BroadwaveUSA™
Creating Cable Competition with Northpoint Technology

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February 12, 2001

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

VIA HAND DELIVERY

Magalie Roman Salas, Secretary
Federal Communications Commission
The Portals, 445 12th Street, S.W., Room TW-B204
Counter TW-A325
Washington, D.C. 20554

Re: *Ex Parte* Presentation – In the Matter of Applications of BroadwaveUSA, PDC Broadband Corporation, and Satellite Receivers, Ltd., to Provide a Fixed Service in the 12.2-12.7 GHz Band, ET Docket No. 98-206, RM-9147, RM-9245

Dear Ms. Salas:

Pursuant to 47 C.F.R. Section 1.1206, Northpoint Technology, Ltd. and Broadwave USA, submits this letter to report a February 9, 2001 email transmittal from Mr. Robert Combs of Northpoint to Mr. Jim Marshall of The MITRE Corporation. Attached to the email and provided herewith are Northpoint's "Answers to the Second Set of Questions for the MVDDS Industry from the MITRE Corporation."

Respectfully submitted,

Antoinette Cook Bush
Executive Vice President
Northpoint Technology, Ltd.
Broadwave USA

Attachments

cc: Julius Knapp
Thomas Stanley
Thomas Derenge
Rebecca Dorch
Michael Marcus
Mark Oakey
Paul Locke

No. of Copies rec'd 0+12
List A B C D E

Bob Combs

From: Bob Combs <bobcombs@sso.org>
To: Jim Marshall <jmarshal@mitre.org>
Cc: <txTV@aol.com>; Sophia Collier <sophia@efund.com>; Antoinette C. Bush <abush@sso.org>
Sent: Friday, February 09, 2001 4:07 PM
Attach: MITREpackage.ZIP; ResponseMitreQuestions.doc
Subject: Re: 2nd set of questions

Dear Jim,

We are pleased to provide you with our answers to the second set of questions concerning the potential impact of Northpoint interference into DBS receivers.

Additionally, I am providing the ITU circular letter 116 cited in our response, which provides an example calculation of G/T, along with a supplemental spreadsheet which may be used to compute various parameters of DBS systems from information submitted to the ITU.

If there are any questions or comments, please contact me directly.

Regards,

Bob Combs
==
Dir. System Development
Broadwave USA
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400 North Capitol, St. N.W.
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Washington DC 20001

cc: FCC (Magalie Roman Salas) w/copy of spreadsheet.

----- Original Message -----
From: Jim Marshall <jmarshal@mitre.org>
To: txtv <txtv@aol.com>; bobcombs <bobcombs@sso.org>; rggould <rggould@mindspring.com>; dcharles <dcharles@gbonline.com>; dapatillo <dapatillo@directv.com>; ed.petruzzelli <ed.petruzzelli@echostar.com>
Cc: <mmarcus@fcc.gov>
Sent: Tuesday, February 06, 2001 3:06 PM
Subject: 2nd set of questions

> Please find attached a second set of questions related to the

potential
> impact of MVDDS interference into DBS receivers. Two documents are
> attached. One document has questions for the MVDDS industry and one
is
> for the DBS industry. Please provide answers to these questions as
soon
> as possible. Answers can be provided by return e-mail or to the
> addresses given in the attached documents.
>
> Note that this e-mail is being sent only to the designated POC for
each
> company.
>
> Thanks for your assistance.
> --
> Jim Marshall
> Principal Staff
> Network and Communications Engineering
> The MITRE Corporation
> (703) 883-5488 voice
> (703) 883-7142 fax

Answers to the Second Set of Questions for the MVDDS Industry from the MITRE Corporation

1. *To determine the rain margin an important calculation is the decrease of the receive antenna G/T as a result of rain losses. In order to calculate G/T in rain we need some antenna parameters. Please describe your methodology for computing G/T and provide the LNB noise figure, feed loss, antenna efficiency loss, and other losses used for this calculation in your analyses of the DBS receive antenna.*

We recommend accounting for the decrease of antenna G/T by calculating the increase in the noise due to rain, and subtracting it from the rain margin, which is the method that we have used. We assume that DBS system has a clear sky noise temperature of 120°K, including the contribution of the LNB noise, the feed loss and antenna efficiency losses.[1]

To determine G (gain of the antenna), we have test results indicating gain of 33.8 to 34 dBi or greater, which is the gain assumed. The antenna efficiency for the 45 cm antenna is generally assumed to be above 70%. The result is an overall clear sky G/T is thus better than 13 dB/°K. While the actual G/T achieved in the field is generally better than 13 dB/°K, we have used this figure as a minimum in calculating reliability and availability.

The increase in noise due to rain along a path to a satellite can be calculated from the following equation:

```
dRx_Temp=10*LOG((Rx_Temp+290*(1-10^(-(A_Gaz_dw + Ap_dw)/10)))/Rx_Temp)
```

where:

Rx_Temp = Clear sky receive system noise temperature at antenna output (120°K),
A_Gaz_dw = Atmospheric absorption (generally assumed to be 0.2 dB[2]),
Ap_dw = Rain attenuation for availability percentage of time, in dB,
dRx_Temp = Noise increase due to rain for availability percentage of time.

For your convenience, I have attached the ITU Circular Letter 116 annex 5, which provides the above method in spreadsheet format, and was used in the ITU study groups for calculating this parameter. (See also the answer to your question 2 below.)

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[1] Having said that, we understand that the LNB noise figure is between 0.9 and 1.1 dB, with feed coupling loss of about 0.5 dB. Assuming a sky temperature of less than 100°K, the resulting system temperature at the antenna output is then less than120°K.

[2] This is a worst-case figure. The actual atmospheric absorption is usually less than 0.2 dB in the Continental U.S.

2. *What link reliability do you currently expect for DBS receivers? Identify several cities and provide reliability values. In your view, how much degradation to these values would be acceptable if MVDDS interference were present?*

What link reliability do you currently expect for DBS receivers? Identify several cities and provide reliability values.

For the purposes of establishing link reliability or link availability one must define several system characteristics, including the point at which the link becomes unavailable. We propose to use the "loss of synchronization" point. Others have proposed to use the so-called operational threshold, typically set more than 1.5 dB above the loss of sync point.

Some further discussion on the difference between the 'quasi-error free,' 'freeze frame,' 'operational threshold,' and 'loss of sync' conditions would be illustrative. We define these conditions as follows:

- Loss of synchronization occurs when the digital signal is distorted to the extent that the QPSK demodulator fails to maintain synchronization with the bit stream, and occurs at a BER of approximately 10^{-2}.

- The quasi-error free condition occurs when the errors in the bit stream detected and uncorrected by the Reed-Solomon and Viterbi decoders are below the level of 10^{-6}.

- The operational threshold is set at an arbitrary value in the lower end of the quasi-error free range, approximately 1 to 1.5 dB above the typical freeze frame condition.

- The freeze frame condition occurs when the MPEG decoder ceases to provide full pictures. This occurs when the errors in the MPEG packets exceed a rate of 10^{-2} to 10^{-3}.

It is important to note that the last two conditions are somewhat independent. For example, the Reed-Solomon and Viterbi decoders may indicate that the bit stream is operating in a 'quasi-error free' condition, while the underlying MPEG packet stream has an inherent error rate of 10^{-5}, which may occur due to faulty MPEG encoding prior to RS and Viterbi encoding. Moreover, even if the MPEG packet stream is error free, instructions therein may cause the IRD to display a "freeze frame."

With respect to satellite EIRP and other link budget information required to perform the reliability calculation for locations within the United States, the U.S. DBS industry provided information to the ITU describing its link parameters. We have not verified this information, but we have used it to develop the attached spreadsheet supplemental analysis, according to the guidelines of ITU CR 116. Based upon this data, the analysis shows the DBS reliability for a selection of U.S. locations, according to the

ITU method for calculating availability. We are providing the supplemental analysis for both the "freeze frame" and "operational threshold" outage conditions, because the C/N values for parameters were provided to the ITU.

However, we cannot vouch for the system assumptions provided to the ITU. In fact, we have found that the margin for error in the assumptions in this spreadsheet is far greater than the amount of protection that the DBS has requested they be afforded.[3] For example, we note that the choice of "operational threshold" over "freeze frame" as the outage condition results in an "increase in unavailability" of an average of 90%, as demonstrated in the supplemental spreadsheet.

The only city for which for we have sufficient field data to make a reliability prediction is the city of Washington D.C. We performed an analysis of the data taken during our test operations in 1999, which included data taken during Hurricane Floyd. This analysis showed the DBS availability/reliability to be between about 99.9% and 99.95% in the Washington D.C. area.[4]

In your view, how much degradation to these values would be acceptable if MVDDS interference were present?

To understand what would constitute an acceptable level of degradation, one must bear in mind that the Northpoint signal strength falls off rapidly as you move away from the transmitter, so that in 99.5% of the Northpoint service area the increase in outage is not measurable.[5] Even within the nearest 0.5% of the Northpoint service area, we have determined that most DBS customers will be naturally shielded from the Northpoint transmitter, or will be protected because the DBS antenna will provide sufficient isolation from the Northpoint signal. As a result, we believe the number of affected DBS customers to be far below 0.5%

Based on the small number of affected customers, we propose a 20% increase in outage be accepted. This would be equivalent to an increase of about *1.5 hours per year* of additional outage, or a C/I ratio of about 19 dB. As a basis of comparison, this C/I ratio causes about 0.4 dB of link degradation, which is less than the "antenna pointing error" customarily used by DBS.[6] Thus, we feel that a 20% increase in outage should be considered acceptable for the few affected customers. The remainder (> 99.5%) of DBS customers will not have a measurable outage.

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[3] See also: "Technical Annex to Reply Comments of Northpoint" pages 10-12.

[4] See "Northpoint-DBS Compatibility Tests," October 1999, page 19.

[5] There is a small area within a radius of about 2 kilometers of the transmitter where some measurable interference might be found. The shape area is dependent upon the look angle of the satellite receiver, and the orientation of the Northpoint transmitter.

[6] We believe that 0.4 dB of link degradation is within the margin of error for computing the DBS availability.

For substantiation of this level, we turn to the recent agreement made between DBS and another entrant to the band (non-geostationary satellite systems) as a point of reference. In that case, DBS readily agreed to accept a 10% increase in outage (unavailability) for *every DBS customer*.[7] Thus, clearly, a 10% increase in outage for every DBS customer is one acceptable standard. We also note that DBS proposed in 1994 to allot up to 20% increase in outage to terrestrial systems in the 1994 DBS report. Thus, we feel that a 20% increase in outage should be considered acceptable.

DBS also designs their system to an availability of 99.7%.[8] Certainly from that logic, a C/I of 16 dB would be acceptable in all of the cases in the attached spreadsheet.[9]

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[7] Unavailability = 100% - Availability.

[8] See also: "Technical Annex to Reply Comments of Northpoint" pages 10-12.

[9] See spreadsheet "C_I Rqd (FF)" in the attachment.

Explanation of Sheets

This document contains three spreadsheets:

1. *"Freeze frame Point"*	This sheet provides the DBS system description, with the availability as described by the "freeze frame" outage condition.
2. *"Operational Threshold Point"*	The purpose of this spreadsheet is to show the "Percentage increase in unavailability" when using the "Operational Threshold" as the outage condition, as opposed to the "freeze frame" threshold.
3. *"C_I Rqd (FF)"*	This sheet may be used to determine the C/I due to Northpoint to cause a given "increase in unavailability" for the Freeze Frame outage condition.

To use the spreadsheets

1. *"Freeze frame Point"* 2. *"Operational Threshold Point"*	These sheets are intended to present and verify information only.
3. *"C_I Rqd (FF)"*	In this sheet, change the cells in Blue (cell B12 hours, or B13 percent) and the spreadsheet calculates the C/I required in line 21
Note:	In spreadsheet (3) the user reads the cells highlighted in GREEN

Macros and formulas

Several user defined formulas are contained in the attached Visual Basic module.

Function distance(el, rad)	'Returns distance to a satellite as function of elevation angle (degrees), 'and satellite radius (km)
Function ITU_Rain(region, polarization, sta	' ITU rain attenuation model ' based on Rec. ITU-R 618-5, 1998

The purpose of this spreadsheet is to show the "System Availability when using the "Freeze Frame" threshold as the outage condition, in line 10

Line 24 shows the C/N+I required at the outage condition, which in this case is the "Freeze Frame".

The satellite system characteristics were taken from ITU-R Recommendation BO 1444, and the associated Appendix 1, which is available at the following URL: http://www.itu.int//itudoc/itu-r/sg11/docs/sg11/1998-00/contrib/138e2.html

	Units	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA
		US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO
		1(a)	D1(a)	D2(a)	D3(a)	D6(a)	D7(a)	D8(a)	D9(a)	D10(a)	D12(a)	4A3	4A5	4A6	4A8	4A9	4A10	4D2	4D3
System Characteristics		Seattle	Florida	New York	Minn.	Seattle	Seattle	Florida	New York	Minn.	Seattle	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas
Frequency	GHz	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450
System Availability at freeze frame poi	%	99.97	99.88	99.95	99.90	99.98	99.97	99.88	99.95	99.90	99.98	99.82	99.82	99.93	99.99	99.82	99.94	99.91	99.90
Outage Hours at freeze frame point	Hours per Year	2.75	10.73	4.60	9.10	1.72	2.75	10.73	4.60	9.10	1.72	15.74	15.90	6.46	0.72	15.52	4.89	7.65	8.86
Receiver noise Bandwidth	MHz	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Modulation type		QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
C/I due to other GSO BSS networks	dB	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
C(faded)/I(unfaded) due to Northpoint req	dB	96.6	92.0	94.3	95.9	96.1	96.6	92.0	94.3	95.9	96.1	93.9	93.6	97.0	97.2	94.0	97.2	95.5	93.5
Clear sky C/I due to Northpoint require	dB	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
Clear sky feeder link C/N+I	*dB*	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1
C/N+I required at the outage condition	**dB**	**3.5**	**3.5**	**3.5**	**3.5**	**3.5**	**3.5**	**3.5**	**3.5**	**3.5**	**3.5**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**
Clear sky C/N+I margin above outage con	dB	5.1	10.6	8.3	6.3	6.9	5.1	10.6	8.3	6.3	6.9	9.2	9.4	5.4	5.1	9.1	5.0	7.5	9.5
C/N+I margin above operating threshold f	dB	2.92	2.96	3.82	2.02	4.14	2.92	2.96	3.82	2.02	4.14	1.57	1.58	2.25	3.71	1.59	2.43	2.65	3.04
Space station characteristics																			
Longitude	°	101W	101W	101W	101W	101W	101W	101W	101W	101W	101W	-148.0	-148.0	-148.0	-148.0	-148.0	-148.0	-61.5	-61.5
Satellite e.i.r.p. in the direction of the earth	dBW	48.0	53.9	51.4	49.1	48.0	48.0	53.9	51.4	49.1	48.0	53.2	53.5	48.2	48.0	53.0	48.0	50.7	53.4
Earth station characteristics		Seattle	Florida	New York	Minn.	Seattle	Seattle	Florida	New York	Minn.	Seattle	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas
Receive antenna diameter	cm	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Receive antenna efficiency	%	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
On-axis antenna gain at receiver input	dBi	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0								
On-axis antenna gain at antenna output												33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8
Clear sky receive system noise temperature	K	125	125	125	125	80	125	125	125	125	80								
Clear sky receive system noise temperature	K											85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
Clear sky G/T	*dB/K*	13.0	13.0	13.0	13.0	15.0	13.0	13.0	13.0	13.0	15.0	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5
Total pointing loss	dB	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Latitude	°	47.6	27.9	40.7	45.0	47.6	47.6	27.9	40.7	45.0	47.6	32.8	29.8	34.0	40.8	29.5	47.6	41.8	32.8
Longitude	°	122.3W	82.5W	74W	93.3W	122.3W	122.3W	82.5W	74W	93.3W	122.3W	-96.8	-95.3	-118.2	-111.9	-98.5	-122.3	-87.8	-96.8
Altitude	km	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.3	0.2	0.1	0.2	0.1
Rain climatic zone		D	N	K	K	D	D	N	K	K	D	M	M	E	B	M	D	K	M
Elevation angle	°	31.5	51.5	35.4	37.6	31.5	31.5	51.5	35.4	37.6	31.5	23.8	23.8	39.3	30.2	26.6	29.9	34.8	36.3
Propagation characteristics		Seattle	Florida	New York	Minn	Seattle	Seattle	Florida	New York	Minn	Seattle	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas
Slant path	*km*	38479	36985	38147	37966	38479	38479	36985	38147	37966	38479	39180	39186	37837	38590	38916	38620	38198	38076
Free space loss	*dB*	206.2	205.9	206.1	206.1	206.2	206.2	205.9	206.1	206.1	206.2	206.2	206.2	205.9	206.1	206.1	206.1	206.0	206.0
Atmospheric absorption	*dB*	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Rain attenuation for 99.7% of the time	dB	0.840	4.540	2.097	1.879	0.840	0.840	4.540	2.097	1.879	0.840	3.983	4.184	1.037	0.382	3.873	0.827	1.928	3.247
Noise increase due to rain for 99.7% of th	*dB*	1.485	3.987	2.761	2.589	2.141	1.485	3.987	2.761	2.589	2.141	4.840	4.928	2.367	1.097	4.790	2.017	3.470	4.466
Rain attenuation for availability percentag	dB	2.367	7.007	4.746	3.131	2.866	2.367	7.007	4.746	3.131	2.866	5.126	5.359	2.019	1.824	5.017	1.821	3.478	5.476
Noise increase due to rain for availability	*dB*	2.956	4.560	4.052	3.408	4.395	2.956	4.560	4.052	3.408	4.395	5.329	5.395	3.738	3.562	5.296	3.559	4.697	5.426
Downlink budget clear sky																			
C/N thermal clear sky downlink	*dB*	8.9	15.2	12.4	10.1	10.8	8.9	15.2	12.4	10.1	10.8	15.7	16.0	11.0	10.6	15.6	10.6	13.4	16.1
C/N+I clear sky downlink	*dB*	8.6	14.1	11.8	9.8	10.4	8.6	14.1	11.8	9.8	10.4	14.3	14.5	10.5	10.2	14.2	10.1	12.6	14.6
C/N+I clear sky total link	*dB*	8.5	13.7	11.5	9.6	10.2	8.5	13.7	11.5	9.6	10.2	14.0	14.3	10.4	10.0	14.0	10.0	12.4	14.4
Clear sky C/N downlink margin above out	dB	5.4	11.7	8.9	6.6	7.3	5.4	11.7	8.9	6.6	7.3	10.6	10.9	5.9	5.5	10.5	5.5	8.3	11.0
Clear sky C/N+I downlink margin above o	dB	5.1	10.6	8.3	6.3	6.9	5.1	10.6	8.3	6.3	6.9	9.2	9.4	5.4	5.1	9.1	5.0	7.5	9.5
Clear sky C/N+I total margin above outag	dB	5.0	10.2	8.0	6.1	6.7	5.0	10.2	8.0	6.1	6.7	8.9	9.2	5.3	4.9	8.9	4.9	7.3	9.3
Downlink budget 99.7% of the time																			
C/N thermal for 99.7% of the time, downli	*dB*	6.58	6.62	7.52	5.65	7.86	6.58	6.62	7.52	5.65	7.86	6.87	6.88	7.60	9.15	6.89	7.78	8.02	8.43
C/N+I for 99.7% of the time, downlink	*dB*	6.42	6.46	7.32	5.52	7.64	6.42	6.46	7.32	5.52	7.64	6.67	6.68	7.35	8.81	6.69	7.53	7.75	8.14
C/N margin above outage condition for 99	dB	3.08	3.12	4.02	2.15	4.36	3.08	3.12	4.02	2.15	4.36	1.77	1.78	2.50	4.05	1.79	2.68	2.92	3.33
C/N+I margin above outage condition thre	dB	2.92	2.96	3.82	2.02	4.14	2.92	2.96	3.82	2.02	4.14	1.57	1.58	2.25	3.71	1.59	2.43	2.65	3.04
Downlink budget for availability percentage of time																			
C/N thermal for availability percentage o	*dB*	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24
C/N+I for availability percentage of time,	*dB*	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
C/N margin above outage condition for av	dB	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
C/N+I margin above outage condition fo	dB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

USA	CNI	USA	USA	USA	USA	USA	CNI	USA	USA	USA	USA	USA	USA	CNI	USA	USA	USA	USA	USA	USA	USA	USA
US-GSO	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**	**US-GSO**
4D5	**4D8**	**4D9**	**4B2**	**4B3**	**4B5**	**4B6**	**4B8**	**4B9**	**4B10**	**4C2**	**4C3**	**4C5**	**4C6**	**4C8**	**4C9**	**4C10**	**1(b)**	**D1(b)**	**D2(b)**	**D3(b)**	**D6(b)**	**D7(b)**
Houston	Salt Lake City	San Antonio	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Seattle	Florida	New York	Minn.	Seattle	Seattle
12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.700	12.700	12.700	12.700	12.700	12.700
99.83	**99.98**	**99.83**	**99.91**	**99.90**	**99.83**	**99.95**	**100.00**	**99.84**	**99.96**	**99.91**	**99.88**	**99.80**	**99.92**	**100.00**	**99.79**	**99.94**	**99.98**	**99.89**	**99.95**	**99.91**	**99.98**	**99.98**
14.93	1.77	15.09	7.97	8.86	14.76	4.74	0.30	14.15	3.52	8.02	10.17	17.94	6.69	0.29	18.32	5.66	2.16	9.66	3.96	7.58	1.39	2.16
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	23.7	23.7	23.7	23.7	23.7	23.7
94.6	97.3	94.7	95.4	94.0	94.9	97.0	97.1	95.0	97.1	95.7	94.5	95.4	97.3	97.1	95.6	97.4	99.4	94.6	96.9	98.6	98.9	99.4
99.0	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**99.0**	**102.0**	**102.0**	**102.0**	**102.0**	**102.0**	**102.0**
26.1	26.1	26.1	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	24.2	24.2	24.2	24.2	24.2	24.2
5.1	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**5.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**
8.5	4.9	8.4	7.6	9.1	8.2	5.4	5.3	8.1	5.1	7.2	8.6	7.6	4.9	5.3	7.4	4.6	5.5	11.0	8.7	6.7	7.3	5.5
1.57	3.13	1.54	2.62	2.89	1.55	2.58	4.18	1.62	2.76	2.51	2.46	1.03	2.07	4.20	0.96	2.12	3.32	3.36	4.22	2.42	4.54	3.32
-61.5	-61.5	-61.5	-119.0	-119.0	-119.0	-119.0	-119.0	-119.0	-119.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	101W	101W	101W	101W	101W	101W
51.9	48.0	51.9	50.9	52.6	51.4	48.0	48.0	51.2	48.0	50.4	51.9	50.6	47.5	48.0	50.3	47.4	51.0	56.9	54.4	52.1	51.0	51.0
Houston	Salt Lake City	San Antonio	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Seattle	Florida	New York	Minn.	Seattle	Seattle
45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
																	34.0	34.0	34.0	34.0	34.0	34.0
33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8						
																	125	125	125	125	80	125
85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0						
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	13.0	13.0	13.0	13.0	15.0	13.0
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5
29.8	40.8	29.5	41.8	32.8	29.8	34.0	40.8	29.5	47.6	41.8	32.8	29.8	34.0	40.8	29.5	47.6	47.6	27.9	40.7	45.0	47.6	47.6
-95.3	-111.9	-98.5	-87.8	-96.8	-95.3	-118.2	-111.9	-98.5	-122.3	-87.8	-96.8	-95.3	-118.2	-111.9	-98.5	-122.3	122.3W	82.5W	74W	93.3W	122.3W	122.3W
0.0	1.3	0.2	0.2	0.1	0.0	0.0	1.3	0.2	0.1	0.2	0.1	0.0	0.0	1.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
M	B	M	K	M	M	E	B	M	D	K	M	M	F	B	M	D	D	N	K	K	D	D
39.4	20.7	37.1	32.2	44.9	46.6	50.5	42.3	48.9	35.2	36.6	49.2	51.7	49.5	42.8	53.3	34.0	31.5	51.5	35.4	37.6	31.5	31.5
Houston	Salt Lake City	San Antonio	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Seattle	Florida	New York	Minn.	Seattle	Seattle
37827	39482	38008	38417	37416	37298	37049	37605	37148	38162	38047	37127	36974	37109	37567	36875	38263	38479	36985	38147	37966	38479	38479
205.9	206.3	205.9	206.0	205.8	205.8	205.7	205.9	205.7	206.0	206.0	205.7	205.7	205.7	205.8	205.7	206.0	206.2	205.9	206.1	206.1	206.2	206.2
0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
3.316	0.510	3.310	2.021	2.947	3.093	0.900	0.299	2.945	0.738	1.870	2.841	2.982	0.909	0.296	2.857	0.756	0.840	4.540	2.097	1.879	0.840	0.840
4.505	1.393	4.502	3.559	4.283	4.374	2.144	0.888	4.281	1.855	3.411	4.213	4.305	2.159	0.881	4.224	1.889	1.485	3.987	2.761	2.589	2.141	1.485
4.378	1.723	4.347	3.579	4.972	4.105	2.010	1.941	3.988	1.874	3.302	4.497	3.601	1.742	1.946	3.416	1.561	2.614	7.360	5.062	3.405	3.113	2.614
5.082	3.465	5.071	4.746	5.282	4.977	3.730	3.670	4.929	3.609	4.607	5.125	4.757	3.484	3.674	4.665	3.299	3.116	4.615	4.144	3.542	4.556	3.116
14.7	10.4	14.7	13.6	15.5	14.3	11.0	10.9	14.2	10.7	13.2	14.9	13.6	10.5	10.9	13.3	10.1	11.9	18.2	15.4	13.1	13.8	11.9
13.6	10.0	13.5	12.7	14.2	13.3	10.5	10.4	13.2	10.2	12.3	13.7	12.7	10.0	10.4	12.5	9.7	11.6	17.1	14.8	12.8	13.4	11.6
13.3	9.9	13.3	12.5	13.9	13.1	10.4	10.2	12.9	10.1	12.2	13.5	12.5	9.9	10.3	12.3	9.6	11.4	16.3	14.3	12.5	13.1	11.4
9.6	5.3	9.6	8.5	10.4	9.2	5.9	5.8	9.1	5.6	8.1	9.8	8.5	5.4	5.8	8.2	5.0	5.8	12.1	9.3	7.0	7.7	5.8
8.5	4.9	8.4	7.6	9.1	8.2	5.4	5.3	8.1	5.1	7.2	8.6	7.6	4.9	5.3	7.4	4.6	5.5	11.0	8.7	6.7	7.3	5.5
8.2	4.8	8.2	7.4	8.8	8.0	5.3	5.1	7.8	5.0	7.1	8.4	7.4	4.8	5.2	7.2	4.5	5.3	10.2	8.2	6.4	7.0	5.3
6.88	8.53	6.85	7.99	8.27	6.86	7.94	9.67	6.93	8.13	7.87	7.81	6.31	7.40	9.68	6.24	7.46	9.58	9.62	10.52	8.65	10.86	9.58
6.67	8.23	6.64	7.72	7.99	6.65	7.68	9.28	6.72	7.86	7.61	7.56	6.13	7.17	9.30	6.06	7.22	9.42	9.46	10.32	8.52	10.64	9.42
1.78	3.43	1.75	2.89	3.17	1.76	2.84	4.57	1.83	3.03	2.77	2.71	1.21	2.30	4.58	1.14	2.36	3.48	3.52	4.42	2.55	4.76	3.48
1.57	3.13	1.54	2.62	2.89	1.55	2.58	4.18	1.62	2.76	2.51	2.46	1.03	2.07	4.20	0.96	2.12	3.32	3.36	4.22	2.42	4.54	3.32
5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	5.24	6.18	6.18	6.18	6.18	6.18	6.18
5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	6.1	6.1	6.1	6.1	6.1	6.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

USA	USA	USA	USA
US-GSO	**US-GSO**	**US-GSO**	**US-GSO**
D8(b)	**D9(b)**	**D10(b)**	**D12(b)**
Florida	New York	Minn.	Seattle
12.700	12.700	12.700	12.700
99.89	**99.95**	**99.91**	**99.98**
9.66	3.96	7.58	1.39
24	24	24	24
QPSK	QPSK	QPSK	QPSK
23.7	23.7	23.7	23.7
94.6	96.9	98.6	98.9
102.0	**102.0**	**102.0**	**102.0**
24.2	24.2	24.2	24.2
6.1	**6.1**	**6.1**	**6.1**
11.0	8.7	6.7	7.3
3.36	4.22	2.42	4.54

101W	101W	101W	101W
56.9	54.4	52.1	51.0
Florida	New York	Minn.	Seattle
45	45	45	45
70	70	70	70
34.0	34.0	34.0	34.0
125	125	125	80
13.0	13.0	13.0	15.0
0.5	0.5	0.5	0.5
27.9	40.7	45.0	47.6
82.5W	74W	93.3W	122.3W
0.0	0.0	0.0	0.0
N	K	K	D
51.5	35.4	37.6	31.5
Florida	New York	Minn.	Seattle
36985	38147	37966	38479
205.9	206.1	206.1	206.2
0.20	0.20	0.20	0.20
4.540	2.097	1.879	0.840
3.987	2.761	2.589	2.141
7.360	5.062	3.405	3.113
4.615	4.144	3.542	4.556

18.2	15.4	13.1	13.8
17.1	14.8	12.8	13.4
16.3	14.3	12.5	13.1
12.1	9.3	7.0	7.7
11.0	8.7	6.7	7.3
10.2	8.2	6.4	7.0

9.62	10.52	8.65	10.86
9.46	10.32	8.52	10.64
3.52	4.42	2.55	4.76
3.36	4.22	2.42	4.54

6.18	6.18	6.18	6.18
6.1	6.1	6.1	6.1
0.1	0.1	0.1	0.1
0.000	0.000	0.000	0.000

The purpose of this spreadsheet is to show the "percentage increase in unavailability" when using the "Operational Threshold" as the outage condition, as opposed to the "Freeze Frame" threshold

This spreadsheet shows the availability objective from the spreadsheet "Freeze Frame Point" as a baseline, in line 10

Line 24 shows the C/N+I required at the outage condition, which in this case is the "operational threshold".

The availability computed from this outage condition is shown in line 14.

Lines 12 and 13 show the delta between the two different levels of availability

	Units	USA US-GSO 1(a)	USA US-GSO D1(a)	USA US-GSO D2(a)	USA US-GSO D3(a)	USA US-GSO D6(a)	USA US-GSO D7(a)	USA US-GSO D8(a)	USA US-GSO D9(a)	USA US-GSO D10(a)	USA US-GSO D12(a)	USA US-GSO 4A3	USA US-GSO 4A5	USA US-GSO 4A6	USA US-GSO 4A8	USA US-GSO 4A9	USA US-GSO 4A10	USA US-GSO 4D2
System Characteristics		Seattle	Florida	New York	Minn.	Seattle	Seattle	Florida	New York	Minn	Seattle	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago
Frequency	GHz	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.450	12.450	12.450	12.450	12.450	12.450	12.450
System availability at Freeze Frame point	%	99.97	99.88	99.95	99.90	99.98	99.97	99.88	99.95	99.90	99.98	99.82	99.82	99.93	99.99	99.82	99.94	99.91
Outage Hours at freeze frame point	Hours per Year	2.75	10.73	4.60	9.10	1.72	2.75	10.73	4.60	9.10	1.72	15.74	15.90	6.46	0.72	15.52	4.89	7.65
Increase in outage hours at "operational threshold"	Hours per Year	4.84	5.71	3.82	10.37	2.28	4.84	5.71	3.82	10.37	2.28	6.33	6.16	5.96	0.95	6.36	5.12	4.45
Percentage increase in unavailability	%	176.2%	53.2%	83.0%	113.9%	132.4%	176.2%	53.2%	83.0%	113.9%	132.4%	40.2%	38.8%	92.3%	132.6%	40.9%	104.6%	58.1%
Availability at "Operating Threshold" point	%	99.913	99.812	99.904	99.778	99.954	99.913	99.812	99.904	99.778	99.954	99.748	99.748	99.858	99.981	99.750	99.886	99.862
Receiver noise Bandwidth	MHz	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Modulation type		QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
C/I due to other GSO BSS networks	dB	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.0	20.0	20.0	20.0	20.0	20.0	20.0
C(faded)/I(unfaded) due to Northpoint required for Percentage increa	dB	97.5	93.3	95.4	96.8	97.0	97.5	93.3	95.4	96.8	97.0	94.7	94.4	97.5	97.7	94.8	97.7	96.2
Clear sky C/I due to Northpoint required for Percentage increase in t	dB	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
Clear sky feeder link C/N+I	dB	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	26.1	26.1	26.1	26.1	26.1	26.1	26.1
C/N+I required at the outage condition	**dB**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**
Clear sky C/N+I margin above outage condition	dB	3.6	9.1	6.8	4.8	5.4	3.6	9.1	6.8	4.8	5.4	8.2	8.4	4.4	4.1	8.1	4.0	6.5
C/N+I margin above operating threshold for 99.7% of the time	dB	1.42	1.46	2.32	0.52	2.64	1.42	1.46	2.32	0.52	2.64	0.57	0.58	1.25	2.71	0.59	1.43	1.65
Space station characteristics																		
Longitude	°	101W	101W	101W	101W	101W	101W	101W	101W	101W	101W	-148.0	-148.0	-148.0	-148.0	-148.0	-148.0	-61.5
Satellite e.i.r.p. in the direction of the earth station	dBW	48.0	53.9	51.4	49.1	48.0	48.0	53.9	51.4	49.1	48.0	53.2	53.5	48.2	48.0	53.0	48.0	50.7
Earth station characteristics		Seattle	Florida	New York	Minn.	Seattle	Seattle	Florida	New York	Minn	Seattle	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago
Receive antenna diameter	cm	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Receive antenna efficiency	%	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
On-axis antenna gain at receiver input	dBi	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0							
On-axis antenna gain at antenna output												33.8	33.8	33.8	33.8	33.8	33.8	33.8
Clear sky receive system noise temperature at receiver input	K	125	125	125	125	80	125	125	125	125	80							
Clear sky receive system noise temperature at antenna output	K											85.0	85.0	85.0	85.0	85.0	85.0	85.0
Clear sky G/T	*dB/K*	13.0	13.0	13.0	13.0	15.0	13.0	13.0	13.0	13.0	15.0	14.5	14.5	14.5	14.5	14.5	14.5	14.5
Total pointing loss	dB	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Latitude	°	47.6	27.9	40.7	45.0	47.6	47.6	27.9	40.7	45.0	47.6	32.8	29.8	34.0	40.8	29.5	47.6	41.8
Longitude	°	122.3W	82.5W	74W	93.3W	122.3W	122.3W	82.5W	74W	93.3W	122.3W	-96.8	-95.3	-118.2	-111.9	-98.5	-122.3	-87.8
Altitude	km	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.3	0.2	0.1	0.2
Rain climatic zone		D	N	K	K	D	D	N	K	K	D	M	M	L	B	M	D	K
Elevation angle	°	31.5	51.5	35.4	37.6	31.5	31.5	51.5	35.4	37.6	31.5	23.8	23.8	39.3	30.2	26.6	29.9	34.8
Propagation characteristics		Seattle	Florida	New York	Minn.	Seattle	Seattle	Florida	New York	Minn.	Seattle	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago
Slant path	*km*	38479	36985	38147	37966	38479	38479	36985	38147	37966	38479	39180	39186	37837	38590	38916	38620	38198
Free space loss	*dB*	206.2	205.9	206.1	206.1	206.2	206.2	205.9	206.1	206.1	206.2	206.2	206.2	205.9	206.1	206.1	206.1	206.0
Atmospheric absorption	*dB*	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Rain attenuation for 99.7% of the time	dB	0.840	4.540	2.097	1.879	0.840	0.840	4.540	2.097	1.879	0.840	3.983	4.184	1.037	0.382	3.873	0.827	1.928
Noise increase due to rain for 99.7% of the time	*dB*	1.485	3.987	2.761	2.589	2.141	1.485	3.987	2.761	2.589	2.141	4.840	4.928	2.367	1.097	4.790	2.017	3.470
Rain attenuation for availability percentage of time	dB	1.521	5.721	3.622	2.181	2.020	1.521	5.721	3.622	2.181	2.020	4.346	4.566	1.494	1.321	4.244	1.318	2.813
Noise increase due to rain for availability percentage of time	*dB*	2.267	4.311	3.641	2.824	3.707	2.267	4.311	3.641	2.824	3.707	5.070	5.150	3.226	3.028	5.032	3.024	4.325
Downlink budget clear sky																		
C/N thermal clear sky downlink	*dB*	8.9	15.2	12.4	10.1	10.8	8.9	15.2	12.4	10.1	10.8	15.7	16.0	11.0	10.6	15.6	10.6	13.4
C/N+I clear sky downlink	*dB*	8.6	14.1	11.8	9.8	10.4	8.6	14.1	11.8	9.8	10.4	14.3	14.5	10.5	10.2	14.2	10.1	12.6
C/N+I clear sky total link	*dB*	8.5	13.7	11.5	9.6	10.2	8.5	13.7	11.5	9.6	10.2	14.0	14.3	10.4	10.0	14.0	10.0	12.4
Clear sky C/N downlink margin above outage condition	dB	3.9	10.2	7.4	5.1	5.8	3.9	10.2	7.4	5.1	5.8	9.6	9.9	4.9	4.5	9.5	4.5	7.3
Clear sky C/N+I downlink margin above outage condition	dB	3.6	9.1	6.8	4.8	5.4	3.6	9.1	6.8	4.8	5.4	8.2	8.4	4.4	4.1	8.1	4.0	6.5
Clear sky C/N+I total margin above outage condition	dB	3.5	8.7	6.5	4.6	5.2	3.5	8.7	6.5	4.6	5.2	7.9	8.2	4.3	3.9	7.9	3.9	6.3
Downlink budget 99.7% of the time																		
C/N thermal for 99.7% of the time, downlink	*dB*	6.58	6.62	7.52	5.65	7.86	6.58	6.62	7.52	5.65	7.86	6.87	6.88	7.60	9.15	6.89	7.78	8.02
C/N+I for 99.7% of the time, downlink	*dB*	6.42	6.46	7.32	5.52	7.64	6.42	6.46	7.32	5.52	7.64	6.67	6.68	7.35	8.81	6.69	7.53	7.75
C/N margin above outage condition for 99.7% of the time, downlink	dB	1.58	1.62	2.52	0.65	2.86	1.58	1.62	2.52	0.65	2.86	0.77	0.78	1.50	3.05	0.79	1.68	1.92
C/N+I margin above outage condition threshold for 99.7% of the tim	dB	1.42	1.46	2.32	0.52	2.64	1.42	1.46	2.32	0.52	2.64	0.57	0.58	1.25	2.71	0.59	1.43	1.65
Downlink budget for availability percentage of time																		
C/N thermal for availability percentage of time, downlink	*dB*	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	5.12	6.28	6.28	6.28	6.28	6.28	6.28	6.28
C/N+I for availability percentage of time, downlink	*dB*	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	6.1	6.1	6.1	6.1	6.1	6.1	6.1
C/N margin above outage condition for availability percentage of the	dB	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
C/N+I margin above outage condition for availability percentage	dB	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	-0.001	0.000	-0.001	0.000	-0.001	0.000	0.000	0.000

USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA	USA
US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO
4D3	4D5	4D8	4D9	4B2	4B3	4B5	4B6	4B8	4B9	4B10	4C2	4C3	4C5	4C6	4C8	4C9	4C10	1(b)	D1(b)	D2(b)	D3(b)	D6(b)
Dallas	Houston	Salt Lake City	San Antonio	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Seattle	Florida	New York	Minn.	Seattle
12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.700	12.700	12.700	12.700	12.700
99.90	99.83	99.98	99.83	99.91	99.90	99.83	99.95	100.00	99.84	99.96	99.91	99.88	99.80	99.92	100.00	99.79	99.94	99.98	99.89	99.95	99.91	99.98
8.86	14.93	1.77	15.09	7.97	8.86	14.76	4.74	0.30	14.15	3.52	8.02	10.17	17.94	6.69	0.29	18.32	5.66	2.16	9.66	3.96	7.58	1.39
3.56	6.82	2.20	6.92	4.51	3.85	7.09	4.54	0.42	6.98	3.72	4.83	4.71	9.37	7.04	0.41	9.94	6.75	3.50	4.94	3.14	8.10	1.76
40.2%	45.7%	124.4%	45.9%	56.6%	43.4%	48.1%	95.9%	141.9%	49.3%	105.7%	60.2%	46.4%	52.2%	105.2%	142.3%	54.3%	119.3%	162.3%	51.2%	79.3%	106.9%	126.4%
99.858	99.752	99.955	99.749	99.858	99.855	99.751	99.894	99.992	99.759	99.917	99.853	99.830	99.688	99.843	99.992	99.678	99.858	99.935	99.833	99.919	99.821	99.964
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	23.7	23.7	23.7	23.7	23.7
94.3	95.4	97.8	95.4	96.1	94.8	95.6	97.5	97.6	95.7	97.6	96.3	95.2	96.1	97.8	97.6	96.2	97.9	100.3	95.9	98.1	99.6	99.8
99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	102.0	102.0	102.0	102.0	102.0
26.1	26.1	26.1	26.1	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	24.2	24.2	24.2	24.2	24.2
6.1	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**6.1**	**7.6**	**7.6**	**7.6**	**7.6**	**7.6**
8.5	7.5	3.9	7.4	6.6	8.1	7.2	4.4	4.3	7.1	4.1	6.2	7.6	6.6	3.9	4.3	6.4	3.6	4.0	9.5	7.2	5.2	5.8
2.04	0.57	2.13	0.54	1.62	1.89	0.55	1.58	3.18	0.62	1.76	1.51	1.46	0.03	1.07	3.20	-0.04	1.12	1.82	1.86	2.72	0.92	3.04
-61.5	-61.5	-61.5	-61.5	-119.0	-119.0	-119.0	-119.0	-119.0	-119.0	-119.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	101W	101W	101W	101W	101W
53.4	51.9	48.0	51.9	50.9	52.6	51.4	48.0	48.0	51.2	48.0	50.4	51.9	50.6	47.5	48.0	50.3	47.4	51.0	56.9	54.4	52.1	51.0
Dallas	Houston	Salt Lake City	San Antonio	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Seattle	Florida	New York	Minn.	Seattle
45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
																		34.0	34.0	34.0	34.0	34.0
33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8					
																		125	125	125	125	80
85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0					
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	13.0	13.0	13.0	13.0	15.0
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5
32.8	29.8	40.8	29.5	41.8	32.8	29.8	34.0	40.8	29.5	47.6	41.8	32.8	29.8	34.0	40.8	29.5	47.6	47.6	27.9	40.7	45.0	47.6
-96.8	-95.3	-111.9	-98.5	-87.8	-96.8	-95.3	-118.2	-111.9	-98.5	-122.3	-87.8	-96.8	-95.3	-118.2	-111.9	-98.5	-122.3	122.3W	82.5W	74W	93.3W	122.3W
0.1	0.0	1.3	0.2	0.2	0.1	0.0	0.0	1.3	0.2	0.1	0.2	0.1	0.0	0.0	1.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0
M	M	B	M	K	M	M	E	B	M	D	K	M	M	E	B	M	D	D	N	K	K	D
36.3	39.4	20.7	37.1	32.2	44.9	46.6	50.5	42.3	48.9	35.2	36.6	49.2	51.7	49.5	42.8	53.3	34.0	31.5	51.5	35.4	37.6	31.5
Dallas	Houston	Salt Lake City	San Antonio	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Seattle	Florida	New York	Minn.	Seattle
38076	37827	39482	38008	38417	37416	37298	37049	37605	37148	38162	38047	37127	36974	37109	37567	36875	38263	38479	36985	38147	37966	38479
206.0	205.9	206.3	205.9	206.0	205.8	205.8	205.7	205.9	205.7	206.0	206.0	205.7	205.7	205.7	205.8	205.7	206.0	206.2	205.9	206.1	206.1	206.2
0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
3.247	3.316	0.510	3.310	2.021	2.947	3.093	0.900	0.299	2.945	0.738	1.870	2.841	2.982	0.909	0.296	2.857	0.756	0.840	4.540	2.097	1.879	0.840
4.466	4.505	1.393	4.502	3.559	4.283	4.374	2.144	0.888	4.281	1.855	3.411	4.213	4.305	2.159	0.881	4.224	1.889	1.485	3.987	2.761	2.589	2.141
4.677	3.645	1.232	3.617	2.906	4.201	3.391	1.486	1.425	3.283	1.365	2.652	3.756	2.926	1.249	1.429	2.755	1.089	1.734	6.057	3.912	2.423	2.233
5.188	4.777	2.919	4.764	4.382	5.015	4.653	3.217	3.149	4.596	3.080	4.220	4.828	4.394	2.940	3.154	4.288	2.733	2.464	4.385	3.761	2.993	3.904
16.1	14.7	10.4	14.7	13.6	15.5	14.3	11.0	10.9	14.2	10.7	13.2	14.9	13.6	10.5	10.9	13.3	10.1	11.9	18.2	15.4	13.1	13.8
14.6	13.6	10.0	13.5	12.7	14.2	13.3	10.5	10.4	13.2	10.2	12.3	13.7	12.7	10.0	10.4	12.5	9.7	11.6	17.1	14.8	12.8	13.4
14.4	13.3	9.9	13.3	12.5	13.9	13.1	10.4	10.2	12.9	10.1	12.2	13.5	12.5	9.9	10.3	12.3	9.6	11.4	16.3	14.3	12.5	13.1
10.0	8.6	4.3	8.6	7.5	9.4	8.2	4.9	4.8	8.1	4.6	7.1	8.8	7.5	4.4	4.8	7.2	4.0	4.3	10.6	7.8	5.5	6.2
8.5	7.5	3.9	7.4	6.6	8.1	7.2	4.4	4.3	7.1	4.1	6.2	7.6	6.6	3.9	4.3	6.4	3.6	4.0	9.5	7.2	5.2	5.8
8.3	7.2	3.8	7.2	6.4	7.8	7.0	4.3	4.1	6.8	4.0	6.1	7.4	6.4	3.8	4.2	6.2	3.5	3.8	8.7	6.7	4.9	5.5
8.43	6.88	8.53	6.85	7.99	8.27	6.86	7.94	9.67	6.93	8.13	7.87	7.81	6.31	7.40	9.68	6.24	7.46	9.58	9.62	10.52	8.65	10.86
8.14	6.67	8.23	6.64	7.72	7.99	6.65	7.68	9.28	6.72	7.86	7.61	7.56	6.13	7.17	9.30	6.06	7.22	9.42	9.46	10.32	8.52	10.64
2.33	0.78	2.43	0.75	1.89	2.17	0.76	1.84	3.57	0.83	2.03	1.77	1.71	0.21	1.30	3.58	0.14	1.36	1.98	2.02	2.92	1.05	3.26
2.04	0.57	2.13	0.54	1.62	1.89	0.55	1.58	3.18	0.62	1.76	1.51	1.46	0.03	1.07	3.20	-0.04	1.12	1.82	1.86	2.72	0.92	3.04
6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	7.71	7.71	7.71	7.71	7.71
6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	7.6	7.6	7.6	7.6	7.6
0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	-0.001

USA	USA	USA	USA	USA			
US-GSO	US-GSO	US-GSO	US-GSO	US-GSO			
D7(b)	D8(b)	D9(b)	D10(b)	D12(b)			
Seattle	Florida	New York	Minn	Seattle	Max	Min	Average
12.700	12.700	12.700	12.700	12.700			
99.98	99.89	99.95	99.91	99.98			
2.16	9.66	3.96	7.58	1.39	18.32	0.29	7.47
3.50	4.94	3.14	8.10	1.76	10.37	0.41	5.02
162.3%	51.2%	79.3%	106.9%	126.4%	176.2%	38.8%	90.1%
99.935	99.833	99.919	99.821	99.964	99.99	99.68	99.86
24	24	24	24	24			
QPSK	QPSK	QPSK	QPSK	QPSK			
23.7	23.7	23.7	23.7	23.7			
100.3	95.9	98.1	99.6	99.8			
102.0	102.0	102.0	102.0	102.0			
24.2	24.2	24.2	24.2	24.2			
7.6	7.6	7.6	7.6	7.6			
4.0	9.5	7.2	5.2	5.8			
1.82	1.86	2.72	0.92	3.04			

101W	101W	101W	101W	101W
51.0	56.9	54.4	52.1	51.0
Seattle	Florida	New York	Minn	Seattle
45	45	45	45	45
70	70	70	70	70
34.0	34.0	34.0	34.0	34.0
125	125	125	125	80
13.0	13.0	13.0	13.0	15.0
0.5	0.5	0.5	0.5	0.5
47.6	27.9	40.7	45.0	47.6
122.3W	82.5W	74W	93.3W	122.3W
0.0	0.0	0.0	0.0	0.0
D	N	K	K	D
31.5	51.5	35.4	37.6	31.5
Seattle	Florida	New York	Minn.	Seattle
38479	36985	38147	37966	38479
206.2	205.9	206.1	206.1	206.2
0.20	0.20	0.20	0.20	0.20
0.840	4.540	2.097	1.879	0.840
1.485	3.987	2.761	2.589	2.141
1.734	6.057	3.912	2.423	2.233
2.464	4.385	3.761	2.993	3.904

11.9	18.2	15.4	13.1	13.8
11.6	17.1	14.8	12.8	13.4
11.4	16.3	14.3	12.5	13.1
4.3	10.6	7.8	5.5	6.2
4.0	9.5	7.2	5.2	5.8
3.8	8.7	6.7	4.9	5.5

9.58	9.62	10.52	8.65	10.86
9.42	9.46	10.32	8.52	10.64
1.98	2.02	2.92	1.05	3.26
1.82	1.86	2.72	0.92	3.04

7.71	7.71	7.71	7.71	7.71
7.6	7.6	7.6	7.6	7.6
0.1	0.1	0.1	0.1	0.1
0.000	0.000	0.000	0.000	-0.001

The purpose of this spreadsheet is to show the impact of terrestrial interference upon the system availability.

This spreadsheet uses the availability objective from the spreadsheet "Freeze Frame Point" as a baseline, in line 10

The user may enter a change in cells B12 or B13, which independently add an increase in outage hour(s), and/or a percent increase in unavailability.

The C/I required to cause this change is computed and shown in line 21.

The new availability computed from this outage condition is shown in line 14

	Units	USA US-GSO 1(a)	USA US-GSO D1(a)	USA US-GSO D2(a)	USA US-GSO D3(a)	USA US-GSO D6(a)	USA US-GSO D7(a)	USA US-GSO D8(a)	USA US-GSO D9(a)	USA US-GSO D10(a)	USA US-GSO D12(a)	USA US-GSO 4A3	USA US-GSO 4A5	USA US-GSO 4A6	USA US-GSO 4A8	USA US-GSO 4A9	USA US-GSO 4A10	USA US-GSO 4D2	USA US-GSO 4D3
System Characteristics		Seattle	Florida	New York	Minn.	Seattle	Seattle	Florida	New York	Minn.	Seattle	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas
Frequency	GHz	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.700	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450
Availability objective	%	99.97	99.88	99.95	99.90	99.98	99.97	99.88	99.95	99.90	99.98	99.82	99.82	99.93	99.99	99.82	99.94	99.91	99.90
Outage Hours	Hours per Year	2.75	10.73	4.60	9.10	1.72	2.75	10.73	4.60	9.10	1.72	15.74	15.90	6.46	0.72	15.52	4.89	7.65	8.86
Increase in outage hours		0.549	2.147	0.919	1.821	0.344	0.549	2.147	0.919	1.821	0.344	3.148	3.180	1.292	0.143	3.105	0.979	1.531	1.773
Percentage increase in unavailability		20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
New Availability Objective	%	99.962	99.853	99.937	99.873	99.976	99.962	99.853	99.937	99.873	99.976	99.785	99.782	99.912	99.990	99.787	99.933	99.899	99.879
Availability Degradation	%	-0.006	-0.024	-0.010	-0.021	-0.004	-0.006	-0.024	-0.010	-0.021	-0.004	-0.036	-0.036	-0.015	-0.002	-0.035	-0.011	-0.017	-0.020
Receiver noise Bandwidth	MHz	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Modulation type		QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
C/I due to other GSO BSS networks	dB	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
C(faded)/I(unfaded) due to Northpoint req	dB	15.4	12.0	13.4	14.2	14.7	15.4	12.0	13.4	14.2	14.7	14.3	14.2	17.0	18.0	14.4	17.3	15.6	14.3
Clear sky C/I due to Northpoint require	dB	17.6	18.4	17.7	17.1	17.4	17.6	18.4	17.7	17.1	17.3	19.0	19.1	18.8	19.8	19.0	19.0	18.8	19.4
Clear sky feeder link C/N+I	dB	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1
C/N+I required at the outage condition	dB	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
Clear sky C/N+I margin above outage con	dB	4.3	6.4	6.0	4.9	5.6	4.3	6.4	6.0	4.9	5.6	6.2	6.3	4.5	4.4	6.2	4.3	5.7	6.4
C/N+I margin above operating threshold f	dB	2.40	1.89	2.85	1.47	3.37	2.40	1.89	2.85	1.47	3.37	0.88	0.87	1.80	3.22	0.91	1.99	1.99	2.11
Space station characteristics																			
Longitude	°	101W	101W	101W	101W	101W	101W	101W	101W	101W	101W	-148.0	-148.0	-148.0	-148.0	-148.0	-148.0	-61.5	-61.5
Satellite e i r p in the direction of the eart	dBW	48.0	53.9	51.4	49.1	48.0	48.0	53.9	51.4	49.1	48.0	53.2	53.5	48.2	48.0	53.0	48.0	50.7	53.4
Earth station characteristics		Seattle	Florida	New York	Minn.	Seattle	Seattle	Florida	New York	Minn.	Seattle	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas
Receive antenna diameter	cm	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Receive antenna efficiency	%	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
On-axis antenna gain at receiver input	dBi	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0								
On-axis antenna gain at antenna output												33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8
Clear sky receive system noise temperatur	K	125	125	125	125	80	125	125	125	125	80								
Clear sky receive system noise temperatur	K											85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
Clear sky G/T	*dB/K*	13.0	13.0	13.0	13.0	15.0	13.0	13.0	13.0	13.0	15.0	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5
Total pointing loss	dB	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Latitude	°	47.6	27.9	40.7	45.0	47.6	47.6	27.9	40.7	45.0	47.6	32.8	29.8	34.0	40.8	29.5	47.6	41.8	32.8
Longitude	°	122.3W	82.5W	74W	93.3W	122.3W	122.3W	82.5W	74W	93.3W	122.3W	-96.8	-95.3	-118.2	-111.9	-98.5	-122.3	-87.8	-96.8
Altitude	km	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.3	0.2	0.1	0.2	0.1
Rain climatic zone		D	N	K	K	D	D	N	K	K	D	M	M	E	B	M	D	K	M
Elevation angle	°	31.5	51.5	35.4	37.6	31.5	31.5	51.5	35.4	37.6	31.5	23.8	23.8	39.3	30.2	26.6	29.9	34.8	36.3
Propagation characteristics		Seattle	Florida	New York	Minn.	Seattle	Seattle	Florida	New York	Minn.	Seattle	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas
Slant path	*km*	38479	36985	38147	37966	38479	38479	36985	38147	37966	38479	39180	39186	37837	38590	38916	38620	38198	38076
Free space loss	*dB*	206.2	205.9	206.1	206.1	206.2	206.2	205.9	206.1	206.1	206.2	206.2	206.2	205.9	206.1	206.1	206.1	206.0	206.0
Atmospheric absorption	*dB*	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Rain attenuation for 99.7% of the time	dB	0.840	4.540	2.097	1.879	0.840	0.840	4.540	2.097	1.879	0.840	3.983	4.184	1.037	0.382	3.873	0.827	1.928	3.247
Noise increase due to rain for 99.7% of th	*dB*	1.485	3.987	2.761	2.589	2.141	1.485	3.987	2.761	2.589	2.141	4.840	4.928	2.367	1.097	4.790	2.017	3.470	4.466
Rain attenuation for availability percentag	dB	2.193	6.430	4.381	2.877	2.663	2.193	6.430	4.381	2.877	2.663	4.692	4.905	1.859	1.705	4.593	1.680	3.199	5.032
Noise increase due to rain for availability	*dB*	2.833	4.459	3.934	3.271	4.251	2.833	4.459	3.934	3.271	4.251	5.193	5.261	3.595	3.447	5.159	3.422	4.552	5.301
Downlink budget clear sky																			
C/N thermal clear sky downlink	*dB*	8.9	15.2	12.4	10.1	10.8	8.9	15.2	12.4	10.1	10.8	15.7	16.0	11.0	10.6	15.6	10.6	13.4	16.1
C/N+I clear sky downlink	*dB*	7.8	9.9	9.5	8.4	9.1	7.8	9.9	9.5	8.4	9.1	11.3	11.4	9.6	9.5	11.3	9.4	10.8	11.5
C/N+I clear sky total link	*dB*	7.7	9.7	9.3	8.3	8.9	7.7	9.7	9.3	8.3	8.9	11.2	11.2	9.5	9.4	11.2	9.3	10.7	11.3
Clear sky C/N downlink margin above out	dB	5.4	11.7	8.9	6.6	7.3	5.4	11.7	8.9	6.6	7.3	10.6	10.9	5.9	5.5	10.5	5.5	8.3	11.0
Clear sky C/N+I downlink margin above c	dB	4.3	6.4	6.0	4.9	5.6	4.3	6.4	6.0	4.9	5.6	6.2	6.3	4.5	4.4	6.2	4.3	5.7	6.4
Clear sky C/N+I total margin above outag	dB	4.2	6.2	5.8	4.8	5.4	4.2	6.2	5.8	4.8	5.4	6.1	6.1	4.4	4.3	6.1	4.2	5.6	6.2
Downlink budget 99.7% of the time																			
C/N thermal for 99.7% of the time, downl	*dB*	6.58	6.62	7.52	5.65	7.86	6.58	6.62	7.52	5.65	7.86	6.87	6.88	7.60	9.15	6.89	7.78	8.02	8.43
C/N+I for 99.7% of the time, downlink	*dB*	5.90	5.39	6.35	4.97	6.87	5.90	5.39	6.35	4.97	6.87	5.98	5.97	6.90	8.32	6.01	7.09	7.09	7.21
C/N margin above outage condition for 99	dB	3.08	3.12	4.02	2.15	4.36	3.08	3.12	4.02	2.15	4.36	1.77	1.78	2.50	4.05	1.79	2.68	2.92	3.33
C/N+I margin above outage condition thre	dB	2.40	1.89	2.85	1.47	3.37	2.40	1.89	2.85	1.47	3.37	0.88	0.87	1.80	3.22	0.91	1.99	1.99	2.11
Downlink budget for availability percentage of time																			
C/N thermal for availability percentage o	*dB*	3.88	4.26	4.07	3.97	3.93	3.88	4.26	4.07	3.97	3.93	5.81	5.83	5.55	5.48	5.80	5.52	5.67	5.81
C/N+I for availability percentage of time.	*dB*	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
C/N margin above outage condition for av	dB	0.4	0.8	0.6	0.5	0.4	0.4	0.8	0.6	0.5	0.4	0.7	0.7	0.4	0.4	0.7	0.4	0.6	0.7
C/N+I margin above outage condition fo	dB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Decrease in link margin		0.30	0.68	0.48	0.39	0.35	0.30	0.68	0.48	0.39	0.35	0.57	0.59	0.30	0.23	0.56	0.28	0.42	0.57

USA	USI	USA	USA	USA	USA	USA	USI	USA	USA	USA	USA	USA	USA	USI	USA	USA	USA	USA	USA	USA	USA	USA
US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO	US-GSO
4D5	4D8	4D9	4B2	4B3	4B5	4B6	4B8	4B9	4B10	4C2	4C3	4C5	4C6	4C8	4C9	4C10	1(b)	D1(b)	D2(b)	D3(b)	D6(b)	D7(b)
Houston	Salt Lake City	San Antonio	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Seattle	Florida	New York	Minn	Seattle	Seattle
12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.450	12.700	12.700	12.700	12.700	12.700	12.700
99.83	99.98	99.83	99.91	99.90	99.83	99.95	100.00	99.84	99.96	99.91	99.88	99.80	99.92	100.00	99.79	99.94	99.98	99.89	99.95	99.91	99.98	99.98
14.93	1.77	15.09	7.97	8.86	14.76	4.74	0.30	14.15	3.52	8.02	10.17	17.94	6.69	0.29	18.32	5.66	2.16	9.66	3.96	7.58	1.39	2.16
2.985	0.353	3.017	1.594	1.772	2.952	0.948	0.059	2.831	0.703	1.603	2.034	3.589	1.337	0.057	3.665	1.132	0.432	1.932	0.793	1.517	0.279	0.432
20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
99.796	99.976	99.793	99.891	99.879	99.798	99.935	99.996	99.806	99.952	99.890	99.861	99.754	99.908	99.996	99.749	99.923	99.970	99.868	99.946	99.896	99.981	99.970
-0.034	-0.004	-0.034	-0.018	-0.020	-0.034	-0.011	-0.001	-0.032	-0.008	-0.018	-0.023	-0.041	-0.015	-0.001	-0.042	-0.013	-0.005	-0.027	-0.009	-0.017	-0.003	-0.005
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	23.7	23.7	23.7	23.7	23.7	23.7
14.8	17.8	14.8	15.5	14.6	14.9	17.1	18.3	15.0	17.4	15.7	14.8	15.2	17.3	18.3	15.3	17.7	17.8	14.5	15.8	16.7	17.2	17.8
18.8	19.4	18.8	18.8	19.2	18.7	18.9	20.1	18.7	19.1	18.7	18.9	18.5	18.9	20.1	18.4	19.1	20.2	21.2	20.5	19.8	20.1	20.2
26.1	26.1	26.1	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	24.2	24.2	24.2	24.2	24.2	24.2
5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	6.1	6.1	6.1	6.1	6.1	6.1
6.0	4.2	6.0	5.7	6.3	5.9	4.5	4.6	5.9	4.4	5.6	6.1	5.7	4.2	4.6	5.6	3.9	4.6	6.5	6.2	5.2	5.8	4.6
0.95	2.68	0.92	1.95	2.03	0.95	2.11	3.67	1.02	2.30	1.88	1.71	0.52	1.67	3.68	0.48	1.75	2.73	2.17	3.14	1.80	3.68	2.73
-61.5	-61.5	-61.5	-119.0	-119.0	-119.0	-119.0	-119.0	-119.0	-119.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	-110.0	101W	101W	101W	101W	101W	101W
51.9	48.0	51.9	50.9	52.6	51.4	48.0	48.0	51.2	48.0	50.4	51.9	50.6	47.5	48.0	50.3	47.4	51.0	56.9	54.4	52.1	51.0	51.0
Houston	Salt Lake City	San Antonio	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Seattle	Florida	New York	Minn	Seattle	Seattle
45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
																	34.0	34.0	34.0	34.0	34.0	34.0
33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8						
																	125	125	125	125	80	125
85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0						
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	13.0	13.0	13.0	13.0	15.0	13.0
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5
29.8	40.8	29.5	41.8	32.8	29.8	34.0	40.8	29.5	47.6	41.8	32.8	29.8	34.0	40.8	29.5	47.6	47.6	27.9	40.7	45.0	47.6	47.6
-95.3	-111.9	-98.5	-87.8	-96.8	-95.3	-118.2	-111.9	-98.5	-122.3	-87.8	-96.8	-95.3	-118.2	-111.9	-98.5	-122.3	122.3W	82.5W	74W	93.3W	122.3W	122.3W
0.0	1.3	0.2	0.2	0.1	0.0	0.0	1.3	0.2	0.1	0.2	0.1	0.0	0.0	1.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
M	B	M	K	M	M	E	B	M	D	K	M	M	E	B	M	D	D	N	K	K	D	D
39.4	20.7	37.1	32.2	44.9	46.6	50.5	42.3	48.9	35.2	36.6	49.2	51.7	49.5	42.8	53.3	34.0	31.5	51.5	35.4	37.6	31.5	31.5
Houston	Salt Lake City	San Antonio	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Chicago	Dallas	Houston	Los Angeles	Salt Lake City	San Antonio	Seattle	Seattle	Florida	New York	Minn	Seattle	Seattle
37827	39482	38008	38417	37416	37298	37049	37605	37148	38162	38047	37127	36974	37109	37567	36875	38263	38479	36985	38147	37966	38479	38479
205.9	206.3	205.9	206.0	205.8	205.8	205.7	205.9	205.7	206.0	206.0	205.7	205.7	205.7	205.8	205.7	206.0	206.2	205.9	206.1	206.1	206.2	206.2
0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
3.316	0.510	3.310	2.021	2.947	3.093	0.900	0.299	2.945	0.738	1.870	2.841	2.982	0.909	0.296	2.857	0.756	0.840	4.540	2.097	1.879	0.840	0.840
4.505	1.393	4.502	3.559	4.283	4.374	2.144	0.888	4.281	1.855	3.411	4.213	4.305	2.159	0.881	4.224	1.889	1.485	3.987	2.761	2.589	2.141	1.485
4.008	1.601	3.980	3.291	4.569	3.759	1.855	1.826	3.653	1.733	3.037	4.128	3.293	1.604	1.830	3.123	1.439	2.426	6.759	4.677	3.132	2.897	2.426
4.938	3.341	4.926	4.601	5.151	4.830	3.591	3.564	4.781	3.475	4.460	4.986	4.602	3.344	3.568	4.509	3.165	2.995	4.519	4.031	3.408	4.416	2.995
14.7	10.4	14.7	13.6	15.5	14.3	11.0	10.9	14.2	10.7	13.2	14.9	13.6	10.5	10.9	13.3	10.1	11.9	18.2	15.4	13.1	13.8	11.9
11.1	9.3	11.1	10.8	11.4	11.0	9.6	9.7	11.0	9.5	10.7	11.2	10.8	9.3	9.7	10.7	9.0	10.7	12.6	12.3	11.3	11.9	10.7
11.0	9.2	11.0	10.7	11.2	10.9	9.5	9.6	10.8	9.4	10.6	11.1	10.6	9.2	9.6	10.5	9.0	10.5	12.3	12.0	11.1	11.7	10.5
9.6	5.3	9.6	8.5	10.4	9.2	5.9	5.8	9.1	5.6	8.1	9.8	8.5	5.4	5.8	8.2	5.0	5.8	12.1	9.3	7.0	7.7	5.8
6.0	4.2	6.0	5.7	6.3	5.9	4.5	4.6	5.9	4.4	5.6	6.1	5.7	4.2	4.6	5.6	3.9	4.6	6.5	6.2	5.2	5.8	4.6
5.9	4.1	5.9	5.6	6.1	5.8	4.4	4.5	5.7	4.3	5.5	6.0	5.5	4.1	4.5	5.4	3.9	4.4	6.2	5.9	5.0	5.6	4.4
6.88	8.53	6.85	7.99	8.27	6.86	7.94	9.67	6.93	8.13	7.87	7.81	6.31	7.40	9.68	6.24	7.46	9.58	9.62	10.52	8.65	10.86	9.58
6.05	7.78	6.02	7.05	7.13	6.05	7.21	8.77	6.12	7.40	6.98	6.81	5.62	6.77	8.78	5.58	6.85	8.83	8.27	9.24	7.90	9.78	8.83
1.78	3.43	1.75	2.89	3.17	1.76	2.84	4.57	1.83	3.03	2.77	2.71	1.21	2.30	4.58	1.14	2.36	3.48	3.52	4.42	2.55	4.76	3.48
0.95	2.68	0.92	1.95	2.03	0.95	2.11	3.67	1.02	2.30	1.88	1.71	0.52	1.67	3.68	0.48	1.75	2.73	2.17	3.14	1.80	3.68	2.73
5.76	5.49	5.75	5.68	5.78	5.74	5.54	5.46	5.73	5.52	5.66	5.75	5.71	5.52	5.46	5.69	5.50	6.49	6.87	6.67	6.58	6.53	6.49
5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	6.1	6.1	6.1	6.1	6.1	6.1
0.7	0.4	0.7	0.6	0.7	0.6	0.4	0.4	0.6	0.4	0.6	0.7	0.6	0.4	0.4	0.6	0.4	0.4	0.8	0.6	0.5	0.4	0.4
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.51	0.25	0.51	0.43	0.53	0.49	0.29	0.22	0.48	0.28	0.41	0.51	0.46	0.28	0.22	0.45	0.26	0.31	0.70	0.50	0.41	0.36	0.31

USA	USA	USA	USA			
US-GSO	US-GSO	US-GSO	US-GSO			
D8(b)	D9(b)	D10(b)	D12(b)			
Florida	New York	Minn.	Seattle	Max	Min	Average
12.700	12.700	12.700	12.700			
99.89	99.95	99.91	99.98	99.997	99.791	99.915
9.66	3.96	7.58	1.39			
1.932	0.793	1.517	0.279	3.66	0.06	1.49
20.0%	20.0%	20.0%	20.0%			
99.868	99.946	99.896	99.981	99.996	99.749	99.898
-0.022	-0.009	-0.017	-0.003	- 0.001	- 0.042	- 0.017
24	24	24	24			
QPSK	QPSK	QPSK	QPSK			
23.7	23.7	23.7	23.7			
14.5	15.8	16.7	17.2			
21.2	20.5	19.8	20.1	21.2	17.1	19.0
24.2	24.2	24.2	24.2			
6.1	6.1	6.1	6.1			
6.5	6.2	5.2	5.8			
2.17	3.14	1.80	3.68			

101W	101W	101W	101W
56.9	54.4	52.1	51.0
Florida	New York	Minn.	Seattle
45	45	45	45
70	70	70	70
34.0	34.0	34.0	34.0
125	125	125	80
13.0	13.0	13.0	15.0
0.5	0.5	0.5	0.5
27.9	40.7	45.0	47.6
82.5W	74W	93.3W	122.3W
0.0	0.0	0.0	0.0
N	K	K	D
51.5	35.4	37.6	31.5
Florida	New York	Minn.	Seattle
36985	38147	37966	38479
205.9	206.1	206.1	206.2
0.20	0.20	0.20	0.20
4.540	2.097	1.879	0.840
3.987	2.761	2.589	2.141
6.759	4.677	3.132	2.897
4.519	4.031	3.408	4.416

18.2	15.4	13.1	13.8
12.6	12.3	11.3	11.9
12.3	12.0	11.1	11.7
12.1	9.3	7.0	7.7
6.5	6.2	5.2	5.8
6.2	5.9	5.0	5.6

9.62	10.52	8.65	10.86
8.27	9.24	7.90	9.78
3.52	4.42	2.55	4.76
2.17	3.14	1.80	3.68

6.87	6.67	6.58	6.53			
6.1	6.1	6.1	6.1			
0.8	0.6	0.5	0.4			
0.000	0.000	0.000	0.000			
0.70	0.50	0.41	0.36	0.70	0.22	0.42