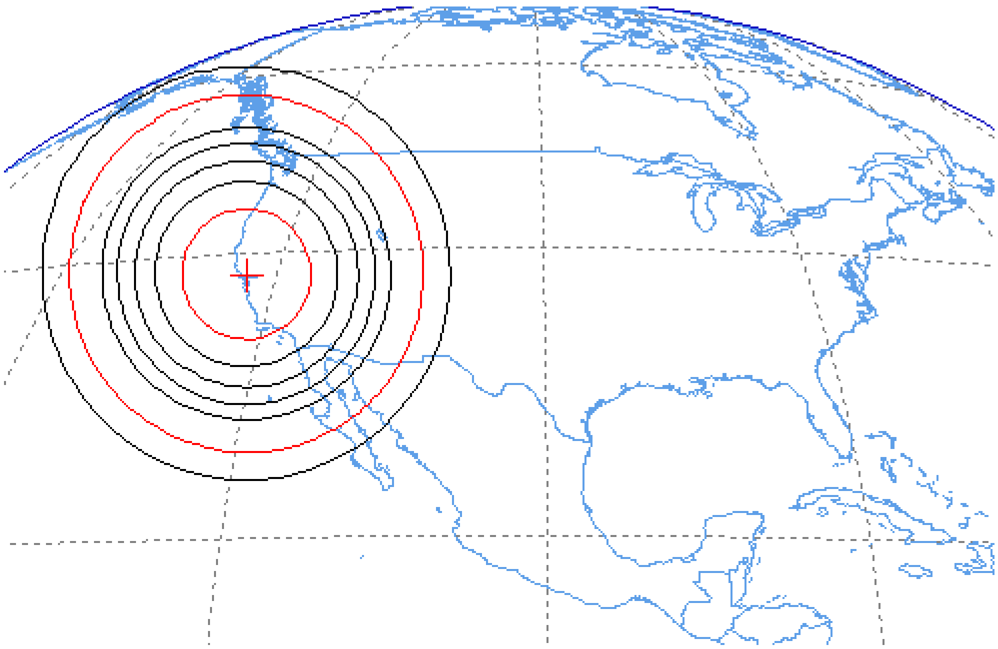


Figure 14 - Feeder-link Beam Ottawa, Ontario showing beam peak and -2, -4, -6, -8, -10, -15, and -20 dB contours.

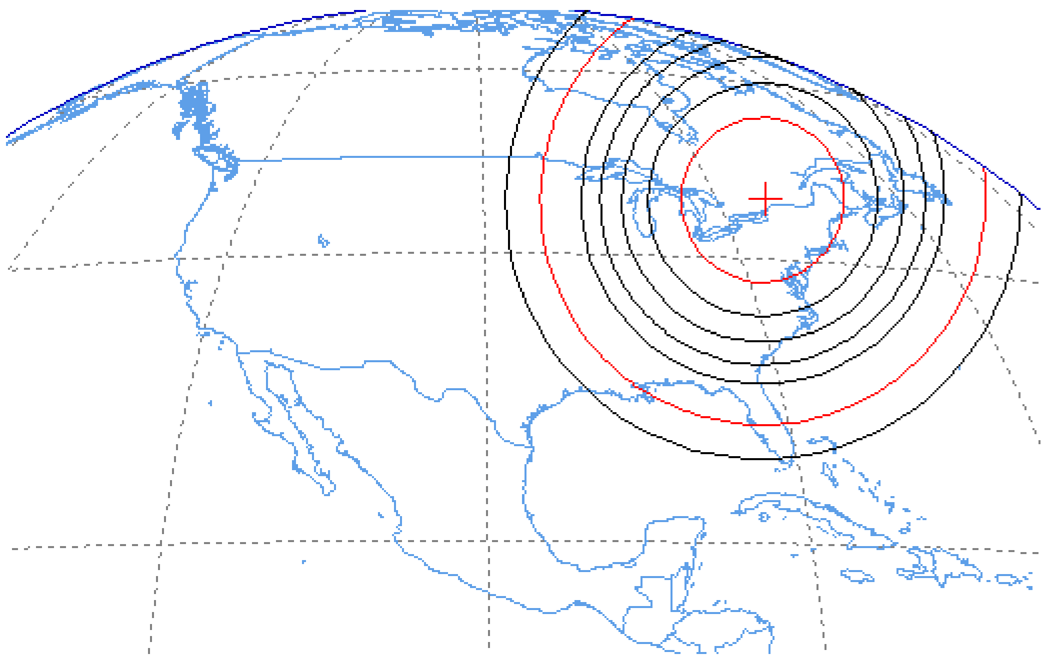


Figure 15 – Feeder-link Beam Saskatoon, Saskatchewan showing beam peak and -2, -4, -6, -8, -10, -15, and -20 dB contours.

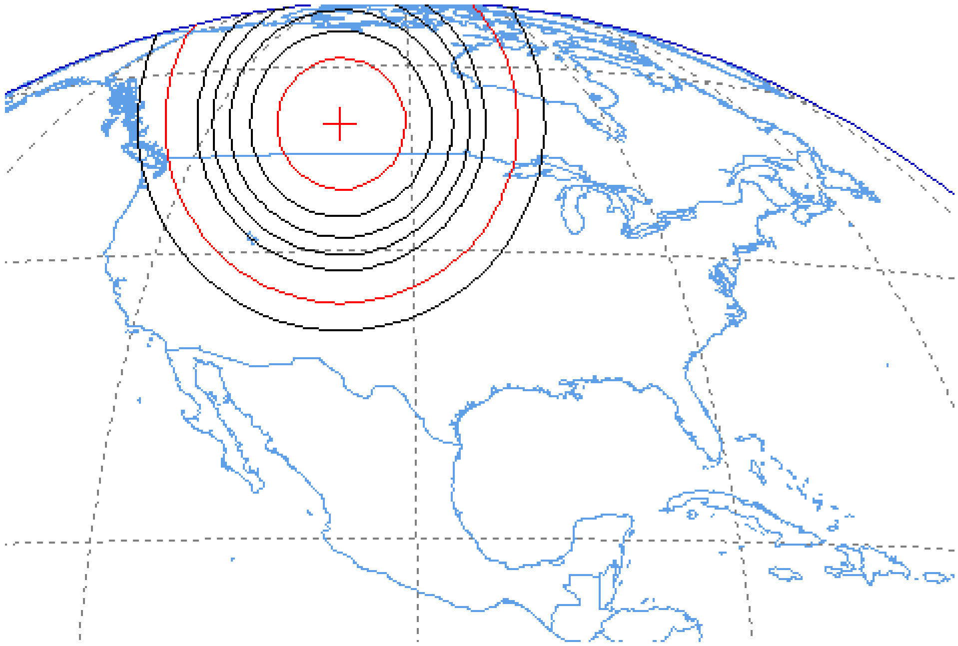
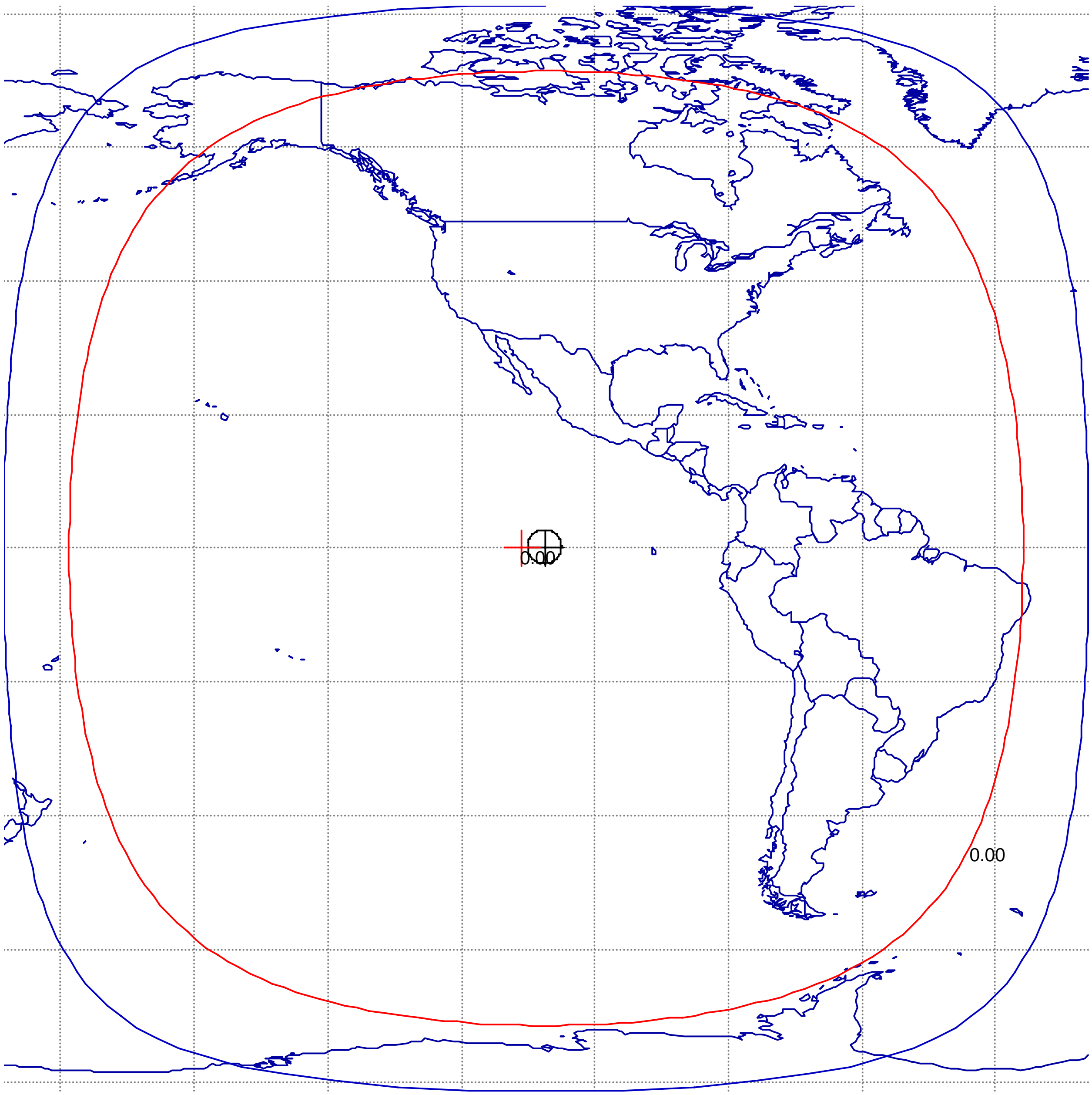


Figure 16 - Omni Antenna showing beam peak and -2 dB contour



M. Service Description, Link Descriptions, and Typical User and Gateway Terminals (47 C.F.R. § 24.114(d)(4))

1. Service Description

The satellite system will be capable of providing high quality voice and packet data services ranging from up to 150 kbps to 300 kbps in the downlink and 9 kbps to 38 kbps in the uplink to a variety of devices such as smart-phones, USB dongles, vehicular terminals, and vertical specific devices which incorporate an embedded satellite modem module. Further system capabilities include voice mail, Short Message Service, and most other terrestrial network services, including support to Law Enforcement Agencies.

2. Link Performance

a. Communications and Feeder-Link Performance

Representative link budgets, describing relevant service link transmission characteristics, are provided in Table 10 through Table 27.

Table 10 - First-Generation Voice Link Budget, Emulation Mode

MSAT VOICE EMULATION MODE					
PARAMETER	**UNITS**	**FORWARD (Hub to User)**		**RETURN (User to Hub)**	
Noise Bandwidth	kHz	4	4	4	4
Boltzmann's constant	dBW/Hz·K	-228.6	-228.6	-228.6	-228.6
UPLINK		**Clear**	**Faded**	**Clear**	**Faded**
Frequency	GHz	13	13	1.64	1.64
Earth Station EIRP	dBW	33.7	40.7	12	12
Body Shielding Loss	dB	x	x	0	0
Polarization Loss	dB	x	x	-0.5	-0.5
Free Space Loss	dB	-206.7	-206.7	-188.8	-188.8
Uplink Fade	dB	0	7	x	x
Satellite Antenna Gain, EOC	dBi	42	42	30	30
Received Carrier Power	dBW	-131	-131	-147.3	-147.3
Satellite G/T	dB/K	11	11	5	5
Intersystem Interference Allowance	dB	0.5	0.5	1	1
C/No	dB·Hz	66.1	66.1	55.3	55.3
C/Imo	dB·Hz	58	58	60	60
Frequency Reuse Allowance	dB	1	1	1	1
Satellite C/(No+Io)	dB·Hz	56.4	56.4	53.0	53.0
DOWNLINK					
Frequency	GHz	1.55	1.55	11	11
Satellite Active Gain	dB	129	129	120	120
Satellite Antenna Gain, EOC	dBi	30	30	42	42
Power Loss and Scan Loss	dB	0	0	x	x
Satellite EOC EIRP	dBW	28	28	14.7	14.7
Free Space Loss	dB	-188.5	-188.5	-205.2	-205.2
Downlink Fade	dB	x	x	0	4
Earth Station G/T	dB/K	-16	-16	38	35.3
Interference Allowance	dB	1	1	0.5	0.5
C/No	dB·Hz	51.1	51.1	75.6	68.9
LINK					
Link C/(No+Io)	dB·Hz	50.0	50.0	53.0	52.9
Required C/No	dB-Hz	45.0	45.0	45.0	45.0
Margin	dB	5.0	5.0	8.0	7.9

Table 11 - Mobile Messaging Link Budget, Emulation Mode (first-generation service)

MSAT MMS EMULATION MODE					
PARAMETER	**UNITS**	**FORWARD (Hub to User)**		**RETURN (User to Hub)**	
Noise Bandwidth	kHz	1	1	1	1
Boltzmann's constant	dBW/Hz·K	-228.6	-228.6	-228.6	-228.6
UPLINK		**Clear**	**Faded**	**Clear**	**Faded**
Frequency	GHz	13	13	1.64	1.64
Earth Station EIRP	dBW	27.7	34.7	4	4
Free Space Loss	dB	-206.7	-206.7	-188.8	-188.8
Uplink Fade	dB	0	7	x	x
Satellite Antenna Gain, EOC	dBi	42	42	30	30
Received Carrier Power	dBW	-137	-137	-154.8	-154.8
Satellite G/T	dB/K	11	11	5	5
Intersystem Interference Allowance	dB	0.5	0.5	1	1
C/No	dB·Hz	60.1	60.1	47.8	47.8
C/Imo	dB·Hz	52.0	52.0	53.0	54.0
Satellite C/(No+Io)	dB·Hz	51.4	51.4	46.7	46.9
DOWNLINK					
Frequency	GHz	1.55	1.55	11	11
Satellite Active Gain	dB	129	129	120	120
Satellite Antenna Gain, EOC	dBi	30	30	42	42
Power Loss and Scan Loss	dB	0	0	x	x
Satellite EOC EIRP	dBW	22	22	7.2	7.2
Free Space Loss	dB	-188.5	-188.5	-205.2	-205.2
Downlink Fade	dB	x	x	0	4
Earth Station G/T	dB/K	-20	-20	38	35.3
Interference Allowance	dB	1	1	0.5	0.5
C/No	dB·Hz	41.1	41.1	68.1	61.4
LINK					
Link C/(No+Io)	dB·Hz	40.7	40.7	46.6	46.7
Required C/No	dB-Hz	34.2	34.2	34.2	34.2
Margin	dB	6.5	6.5	12.4	12.5

Table 12 - GMSA Forward Link Budget – Handheld Terminal[8]
CDMA Carrier – Terminal G/T=-31 dB/K

Parameter	Units	
Allocated Satellite EIRP	dBW	78.1
Number of satellites		2
Number of beams- Primary Coverage Area		170
Carrier Bandwidth	MHz	1.25
Downlink L-band C/N		
EIRP per carrier	dBW	58.8
Beam roll off at EoC	dB	1.14
EIRP per carrier at EoC	dBW	57.7
Free space propagation loss	dB	-187.7
Average blockage margin	dB	-5.0
MT G/T	dB/K	-31.0
Boltzmann's constant	dBW/Hz.K	-228.6
Equivalent Noise Bandwidth	dBHz	60.9
C/N	dB	1.67
Downlink L-band Inter-beam Interference		
C/I	dB	1.04
Up-link Ku-band Feederlink C/N		
Earth station EIRP / 1.25MHz carrier	dBW	62.0
Free space propagation	dB	-206.9
Atmospheric loss 99.5% Availability	dB	-8.7
Satellite Ku band G/T	dB/K	11.5
(C/N) up link /1.25MHz carrier	dB Hz	25.6
Up-link Ku-band Feederlink C/I		
C/I (Adjacent Channel)	dB	27.0
C/I (Co-channel Interference)	dB	19.0
Cross-polarization Isolation	dB	25.0
Multi-beam C/I Factor	dB	-2.0
C/I (NPR Interference)	dB	20.0
C/I (rain Depolarization)	dB	17.5
Interference from calibration signal	dB	21.0
C/I (NPR Interference)	dB	15.0
C/I_Up / 1.25MHz Carrier	dB	10.6
Total Link		
Effective C/(I+N)	dB	-1.9
Aggregate Data Rate per Carrier	kbps	307.2

[8] All GMSA forward links use 1.25 MHz-wide CDMA carriers. However, the GMSA return links use both 1.25 MHz-wide CDMA and narrow-band single channel per carrier (SCPC) carriers. Therefore, the GMSA link budgets do not appear in paired sets.

Table 13 - GMSA Forward Link Budget – PC Card
CDMA Carrier – Terminal G/T=-26 dB/K

Parameter	Units	
Allocated Satellite EIRP	dBW	78.1
Number of satellites		2
Number of beams- Primary Coverage Area		170
Carrier Bandwidth	MHz	1.25
Downlink L-band C/N		
EIRP per carrier	dBW	58.8
Beam roll off at EoC	dB	1.14
EIRP per carrier at EoC	dBW	57.7
Free space propagation loss	dB	-187.7
Average blockage margin	dB	-5.0
MT G/T	dB/K	-26.0
Boltzmann's constant	dBW/Hz.K	-228.6
Equivalent Noise Bandwidth	dBHz	60.9
C/N	dB	6.67
Downlink L-band Inter-beam Interference		
C/I	dB	1.04
Up-link Ku-band C/N (Thermal)		
Earth station EIRP / 1.25MHz carrier	dBW	62.0
Free space propagation	dB	-206.9
Atmospheric loss 99.5% Availability	dB	-8.7
Satellite Ku band G/T	dB/K	11.5
(C/N) up link /1.25MHz carrier	dB Hz	25.6
Up-link Ku-band C/I (Interference)		
C/I (Adjacent Channel)	dB	27.0
C/I (Co-channel Interference)	dB	19.0
Cross-polarization Isolation	dB	25.0
Multi-beam C/I Factor	dB	-2.0
C/I (NPR Interference)	dB	20.0
C/I (rain Depolarization)	dB	17.5
Interference from calibration signal	dB	21.0
C/I (NPR Interference)	dB	15.0
C/I_Up / 1.25MHz Carrier	dB	10.6
Effective C/(I+N)	dB	-0.4
Aggregate Data Rate per Carrier	kbps	614.4

Table 14 - GMSA Forward Link Budget – Home Gateway

CDMA Carrier – Terminal G/T=-15 dB/K

Parameter	Units	
Allocated Satellite EIRP	dBW	78.1
Number of satellites		2
Number of beams- Primary Coverage Area		170
Carrier Bandwidth	MHz	1.25
Downlink L-band C/N		
EIRP per carrier	dBW	58.8
Beam roll off at EoC	dB	1.14
EIRP per carrier at EoC	dBW	57.7
Free space propagation loss	dB	-187.7
Average blockage margin	dB	-5.0
MT G/T	dB/K	-15.0
Boltzmann's constant	dBW/Hz.K	-228.6
Equilivalent Noise Bandwidth	dBHz	60.9
C/N	dB	17.67
Downlink L-band Inter-beam Interference		
C/I	dB	1.04
Up-link Ku-band C/N (Thermal)		
Earth station EIRP / 1.25MHz carrier	dBW	62.0
Free space propagation	dB	-206.9
Atmospheric loss 99.5% Availability	dB	-8.7
Satellite Ku band G/T	dB/K	11.5
(C/N) up link /1.25MHz carrier	dB Hz	25.6
Up-link Ku-band C/I (Interference)		
C/I (Adjacent Channel)	dB	27.0
C/I (Co-channel Interference)	dB	19.0
Cross-polarization Isolation	dB	25.0
Multi-beam C/I Factor	dB	-2.0
C/I (NPR Interference)	dB	20.0
C/I (rain Depolarization)	dB	17.5
Interference from calibration signal	dB	21.0
C/I (NPR Interference)	dB	15.0
C/I_Up / 1.25MHz Carrier	dB	10.6
Effective C/(I+N)	dB	0.5
Aggregate Data Rate per Carrier	kbps	614.4

Table 15 - GMSA Return Link – Handheld Terminal
Narrowband Voice Channel Terminal G/T=-31 dB/K

Parameter	Units	
Carrier Bandwidth	KHz	6.4
Voice channel data rate	kbps	4.8
Narrowband channel reuse scheme		6
Number of beams		170
Uplink L-band C/N		
Terminal EIRP	dBW	-7.0
Power Control Range	dB	15.2
L-Band Free-Space Loss	dB	-188.4
G/T	dB/K	20.6
Boltzmann's constant	dBW/Hz.K	-228.6
Bandwidth	dB-Hz	38.1
C/N	dB	0.5
Co-channel Adjacent-beam NB Voice Channels Interference		
C/I from all narrow band users from other beams	dB	7.6
Voice Activity Factor	dB	2.0
C/I		9.6
Downlink Ku-Band Feederlink C/N		
Frequency	GHz	11.5
Ku-Band EIRP per gateway	dBW	51.5
Return downlink bandwidth per gateway	MHz	480
L-Band EIRP (for Power Robbing)	dBW	32.0
Satellite (L-Band) G/T	dB/°K	20.6
U/L Propagation Losses	dB	-188.8
Boltzmann's Constant	dBW/K-Hz	-228.6
Satellite EIRP per gateway per carrier net of power robbing	dBW	-4.7
Ku-Band Free-Space Loss	dB	-215.2
Gateway Equipment Ku-Band G/T	dB/°K	37.9
Boltzmann's Constant	dBW/K-Hz	-228.6
C/N	dB	8.5
Downlink Ku-Band Feederlink C/I		
Effective C/I (across 480 MHz)	dB	14.5
Interference psd	dBW -Hz	-49.8
Effective C/I per carrier	dB	7.1
Total Link		
C/(I+N)	dB	-1.2
Processing Gain	dB	1.2
Effective Eb/No	dB	0.0
Satellite Diversity Rx Gain	dB	2.5
Required Eb/No	dB	2.6
Power Control Range	dB	13.7
Margin	dB	13.6

Table 16 - GMSA Return Link – SmartPhone Terminal

9.6 kbps Narrow-band Data Channel - Terminal G/T=-24 dB/K

Parameter	Units	
Carrier Bandwidth	KHz	6.4
Data rate	Kbps	9.6
Narrowband channel reuse scheme		6
Number of beams		170
Uplink L-band C/N		
Terminal EIRP	dBW	-4.0
Power Control Range	dB	14.8
L-Band Free-Space Loss	dB	-188.4
G/T	dB/K	20.6
Boltzmann's constant	dBW/Hz.K	-228.6
1/BW		-38.1
C/N	dB	4.0
Co-channel Adjacent-beam NB Voice Channels Interference		
C/I from All narrow band users from other beams	dB	7.6
Voice Activity Factor	dB	2.0
C/I		9.6
Downlink (Feeder Link) C/N (Thermal)		
Frequency	GHz	11.5
Ku-Band EIRP per gateway	dBW	51.5
Return downlink bandwidth per gateway	MHz	480
L-Band EIRP (for Power Robbing)	dBW	32.0
Satellite (L-Band) G/T	dB/°K	20.6
U/L Propagation Losses	dB	-188.8
Boltzmann’s Constant	dBW/K-Hz	-228.6
Satellite EIRP per GW per carrier net of power robbing	dBW	-1.40
Ku-Band Free-Space Loss	dB	-215.2
Gateway Equipment Ku-Band G/T	dB/°K	37.9
Boltzmann's Constant	dBW/K-Hz	-228.6
C/N	dB	11.8
Downlink (Ku-Band) Interference		
Effective C/I (across 480 MHz)	dB	14.5
Interference psd	dBW -Hz	-49.8
Effective C/I per carrier	dB	10.4
C/(I+N)	dB	1.8
Processing Gain	dB	-1.8
Effective Eb/No	dB	0.0
Satellite Diversity Rx Gain	dB	2.5
Required Eb/No	dB	8.0
Power Control Range	dB	13.3
Margin	dB	7.8

Table 17 - GMSA Return Link – Home Gateway

19.2 kbps Narrow-band Data Channel - Terminal G/T=-15 dB/K

Carrier Bandwidth	KHz	12.6
Data rate	kbps	19.2
Narrowband channel reuse scheme		6
Number of beams		170
Uplink L-band C/N		
Terminal EIRP	dBW	15.0
Power Control Range	dB	20.0
L-Band Free-Space Loss	dB	-188.4
G/T	dB/K	20.6
Boltzmann's constant	dBW/Hz.K	-228.6
1/BW		-41.0
C/N	dB	14.8
Co-channel Adjacent-beam NB Voice Channels Interference		
C/I from All narrow band users from other beams	dB	7.6
Voice Activity Factor	dB	2.0
C/I		9.6
Downlink (Feeder Link) C/N (Thermal)		
Frequency	GHz	11.5
Ku-Band EIRP per gateway	dBW	51.5
Return downlink bandwidth per gateway	MHz	480
L-Band EIRP (for Power Robbing)	dBW	32.0
Satellite (L-Band) G/T	dB/°K	20.6
U/L Propagation Losses	dB	-188.8
Boltzmann's Constant	dBW/K-Hz	-228.6
Satellite EIRP per GW per carrier net of power robbing	dBW	9.6
Ku-Band Free-Space Loss	dB	-215.2
Gateway Equipment Ku-Band G/T	dB/°K	37.9
Boltzmann's Constant	dBW/K-Hz	-228.6
C/N	dB	19.9
Downlink (Ku-Band) Interference		
Effective C/I (across 480 MHz)	dB	14.5
Interference psd	dBW -Hz	-49.8
Effective C/I per carrier	dB	18.4
C/(I+N)	dB	7.8
Processing Gain	dB	-1.8
Effective Eb/No	dB	6.0
Satellite Diversity Rx Gain	dB	2.5
Required Eb/No	dB	7.8
Power Control Range	dB	18.5
Margin	dB	19.2

Table 18 - GMSA Broadband Return Link – SmartPhone Terminal

38.4 kbps Broadband Data Channel - Terminal G/T=-24 dB/K

Parameter	Units	
Carrier Bandwidth	KHz	1228.8
Data Rate	kbps	38.4
Broadband channel reuse scheme		3
Narrowband channel reuse scheme		8
Number of beams		170
Uplink L-band C/N		
Terminal EIRP	dBW	-4.0
Power Control Range	dB	15.0
L-Band Free-Space Loss	dB	-188.4
G/T	dB/K	20.6
Boltzmann's constant	dBW/Hz·K	-228.6
Bandwidth	dB-Hz	60.9
C/N	dB	-19.1
Co-channel Co-Beam Broadband Channel Interference		
Average number of co-channel users		6.0
C/I	dB	-7.8
Co-channel Adjacent-Beam Broadband Channel Interference		
Average number of co-channel users per beam		1.0
Total C/I		1.0
Downlink Ku-Band Feederlink C/N		
Frequency	GHz	11.5
Ku-Band EIRP per gateway	dBW	51.5
Return downlink bandwidth per gateway	MHz	480
L-Band EIRP (for Power Robbing)	dBW	32.0
Satellite (L-Band) G/T	dB/°K	20.6
U/L Propagation Losses	dB	-188.8
Boltzmann's Constant	dBW/K-Hz	-228.6
Satellite EIRP per gateway per user, net of power robbing	dBW	-1.6
Ku-Band Free-Space Loss	dB	-215.2
Gateway Equipment Ku-Band G/T	dB/°K	37.9
Boltzmann's Constant	dBW/K-Hz	-228.6
C/N	dB	-11.2
Downlink (Ku-Band) Interference		
Effective C/I (across 480 MHz)	dB	14.5
Interference psd	dBW -Hz	-49.8
Effective C/I per carrier	dB	-12.7
Total Link		
C/(I+N)	dB	-20.8
Processing Gain	dB	15.1
Effective Eb/No	dB	-5.8
Satellite Diversity Rx Gain	dB	2.5
Required Eb/No	dB	2.7
Margin	dB	7.6

Table 19 - GMSA Broadband Return Link – Home Gateway

460 kbps Broadband Data Channel - Terminal G/T=-15 dB/K

Parameter	Units	
Carrier Bandwidth	KHz	1228.8
Data Rate	kbps	460.8
Broadband channel reuse scheme		3
Number of beams		170
Uplink L-band C/N		
Terminal EIRP	dBW	15.0
Power Control Range	dB	12.0
L-Band Free-Space Loss	dB	-188.4
G/T	dB/K	20.6
Boltzmann's constant	dBW/Hz·K	-228.6
Bandwidth		60.9
C/N	dB	2.9
Co-channel Co-Beam Broadband Channel Interference		
Average number of co-channel users		0.0
C/I		99.0
Co-channel Adjacent-Beam Broadband Channel Interference		
Average number of co-channel users per beam		1.0
Total C/I		1.0
Downlink Ku-Band Feederlink C/N		
Frequency	GHz	11.5
Ku-Band EIRP per gateway	dBW	51.5
Return downlink bandwidth per gateway	MHz	480
Simultaneous User Transmissions		7500
L-Band EIRP (for Power Robbing)	dBW	32.0
Satellite (L-Band) G/T	dB/°K	20.6
U/L Propagation Losses	dB	-188.8
Boltzmann’s Constant	dBW/K-Hz	-228.6
Satellite EIRP per gateway per user	dBW	12.1
Ku-Band Free-Space Loss	dB	-215.2
Gateway Equipment Ku-Band G/T	dB/°K	37.9
Boltzmann's Constant	dBW/K-Hz	-228.6
C/N	dB	2.5
Downlink Ku-Band Feederlink Interference		
Effective C/I (across 480 MHz)	dB	14.5
Interference psd	dBW -Hz	-49.8
Effective C/I per carrier	dB	1.0
Total Link		
C/(I+N)	dB	-4.2
Processing Gain	dB	4.3
Effective Eb/No	dB	0.0
Satellite Diversity Rx Gain	dB	2.5
Required Eb/No	dB	3.1
Margin	dB	10.0

Table 20 - GMR-3G Forward Link Budget – Handheld Terminal

4 kbps Voice - Terminal G/T=-31 dB/K

Parameter	Units	
Burst type		PNB(1 8)
Modulation		PI/2 BPSK
Bits / symbol		1
Code rate		Conv.
Es/No	dB	0.70
Implementation margin	dB	0.20
Burst duration	ms	13.33
Symbol rate	ksps	23.40
Occupied bandwidth	kHz	31.25
Gateway Uplink C/No		
Gateway EIRP	dBW	45.98
Frequency	GHz	13.250
Path loss	dB	206.57
Atmospheric loss	dB	8.70
Satellite G/T	dB/K	11.50
C/No, uplink	dBHz	70.81
Gateway Uplink C/Io		
C/I, adjacent channel	dB	27.00
C/I, co-channel	dB	19.00
Cross-polarization Isolation	dB	25.00
Multi-beam C/I Factor	dB	-1.0
C/I, Gateway crosspol	dB	30.00
C/I, NPR	dB	20.00
C/I, rain depolarization	dB	17.50
C/I, calibration signal	dB	21.00
C/Io, uplink	dBHz	57.52

Parameter	Units	
MT Downlink C/No		
Satellite EIRP	dBW	48.30
Frequency	GHz	1.540
Path loss	dB	188.30
Fade and blocking loss	dB	8.00
Polarization mismatch loss	dB	3.50
MT G/T	dB/K	-31.00
C/No, downlink	dBHz	45.80
MT Downlink C/Io		
C/I, co-channel	dB	23.00
Number of co-frequency beams		24
Adjacent beam loading	%	100.00
VAD gain	dB	3.98
C/I, co-channel	dB	13.18
C/I, NPR	dB	15.00
C/Io, downlink	dBHz	55.93
Total Link		
Uplink C/(No+Io)	dBHz	57.32
Downlink C/(No+Io)	dBHz	45.40
C/(No+Io)	dBHz	45.13
Es/(No+Io)	dB	1.44
Required Es/(No+Io)	dB	0.90

Table 21 - GMR-3G Return Link Budget – Handheld Terminal

4 kbps Voice - Terminal G/T=-31 dB/K

Parameter	Units	
Burst type		PNB(1 8)
Modulation		PI/2 BPSK
Bits / symbol		1
Code rate		N/A
Es/No	dB	0.70
Implementation margin	dB	0.20
Burst duration	ms	13.33
Symbol rate	ksps	23.40
Occupied bandwidth	kHz	31.25
MT Uplink C/No		
MT EIRP	dBW	-7.00
Frequency	GHz	1.640
Path loss	dB	188.80
Fade and blocking loss	dB	8.00
Satellite G/T	dB/K	20.60
Polarization mismatch loss	dB	3.50
C/No, uplink	dBHz	41.90
MT Uplink C/Io		
C/I, co-channel	dB	22.50
Number of co-frequency beams		24
Adjacent beam loading	%	100.00
VAD gain	dB	2.01
C/I, co-channel	dB	10.70
C/I, adjacent channel	dB	7.58
C/I, calibration signal	dB	11.92
C/I, pointing beacon	dB	5.92
C/Io, uplink	dBHz	47.32

Parameter	Units	
Gateway Downlink C/No		
Downlink bandwidth	MHz	480
Number of voice carriers per Gateway		4388
Satellite EIRP per Gateway	dBW	51.50
Satellite EIRP per carrier, net	dBW	-2.03
Satellite EIRP		-2.03
Frequency	GHz	11.450
Path loss	dB	205.25
Atmospheric loss	dB	6.95
Gateway G/T	dB/K	37.90
G/T degradation	dB	2.80
C/No, downlink	dBHz	49.47
Gateway Downlink C/Io		
C/I (across 480 MHz)	dB	14.85
C/Io, downlink	dBHz	48.13
Total Link		
Uplink C/(No+Io)	dBHz	40.80
Downlink C/(No+Io)	dBHz	45.74
C/(No+Io)	dBHz	39.59
Received Es/(No+Io)	dB	-4.10
Polarization diversity gain	dB	2.91
Satellite diversity gain	dB	2.91
Es/(No+Io)	dB	1.71
Required Es/(No+Io)	dB	0.90
Margin	dB	0.81

Table 22 - GMR-3G Forward Link Budget – PC Card Terminal

56 kbps Data - Terminal G/T=-26 dB/K

Parameter	Units	
Traffic type		Data
Burst type		PNB(2 6)
Throughput	kbps	56
Modulation		PI/4 QPSK
FEC/Code rate		Turbo/0.7
Es/No	dB	6.70
Implementation margin	dB	0.60
Burst duration	ms	10.00
Symbol rate	ksps	46.80
Occupied bandwidth	kHz	62.5
Gateway Uplink C/No		
Gateway EIRP	dBW	48.99
Frequency	GHz	13.250
Path loss	dB	206.57
Atmospheric loss	dB	8.70
Satellite G/T	dB/K	11.50
C/No, uplink	dBHz	73.82
Gateway Uplink C/Io		
C/I, adjacent channel	dB	27.00
C/I, co-channel	dB	19.00
Cross-polarization Isolation	dB	25.00
Multi-beam C/I Factor	dB	-1.0
C/I, Gateway Cross-polarization	dB	30.00
C/I, NPR	dB	20.00
C/I, rain depolarization	dB	17.50
C/I, calibration signal	dB	21.00
C/Io, uplink	dBHz	60.53

Parameter	Units	
MT Downlink C/No		
Satellite EIRP	dBW	53.00
Frequency	GHz	1.540
Path loss	dB	188.30
Fade and blocking loss	dB	6.00
Polarization mismatch loss	dB	0.70
MT G/T	dB/K	-26.00
C/No, downlink	dBHz	60.60
MT Downlink C/Io		
C/I, co-channel	dB	22.50
Number of co-frequency beams		24
Adjacent beam loading	%	71.75
VAD gain	dB	0.00
C/I, co-channel	dB	10.14
C/I, NPR	dB	15.00
C/Io, downlink	dBHz	56.87
Total Link		
Uplink C/(No+Io)	dBHz	60.33
Downlink C/(No+Io)	dBHz	55.34
C/(No+Io)	dBHz	54.14
Es/(No+Io)	dB	7.44
Required Es/(No+Io)	dB	7.30
Margin	dB	0.14

Table 23 - GMR-3G Return Link Budget – PC Card Terminal

21 kbps Data - Terminal G/T=-26 dB/K

Parameter	Units	
Traffic type		Data
Burst type		PNB(1 6)
Throughput	kbps	21
Modulation		PI/4 QPSK
FEC/Code rate		Turbo/.6
Es/No	dB	5.80
Implementation margin	dB	0.50
Burst duration	ms	10.00
Symbol rate	ksps	23.40
Occupied bandwidth	kHz	31.25
MT Uplink C/No		
MT EIRP	dBW	-2.30
Frequency	GHz	1.640
Path loss	dB	188.80
Fade and blocking loss	dB	6.00
Satellite G/T	dB/K	20.60
Polarization mismatch loss	dB	0.70
C/No, uplink	dBHz	51.40
MT Uplink C/Io		
C/I, co-channel	dB	22.50
Number of co-frequency beams		24
Adjacent beam loading	%	0.60
VAD gain	dB	2.01
C/I, co-channel	dBHz	32.92
C/I, adjacent channel	dB	11.28
C/I, calibration signal	dB	21.42
C/I, pointing beacon	dB	15.42
C/Io, uplink	dBHz	54.50

Parameter	Units	
Gateway Downlink C/No		
Downlink bandwidth	MHz	480
Number of data carriers per Gateway		1260
Satellite EIRP per Gateway	dBW	51.50
Satellite EIRP per carrier, net		2.85
Frequency	GHz	11.450
Path loss	dB	205.25
Atmospheric loss	dB	6.95
Gateway G/T	dB/K	37.90
G/T degradation	dB	2.80
C/No, downlink	dBHz	54.35
Gateway Downlink C/Io		
C/I (across 480 MHz)	dB	14.85
C/Io, downlink	dBHz	53.01
Total Link		
Uplink C/(No+Io)	dBHz	49.67
Downlink C/(No+Io)	dBHz	50.62
C/(No+Io)	dBHz	47.11
Received Es/(No+Io)	dB	3.41
Polarization diversity gain	dB	0.00
Satellite diversity gain	dB	2.95
Es/(No+Io)	dB	6.36
Required Es/(No+Io)	dB	6.30
Margin	dB	0.06

Table 24 - GMR-3G Forward Link Budget – PDA Terminal

47 kbps Data – Terminal G/T=-24 dB/K

Parameter	Units	
Traffic type		Data
Burst type		PNB(2 6)
Throughput	kbps	64
Modulation		PI/4 QPSK
FEC/Code rate		Turbo/0.8
Es/No	dB	8.10
Implementation margin	dB	0.60
Burst duration	ms	10.00
Symbol rate	ksps	46.80
Occupied bandwidth	kHz	62.5
Gateway Uplink C/No		
Gateway EIRP	dBW	48.99
Frequency	GHz	13.250
Path loss	dB	206.57
Atmospheric loss	dB	8.70
Satellite G/T	dB/K	11.50
C/No, uplink	dBHz	73.82
Gateway Uplink C/Io		
C/I, adjacent channel	dB	27.00
C/I, co-channel	dB	19.00
Cross-polarization Isolation	dB	25.00
Multi-beam C/I Factor	dB	-1.0
C/I, Gateway Cross-polarization	dB	30.00
C/I, NPR	dB	20.00
C/I, rain depolarization	dB	17.50
C/I, calibration signal	dB	21.00
C/Io, uplink	dBHz	60.53

Parameter	Units	
MT Downlink C/No		
Satellite EIRP	dBW	53.00
Frequency	GHz	1.540
Path loss	dB	188.30
Fade and blocking loss	dB	6.00
Polarization mismatch loss	dB	0.70
MT G/T	dB/K	-24.00
C/No, downlink	dBHz	62.60
MT Downlink C/Io		
C/I, co-channel	dB	22.50
Number of co-frequency beams		24
Adjacent beam loading	%	34.11
VAD gain	dB	0.00
C/I, co-channel	dB	13.37
C/I, NPR	dB	15.00
C/Io, downlink	dBHz	59.06
Total Link		
Uplink C/(No+Io)	dBHz	60.33
Downlink C/(No+Io)	dBHz	57.47
C/(No+Io)	dBHz	55.66
Es/(No+Io)	dB	8.95
Required Es/(No+Io)	dB	8.70
Margin	dB	0.25

Table 25 - GMR-3G Return Link Budget – PDA Terminal

47 kbps Data – Terminal G/T=-24 dB/K

Parameter	Units	
Traffic type		Data
Burst type		PNB(2 6)
Throughput	kbps	47
Modulation		PI/4 QPSK
FEC/Code rate		Turbo/.6
Es/No	dB	4.90
Implementation margin	dB	0.80
Burst duration	ms	10.00
Symbol rate	ksps	46.80
Occupied bandwidth	kHz	62.50
MT Uplink C/No		
MT EIRP	dBW	0.00
Frequency	GHz	1.640
Path loss	dB	188.80
Fade and blocking loss	dB	6.00
Satellite G/T	dB/K	20.60
Polarization mismatch loss	dB	0.70
C/No, uplink	dBHz	53.70
MT Uplink C/Io		
C/I, co-channel	dB	22.50
Number of co-frequency beams		24
Adjacent beam loading	%	34.11
VAD gain	dB	0.00
C/I, co-channel	dBHz	13.37
C/I, adjacent channel	dB	13.57
C/I, calibration signal	dB	20.71
C/I, pointing beacon	dB	14.71
C/Io, uplink	dBHz	56.74

Parameter	Units	
Gateway Downlink C/No		
Downlink bandwidth	MHz	480
Number of data carriers per Gateway		661
Satellite EIRP per Gateway	dBW	51.50
Satellite EIRP per carrier, net	dBW	5.16
Frequency	GHz	11.450
Path loss	dB	205.25
Atmospheric loss	dB	6.95
Gateway G/T	dB/K	37.90
G/T degradation	dB	2.80
C/No, downlink	dBHz	56.65
Gateway Downlink C/Io		
C/I (across 480 MHz)	dB	14.85
C/Io, downlink	dBHz	55.32
Total Link		
Uplink C/(No+Io)	dBHz	51.95
Downlink C/(No+Io)	dBHz	52.93
C/(No+Io)	dBHz	49.40
Received Es/(No+Io)	dB	2.70
Polarization diversity gain	dB	0.00
Satellite diversity gain	dB	3.00
Es/(No+Io)	dB	5.70
Required Es/(No+Io)	dB	5.70
Margin	dB	0.00

Table 26 - GMR-3G Forward Link Budget – Home Gateway

160 kbps Data – Terminal G/T=-17 dB/K

Parameter	Units	
Traffic type		Data
Burst type		PNB(5 3)
Throughput	kbps	160
Modulation		PI/4 QPSK
FEC/Code rate		Turbo/.83
Es/No	dB	7.20
Implementation margin	dB	0.60
Burst duration	ms	5.00
Symbol rate	ksps	117.00
Occupied bandwidth	kHz	156.25
Gateway Uplink C/No		
Gateway EIRP	dBW	52.97
Frequency	GHz	13.250
Path loss	dB	206.57
Atmospheric loss	dB	8.70
Satellite G/T	dB/K	11.50
C/No, uplink	dBHz	77.80
Gateway Uplink C/Io		
C/I, adjacent channel	dB	27.00
C/I, co-channel	dB	19.00
Cross-polarization Isolation	dB	25.00
Multi-beam C/I Factor	dB	-1.0
C/I, Gateway Cross-polarization	dB	30.00
C/I, NPR	dB	20.00
C/I, rain depolarization	dB	17.50
C/I, calibration signal	dB	99.00
C/Io, uplink	dBHz	65.19

Parameter	Units	
MT Downlink C/No		
Satellite EIRP	dBW	55.00
Frequency	GHz	1.540
Path loss	dB	188.30
Fade and blocking loss	dB	5.00
Polarization mismatch loss	dB	0.00
MT G/T	dB/K	-17.00
C/No, downlink	dBHz	73.30
MT Downlink C/Io		
C/I, co-channel	dB	22.50
Number of co-frequency beams		24
Adjacent beam loading	%	100.00
Duty Cycle	dB	0.00
C/I, co-channel	dB	8.70
C/I, NPR	dB	15.00
C/Io, downlink	dBHz	59.72
Total Link		
Uplink C/(No+Io)	dBHz	64.95
Downlink C/(No+Io)	dBHz	59.53
C/(No+Io)	dBHz	58.44
Es/(No+Io)	dB	7.76
Required Es/(No+Io)	dB	7.80
Margin	dB	-0.04

Table 27 - GMR-3G Return Link Budget – Home Gateway

160 kbps Data – Terminal G/T=-17 dB/K

Parameter	Units	
Traffic type		Data
Burst type		PNB(5 3)
Throughput	kbps	160
Modulation		PI/4 QPSK
FEC/Code rate		Turbo/.83
Es/No	dB	7.20
Implementation margin	dB	0.60
Burst duration	ms	5.00
Symbol rate	ksps	117.00
Occupied bandwidth	kHz	312.50
MT Uplink C/No		
MT EIRP	dBW	11.00
Frequency	GHz	1.640
Path loss	dB	188.80
Fade and blocking loss	dB	5.00
Satellite G/T	dB/K	20.60
Polarization mismatch loss	dB	0.00
C/No, uplink	dBHz	66.40
MT Uplink C/Io		
C/I, co-channel	dB	22.50
Number of co-frequency beams		24
Adjacent beam loading	%	50.00
Duty Cycle	dB	0.00
C/I, co-channel	dB	11.71
C/I, adjacent channel	dB	17.58
C/I, calibration signal	dB	26.42
C/I, pointing beacon	dB	20.42
C/Io, uplink	dBHz	65.11

Parameter	Units	
Gateway Downlink C/No		
Downlink bandwidth	MHz	480
Number of data carriers per Gateway		273
Satellite EIRP per Gateway	dBW	51.50
Satellite EIRP per carrier, net	dBW	17.43
Frequency	GHz	11.450
Path loss	dB	205.25
Atmospheric loss	dB	6.95
Gateway G/T	dB/K	37.90
G/T degradation	dB	2.80
C/No, downlink	dBHz	68.93
Gateway Downlink C/Io		
C/I (across 480 MHz)	dB	14.85
C/Io, downlink	dBHz	67.59
Total Link		
Uplink C/(No+Io)	dBHz	62.70
Downlink C/(No+Io)	dBHz	65.20
C/(No+Io)	dBHz	60.76
Received Es/(No+Io)	dB	10.08
Polarization diversity gain	dB	0.00
Satellite diversity gain	dB	3.00
Es/(No+Io)	dB	13.08
Required Es/(No+Io)	dB	7.80
Margin	dB	5.28

b TT&C Link Performance

Table 28 presents the link budgets for satellite telemetry and command.

Table 28 - Telemetry Link Budget

PARAMETER	UNITS	SPOT	OMNI
Frequency	GHz	11.201 & 11.202	11.201 & 11.202
Range	km	39,347	39,347
Telemetry EIRP	dBW	20	0
Range loss	dB/m²	-162.9	-162.9
Rain Fade	dB	-1.2	-1.2
Scintillation	dB	-0.2	-0.2
Co-polarization Inclined Orbit Mismatch	dB	-0.1	-0.1
Tracking Gain	dB	-0.1	-0.1
Isotropic gain	dB	-42.6	-42.6
Clear Sky GW Antenna G/T	dB/ºK	33.8	33.8
G/T Degradation Due to Fade	dB	-1.2	-1.2
Boltzmann's Constant	dBW/Hz·ºK	228.6	228.6
Received C/No	dB·Hz	74.1	54.1
Received C/Io	dB·Hz	74.1	54.1
Received C/(No+Io)	dB·Hz	71.1	51.1
Data Rate	kbps	4	1
TM Mod Index	radians	0.9	0.9
Data Rate	dB·Hz	36	30
Mod loss	dB	3.9	3.9
Implementation loss	dB	3	3
Theoretical Eb/No (BER 1E-6)	dB·Hz	10.8	10.8
Required C/No	dB·Hz	53.7	48
Faded Margin	dB	17.4	3.1

Table 29 - Command Link Budget

PARAMETER	UNITS	SPOT	OMNI
Frequency	MHz	12750.1	13249.9
Range	km	39.347	39.347
Uplink EIRP	dBW	68	90
Range loss	dB/m²	-162.9	-162.9
Rain Fade	dB	-2	-2
Scintillation	dB	-0.2	-0.2
Co-polarization Inclined Orbit Mismatch	dB	-0.1	-0.1
Tracking Gain	dB	-0.3	-0.3
PFD	dBW/m²	-97.5	-75.5
Required PFD	dBW/m²	-115	-85
Link Margin	dB	17.5	9.5

Table 30 - Beacon Link Budget

PARAMETER	UNITS	SPOT
Frequency	GHz	11446.25& 11448.75
Range	km	39,347
Beacon EIRP	dBW	20
Range loss	dB/m²	-162.9
Rain Fade	dB	-1.2
Scintillation	dB	-0.2
Co-polarization Inclined Orbit Mismatch	dB	-0.1
Tracking Gain	dB	-0.1
Isotropic gain	dB	-42.6
Clear Sky GW Antenna G/T	dB/ºK	33.8
G/T Degradation Due to Fade	dB	-1.2
Boltzmann's Constant	dBW/Hz·K	228.6
Received C/No	dB·Hz	74.1
Received C/Io	dB·Hz	74.1
Received C/(No+Io)	dB·Hz	71.1
Required C/No	dB·Hz	55.0
Faded Margin	dB	16.1

3. Typical Subscriber Terminals

Next-generation mobile terminals will be similar in size to today's mobile handsets. These terminals will be multi-functional, capable of supporting voice, voice dispatch, packet-data, and multi-cast services with common hardware. They will be capable of detecting potential interference and adjusting configurations to ensure that signal-to-noise ratios are maintained for an error-free connection.

N. Requirements for Domestic FSS Applicants (47 C.F.R. §§ 25.114(d)(7) and 25.140(b)(2))

LightSquared provides the following two-degree spacing analysis demonstrating compliance with 47 C.F.R. §§ 25.114(d)(7) and 25.140(b)(2). The SkyTerra 2 feeder links operate in the Ku-band frequencies defined in Appendix 30B of the ITU Radio Regulations, and the interference analyses are provided below. The SkyTerra 2 service links operate in the L band, for which a two-degree analysis is not required.[9] In the Appendix 30B plan, there is one satellite allotment (JMC0000) within 2° of 107.3°W, and that allotment is to Jamaica at 108.6°W, 1.3° away.[10] Therefore, the interference analysis has been performed assuming that a satellite with Appendix 30B Ku-band carriers and antenna parameters identical to those of SkyTerra 2 operates at 105.3°W,[11] and one with the characteristics of the Jamaica allotment at 108.6°W.

Interference Analysis for the Appendix 30B Ku-Band carriers

The carrier types and power densities for SkyTerra 2 are provided in Table 31.[12]

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[9] *Cf.* 47 C.F.R.§ 25.140(b); *see also* Letter to Lon Levin from Bob Nelson, File No. SAT-AMD-20031118-00335 (April 23, 2004).

[10] SkyTerra Canada operates MSAT-1 at 106.5°W using the Appendix 30B Ku-band. When SkyTerra 2 is launched, SkyTerra Canada will resolve potential interference issues between SkyTerra 2 and MSAT-1 operationally. The 106.5°W allotment is being retired from the Appendix 30B plan.

[11] *See* Public Notice, Report No. SPB-207, DA 04-1708 (June 16, 2004).

[12] SkyTerra 1 is authorized to use a number of additional carrier types and power densities. Because LightSquared no longer expects to use such carrier types on its next-generation system, it does not seek such authority for use with SkyTerra 2.

Table 31- SkyTerra 2 Feeder-link Carriers

Uplink					Downlink		
Carrier	**EIRP (dBW)**	**BW (kHz)**	**Density dBW/Hz**		**EIRP (dBW)**	**BW (kHz)**	**Density dBW/Hz**
GMSA	65	1250	4.0		-2.7	6.4	-40.8
GMSA	---	---	---		0.6	6.4	-37.5
GMSA	---	---	---		11.6	12.8	-29.5
GMSA	---	---	---		14.1	1250	-46.9
GMR-3G	49	31.25	4.1		-0.03	31.25	-45.0
GMR-3G	52	62.5	4.0		4.85	31.25	-40.1
GMR-3G	52	62.5	4.0		7.16	62.5	-40.8
GMR-3G	56	156.25	4.1		19.4	156.25	-32.5
MSAT-Voice	46.7	4.8	9.9		1.7	4.8	-35.1
MSAT-Data	40.0	1.2	9.2		-10.3	1.2	-41.1
Command	68.0	1000	8.0		---	---	---
Telemetry	---	---	---		20.0	100	-30.0

Since the Jamaican allotment has not been brought into use, the Appendix 30B plan carrier densities and antenna characteristics will be used for the analysis. Relevant feeder-link earth station characteristics, including sidelobe antenna gains toward adjacent satellites located at 105.3°W and 108.6ºW, are shown in Table 32.

Table 32 – Feeder-link Earth Station (ES) Antenna Characteristics

	Uplink	**Downlink**
SkyTerra 2 Satellite Longitude	107.3°W	107.3°W
SkyTerra 2 ES Antenna Gain (dBi)	61.1	60.1
ES Sidelobe Pattern	29-25Log(θ)	29-25Log(θ)
Adjacent Satellite Longitude	105.3°W	105.3°W
Orbital Separation	2.0°	2.0°
Topocentric Separation	2.2°	2.2°
ES Antenna Gain (dBi)	61.1	60.1
Adjacent Satellite Longitude	108.6°W	108.6°W
Orbital Separation	1.3°	1.3°
Topocentric Separation	1.4°	1.4°
ES Antenna Gain (dBi)	49.8	48.4

Analysis

The analysis comprises calculation of uplink interference from earth stations to satellites, and calculation of downlink from the satellites to the earth stations. The isolation provided by the discrimination of the satellite antennas has not been included. In the case of the Jamaican allocation, the gain patterns of both the Jamaican and SkyTerra 2 satellite Ku-band antenna would provide significant additional mutual isolation, Therefore the analysis of interference between the SkyTerra 2 and Jamaica satellites presented below overestimates the interference.

Uplink Analysis

The uplink C/I values are calculated using the equation:

$$C/I_{up} = C_{oVup} - C_{oIup} + \Delta G_{tI}$$

Where:

C/I_{up} = Uplink carrier to interference ratio of the victim carrier caused by the interfering carrier

C_{oVup} = EIRP density of the victim carrier toward the victim satellite

C_{oIup} = EIRP density of the interfering carrier in the main lobe of its transmitting antenna

ΔG_{tI} = Difference in gain between the main lobe interfering antenna gain and the gain toward the victim satellite.

Table 33 and Table 34 show the results of the uplink C/I calculations for all pair-wise combinations of carriers. Calculations have been performed with respect to a satellite located at 105.3°W, which is 2° away from SkyTerra 2 (Table 33), and with respect to the allocation located at 108.6°W, which is 1.3° away from SkyTerra 2 (Table 34).

As demonstrated in Table 33 and Table 34, all carrier combinations result in very low interference. The worst case C/I is 19.1 dB, which corresponds to a ΔT/T value of 1.08%, well below the coordination threshold value of 6%.

Table 33 - Uplink Co/Io Calculation for SkyTerra 2 at 107.3W
With an Identical Satellite at 105.3W

Topocentric Angle =		**2.2 deg**	**GMSA**	**GMR-3G**	**MSAT-Voice**	**MSAT-Data**	**Com-mand**
			Victim Carrier Density (dBW/Hz)				
Interferer	**Density dBW/Hz**	**Sidelobe Rejection**	4.0	4.1	9.9	9.2	8.0
GMSA	4.0 dBW/Hz	40.7 dB	40.7	40.8	46.5	45.9	44.7
GMR-3G	4.1 dBW/Hz	40.7 dB	40.6	40.7	46.4	45.8	44.6
MSAT-Voice	9.9 dBW/Hz	40.7 dB	34.8	34.9	40.7	40.0	38.8
MSAT-Data	9.2 dBW/Hz	40.7 dB	35.5	35.6	41.3	40.7	39.5
Command	8.0 dBW/Hz	40.7 dB	36.7	36.8	42.5	41.9	40.7
		Min Co/Io =	**34.8**				
		Max Delta T/T =	**0.03%**				

Table 34 - Uplink Co/Io Calculation for SkyTerra 2 at 107.3W
with the JMC0000 Allotment at 108.6W

Topocentric Angle =		**1.4 deg**	**SkyTerra 2**					**JMC0000**
			GMSA	**GMR-3G**	**MSAT-Voice**	**MSAT-Data**	**Com-mand**	**Cxr Density**
			Victim Carrier Density (dBW/Hz)					
Interferer	**Density dBW/Hz**	**Earth Station Sidelobe Rejection**	**4.0**	**4.1**	**9.9**	**9.2**	**8.0**	**-6.2**
SkyTerra 2								
GMSA	4.0	35.8 dB	----	----	----	----	----	25.6
GMR-3G	4.1	35.8 dB	----	----	----	----	----	25.5
MSAT-Voice	9.9	35.8 dB	----	----	----	----	----	19.7
MSAT-Data	9.2	35.8 dB	----	----	----	----	----	20.3
Command	8.0	35.8 dB	----	----	----	----	----	21.6
Jamaica Allotment								
JMC0000	-6.2	24.5 dB	34.7	34.8	40.5	39.9	38.7	----
		Min Co/Io =	**19.7**					
		Max Delta T/T =	**1.08%**					

Downlink Analysis

The downlink C/I values are calculated using the equation:

$$C/I_{down} = C_{oVdown} - C_{oIdown} + \Delta G_{rI}$$

Where:

C/I_{down} = Downlink carrier to interference ratio of the victim carrier caused by the interfering carrier

C_{oVdown} = EIRP density of the victim satellite carrier toward its earth station

C_{oIdown} = EIRP density of the interfering satellite carrier toward the victim earth station

ΔG_{tI} = Difference in gain between the main lobe victim antenna gain and the gain toward the interfering satellite.

Table 35 and Table 36 show the results of the downlink C/I calculations for all pair-wise combinations of carriers. Calculations have been performed with respect to a satellite located at 105.3°W, which is 2° away from SkyTerra 2 (Table 35), and with respect to the allocation located at 108.6°W, which is 1.3° away from SkyTerra 2 (Table 36).

As demonstrated in Table 35 and Table 36, all carrier combinations result in very low interference. The worst case C/I is 13.8 dB, which corresponds to a ΔT/T value of 4.21%, well below the coordination threshold value of 6%.

Table 35 - Downlink Co/Io Calculation for SkyTerra 2 at 107.3W **With an Identical Satellite at 105.3W**							
Topocentric Angle =	**2.2 deg**	**Victim Carrier**					
		GMSA n*	**GMSA w***	**GMR-3G**	**MSAT-Voice**	**MSAT-Data**	**Telemetry**
Density (dBW/Hz)		-40.8	-46.9	-45.0	-35.1	-41.1	-30.0
Sidelobe Rejection (dB)		39.7	39.7	39.7	39.7	39.7	39.7
Interferer	**Max Density dBW/Hz**						
GMSA n*	-29.5 dBW/Hz	28.4	22.3	24.2	34.0	28.1	39.2
GMSA w*	-46.9 dBW/Hz	45.8	39.7	41.6	51.4	45.5	56.6
GMR-3G	-32.5 dBW/Hz	31.4	25.3	27.2	37.0	31.1	42.2
MSAT-Voice	-35.1 dBW/Hz	34.0	27.9	29.8	39.7	33.7	44.8
MSAT-Data	-41.1 dBW/Hz	40.0	33.9	35.8	45.6	39.7	50.8
Telemetry	-30.0 dBW/Hz	28.9	22.8	24.7	34.5	28.6	39.7
		Min Co/Io =	**22.3**				
		Max Delta T/T =	**0.59%**				

* n and w refer to narrowband (6.4 and 12.8 kHz) and wideband (1250 kHz) GMSA return carriers.

Table 36 - Downlink Co/Io Calculation for SkyTerra 2 at 107.3W **with the JMC0000 Allotment at 108.6W**								
Topocentric Angle =	**1.4 deg**	**Victim Carrier**						
		SkyTerra 2						**JMC0000**
		GMSA n*	**GMSA w***	**GMR-3G**	**MSAT-Voice**	**MSAT-Data**	**Tele-metry**	**Cxr Density**
Density (dBW/Hz)		-40.8	-46.9	-45.0	-35.1	-41.1	-30.0	-25.9
Sidelobe Rejection (dB)		34.8	34.8	34.8	34.8	34.8	34.8	23.1
Interferer	**Max Density dBW/Hz**							
SkyTerra 2								
GMSA n	-29.5	---	---	---	---	---	---	29.5
GMSA w	-46.9	---	---	---	---	---	---	46.9
GMR-3G	-32.5	---	---	---	---	---	---	32.5
MSAT-Voice	-35.1	---	---	---	---	---	---	35.1
MSAT-Data	-41.1	---	---	---	---	---	---	41.1
Telemetry	-30.0	---	---	---	---	---	---	30.0
Jamaica Allotment								
JMC0000	-25.9	19.9	13.8	15.7	25.5	19.6	30.7	---
		Min Co/Io =	**13.8**					
		Max Delta T/T =	**4.21%**					

O. Priority and Preemptive Access for Aviation and Maritime Safety Communications for L-band MSS Applicants (47 C.F.R. § 25.114(d)(8))

SkyTerra 2's operations will comply with applicable requirements regarding the provision of priority and preemptive access for safety communications services. 47 C.F.R. § 2.106 Footnotes US308, US315; *see also* ITU Radio Regulations 5.353A, 5.357A, 5.362A. Indeed, the Commission has already approved LightSquared's system in the context of the SkyTerra 1 application.[13] Nonetheless, for completeness,

[13] *In the Matter of Mobile Satellite Ventures Subsidiary LLC*, 20 FCC Rcd 9752, at ¶ 29 (2005).

LightSquared reiterates the process by which its satellite system will comply with this requirement.

The GSS/MSC will manage all satellite resources (*i.e.*, frequencies and power) and completely control the allocation of those resources to the mobile terminals that use the satellite. The satellite system will maintain a reserve pool of resources that will permit any additional demands of any AMS(R)S and GMDSS network to be met immediately. This AMS(R)S and GMDSS reserve pool will be maintained by retrieving resources from within the LightSquared satellite network. The size of the pool and the parameters for retrieving additional resources will be established when any AMS(R)S or GMDSS network is designed and its needs can be assessed. LightSquared will have the flexibility to adapt the system to whatever design the AMS(R)S or GMDSS provider chooses to implement.

P. Orbital Debris Mitigation (47 C.F.R. §§ 25.114(d)(14))

1. Spacecraft Hardware Design (47 C.F.R. § 25.114(d)(14)(i))

SkyTerra Canada has assessed and limited the amount of debris released in a planned manner during normal operations. SkyTerra 2 will not be a source of debris during launch, drift, or operating mode, as SkyTerra Canada does not intend to release debris during the planned course of operations of SkyTerra 2. SkyTerra Canada has considered the possibility of SkyTerra 2 becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control of the spacecraft and prevent post-mission disposal. SkyTerra Canada has addressed the possibility of collision by ensuring that critical spacecraft components are located inside the protective body of the spacecraft and are properly shielded and by ensuring that satellite subsystems have redundant components. For example, omnidirectional antennas will be mounted on opposite sides of the satellite, and either antenna will be sufficient to support orbit-raising. The command receivers and decoders, telemetry encoders and transmitters, bus control electronics, and power subsystem components are fully redundant, physically separated, and located within a shielded area to minimize the probability of the spacecraft becoming a source of debris due to a collision.

2. Minimizing Accidental Explosions (47 C.F.R. § 25.114(d)(14)(ii))

To the extent necessary, LightSquared seeks partial waiver of this requirement as explained in Section II.B.6 of the application narrative.

SkyTerra Canada has assessed and will limit the probability of accidental explosions during and after completion of mission operations. The SkyTerra 2 satellite is designed to minimize the potential for accidental explosions through propellant leakage and fuel and oxidizer mixing or other means. Propellant tanks and thrusters are isolated using redundant values, and electrical power systems are shielded in accordance with standard industry practices. During the mission, batteries and various critical areas of the propulsion subsystem will be monitored to avoid conditions that could result in explosion. After SkyTerra 2 reaches its final disposal orbit, all on-board sources of stored energy will be removed, with the exception of the pressurized vessels discussed below, by depleting all propellant tanks, venting all pressurized systems, discharging batteries, and turning off all active units. SkyTerra 2 uses a Boeing 702 spacecraft bus that has a liquid propulsion system design that includes two helium (pressurant) tanks plus two pairs of fuel and oxidizer tanks. Venting of the excess propellant in the fuel and oxidizer tanks is performed as part of the end-of-life shutdown operations. The helium tanks provide proper propellant tank pressurization for apogee engine firings during transfer orbit. Both helium tanks are isolated at the end of transfer orbit by firing pyrotechnic valves, and there is no venting provision for these helium tanks at the satellite end-of-life. SkyTerra Canada has estimated that approximately 719 grams of Helium will be sealed in each tank when they are isolated resulting in a final pressure of 860 psi, which is extremely low relative to the design burst pressure of 5,249 psi. Due to the low blanket pressure in the Helium tanks at the satellite end-of-life, an explosive event is unlikely, even in the event of a tank rupture (e.g. a meteorite strike). Accordingly, the satellite design results in minimal potential for the release of orbital debris.

Additionally, after the Liquid Propulsion Subsystem ("LPS") is fully integrated (i.e. all the components and interconnections are welded), the manufacturer conducts subsystem acceptance testing, which verifies the integrity of all the components and interconnections of the LPS, including the pyrotechnic valves, filter, and dual series redundant regulator, at pressures of over 4,000 psi, which is more than four times higher than the expected operating condition after isolation. The LPS is also subjected to leakage and functional testing during Final Integrated System Tests (FIST) for post-vibration verification and again at the launch site prior to loading of the bi-propellant and Helium pressurant. Further, the Helium tank, which is considered the weakest link in the subsystem, has a design life of more than four times mission life (i.e. 60+ years) based on fatigue life analysis, which takes into consideration the on orbit operating environment (e.g. launch loads, pressure profile over life, thermal cycles, and radiation dosage). The

Helium tank also is designed to leak before burst, further minimizing the potential for orbital debris.

3. Safe Flight Profiles (47 C.F.R. § 25.114(d)(14)(iii))

SkyTerra Canada has assessed and limited the probability of SkyTerra 2 becoming a source of debris by collisions with large debris or other operational space stations.

Industry Canada has authorized SkyTerra 2 to operate at the 107.3°W.L. orbital location. Two other Canadian satellites, ANIK-F1 and ANIK-F1R, which are licensed to Telesat, also operate at 107.3°W.L. Telesat will manage the operational control of all three satellites at the nominal orbital location at 107.3W and accordingly will self-coordinate and control the orbital locations of the satellites, as necessary, to prevent collisions.

4. Post-Mission Disposal (47 C.F.R. § 25.114(d)(14)(iv))

At the end of satellite life, SkyTerra 2 will be maneuvered into a disposal orbit with an altitude no less than that calculated using the Inter-Agency Space Debris Coordination Committee (IADC) formula: 36,021 km + ($1000 \cdot C_R \cdot A/m$), where:

C_R (solar radiation pressure coefficient of the spacecraft) = 1.17

A/m (Area to mass ratio) = .03679. *See* 47 C.F.R. § 25.283(a).

This calculation will lead to a disposal orbit with a minimum perigee of 278 km above the normal GSO operational orbit. LightSquared anticipates that SkyTerra 2 will be maneuvered to an altitude 300 km above GSO orbit at the end of its operational life, which will provide additional margin above the results of the IADC formula.

Approximately 18.5 kg of propellant has been allocated to SkyTerra 2 for final orbit raising maneuvers, which corresponds to a 300 km increase in orbit. The reserved fuel provided for in the propellant budget was calculated by the spacecraft manufacturer based on expected mass of the satellite at end of life and the required delta-velocity to achieve the desired orbit. The final propellant reserve will be allocated based on the final mass, area, and solar radiation coefficient of the spacecraft. LightSquared has assessed fuel gauging uncertainty and believes there is an adequate margin of fuel reserve to address the assessed uncertainty in remaining propellant.

Q. Waiver Request

1. Section 25.210(i) – Cross-Polarization Isolation

LightSquared requests a waiver of Section 25.210(i) of the Commission's rules to enable SkyTerra 2 to operate with 25 dB of cross-polarization isolation in the Appendix 30B Ku band within the primary coverage area of the antenna for feeder link, command, telemetry, and power control beacon operations. 47 C.F.R. § 25.210(i). Moreover, SkyTerra 2 is equipped with wide-angle coverage antennas used for TT&C that have 9 dB transmit and 12 dB receive cross-polarization isolation, but these antennas are used only during orbit-raising and are not expected to be used in any future operation except in the event of certain operational contingencies.

The Bureau has explained that the cross-polarization isolation requirement of Section 25.210(i) is necessary in order to facilitate two-degree orbital spacing between geostationary satellites.[14] In the case of SkyTerra 2, there are no other satellites (other than SkyTerra Canada's MSAT-1 satellite) that use Appendix 30B Ku-band frequencies within two degrees of the 107.3°W.L. orbital location. Accordingly, the operation of SkyTerra 2 with less than 30B of cross-polarization isolation will not result in harmful

[14] *See DIRECTV Enterprises, LLC, Order and Authorization*, DA 06-1493 (July 21, 2006) ("*DIRECTV Order*").

interference to any U.S. or foreign-licensed satellite. Moreover, consistent with the Bureau's decision in the *DIRECTV Order*, if in the future the Commission should authorize access to the U.S. market for a satellite within two degrees of SkyTerra 2, that uses the Appendix 30B Ku-band frequencies and is compliant with the two-degree spacing requirement, LightSquared understands that, unless a coordination agreement between that operator and SkyTerra Canada is reached, the operation of SkyTerra 2 must be on a non-harmful interference basis relative to U.S. services provided in the Appendix 30B Ku-band by that satellite operator. Accordingly, the operation of SkyTerra 2 will not cause more interference than would be caused if SkyTerra 2 complied with Section 25.210(i) of the Commission's rules, and LightSquared will not claim protection against interference to its operations caused by U.S. services provided in the Appendix 30B Ku band by a two-degree compliant satellite if such interference results from failure of SkyTerra 2 to comply with Section 25.210(i).

2. Section 25.114(c) – Schedule S

LightSquared requests a partial waiver of the following subsections of Section 25.114(c) of the Commission's rules to allow LightSquared flexibility in completing the information required by the Schedule S submitted with this application. The Commission implicitly granted similar waiver requests by LightSquared in the grant of authority to launch and operate SkyTerra 1.[15] As discussed below, good cause exists for a waiver because the the Schedule S does not account for the following unique aspects of the SkyTerra 2 GSO MSS satellite.

[15] *See In the Matter of Mobile Satellite Ventures Subsidiary LLC*, 20 FCC Rcd 9752 (2005); Application, File Nos. SAT-AMD-20040209-00014, SAT-AMD-20040928-00192.

The SkyTerra 2 satellite will use GBBF to provide great flexibility in sizing and locating L-band beams. The satellite and GBBF have the ability to form up to 500 L-band spot beams, or to form a large number of L-band spot beams in a portion of LightSquared's spectrum and simultaneously form a smaller number of larger beams in another portion of the spectrum. That capability can be used to form beams that emulate the AMSC-1 beams. Alternatively, multiple spot beams may be placed to overlap an area requiring unusually large capacity, an ability that will provide increased capacity in emergency situations. Therefore, LightSquared herein provides a description of the spot beams and AMSC-1 emulation beams as representative of the possible configurations.

a. Section 25.114(c)(4)(ii)

Schedule S, Table S7 and S13 -- Emission designators, associated bandwidths, final amplifier output power, loss, and maximum EIRP per beam.

As explained above, SkyTerra 2 can form 500 L-band spot beams, a few larger beams, and many other possible configurations. Therefore, the Schedule S provides the required information for a typical North American spot beam, a Hawaii beam, one MSAT emulation beam, as well as for each Appendix 30B Ku-band feeder link and TT&C beam. LightSquared requests that the Commission accept these representative entries as sufficient for compliance with Section 25.114(c)(4)(ii), and grant a partial waiver of this rule in order to avoid the substantial burden of providing the required information for all of the beams formed by SkyTerra 2.

b. Section 25.114(c)(4)(iii)

Schedule S, Table S10 -- Identification of which antenna beams are connected or switchable to each transponder and TT&C function.

As referred to in Schedule S, a transponder comprises a satellite receive channel connected to an associated satellite transmit channel. That model applies well to satellites with hardwired connections between receive and transmit beams. SkyTerra 2 does not contain transponders in that hard-wired sense. Rather, it has full flexibility in interconnecting Appendix 30B Ku-band feeder-link sites, polarizations, and frequencies to L-band beams, polarizations, and frequencies. Thus, the number of transponders is quite large.

In the **forward** direction, there are 4000 "transponders," as detailed below:

500 L-band beams over the service area (not including MSAT emulation beams)
4 Appendix 30B Ku-band feeder-link sites

x 2	Appendix 30B Ku-band feeder-link polarizations
4,000	**"Transponders"**

In the **return** direction, there are more "transponders" because there are two L-band satellite receive polarizations and two Appendix 30B Ku band sub-bands (10.7-10.95 GHz and 11.2-11.45 GHz) in the downlink direction, as detailed below:

500	L-band beams over the service area (not including MSAT emulation beams)
4	Appendix 30B Ku band feeder link sites
2	Appendix 30B Ku band feeder link polarizations
2	L band receive polarizations
x 2	Appendix 30B Ku band sub-bands
16,000	**"Transponders"**

Therefore, an exhaustive listing of all possible connections between beam types, feeder-link sites, and polarizations is impractical. Fortunately, a number of the possibilities have identical parameters, and so they can be combined.

1. Consider the 500 L-band spot beams as having equivalent parameters. Doing so reduces the 500 spot beams to one representative spot beam. For Schedule S, a Hawaii spot beam is separately identified because it is non-contiguous to the other beams. Further, one MSAT emulation beam (TLEM1/RLEM1) is identified that has equivalent parameters. Considering one L-band spot beam, plus one Hawaii spot beam coverage area, plus a representative MSAT emulation beam reduces the number of forward service link beams to be considered from 500 to three.

2. Next, the paths that connect the feeder-link stations to L-band beams are identical for all four feeder-link stations. Therefore, one feeder-link station is used in Schedule S, Table S10.

The combining of like paths reduces the number of transponders listed in Schedule S, Table S10 to ten in the Ku-band to L-band direction and eleven in the L-band to Ku-band direction. These quantities are far more practical to present and are representative of the relevant connections. Accordingly, LightSquared requests that the Commission accept these representative entries as sufficient for compliance with Section 25.114(c)(4)(iii), and grant a partial waiver of this rule in order to avoid the substantial burden of providing the required information for all of the possible combinations.

TT&C paths are also shown in the Transponder table S10, but since telemetry paths originate at the satellite, and command paths terminate at the satellite, they are shown as transmit-only or receive-only transponders.

c. Section 25.114(c)(4)(v)

Schedule S, Table S7 -- The relationship between satellite receive antenna gain and gain–to-temperature ratio and saturation flux density.

These relationships provided in Table S7 are for the representative beam types. LightSquared requests that the Commission accept these representative entries as sufficient for compliance with Section 25.114(c)(4)(v), and grant a partial waiver this rule in order to avoid the substantial burden of providing the required information for all of the beams formed by SkyTerra 2.

For the Appendix 30B Ku-band receive beams, the value shown for Saturation Flux Density (“SFD”) is the flux density that will drive the L-band solid-state power amplifiers (SSPAs) to the desired operating point with the required linearity, not in saturation. L-band SSPAs will be operated in the linear region, not in saturation.

d. Section 25.114(c)(4)(vi)

Schedule S, Table S9 -- The gain of each transponder channel.

Given the potential number of "transponders," the gain is provided for each of the representative channels shown. LightSquared requests that the Commission accept these representative entries as sufficient for compliance with Section 25.114(c)(4)(vi), and grant a partial waiver this rule in order to avoid the substantial burden of providing the required information for all of the possible channels.

e. Further Clarifications of Responses to Schedule S

Schedule S, Tables S6, S7, and S8

(a) SAKU is the Appendix 30B Ku-band feeder-link service area that comprises four spot beams, two pointed toward locations in the United States, and two pointed toward locations in Canada. The feeder-link earth station locations are: Saskatoon, Saskatchewan; Ottawa, Ontario; Napa, California; and Dallas, Texas. Under Questions S7 and S8, RKU1 and TKU1 are the beam patterns for the Dallas spot, and RKU2 and TKU2 are the beam patterns for the Napa spot.

(b) SAL1 is an L-band service area comprising North America and portions of Central America and the Caribbean. SAL2 is the L-band service area that includes Hawaii. SAL2 is separate because Schedule S will not accept a service area that has two non-contiguous regions.

(c) OMNI is the area served by the omnidirectional TT&C antenna.

(d) SkyTerra 2 can form up to 500 L-band beams. Therefore, the beam gain patterns provided are: the aggregate uplink L-band beam (RL1), the Hawaiian beam (RLHI), the AMSC-1 emulation beams (RLEM1-6), aggregate downlink L-band beam (TL1), the Hawaiian beam (TLHI), and the AMSC-1 emulation beams (TLEM1-6). Beams RL1 and TL1 are aggregate beams that include the contiguous United States plus

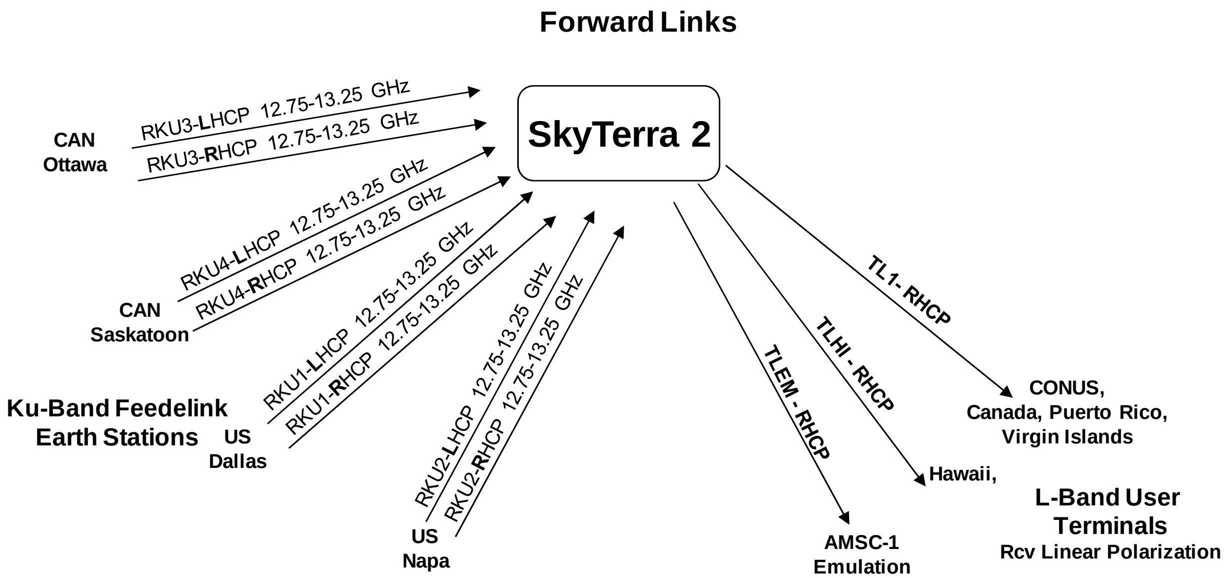
Alaska, Canada, Puerto Rico, and the Virgin Islands. Two additional beam gain patterns are provided, RLTYP1 and TLTYP1, that are typical receive and transmit beam gain patterns for a single spot beam. The use of a phased array feed structure and GBBF permits great flexibility in the generation of spot beams, in quantity, geographical coverage, and gain. There are thus a very large number of beam types that can be formed.

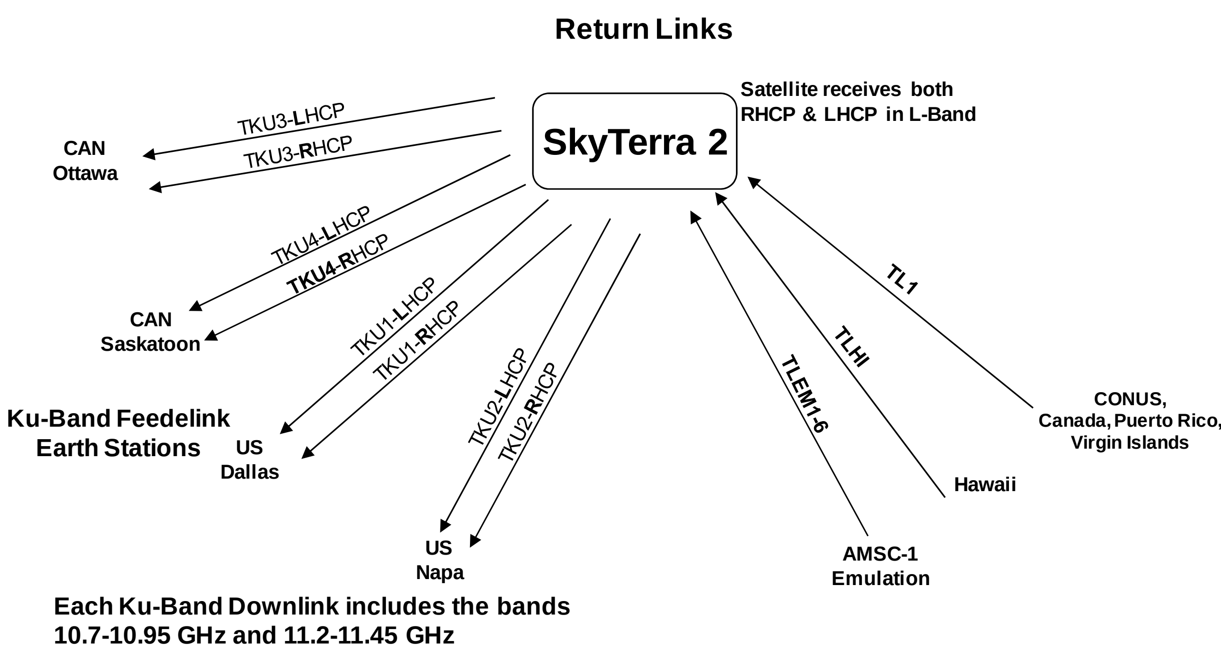
(f) Rotational Error (degrees) – All beam pointing errors are included in the values provided in Section S7 column (e). Those values are the 3-sigma half-cone error values and include pointing as well as rotation.

(m) Transmit Maximum EIRP (dBW) for the TL1, TLHI, and TLEM 1-6 beams – The value entered is the maximum aggregate EIRP even though that power would operationally be spread over all the downlink beams.

(n) Transmit Maximum EIRP (dBW) for the TKU1-4 beams – The value entered is that for each of two downlink polarizations, and so the aggregate EIRP is 3 dB greater than the value entered.

The following diagrams are intended to clarify the beam descriptions.





Schedule S, Table S13

(e) Carriers per transponder – Since the satellite does not have transponders in the conventional fixed satellite service sense, carriers per transponder is not a definable quantity. System capacity is a more appropriate measure. Therefore, the quantity "1" has been entered in Schedule S.

(j) & (k) Associated Station Minimum Transmit Power (dBW) and Associated Station Maximum Transmit Power (dBW) – Schedule S will not accept values less than -20 dBW in columns (j) or (k). In such cases, -20 dBW was entered. The correct values are listed below.

A	B	c	j	k
FWD5	FWD6	CW1	-26.3	
FWD5	FWD6	FESC	-26.3	
FWD5	FWD6	MMS	-30.3	-25.3