APPLICATION

SES Government Solutions, Inc. ("SES-GS") hereby seeks a license for a new earth station in Pago Pago, American Samoa, that will communicate with the O3b Ka-band non-geostationary orbit fixed-satellite service ("NGSO FSS") satellite fleet. Operations of this earth station have commenced pursuant to special temporary authority ("STA"). *See* File Nos. SES-STA-20160426-00372 & SES-STA-20160624-00604. Grant of the requested license is in the public interest as it will allow SES-GS to provide O3b capacity to the National Oceanic and Atmospheric Agency to support the provision by the National Weather Service of data on weather and climate, including warnings for the protection of life and property.

SES-GS incorporates herein the information included in its initial STA request for this site, File No. SES-STA-20160426-00372. As noted in that request, the Commission has granted U.S. market access for the O3b constellation, authorizing U.S. earth stations to communicate with the O3b fleet.[1] Moreover, the antenna model that SES-GS is seeking to use has already been approved by the Commission for operations with the O3b network throughout the continental U.S., Hawaii, Puerto Rico, and the U.S. Virgin Islands.[2] For the Commission's convenience, SES-GS is reattaching the radiation hazard study for this antenna that was included in the STA request, as well as a set of link budgets for the proposed operations.

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[1] *See* O3b Limited, Call Sign S2935, File Nos. SAT-LOI-20141029-00118 & SAT-AMD-20150115-00004, granted Jan. 22, 2015 (authorizing operations in the 17.8-18.6 GHz, 18.8-19.3 GHz, 27.6-28.4 GHz, and 28.6-29.1 GHz bands).

O3b was granted certain waivers in connection with its request for U.S. market access, including waivers of the geographical coverage requirements for Ka-band NGSO systems in Section 25.145(c) and of the cross-polarization isolation requirements in Section 25.210(i)(1). *See id.,* Attachment to Grant at 3-4. To the extent necessary, SES-GS requests that these waivers be extended to the operations proposed in this license application.

[2] *See* O3b Limited, Call Sign E140101, File No. SES-LIC-20141001-00781, granted June 8, 2015. A full set of patterns for this antenna model is already on file as a part of that application.

SES Government Solutions

RADIATION HAZARD STUDY

In this report SES Government Solutions, Inc. ("SES-GS") analyzes the maximum radiofrequency (RF) levels emitted from the satellite communications antenna described below. The reference document for this study is OET Bulletin No. 65, Edition 97-01, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, August 1997.

1. The following data is used throughout the analysis:

Parameters	Symbol	Value	Units	Notes/Formulas
Transmit Power	P	35.90	W	
Frequency	F	28388	MHz	
Wavelength	λ	0.011	m	299.792458 / F
Antenna Diameter	Dref	2.4	m	
Antenna Surface Area	Aref	4.524	m^2	π $Dref^2$ / 4
Subreflector Diameter	Dsub	N/A	m	Offset feed antenna
Subreflector Surface Area	Asub	N/A	m^2	π $Dsub^2$ / 4
Feed Flange Diameter	Dflange	0.0445	m	Direct measurement
Feed Flange Area	Aflange	0.002	m^2	π $Dflange^2$ / 4
Antenna Gain	Ges	55.20	dBi	Mfg spec
Antenna Gain	G	331131.121		10^(Ges / 10)
Antenna Efficiency	η	0.650		G λ^2 / π^2 $Dref^2$
Pi	π	3.142		

2. Density at Feed Flange

The maximum power flux density at the surface of the feed flange is as follows:

Parameters	Symbol	Value	Units	Notes/Formulas
Density @ flange		92330.362	W/m^2	4 P / Aflange
	Sflange	9232.304	mW/cm^2	

3. Density at Main Reflector

The maximum power flux density at the surface of the main reflector is as follows:

Parameters	Symbol	Value	Units	Notes/Formulas
Density @ Main Reflector		31.740	W/m^2	4 P / Aref
	Ssurface	3.174	mW/cm^2	

4. Density between Main Reflector and Ground

The maximum power flux density in the area between the edge of the main reflector and the ground is as follows

Parameters	Symbol	Value	Units	Notes/Formulas
Density, Main Reflector/Ground		7.935	W/m^2	P / Aref
	Sground	0.794	mW/cm^2	

5. Density within the Near Field

The Near Field environment for a parabolic reflector antenna is contained within a cylinder with the same diameter as the main reflector which extends to a distance called the Near Field Extent

Power within the Near Field is constant with the following maximum flux density:

Parameters	Symbol	Value	Units	Notes/Formulas
Range to Near Field Extent	Rnf	136.357	m	$Dref^2 / 4 \lambda$
Density within the Near Field		20.619	W/m^2	$16.0 \eta P / \pi Dref^2$
	Snf	2.062	mW/cm^2	

6. Density at Transition Region

The Transition Region is the area between the Near Field and Far Field regions where power decreases linearly with distance.

The maximum power flux density within the Transition Region is located at the Near Field extent range and is calculated as follows:

Parameters	Symbol	Value	Units	Notes/Formulas
Range to Transition Region	Rt	136.357	m	Occurs at near field extent
Density @ Transition		20.619	W/m^2	Snf Rnf / Rt
	Snf	2.062	mW/cm^2	

7. Density at Beginning of the Far Field

The Far Field region is the range at which power decreases inversely with the square of the distance. The maximum power flux density within the Far Field region occurs at the Far Field Boundary and is calculated as follows:

Parameters	Symbol	Value	Units	Notes/Formulas
Range to Far Field Boundary	Rff	327.256	m	$0.6 D^2 / \lambda$
Density @ Far Field Boundary		8.832	W/m^2	$P G / 4 \pi Rff^2$
	Sff	0.883	mW/cm^2	

8. Range to Far Field General Population Exposure Limit

In addition to the power flux density calculations at key locations, it's valuable to locate the specific range at which MPE limits are reached to aid in managing exposure control. The following calculation shows the range at which the Far Field General Population MPE limit occurs:

Parameters	Symbol	Value	Units	Notes/Formulas
Range to 1 mW/cm²		307.541	m	Range to General Population Limit
		10.001	W/m²	
		1.000	mW/cm²	

9. Non-Ionizing Radiation Summary

Flux Densities & Exposure Limits

General Population Exposure Limit = 1.0 mW/cm^2

Occupational Exposure Limit = 5.0 mW/cm^2

Region	Symbol	Level	Units	Hazard Assessment
Density @ Antenna Flange	Sflange	9232.304	mW/cm²	Exceeds General Population Exposure limit
				Exceeds Occupational Exposure limit
Density @ Main Reflector	Ssurface	3.174	mW/cm²	Exceeds General Population Exposure limit
				Does not exceed Occupational Exposure limit
Density Between Main Reflector and Ground	Sground	0.794	mW/cm²	Does not exceed General Population Exposure limit
				Does not exceed Occupational Exposure limit
Max Density @ Near Field Extent	Snf	2.062	mW/cm²	Exceeds General Population Exposure limit
				Does not exceed Occupational Exposure limit
Max Density @ Transition Region	St	2.062	mW/cm²	Exceeds General Population Exposure limit
				Does not exceed Occupational Exposure limit
Density @ Beginning of Far Field	Sff	0.883	mW/cm²	Does not exceed General Population Exposure limit
				Does not exceed Occupational Exposure limit

Range to Key Points and General Population Exposure Limit Avoidance Methods

Distance from Antenna	Symbol	Value	Units	Protection Method
Antenna Immediate Area				Fencing and Signage, no public access
Range to Near Field Extent	Rnf	136.357	m	Main lobe offset greater than 1 diameter
Range to Far Field Boundary	Rff	327.256	m	Main lobe offset greater than 1 diameter
Range to 1 mW/cm² MPE Limit		307.541	m	Main lobe offset greater than 1 diameter

10. Conclusion

The above analysis confirms the presence of potentially hazardous power flux densities at the terminals which will require physical and operation protections to manage General Population and Occupational Exposure.

As appropriate, SES GS will use fencing, signage, and other measures to limit access to the relevant area. Procedures will be in place requiring that transmit power be turned off before work on the 2.4m antennas is performed. Where an enclosed area is necessary, the size of the enclosed area will consider the RF hazards and the surrounding terrain. The signage will clearly state the standard Radiation Hazard warning.

Personnel with access to the antenna will be trained to ensure that the antennas are off before working in the vicinity or on the antenna systems directly.

11. Certification

I hereby certify I have reviewed the engineering information submitted, and that it is complete and accurate to the best of my knowledge.

/s/ Majid Borojeni
Majid Borojeni
Network Engineering Director
SES Government Solutions
April 26, 2016

O3b Networks
Johan van Oldenbarneveltlaan 5
2582 NE The Hague
The Netherlands

Fiber Speed, Satellite Reach.

Satellite and Transponder Information

Satellite:	O3b C1
Longitude [deg E]:	213.50
Transponder ID:	R08-TL14/GW1
Bandwidth [MHz]:	216.0
Usable Bandwidth [MHz]:	216.0
Nominal Input Backoff [dB]:	-18.0
Nominal Output Backoff [dB]:	-12.8
Transponder Operating Mode:	FGM
ALC Dynamic Range[dB]:	

Uplink Information

Beam Name:	TELCO-L
Begin Freq [MHz]:	28,601.00
Center Freq [MHz]:	28,709.00
End Freq [MHz]:	28,817.00
Bandwidth [MHz]:	216.00
Beam-Peak SFD [dBW/m^2]:	-63.0
Beam-Peak G/T [dB/K]:	5.7
Polarization:	LHCP
Beam Center City:	
Beam Center Country:	
Beam Center Latitude [deg N]:	-14.2800
Beam Center Longitude [deg E:	170.7000

Downlink Information

Beam Name:	GW1-R
Begin Freq [MHz]:	18,801.00
Center Freq [MHz]:	18,909.00
End Freq [MHz]:	19,017.00
Bandwidth [MHz]:	216.00
Saturation Beam-Peak EIRP [dBW]:	49.0
Operational Beam-Peak EIRP [dBW]:	36.2
Polarization:	RHCP
Beam Center City:	Sunset Beach
Beam Center Country:	U.S.A.
Beam Center Latitude [deg N]:	21.6700
Beam Center Longitude [deg E]:	201.9700

Key Status Indicators

Overall	☐
Sys Margin	☒
Availability	☑
U/L EIRP Lim	☑
D/L PFD Lim	☑
Xpdr Power	☑
Xpdr BW	☑
HPA OBO	☐

Performance computed from user specified HPA power rating and required availability.

Carrier Information

Carrier ID:	ASTCA SESGS NOAA 10Mbps RTN
Carrier Type:	Digital
Revision Number:	1
Uplink Center Frequency [MHz]:	28,709.0000
Downlink Center Frequency [MHz]:	18,909.0000
Information Rate [Mbit/s]:	16.4851
Overhead [Mbit/s]:	0.1649
Composite Data Rate [Mbit/s]:	16.6500
Inner Code Rate	0.83250
RS Code (n,k):	N/A
Outer Code Rate	
Effective Code Rate:	0.83250
Modulation Type:	16APSK
Number of Bits Per Symbol:	4.0000 MHz
Symbol Rate [Msym/s]:	5.0000
Noise Bandwidth [MHz]:	5.0000
Filter Roll-off Factor	0.05
Spreading Factor	1.00
Bandwidth Allocation Factor:	1.05
Allocated Bandwidth [MHz]:	5.2500
Required Clear-Sky C/N [dB]:	12.4
Required Clear-Sky Eb/No [dB]:	7.2
Required Rain-Degraded C/N [dB]:	2.8
Required Rain-Degraded Eb/No [dB]:	1.9
Required Link Availability [%/yr]:	98.500%
Required C/N Rain Margin [dB]:	
Required Eb/No Rain Margin [dB]:	
Other Carrier Losses [dB]:	0.0
Required System Margin [dB]:	0.5
Link Budget Type	Preliminary

Transmit E/S Information

Name:	SMA_PAP_002
Code:	SMA_PAP_002
City / Country:	Pago Pago, American Samoa/U.S.A.
Latitude [deg N]:	-14.330000
Longitude [deg E]:	189.250000
Altitude [m]:	195
Range to Satellite [km]:	9,303.0
True Azimuth [deg]:	61.4
True Elevation [deg]:	43.4
Magnetic Azimuth [deg]:	49.7
Effective (Refracted) Elevation [deg]:	43.4
Distance from Beam Center [km]:	7.75
Offset from Beam Center [deg]:	0.04
HPA Size [W]:	40.0
HPA Required Size [W]:	25.0
HPA Operating Mode:	
HPA Operation Loss [dB]:	0.0
UPC Type:	None
UPC Dynamic Range [dB]:	0.0
Uplink System Loss [dB]:	0.8
Diameter / Effective Aperture [m]:	2.4
Efficiency [%]:	71.0%
Antenna Gain (at Cxr Uplink Freq) [dBi]:	55.7
Radome Loss [dB]:	1.5
Antenna Uplink Mispointing Loss [dB]:	0.5
Uplink Depolarization Loss [dB]:	0.0
Other Uplink Losses [dB]:	0.0
Uplink Aspect Correction [dB]:	-0.6
Total HPA OBO (All Carriers)	
Maximum HPA OBO	-2.0

Receive E/S Information

Name:	SUN_RH
Code:	SUN_RH
City / Country:	Sunset Beach/U.S.A.
Latitude [deg N]:	21.670000
Longitude [deg E]:	201.970000
Altitude [m]:	0
Range to Satellite [km]:	9,026.4
True Azimuth [deg]:	150.9
True Elevation [deg]:	48.8
Magnetic Azimuth [deg]:	141.3
Effective (Refracted) Elevation [deg]:	48.8
Distance from Beam Center [km]:	0.00
Offset from Beam Center [deg]:	0.00
Radome Loss [dB]:	0.0
Diameter / Effective Aperture [m]:	7.3
Efficiency [%]:	80.0%
Antenna Gain (at Cxr Downlink Freq) [dBi]:	62.2
Downlink Feed Loss [dB]:	0.8
Antenna Noise Temperature [K]:	45.0
LNA Noise Temperature [K]:	60.0
Ambient Temperature [K]:	120.0
System Noise Temperature (Clear-Sky) [K]:	119.9
MEO Boost Gain [dB]:	0.0
Effective G/T (Clear-Sky) [dB/K]:	40.7
Antenna Downlink Mispointing Loss [dB]:	0.5
Downlink Depolarization Loss [dB]:	0.0
Other Downlink Losses [dB]:	0.0
Downlink Aspect Correction [dB]:	0.1

Bandwidth Analysis

Allocated Bandwidth [MHz/%]:	5.2500	2.43%
Power Equivalent Bandwidth [MHz/%]:	68.3426	31.64%
Leased Bandwidth [MHz/%]:	68.3426	31.64%
Capacity Optimal / BW / PWR Limited:		**PWR Limited**

** The predicted availability for rain on uplink may be worse than actual due to un-modeled gain compression.

Uplink Calculations

	Clear	Rain Up **	Rain Dn
E/S HPA Required Size [dBW]:	14.0	14.0	14.0
E/S HPA Operation Loss [dB]:	0.0	0.0	0.0
E/S HPA OBO (per-carrier) [dB]:	-2	-2	-2
UPC Power Boost [dB]:	0.0	*0.0*	0.0
Effective E/S HPA OBO (per-carrier) [dB]:	-2.0	*-2.0*	-2.0
Power at HPA Output Flange [dBW]:	12.0	*12.0*	12.0
E/S HPA C/IM [dB]:	200.0	200.0	200.0
Uplink System Loss [dB]:	0.8	0.8	0.8
Power at Antenna Input Flange [dBW]:	11.2	*11.2*	11.2
Uplink Antenna Gain [dBi]:	55.7	55.7	55.7
Uplink EIRP [dBW]:	66.9	*66.9*	66.9
Radome Loss [dB]:	1.5	1.5	1.5
Effective Uplink EIRP [dBW]:	65.4	*65.4*	65.4
Uplink Free Space Loss [dB]:	201.0	201.0	201.0
Uplink Miscellaneous Losses [dB]:	0.5	0.5	0.5
Uplink Propagation Loss Margin [dB]:	1.0	*25.6*	1.0
Uplink ALC Gain [dB]	0.0	*0.0*	0.0
Uplink Diversity Gain [dB]	0.0	*0.0*	0.0
Uplink Availability [%/yr]:		*99.712%*	0.000%
Gain of 1m^2 Antenna [dBi]:	50.6	50.6	50.6
Carrier FD From Direction of Uplink E/S [dBW/m^2]:	-86.5	*-111.1*	-86.5
Transponder SFD from Beam-Peak [dBW/m^2]:	-63.0	-63.0	-63.0
Uplink Aspect Correction [dB]:	-0.6	-0.6	-0.6
Transponder SFD from Direction of Tx E/S [dBW/m^2]:	-63.6	-63.6	-63.6
IMUX Filter Response [dB]:	-0.1	-0.1	-0.1
Carrier Input Backoff [dB]:	-23.0	-47.6	-23.0
Transponder Beam-Peak G/T [dB/K]:	5.7	5.7	5.7
Transponder G/T in Direction of Tx E/S [dB/K]:	6.3	6.3	6.3
Uplink Thermal Noise C/N [dB]:	30.7	*6.2*	30.7
Uplink Co-Channel Interference (CCI) C/I [dB]:	52.3	*27.8*	52.3
Uplink Adjacent Satellite Interference (ASI) C/I [dB]:	200.0	*200.0*	200.0

Transponder Calculations

	Clear	Rain Up	Rain Dn
Xpdr Dlk Saturation EIRP Towards Beam-Peak [dBW]:	49.0	49.0	49.0
Xpdr Dlk Saturation EIRP Towards Receive E/S [dBW]:	48.9	48.9	48.9
Carrier OBO - IBO Delta [dB]:	5.2	*5.2*	5.2
Carrier Output Backoff [dB]:	-17.8	*-42.4*	-17.8
OMUX Filter Response [dB]:	0.0	0.0	0.0
Carrier Downlink EIRP Towards Beam-Peak [dBW]:	31.2	6.7	31.2
Downlink Aspect Correction [dB]:	0.1	0.1	0.1
Carrier Downlink EIRP (Towards Receive E/S) [dBW]:	31.1	*6.5*	31.1
Transponder HPA Intermodulation C/IM [dB]:	35.6	*11.0*	35.6
Adjacent Carrier Interference (ACI) C/I [dB]:	37.6	*13.0*	37.6

Downlink Calculations

	Clear	Rain Up	Rain Dn
Downlink Free Space Loss [dB]:	197.1	197.1	197.1
Downlink Miscellaneous Losses [dB]:	0.5	0.5	0.5
Downlink Propagation Loss Margin [dB]:	0.4	0.4	*27.8*
Downlink Diversity Gain [dB]	0.0	0.0	*0.0*
Downlink Availability [%/yr]:		0.000%	*99.990%*
Effective Rx E/S G/T [dB/K]:	40.7	40.7	*36.0*
Downlink Thermal Noise C/N [dB]:	35.4	*10.8*	*3.3*
Downlink Co-Channel Interference C/I [dB]:	42.9	*18.4*	42.9
Downlink Adjacent Satellite Interference C/I [dB]:	40.0	*15.4*	40.0

Performance Summary

	Clear	Rain Up	Rain Dn
Carrier Total C/N [dB]:	27.6	*3.0*	*3.3*
Other Carrier Losses [dB]:	0.0	0.0	0.0
Predicted C/N [dB]:	27.6	*3.0*	*3.3*
Required C/N [dB]:	12.4	2.8	2.8
Predicted Eb/No [dB]:	22.4	*2.1*	*2.4*
Required Eb/No [dB]:	12.4	2.8	2.8

Feasibility Analysis

	Achieved C/W	Achieved CW & Rain	Required	Satisfied?
C/W System Margin [dB]:	15.2	0.2	0.5	NO
Required Link Availability [%/yr]:		99.702%	98.500%	YES
Required Eb/No Rain Margin:	14.67			N/A

Uplink Off-Axis EIRP Margin

Effective Carrier U/L Boresight EIRP [d	FALSE
Off-Axis Analysis Angle [deg]:	3.0
Antenna Off-Axis Gain [dBi]:	17.1
Carrier U/L Off-Axis EIRP [dBW]:	-38.6
ITU Off-Axis EIRP Limit [dBW]:	48.0
Off-Axis EIRP Limit Margin [dB]:	**86.7**

Downlink PFD Margin

Carrier D/L EIRP at Beam Peak [dBW]:	FALSE
Assumed Angle of Arrival [deg]:	5.0
Path Loss Towards Ang Arr [dB]:	201.5
PFD at Earth's Surface [dBW/m^2]:	-154.5
ITU RR-28 Limit [dBW/m^2]:	-108.0
PFD Margin [dB]:	**46.5**

Noise Analysis

	Percent of Total [%]			C/I or C/IM or C/N [dB]		
	Clear	Rain Up	Rain Dn	Clear	Rain Up	Rain Dn
E/S HPA IM	0.0%	0.0%	0.0%	200.0	200.0	200.0
Uplink Thermal Noise	0.2%	48.4%	0.2%	30.7	6.2	30.7
Uplink CCI	0.0%	0.3%	0.0%	52.3	27.8	52.3
Uplink ASI	0.0%	0.0%	0.0%	200.0	200.0	200.0
Xpdr HPA IM	0.1%	15.9%	0.1%	35.6	11.0	35.6
ACI	0.0%	10.1%	0.0%	37.6	13.0	37.6
Downlink Thermal Noise	0.1%	16.6%	94.1%	35.4	10.8	3.3
Downlink CCI	0.0%	2.9%	0.0%	42.9	18.4	42.9
Downlink ASI	0.0%	5.7%	0.0%	40.0	15.4	40.0
Total Noise	**0.3%**	**100.0%**	**94.4%**	**27.6**	**3.0**	**3.3**

Modulation	Information	Overhead	Modulation	Composite		is C/W	Required C/N	Predicted C/	Ulk/Dlk	Ulk/Dlk	Ulk/Dlk	Availability		

O3b Networks
Johan van Oldenbarneveltlaan 5
2582 NE The Hague
The Netherlands

Fiber Speed, Satellite Reach.

Satellite and Transponder Information

Satellite:	O3b C1
Longitude [deg E]:	213.50
Transponder ID:	R08-GW1/TL14
Bandwidth [MHz]:	216.0
Usable Bandwidth [MHz]:	216.0
Nominal Input Backoff [dB]:	-6.0
Nominal Output Backoff [dB]:	-3.8
Transponder Operating Mode:	ALC
ALC Dynamic Range[dB]:	25.00

Uplink Information

Beam Name:	GW1-R
Begin Freq [MHz]:	28,601.00
Center Freq [MHz]:	28,709.00
End Freq [MHz]:	28,817.00
Bandwidth [MHz]:	216.00
Beam-Peak SFD [dBW/m^2]:	-73.8
Beam-Peak G/T [dB/K]:	5.4
Polarization:	RHCP
Beam Center City:	set Beach
Beam Center Country:	U.S.A.
Beam Center Latitude [deg N]:	21.6700
Beam Center Longitude [deg E	201.9700

Downlink Information

Beam Name:	TELCO-L
Begin Freq [MHz]:	18,801.00
Center Freq [MHz]:	18,909.00
End Freq [MHz]:	19,017.00
Bandwidth [MHz]:	216.00
Saturation Beam-Peak EIRP [dBW]:	49.0
Operational Beam-Peak EIRP [dBW]:	45.2
Polarization:	LHCP
Beam Center City:	ıa telecommunications
Beam Center Country:	Authority-2
Beam Center Latitude [deg N]:	-14.1800
Beam Center Longitude [deg E]:	-170.4100

Key Status Indicators

Overall	☑
Sys Margin	☑
Availability	☑
U/L EIRP Lim	☑
D/L PFD Lim	☑
Xpdr Power	☑
Xpdr BW	☑
HPA OBO	☑

Performance computed from user specified HPA power rating and required availability.

Carrier Information

Carrier ID:	ASTCA SESGS NOAA 10Mbps FWD
Carrier Type:	Digital
Revision Number:	1
Uplink Center Frequency [MHz]:	28,709.0000
Downlink Center Frequency [MHz]:	18,909.0000
Information Rate [Mbit/s]:	19.1584
Overhead [Mbit/s]:	0.1916
Composite Data Rate [Mbit/s]:	19.3500
Inner Code Rate	0.77400
RS Code (n,k):	N/A
Outer Code Rate	
Effective Code Rate:	0.77400
Modulation Type:	32APSK
Number of Bits Per Symbol:	5.0000 MHz
Symbol Rate [Msym/s]:	5.0000
Noise Bandwidth [MHz]:	5.0000
Filter Roll-off Factor	0.05
Spreading Factor	1.00
Bandwidth Allocation Factor:	1.05
Allocated Bandwidth [MHz]:	5.2500
Required Clear-Sky C/N [dB]:	13.9
Required Clear-Sky Eb/No [dB]:	8.0
Required Rain-Degraded C/N [dB]:	7.6
Required Rain-Degraded Eb/No [dB]:	4.5
Required Link Availability [%/yr]:	98.500%
Required C/N Rain Margin [dB]:	
Required Eb/No Rain Margin [dB]:	
Other Carrier Losses [dB]:	0.0
Required System Margin [dB]:	0.5
Link Budget Type	Preliminary

Transmit E/S Information

Name:	SUN_LH
Code:	SUN_LH
City / Country:	Sunset Beach/U.S.A.
Latitude [deg N]:	21.670000
Longitude [deg E]:	201.970000
Altitude [m]:	0
Range to Satellite [km]:	9,026.4
True Azimuth [deg]:	150.9
True Elevation [deg]:	48.8
Magnetic Azimuth [deg]:	141.3
Effective (Refracted) Elevation [deg]:	48.8
Distance from Beam Center [km]:	0.00
Offset from Beam Center [deg]:	0.00
HPA Size [W]:	500.0
HPA Required Size [W]:	3.1
HPA Operating Mode:	
HPA Operation Loss [dB]:	0.0
UPC Type:	AUPC
UPC Dynamic Range [dB]:	9.0
Uplink System Loss [dB]:	2.5
Diameter / Effective Aperture [m]:	7.3
Efficiency [%]:	74.0%
Antenna Gain (at Cxr Uplink Freq) [dBi]:	65.5
Radome Loss [dB]:	0.0
Antenna Uplink Mispointing Loss [dB]:	0.0
Uplink Depolarization Loss [dB]:	0.0
Other Uplink Losses [dB]:	0.0
Uplink Aspect Correction [dB]:	-0.3
Total HPA OBO (All Carriers)	-23.8
Maximum HPA OBO	-4.0

Receive E/S Information

Name:	SMA_PAP_002
Code:	SMA_PAP_002
City / Country:	Pago Pago, American Samoa/U.S.A.
Latitude [deg N]:	-14.330000
Longitude [deg E]:	189.250000
Altitude [m]:	195
Range to Satellite [km]:	9,303.0
True Azimuth [deg]:	61.4
True Elevation [deg]:	43.4
Magnetic Azimuth [deg]:	49.7
Effective (Refracted) Elevation [deg]:	43.4
Distance from Beam Center [km]:	40.29
Offset from Beam Center [deg]:	0.17
Radome Loss [dB]:	0.0
Diameter / Effective Aperture [m]:	2.4
Efficiency [%]:	74.9%
Antenna Gain (at Cxr Downlink Freq) [dBi]:	52.3
Downlink Feed Loss [dB]:	0.5
Antenna Noise Temperature [K]:	51.7
LNA Noise Temperature [K]:	120.0
Ambient Temperature [K]:	290.0
System Noise Temperature (Clear-Sky) [K]:	200.0
MEO Boost Gain [dB]:	0.0
Effective G/T (Clear-Sky) [dB/K]:	28.8
Antenna Downlink Mispointing Loss [dB]:	0.5
Downlink Depolarization Loss [dB]:	0.0
Other Downlink Losses [dB]:	0.0
Downlink Aspect Correction [dB]:	0.0

Bandwidth Analysis

Allocated Bandwidth [MHz/%]:	5.2500	2.43%
Power Equivalent Bandwidth [MHz/%]:	5.2860	2.45%
Leased Bandwidth [MHz/%]:	5.2860	2.45%
Capacity Optimal / BW / PWR Limited:	Capacity Optimal	

** The predicted availability for rain on uplink may be worse than actual due to un-modeled gain compression.

Uplink Calculations

	Clear	Rain Up **	Rain Dn
E/S HPA Required Size [dBW]:	4.9	4.9	4.9
E/S HPA Operation Loss [dB]:	0.0	0.0	0.0
E/S HPA OBO (per-carrier) [dB]:	-13	-13	-13
UPC Power Boost [dB]:	0.0	*9.0*	0.0
Effective E/S HPA OBO (per-carrier) [dB]:	-13.0	*-4.0*	-13.0
Power at HPA Output Flange [dBW]:	-8.1	*0.9*	-8.1
E/S HPA C/IM [dB]:	200.0	200.0	200.0
Uplink System Loss [dB]:	2.5	2.5	2.5
Power at Antenna Input Flange [dBW]:	-10.6	*-1.6*	-10.6
Uplink Antenna Gain [dBi]:	65.5	65.5	65.5
Uplink EIRP [dBW]:	54.9	*63.9*	54.9
Radome Loss [dB]:	0.0	0.0	0.0
Effective Uplink EIRP [dBW]:	54.9	*63.9*	54.9
Uplink Free Space Loss [dB]:	200.7	200.7	200.7
Uplink Miscellaneous Losses [dB]:	0.0	0.0	0.0
Uplink Propagation Loss Margin [dB]:	0.9	*21.8*	0.9
Uplink ALC Gain [dB]	0.0	*11.9*	0.0
Uplink Diversity Gain [dB]	0.0	*0.0*	0.0
Uplink Availability [%/yr]:		*99.842%*	0.000%
Gain of 1m^2 Antenna [dBi]:	50.6	50.6	50.6
Carrier FD From Direction of Uplink E/S [dBW/m^2]:	-96.1	*-108.0*	-96.1
Transponder SFD from Beam-Peak [dBW/m^2]:	-73.8	-73.8	-73.8
Uplink Aspect Correction [dB]:	-0.3	-0.3	-0.3
Transponder SFD from Direction of Tx E/S [dBW/m^2]:	-74.1	-74.1	-74.1
IMUX Filter Response [dB]:	-0.1	-0.1	-0.1
Carrier Input Backoff [dB]:	-22.1	-22.1	-22.1
Transponder Beam-Peak G/T [dB/K]:	5.4	5.4	5.4
Transponder G/T in Direction of Tx E/S [dB/K]:	5.7	5.7	5.7
Uplink Thermal Noise C/N [dB]:	20.6	*8.7*	20.6
Uplink Co-Channel Interference (CCI) C/I [dB]:	50.1	*38.2*	50.1
Uplink Adjacent Satellite Interference (ASI) C/I [dB]:	200.0	*200.0*	200.0

Transponder Calculations

	Clear	Rain Up	Rain Dn
Xpdr Dlk Saturation EIRP Towards Beam-Peak [dBW]:	49.0	49.0	49.0
Xpdr Dlk Saturation EIRP Towards Receive E/S [dBW]:	49.0	49.0	49.0
Carrier OBO - IBO Delta [dB]:	2.2	*2.2*	2.2
Carrier Output Backoff [dB]:	-19.9	*-19.9*	-19.9
OMUX Filter Response [dB]:	0.0	0.0	0.0
Carrier Downlink EIRP Towards Beam-Peak [dBW]:	29.0	29.0	29.0
Downlink Aspect Correction [dB]:	0.0	0.0	0.0
Carrier Downlink EIRP (Towards Receive E/S) [dBW]:	29.1	*29.1*	29.1
Transponder HPA Intermodulation C/IM [dB]:	20.4	*20.4*	20.4
Adjacent Carrier Interference (ACI) C/I [dB]:	26.4	*26.4*	26.4

Downlink Calculations

	Clear	Rain Up	Rain Dn
Downlink Free Space Loss [dB]:	197.4	197.4	197.4
Downlink Miscellaneous Losses [dB]:	0.5	0.5	0.5
Downlink Propagation Loss Margin [dB]:	0.7	0.7	*9.7*
Downlink Diversity Gain [dB]	0.0	0.0	*0.0*
Downlink Availability [%/yr]:		0.000%	*99.557%*
Effective Rx E/S G/T [dB/K]:	28.8	28.8	*25.6*
Downlink Thermal Noise C/N [dB]:	21.0	*21.0*	*8.7*
Downlink Co-Channel Interference C/I [dB]:	57.4	*57.4*	57.4
Downlink Adjacent Satellite Interference C/I [dB]:	40.0	*40.0*	40.0

Performance Summary

	Clear	Rain Up	Rain Dn
Carrier Total C/N [dB]:	15.5	*8.1*	*8.1*
Other Carrier Losses [dB]:	0.0	0.0	0.0
Predicted C/N [dB]:	15.5	*8.1*	*8.1*
Required C/N [dB]:	13.9	7.6	7.6
Predicted Eb/No [dB]:	9.6	*5.0*	*5.0*
Required Eb/No [dB]:	13.9	7.6	7.6

Feasibility Analysis

	Achieved C/W	Achieved CW & Rain	Required	Satisfied?
C/W System Margin [dB]:	1.6	0.5	0.5	YES
Required Link Availability [%/yr]:		99.399%	98.500%	YES
Required Eb/No Rain Margin:	1.14			N/A

Uplink Off-Axis EIRP Margin

Effective Carrier U/L Boresight EIRP [d	FALSE
Off-Axis Analysis Angle [deg]:	3.0
Antenna Off-Axis Gain [dBi]:	17.1
Carrier U/L Off-Axis EIRP [dBW]:	-48.5
ITU Off-Axis EIRP Limit [dBW]:	48.0
Off-Axis EIRP Limit Margin [dB]:	96.5

Downlink PFD Margin

Carrier D/L EIRP at Beam Peak [dBW]:	FALSE
Assumed Angle of Arrival [deg]:	5.0
Path Loss Towards Ang Arr [dB]:	201.5
PFD at Earth's Surface [dBW/m^2]:	-154.5
ITU RR-28 Limit [dBW/m^2]:	-108.0
PFD Margin [dB]:	46.5

Noise Analysis

	Percent of Total [%]			C/I or C/IM or C/N [dB]		
	Clear	Rain Up	Rain Dn	Clear	Rain Up	Rain Dn
E/S HPA IM	0.0%	0.0%	0.0%	200.0	200.0	200.0
Uplink Thermal Noise	5.6%	87.1%	5.6%	20.6	8.7	20.6
Uplink CCI	0.0%	0.1%	0.0%	50.1	38.2	50.1
Uplink ASI	0.0%	0.0%	0.0%	200.0	200.0	200.0
Xpdr HPA IM	5.8%	5.8%	5.8%	20.4	20.4	20.4
ACI	1.5%	1.5%	1.5%	26.4	26.4	26.4
Downlink Thermal Noise	5.2%	5.2%	87.0%	21.0	21.0	8.7
Downlink CCI	0.0%	0.0%	0.0%	57.4	57.4	57.4
Downlink ASI	0.1%	0.1%	0.1%	40.0	40.0	40.0
Total Noise	**18.2%**	**99.8%**	**100.0%**	**15.5**	**8.1**	**8.1**

Modulation	Information	Overhead	Modulation	Composite		is C/W	Required C/N	Predicted C/	Ulk/Dlk	Ulk/Dlk	Ulk/Dlk	Availability		