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(File No.) 021992-0010

July 25, 2000

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BY HAND DELIVERY

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Re: DIRECTV/EchoStar Report; File No. 0418-EX-ST-1999; File No. 0094-EX-ST-1999; ET Docket No. 98-206; DA 99-494; <u>EX PARTE</u>

Dear Chairman Kennard and Commissioners:

DIRECTV, Inc. ("DIRECTV") and EchoStar Satellite Corp. ("EchoStar") hereby submit the attached "Report of Interference Impact on DBS Systems from Northpoint Transmitter

Operating at Oxon Hill, MD, May 22 to June 7, 2000" for the Commission's consideration in the above-captioned proceedings.

As the Commission knows, DIRECTV and EchoStar are the leading direct broadcast satellite ("DBS") operators in the United States. These companies collectively have invested billions of dollars over more than a decade to develop DBS systems that serve 13 million subscribers nationwide, and that are clearly the best, most competitive alternative to cable television systems today. Hence, the Commission recognized in this year's report to Congress on the status of competition among multichannel video programming distributors ("MVPDs") that, although the cable industry continues to serve a dominant 82% share of the MVPD market,[1] the growth in noncable MVPD subscribership is being driven by the DBS operators,[2] which has emerged as the cable industry's most formidable competitors.[3] Furthermore, the Commission have noted the positive effect that the recent Congressional amendment to the Satellite Home Viewer Act ("SHVA") will have for many consumers, who will for the first time be able to receive local broadcast signals on their DBS systems, thus ensuring near-complete substitutability between DBS and cable as MVPD competitors.

Northpoint Technology, Ltd., along with its affiliated companies Diversified Communication Engineering, Inc. and a number of entities operating under the name of "Broadwave" (collectively, "Northpoint") has proposed to introduce a secondary terrestrial service into the 12 GHz band, which is the primary, "mission critical" frequency band used by DBS operators. Based upon recent demonstrations of its technology in the Washington, DC area conducted over the summer and fall of 1999, the purported results of which are summarized in a Progress Report submitted to the Commission this past October,[4] Northpoint has claimed that its system and architecture showed "no impact to DBS," and urges the Commission to agree that "Northpoint is a viable technology and ready for deployment through the United States."[5] The U.S. DBS operators emphatically disagree with this assertion, and DIRECTV and EchoStar have each submitted detailed technical objections to Northpoint's proposed operations in the 12 GHz

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1 *Annual Assessment of the Status of Competition in Markets for the Delivery of Video Programming*, CS Docket No. 99-230 (rel. Jan. 14, 2000) ("MVPD Competition Report"), at ¶ 5.

2 *Id.* at ¶ 8.

3 *Id.* at ¶ 70.

4 Progress Report WA2XMY, Northpoint-DBS Compatability Tests, Washington, DC (Oct. 1999) ("Northpoint Progress Report").

5 *Id.* at 27.

band, including rebuttals to the Northpoint claims based upon Northpoint's Washington demonstrations.[6]

In addition, DIRECTV and EchoStar undertook to cooperate on a more balanced effort to assess the interference effects of Northpoint technology on DBS systems at 12 GHz, in order to show the Commission that Northpoint's extravagant claims regarding the ability of its terrestrial systems to coexist in the DBS downlink band with no harmful impact on DBS subscribers are extremely misleading and unsupported. DIRECTV and EchoStar jointly applied for and were granted a joint authorization for Special Temporary Authority[7] to conduct their own interference testing of Northpoint transmitters into DBS systems. DIRECTV and EchoStar in fact conducted field tests in late May and early June of this year at a Northpoint-selected test site in Oxon Hill, MD.

The results of these tests are presented in the attached report. Importantly, the report was prepared:

- With a transmitter specifically constructed and configured to Northpoint transmitter specifications;[8]

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6 *See, e.g.*, DIRECTV, Inc., *Conclusions to Date Regarding Harmful Interference From a Proposed Northpoint Technology Terrestrial System Operating in the DBS Downlink Band, 12.2-12.7 GHz* (January 27, 2000); *Application of DIRECTV, Inc. For Expedited Review and Request for Immediate Suspension of Testing, In the Matter of Diversified Communication Engineering, Inc., Experimental Special Temporary Authorization,* File No. 0094-EX-ST-1999, Call Sign WA2XMY (June 25, 1999); *Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency, with GSO and Terrestrial Systems in the Ku-band Frequency Range, ET Docket No. 98-206,* Comments of DIRECTV, Inc. (filed Mar. 2, 1999); Reply Comments of DIRECTV (filed Apr. 14, 1999); *see also Comments of Pegasus Communications Corporation,* ET Docket No. 98-206 (Dec. 29, 1999); *EchoStar Preliminary Report on the Impact of Northpoint on the Direct Broadcast Satellite Service Based Upon Testing Performed to Date* (Oct. 29, 1999). DIRECTV plans to file under separate cover a further rebuttal to Northpoint's claims based upon Northpoint's Washington, DC demonstrations.

7 *In the Matter of Request for Special Temporary Authorization to test for 120 days the interference caused to typical Direct Broadcast Satellite receivers from the system proposed by Diversified Communications Engineering, Inc. in the 12.2 – 12.7 GHz band,* File No. 0418-EX-ST-1999.

8 Northpoint refused DIRECTV and EchoStar requests for an actual Northpoint transmitter and antenna to be used in conducting their field tests, *see* Letter from Antoinette Cook Bush, Esq. to James H. Barker, Esq. and Pantelis Michalopoulis, Esq. (Dec. 21, 1999), so DIRECTV and EchoStar replicated one by using specifications taken from Northpoint filings to order a specially-manufactured transmit horn and to calibrate transmit power.

- Using a test site specifically selected by Northpoint, so that the test would replicate a desired Northpoint location to the greatest degree possible;

- With the retention of the well-known engineering firm Comsearch, which conducted its own measurements during the tests to verify DIRECTV's and EchoStar's recorded data; and

- With the attendance of FCC staff from the Wireless and International Bureaus, and the Office of Engineering and Technology, on two demonstration days during the testing, in order to view the test set-up and some of the interference measurements.

The results of the tests, as DIRECTV and EchoStar predicted, and as summarized in the report, are extremely revealing:

- Significant interference from the replicated Northpoint transmitter was recorded for DBS receivers pointing to satellites at the 61.5°, 91°, 101°, and 110° W.L. orbital positions. Lower levels of interference were recorded into a DBS receiver pointing to a satellite at the 119° W.L. orbital location due to the southeast pointing of the Northpoint transmit antenna, as selected by Northpoint in its filing.[9]

- DBS service from the EchoStar satellite at 61.5° W.L. was most affected by the replicated Northpoint transmitter at the Oxon Hill location, since one of the receive antenna backlobes lay close to the boresight of the transmit beam. The receiver signal strength meter, which relates directly to received C/N and C/(N+I) values, indicated as much as a *17 count drop* at this test location, which corresponds to a *122.4% increase in unavailability of EchoStar's DBS service from that location*. More alarmingly, it was demonstrated that an increase in Northpoint transmit power of only 7 dB was sufficient to cause *complete loss of picture* on EchoStar transponder 2 under clear sky conditions. In other words, during a typical rain fade, the DBS picture would be lost sooner and/or for a longer period of time due to Northpoint interference.

- Interference into receivers for DBS satellites at 91°, 101° and 110° was also significant. The increase in unavailability for DIRECTV's 101° satellite was 30.6% for transponder 2, 17.6% for transponder 16, and 7.2% for transponder 32. EchoStar's 110° satellite experienced an increase in unavailability of 59.8% and 12.3% for transponders 2 and 16, respectively. All of these interference levels greatly

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9 Tests were not conducted from satellite locations further west of 119 degrees because no DBS satellite was active at any other location during the test period.

exceed internationally agreed-upon ITU criteria for interference into DBS service *by orders of magnitude*.

- Northpoint testing conducted in the Washington, DC area, relied upon to establish Northpoint's claims, showed little interference into DBS receivers because the test sites apparently were carefully placed at locations where little interference would be expected, *e.g.*, where the transmit antenna was pointed such that the DBS interference zones were outside the half-power beamwidth of the transmit antenna. There will always be selected locations where interference is minimized, but the more significant issues -- which Northpoint has strategically ignored -- relate to the level of interference that Northpoint causes inside the most susceptible areas, and how large these interference zones are.

Northpoint to date has proffered highly questionable, politicized exercises in selective data collection as "conclusive" evidence of the ability of its technology to operate at 12 GHz without interfering with DBS operations.[10] The Oxon Hill testing, however, demonstrates the real, measurable harmful interference threat that Northpoint technology poses to DBS operations.

As DBS has become a successful alternative to cable television, the interference created by Northpoint technology, which is also proposed to be deployed on a mass-market consumer basis, is absolutely unacceptable. The 12 GHz band is the primary, mission-critical frequency band used by the DBS service, which, after billions of dollars of investment by the DBS operators, is offering tremendous benefits to American consumers in the form of competition to incumbent cable television operators. The success of the DBS operators and the commensurate benefits they have provided to consumers demand that the Commission reject a proposed use of the 12 GHz band that will result in the proliferation of terrestrial systems and transmitters that will interfere with DBS service.

DIRECTV and EchoStar welcome and recommend independent testing to measure Northpoint interference into DBS systems.[11] The testing should include measurements for all current DBS satellites with CONUS coverage, as well as testing during rain conditions to determine the impact on DBS service availability. However, Northpoint technology cannot be authorized at 12 GHz in any fashion unless the Commission can conclude with certainty that

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10 Northpoint Progress Report at 27.

11 *See* Letter to Chairman William E. Kennard, Federal Communications Commission, from the Satellite Broadcasting and Communications Association, *et al.* (February 28, 2000); *see also* Letter to Chairman William E. Kennard, Federal Communications Commission, from Representatives Oxley, Tauzin, Armey, Kuykendall, Cox, Largent and Watts (May 2, 2000) (insisting that the Commission conduct independent interference testing before allocating spectrum in the DBS downlink band to any terrestrial service).

Northpoint's proposed terrestrial fixed service will not cause harmful interference to DBS operations and to DBS subscribers' receipt of service. The results of the Oxon Hill tests prove once again that such a conclusion cannot be supported.

Respectfully submitted,

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Enclosure

cc: Attached Service List

Report of Interference Impact on DBS Systems from Northpoint Transmitter Operating at Oxon Hill, MD

May 22 to June 7, 2000

DIRECTV, Inc.

EchoStar Satellite Corp.

July 25, 2000

Executive Summary

Northpoint Technology, Ltd., along with its affiliated companies Diversified Communication Engineering, Inc. and a number of entities operating under the name of "Broadwave" (collectively, "Northpoint") has proposed to introduce a terrestrial service on a secondary/non-interference basis into the 12 GHz band, which is the primary, "mission critical" frequency band used by DBS operators in the United States. In the wake of claims by Northpoint that its proposed operations will have no effect on consumers' receipt of DBS service, DIRECTV and EchoStar, the United States' two leading DBS providers, cooperated in an effort to assess the interference effects of Northpoint technology on DBS systems at 12 GHz. DIRECTV and EchoStar jointly applied for and were granted by the FCC a joint authorization for Special Temporary Authority to conduct their own interference testing of Northpoint transmitters into DBS systems.

Specifically, a series of field measurements was performed in the Washington, DC area by DIRECTV, EchoStar and Comsearch to measure and document the interference impact of a single Northpoint transmitter into nearby DBS receivers. These tests were performed at Oxon Hill, MD from May 23 through June 7, 2000. Additional measurements were made by Comsearch during this same period to independently verify the recorded data. Two field demonstrations were conducted to allow FCC personnel to witness the interference that would be experienced by DBS systems for several orbit locations.

Test Results

Significant interference from a replicated Northpoint transmitter was recorded for DBS receivers pointing to satellites at 61.5, 91, 101, and 110 degrees W.L. Lower levels of interference were recorded into a DBS receiver for a satellite at the 119 degree W.L. location due to the southeast pointing of the Northpoint transmit antenna, as selected by Northpoint in its filing. No measurements were taken for any of the further west DBS orbit locations (*e.g.*, 148 and 175 degrees W.L.) since there are no satellites currently in operation at these locations.

DBS service from the EchoStar satellite at 61.5 degrees was most affected by the replicated Northpoint (NP) transmitter at the Oxon Hill location, since one of the receive antenna backlobes lies close to the boresight of the transmit beam. The receiver signal strength meter, which relates directly to received C/N and C/(N+I) values, indicated as much as a *17 count drop* at this test location. This corresponds to a change from a C/N of 14.4 dB to a C/(N+I) of 9.6 dB, which calculates to a C/I of 11.3 dB. This interference would result *in a 122.4% increase in unavailability of EchoStar's DBS service from that location*. More alarmingly, it was demonstrated that an increase in NP transmit power of only 7 dB was sufficient to cause complete loss of picture on EchoStar's transponder 2 under clear sky conditions. In other words, during a typical rain fade, the DBS picture would be lost sooner and/or for a longer period of time due to Northpoint interference.

Interference into receivers for DBS satellites at 91, 101 and 110 degrees was also significant. The increase in unavailability for DIRECTV's 101 degree satellite was 30.6% for transponder 2, 17.6% for transponder 16, and 7.2% for transponder 32. EchoStar's 110 degree satellite experienced an increase in unavailability of 59.8% and 12.3% for transponders 2 and 16, respectively.

Test Configuration

Care was taken to replicate the proposed Northpoint transmit site for Oxon Hill, specifically for EIRP and antenna azimuth orientation.[1] The transmit horn was manufactured to the characteristics specified in the technical appendix to Northpoint's October 1999 Progress Report.[2] Transmit power was determined using calibrated test equipment. The proposed NP transmit site in Oxon Hill calls for EIRP of -21.7 dBW at an azimuth angle of 130 degrees. The transmitter produced a 24 MHz QPSK modulated signal.

Transmit power was monitored continuously during testing, and was set to provide -21.7 dBW EIRP for the nominal "TX ON" condition. The azimuth pointing of the transmit horn was set to 130 degrees for all tests. The azimuth angle was determined by using GPS readings at the transmit site and in the field to find true south, then rotating the transmit horn 50 degrees east on a protractor mount.

The receive configuration consisted of DIRECTV, EchoStar, and ExpressVu receivers and antennas available off the shelf at any retailer. The antennas were mounted at various heights, either on a tripod, approximately five feet above ground, or on a boom extension, approximately 30 feet above ground. Calibrated receiver signal strength meters allowed recording of signal count deltas under NP interference "TX OFF" and "TX ON" conditions. Also recorded for each test location was the increase in transmit power sufficient to cause loss of lock in the DBS receiver, resulting in picture loss.[3]

Receive Test Sites

Receive test locations were chosen to be representative of current and future DBS customers in the nearby area. Test sites were set up both directly in front of and behind the Prophesy condominium complex on Saint Barnabas Rd. Measurements were made at locations on Saint Barnabas Rd. based on where the susceptible DBS receive antenna backlobes intersected the NP transmitter site.

The maximum interference zones for DBS receivers occur where the antenna backlobes intersect the NP transmit beam, approximately ± 50 degrees from the back of the antenna,

[1] Northpoint transmit site parameters were taken from Broadwave USA's filing of its "Methodology for Predicting Terrestrial Interaction with DBS In the 12.2 - 12.7 GHz Band" (January 18, 2000), Table 7.
[2] Northpoint refused DIRECTV and EchoStar requests to loan one of its experimental transmitters and antennas for these tests.
[3] The transmit EIRP never exceeded the allowable maximum value specified in the STA.

and are 15 to 20 degrees wide. DBS receive antennas in the interference zone for the EchoStar 61.5 degree satellite are closer to the NP transmit antenna boresight for Oxon Hill than are receivers for the 101, 110, and 119 degree satellites, which are nearing the edge of the 3 dB beamwidth. Accordingly, a transmitter pointed at 130 degrees will cause more interference into DBS receivers for the satellite at 61.5 degrees, everything else being equal.

Interference measurements were made for all active DBS satellites with CONUS coverage. This included satellites at 61.5, 91, 101, 110, and 119 degrees. Data was recorded for low, mid-band, and high frequency transponders, 2, 16, and 32, respectively. Several measurements were made on different days, with good repeatability. In general, lower frequency transponders were more susceptible to Northpoint interference than higher frequency transponders. This may be the result of increased sensitivity of the receive antenna backlobes at lower frequencies. The DBS operators are currently investigating this possibility.

Apparent Reason Northpoint Testing from USA Today Building Showed Little Interference

The reason that the most recent Northpoint testing from the USA Today building in Rosslyn, VA showed little interference into DBS receivers is that its test sites were apparently carefully located where little interference would be expected, *e.g.*, where the transmit antenna was pointed such that the DBS interference zones were outside the half-power beamwidth of the transmit antenna. Of the 29 measurement sites specified by Northpoint in its October 1999 Progress Report, none were in the interference zone for the 61.5 degree satellite (site 13A was on the edge of this zone); only three were in the 110 degree interference zone, although Northpoint failed to measure signals from the 110 degree orbit location; and three were in the 101 degree interference zone, which is right on the edge of the 3 dB beamwidth of the transmit antenna pointed at 113 degrees azimuth. The interference zone for the 119 degree satellite is well outside the usable transmit beamwidth from the USA Today building, so little interference should be expected. There will always be selected locations where the interference is minimized. The more significant issues relate to the level of interference Northpoint causes inside the most susceptible areas, and how large these interference zones are.

Conclusion

The results of the DIRECTV/EchoStar tests prove that serious degradation to DBS service would result from a Northpoint transmitter at the Oxon Hill site. All measured interference levels for reception from the 61.5, 91, 101, and 110 degree satellites were well in excess of allowable levels. By comparison, the internationally agreed upon interference criterion for NGSO satellites as an aggregate is a 10% increase in unavailability to BSS (DBS) systems. Interference levels that double the amount of outage hours are clearly unacceptable.

Additionally, three factors should be pointed out. First, the EIRP for the Oxon Hill site is near the low end of the power range proposed by Northpoint, -22.7 to -16.7 dBW. If additional power is determined to be necessary to close the NP links, even more unavailability will occur to DBS customers in any area where the power is increased. Second, the transmit azimuth for Oxon Hill is 130 degrees, making interference zones for the 101 and 110 degree satellites near the edge of the 3 dB beamwidth of the NP transmit beam, and the interference zone for the 119 degree satellite beyond the edge of the 3 dB beamwidth, meaning that interference into these locations will be less. Interference into DBS receivers for satellites at 101, 110, and 119 degrees will increase significantly near Northpoint locations where transmit azimuths are in a more southerly direction. Similarly, interference into DBS receivers for satellites at 148 degrees and beyond will increase significantly near Northpoint transmitters pointed in a more southwesterly direction. Northpoint proposes using transmit azimuths ranging from 113 to 230 degrees to cover the Washington, DC area. Third, no reflective surfaces were observed near the DBS test site. If such surfaces were nearby, it is likely that additional interference would have been measured.

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1. Introduction

In response to proposals to introduce operations into the DBS downlink band (12.2 - 12.7 GHz), a controlled series of field tests was conducted by DIRECTV and EchoStar at one proposed Northpoint transmitter site in the Washington, DC area to measure and document the interference into DBS systems caused by a Northpoint transmitter, and to determine the impact on DBS customers. The engineering services of Comsearch, located in Reston, Virginia, were contracted for to provide independent verification of the test data collected. Additionally, Comsearch engineers performed their own measurements during this same time period to determine interference levels.

The field tests were performed at Oxon Hill, MD under FCC-granted Special Temporary Authority (STA) from May 23 through June 7, 2000. Two demonstrations were conducted for FCC personnel to witness the interference first hand. The purpose of the STA was to allow DIRECTV and EchoStar an opportunity to measure interference under controlled transmit operation. This is in contrast to DIRECTV's and EchoStar's efforts to measure interference during Northpoint's Washington, DC demonstration last fall, where the exact state and characteristics of the transmitter were less well known.

This report concentrates on the following:

- selection of Oxon Hill as test site;
- description of the test setup and test execution;
- test data and its impact on DBS link budgets;
- interpretation of test results and what the DBS customer can expect if a Northpoint-type system is implemented; and
- apparent reason that earlier Northpoint testing found little interference.

2. Oxon Hill

DIRECTV and EchoStar wanted to simulate a Northpoint transmit configuration to the greatest degree possible. Therefore, testing would take place from a Northpoint-proposed transmit site, and with transmit equipment replicating the Northpoint configuration.

DIRECTV spent two weeks surveying Northpoint's proposed transmit sites for the Washington, DC area. Of the 23 sites, only two were located on buildings: those in Rosslyn, VA and Oxon Hill, MD. The rest of the sites were either towers, or no structure was present.

The rooftop of the Oxon Hill building provided a good platform from which to set up the transmit equipment. The predicted interference zones for the various satellites were easily accessible. This allowed interference into the DBS receivers to be easily measured.

3. Test Description

Transmit Setup and Configuration

The transmit configuration was constructed to simulate a Northpoint transmitter as closely as possible. Figure 1 provides a block diagram of the transmit equipment. The transmit horn was manufactured to the characteristics provided in Northpoint's October 1999 Progress Report: 10 dBi gain; 110 degree horizontal beamwidth; 17 degree vertical beamwidth; and horizontal polarization.

A "spooler" was used as the video source, which fed an encoder/QPSK modulator. This 24 MHz signal was upconverted to the 12.2 to 12.7 GHz band, amplified, and connected to a 20 dB directional coupler with the straight-through port connected to the transmit horn via a two-foot section of RG-141 coax cable. The coupled port was monitored continuously with an HP E4418A power meter.

The transmit power was set to provide -21.7 dBW EIRP for the nominal "TX ON" condition. The transmit horn was set to an azimuth angle of 130 degrees for all tests. This specific azimuth was accomplished by using GPS readings at the transmit site and in the field to find true south, then rotating the transmit horn 50 degrees east on a protractor mount.

Receive Setup and Configuration

The receive configuration consisted of DIRECTV, EchoStar, and ExpressVu receivers and antennas available off the shelf at any retailer. Consumer-grade equipment was intentionally used to measure the interference DIRECTV, EchoStar and ExpressVu customers would experience under these interference conditions.

The antennas were mounted at various heights either on a tripod, approximately five feet above ground, or a boom extension, raised to approximately 30 feet above ground. The dual LNB fed two 100-foot RG-6 cables. One cable was connected to a hybrid where one output was connected to the spectrum analyzer and the other output to a patch panel. The patch panel facilitated quick and easy connections to different DBS receivers. The second RG-6 cable was connected directly to the patch panel that fed the receivers. Each receiver was connected to a video monitor for visual confirmation of picture/no picture. A block diagram of the receive configuration is provided in Figure 2.

Receive Test Sites

Receive test locations were chosen to be representative of current and future DBS customers in the area. Test sites were set up both directly in front of and behind the Prophesy condominium complex located in the 6300 block of Saint Barnabas Rd. Measurements were made at locations on Saint Barnabas Rd. based on where the susceptible DBS receive antenna backlobes intersected the NP transmitter site. Exact locations of the receive sites are provided in the table below.

Site #	Satellite Orbit Location	Latitude DMS	Longitude DMS	Physical Location	Distance from Transmitter, km	Antenna Height AGL During Test, ft.
1	110°	38 48 06.9	76 58 39.1	Grassy area in front of condominiums	0.44	5
5	61.5°	38 48 16.2	76 58 25.1	NE corner of parking area inside condominium courtyard	0.43	34
9	101°	38 48 09.9	76 58 35.6	On St. Barnabas Rd. in front of condominiums	0.38	30
11	91°	38 48 11.2	76 58 33.2	On St. Barnabas Rd. in front of condominiums	0.37	35

The maximum interference zones for DBS receivers occur where the antenna backlobes intersect the NP transmit beam, approximately ± 50 degrees from the back of the antenna, and are 15 to 20 degrees wide.[1] Figure 3 provides a simplified diagram of the interference configuration between a NP transmit site and a DBS receiver. DBS receive antennas in the interference zone for the EchoStar 61.5 degree satellite are closer to the NP transmit antenna boresight for Oxon Hill than are receivers for the 101, 110, and 119 degree satellites, which are nearing, or beyond, the edge of the transmit 3 dB beamwidth. As a result, a transmitter pointed at 130 degrees (SE) will cause more interference into DBS receivers for the satellite at 61.5 degrees, everything else being equal.

4. Measurements and Results

Interference measurements were made for all current DBS satellites with CONUS coverage. This included satellites at 61.5, 91, 101, 110, and 119 degrees. Data were recorded for low, mid-band, and high frequency transponders, 2, 16, and 32, respectively, as available for each satellite. Several measurements were made on different days, with good repeatability. In general, lower frequency transponders were more susceptible to Northpoint interference than higher frequency transponders. This may be the result of increased sensitivity of the receive antenna backlobes at lower frequencies. DIRECTV and EchoStar are currently investigating this possibility.

The receive antenna was mounted either on a tripod or on a platform on top of an adjustable boom. The tripod positioned the antenna approximately five feet above the ground. The tripod mount was used for the 110 degree satellite testing since clear line of sight to the transmitter was possible from ground level. The boom was used for the tests of the other satellite positions. The adjustable boom was raised to a level approximating the height of the condominium rooftop.

[1] *See* 40 degree elevation pattern contained in DIRECTV, Inc., "Terrestrial Interference in the DBS Downlink Band" (April 14, 1994), Figure 2.3-2.

After the transmit and receive sites were configured, testing was performed in the following sequence:

1. With the Northpoint transmitter OFF, the receive antenna was peaked on the DBS satellite. The DBS receiver signal meter count was recorded in the log book.
2. The NP transmitter was switched ON at nominal power (-21.7 dBW EIRP). The receiver count was again recorded.
3. The transmitter power was increased in 1 or 2 dB increments until the DBS receiver lost lock. Receiver counts were recorded for each step.
4. The transmit power was turned OFF.

These steps were repeated for different locations within the interference zone for a given satellite, and then for interference zones for the other DBS satellites.

Receiver Calibrations

Receivers for DIRECTV, EchoStar, and ExpressVu were calibrated for C/N versus signal strength. These calibrations allow a C/I to be calculated and input into a link budget. The inclusion of an additional C/I term in the link budget results in less margin for rain attenuation. The resulting decrease in the amount of rain attenuation a system can overcome and still provide a recoverable signal directly correlates to the increase in unavailability due to the interfering source. The calibrated C/N curves for DIRECTV, EchoStar, and ExpressVu receivers are provided in Figures 4, 5, and 6, respectively. A description of the receiver signal strength meters can be found in Appendix A.

Receiver signal strength meters allowed recording of signal count deltas under interference TX OFF and TX ON conditions. Also recorded for each test location was the increase in transmit power sufficient to cause loss of lock in the DBS receiver, resulting in a loss of picture. Table 1 provides a summary of the receiver count deltas recorded for each test, along with the corresponding C/I introduced into the link budgets. Also included in this table is the percent increase in unavailability and the number of outage minutes per year.

Results

EchoStar receivers for the satellite at 61.5 were the most affected by Northpoint signals transmitted at an azimuth angle of 130 degrees. Receiver count deltas ranged from 6 counts for transponder 32, the least susceptible to interference, to 17 counts for transponder 2, the most susceptible. This corresponds to an 11.9% and 122.4% increase in unavailability, respectively. Most alarming is the finding that a NP transmit power increase of only 7 dB is needed to cause complete loss of picture for transponder 2 under clear sky conditions. In other words, during a typical rain fade, the DBS picture would either be lost sooner or for a longer period of time due to Northpoint interference.

EchoStar receivers for the 110 degree service suffered significant interference as well. A 12 count delta was recorded for transponder 2, and a 5 count delta for transponder 16. This corresponds to a 59.8% and a 12.3% increase in unavailability, respectively. The decrease in the interference impact compared to 61.5 degrees is expected since receivers in the interference zone for 110 degree service are right on the edge of the transmit 3 dB beamwidth, so the actual power flux density reaching the receive antenna is less. Minimal interference was recorded for receivers pointing to EchoStar's 119 degree satellite due to the southeast pointing of the transmit antenna, so the data are not presented in this report.

DIRECTV receivers for the 101 degree satellite experienced a 9 count drop for transponder 2, a 6 count drop for transponder 16, and a 3 count drop for transponder 32 due to the NP interfering source. The corresponding increases in unavailability are 30.6%, 17.6%, and 7.2%, respectively. Again, the decrease in the interference impact compared to 61.5 degrees is expected since receivers in the interference zone for 101 degree service are close to the edge of the transmit 3 dB beamwidth, and the DIRECTV antenna has slightly lower backlobe gain than the EchoStar antenna.

Interference into the ExpressVu receivers was also measured. Although no ExpressVu service is currently authorized into the United States, the Nimiq satellite at 91 degrees W.L. transmits a beam over CONUS, and so the possibility of future U.S. service exists. Receiver count decreases of 10 counts were recorded for transponders 2 and 16, and a two count drop was recorded for transponder 32. The increases in unavailability for transponders 2, 16, and 32 are 69.0%, 85.5%, and 9.4%, respectively. Link budget parameter values for the ExpressVu service were taken from the list of BSS system characteristics provided in response to ITU-R circular letters CR-92 and CR-116. The only deviation from the given links is the use of the ITU 618-5 rain model rather than the Crane model.

The unavailability increases due to a Northpoint transmitter must be considered in the context of the internationally agreed upon interference criteria for NGSO satellites, where the *aggregate* allowable increase in unavailability to BSS systems is 10%.[2] If Northpoint is permitted to operate in the DBS band, customers of DIRECTV, EchoStar, and ExpressVu can expect increased outages on all viewer channels.

Link budgets for all tests listed in Table 1 are provided in Appendix B. ITU rain model 618-5 was used for all rain attenuation values.

Attachment A is a statement by Comsearch that attests to the accuracy of the data taken during the Oxon Hill tests.

Comparisons to Previous Measurements

When Northpoint performed its Washington, DC demonstration in the fall of 1999, DIRECTV was operating all of its even numbered transponders at 101 degrees W.L. in low power mode, and all odd numbered transponders in high power mode.

Since December of 1999, with the launch of a new satellite, all of DIRECTV's transponders at the 101 degree orbital location have been operating in high power mode. In this mode, fewer forward error correction overhead bits are needed to maintain the same quality of service (*i.e.*, availability performance) to the subscriber. This lower overhead directly results

[2] Recommendation ITU-R BO. 1444.

in more bits available in each transponder (more throughput) for added services to subscribers.

The difference in satellite EIRP between the high power and low power modes is roughly 3 dB, resulting in roughly a 3 dB higher C/N to support the higher throughput.

The EIRP in the Washington, DC area is now about 3 dB higher than it was in the fall of 1999. This means that caution must be used when comparing measurements made in the fall of 1999 with the Oxon Hill measurements made in the spring of 2000. For the Oxon Hill measurement set, the C/N (and correspondingly, the receiver signal strength meter), under no interference conditions, is higher. Consequently, for the same signal meter count drop caused by interference, the corresponding C/I value is higher. For example, a 10 count drop from 82 to 72 results in a C/I of 13.6 dB, whereas a 10 count drop from 91 to 81 yields a C/I of 16.5 dB. The different C/I values will affect the DBS link budgets differently.

5. FCC Demonstrations

Demonstrations were conducted on June 6 and 7 in Oxon Hill to allow FCC personnel to witness the interference into nearby DBS systems caused by a Northpoint transmitter. Interference was demonstrated, and witnessed by FCC personnel, but not recorded on June 6. The following receiver count changes were recorded during the demonstration on June 7:

DBS System	Xpndr	Receiver Count Drop	Calculated C/I due to NP Interference, dB	Resulting Increase in Unavailability, %
EchoStar - 61.5°	2	15	12.2	84.2
EchoStar - 110°	2	8	14.4	39.1
DIRECTV - 101°	2	10	16.5	28.9

During the demonstration for DIRECTV's 101 degree satellite, a question was raised regarding the height of the receive dish above the mounting platform of the boom, and whether it was high enough to sufficiently minimize reflections into the feed. To address this, after the demonstration had concluded, a 3-foot mast made from PVC pipe was added to the antenna mount. A complete set of data (tests 33, 34, and 35) was taken at the same location used for the 101 degree satellite demonstration, although the boom height was approximately 20 feet rather than 30 feet as during the demonstration. This data is provided in the test summary table along with the previously recorded measurements.

6. Northpoint Tests

A review of the Northpoint Progress Report of October 1999 reveals two very interesting facts about the Northpoint-conducted testing at the USA Today site:

1. The Northpoint transmit beam was pointed so far east (113 degrees) rather than south, that the half-power beamwidth bisected the interference zone for the 101 degree satellite, thus making it unlikely that significant interference would be found in the 101 degree interference zone. The interference zones for the 110 and 119 degree satellites lie completely outside the 3 dB transmit beamwidth, where the power drops off quickly, so measuring interference in these areas is futile. The USA Today site is the most easterly pointing transmit angle of all 23 proposed Northpoint transmit sites. The remaining transmit sites range in transmit azimuth from 130 to 230 degrees.
2. No measurements were made in the interference zone for the 61.5 degree satellite. One measurement was made right on the edge of the zone (NP site 13A) where the susceptible antenna backlobe rolls off quickly, but for whatever reason, no measurements were made anywhere near the peak interference area.

EchoStar and DIRECTV performed measurements during this same test period in an area known as the polo field in West Potomac Park. This location is more toward the center of one of the known interference zones than the Northpoint measurement site 13A. On September 8, 1999 a degradation of 8 signal strength counts was observed using an EchoStar Model 4000 receiver and an antenna pointing to 61.5° W.L. This confirmed the existence of the predicted interference zones and further proved that Northpoint service within one of these zones would result in measurable interference to DBS operations.

Figure 7 is a copy of Northpoint's "Near In Region, USA Today" figure with overlays of the satellite interference zones. Northpoint test sites 6A, 7, and 7A are very near the edge of the transmit half-power beamwidth, so the power reaching these sites is already 3 dB down from the beam peak. It is not surprising that lower interference levels were recorded at these sites.

For Northpoint service areas with more southerly transmit azimuth angles, the interference zones for 101, 110, and 119 degree satellites will lie more squarely in the main beam. Similarly, for Northpoint service areas with a more southwesterly transmit azimuth angle, the interference zones for 148 degree satellites will be more squarely in the main beam. The interference impact for these configurations will be much more severe.

7. Impact of Northpoint Transmit Sites Across CONUS

To establish a mass-market service, Northpoint will need to deploy many thousands of transmit sites across the country for complete service coverage. The interference impact of these sites on DBS service in cities with lower satellite EIRPs compared to Washington, DC, and hence lower clear-sky margin, will be even greater. If the interference power (I) remains the same, but the satellite power (C) is lower, then C/I is decreased. This lower C/I has a greater impact on the satellite link budget. The result is a higher increase in unavailability.

Washington, DC is on the high end of DBS satellite EIRP across CONUS for both DIRECTV and EchoStar. Cities near the edge of DBS coverage, such as Los Angeles, Chicago, and Seattle, and those in the southwestern U.S., such as Denver, have satellite EIRPs 2 to 3.5 dB lower than that in Washington, DC. These cities are more susceptible to interference and consequently, will be more severely impacted by Northpoint transmitters. For example, if the transmit power for the Oxon Hill site were used in Los Angeles, a DIRECTV system 0.4 km from the transmitter would experience a 140% increase in unavailability on transponder 2, compared with 30% for the same distance in Oxon Hill. The geometric relationship between the transmitter and DBS receiver would of course be different due to the different azimuth angle to the 101 degree satellite for the DBS receiver.

The impact of Northpoint interference on DIRECTV receivers (101 degrees W.L., transponder 2) in Los Angeles, Seattle, Chicago, and Denver were calculated using the transmit parameters for Oxon Hill. The table below shows the interference impact on four selected cities. The increases in unavailability range from 66% for Chicago to 239% for Seattle. These link budgets are provided in Appendix B.

City	Increase % in Unavailability for DIRECTV Transponder 2 Using Oxon Hill Transmit Parameters
Washington, DC	30.6
Los Angeles	140.8
Seattle	239.2
Chicago	66.5
Denver	144.4

8. Conclusions

The results of the DIRECTV/EchoStar tests prove that serious degradation to DBS service would result from a Northpoint transmitter at the Oxon Hill site. Interference levels that double the amount of outage hours clearly create an unacceptable condition.

It is important to note that Oxon Hill is one of the more benign Northpoint transmit sites with regard to interference into DBS systems. The EIRP of -21.7 dBW is near the low end of the EIRPs proposed by Northpoint, -22.7 to -16.7 dBW. Additionally, except for the USA Today site, Oxon Hill is the most easterly pointing of all the transmit sites, which range in transmit azimuths from 113 to 230 degrees to cover the Washington, DC area. At NP transmit sites where the azimuth is in a more southerly direction, DBS receivers pointed to satellites at 91, 101, 110, and 119 degrees will experience interference levels similar to that experienced by the 61.5 degree receiver in this test.

Even more troubling is the fact that cities with lower satellite EIRPs will experience even higher increases in unavailability. Many major cities, such as Los Angeles and Denver, have lower EIRP than Washington, DC. The impact on DBS customers in these cities should be examined.

Interference zones exist for every DBS satellite with CONUS coverage due to Northpoint transmitters. Regardless of the Northpoint transmit azimuths, DBS receivers will be affected by Northpoint transmitters. For the Washington, DC area, transmit azimuths of 130 to 180 degrees will interfere with DBS receivers pointed to orbit locations 61.5 to 110 degrees. Transmit azimuths of 180 to 230 degrees will interfere with DBS receivers pointed to orbit locations 101 to 148 degrees. For any given Northpoint transmit site, the DBS receiver interference zones can be predicted and overlaid on a map to see the affected areas. Eliminating interference into receivers for all DBS orbit locations with CONUS coverage simply is not possible. In contrast to the internationally agreed upon interference criterion for NGSO satellites into BSS systems, namely, 10% increase in unavailability for all NGSO systems, the increases in unavailability due to a Northpoint transmitter at the Oxon Hill site range from 7.2% to 122.4%.

DIRECTV and EchoStar recommend further independent testing to measure Northpoint interference into DBS systems. The testing should include measurements for all current DBS satellites with CONUS coverage, as well as testing during rain conditions to determine the impact on availability. Tests should also be conducted in cities with lower satellite EIRPs, such as Seattle and Denver, to better gauge the nationwide impact of a fully deployed Northpoint system on DBS customers.

Test #	Sat/Loc	Xpndr	Rcvr Counts TX OFF	Rcvr Counts TX ON	Rcvr Count Decrease	C/N, dB TX OFF	C/(N+I), dB TX ON	C/I, dB	% Increase in Unavail.	Outage Minutes per Year w/o NP/NP		Increase in interference power to cause picture loss, dB
5	Echo/110	2	88	76	12	13.6	10.3	13.1	59.8	376	601	9
7	Echo/110	16	91	86	5	14.4	13.0	18.6	12.3	376	422	12
14	Echo/61.5	2	91	74	17	14.4	9.6	11.3	122.4	305	679	7
15	Echo/61.5	16	92	76	16	14.7	10.3	12.3	81.2	305	553	8
16	Echo/61.5	32	93	87	6	14.8	13.3	18.8	11.9	305	342	12
20	DTV/101	2	92	83	9	13.1	11.4	16.3	30.6	219	286	9
21	DTV/101	16	87	81	6	12.2	11.2	18.3	17.6	219	257	12
22	DTV/101	32	91	88	3	12.7	12.2	21.8	7.2	219	235	15
23	ExpressVu/91	2	82	72	10	11.4	9.9	15.4	69.0	4132	6984	9
24	ExpressVu/91	16	78	68	10	10.8	9.3	14.8	85.5	4132	7666	9
25	ExpressVu/91	32	80	78	2	11.1	10.8	22.5	9.4	4132	4521	15
30 (FCC Demo)	Echo/61.5	2	91	76	15	14.3	10.1	12.2	84.2	305	563	8
31 (FCC Demo)	Echo/110	2	85	77	8	12.6	10.4	14.4	39.1	376	523	8
32 (FCC Demo)	DTV/101	2	91	81	10	12.7	11.2	16.5	28.9	219	282	9
33 (w/ant. mast)	DTV/101	2	91	76	15	12.7	10.6	14.6	51.8	219	332	9
34 (w/ant. mast)	DTV/101	16	88	79	9	12.3	10.9	16.3	30.6	219	286	8
35 (w/ant. mast)	DTV/101	32	90	83	7	12.6	11.4	17.9	20.4	219	263	10

Table 1. Test Data Summary

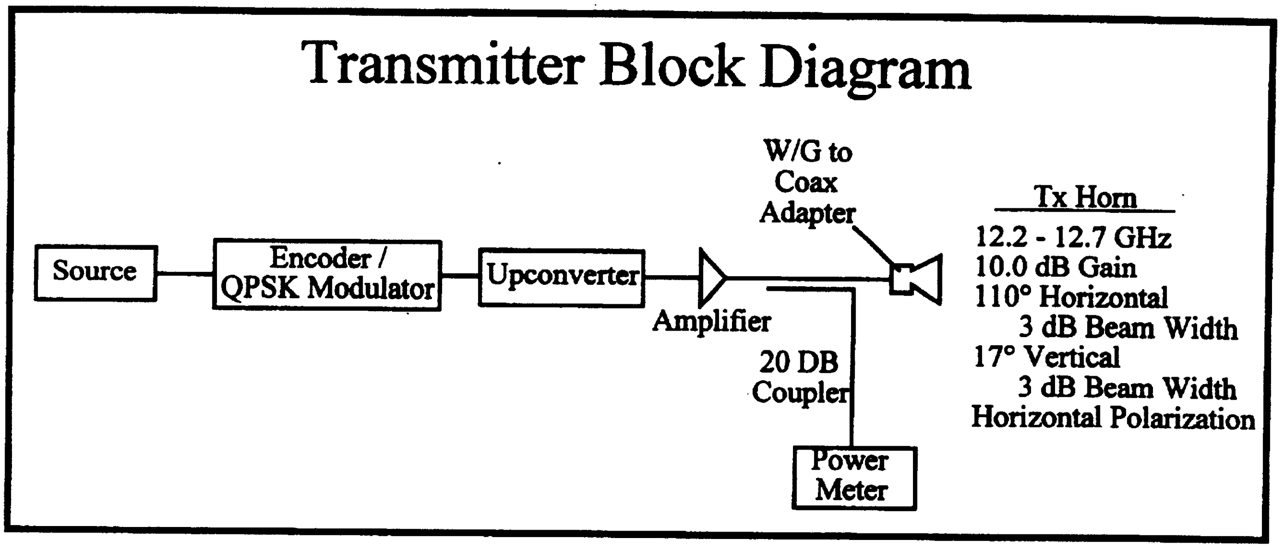

Figure 1. Transmit Site Block Diagram

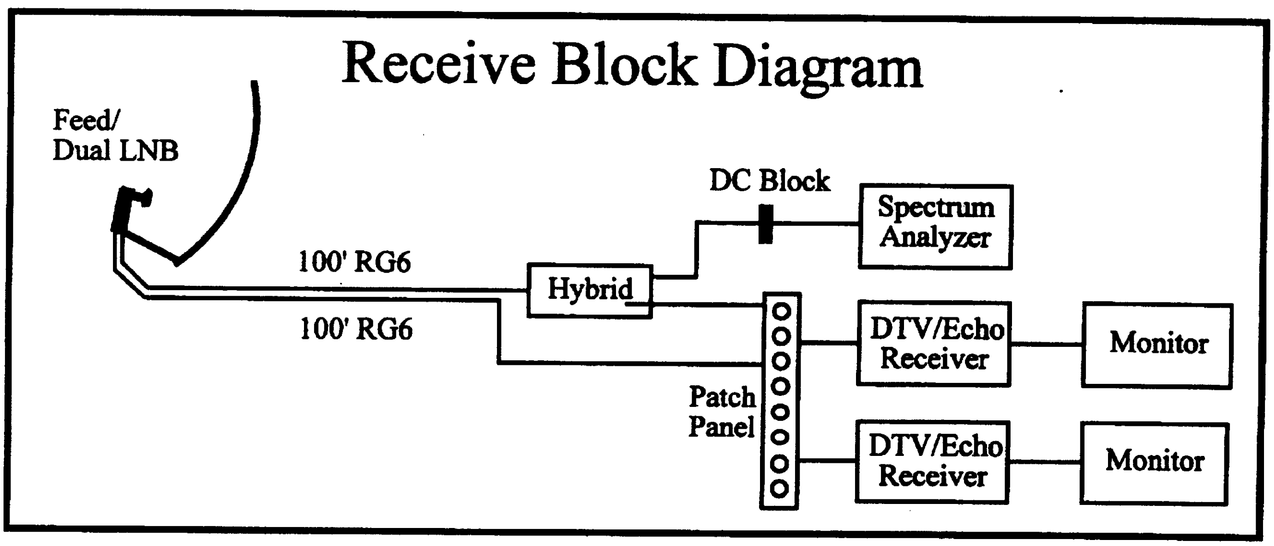

Figure 2. Receive Site Block Diagram

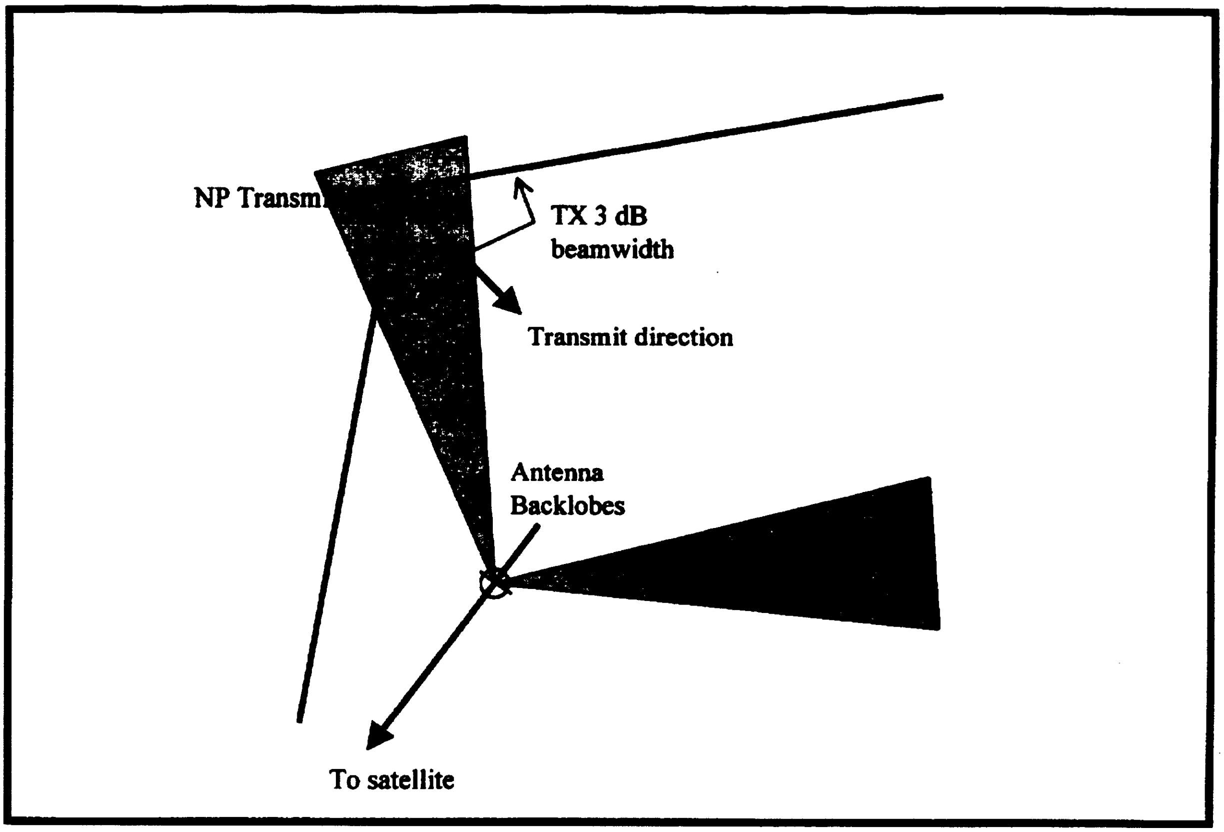

Figure 3. Interference Configuration Between NP Transmitter and DBS Receiver

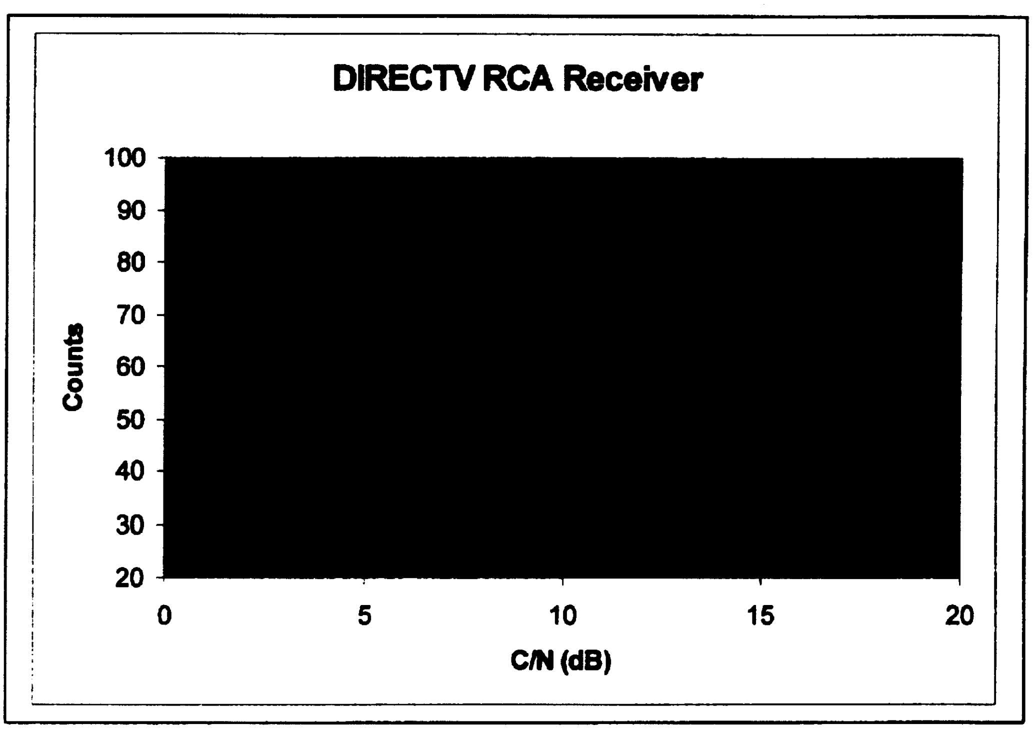

Figure 4. DIRECTV Receiver Calibration

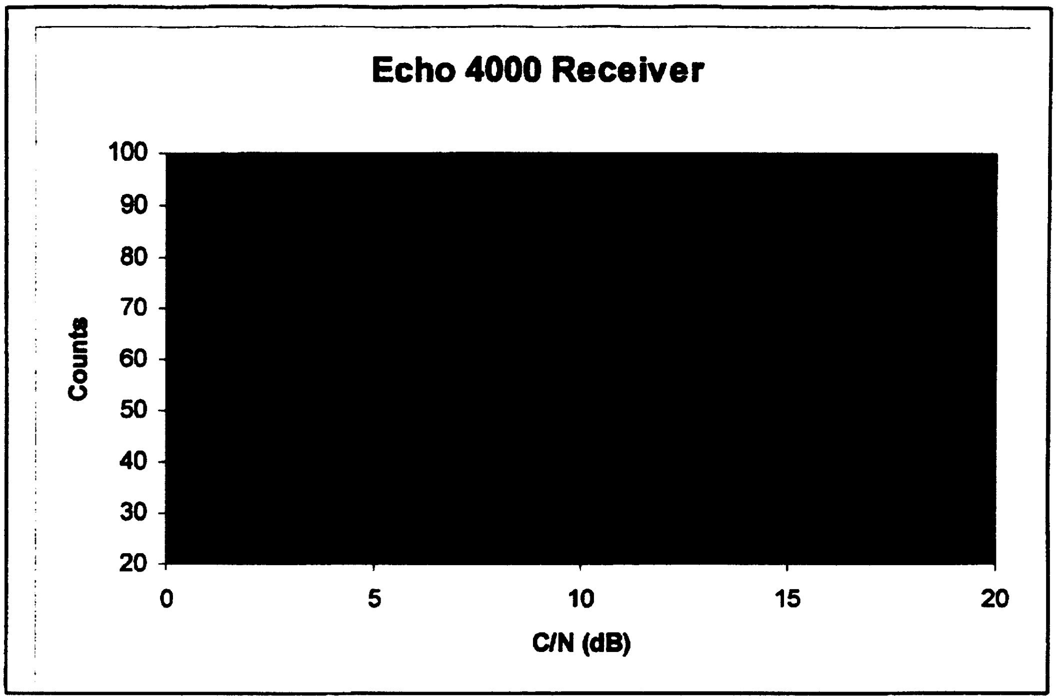

Figure 5. EchoStar Receiver Calibration

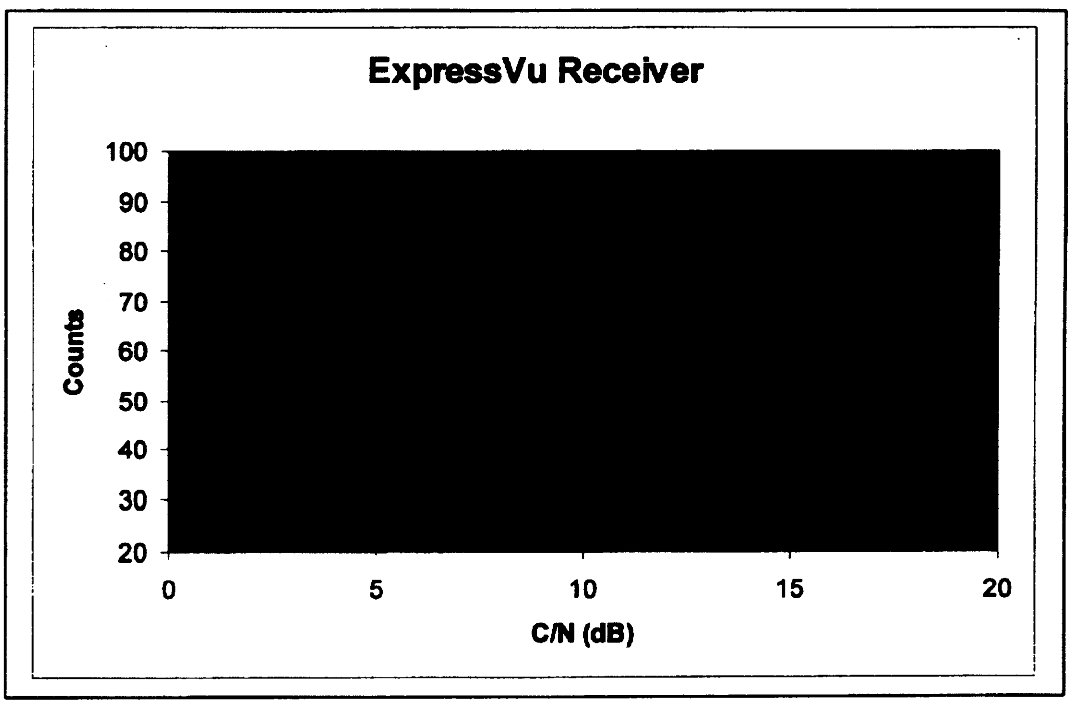

Figure 6. ExpressVu Receiver Calibration

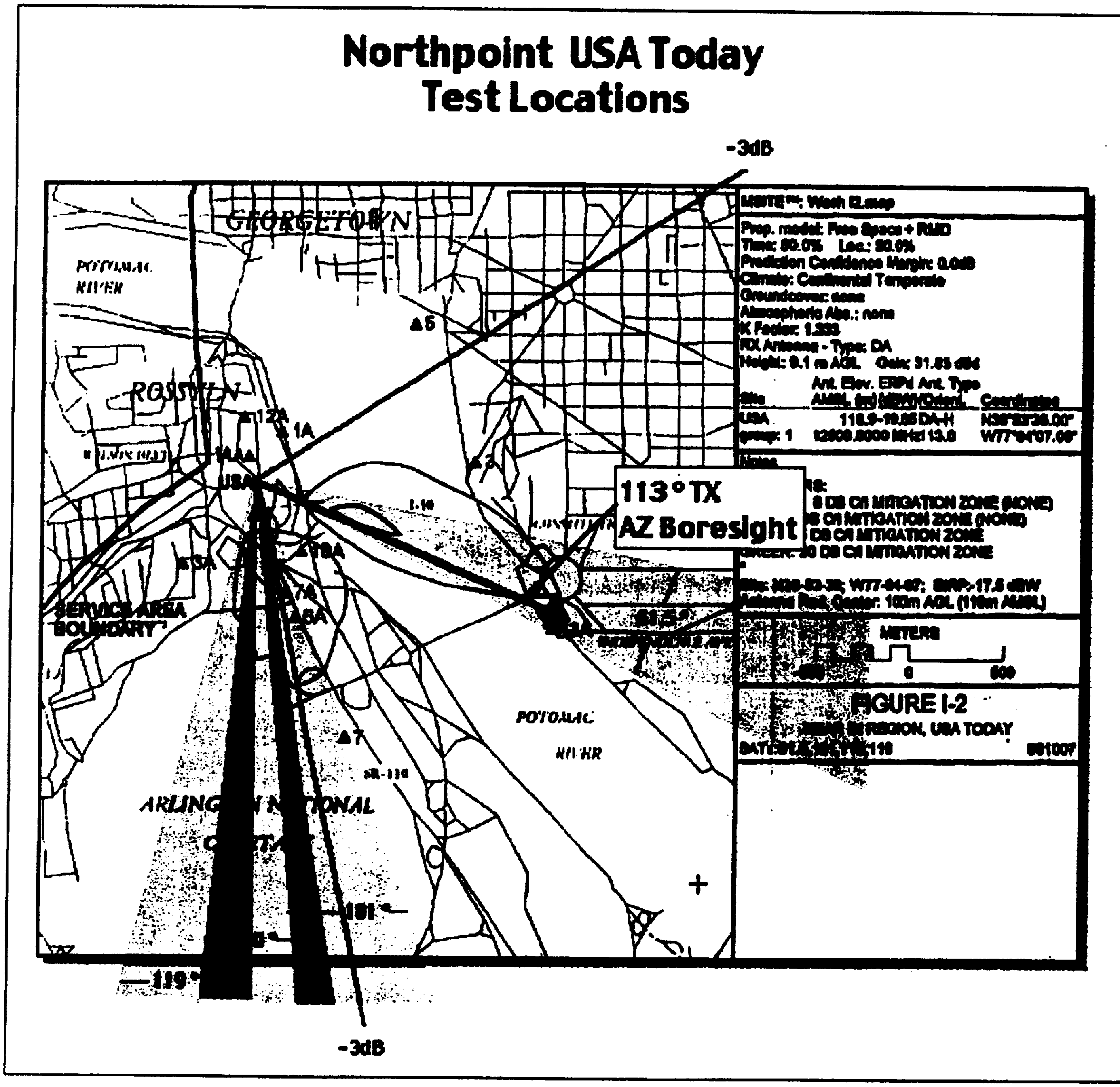

Figure 7. Northpoint USA Today Test Locations versus Interference Zones

Appendix A

DBS Receiver Signal Strength Meters

Signal Strength Indicators in DBS Receivers:

Consumer grade receivers used for the reception of Direct Broadcast Satellite (DBS) signals employ some form of signal strength (SS) indication. The SS indication function is normally accessed by the consumer via the User Interface (UI) software associated with the installation and alignment of the home receiving equipment. The SS indication device in both DIRECTV and EchoStar consumer receivers is in the form of a bar graph meter. The meter provides a relative measure of the received signal quality. The primary intent of this indicating function is to aid in the alignment of the outdoor antenna to achieve the strongest signal possible in any particular geographic area. However, engineers for both DIRECTV and EchoStar have come to rely on these SS indicators as a valuable tool in assessing signal transmission quality and deleterious effects from rain or other interfering or noise generating phenomena.

The utility of the SS indicator comes primarily from the fact that it is not a simple RF power indicator such as a Received Signal Strength Indicator (RSSI) from a receiver's pre-detection IF chain or Automatic Gain Control (AGC) from either the RF tuner/IF strip. This source of SS indication is common to home FM stereo receivers.

The SS indicator of a DBS receiver derives its information from the QPSK symbol demodulation and tracking loop. Internal to the demodulator, an algorithm estimates the residual noise associated with the QPSK symbols. The quantity typically reported is the Es/No, the average energy of a symbol to the average noise power in a 1 Hz bandwidth. For Gray coded QPSK, the quantities Es/No and Eb/No are mathematically related by a factor of 2. That is Es/No = Eb/No + 3db. Both Es/No and Eb/No are measured in the digital domain. These quantities can be likened to the signal-to-noise ratio (S/N) which is the common qualitative quantity of measure for analog transmission systems. In both analog and digital systems, knowing Eb/No or S/N and channel bit-rates and noise bandwidths, it is possible to determine the carrier-to-noise (C/N) of the RF carrier. Therefore, with simple mathematical relationships, the information from the demodulators can be used to derive Es/No, Eb/No or C/N, all very useful quantities for characterizing transmission quality and impairments to a channel.

Minor differences are encountered between IC manufacturers in the methods for calculating the bit-noise ratio and hence the absolute value of the unit quantity. This is the reason why the same absolute value of a particular channel C/N may be reported as SS = 94 for one model of receiver and SS = 85 on another receiver. All that is different between the receiver models is the slope of the number of SS counts vs. decibel curve.

For example, the EchoStar Model 4000 receiver has SS meter slope of 6-7 counts per dB. This is fairly linear from below threshold. The demodulator actually remains locked below the point of the FEC lock to very close to the end of the range of the internal IC register that holds the processed Es/No value. In the case of the Model 4000, this relates to C/N values from about 1 dB to 14 dB for the currently used channel and code rates. This range is sufficient to provide accurate antenna peaking anywhere in the continental US EIRP footprints using small 18-inch antennas.

The important point to note is that any receiver can be calibrated to provide very accurate C/N or Eb/No values from the deflection of the SS meter. Once a calibration has been performed, the number of SS count difference observed under varying channel conditions can be directly related to absolute dB values of C/N degradation from the impairment. Stated another way, for a 1 dB degradation of C/N, one model receiver may report a 10 SS count delta and another model 7 SS count delta. Both SS data points are correct, accurate, and repeatable knowing the associated calibration curve. Even without calibration, the change in the SS count reading from peak value to some lower value indicates the channel is suffering impairments but on a relative rather than absolute basis.

The accuracy and dependability of the data interpreted from the SS meter can provide valuable information to engineering and satellite operations. It provides a means to constantly monitor the condition of the satellite payload and varying regional link conditions. The information is used for statistical data collection to verify and support availability predictions and to evaluate the performance of system design improvements from the uplink transmission plant to the set-top and outdoor electronics.

Appendix B

Link Budgets

Echo at 110; 3/4 code								
Oxon Hill, MD								
Transponder 2		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
Test 5								
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20			
Downlink:	Satellite EIRP, dBW	54.0	54.0	54.0	54.0			
Washington, DC	Downlink path loss, dB	-206.1	-206.1	-206.1	-206.1			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.12	-3.33	Availability w/o NP	99.9285	376
	Rain temp increase, dB	0.0	0.0	-3.8	-3.5	Availability with NP	99.8857	601
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	59.8	225
	Ground G/T, dB/K	12.7	12.7	12.7	12.7			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		14.7	14.7	6.7	7.8			
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2			
	Downlink C/N (thermal), dB	14.7	14.7	6.7	7.8			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	22.2	22.2	22.2	22.2			
	C/I from NP	**99.0**	**13.1**	**99.0**	**13.1**			
	Total C/(N+I), dB	13.1	10.1	6.4	6.4			
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4			
	Margin, dB	6.7	3.7	0.0	0.0			

Echo at 110; 3/4 code								
Oxon Hill, MD								
Transponder 16		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
Test 7								
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20			
Downlink:	Satellite EIRP, dBW	54.0	54.0	54.0	54.0			
Washington, DC	Downlink path loss, dB	-206.1	-206.1	-206.1	-206.1			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.12	-3.91	Availability w/o NP	99.9285	376
	Rain temp increase, dB	0.0	0.0	-3.8	-3.8	Availability with NP	99.9197	422
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	**12.3**	**46**
	Ground G/T, dB/K	12.7	12.7	12.7	12.7			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		14.7	14.7	6.7	7.0			
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2			
	Downlink C/N (thermal), dB	14.7	14.7	6.7	7.0			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	22.2	22.2	22.2	22.2			
	C/I from NP	**99.0**	**18.6**	**99.0**	**18.6**			
	Total C/(N+I), dB	13.1	12.0	6.4	6.4			
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4			
	Margin, dB	6.7	5.6	0.0	0.0			

Echo at 61.5; 3/4 code									
Oxon Hill, MD									
Transponder 2		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP				
Test 14									
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20				
Downlink:	Satellite EIRP, dBW	53.5	53.5	53.5	53.5				
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-3.98	-2.77		Availability w/o NP	99.9419	305
	Rain temp increase, dB	0.0	0.0	-3.8	-3.2		Availability with NP	99.8708	679
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	**122.4**	374
	Ground G/T, dB/K	12.7	12.7	12.7	12.7				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		14.4	14.4	6.6	8.4				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2				
	Downlink C/N (thermal), dB	14.4	14.4	6.6	8.4				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	30.0	30.0	30.0	30.0				
	C/I from NP	**99.0**	**11.3**	**99.0**	**11.3**				
	Total C/(N+I), dB	13.3	9.2	6.4	6.4				
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4				
	Margin, dB	6.9	2.8	0.0	0.0				

Echo at 61.5; 3/4 code									
Oxon Hill, MD									
Transponder 16		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
Test 15									
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20				
Downlink:	Satellite EIRP, dBW	53.5	53.5	53.5	53.5				
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-3.98	-3.04		Availability w/o NP	99.9419	305
	Rain temp increase, dB	0.0	0.0	-3.8	-3.4		Availability with NP	99.8947	553
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	81.2	248
	Ground G/T, dB/K	12.7	12.7	12.7	12.7				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		14.4	14.4	6.6	8.0				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2				
	Downlink C/N (thermal), dB	14.4	14.4	6.6	8.0				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	30.0	30.0	30.0	30.0				
	C/I from NP	99.0	12.3	99.0	12.3				
	Total C/(N+I), dB	13.3	9.8	6.4	6.4				
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4				
	Margin, dB	6.9	3.4	0.0	0.0				

Echo at 61.5; 3/4 code									
Oxon Hill, MD									
Transponder 32		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
Test 16									
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20				
Downlink:	Satellite EIRP, dBW	53.5	53.5	53.5	53.5				
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-3.98	-3.79		Availability w/o NP	99.9419	305
	Rain temp increase, dB	0.0	0.0	-3.8	-3.7		Availability with NP	99.9350	342
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	11.9	36
	Ground G/T, dB/K	12.7	12.7	12.7	12.7				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		14.4	14.4	6.6	6.9				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2				
	Downlink C/N (thermal), dB	14.4	14.4	6.6	6.9				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	30.0	30.0	30.0	30.0				
	C/I from NP	**99.0**	**18.8**	**99.0**	**18.8**				
	Total C/(N+I), dB	13.3	12.2	6.4	6.4				
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4				
	Margin, dB	6.9	5.8	0.0	0.0				

DIRECTV at 101; 6/7 code									
Oxon Hill, MD									
Transponder 2		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
Test 20									
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70				
Downlink:									
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8				
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.30		Availability w/o NP	99.9584	219
	Rain temp increase, dB	0.0	0.0	-4.1	-3.9		Availability with NP	99.9457	286
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	**30.6**	67
	Ground G/T, dB/K	13.0	13.0	13.0	13.0				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		16.9	16.9	8.0	8.7				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7				
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.7				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7				
	C/I from NP	**99.0**	**16.3**	**99.0**	**16.3**				
	Total C/(N+I), dB	14.5	12.3	7.6	7.6				
	Required C/(N+I), dB	7.6	7.6	7.6	7.6				
	Margin, dB	6.9	4.7	0.0	0.0				

DIRECTV at 101; 6/7 code								
Oxon Hill, MD								
Transponder 16		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP			
Test 21								
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70			
Downlink:								
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8			
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.50	Availability w/o NP	99.9584	219
	Rain temp increase, dB	0.0	0.0	-4.1	-4.0	Availability with NP	99.9511	257
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	**17.6**	38
	Ground G/T, dB/K	13.0	13.0	13.0	13.0			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		16.9	16.9	8.0	8.4			
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7			
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.4			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7			
	C/I from NP	**99.0**	**18.3**	**99.0**	**18.3**			
	Total C/(N+I), dB	14.5	13.0	7.6	7.6			
	Required C/(N+I), dB	7.6	7.6	7.6	7.6			
	Margin, dB	6.9	5.4	0.0	0.0			

DIRECTV at 101; 6/7 code									
Oxon Hill, MD									
Transponder 32		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
Test 22									
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70				
Downlink:									
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8				
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.68		Availability w/o NP	99.9584	219
	Rain temp increase, dB	0.0	0.0	-4.1	-4.0		Availability with NP	99.9554	235
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	7.2	16
	Ground G/T, dB/K	13.0	13.0	13.0	13.0				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		16.9	16.9	8.0	8.2				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7				
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.2				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7				
	C/I from NP	**99.0**	**21.8**	**99.0**	**21.8**				
	Total C/(N+I), dB	14.5	13.7	7.6	7.6				
	Required C/(N+I), dB	7.6	7.6	7.6	7.6				
	Margin, dB	6.9	6.1	0.0	0.0				

ExpressVu at 91; 3/4 code								
Oxon Hill, MD								
Transponder 2		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
Test 23								
Uplink C/N (thermal), dB		25.70	25.70	25.70	25.70			
Downlink:	Satellite EIRP, dBW	48.8	48.8	48.8	48.8			
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-1.11	-0.83	Availability w/o NP	99.2139	4132
	Rain temp increase, dB	0.0	0.0	-1.8	-1.5	Availability with NP	98.6713	6984
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	**69.0**	2852
	Ground G/T, dB/K	12.6	12.6	12.6	12.6			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		9.6	9.6	6.7	7.3			
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
	Uplink C/N (thermal), dB	25.7	25.7	25.7	25.7			
	Downlink C/N (thermal), dB	9.6	9.6	6.7	7.3			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	30.0	30.0	22.2	22.2			
	C/I from NP	**99.0**	**15.4**	**99.0**	**15.4**			
	Total C/(N+I), dB	9.3	8.3	6.4	6.4			
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4			
	Margin, dB	2.9	1.9	0.0	0.0			

ExpressVu at 91; 3/4 code									
Oxon Hill, MD									
Transponder 16		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
Test 24									
Uplink C/N (thermal), dB		25.70	25.70	25.70	25.70				
Downlink:	Satellite EIRP, dBW	48.8	48.8	48.8	48.8				
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-1.11	-0.79		Availability w/o NP	99.2139	4132
	Rain temp increase, dB	0.0	0.0	-1.8	-1.4		Availability with NP	98.5415	7666
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	**85.5**	3534
	Ground G/T, dB/K	12.6	12.6	12.6	12.6				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		9.6	9.6	6.7	7.4				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	25.7	25.7	25.7	25.7				
	Downlink C/N (thermal), dB	9.6	9.6	6.7	7.4				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	30.0	30.0	22.2	22.2				
	C/I from NP	**99.0**	**14.8**	**99.0**	**14.8**				
	Total C/(N+I), dB	9.3	8.2	6.4	6.4				
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4				
	Margin, dB	2.9	1.8	0.0	0.0				

ExpressVu at 91; 3/4 code								
Oxon Hill, MD								
Transponder 32		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
Test 25								
Uplink C/N (thermal), dB		25.70	25.70	25.70	25.70			
Downlink:	Satellite EIRP, dBW	48.8	48.8	48.8	48.8			
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-1.11	-1.05	Availability w/o NP	99.2139	4132
	Rain temp increase, dB	0.0	0.0	-1.8	-1.8	Availability with NP	99.1398	4521
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	**9.4**	390
	Ground G/T, dB/K	12.6	12.6	12.6	12.6			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		9.6	9.6	6.7	6.8			
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
	Uplink C/N (thermal), dB	25.7	25.7	25.7	25.7			
	Downlink C/N (thermal), dB	9.6	9.6	6.7	6.8			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	30.0	30.0	22.2	22.2			
	C/I from NP	**99.0**	**22.5**	**99.0**	**22.5**			
	Total C/(N+I), dB	9.3	9.1	6.4	6.4			
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4			
	Margin, dB	2.9	2.7	0.0	0.0			

Echo at 61.5; 3/4 code									
Oxon Hill, MD									
Transponder 2		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
Test 30	**FCC Demo**								
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20				
Downlink:	Satellite EIRP, dBW	53.5	53.5	53.5	53.5				
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-3.98	-3.02		Availability w/o NP	99.9419	305
	Rain temp increase, dB	0.0	0.0	-3.8	-3.3		Availability with NP	99.8930	563
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	84.2	257
	Ground G/T, dB/K	12.7	12.7	12.7	12.7				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		14.4	14.4	6.6	8.0				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2				
	Downlink C/N (thermal), dB	14.4	14.4	6.6	8.0				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	30.0	30.0	30.0	30.0				
	C/I from NP	**99.0**	**12.2**	**99.0**	**12.2**				
	Total C/(N+I), dB	13.3	9.7	6.4	6.4				
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4				
	Margin, dB	6.9	3.3	0.0	0.0				

Echo at 110; 3/4 code								
Oxon Hill, MD								
Transponder 16		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
Test 31	**FCC Demo**							
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20			
Downlink:	Satellite EIRP, dBW	54.0	54.0	54.0	54.0			
Washington, DC	Downlink path loss, dB	-206.1	-206.1	-206.1	-206.1			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.12	-3.55	Availability w/o NP	99.9285	376
	Rain temp increase, dB	0.0	0.0	-3.8	-3.6	Availability with NP	99.9005	523
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	**39.1**	147
	Ground G/T, dB/K	12.7	12.7	12.7	12.7			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		14.7	14.7	6.7	7.5			
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2			
	Downlink C/N (thermal), dB	14.7	14.7	6.7	7.5			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	22.2	22.2	22.2	22.2			
	C/I from NP	**99.0**	**14.4**	**99.0**	**14.4**			
	Total C/(N+I), dB	13.1	10.7	6.4	6.4			
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4			
	Margin, dB	6.7	4.3	0.0	0.0			

DIRECTV at 101; 6/7 code								
Oxon Hill, MD								
Transponder 2		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP			
Test 32	FCC Demo							
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70			
Downlink:								
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8			
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.32	Availability w/o NP	99.9584	219
	Rain temp increase, dB	0.0	0.0	-4.1	-3.9	Availability with NP	99.9464	282
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	28.9	63
	Ground G/T, dB/K	13.0	13.0	13.0	13.0			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		16.9	16.9	8.0	8.7			
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7			
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.7			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7			
	C/I from NP	**99.0**	**16.5**	**99.0**	**16.5**			
	Total C/(N+I), dB	14.5	12.4	7.6	7.6			
	Required C/(N+I), dB	7.6	7.6	7.6	7.6			
	Margin, dB	6.9	4.8	0.0	0.0			

DIRECTV at 101; 6/7 code									
Oxon Hill, MD									
Transponder 2		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
Test 33	**Mast Extension**								
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70				
Downlink:									
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8				
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.02		Availability w/o NP	99.9584	219
	Rain temp increase, dB	0.0	0.0	-4.1	-3.8		Availability with NP	99.9368	332
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	**51.8**	113
	Ground G/T, dB/K	13.0	13.0	13.0	13.0				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		16.9	16.9	8.0	9.1				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7				
	Downlink C/N (thermal), dB	16.9	16.9	8.0	9.1				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7				
	C/I from NP	**99.0**	**14.6**	**99.0**	**14.6**				
	Total C/(N+I), dB	14.5	11.5	7.6	7.6				
	Required C/(N+I), dB	7.6	7.6	7.6	7.6				
	Margin, dB	6.9	3.9	0.0	0.0				

DIRECTV at 101; 6/7 code									
Oxon Hill, MD									
Transponder 16		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
Test 34	**Mast Extension**								
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70				
Downlink:									
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8				
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.30		Availability w/o NP	99.9584	219
	Rain temp increase, dB	0.0	0.0	-4.1	-3.9		Availability with NP	99.9457	286
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	30.6	67
	Ground G/T, dB/K	13.0	13.0	13.0	13.0				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		16.9	16.9	8.0	8.7				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7				
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.7				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7				
	C/I from NP	**99.0**	**16.3**	**99.0**	**16.3**				
	Total C/(N+I), dB	14.5	12.3	7.6	7.6				
	Required C/(N+I), dB	7.6	7.6	7.6	7.6				
	Margin, dB	6.9	4.7	0.0	0.0				

DIRECTV at 101; 6/7 code									
Oxon Hill, MD									
Transponder 32		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP				
Test 35	Mast Extension								
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70				
Downlink:									
Washington, DC	Satellite EIRP, dBW	55.8	55.8	55.8	55.8				
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.45		Availability w/o NP	99.9584	219
	Rain temp increase, dB	0.0	0.0	-4.1	-4.0		Availability with NP	99.9499	263
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	20.4	45
	Ground G/T, dB/K	13.0	13.0	13.0	13.0				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		16.9	16.9	8.0	8.5				
Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP				
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7				
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.5				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7				
	C/I from NP	**99.0**	**17.9**	**99.0**	**17.9**				
	Total C/(N+I), dB	14.5	12.8	7.6	7.6				
	Required C/(N+I), dB	7.6	7.6	7.6	7.6				
	Total Eb/(N+I)o, dB	13.5	11.8	6.6	6.6				
	Required Eb/(N+I)o, dB	6.6	6.6	6.6	6.6				

DIRECTV at 101; 6/7 code								
Los Angeles								
		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP			
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70			
Downlink:								
Los Angeles	Satellite EIRP, dBW	52.9	52.9	52.9	52.9			
	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-2.84	-1.96	Availability w/o NP	99.9764	124
	Rain temp increase, dB	0.0	0.0	-3.3	-2.7	Availability with NP	99.9432	298
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	140.8	174
	Ground G/T, dB/K	13.0	13.0	13.0	13.0			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		14.1	14.1	8.0	9.5			
Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP			
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7			
	Downlink C/N (thermal), dB	14.1	14.1	8.0	9.5			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7			
	C/I from NP	99.0	13.4	99.0	13.4			
	Total C/(N+I), dB	12.7	10.0	7.6	7.6			
	Required C/(N+I), dB	7.6	7.6	7.6	7.6			
	Margin, dB	5.1	2.4	0.0	0.0			

DIRECTV at 101; 6/7 code								
Seattle								
		Clear Sky	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70			
Downlink:								
Seattle	Satellite EIRP, dBW	52.2	52.2	52.2	52.2			
	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-2.41	-1.43	Availability w/o NP	99.9758	127
	Rain temp increase, dB	0.0	0.0	-3.0	-2.2	Availability with NP	99.9178	432
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	**239.2**	305
	Ground G/T, dB/K	13.0	13.0	13.0	13.0			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		13.4	13.4	8.0	9.8			
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7			
	Downlink C/N (thermal), dB	13.4	13.4	8.0	9.8			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7			
	C/I from NP	**99.0**	**12.7**	**99.0**	**12.7**			
	Total C/(N+I), dB	12.1	9.4	7.6	7.6			
	Required C/(N+I), dB	7.6	7.6	7.6	7.6			
	Margin, dB	4.5	1.8	0.0	0.0			

DIRECTV at 101; 6/7 code									
Chicago									
		Clear Sky	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70				
Downlink:									
Chicago	Satellite EIRP, dBW	54.0	54.0	54.0	54.0				
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0				
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2			%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-3.51	-2.78		Availability w/o NP	99.9320	358
	Rain temp increase, dB	0.0	0.0	-3.6	-3.2		Availability with NP	99.8867	596
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5		Increase in unavailability	**66.5**	238
	Ground G/T, dB/K	13.0	13.0	13.0	13.0				
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8				
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6				
Downlink C/N (thermal),dB		15.1	15.1	8.0	9.1				
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**				
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7				
	Downlink C/N (thermal), dB	15.1	15.1	8.0	9.1				
	Crosspol interference, dB	22.9	22.9	22.9	22.9				
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7				
	C/I from NP	**99.0**	**14.5**	**99.0**	**14.5**				
	Total C/(N+I), dB	13.3	10.9	7.6	7.6				
	Required C/(N+I), dB	7.6	7.6	7.6	7.6				
	Margin, dB	5.7	3.3	0.0	0.0				

DIRECTV at 101; 6/7 code								
Denver								
		Clear Sky	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70			
Downlink:								
Denver	Satellite EIRP, dBW	53.2	53.2	53.2	53.2			
	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9			
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2		%	Outage min./yr.
	Downlink rain loss, dB	0.0	0.0	-3.04	-2.20	Availability w/o NP	99.9954	24
	Rain temp increase, dB	0.0	0.0	-3.4	-2.8	Availability with NP	99.9887	59
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5	Increase in unavailability	**144.4**	35
	Ground G/T, dB/K	13.0	13.0	13.0	13.0			
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8			
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6			
Downlink C/N (thermal),dB		14.4	14.4	8.0	9.4			
Total		**Clear Sky**	**Clear Sky w/NP**	**Rain Dn**	**Rain Dn w/NP**			
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7			
	Downlink C/N (thermal), dB	14.4	14.4	8.0	9.4			
	Crosspol interference, dB	22.9	22.9	22.9	22.9			
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7			
	C/I from NP	**99.0**	**13.7**	**99.0**	**13.7**			
	Total C/(N+I), dB	12.9	10.3	7.6	7.6			
	Required C/(N+I), dB	7.6	7.6	7.6	7.6			
	Margin, dB	5.3	2.7	0.0	0.0			

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ATTACHMENT A

Comsearch's Role in STA Testing and FCC Demonstration

Comsearch was an active participant in the STA Testing performed by DIRECTV and ECHOSTAR personnel. Comsearch's role was to observe and critique the in-progress testing and provide an independent assessment of the validity of the procedures used. The technical assessment also applied to the assembly and presentation of the data in this report and the conclusions drawn from the measured data. To do this the same personnel who actively observed the testing reviewed this report. Two of Comsearch's most experienced field measurement engineers were assigned to this project and were present during the entire period of testing.

Comsearch personnel monitored all of the interference testing to insure that the tests were 1) repeatable, 2) properly calibrated, 3) the interference transmitter was set for the correct EIRP and aligned properly, and 4) that the test met the prescribed and acceptable test procedure. During the testing Comsearch personnel determined or verified the following data:

1. The exact coordinates of the transmitter and the various receiver sites.
2. The line-of-sight condition of the satellite for the test.
3. The relative azimuth to the interference transmitter from the test site.
4. The interference measurement-- from initial transmitter-Off, to transmitter-On at nominal power, and for each transmitter incremental dB step increase up to loss of video.
5. The accurate determination of interference transmitter power output.

Based on the first hand knowledge of the interference testing by Comsearch's field engineers, it is our opinion that the tests were conducted in a highly professional, fair and proper manner. The data collected is a true representation of the interference conditions that were created to the reception of the satellite signals by the interfering transmitter. The report describes the testing accurately. The degradation of the satellite program availability by the interfering signal as a percentage increase in lost availability is a fair way to describe the impact of the operation of an interfering source. The conclusions presented in this report that the satellite operations will be harmed by loss of designed availability in their operation by the interference generated by the proposed terrestrial system are correct and are fully supported by the measurement results.

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