SES LINK BUDGET ANALYSIS

PREPARED BY
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DATE
20-Jun-19
BUSINESS PARTNER

PROJECT
GEE SES-14 NA
REVISION
GEE SES-14 NA Analysis

Satellite		SES-14
Orbital location	°E	-47.50

Transponder information		
Transponder ID		NAV-D21/NAH-D21 (Multi-Carrier) FCA37
Center frequency and polarisation (U/D)	MHz	14295 VLP / 11995 HLP
Bandwidth	MHz	72.00
Transponder Dlk Saturation EIRP Towards Beam-Peak	dBW	54.24
Transponder Beam-Peak G/T	dB/K	8.01
Beam-Peak SFD	dBW/m²	-92.17
Operational mode		Multiple Carrier, [IBO: -4.5 dB | OBO: -3.5 dB]
Inclined (Yes,No)		No

AGGREGATE RESOURCE REQUIREMENTS		
Capacity Balanced / BW / PWR Limited		
Number of carriers in transponder		3
Required bandwidth	MHz	70.3
Allocated bandwidth	MHz	59.32
PEB of carriers	MHz	70.29

ANALYSIS HIGHLIGHTS ACROSS ALL SITES IN ANALYSI

Link margin review [over sites]	
Site with highest clear sky link margin	Ku_Tecom_KuStream1000 >Holmdel Teleport Woodbine K-13 SES-14 Ku-Band TT&C/GW : 1.8 dB
Site with lowest clear sky link margin	Holmdel Teleport Woodbine K-13 SES-14 Ku-Band TT&C/GW>Ku_Tecom_KuStream1000 : 0.2 dB
Link availability review [over sites]	
Site with highest link availability	Holmdel Teleport Woodbine K-13 SES-14 Ku-Band TT&C/GW>Ku_Tecom_KuStream1000 : 99.6226 %
Site with lowest link availability	Ku_Tecom_KuStream1000 >Holmdel Teleport Woodbine K-13 SES-14 Ku-Band TT&C/GW : 99.0000 %

Calculation type		Uncorrelated rain events	Uncorrelated rain events	Uncorrelated rain events
Carrier Name		**GEE D21 RTN 512kbps C)**	**GEE D21 RTN 1024kb (**	**GEE D21 FWD 54MHz CXR v6**
Carrier PEB	MHz	**0.09**	**0.19**	**70.00**
Carrier Predicted Total C/(N+I)	dB	1.05	4.06	6.50
Link total Eb/No	dB	7.07	7.07	4.31
Required Eb/No (including implementation and additional margin)	dB	5.30	5.30	4.16
Link closes? [3 out of 3]		Yes	Yes	Yes
Link margin in clear sky (For ACM carriers, residual margin in CS)	dB	1.77	1.77	0.15
Target Link Availability	% yr	99.000	99.000	99.000
Achieved Link Availability	% yr	99.000	99.000	99.623
Availability Requirement Satisfied? [3 out of 3]		Yes	Yes	Yes
Balanced/Power/Bandwidth limited		**BW Lim**	**BW Lim**	**PWR Lim**
Summary of carrier emission levels in dBW/Hz				
Carrier power density at transmit antenna flange	dBW/Hz	-53.28	-50.23	-66.07
Carrier Uplink EIRP density	dBW/Hz	-24.99	-21.95	-8.86
Carrier power flux spectral density	dBW/m2/Hz	-187.98	-184.94	-173.32
Carrier Downlink EIRP density at beam peak	dBW/Hz	-41.17	-38.13	-25.91

EARTH STATIONS				
Tx earth station ID		Ku_Tecom_KuStream1000	Ku_Tecom_KuStream10	Holmdel Teleport Woodbine K-13 SES-14 Ku-Band TT&C/GW
Latitude	°N	38.84	38.84	40.39

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Longitude	°E	-76.22	-76.22	285.83
Antenna diameter	m	0.38	0.38	6.10
Skew angle at transmit location	deg.	30.65	30.65	27.65
Effective (Refracted) Elevation	deg.	36.24	36.24	36.03
Uplink aspect correction	dB	0.73	0.73	1.71
Receive earth station ID		Holmdel Teleport Woodbine	Holmdel Teleport Woodb	Ku_Tecom_KuStream1000
Latitude	°N	40.39	40.39	38.84
Longitude	°E	285.83	285.83	-76.22
Antenna diameter	m	6.10	6.10	0.38
Skew angle at receive location	deg.	27.65	27.65	30.65
Effective (Refracted) Elevation	deg.	36.03	36.03	36.24
Effective G/T at the carrier frequency (Clear-Sky)	dB/K	34.29	34.29	12.06
Downlink aspect correction	dB	1.29	1.29	1.01

CARRIER INFORMATION				
Carrier uplink centre frequency	MHz	14295.00	14295.00	14295.00
Carrier downlink centre frequency	MHz	11995.00	11995.00	11995.00
Number of carriers		1.00	1.00	1.00
Modulation setting name (clear sky)		OQPSK_1/2_TURBO_1.3_	OQPSK_1/2_TURBO_1.	QPSK 5/6_S2|OFF|N_1.20
Information rate (clear sky)	Mbps	0.51	1.02	74.46
Symbol rate	Msps	0.51	1.02	45.00
Aggregate code rate (clear sky)		0.50	0.50	0.83
Noise Bandwidth	MHz	2.05	2.05	45.00
Spreading Factor		4.00	2.00	1.00
Allocated bandwidth	MHz	2.66	2.66	54.00
Power Equivalent Bandwidth	MHz	0.09	0.19	70.00
ACM analysis (constant SR)				
Spectral efficiency in clear sky	b/sym	1.00	1.00	1.65
Clear sky throughput	Mbps	0.51	1.02	74.46
Clear sky achievable modulation setting		OQPSK_1/2_TURBO_1.3	OQPSK_1/2_TURBO_1.	QPSK 5/6_S2|OFF|N_1.20
Under fade: Spectral efficiency at required availability	b/sym	1.00	1.00	0.99
Under fade: Throughput when meeting the required availability	Mbps	0.51	1.02	44.50
Under fade : Mod Cod meeting the required availability		OQPSK_1/2_TURBO_1.3_	OQPSK_1/2_TURBO_1.	QPSK 1/2_S2|OFF|N_1.20

LINK BUDGET				
Uplink Calculations				
Carrier Input Backoff in clear sky	dB	-33.30	-30.26	-4.62
$C/N_{UP,Thermal}$: Uplink Thermal Noise ratio (clear sky)	dB	3.47	6.51	18.72
$C/I_{UP,\ NO\ ASI}$: Uplink Thermal Noise and interference ratio prior to ASI (clear sky)	dB	3.46	6.49	18.41
$C/(N+I)_{UP}$ Uplink Thermal Noise and interference ratio (clear sky)	**dB**	**2.16**	**5.19**	**17.19**
Total propagation loss considering uplink rain fade	dB	1.92	1.92	4.50
Resulting uplink path availability	**% yr**	**99.0166**	**99.0166**	**99.8924**
Downlink Calculations				
Carrier Downlink EIRP towards Receive E/S	dBW	20.66	23.70	49.61
Carrier Downlink EIRP at beam peak	dBW	21.94	24.98	50.62
Carrier Output Backoff (clear sky)	dB	-32.30	-29.26	-3.62
$C/I_{DN,\ NO\ ASI}$: Downlink Thermal Noise and interference ratio prior to ASI (clear sky)	dB	7.90	10.82	7.76
$C/N_{DN,Thermal}$: Downlink Thermal Noise ratio (clear sky)	dB	14.67	17.71	7.98
$C/(N+I)_{DN}$ Downlink Thermal Noise and interference ratio (clear sky)	**dB**	**7.51**	**10.44**	**6.88**
Total propagation loss considering downlink rain fade	dB	7.01	7.03	2.24
Resulting downlink path availability	**% yr**	**99.98**	**99.98**	**99.73**

NOISE CONTRIBUTION ANALYSIS				
Limiting factor		**Uplink Thermal Noise**	**Uplink Thermal Noise**	**Downlink Thermal Noise**
E/S HPA Intermodulation	dB	33.00	33.00	33.00
Uplink Thermal Noise	dB	**3.47**	**6.51**	18.72
Uplink Co-channel Interference	dB	33.00	33.00	33.00
Uplink Adjacent Satellite Interference	dB	8.04	11.08	23.29
Transponder Intermodulation	dB	9.08	12.12	24.34
Adjacent Channel Interference	dB	27.00	27.00	27.00
Downlink Thermal Noise	dB	14.67	17.71	**7.98**
Downlink Co-channel Interference	dB	26.00	26.00	26.00
Downlink Adjacent Satellite Interference	dB	18.16	21.20	14.26
Thermal noise delta (Up - Dn)	dB	**11.20**	**11.20**	**10.74**
Upper bound to C/(N+I)	dB	**3.15**	**6.19**	**7.63**

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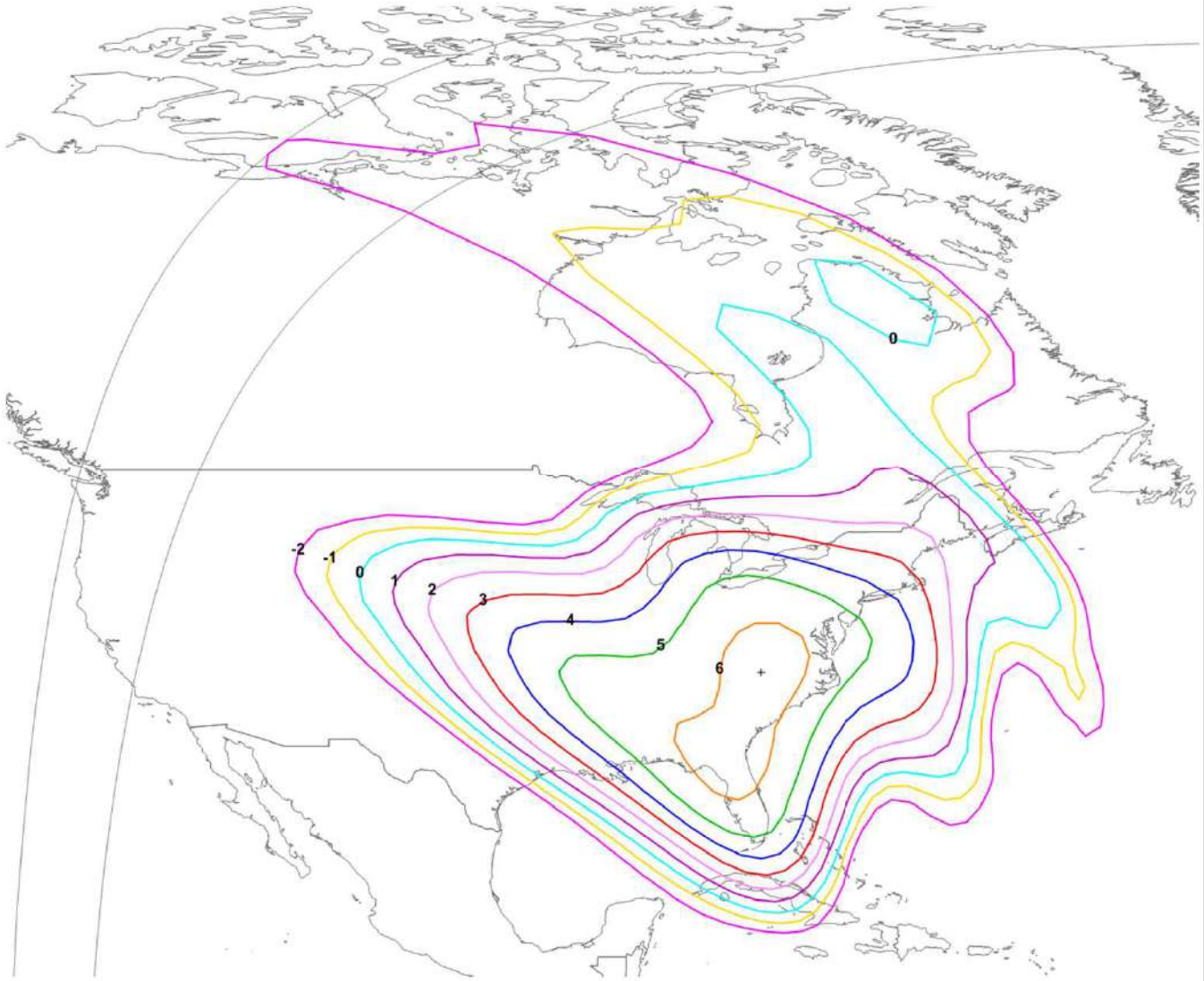
Total C/(N+I) clear sky	**dB**	**1.05**	**4.06**	**6.50**
Total Eb/No	dB	7.07	7.07	4.31
Total C/(N+I), excluding ASI, clear sky	**dB**	**2.12**	**5.12**	**7.40**
Link margin in clear sky (For ACM carriers, residual margin in CS	**dB**	**1.77**	**1.77**	**0.15**
POWER DENSITY REVIEW				
Carrier power density at antenna flange (clear sky)	dBW/Hz	-53.28	-50.23	-66.07
Uplink EIRP density	dBW/Hz	-24.99	-21.95	-8.86
Skew angle at transmit location	deg.	30.65	30.65	27.65
Uplink off-axis EIRP density at 2 deg.	dBW/Hz	-36.78	-33.74	-44.60
Downlink EIRP density at beam peak	dBW/Hz	-41.17	-38.13	-25.91
HPA Sizing				
Total number of carriers through HPA		1.00	1.00	1.00
Total EIRP required from E/S	dBW	38.01	41.05	67.67
UPC Range	dB	0.00	0.00	0.00
HPA type/mode		SSPA | Multi Carrier	SSPA | Multi Carrier	Not Defined | Multi Carrier
Required backoff	dB	-1.00	-1.00	-4.00
Required HPA capability	W	12.13	24.43	31.34
Recommended HPA size	W	16.00	25.00	35.00

Satellite Coverage Beams

Ku-band

Ku-band: USA, East coast (NA) G/T



Contours Shown

G/T [dB/K]	Min. SFD [dBW/m²]	Max. SFD [dBW/m²]
6.4	Beam peak	
6	-102	-77
5	-101	-76
4	-100	-75
3	-99	-74
2	-98	-73
1	-97	-72
0	**-96**	**-71**
-1	**-95**	**-70**

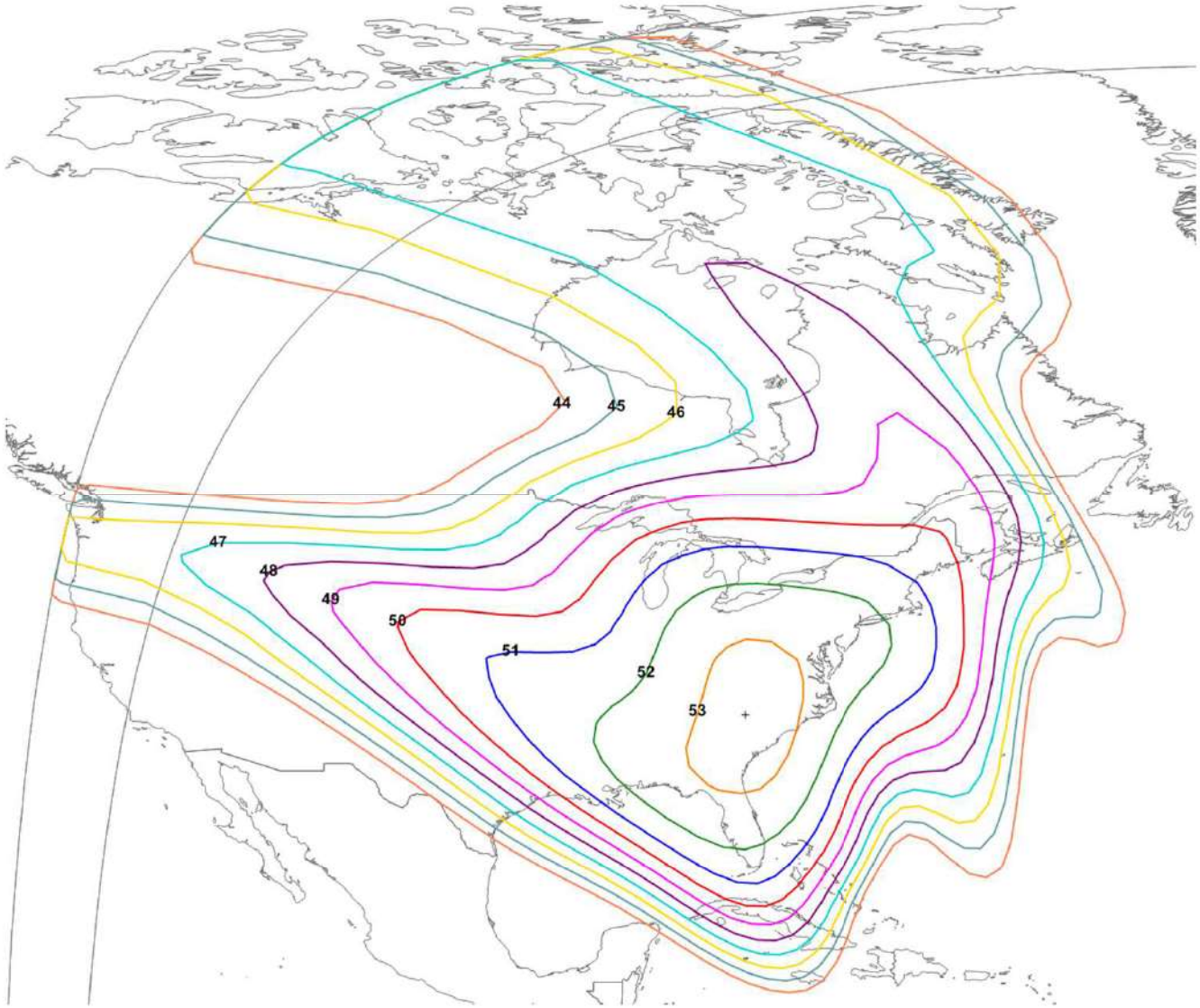
Notes

The adjacent plot shows the predicted performance of a satellite transponder. The coverage is preliminary and performance changes should be expected..

The value in bold represents the nominal edge of coverage. For operation beyond this contour, co-channel interference levels should be assessed on a case by case basis.

Elevation Angles are shown at 0 and 5 degrees.

Ku-band: USA, East coast (NA) EIRP



Contours Shown

EIRP [dBW]

53.4 Beam peak

52
51
50
49
48
47
46
45
44

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