

# **O3B NON-GEOSTATIONARY SATELLITE SYSTEM**

## **Technical Information to Supplement the Existing Schedule S for the Texas Gateway Earth Station**

**(FCC File No. SES-LIC-20130124-00089)**

### **A.1 Scope**

A Schedule S for the O3b non-geostationary satellite system was filed with the Commission as part of the license application for the Hawaii gateway earth station. O3b incorporated the technical information that had been filed with the Hawaii application, including the Schedule S, in its application for a Texas gateway earth station. This filing supplements the Texas earth station application by providing modified and additional technical information that is tailored to the operation of the Texas gateway earth station.

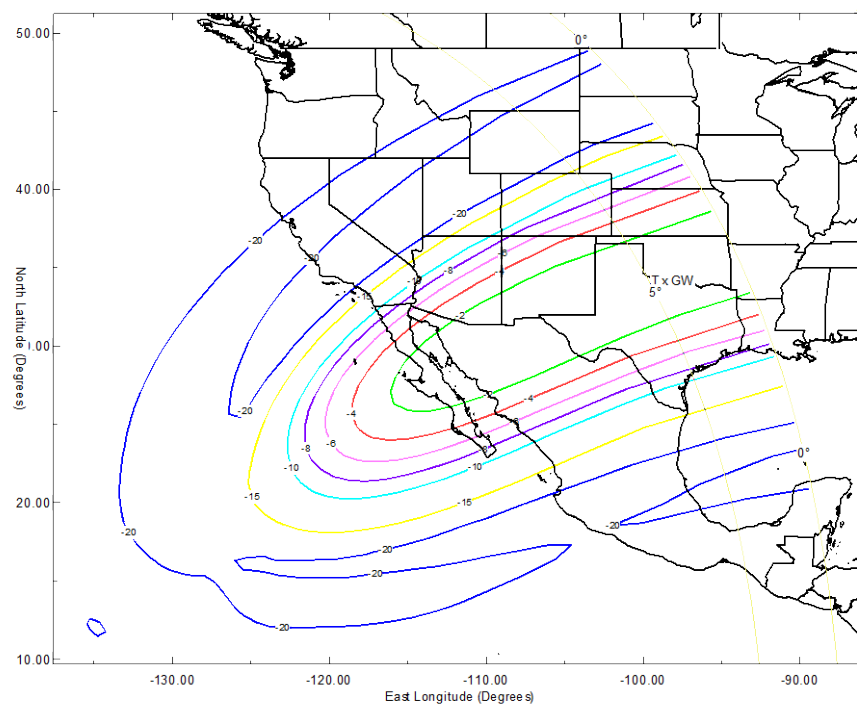
### **A.2 Predicted Space Station Antenna Gain Contours**

The mid-band antenna gain contours for the O3b satellite receive and transmit beams, when directed towards the Texas gateway earth station, are shown below. Only one set of beam patterns is provided for transmit and one set for receive because all O3b satellite transmit beams are identical and all receive beams are identical.

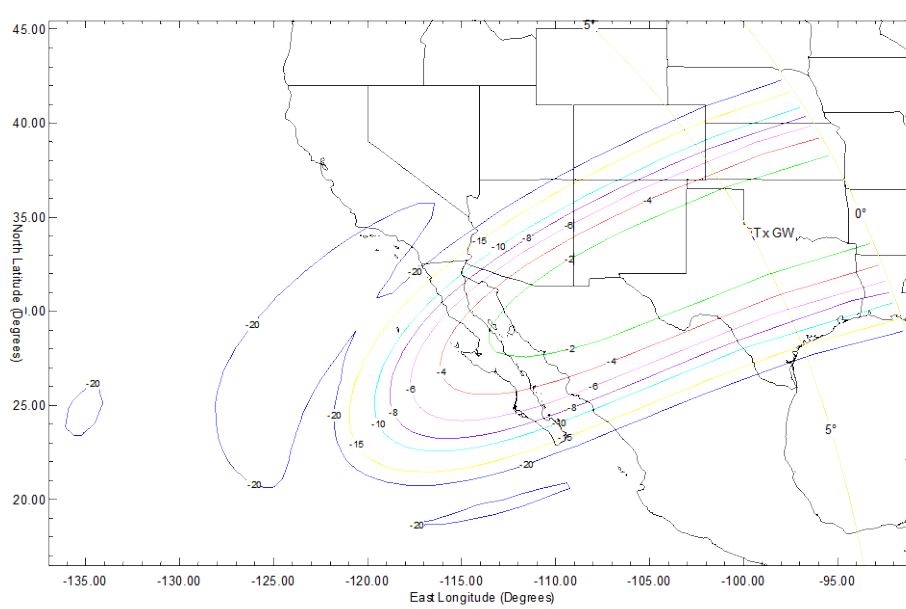
These beam patterns demonstrate the effects on the satellite antenna gain contours as the O3b satellite moves in its orbit. Various satellite positions are shown starting with the O3b satellite appearing at 5° elevation angle in the west as viewed from the Texas earth station (see Figure A.2-1). The next O3b satellite position (Figure A.2-2) is at the point when it is at the same longitude as the Texas earth station. The third O3b satellite position is when the O3b satellite is disappearing below the 5° elevation angle in the east as viewed from the Texas earth station (Figure A.2-3). For each of these Figures both the transmit and receive antenna gain contours are shown.

**Figure A.2-1: Satellite antenna gain contours when O3b satellite is at 151°W**

**(a) Transmit**

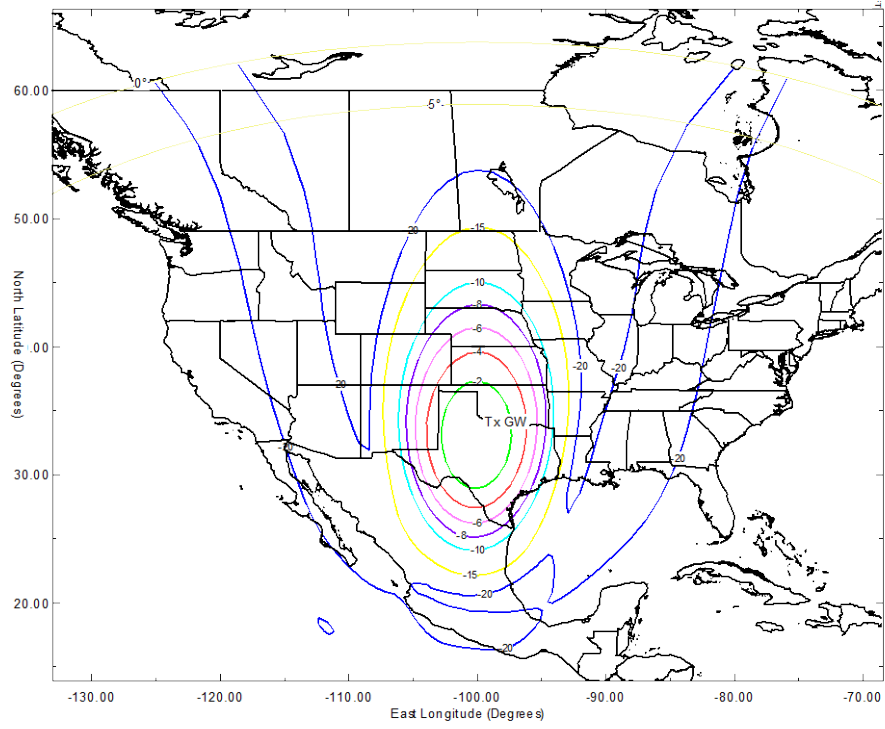


**(b) Receive**

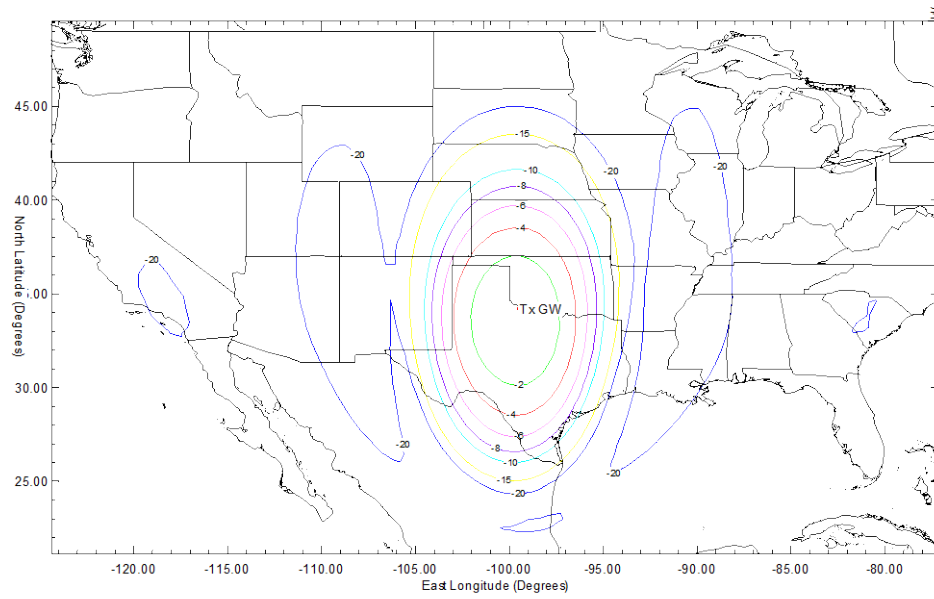


**Figure A.2-2: Satellite antenna gain contours when O3b satellite is at 100°W**

**(a) Transmit**

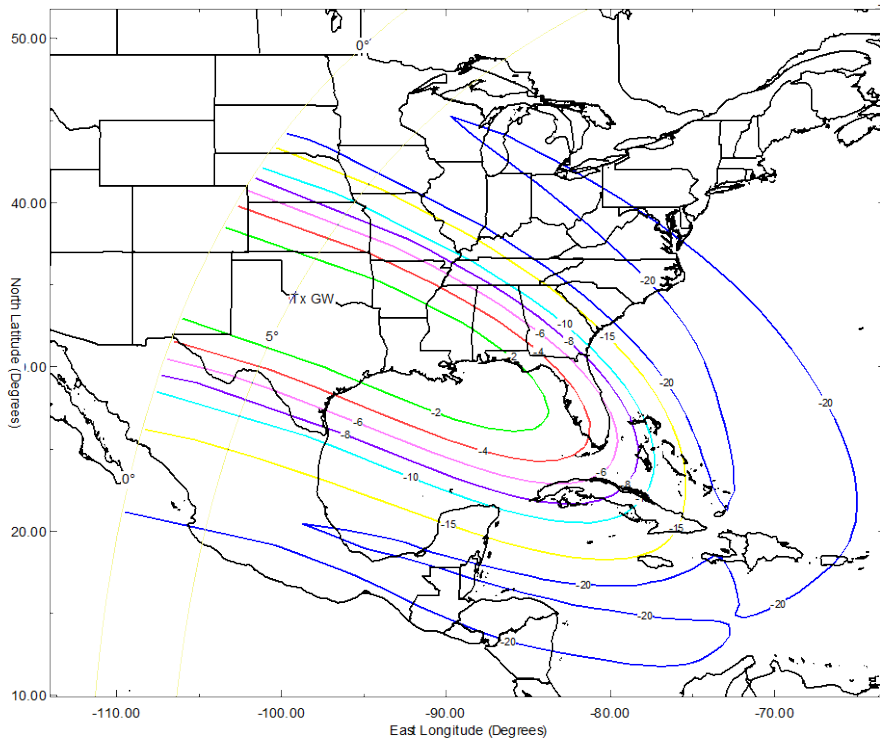


**(b) Receive**

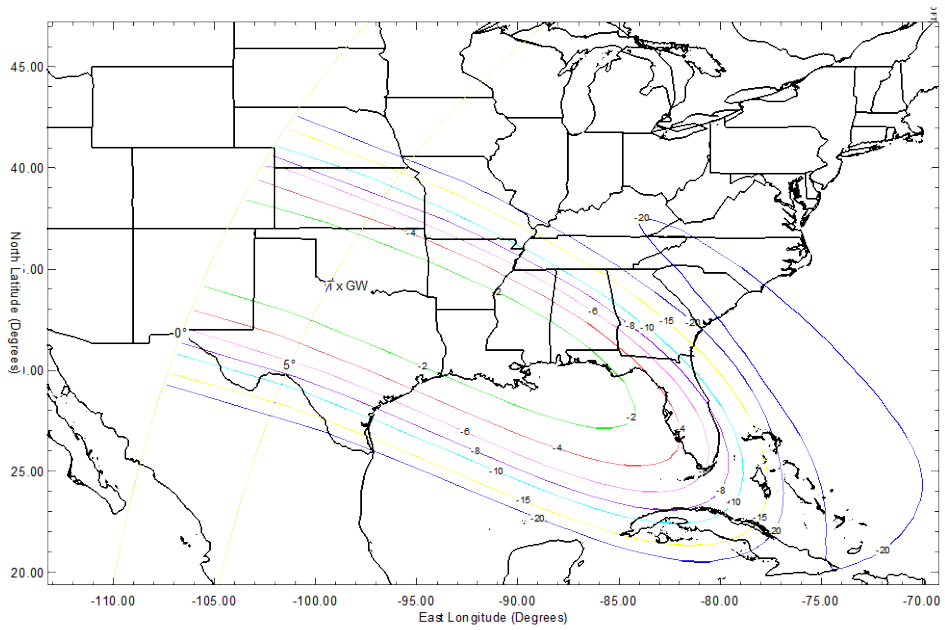


**Figure A.2-3: Satellite antenna gain contours when O3b satellite is at 48°W**

**(a) Transmit**



**(b) Receive**



### **A.3 Service Area**

The service area designated as “G1” in the original Schedule S for the O3b non-geostationary satellite system is extended to include the Texas gateway location. The new service area is therefore defined to be “Haleiwa, HI + Vernon, TX” for the purpose of O3b gateway earth stations.

### **A.4 Link Budgets for the Texas Gateway Earth Station**

New representative link budgets are provided in Annex 1 for the Texas gateway earth station. The earth station in Texas is identical to that in Hawaii, and the geometry of the link between the gateway and the O3b satellite is identical as it is bounded by the minimum elevation angle of 5 degrees. Even the difference in rain region is relatively unimportant because of the use of adaptive coding and modulation which compensates for rain fades.

### **A.5 TT&C Characteristics**

There is no change to the TT&C information for the O3b non-geostationary satellite system compared to that provided in the Hawaii gateway earth station application. However, the Texas earth station will be used primarily for communications traffic as the regional gateway, and will only be available to perform the TT&C function as a back-up to O3b’s Peru gateway station.

### **A.6 Coordination with US Government Satellite Networks and Earth Stations**

O3b has completed all necessary coordination with US government satellite networks operating in Ka-band, including GSO and non-GSO, as well as their associated specific earth stations filed under 9.7A and 9.7B of the ITU Radio Regulations through other administrations. O3b has also completed coordination, according to US footnote 334 of the FCC table of frequency allocations, with the US government, and this US334 coordination agreement specifically takes into account O3b earth stations such as the Texas gateway.

## **Annex 1 - Representative Link Budgets**

The next 22 pages contain representative link budgets for communications transmissions to and from the Texas gateway earth station.

The three pages following the communications link budgets contain link budgets for the TT&C links that may be operated from the Texas gateway earth station.

## O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico

Link Budget Creator - Rev 3.2.9: March 26, 2013		Tier 1	Tier 1
Ground Parameter		Teleport	Telco
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	10837.9	9219.0
E/S Minimum Elevation to SV	(°)	21.4	44.8
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)		23
Minutes Into Pass (Sample #84)	(Min)		40:10
Telco Spot Beam Off-Angle	(°)		0.20
Telco Spot Beam Diameter	(km)		61.10
Maximum Roundtrip Latency	(msec)		133.81
Modulation Parameters		Forward	Return
Enter Receiver	Type	DVB-S2	
Modem Overhead	(%)	3.2%	
Number of Carriers per Channel	(#)	1	
Available Bandwidth	(Hz)	216,000,000	
Channel Symbol Rate	(sps)	180,000,000	
Channel Modulation Type		8PSK	
Channel FEC Rate		0.67	
Channel Spectral Efficiency	(bits/Sym)	2.00	
Channel Throughput (100% / 100% of Full Rate)	(bps)	348,418,491.48	
Uplink		Forward	Return
E/S Tx Channels per HPA	(#)	5	
E/S Tx Carrier Frequency	(MHz)	28,280	
E/S Tx HPA Power Level	(W)	500	
E/S Tx OBO	(dB)	-4.00	
E/S Tx Post-HPA Losses	(dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 4.5 m)	(dB)	64.90	
E/S Tx EIRP Per Channel	(dBW)	78.66	
E/S Tx Pointing Loss	(dB)	-0.50	
E/S Tx RF Link Availability	(%)	99.500	
E/S Tx Atmospheric Losses	(dB)	-15.92	
E/S Tx Spreading Loss	(dB)	-151.69	
Satellite		Forward	Return
SV Number of Channels per HPA	(#)	1	
SV Rx G/T	(dB/K)	5.40	
SV Rx Power Per Tier	(dBW)	-134.54	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-89.45	
SV Tx OBO (ALC / ALC)	(dB)	-3.80	
SV Tx Post-TWTA Losses	(dB)	-1.50	
SV Tx Antenna Gain	(dBi)	31.54	
SV Tx EIRP Per Channel/Carrier	(dBW)	44.37	
SV Tx Pointing Loss	(dB)	0.00	
Downlink		Forward	Return
E/S Rx Carrier Frequency	(MHz)	18,480	
E/S Rx Wavelength	(m)	0.016223	
E/S Rx RF Link Availability	(%)	99.500	
E/S Rx Atmospheric Losses	(dB)	-8.06	
E/S Rx Pointing Loss	(dB)	-0.50	
E/S Rx Antenna Gain (4.5 m / 7.3 m)	(dBi)	56.13	
E/S Rx Effective G/T	(dB/K)	30.03	
E/S Rx Power Per Channel	(dBW)	-105.14	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-114.48	
Total Link		Forward	Return
Carrier / Noise Bandwidth	(dB)	82.55	
Carrier / Noise Uplink	(dB)	11.51	
Carrier / Noise Downlink	(dB)	14.81	
Carrier / Intermodulation Im (C/Im)	(dB)	23.53	
(C/N) - Total Actual	(dB)	9.49	
(C/N) - Total Required	(dB)	8.20	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)	6.48	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)	5.19	
<b>Excess Margin</b>	<b>(dB)</b>	<b>1.29</b>	
<b>Fade Margin</b>	<b>(dB)</b>	<b>11.69</b>	

#1

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>	<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>	<b>Teleport</b>	<b>Telco</b>
Location	Vernon (LHCP), United States	Cozumel, Mexico
Latitude (°)	34.2	20.5
Longitude (East) (°)	260.7	273.1
E/S Maximum Range to SV (km)	10557.4	9006.2
E/S Minimum Elevation to SV (°)	24.8	49.0
E/S Altitude (km)	0.3	0.0
SV Beam Identifier (#)		23
Minutes Into Pass (Sample #74) (Min)		35:20
Telco Spot Beam Off-Angle (°)		0.20
Telco Spot Beam Diameter (km)		61.10
Maximum Roundtrip Latency (msec)		130.51
<b>Modulation Parameters</b>	<b>Forward</b>	<b>Return</b>
Enter Receiver Type		DVB-S2
Modem Overhead (%)		3.2%
Number of Carriers per Channel (#)		1
Available Bandwidth (Hz)		216,000,000
Channel Symbol Rate (sps)		180,000,000
Channel Modulation Type		8PSK
Channel FEC Rate		0.67
Channel Spectral Efficiency (bits/Sym)		2.00
Channel Throughput (100% / 100% of Full Rate) (bps)		348,418,491.48
<b>Uplink</b>	<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA (#)		1
E/S Tx Carrier Frequency (MHz)		28,280
E/S Tx HPA Power Level (W)		500
E/S Tx OBO (dB)		-4.50
E/S Tx Post-HPA Losses (dB)		-3.15
E/S Tx Antenna Gain (7.3 m / 4.5 m) (dB)		59.82
E/S Tx EIRP Per Channel (dBW)		79.16
E/S Tx Pointing Loss (dB)		-0.50
E/S Tx RF Link Availability (%)		99.500
E/S Tx Atmospheric Losses (dB)		-16.85
E/S Tx Spreading Loss (dB)		-150.08
<b>Satellite</b>	<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA (#)		5
SV Rx G/T (dB/K)		4.23
SV Rx Power Per Tier (dBW)		-134.52
SV Rx Flux Density Per Tier (dBW/m <sup>2</sup> )		-88.26
SV Tx OBO (ALC / ALC) (dB)		-5.80
SV Tx Post-TWTA Losses (dB)		-1.50
SV Tx Antenna Gain (dBi)		31.82
SV Tx EIRP Per Channel/Carrier (dBW)		35.66
SV Tx Pointing Loss (dB)		0.00
<b>Downlink</b>	<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency (MHz)		18,480
E/S Rx Spreading Loss (dB)		-151.46
E/S Rx RF Link Availability (%)		99.500
E/S Rx Atmospheric Losses (dB)		-6.28
E/S Rx Pointing Loss (dB)		-0.50
E/S Rx Antenna Gain (4.5 m / 7.3 m) (dBi)		62.04
E/S Rx Effective G/T (dB/K)		36.74
E/S Rx Power Per Channel (dBW)		-107.33
E/S Rx Flux Density Per Channel (dBW/m <sup>2</sup> )		-122.58
<b>Total Link</b>	<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth (dB)		82.55
Carrier / Noise Uplink (dB)		11.53
Carrier / Noise Downlink (dB)		13.42
Carrier / Intermodulation Im (C/Im) (dB)		23.22
(C/N) - Total Actual (dB)		8.85
(C/N) - Total Required (dB)		8.20
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual (dB)		5.84
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required (dB)		5.19
<b>Excess Margin (dB)</b>		<b>0.65</b>
<b>Fade Margin (dB)</b>		<b>11.05</b>

#2



<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>			
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>		<b>Teleport</b>	<b>Telco</b>
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	10480.9	8954.4
E/S Minimum Elevation to SV	(°)	25.7	50.1
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)		23
Minutes Into Pass (Sample #71)	(Min)		33:53
Telco Spot Beam Off-Angle	(°)		0.20
Telco Spot Beam Diameter	(km)		61.10
Maximum Roundtrip Latency	(msec)		129.66
<b>Modulation Parameters</b>		<b>Forward</b>	<b>Return</b>
Enter Receiver	Type	DVB-S2	
Modem Overhead	(%)	3.3%	
Number of Carriers per Channel	(#)	1	
Available Bandwidth	(Hz)	216,000,000	
Channel Symbol Rate	(sps)	180,000,000	
Channel Modulation Type		32APSK	
Channel FEC Rate		0.83	
Channel Spectral Efficiency	(bits/Sym)	4.17	
Channel Throughput (100% / 100% of Full Rate)	(bps)	725,506,072.87	
<b>Uplink</b>		<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA	(#)	5	
E/S Tx Carrier Frequency	(MHz)	28,280	
E/S Tx HPA Power Level	(W)	500	
E/S Tx OBO	(dB)	-4.00	
E/S Tx Post-HPA Losses	(dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 4.5 m)	(dB)	64.90	
E/S Tx EIRP Per Channel	(dBW)	78.66	
E/S Tx Pointing Loss	(dB)	-0.50	
E/S Tx RF Link Availability	(%)	75.000	
E/S Tx Atmospheric Losses	(dB)	-1.44	
E/S Tx Spreading Loss	(dB)	-151.40	
<b>Satellite</b>		<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA	(#)	1	
SV Rx G/T	(dB/K)	5.32	
SV Rx Power Per Tier	(dBW)	-119.85	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-74.68	
SV Tx OBO (ALC / ALC)	(dB)	-3.80	
SV Tx Post-TWTA Losses	(dB)	-1.50	
SV Tx Antenna Gain	(dBi)	31.47	
SV Tx EIRP Per Channel/Carrier	(dBW)	44.30	
SV Tx Pointing Loss	(dB)	0.00	
<b>Downlink</b>		<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency	(MHz)	18,480	
E/S Rx Wavelength	(m)	0.016223	
E/S Rx RF Link Availability	(%)	70.000	
E/S Rx Atmospheric Losses	(dB)	-0.73	
E/S Rx Pointing Loss	(dB)	-0.50	
E/S Rx Antenna Gain (4.5 m / 7.3 m)	(dBi)	56.13	
E/S Rx Effective G/T	(dB/K)	32.16	
E/S Rx Power Per Channel	(dBW)	-97.62	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-106.96	
<b>Total Link</b>		<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth	(dB)	82.55	
Carrier / Noise Uplink	(dB)	26.20	
Carrier / Noise Downlink	(dB)	24.46	
Carrier / Intermodulation Im (C/Im)	(dB)	23.53	
(C/N) - Total Actual	(dB)	18.23	
(C/N) - Total Required	(dB)	16.60	
(E <sub>v</sub> /N <sub>0</sub> ) - Total Actual	(dB)	12.03	
(E <sub>v</sub> /N <sub>0</sub> ) - Total Required	(dB)	10.40	
<b>Excess Margin</b>	<b>(dB)</b>	<b>1.63</b>	
<b>Fade Margin</b>	<b>(dB)</b>	<b>20.43</b>	

#3

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>	<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>	<b>Teleport</b>	<b>Telco</b>
Location	Vernon (LHCP), United States	Cozumel, Mexico
Latitude (°)	34.2	20.5
Longitude (East) (°)	260.7	273.1
E/S Maximum Range to SV (km)	10156.8	8784.3
E/S Minimum Elevation to SV (°)	30.0	54.0
E/S Altitude (km)	0.3	0.0
SV Beam Identifier (#)		23
Minutes Into Pass (Sample #56) (Min)		26:37
Telco Spot Beam Off-Angle (°)		0.20
Telco Spot Beam Diameter (km)		61.10
Maximum Roundtrip Latency (msec)		126.36
<b>Modulation Parameters</b>	<b>Forward</b>	<b>Return</b>
Enter Receiver Type		DVB-S2
Modem Overhead (%)		3.3%
Number of Carriers per Channel (#)		1
Available Bandwidth (Hz)		216,000,000
Channel Symbol Rate (sps)		180,000,000
Channel Modulation Type		32APSK
Channel FEC Rate		0.83
Channel Spectral Efficiency (bits/Sym)		4.17
Channel Throughput (100% / 100% of Full Rate) (bps)		725,506,072.87
<b>Uplink</b>	<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA (#)		1
E/S Tx Carrier Frequency (MHz)		28,280
E/S Tx HPA Power Level (W)		500
E/S Tx OBO (dB)		-4.50
E/S Tx Post-HPA Losses (dB)		-3.15
E/S Tx Antenna Gain (7.3 m / 4.5 m) (dB)		59.82
E/S Tx EIRP Per Channel (dBW)		79.16
E/S Tx Pointing Loss (dB)		-0.50
E/S Tx RF Link Availability (%)		70.000
E/S Tx Atmospheric Losses (dB)		-1.29
E/S Tx Spreading Loss (dB)		-149.87
<b>Satellite</b>	<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA (#)		5
SV Rx G/T (dB/K)		4.12
SV Rx Power Per Tier (dBW)		-118.85
SV Rx Flux Density Per Tier (dBW/m <sup>2</sup> )		-72.49
SV Tx OBO (ALC / ALC) (dB)		-5.80
SV Tx Post-TWTA Losses (dB)		-1.50
SV Tx Antenna Gain (dB)		31.80
SV Tx EIRP Per Channel/Carrier (dBW)		35.64
SV Tx Pointing Loss (dB)		0.00
<b>Downlink</b>	<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency (MHz)		18,480
E/S Rx Spreading Loss (dB)		-151.13
E/S Rx RF Link Availability (%)		75.000
E/S Rx Atmospheric Losses (dB)		-0.75
E/S Rx Pointing Loss (dB)		-0.50
E/S Rx Antenna Gain (4.5 m / 7.3 m) (dBi)		62.04
E/S Rx Effective G/T (dB/K)		38.69
E/S Rx Power Per Channel (dBW)		-101.49
E/S Rx Flux Density Per Channel (dBW/m <sup>2</sup> )		-116.74
<b>Total Link</b>	<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth (dB)		82.55
Carrier / Noise Uplink (dB)		27.19
Carrier / Noise Downlink (dB)		21.21
Carrier / Intermodulation Im (C/Im) (dB)		23.22
(C/N) - Total Actual (dB)		17.60
(C/N) - Total Required (dB)		16.60
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual (dB)		11.40
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required (dB)		10.40
<b>Excess Margin (dB)</b>		<b>1.00</b>
<b>Fade Margin (dB)</b>		<b>19.80</b>

#4

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>			
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>		<b>Teleport</b>	<b>Telco</b>
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	10929.1	9294.3
E/S Minimum Elevation to SV	(°)	20.3	43.4
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)		23
Minutes Into Pass (Sample #87)	(Min)		41:37
Telco Spot Beam Off-Angle	(°)		0.20
Telco Spot Beam Diameter	(km)		61.10
Maximum Roundtrip Latency	(msec)		134.92
<b>Modulation Parameters</b>		<b>Forward</b>	<b>Return</b>
Enter Receiver	Type	DVB-S2	
Modem Overhead	(%)	4.3%	
Number of Carriers per Channel	(#)	1	
Available Bandwidth	(Hz)	216,000,000	
Channel Symbol Rate	(sps)	180,000,000	
Channel Modulation Type		QPSK	
Channel FEC Rate		0.25	
Channel Spectral Efficiency	(bits/Sym)	0.50	
Channel Throughput (100% / 100% of Full Rate)	(bps)	86,143,861.55	
<b>Uplink</b>		<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA	(#)	5	
E/S Tx Carrier Frequency	(MHz)	28,280	
E/S Tx HPA Power Level	(W)	500	
E/S Tx OBO	(dB)	-4.00	
E/S Tx Post-HPA Losses	(dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 4.5 m)	(dB)	64.90	
E/S Tx EIRP Per Channel	(dBW)	78.66	
E/S Tx Pointing Loss	(dB)	-0.50	
E/S Tx RF Link Availability	(%)	99.800	
E/S Tx Atmospheric Losses	(dB)	-26.27	
E/S Tx Spreading Loss	(dB)	-151.76	
<b>Satellite</b>		<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA	(#)	1	
SV Rx G/T	(dB/K)	5.40	
SV Rx Power Per Tier	(dBW)	-144.96	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-99.88	
SV Tx OBO (ALC / ALC)	(dB)	-3.80	
SV Tx Post-TWTA Losses	(dB)	-1.50	
SV Tx Antenna Gain	(dBi)	31.54	
SV Tx EIRP Per Channel/Carrier	(dBW)	44.37	
SV Tx Pointing Loss	(dB)	0.00	
<b>Downlink</b>		<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency	(MHz)	18,480	
E/S Rx Wavelength	(m)	0.016223	
E/S Rx RF Link Availability	(%)	99.850	
E/S Rx Atmospheric Losses	(dB)	-14.38	
E/S Rx Pointing Loss	(dB)	-0.50	
E/S Rx Antenna Gain (4.5 m / 7.3 m)	(dBi)	56.13	
E/S Rx Effective G/T	(dB/K)	29.49	
E/S Rx Power Per Channel	(dBW)	-111.53	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-120.87	
<b>Total Link</b>		<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth	(dB)	82.55	
Carrier / Noise Uplink	(dB)	1.08	
Carrier / Noise Downlink	(dB)	7.88	
Carrier / Intermodulation Im (C/Im)	(dB)	23.53	
(C/N) - Total Actual	(dB)	0.22	
(C/N) - Total Required	(dB)	-2.20	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)	3.23	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)	0.81	
<b>Excess Margin</b>	<b>(dB)</b>	<b>2.42</b>	
<b>Fade Margin</b>	<b>(dB)</b>	<b>2.42</b>	

#5

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>	<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>	<b>Teleport</b>	<b>Telco</b>
Location	Vernon (LHCP), United States	Cozumel, Mexico
Latitude (°)	34.2	20.5
Longitude (East) (°)	260.7	273.1
E/S Maximum Range to SV (km)	10929.1	9294.3
E/S Minimum Elevation to SV (°)	20.3	43.4
E/S Altitude (km)	0.3	0.0
SV Beam Identifier (#)		23
Minutes Into Pass (Sample #87) (Min)		41:37
Telco Spot Beam Off-Angle (°)		0.20
Telco Spot Beam Diameter (km)		61.10
Maximum Roundtrip Latency (msec)		134.92
<b>Modulation Parameters</b>	<b>Forward</b>	<b>Return</b>
Enter Receiver Type		DVB-S2
Modem Overhead (%)		4.3%
Number of Carriers per Channel (#)		1
Available Bandwidth (Hz)		216,000,000
Channel Symbol Rate (sps)		180,000,000
Channel Modulation Type		QPSK
Channel FEC Rate		0.25
Channel Spectral Efficiency (bits/Sym)		0.50
Channel Throughput (100% / 100% of Full Rate) (bps)		86,143,861.55
<b>Uplink</b>	<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA (#)		1
E/S Tx Carrier Frequency (MHz)		28,280
E/S Tx HPA Power Level (W)		500
E/S Tx OBO (dB)		-4.50
E/S Tx Post-HPA Losses (dB)		-3.15
E/S Tx Antenna Gain (7.3 m / 4.5 m) (dB)		59.82
E/S Tx EIRP Per Channel (dBW)		79.16
E/S Tx Pointing Loss (dB)		-0.50
E/S Tx RF Link Availability (%)		99.850
E/S Tx Atmospheric Losses (dB)		-29.44
E/S Tx Spreading Loss (dB)		-150.36
<b>Satellite</b>	<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA (#)		5
SV Rx G/T (dB/K)		4.34
SV Rx Power Per Tier (dBW)		-147.28
SV Rx Flux Density Per Tier (dBW/m <sup>2</sup> )		-101.13
SV Tx OBO (ALC / ALC) (dB)		-5.80
SV Tx Post-TWTA Losses (dB)		-1.50
SV Tx Antenna Gain (dBi)		31.82
SV Tx EIRP Per Channel/Carrier (dBW)		35.66
SV Tx Pointing Loss (dB)		0.00
<b>Downlink</b>	<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency (MHz)		18,480
E/S Rx Spreading Loss (dB)		-151.76
E/S Rx RF Link Availability (%)		99.800
E/S Rx Atmospheric Losses (dB)		-13.05
E/S Rx Pointing Loss (dB)		-0.50
E/S Rx Antenna Gain (4.5 m / 7.3 m) (dBi)		62.04
E/S Rx Effective G/T (dB/K)		35.87
E/S Rx Power Per Channel (dBW)		-114.41
E/S Rx Flux Density Per Channel (dBW/m <sup>2</sup> )		-129.65
<b>Total Link</b>	<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth (dB)		82.55
Carrier / Noise Uplink (dB)		-1.23
Carrier / Noise Downlink (dB)		5.47
Carrier / Intermodulation Im (C/Im) (dB)		23.22
(C/N) - Total Actual (dB)		-2.11
(C/N) - Total Required (dB)		-2.20
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual (dB)		0.90
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required (dB)		0.81
<b>Excess Margin (dB)</b>		<b>0.09</b>
<b>Fade Margin (dB)</b>		<b>0.09</b>

#6

### O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico

Link Budget Creator - Rev 3.2.9: March 26, 2013			Tier 1	Tier 1
Ground Parameter			Teleport	Telco
Location			Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)		34.2	20.5
Longitude (East)	(°)		260.7	273.1
E/S Maximum Range to SV	(km)		10837.9	9219.0
E/S Minimum Elevation to SV	(°)		21.4	44.8
E/S Altitude	(km)		0.3	0.0
SV Beam Identifier	(#)		23	
Minutes Into Pass (Sample #84)	(Min)		40:10	
Telco Spot Beam Off-Angle	(°)		0.20	
Telco Spot Beam Diameter	(km)		61.10	
Maximum Roundtrip Latency	(msec)		133.81	
Modulation Parameters			Forward	Return
Enter Receiver	Type		DVB-S2	
Modem Overhead	(%)		3.2%	
Number of Carriers per Channel	(#)		1	
Available Bandwidth	(Hz)		216,000,000	
Channel Symbol Rate	(sps)		180,000,000	
Channel Modulation Type			QPSK	
Channel FEC Rate			0.67	
Channel Spectral Efficiency	(bits/Sym)		1.33	
Channel Throughput (100% / 100% of Full Rate)	(bps)		232,341,806.38	
Uplink			Forward	Return
E/S Tx Channels per HPA	(#)		5	
E/S Tx Carrier Frequency	(MHz)		28,280	
E/S Tx HPA Power Level	(W)		500	
E/S Tx OBO	(dB)		-4.00	
E/S Tx Post-HPA Losses	(dB)		-2.24	
E/S Tx Antenna Gain (7.3 m / 4.5 m)	(dB)		64.90	
E/S Tx EIRP Per Channel	(dBW)		78.66	
E/S Tx Pointing Loss	(dB)		-0.50	
E/S Tx RF Link Availability	(%)		99.700	
E/S Tx Atmospheric Losses	(dB)		-20.73	
E/S Tx Spreading Loss	(dB)		-151.69	
Satellite			Forward	Return
SV Number of Channels per HPA	(#)		1	
SV Rx G/T	(dB/K)		5.40	
SV Rx Power Per Tier	(dBW)		-139.34	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )		-94.26	
SV Tx OBO (ALC / ALC)	(dB)		-3.80	
SV Tx Post-TWTA Losses	(dB)		-1.50	
SV Tx Antenna Gain	(dBi)		31.54	
SV Tx EIRP Per Channel/Carrier	(dBW)		44.37	
SV Tx Pointing Loss	(dB)		0.00	
Downlink			Forward	Return
E/S Rx Carrier Frequency	(MHz)		18,480	
E/S Rx Wavelength	(m)		0.016223	
E/S Rx RF Link Availability	(%)		99.700	
E/S Rx Atmospheric Losses	(dB)		-10.42	
E/S Rx Pointing Loss	(dB)		-0.50	
E/S Rx Antenna Gain (4.5 m / 7.3 m)	(dBi)		56.13	
E/S Rx Effective G/T	(dB/K)		29.74	
E/S Rx Power Per Channel	(dBW)		-107.50	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )		-116.83	
Total Link			Forward	Return
Carrier / Noise Bandwidth	(dB)		82.55	
Carrier / Noise Uplink	(dB)		6.70	
Carrier / Noise Downlink	(dB)		12.17	
Carrier / Intermodulation Im (C/Im)	(dB)		23.53	
(C/N) - Total Actual	(dB)		5.48	
(C/N) - Total Required	(dB)		4.80	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)		4.23	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)		3.55	
<b>Excess Margin</b>	<b>(dB)</b>		<b>0.68</b>	
<b>Fade Margin</b>	<b>(dB)</b>		<b>7.68</b>	

#7

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>			
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>		<b>Teleport</b>	<b>Telco</b>
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	10583.8	9024.7
E/S Minimum Elevation to SV	(°)	24.4	48.6
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)		23
Minutes Into Pass (Sample #75)	(Min)		35:49
Telco Spot Beam Off-Angle	(°)		0.20
Telco Spot Beam Diameter	(km)		61.10
Maximum Roundtrip Latency	(msec)		130.81
<b>Modulation Parameters</b>		<b>Forward</b>	<b>Return</b>
Enter Receiver	Type		DVB-S2
Modem Overhead	(%)		3.2%
Number of Carriers per Channel	(#)		1
Available Bandwidth	(Hz)		216,000,000
Channel Symbol Rate	(sps)		180,000,000
Channel Modulation Type			QPSK
Channel FEC Rate			0.67
Channel Spectral Efficiency	(bits/Sym)		1.33
Channel Throughput (100% / 100% of Full Rate)	(bps)		232,341,806.38
<b>Uplink</b>		<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA	(#)		1
E/S Tx Carrier Frequency	(MHz)		28,280
E/S Tx HPA Power Level	(W)		500
E/S Tx OBO	(dB)		-4.50
E/S Tx Post-HPA Losses	(dB)		-3.15
E/S Tx Antenna Gain (7.3 m / 4.5 m)	(dBi)		59.82
E/S Tx EIRP Per Channel	(dBW)		79.16
E/S Tx Pointing Loss	(dB)		-0.50
E/S Tx RF Link Availability	(%)		99.700
E/S Tx Atmospheric Losses	(dB)		-21.67
E/S Tx Spreading Loss	(dB)		-150.10
<b>Satellite</b>		<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA	(#)		5
SV Rx G/T	(dB/K)		4.23
SV Rx Power Per Tier	(dBW)		-139.36
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )		-93.10
SV Tx OBO (ALC / ALC)	(dB)		-5.80
SV Tx Post-TWTA Losses	(dB)		-1.50
SV Tx Antenna Gain	(dBi)		31.82
SV Tx EIRP Per Channel/Carrier	(dBW)		35.66
SV Tx Pointing Loss	(dB)		0.00
<b>Downlink</b>		<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency	(MHz)		18,480
E/S Rx Spreading Loss	(dB)		-151.48
E/S Rx RF Link Availability	(%)		99.700
E/S Rx Atmospheric Losses	(dB)		-8.15
E/S Rx Pointing Loss	(dB)		-0.50
E/S Rx Antenna Gain (4.5 m / 7.3 m)	(dBi)		62.04
E/S Rx Effective G/T	(dB/K)		36.37
E/S Rx Power Per Channel	(dBW)		-109.22
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )		-124.47
<b>Total Link</b>		<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth	(dB)		82.55
Carrier / Noise Uplink	(dB)		6.69
Carrier / Noise Downlink	(dB)		11.16
Carrier / Intermodulation Im (C/Im)	(dB)		23.22
(C/N) - Total Actual	(dB)		5.15
(C/N) - Total Required	(dB)		4.80
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)		3.90
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)		3.55
<b>Excess Margin</b>	<b>(dB)</b>		<b>0.35</b>
<b>Fade Margin</b>	<b>(dB)</b>		<b>7.35</b>

#8

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>			
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>		<b>Teleport</b>	<b>Telco</b>
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	10778.8	9171.7
E/S Minimum Elevation to SV	(°)	22.1	45.7
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)		23
Minutes Into Pass (Sample #82)	(Min)		39:12
Telco Spot Beam Off-Angle	(°)		0.20
Telco Spot Beam Diameter	(km)		61.10
Maximum Roundtrip Latency	(msec)		133.10
<b>Modulation Parameters</b>		<b>Forward</b>	<b>Return</b>
Enter Receiver	Type	DVB-S2	
Modem Overhead	(%)	3.5%	
Number of Carriers per Channel	(#)	1	
Available Bandwidth	(Hz)	216,000,000	
Channel Symbol Rate	(sps)	180,000,000	
Channel Modulation Type		16APSK	
Channel FEC Rate		0.75	
Channel Spectral Efficiency	(bits/Sym)	3.00	
Channel Throughput (100% / 100% of Full Rate)	(bps)	521,337,648.33	
<b>Uplink</b>		<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA	(#)	5	
E/S Tx Carrier Frequency	(MHz)	28,280	
E/S Tx HPA Power Level	(W)	500	
E/S Tx OBO	(dB)	-4.00	
E/S Tx Post-HPA Losses	(dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 4.5 m)	(dB)	64.90	
E/S Tx EIRP Per Channel	(dBW)	78.66	
E/S Tx Pointing Loss	(dB)	-0.50	
E/S Tx RF Link Availability	(%)	99.300	
E/S Tx Atmospheric Losses	(dB)	-12.63	
E/S Tx Spreading Loss	(dB)	-151.64	
<b>Satellite</b>		<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA	(#)	1	
SV Rx G/T	(dB/K)	5.40	
SV Rx Power Per Tier	(dBW)	-131.20	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-86.11	
SV Tx OBO (ALC / ALC)	(dB)	-3.80	
SV Tx Post-TWTA Losses	(dB)	-1.50	
SV Tx Antenna Gain	(dBi)	31.50	
SV Tx EIRP Per Channel/Carrier	(dBW)	44.33	
SV Tx Pointing Loss	(dB)	0.00	
<b>Downlink</b>		<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency	(MHz)	18,480	
E/S Rx Wavelength	(m)	0.016223	
E/S Rx RF Link Availability	(%)	98.000	
E/S Rx Atmospheric Losses	(dB)	-3.72	
E/S Rx Pointing Loss	(dB)	-0.50	
E/S Rx Antenna Gain (4.5 m / 7.3 m)	(dBi)	56.13	
E/S Rx Effective G/T	(dB/K)	31.05	
E/S Rx Power Per Channel	(dBW)	-100.79	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-110.13	
<b>Total Link</b>		<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth	(dB)	82.55	
Carrier / Noise Uplink	(dB)	14.85	
Carrier / Noise Downlink	(dB)	20.17	
Carrier / Intermodulation Im (C/Im)	(dB)	23.53	
(C/N) - Total Actual	(dB)	12.90	
(C/N) - Total Required	(dB)	12.30	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)	8.13	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)	7.53	
<b>Excess Margin</b>	<b>(dB)</b>	<b>0.60</b>	
<b>Fade Margin</b>	<b>(dB)</b>	<b>15.10</b>	

#9

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 1</b>
<b>Ground Parameter</b>		<b>Tier 1</b>
		<b>Teleport</b>
		<b>Telco</b>
Location		Vernon (LHCP), United States
Latitude (°)		Cozumel, Mexico
Longitude (East) (°)		20.5
E/S Maximum Range to SV (km)		273.1
E/S Minimum Elevation to SV (°)		8938.4
E/S Altitude (km)		26.0
SV Beam Identifier (#)		0.3
Minutes Into Pass (Sample #70) (Min)		23
Telco Spot Beam Off-Angle (°)		33:23
Telco Spot Beam Diameter (km)		0.20
Maximum Roundtrip Latency (msec)		61.10
		129.39
<b>Modulation Parameters</b>		<b>Forward</b>
Enter Receiver Type		<b>Return</b>
Modem Overhead (%)		DVB-S2
Number of Carriers per Channel (#)		3.5%
Available Bandwidth (Hz)		1
Channel Symbol Rate (sps)		216,000,000
Channel Modulation Type		180,000,000
Channel FEC Rate		16APSK
Channel Spectral Efficiency (bits/Sym)		0.75
Channel Throughput (100% / 100% of Full Rate) (bps)		3.00
		521,337,648.33
<b>Uplink</b>		<b>Forward</b>
E/S Tx Channels per HPA (#)		<b>Return</b>
E/S Tx Carrier Frequency (MHz)		1
E/S Tx HPA Power Level (W)		28,280
E/S Tx OBO (dB)		500
E/S Tx Post-HPA Losses (dB)		-4.50
E/S Tx Antenna Gain (7.3 m / 4.5 m) (dB)		-3.15
E/S Tx EIRP Per Channel (dBW)		59.82
E/S Tx Pointing Loss (dB)		79.16
E/S Tx RF Link Availability (%)		-0.50
E/S Tx Atmospheric Losses (dB)		98.000
E/S Tx Spreading Loss (dB)		-7.65
		-150.02
<b>Satellite</b>		<b>Forward</b>
SV Number of Channels per HPA (#)		<b>Return</b>
SV Rx G/T (dB/K)		5
SV Rx Power Per Tier (dBW)		4.12
SV Rx Flux Density Per Tier (dBW/m <sup>2</sup> )		-125.37
SV Tx OBO (ALC / ALC) (dB)		-79.00
SV Tx Post-TWTA Losses (dB)		-5.80
SV Tx Antenna Gain (dBi)		-1.50
SV Tx EIRP Per Channel/Carrier (dBW)		31.80
SV Tx Pointing Loss (dB)		35.64
		0.00
<b>Downlink</b>		<b>Forward</b>
E/S Rx Carrier Frequency (MHz)		<b>Return</b>
E/S Rx Spreading Loss (dB)		18,480
E/S Rx RF Link Availability (%)		-151.38
E/S Rx Atmospheric Losses (dB)		99.300
E/S Rx Pointing Loss (dB)		-5.14
E/S Rx Antenna Gain (4.5 m / 7.3 m) (dBi)		-0.50
E/S Rx Effective G/T (dB/K)		62.04
E/S Rx Power Per Channel (dBW)		37.03
E/S Rx Flux Density Per Channel (dBW/m <sup>2</sup> )		-106.13
		-121.38
<b>Total Link</b>		<b>Forward</b>
Carrier / Noise Bandwidth (dB)		<b>Return</b>
Carrier / Noise Uplink (dB)		82.55
Carrier / Noise Downlink (dB)		20.68
Carrier / Intermodulation Im (C/Im) (dB)		14.90
(C/N) - Total Actual (dB)		23.22
(C/N) - Total Required (dB)		12.54
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual (dB)		12.30
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required (dB)		7.77
		7.53
<b>Excess Margin (dB)</b>		<b>0.24</b>
<b>Fade Margin (dB)</b>		<b>14.74</b>

#10



<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>	<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>	<b>Teleport</b>	<b>Telco</b>
Location	Vernon (LHCP), United States	Cozumel, Mexico
Latitude (°)	34.2	20.5
Longitude (East) (°)	260.7	273.1
E/S Maximum Range to SV (km)	10721.2	9126.7
E/S Minimum Elevation to SV (°)	22.8	46.6
E/S Altitude (km)	0.3	0.0
SV Beam Identifier (#)		24
Minutes Into Pass (Sample #80) (Min)		38:14
Telco Spot Beam Off-Angle (°)		0.20
Telco Spot Beam Diameter (km)		61.10
Maximum Roundtrip Latency (msec)		132.41
<b>Modulation Parameters</b>	<b>Forward</b>	<b>Return</b>
Enter Receiver Type	DVB-S2	
Modem Overhead (%)	3.5%	
Number of Carriers per Channel (#)	1	
Available Bandwidth (Hz)	39,960,000	
Channel Symbol Rate (sps)	33,300,000	
Channel Modulation Type	16APSK	
Channel FEC Rate	0.75	
Channel Spectral Efficiency (bits/Sym)	3.00	
Channel Throughput (100% / 100% of Full Rate) (bps)	96,447,464.94	
<b>Uplink</b>	<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA (#)	5	
E/S Tx Carrier Frequency (MHz)	28,709	
E/S Tx HPA Power Level (W)	93	
E/S Tx OBO (dB)	-4.00	
E/S Tx Post-HPA Losses (dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 4.5 m) (dB)	65.03	
E/S Tx EIRP Per Channel (dBW)	71.46	
E/S Tx Pointing Loss (dB)	-0.50	
E/S Tx RF Link Availability (%)	99.400	
E/S Tx Atmospheric Losses (dB)	-13.57	
E/S Tx Spreading Loss (dB)	-151.60	
<b>Satellite</b>	<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA (#)	1	
SV Rx G/T (dB/K)	5.40	
SV Rx Power Per Tier (dBW)	-139.43	
SV Rx Flux Density Per Tier (dBW/m <sup>2</sup> )	-94.21	
SV Tx OBO (ALC / ALC) (dB)	-3.80	
SV Tx Post-TWTA Losses (dB)	-1.50	
SV Tx Antenna Gain (dB)	31.50	
SV Tx EIRP Per Channel/Carrier (dBW)	44.33	
SV Tx Pointing Loss (dB)	0.00	
<b>Downlink</b>	<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency (MHz)	18,909	
E/S Rx Wavelength (m)	0.015854	
E/S Rx RF Link Availability (%)	99.500	
E/S Rx Atmospheric Losses (dB)	-8.40	
E/S Rx Pointing Loss (dB)	-0.50	
E/S Rx Antenna Gain (4.5 m / 7.3 m) (dBi)	56.33	
E/S Rx Effective G/T (dB/K)	30.19	
E/S Rx Power Per Channel (dBW)	-105.43	
E/S Rx Flux Density Per Channel (dBW/m <sup>2</sup> )	-114.77	
<b>Total Link</b>	<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth (dB)	75.22	
Carrier / Noise Uplink (dB)	13.95	
Carrier / Noise Downlink (dB)	21.81	
Carrier / Intermodulation Im (C/Im) (dB)	23.53	
(C/N) - Total Actual (dB)	12.54	
(C/N) - Total Required (dB)	12.30	
(E <sub>v</sub> /N <sub>0</sub> ) - Total Actual (dB)	7.77	
(E <sub>v</sub> /N <sub>0</sub> ) - Total Required (dB)	7.53	
<b>Excess Margin (dB)</b>	<b>0.24</b>	
<b>Fade Margin (dB)</b>	<b>14.74</b>	

#11

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>	<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>	<b>Teleport</b>	<b>Telco</b>
Location	Vernon (LHCP), United States	Cozumel, Mexico
Latitude (°)	34.2	20.5
Longitude (East) (°)	260.7	273.1
E/S Maximum Range to SV (km)	11153.5	9489.0
E/S Minimum Elevation to SV (°)	17.8	40.0
E/S Altitude (km)	0.3	0.0
SV Beam Identifier (#)		24
Minutes Into Pass (Sample #94) (Min)		45:1
Telco Spot Beam Off-Angle (°)		0.20
Telco Spot Beam Diameter (km)		61.10
Maximum Roundtrip Latency (msec)		137.71
<b>Modulation Parameters</b>	<b>Forward</b>	<b>Return</b>
Enter Receiver Type		DVB-S2
Modem Overhead (%)		3.5%
Number of Carriers per Channel (#)		1
Available Bandwidth (Hz)		39,960,000
Channel Symbol Rate (sps)		33,300,000
Channel Modulation Type		16APSK
Channel FEC Rate		0.75
Channel Spectral Efficiency (bits/Sym)		3.00
Channel Throughput (100% / 100% of Full Rate) (bps)		96,447,464.94
<b>Uplink</b>	<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA (#)		1
E/S Tx Carrier Frequency (MHz)		28,709
E/S Tx HPA Power Level (W)		500
E/S Tx OBO (dB)		-4.50
E/S Tx Post-HPA Losses (dB)		-3.15
E/S Tx Antenna Gain (7.3 m / 4.5 m) (dB)		59.96
E/S Tx EIRP Per Channel (dBW)		79.29
E/S Tx Pointing Loss (dB)		-0.50
E/S Tx RF Link Availability (%)		99.500
E/S Tx Atmospheric Losses (dB)		-18.45
E/S Tx Spreading Loss (dB)		-150.54
<b>Satellite</b>	<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA (#)		5
SV Rx G/T (dB/K)		4.34
SV Rx Power Per Tier (dBW)		-136.47
SV Rx Flux Density Per Tier (dBW/m <sup>2</sup> )		-90.19
SV Tx OBO (ALC / ALC) (dB)		-5.80
SV Tx Post-TWTA Losses (dB)		-1.50
SV Tx Antenna Gain (dB)		31.84
SV Tx EIRP Per Channel/Carrier (dBW)		35.68
SV Tx Pointing Loss (dB)		0.00
<b>Downlink</b>	<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency (MHz)		18,909
E/S Rx Spreading Loss (dB)		-151.94
E/S Rx RF Link Availability (%)		99.400
E/S Rx Atmospheric Losses (dB)		-9.09
E/S Rx Pointing Loss (dB)		-0.50
E/S Rx Antenna Gain (4.5 m / 7.3 m) (dBi)		62.24
E/S Rx Effective G/T (dB/K)		36.19
E/S Rx Power Per Channel (dBW)		-110.60
E/S Rx Flux Density Per Channel (dBW/m <sup>2</sup> )		-125.85
<b>Total Link</b>	<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth (dB)		75.22
Carrier / Noise Uplink (dB)		16.91
Carrier / Noise Downlink (dB)		16.73
Carrier / Intermodulation Im (C/Im) (dB)		23.22
(C/N) - Total Actual (dB)		12.93
(C/N) - Total Required (dB)		12.30
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual (dB)		8.15
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required (dB)		7.53
<b>Excess Margin (dB)</b>		<b>0.63</b>
<b>Fade Margin (dB)</b>		<b>15.13</b>

#12

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>			
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 1</b>	
<b>Ground Parameter</b>		<b>Teleport</b>	<b>Telco</b>
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	10583.8	9024.7
E/S Minimum Elevation to SV	(°)	24.4	48.6
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)		24
Minutes Into Pass (Sample #75)	(Min)		35:49
Telco Spot Beam Off-Angle	(°)		0.20
Telco Spot Beam Diameter	(km)		61.10
Maximum Roundtrip Latency	(msec)		130.81
<b>Modulation Parameters</b>		<b>Forward</b>	<b>Return</b>
Enter Receiver	Type	DVB-S2	
Modem Overhead	(%)	3.3%	
Number of Carriers per Channel	(#)	1	
Available Bandwidth	(Hz)	39,960,000	
Channel Symbol Rate	(sps)	33,300,000	
Channel Modulation Type		32APSK	
Channel FEC Rate		0.83	
Channel Spectral Efficiency	(bits/Sym)	4.17	
Channel Throughput (100% / 100% of Full Rate)	(bps)	134,218,623.48	
<b>Uplink</b>		<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA	(#)	5	
E/S Tx Carrier Frequency	(MHz)	28,709	
E/S Tx HPA Power Level	(W)	93	
E/S Tx OBO	(dB)	-4.00	
E/S Tx Post-HPA Losses	(dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 4.5 m)	(dB)	65.03	
E/S Tx EIRP Per Channel	(dBW)	71.46	
E/S Tx Pointing Loss	(dB)	-0.50	
E/S Tx RF Link Availability	(%)	98.000	
E/S Tx Atmospheric Losses	(dB)	-6.74	
E/S Tx Spreading Loss	(dB)	-151.48	
<b>Satellite</b>		<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA	(#)	1	
SV Rx G/T	(dB/K)	5.40	
SV Rx Power Per Tier	(dBW)	-132.48	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-87.26	
SV Tx OBO (ALC / ALC)	(dB)	-3.80	
SV Tx Post-TWTA Losses	(dB)	-1.50	
SV Tx Antenna Gain	(dBi)	31.50	
SV Tx EIRP Per Channel/Carrier	(dBW)	44.33	
SV Tx Pointing Loss	(dB)	0.00	
<b>Downlink</b>		<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency	(MHz)	18,909	
E/S Rx Wavelength	(m)	0.015854	
E/S Rx RF Link Availability	(%)	98.000	
E/S Rx Atmospheric Losses	(dB)	-3.86	
E/S Rx Pointing Loss	(dB)	-0.50	
E/S Rx Antenna Gain (4.5 m / 7.3 m)	(dBi)	56.33	
E/S Rx Effective G/T	(dB/K)	31.22	
E/S Rx Power Per Channel	(dBW)	-100.79	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-110.13	
<b>Total Link</b>		<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth	(dB)	75.22	
Carrier / Noise Uplink	(dB)	20.90	
Carrier / Noise Downlink	(dB)	27.48	
Carrier / Intermodulation Im (C/Im)	(dB)	23.53	
(C/N) - Total Actual	(dB)	17.27	
(C/N) - Total Required	(dB)	16.60	
(E <sub>v</sub> /N <sub>0</sub> ) - Total Actual	(dB)	11.07	
(E <sub>v</sub> /N <sub>0</sub> ) - Total Required	(dB)	10.40	
<b>Excess Margin</b>	<b>(dB)</b>	<b>0.67</b>	
<b>Fade Margin</b>	<b>(dB)</b>	<b>19.47</b>	

#13

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>	<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>	<b>Teleport</b>	<b>Telco</b>
Location	Vernon (LHCP), United States	Cozumel, Mexico
Latitude (°)	34.2	20.5
Longitude (East) (°)	260.7	273.1
E/S Maximum Range to SV (km)	10583.8	9024.7
E/S Minimum Elevation to SV (°)	24.4	48.6
E/S Altitude (km)	0.3	0.0
SV Beam Identifier (#)		24
Minutes Into Pass (Sample #75) (Min)		35:49
Telco Spot Beam Off-Angle (°)		0.20
Telco Spot Beam Diameter (km)		61.10
Maximum Roundtrip Latency (msec)		130.81
<b>Modulation Parameters</b>	<b>Forward</b>	<b>Return</b>
Enter Receiver Type		DVB-S2
Modem Overhead (%)		3.3%
Number of Carriers per Channel (#)		1
Available Bandwidth (Hz)		39,960,000
Channel Symbol Rate (sps)		33,300,000
Channel Modulation Type		32APSK
Channel FEC Rate		0.83
Channel Spectral Efficiency (bits/Sym)		4.17
Channel Throughput (100% / 100% of Full Rate) (bps)		134,218,623.48
<b>Uplink</b>	<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA (#)		1
E/S Tx Carrier Frequency (MHz)		28,709
E/S Tx HPA Power Level (W)		500
E/S Tx OBO (dB)		-4.50
E/S Tx Post-HPA Losses (dB)		-3.15
E/S Tx Antenna Gain (7.3 m / 4.5 m) (dB)		59.96
E/S Tx EIRP Per Channel (dBW)		79.29
E/S Tx Pointing Loss (dB)		-0.50
E/S Tx RF Link Availability (%)		98.000
E/S Tx Atmospheric Losses (dB)		-7.93
E/S Tx Spreading Loss (dB)		-150.10
<b>Satellite</b>	<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA (#)		5
SV Rx G/T (dB/K)		4.23
SV Rx Power Per Tier (dBW)		-125.62
SV Rx Flux Density Per Tier (dBW/m <sup>2</sup> )		-79.23
SV Tx OBO (ALC / ALC) (dB)		-5.80
SV Tx Post-TWTA Losses (dB)		-1.50
SV Tx Antenna Gain (dBi)		31.82
SV Tx EIRP Per Channel/Carrier (dBW)		35.66
SV Tx Pointing Loss (dB)		0.00
<b>Downlink</b>	<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency (MHz)		18,909
E/S Rx Spreading Loss (dB)		-151.48
E/S Rx RF Link Availability (%)		98.000
E/S Rx Atmospheric Losses (dB)		-3.54
E/S Rx Pointing Loss (dB)		-0.50
E/S Rx Antenna Gain (4.5 m / 7.3 m) (dBi)		62.24
E/S Rx Effective G/T (dB/K)		37.86
E/S Rx Power Per Channel (dBW)		-104.61
E/S Rx Flux Density Per Channel (dBW/m <sup>2</sup> )		-119.86
<b>Total Link</b>	<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth (dB)		75.22
Carrier / Noise Uplink (dB)		27.76
Carrier / Noise Downlink (dB)		24.38
Carrier / Intermodulation Im (C/Im) (dB)		23.22
(C/N) - Total Actual (dB)		18.14
(C/N) - Total Required (dB)		16.60
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual (dB)		11.94
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required (dB)		10.40
<b>Excess Margin (dB)</b>		<b>1.54</b>
<b>Fade Margin (dB)</b>		<b>20.34</b>

#14

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>			
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>		<b>Teleport</b>	<b>Telco</b>
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	10665.1	9084.1
E/S Minimum Elevation to SV	(°)	23.4	47.4
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)		24
Minutes Into Pass (Sample #78)	(Min)		37:16
Telco Spot Beam Off-Angle	(°)		0.20
Telco Spot Beam Diameter	(km)		61.10
Maximum Roundtrip Latency	(msec)		131.75
<b>Modulation Parameters</b>		<b>Forward</b>	<b>Return</b>
Enter Receiver	Type	DVB-S2	
Modem Overhead	(%)	4.3%	
Number of Carriers per Channel	(#)	1	
Available Bandwidth	(Hz)	39,960,000	
Channel Symbol Rate	(sps)	33,300,000	
Channel Modulation Type		QPSK	
Channel FEC Rate		0.25	
Channel Spectral Efficiency	(bits/Sym)	0.50	
Channel Throughput (100% / 100% of Full Rate)	(bps)	15,936,614.39	
<b>Uplink</b>		<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA	(#)	5	
E/S Tx Carrier Frequency	(MHz)	28,709	
E/S Tx HPA Power Level	(W)	93	
E/S Tx OBO	(dB)	-4.00	
E/S Tx Post-HPA Losses	(dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 1.5 m)	(dB)	65.03	
E/S Tx EIRP Per Channel	(dBW)	71.46	
E/S Tx Pointing Loss	(dB)	-0.50	
E/S Tx RF Link Availability	(%)	99.900	
E/S Tx Atmospheric Losses	(dB)	-28.28	
E/S Tx Spreading Loss	(dB)	-151.55	
<b>Satellite</b>		<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA	(#)	1	
SV Rx G/T	(dB/K)	5.40	
SV Rx Power Per Tier	(dBW)	-154.08	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-108.87	
SV Tx OBO (ALC / ALC)	(dB)	-3.80	
SV Tx Post-TWTA Losses	(dB)	-1.50	
SV Tx Antenna Gain	(dBi)	31.50	
SV Tx EIRP Per Channel/Carrier	(dBW)	44.33	
SV Tx Pointing Loss	(dB)	0.00	
<b>Downlink</b>		<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency	(MHz)	18,909	
E/S Rx Wavelength	(m)	0.015854	
E/S Rx RF Link Availability	(%)	99.700	
E/S Rx Atmospheric Losses	(dB)	-10.79	
E/S Rx Pointing Loss	(dB)	-0.50	
E/S Rx Antenna Gain (1.5 m / 7.3 m)	(dBi)	46.79	
E/S Rx Effective G/T	(dB/K)	20.37	
E/S Rx Power Per Channel	(dBW)	-117.32	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-117.12	
<b>Total Link</b>		<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth	(dB)	75.22	
Carrier / Noise Uplink	(dB)	-0.71	
Carrier / Noise Downlink	(dB)	9.64	
Carrier / Intermodulation Im (C/Im)	(dB)	23.53	
(C/N) - Total Actual	(dB)	-1.12	
(C/N) - Total Required	(dB)	-2.20	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)	1.89	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)	0.81	
<b>Excess Margin</b>	<b>(dB)</b>	<b>1.08</b>	
<b>Fade Margin</b>	<b>(dB)</b>	<b>1.08</b>	

#15

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>			
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>		<b>Teleport</b>	<b>Telco</b>
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	11186.8	9518.9
E/S Minimum Elevation to SV	(°)	17.4	39.5
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)		24
Minutes Into Pass (Sample #95)	(Min)		45:30
Telco Spot Beam Off-Angle	(°)		0.20
Telco Spot Beam Diameter	(km)		61.10
Maximum Roundtrip Latency	(msec)		138.13
<b>Modulation Parameters</b>		<b>Forward</b>	<b>Return</b>
Enter Receiver	Type		DVB-S2
Modem Overhead	(%)		4.3%
Number of Carriers per Channel	(#)		1
Available Bandwidth	(Hz)		39,960,000
Channel Symbol Rate	(sps)		33,300,000
Channel Modulation Type			QPSK
Channel FEC Rate			0.25
Channel Spectral Efficiency	(bits/Sym)		0.50
Channel Throughput (100% / 100% of Full Rate)	(bps)		15,936,614.39
<b>Uplink</b>		<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA	(#)		1
E/S Tx Carrier Frequency	(MHz)		28,709
E/S Tx HPA Power Level	(W)		500
E/S Tx OBO	(dB)		-4.50
E/S Tx Post-HPA Losses	(dB)		-3.15
E/S Tx Antenna Gain (7.3 m / 1.5 m)	(dB)		50.41
E/S Tx EIRP Per Channel	(dBW)		69.75
E/S Tx Pointing Loss	(dB)		-0.50
E/S Tx RF Link Availability	(%)		99.700
E/S Tx Atmospheric Losses	(dB)		-23.50
E/S Tx Spreading Loss	(dB)		-150.56
<b>Satellite</b>		<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA	(#)		5
SV Rx G/T	(dB/K)		4.43
SV Rx Power Per Tier	(dBW)		-150.99
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )		-104.81
SV Tx OBO (ALC / ALC)	(dB)		-5.80
SV Tx Post-TWTA Losses	(dB)		-1.50
SV Tx Antenna Gain	(dBi)		31.84
SV Tx EIRP Per Channel/Carrier	(dBW)		35.68
SV Tx Pointing Loss	(dB)		0.00
<b>Downlink</b>		<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency	(MHz)		18,909
E/S Rx Spreading Loss	(dB)		-151.97
E/S Rx RF Link Availability	(%)		99.900
E/S Rx Atmospheric Losses	(dB)		-20.76
E/S Rx Pointing Loss	(dB)		-0.50
E/S Rx Antenna Gain (1.5 m / 7.3 m)	(dBi)		62.24
E/S Rx Effective G/T	(dB/K)		35.59
E/S Rx Power Per Channel	(dBW)		-122.29
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )		-137.54
<b>Total Link</b>		<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth	(dB)		75.22
Carrier / Noise Uplink	(dB)		2.38
Carrier / Noise Downlink	(dB)		4.44
Carrier / Intermodulation Im (C/Im)	(dB)		23.22
(C/N) - Total Actual	(dB)		0.23
(C/N) - Total Required	(dB)		-2.20
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)		3.24
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)		0.81
<b>Excess Margin</b>	<b>(dB)</b>		<b>2.43</b>
<b>Fade Margin</b>	<b>(dB)</b>		<b>2.43</b>

#16

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>			
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>		<b>Teleport</b>	<b>Telco</b>
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	10837.9	9219.0
E/S Minimum Elevation to SV	(°)	21.4	44.8
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)		24
Minutes Into Pass (Sample #84)	(Min)		40:10
Telco Spot Beam Off-Angle	(°)		0.20
Telco Spot Beam Diameter	(km)		61.10
Maximum Roundtrip Latency	(msec)		133.81
<b>Modulation Parameters</b>		<b>Forward</b>	<b>Return</b>
Enter Receiver	Type	DVB-S2	
Modem Overhead	(%)	3.2%	
Number of Carriers per Channel	(#)	1	
Available Bandwidth	(Hz)	39,960,000	
Channel Symbol Rate	(sps)	33,300,000	
Channel Modulation Type		8PSK	
Channel FEC Rate		0.67	
Channel Spectral Efficiency	(bits/Sym)	2.00	
Channel Throughput (100% / 100% of Full Rate)	(bps)	64,457,420.92	
<b>Uplink</b>		<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA	(#)	5	
E/S Tx Carrier Frequency	(MHz)	28,709	
E/S Tx HPA Power Level	(W)	93	
E/S Tx OBO	(dB)	-4.00	
E/S Tx Post-HPA Losses	(dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 1.5 m)	(dB)	65.03	
E/S Tx EIRP Per Channel	(dBW)	71.46	
E/S Tx Pointing Loss	(dB)	-0.50	
E/S Tx RF Link Availability	(%)	99.500	
E/S Tx Atmospheric Losses	(dB)	-16.26	
E/S Tx Spreading Loss	(dB)	-151.69	
<b>Satellite</b>		<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA	(#)	1	
SV Rx G/T	(dB/K)	5.40	
SV Rx Power Per Tier	(dBW)	-142.21	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-96.99	
SV Tx OBO (ALC / ALC)	(dB)	-3.80	
SV Tx Post-TWTA Losses	(dB)	-1.50	
SV Tx Antenna Gain	(dBi)	31.54	
SV Tx EIRP Per Channel/Carrier	(dBW)	44.37	
SV Tx Pointing Loss	(dB)	0.00	
<b>Downlink</b>		<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency	(MHz)	18,909	
E/S Rx Wavelength	(m)	0.015854	
E/S Rx RF Link Availability	(%)	99.500	
E/S Rx Atmospheric Losses	(dB)	-8.54	
E/S Rx Pointing Loss	(dB)	-0.50	
E/S Rx Antenna Gain (1.5 m / 7.3 m)	(dBi)	46.79	
E/S Rx Effective G/T	(dB/K)	20.64	
E/S Rx Power Per Channel	(dBW)	-115.16	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-114.96	
<b>Total Link</b>		<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth	(dB)	75.22	
Carrier / Noise Uplink	(dB)	11.17	
Carrier / Noise Downlink	(dB)	12.07	
Carrier / Intermodulation Im (C/Im)	(dB)	23.53	
(C/N) - Total Actual	(dB)	8.32	
(C/N) - Total Required	(dB)	8.20	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)	5.31	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)	5.19	
<b>Excess Margin</b>	<b>(dB)</b>	<b>0.12</b>	
<b>Fade Margin</b>	<b>(dB)</b>	<b>10.52</b>	

#17

<b>O3b Network Link Analysis - Tier 1 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>	<b>Tier 1</b>	<b>Tier 1</b>
<b>Ground Parameter</b>	<b>Teleport</b>	<b>Telco</b>
Location	Vernon (LHCP), United States	Cozumel, Mexico
Latitude (°)	34.2	20.5
Longitude (East) (°)	260.7	273.1
E/S Maximum Range to SV (km)	10456.2	8938.4
E/S Minimum Elevation to SV (°)	26.0	50.5
E/S Altitude (km)	0.3	0.0
SV Beam Identifier (#)	24	
Minutes Into Pass (Sample #70) (Min)	33:23	
Telco Spot Beam Off-Angle (°)	0.20	
Telco Spot Beam Diameter (km)	61.10	
Maximum Roundtrip Latency (msec)	129.39	
<b>Modulation Parameters</b>	<b>Forward</b>	<b>Return</b>
Enter Receiver Type		DVB-S2
Modem Overhead (%)		3.2%
Number of Carriers per Channel (#)		1
Available Bandwidth (Hz)		39,960,000
Channel Symbol Rate (sp/s)		33,300,000
Channel Modulation Type		8PSK
Channel FEC Rate		0.67
Channel Spectral Efficiency (bits/Sym)		2.00
Channel Throughput (100% / 100% of Full Rate) (bps)		64,457,420.92
<b>Uplink</b>	<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA (#)		1
E/S Tx Carrier Frequency (MHz)		28,709
E/S Tx HPA Power Level (W)		500
E/S Tx OBO (dB)		-4.50
E/S Tx Post-HPA Losses (dB)		-3.15
E/S Tx Antenna Gain (7.3 m / 1.5 m) (dB)		50.41
E/S Tx EIRP Per Channel (dBW)		69.75
E/S Tx Pointing Loss (dB)		-0.50
E/S Tx RF Link Availability (%)		99.500
E/S Tx Atmospheric Losses (dB)		-17.15
E/S Tx Spreading Loss (dB)		-150.02
<b>Satellite</b>	<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA (#)		5
SV Rx G/T (dB/K)		4.12
SV Rx Power Per Tier (dBW)		-144.41
SV Rx Flux Density Per Tier (dBW/m <sup>2</sup> )		-97.91
SV Tx OBO (ALC / ALC) (dB)		-5.80
SV Tx Post-TWTA Losses (dB)		-1.50
SV Tx Antenna Gain (dBi)		31.80
SV Tx EIRP Per Channel/Carrier (dBW)		35.64
SV Tx Pointing Loss (dB)		0.00
<b>Downlink</b>	<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency (MHz)		18,909
E/S Rx Spreading Loss (dB)		-151.38
E/S Rx RF Link Availability (%)		99.500
E/S Rx Atmospheric Losses (dB)		-6.39
E/S Rx Pointing Loss (dB)		-0.50
E/S Rx Antenna Gain (1.5 m / 7.3 m) (dBi)		62.24
E/S Rx Effective G/T (dB/K)		36.94
E/S Rx Power Per Channel (dBW)		-107.39
E/S Rx Flux Density Per Channel (dBW/m <sup>2</sup> )		-122.63
<b>Total Link</b>	<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth (dB)		75.22
Carrier / Noise Uplink (dB)		8.97
Carrier / Noise Downlink (dB)		20.69
Carrier / Intermodulation Im (C/Im) (dB)		23.22
(C/N) - Total Actual (dB)		8.34
(C/N) - Total Required (dB)		8.20
(E <sub>p</sub> /N <sub>0</sub> ) - Total Actual (dB)		5.33
(E <sub>p</sub> /N <sub>0</sub> ) - Total Required (dB)		5.19
<b>Excess Margin (dB)</b>		<b>0.14</b>
<b>Fade Margin (dB)</b>		<b>10.54</b>

#18



Ground Parameter		Teleport	Telco
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	10138.9	8778.4
E/S Minimum Elevation to SV	(°)	30.2	54.2
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)	22	
Minutes Into Pass (Sample #55)	(Min)	26:8	
Telco Spot Beam Off-Angle	(°)	1.30	
Telco Spot Beam Diameter	(km)	397.40	
Maximum Roundtrip Latency	(msec)	126.20	
Modulation Parameters		Forward	Return
Enter Receiver	Type	DVB-S2	
Modem Overhead	(%)	3.2%	
Number of Carriers per Channel	(#)	703	
Available Bandwidth	(Hz)	216,000,000	
Channel Symbol Rate	(sps)	256,046	
Channel Modulation Type		8PSK	
Channel FEC Rate		0.67	
Channel Spectral Efficiency	(bits/Sym)	2.00	
Channel Throughput (100% / 100% of Full Rate)	(bps)	495,616.63	
Uplink		Forward	Return
E/S Tx Channels per HPA	(#)	5	
E/S Tx Carrier Frequency	(MHz)	28,020	
E/S Tx HPA Power Level	(W)	500	
E/S Tx OBO	(dB)	-4.00	
E/S Tx Post-HPA Losses	(dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 1.5 m)	(dB)	64.82	
E/S Tx EIRP Per Channel	(dBW)	50.11	
E/S Tx Pointing Loss	(dB)	-0.50	
E/S Tx RF Link Availability	(%)	99.500	
E/S Tx Atmospheric Losses	(dB)	-11.16	
E/S Tx Spreading Loss	(dB)	-151.11	
Satellite		Forward	Return
SV Number of Channels per HPA	(#)	1	
SV Rx G/T	(dB/K)	5.24	
SV Rx Power Per Tier	(dBW)	-129.36	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-84.19	
SV Tx OBO (ALC / ALC)	(dB)	-3.80	
SV Tx Post-TWTA Losses	(dB)	-1.50	
SV Tx Antenna Gain	(dBi)	28.98	
SV Tx EIRP Per Channel/Carrier	(dBW)	13.34	
SV Tx Pointing Loss	(dB)	0.00	
Downlink		Forward	Return
E/S Rx Carrier Frequency	(MHz)	18,220	
E/S Rx Wavelength	(m)	0.016454	
E/S Rx RF Link Availability	(%)	95.000	
E/S Rx Atmospheric Losses	(dB)	-1.92	
E/S Rx Pointing Loss	(dB)	-0.50	
E/S Rx Antenna Gain (1.5 m / 7.3 m)	(dBi)	46.46	
E/S Rx Effective G/T	(dB/K)	21.96	
E/S Rx Power Per Channel	(dBW)	-139.14	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-138.94	
Total Link		Forward	Return
Carrier / Noise Bandwidth	(dB)	54.08	
Carrier / Noise Uplink	(dB)	16.68	
Carrier / Noise Downlink	(dB)	10.87	
Carrier / Intermodulation Im (C/Im)	(dB)	14.17	
(C/N) - Total Actual	(dB)	8.40	
(C/N) - Total Required	(dB)	8.20	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)	5.39	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)	5.19	
<b>Excess Margin</b>	<b>(dB)</b>	<b>0.20</b>	
<b>Fade Margin</b>	<b>(dB)</b>	<b>10.60</b>	

#19

<b>O3b Network Link Analysis - Tier 2 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>		<b>Tier 2</b>
<b>Ground Parameter</b>		<b>Tier 2</b>
		<b>Teleport</b>
		<b>Telco</b>
Location		Vernon (LHCP), United States
Latitude	(°)	34.2
Longitude (East)	(°)	260.7
E/S Maximum Range to SV	(km)	10721.2
E/S Minimum Elevation to SV	(°)	22.8
E/S Altitude	(km)	0.3
SV Beam Identifier	(#)	22
Minutes Into Pass (Sample #80)	(Min)	38:14
Telco Spot Beam Off-Angle	(°)	2.10
Telco Spot Beam Diameter	(km)	642.20
Maximum Roundtrip Latency	(msec)	132.41
<b>Modulation Parameters</b>		<b>Forward</b>
Enter Receiver	Type	DVB-S2
Modem Overhead	(%)	3.2%
Number of Carriers per Channel	(#)	703
Available Bandwidth	(Hz)	216,000,000
Channel Symbol Rate	(sps)	256,046
Channel Modulation Type		8PSK
Channel FEC Rate		0.67
Channel Spectral Efficiency	(bits/Sym)	2.00
Channel Throughput (100% / 100% of Full Rate)	(bps)	495,616.63
<b>Uplink</b>		<b>Forward</b>
E/S Tx Channels per HPA	(#)	1
E/S Tx Carrier Frequency	(MHz)	28,020
E/S Tx HPA Power Level	(W)	10
E/S Tx OBO	(dB)	-1.50
E/S Tx Post-HPA Losses	(dB)	-1.50
E/S Tx Antenna Gain (7.3 m / 1.5 m)	(dB)	50.20
E/S Tx EIRP Per Channel	(dBW)	57.20
E/S Tx Pointing Loss	(dB)	-0.50
E/S Tx RF Link Availability	(%)	98.500
E/S Tx Atmospheric Losses	(dB)	-9.11
E/S Tx Spreading Loss	(dB)	-150.20
<b>Satellite</b>		<b>Forward</b>
SV Number of Channels per HPA	(#)	5
SV Rx G/T	(dB/K)	-3.66
SV Rx Power Per Tier	(dBW)	-128.20
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-74.13
SV Tx OBO (ALC / ALC)	(dB)	-5.80
SV Tx Post-TWTA Losses	(dB)	-1.50
SV Tx Antenna Gain	(dBi)	31.82
SV Tx EIRP Per Channel/Carrier	(dBW)	7.19
SV Tx Pointing Loss	(dB)	0.00
<b>Downlink</b>		<b>Forward</b>
E/S Rx Carrier Frequency	(MHz)	18,220
E/S Rx Spreading Loss	(dB)	-151.60
E/S Rx RF Link Availability	(%)	99.500
E/S Rx Atmospheric Losses	(dB)	-6.85
E/S Rx Pointing Loss	(dB)	-0.50
E/S Rx Antenna Gain (1.5 m / 7.3 m)	(dBi)	61.91
E/S Rx Effective G/T	(dB/K)	36.48
E/S Rx Power Per Channel	(dBW)	-136.51
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-151.76
<b>Total Link</b>		<b>Forward</b>
Carrier / Noise Bandwidth	(dB)	54.08
Carrier / Noise Uplink	(dB)	17.85
Carrier / Noise Downlink	(dB)	12.58
Carrier / Intermodulation Im (C/Im)	(dB)	15.39
(C/N) - Total Actual	(dB)	9.48
(C/N) - Total Required	(dB)	8.20
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)	6.47
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)	5.19
<b>Excess Margin</b>	<b>(dB)</b>	<b>1.28</b>
<b>Fade Margin</b>	<b>(dB)</b>	<b>11.68</b>

#20

Ground Parameter		Teleport	Telco
Location		Vernon (LHCP), United States	Cozumel, Mexico
Latitude	(°)	34.2	20.5
Longitude (East)	(°)	260.7	273.1
E/S Maximum Range to SV	(km)	11186.8	9518.9
E/S Minimum Elevation to SV	(°)	17.4	39.5
E/S Altitude	(km)	0.3	0.0
SV Beam Identifier	(#)	22	
Minutes Into Pass	(Min)	Worst Case	
Telco Spot Beam Off-Angle	(°)	2.10	
Telco Spot Beam Diameter	(km)	642.20	
Maximum Roundtrip Latency	(msec)	138.13	
Modulation Parameters		Forward	Return
Enter Receiver	Type	DVB-S2	
Modem Overhead	(%)	4.3%	
Number of Carriers per Channel	(#)	703	
Available Bandwidth	(Hz)	216,000,000	
Channel Symbol Rate	(sps)	256,046	
Channel Modulation Type		QPSK	
Channel FEC Rate		0.25	
Channel Spectral Efficiency	(bits/Sym)	0.50	
Channel Throughput (100% / 100% of Full Rate)	(bps)	122,537.50	
Uplink		Forward	Return
E/S Tx Channels per HPA	(#)	5	
E/S Tx Carrier Frequency	(MHz)	28,020	
E/S Tx HPA Power Level	(W)	500	
E/S Tx OBO	(dB)	-4.00	
E/S Tx Post-HPA Losses	(dB)	-2.24	
E/S Tx Antenna Gain (7.3 m / 1.5 m)	(dB)	64.82	
E/S Tx EIRP Per Channel	(dBW)	50.11	
E/S Tx Pointing Loss	(dB)	-0.50	
E/S Tx RF Link Availability	(%)	99.500	
E/S Tx Atmospheric Losses	(dB)	-19.80	
E/S Tx Spreading Loss	(dB)	-151.97	
Satellite		Forward	Return
SV Number of Channels per HPA	(#)	1	
SV Rx G/T	(dB/K)	5.46	
SV Rx Power Per Tier	(dBW)	-138.63	
SV Rx Flux Density Per Tier	(dBW/m <sup>2</sup> )	-93.68	
SV Tx OBO (ALC / ALC)	(dB)	-3.80	
SV Tx Post-TWTA Losses	(dB)	-1.50	
SV Tx Antenna Gain	(dBi)	26.01	
SV Tx EIRP Per Channel/Carrier	(dBW)	10.37	
SV Tx Pointing Loss	(dB)	0.00	
Downlink		Forward	Return
E/S Rx Carrier Frequency	(MHz)	18,220	
E/S Rx Wavelength	(m)	0.016454	
E/S Rx RF Link Availability	(%)	99.200	
E/S Rx Atmospheric Losses	(dB)	-6.38	
E/S Rx Pointing Loss	(dB)	-0.50	
E/S Rx Antenna Gain (1.5 m / 7.3 m)	(dBi)	46.46	
E/S Rx Effective G/T	(dB/K)	20.70	
E/S Rx Power Per Channel	(dBW)	-147.28	
E/S Rx Flux Density Per Channel	(dBW/m <sup>2</sup> )	-147.08	
Total Link		Forward	Return
Carrier / Noise Bandwidth	(dB)	54.08	
Carrier / Noise Uplink	(dB)	7.42	
Carrier / Noise Downlink	(dB)	1.47	
Carrier / Intermodulation Im (C/Im)	(dB)	14.17	
(C/N) - Total Actual	(dB)	0.16	
(C/N) - Total Required	(dB)	-2.20	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Actual	(dB)	3.17	
(E <sub>b</sub> /N <sub>0</sub> ) - Total Required	(dB)	0.81	
<b>Excess Margin</b>	<b>(dB)</b>	<b>2.36</b>	
<b>Fade Margin</b>	<b>(dB)</b>	<b>2.36</b>	

#21

<b>O3b Network Link Analysis - Tier 2 Service For Cozumel, Mexico</b>		
<b>Link Budget Creator - Rev 3.2.9: March 26, 2013</b>	<b>Tier 2</b>	<b>Tier 2</b>
<b>Ground Parameter</b>	<b>Teleport</b>	<b>Telco</b>
Location	Vernon (LHCP), United States	Cozumel, Mexico
Latitude (°)	34.2	20.5
Longitude (East) (°)	260.7	273.1
E/S Maximum Range to SV (km)	9913.3	9353.0
E/S Minimum Elevation to SV (°)	33.4	42.4
E/S Altitude (km)	0.3	0.0
SV Beam Identifier (#)		22
Minutes Into Pass (Sample #5) (Min)		1:56
Telco Spot Beam Off-Angle (°)		2.10
Telco Spot Beam Diameter (km)		642.20
Maximum Roundtrip Latency (msec)		128.53
<b>Modulation Parameters</b>	<b>Forward</b>	<b>Return</b>
Enter Receiver Type		DVB-S2
Modem Overhead (%)		4.3%
Number of Carriers per Channel (#)		703
Available Bandwidth (Hz)		216,000,000
Channel Symbol Rate (sps)		256,046
Channel Modulation Type		QPSK
Channel FEC Rate		0.25
Channel Spectral Efficiency (bits/Sym)		0.50
Channel Throughput (100% / 100% of Full Rate) (bps)		122,537.50
<b>Uplink</b>	<b>Forward</b>	<b>Return</b>
E/S Tx Channels per HPA (#)		1
E/S Tx Carrier Frequency (MHz)		28,020
E/S Tx HPA Power Level (W)		10
E/S Tx OBO (dB)		-1.50
E/S Tx Post-HPA Losses (dB)		-1.50
E/S Tx Antenna Gain (7.3 m / 1.5 m) (dB)		50.20
E/S Tx EIRP Per Channel (dBW)		57.20
E/S Tx Pointing Loss (dB)		-0.50
E/S Tx RF Link Availability (%)		99.800
E/S Tx Atmospheric Losses (dB)		-26.18
E/S Tx Spreading Loss (dB)		-150.41
<b>Satellite</b>	<b>Forward</b>	<b>Return</b>
SV Number of Channels per HPA (#)		5
SV Rx G/T (dB/K)		-3.60
SV Rx Power Per Tier (dBW)		-145.42
SV Rx Flux Density Per Tier (dBW/m <sup>2</sup> )		-91.42
SV Tx OBO (ALC / ALC) (dB)		-5.80
SV Tx Post-TWTA Losses (dB)		-1.50
SV Tx Antenna Gain (dBi)		31.77
SV Tx EIRP Per Channel/Carrier (dBW)		7.14
SV Tx Pointing Loss (dB)		0.00
<b>Downlink</b>	<b>Forward</b>	<b>Return</b>
E/S Rx Carrier Frequency (MHz)		18,220
E/S Rx Spreading Loss (dB)		-150.92
E/S Rx RF Link Availability (%)		99.500
E/S Rx Atmospheric Losses (dB)		-4.90
E/S Rx Pointing Loss (dB)		-0.50
E/S Rx Antenna Gain (1.5 m / 7.3 m) (dBi)		61.91
E/S Rx Effective G/T (dB/K)		36.98
E/S Rx Power Per Channel (dBW)		-133.93
E/S Rx Flux Density Per Channel (dBW/m <sup>2</sup> )		-149.18
<b>Total Link</b>	<b>Forward</b>	<b>Return</b>
Carrier / Noise Bandwidth (dB)		54.08
Carrier / Noise Uplink (dB)		0.63
Carrier / Noise Downlink (dB)		15.65
Carrier / Intermodulation Im (C/Im) (dB)		15.39
(C/N) - Total Actual (dB)		-0.23
(C/N) - Total Required (dB)		-2.20
(E <sub>p</sub> /N <sub>0</sub> ) - Total Actual (dB)		2.78
(E <sub>p</sub> /N <sub>0</sub> ) - Total Required (dB)		0.81
<b>Excess Margin (dB)</b>		<b>1.97</b>
<b>Fade Margin (dB)</b>		<b>1.97</b>

#22

TLM Link Analysis (rain)				
On-Station Mode Downlink @ 10 deg				
Parameter	Symbol	Value	Unit	Source
Frequency	f	19.2996	GHz	Specification
Transmitter Power	p	0.4	Watt	
Total Transmit Power	P	26.0	dBm	$P = 10 \log(p)$
S/C Antenna Gain	Gt	7.1	dBi	26 deg half cone angle
Passive Loss	Li	-0.6	dB	Input Parameter Estimate
"multipath"		0	dB	
Equiv. Isotropic Radiated Power	EIRP	32.5	dBm	$EIRP = P+Gt+Li$
Propagation Path Length	S	11896	km	10° Elevation Angle
Free Space Dispersion Loss	LS	-199.7	dB	$LS = -92.44 - 20\log(S) - 20\log(f)$
Atmospheric & Rain Loss	La	-5.3	dB	95% weather at 10 deg (Vernon)
Ground Station Pointing Loss		-1.0	dB	
Ground Station G/T	Grp	34.0	dBm/K	
Total Received Power/T		-139.4	dBm/K	
Boltzmann's Constant	k	-198.6	dBm/Hz/K	$k = 10\log(1.38*10^{-23})$
Total Received C/No		59.2		
CARRIER CHANNEL				
Carrier/Total Power		-9.0	dB	
WC mod index		1.21		
Carrier Power/KT		50.1	dBm/Hz/K	
Carrier Loop Bandwidth ( Hz)		30.0	dB-Hz	
Carrier/Noise		20.1	dB	
Required Carrier/Noise		10.0	dB	
<b>Carrier Margin</b>		<b>10.1</b>	<b>dB</b>	
DATA CHANNEL (PCM/PM)				
Modulation Index		0.99		
Data/Total Power		-1.6	dB	
Data Power/KT		57.6	dBm/Hz/KT	
Information Rate		39.1	dB-Hz	
Available S/N		18.5	dB	
Required $E_b/N_o$ 10E-6 BER		10.5	dB	
Coding Gain				
Implementation Loss		2.0		
<b>Available Signal Margin</b>		<b>6.0</b>	<b>dB</b>	

#23

TLM Link Analysis (rain)				
Contingency Mode Downlink Nadir @ 10 deg				
Parameter	Symbol	Value	Unit	Source
Frequency	f	19.2996	GHz	Specification
Transmitter Power	p	60.0	Watt	
Total Transmit Power	P	47.8	dBm	$P = 10 \log(p)$
Corona safety margin		-1.0	dB	
S/C Antenna Gain	Gt	1	dBi	80 deg cone coverage WBL064
Passive Loss	Li	-5.7	dB	Input Parameter Estimate
"multipath"		-2.5	dB	
Equiv. Isotropic Radiated Power	EIRP	39.6	dBm	$EIRP = P+Gt+Li$
Propagation Path Length	S	11896	km	10° Elevation Angle
Free Space Dispersion Loss	LS	-199.7	dB	$LS = -92.44 - 20\log(S) - 20\log(f)$
Atmospheric & Rain Loss	La	-5.3	dB	95% weather at 10 deg (Vernon)
Ground Station Pointing Loss		-1.0	dB	
Ground Station G/T	Grp	34.0	dBm/K	3 dB of rain impact (sky noise & wet ant)
Total Received Power/T		-132.4	dBm/K	
Boltzmann's Constant	k	-198.6	dBm/Hz/K	$k = 10\log(1.38*10^{-23})$
Total Received C/No		66.2		
CARRIER CHANNEL				
Carrier/Total Power		-9.0	dB	
WC mod index		1.21		
Carrier Power/KT		57.2	dBm/Hz/K	
Carrier Loop Bandwidth ( Hz)		30.0	dB-Hz	
Carrier/Noise		27.2	dB	
Required Carrier/Noise		10.0	dB	
<b>Carrier Margin</b>		<b>17.2</b>	<b>dB</b>	
DATA CHANNEL (PCM/PM)				
Modulation Index		0.99		
Data/Total Power		-1.6	dB	
Data Power/KT		64.7	dBm/Hz/KT	
Information Rate		39.1	dB-Hz	
Available S/N		25.5	dB	
Required $E_b/N_o$ 10E-6 BER		10.5	dB	
Coding Gain				
Implementation Loss		2.0		
<b>Available Signal Margin</b>		<b>13.0</b>	<b>dB</b>	

#24

Link Analysis for				
Command Uplink @ 10 degrees, on-orbit mode				
Item	Symbol	Value	Unit	Source
Frequency	f	29.0885	GHz	
HPA size		100	W	
passive loss		1	dB	
Antenna diam		7.3	m	
Antenna gain		65.1	dBi	
Uplink EIRP	EIRP	83.5	dBW	spec EIRP
Orbital Altitude		8062	km	
Propagation Path Length	S	11896	km	10° Elevation Angle
Space Loss	Ls	-203.2	dB	$L_s = -92.44 - 20\log(S) - 20\log(f)$
Atmospheric & Rain Loss		-8.5	dB	95% weather at 10 deg (Vernon)
Flux Density		-78.5	dBW/m <sup>2</sup>	
Grnd Antenna tracking loss		-1.0	dB	
Polarization Loss	La	-0.1	dB	
"multipath" loss		-0.5	dB	
Receive Antenna Gain	Grp	6.0	dB	gain at 26 deg
S/C Passive Loss		-4.3	dB	
Power at S/C Receiver		-98.1	dBm	
<b>Command Channel Performance</b>				
Minimum Carrier acquisition power		-110	dBm	10 <sup>-6</sup> BER sensitivity
Carrier Acquisition Margin		11.9	dB	

#25

**CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING  
ENGINEERING INFORMATION**

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this supplement, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this supplement and that it is complete and accurate to the best of my knowledge and belief.

\_\_\_\_\_/s/\_\_\_\_

Richard J. Barnett, PhD, BSc  
Telecomm Strategies Inc.  
6404 Highland Drive  
Chevy Chase, MD 20815  
(301) 656-8969

March 27, 2013