ORIGINAL

Exhibit 1
Technical Annex

Technical Annex to Reply Comments

of

Northpoint Technology

Bob Combs & Associates
Telecommunications Consulting
April 14, 1999

OUTLINE

1 INTRODUCTION 3

2 NORTHPOINT IS A VIABLE SYSTEMS CONCEPT WITH MAJOR DIFFERENCES FROM POINT-TO-POINT TERRESTRIAL SYSTEMS. 3

2.1 NORTHPOINT POINT-TO-MULTIPOINT TECHNOLOGY IS DIFFERENT FROM MICROWAVE POINT-TO-POINT TECHNOLOGY. 3

2.2 THE HISTORY OF SHARING BETWEEN TERRESTRIAL AND SATELLITE SYSTEMS. 5

2.3 NORTHPOINT TECHNOLOGY IS ENGINEERED TO MEET LOCAL CONDITIONS 6

3 NORTHPOINT IS COMPATIBLE WITH BSS 7

3.1 THE ANALYSIS PERFORMED BY DIRECTV IN THE COMMENTS OF DIRECTV IS FLAWED. 7

3.2 CRITERIA TO EVALUATE HARMFUL INTERFERENCE FROM NORTHPOINT INTO BSS. 13

3.3 NORTHPOINT WILL NOT CAUSE HARMFUL INTERFERENCE INTO BSS. 17

3.4 AGGREGATE INTERFERENCE FROM NGSO-FSS AND NORTHPOINT IS NOT HARMFUL . 20

3.5 CRITICISM OF DIRECTV REVIEW OF TEST DATA 21

3.6 REFUTATION OF UNSUBSTANTIATED COMMENTS 22

4 NORTHPOINT AND NGSO-FSS SERVICES CAN COEXIST ON A CO-PRIMARY BASIS 25

4.1 NONE OF THE NGSO-FSS SUBMITTED CRITERIA FOR COORDINATION 25

4.2 SHARING BETWEEN NGSO-FSS AND OTHER SERVICES IN THE BAND 12.2 - 12.7 GHZ IS FUNDAMENTALLY DIFFERENT THAN PREVIOUS INSTANCES OF SHARING BETWEEN FSS AND TERRESTRIAL SERVICES. 25

5 CONCLUSION 25

1 INTRODUCTION

This report responds to technical comments presented to the Commission on March 2, 1999, in the proceeding for the 12 GHz NPRM. Most of the comments contain no technical basis. Additionally, most of these criticisms assume that the Northpoint system operates like a point-to-point microwave system, which is incorrect. Point-to-point microwave systems transmit with 60 dB greater power, or one million (1,000,000) times the power of the Northpoint system. This and other differences between Northpoint and point-to-point microwave systems, as well as the inapplicability of previous analyses between terrestrial systems and satellite systems are identified in Section 2.

The only technical analysis presented in the proceeding was by DIRECTV. This analysis, while recognizing the unique nature of Northpoint, is seriously flawed. The criteria suggested by DIRECTV bear no relation to prevention of harmful interference. DIRECTV suggests that more than a 2% increase in unavailability for Northpoint would be harmful, while a 10% increase from NGSO-FSS is acceptable, and therefore not harmful.

It is also shown that the margin for error in the DIRECTV link budget is much larger than the criterion suggested by DIRECTV. Moreover, DIRECTV's criterion is based upon a self-assigned moving target of unavailability that varies across the country. Using this criterion, 3 hours of outage in Miami no more harmful than 0.14 hours of outage in Seattle. In this report, appropriate criteria are identified that are well within the definition of harmful interference.

Further, the interference analysis performed by DIRECTV is fundamentally flawed, resulting in an invalid picture of the sharing environment between Northpoint and BSS. DIRECTV misrepresents both the Northpoint and DIRECTV systems in claiming that over 50% of the service area will suffer "harmful interference".

Because Northpoint is a low-power broadcast technology, transmitted energy is spread over a wide area. While the peak C/I may be as high as 17 dB in a very small area, the average C/I ratio from Northpoint into BSS is over 40 dB, as demonstrated in this report.

2 NORTHPOINT IS A VIABLE SYSTEMS CONCEPT WITH MAJOR DIFFERENCES FROM POINT-TO-POINT TERRESTRIAL SYSTEMS.

2.1 NORTHPOINT POINT-TO-MULTIPOINT TECHNOLOGY IS DIFFERENT FROM MICROWAVE POINT-TO-POINT TECHNOLOGY.

The Northpoint point-to-multipoint broadcast system is fundamentally a different terrestrial service than terrestrial point-to-point systems. Northpoint operates with a

lower noise floor and a much lower transmit power than point-to-point technology. The required availability is also significantly lower, because there is a different customer base. Northpoint provides the one-way base-station to customer final link in a local transmission, as opposed to point-to-point FS systems, which are typically used as part of a 100-1000 km bi-directional communication chain employing from 3-30 links. Northpoint is also different in that the transmit energy is dispersed in point-to-multipoint technology, as opposed to the focused energy in typical terrestrial microwave transmissions.

Table 1. Comparison of Typical 11 GHz Microwave and Northpoint Terrestrial Systems

Characteristic	Units	Typical Microwave	Northpoint
Transmit EIRP	dBW	45	-17.5
Transmit 3 dB Beamwidth	degrees	2	110
Modulation		Analog	Digital
Required BER	BER	10^{-8} or higher	10^{-6}
Transmit Distance	km	10 - 50 (per link)	<16
Noise Floor	Kelvin	1000-5000	300
Required Availability	%	99.95	99.7
Fade Margin Required (to meet availability)[1]	dB	30	3

One commenter questioned the noise floor of Northpoint Technology, comparing Northpoint to typical terrestrial transmissions.[2] Northpoint, unlike typical terrestrial systems, takes advantage of recent technology improvements. While not as low as the BSS systems, due to a higher receiving antenna noise temperature, Northpoint does not have 4-5 dB of line loss that typical terrestrial systems do. Moreover, the LNA used in both BSS and Northpoint technology has a noise figure of less than one dB. These differences lead to a lower noise floor for Northpoint Technology that is as much as 18 dB lower than the typical point-to point link. Figure 1 compares the system noise temperatures of typical BSS and point-to-point microwave systems with that of Northpoint.

[1] The fade margin and availability are given at edge of coverage for Northpoint. The availability is higher everywhere inside the edge of coverage.

[2] Page 112 in the comments of SkyBridge

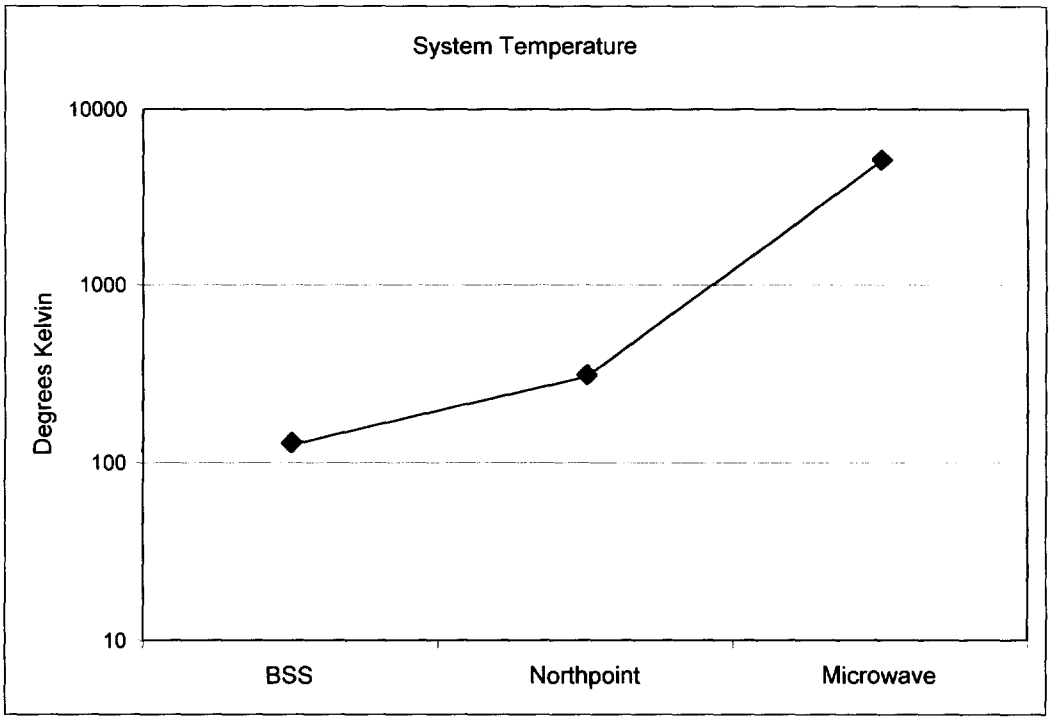

Figure 1. Typical System Noise Temperatures of BSS, Northpoint and Microwave Systems

2.2 THE HISTORY OF SHARING BETWEEN TERRESTRIAL AND SATELLITE SYSTEMS.

There are fundamental technical differences between previous analysis and the current situation in the 12 GHz band. The analysis in those bands does not apply to the current situation. Bands cited in the commentaries as having been previously analyzed included:

- Previous analysis between BSS and terrestrial point-to-point systems in the 12 GHz. band
- Previous analysis between terrestrial systems and the FSS in the 18 and 28 GHz bands.

In previous analysis in the 12 GHz band, the terrestrial point-to-point systems were very different from Northpoint. These systems had much higher EIRP than Northpoint, and they were oriented in a random fashion. While these point-to-point systems could cause unacceptable interference in a large area, they bear no relation to Northpoint.

The EIRP of terrestrial systems examined in the 1994 DIRECTV report on terrestrial interference had EIRP levels of 45dBW and greater. This level is required to achieve high analog transmission requirements at voice grade availability. The typical Northpoint EIRP is -17.5 dBW, to meet BER of digital signals at a broadcast availability. Thus, the terrestrial system transmitters radiate 60 dB greater power, or one million times the power level of Northpoint Technology.

The orientation of typical point-to-point terrestrial systems is also truly random. Northpoint on the other hand, designed for sharing with geostationary systems transmits only in the southern direction. Any interfering signals that are not blocked by natural shielding will enter the back lobe or far side lobes of the BSS receive antenna.

In the 18 GHz band, power levels of the proposed system were also much higher than Northpoint. Northpoint, EIRP at a nominal -17.5 dBW/24 MHz is lower than the proposed 18 GHz systems by 50 dB[3] or 100,000 times the EIRP of Northpoint. This fundamental difference is enough to question the validity of applying the analysis in the 18 GHz band to the 12 GHz band.

Some commenters cited the 28 GHz band as an example relevant to the 12 GHz band. In the 28 GHz band, the sharing situation was also quite different. The 28 GHz band is an uplink band for satellites. The issue in the 28 GHz band was not interference into satellite systems, but into the terrestrial system. Therefore, the 28 GHz analysis is also not applicable to the 12 GHz band.

2.3 NORTHPOINT TECHNOLOGY IS ENGINEERED TO MEET LOCAL CONDITIONS.

Some commenters questioned the ability of Northpoint to provide an adequate level of availability. This issue was thoroughly addressed in the comments of Northpoint Technology on March 2, 1999. However, it was not made clear that each Northpoint installation is engineered locally, and the EIRP and cell size can vary depending on local conditions. Some of these factors include:

- Topography (Affects line of sight and "fading")
- Rain Region
- Requirement to protect BSS.
- Transmit height above average terrain.

For example, in Phoenix, Arizona the local topography allows for placement of a terrestrial broadcast antenna several thousand feet above average terrain. Under these conditions, a different EIRP could be used while providing the same level of protection to BSS. For another example, in the Pacific Northwest, low rain margins mean the same Northpoint EIRP can provide service in a larger cell than in the Gulf Coast, where higher rain margins will limit the Northpoint cell size.

[3] See FCC Common Carrier Radio Station License dated 10/29/97, file number 9401974, Call Sign WMT307 for operation in the 18 GHz band. The EIRP given is 58.4 dBm in a 10 MHz bandwidth, equating to 32.2 dBW/24 MHz.

3 NORTHPOINT IS COMPATIBLE WITH BSS

The basis for all technical objections that Northpoint will cause harmful interfere with BSS is founded upon the analysis performed by DIRECTV in the Comments of DIRECTV. In section 3.1 their technical analysis is dealt with in detail. In section 3.2, criteria for harmful interference into BSS are presented. In section 3.3 an analysis identifies the actual interference environment in Seattle, Washington, in contrast to that presented in the comments of DIRECTV. The introduction of both NGSO-FSS and Northpoint will not cause harmful interference to BSS as reviewed in section 3.4 DIRECTV provides criticisms of Northpoint testing that are not well founded in engineering, as discussed in section 3.5 In addition, a number of comments made by various parties were asserted without technical substantiation, these comments are dealt with in section 3.6

3.1 THE ANALYSIS PERFORMED BY DIRECTV IN THE COMMENTS OF DIRECTV IS FLAWED.

DIRECTV analysis is flawed in many respects. DIRECTV makes assumptions about Northpoint that are incorrect. DIRECTV makes an inaccurate representation of their system. DIRECTV then suggests a protection criterion that is developed from a level of accepted interference from NGSO-FSS, and also relies on protection of overachievement and thus is inappropriate for establishing a level of harmful interference. In addition, DIRECTV totally ignores the effects of natural shielding

3.1.1 DIRECTV completely ignores the effect of natural shielding.

DIRECTV has never refuted that the effect of natural shielding will protect the vast majority of BSS customers. What the Commission should realize is that natural shielding against interference from Northpoint will exist for nearly every BSS customer installation. BSS receive antennas must point southwards towards the geostationary arc, and Northpoint transmitters will be located towards the North. Nearly all BSS receiving dishes are installed at the eave line, on the south side of the chimney, on a balcony railing or at ground level, and therefore will be afforded protection by natural shielding. Thus, to receive interference from Northpoint, the BSS receive antenna must be installed on, and above the peak of the roof. The equipment manufacturers uniformly recommend rooftop installation only as a last resort.

Because BSS satellites are to the south, the normal placement of a BSS receive antenna is on the southern side of the dwelling. In order not to be afforded any natural shielding, a BSS receive antenna would need to be placed upon the northern facing rooftop (point C of Figure 2) of a dwelling. Placement on the north side of the dwelling is difficult, and in most cases a roof-top installation would be required.

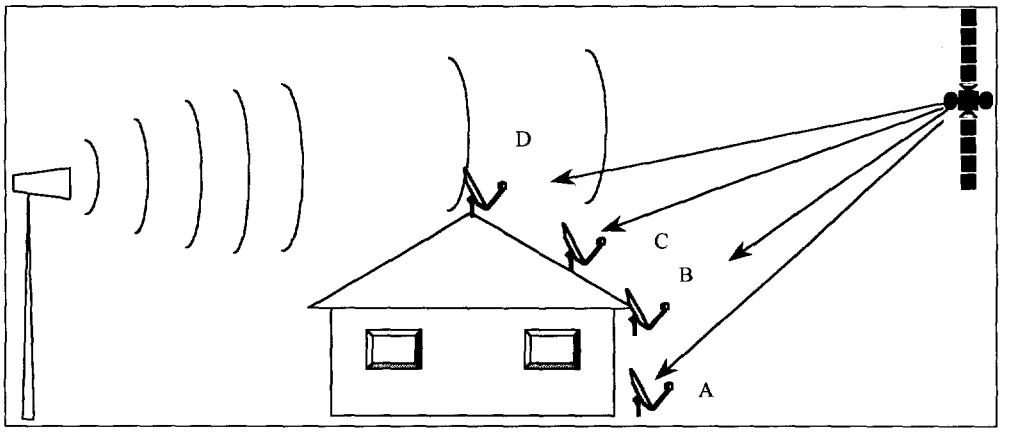

Figure 2. Interference Geometry

In Figure 2, BSS receive antennas installed at points A, B, C are naturally shielded, only point D is not. Northpoint asserts that at least 90% of the BSS receive antennas throughout the country will be afforded protection through this natural shielding.

3.1.2 DIRECTV makes incorrect assumptions about Northpoint Technology.

DIRECTV confuses the Northpoint link budget with the Northpoint interference budget.

DIRECTV, on page 4 of their technical annex, attempts to reproduce some Northpoint technical information presented in the Northpoint Reply Comments of 5 May 98. DIRECTV then asserts that our power level is 3.5 dB higher after zeroing out lines 12 and 14 of this link budget, and calling them "corrected link parameters". In fact, no corrections are required, except in the DIRECTV analysis. DIRECTV assumes that Northpoint power levels used to identify potential interference were faded signals.[4] This is untrue; the analysis in the May 5 Reply Comments is performed on the unfaded signal power. DIRECTV s confusing the Northpoint link budget presented on page 22 (of the Reply Comments of 5 May 98) with the interference budget presented on pages 23-24.

DIRECTV ignores polarization isolation.

In the 1994 report on terrestrial interference, DIRECTV accounts for isolation between linear terrestrial and circular satellite polarizations.[5] However, in the comments of 2 March 1999, DIRECTV ignores polarization isolation of 3 dB in its analysis, clearly identified in line 17 of the table on page 24 of the Reply Comments of Northpoint Technology on 5 May 1998.

DIRECTV then references the figure 2-4 on page 14 of the reply comments, and inaccurately reproduces this figure using these erroneous assumptions. When using the clearly identified assumptions, the correct maximum RSSi of -143 dBW/24 MHz is calculated, at the 1 km distance, not -140 dBW as DIRECTV represents on page 5. This

[4] Page 4 of DIRECTV Annex.
[5] Pages 15, 23 and 24 of DIRECTV 1994 Report to the commission

3 dB difference (polarization isolation) is a significant source of error in the DIRECTV analysis.

Incorrect calculation of allowable RSSi

On page 11, DIRECTV presents a calculation of allowable RSSi, and computes -154.2 dBW in table 2.2.2-2. DIRECTV adds a line 15 for 0.2 dB loss in atmospheric absorption, along with line 8 for 0.5 dB of antenna pointing loss. Both the pointing loss and the atmospheric absorption are included in the clear sky margin, this double counting lead to a 0.7 dB error. Second, DIRECTV fails to take into account the localized engineering that is available to terrestrial engineers. Additionally, the C/I of 28.6 dB used in line 10 was developed from a totally flawed analysis as shown in section 2.2.3 of this report.

3.1.3 DIRECTV presents an inaccurate representation of their system.

In this section, it will also be shown that the margin of error in the DIRECTV "reference system" link budget is far higher than the level of protection that they are claiming. In addition to the errors presented in sections 3.1.1 and 3.1.2 of this report, DIRECTV makes unsound assumptions in their analysis of 2 March 1999. The most prominent of these is the DIRECTV assumed gain towards Northpoint, which is in error between 2 and 16 dB. DIRECTV also presents link budgets, ("reference system" link budgets presented as USA US-GSO 1(a) through US-GSO D12(b)) without substantiation, as if the Commission should accept these budgets de facto. However, when examining these budgets closely, one finds a number of errors, small and large. The reader should keep in mind that DIRECTV suggests that Northpoint be assigned a C/I criterion in Seattle, Washington of 28.6 dB. A C/I of 28.6 dB will cause less than a 0.03 dB impact on the overall link, as explained in the following paragraph.

DIRECTV asserts that the criteria of $C_{unfaded}/I_{unfaded}$ = 28.6 dB, (or a $C_{faded}/I_{unfaded}$ = 27.1 dB) is required. Using the spreadsheet provided by DIRECTV to the ITU, this C/I ratio causes a degradation in link total C/N of less than 0.027 dB. To understand how this degradation is calculated, see the link budget presented in the annex to this report. This is the same link budget presented by DIRECTV in their comments of March 2, 1999. The total link degradation caused by Northpoint is the difference between columns C and D of line 67 "C/N margin above operating threshold for availability percentage of the time, downlink." One must increase the resolution of the link budget to 3 decimal places to see the change.

Invalid Antenna Gain Towards Northpoint.

DIRECTV presents a table of "gain toward horizon" where the gain towards Northpoint varies between -2 and -16 dBi.[6] This presentation agrees well with the measurements presented in the 1994 report, as well as the antenna patterns presented in WP 10-11S and

[6] Page 10 of DIRECTV Annex, also see DIRECTV 1994 Report and the antenna patterns presented in ITU-R JTG 4-9-11/356

JTG 4-9-11. Therefore, the table presented on page 10 of the comments of DIRECTV applies to all BSS dishes.

Although DIRECTV presents a table showing the gain varies between -2 and -16 dBi towards Northpoint, DIRECTV then assumes that all the DIRECTV receivers have 0 dBi gain towards Northpoint.[7] For this reason, and on this basis alone, the analysis that DIRECTV performs must be thrown out, because it overestimates interference by 8 dB in the average, and by 16 dB in the worst case.

Using the gain of 0 dBi, DIRECTV then asserts that Northpoint exceeds a DIRECTV proposed criteria in 50% of the Northpoint service area. As shown in section 3.2 of this report, DIRECTV's presentation of the sharing environment is fallacious. Although the DIRECTV proposed criteria is unreasonable, (and bears no relation to harmful interference) Northpoint meets it in 95% of its service area.

Table 2. Summary of some of the errors in analysis of DIRECTV.

Line	Item	Error	Units
1	Calculation of Northpoint Power Level	3.5	dB
2	Calculation of allowable RSSi	0.7	dB
3	Overestimation of BSS Antenna Gain towards Northpoint Transmitter	2 - 16	dB

In summary, as shown in Table 2, DIRECTV overestimates Northpoint's power, incorrectly calculates the allowable RSSi, overestimates the antenna gain towards Northpoint by an average of 9 dB, and underestimates the link C/N, of the BSS satellite. The errors in lines 1, 2 and 3 can be added directly, and lead to an overestimation of C/I of 6-20 dB. Using the graphics on pages 14-17 of their March 2, 1999 comments DIRECT TV asserts their proposed criteria is exceeded in 50% of the service area. For the reasons stated above, these graphics completely misrepresent the sharing scenario between BSS and Northpoint, and this seriously calls into question the analysis by DIRECTV.

"Reference System" Link Budgets.[8]

The DIRECTV analysis presented in its comments to the Commission on March 2, 1999 is based on the reference system parameters as presented to the ITU. (This discussion refers to the link budgets presented for US-GSO 1(a) (through US-GSO D12(b)) link budgets presented in Annex 1 of the comments of DIRECTV, beginning on page 37.) The margin for error in these link budgets is far higher than the allowable link degradation that DIRECTV proposes be assigned to Northpoint.

[7] Page 9 of DIRECTV Annex in the March 2, 1999 comments.

[8] See US-GSO 1(a) through 12. Some of the information appears to be based upon information used in developing the BSS plan, although DIRECTV presents these budgets without explanatory notes. As noted by DIRECTV in ITU-R JTG 4-9-11/46, "it is totally unrealistic to use the reference system parameters that were used for planning fifteen, or even one year ago."

DIRECTV asserts that the criteria of $C_{unfaded}/I_{unfaded}$ = 28.6 dB, (or a $C_{faded}/I_{unfaded}$ = 27.1 dB) is required. Using the spreadsheet provided by DIRECTV, and presented in the annex of this report, this C/I ratio causes a degradation in link total C/N of less than 0.027 dB. To understand how this degradation is calculated, see the link budget presented in the annex to this report. This is the same link budget presented by DIRECTV in their comments of March 2, 1999. The total link degradation caused by Northpoint is the difference between columns C and D of line 69 "C/N margin above operating threshold for availability percentage of the time, downlink." One must increase the link budget to 3 decimal places to see the change. The delta is identified in line 71, "Total Link Degradation due to Northpoint."

The following points identify the number of inaccuracies presented in these link budgets, any one of which would cause a change in C/N of greater than 0.027 dB.

1. The path loss for the BSS signal is calculated upon a 38500 km path, instead of the actual path length, and is calculated at 12.7 GHz (edge of band). DIRECTV then goes on to compare this budget with Northpoint signal levels calculated at 12.45 GHz (center of band). This leads to overestimation of the actual path loss, and thus an underestimation of the actual BSS carrier power by 0.1 - 0.5 dB.

2. The gaseous attenuation is stated as a uniform 0.2 dB. Using the U.S. standard atmosphere, the gaseous attenuation is actually between 0.08 and 0.13 dB. Thus, 0.2 dB of gaseous attenuation effectively underestimates the carrier power by 0.07 to 0.12 dB.

3. The required rain margin appears to be calculated incorrectly in the cases of US GSO 2(a) and 2(b). Using the ITU model, the calculated rain margin is 3.5 dB, not 5.4 - 5.8 dB, a difference of 1.9 - 2.3 dB.

4. The pointing error of the BSS receive antenna is given as 0.5 dB. In the 1994 report, this is given as 0.3 dB.[9] In fact, many BSS customers will have 0 dB error in their pointing, based upon the thorough installation instructions provided by the equipment manufacturers. A valid engineering assumption can be relied upon in the DIRECTV 1994 report, that is 0.3 dB.

5. The EIRP given, 48 dBW, for Seattle, WA (US GSO 1(a)) in 1 dB below that in the 1994 report. In the 1994 report, DIRECTV asserts it will provide a minimum EIRP of 49 dB throughout the U.S. At the other end of the country, in Tampa, Florida US-GSO D1(a), the EIRP given is 53.9, 0.5 dB below that described in the 1994 report.

Table 3. Some inaccuracies in the BSS link budgets presented in the DIRECTV comments.

Item	Error	Units

[9] Pages 5 and 6 of DIRECTV 1994 Report

Path Loss error	0.1 - 0.5	dB
Gaseous attenuation error	0.07 - 0.13	dB
Pointing Error	0.2	dB
EIRP Error	0.5 - 1.0	dB
Total Error in BSS Carrier Power	**0.87 - 1.83**	**dB**

These errors in aggregate, or even singly, are far higher than the level of protection that DIRECTV is requesting. (DIRECTV suggests that Northpoint be assigned a clear-sky C/I of 28.6 dB, which leads to a link degradation of less than 0.03 dB.) Table 3 summarizes some of these the errors.

As a final note, even the best estimate of required rain margin to meet a specified availability has a margin of error of at least (plus or minus) 30%. This is true when using either the Crane model (better for North America) or the ITU model (better for the rest of the world). Thus, even in the best case, the link budgets do not allow for planning of the availability to better than 30% accuracy. Thus, it would be misleading to use these link budgets as they are for determining the level of interference that should be assigned to Northpoint.

3.1.4 DIRECTV's Clear Sky Margin.

In the 1994 report, DIRECTV identifies typical links for protection from FS systems.[10] This same report identifies the uncertainty[11] of hardware performance, with a potential variation in C/(N+I) of 5 to 8 dB, <u>and assumes 8 dB required C/(N+I)</u>.

The DIRECTV (and all BSS systems) are designed to provide a minimum availability of 99.7%.[12] DIRECTV has educated the consumer not to expect performance greater than 99.7%. On the other hand, DIRECTV has attempted to convince the Commission that the BSS is entitled to protection of links that have availability as high as 99.99%, or higher. This availability is not consumer broadcast grade reception, but it is characteristic of non-BSS services, such as FSS.

As DIRECTV today acknowledges, the consumer receive equipment maintains signal without any BER or picture degradation at C/N+I less than 5 dB. Therefore, the link was designed with a 3 dB margin for performance of the receive hardware. Moreover, today's receive equipment maintains synchronization of the signal below 5 dB. That is, loss of sync does not occur until the BER drops below 10^{-3}, which occurs at C/(N+I) of around 3 dB. All of the previous discussion applies to the performance of the lower-power transponders. The logic is the same for the transponders operating at higher EIRP to meet the correspondingly higher Eb/No requirement of the different convolutional coding.

[10] These typical links are Miami, 99.7%, Los Angeles, 99.9% and Chicago at 99.8%. Further, as demonstrated previously, (see Reply Comments of Northpoint Technology 5 May 88, Comments of Northpoint Technology 2 Mar 99), Northpoint does not cause harmful interference to these typical links.

[11] Page 5 of 1994 report.

[12] See attachment contained in all purchases of DSS system, clearly identifying the performance as 99.7%.

DIRECTV provides an example[13] of a typical northwest link (Seattle Washington), with a "availability objective" of 99.9228%. The EIRP given to meet this objective is 48 dBW. However, this EIRP is understated, DIRECTV has repeatedly described its system as having a minimum EIRP of 49 dBW throughout the CONUS. The 1994 report clearly shows that the Pacific Northwest is no more than 4.5 dB down from a peak EIRP of 54.4 dB, for an EIRP of 50 dBW.[14] The 1994 report also states the minimum EIRP will be greater than 49 dBW throughout the U.S.[15]

As represented to the Commission in the 1994 report on terrestrial interference by DIRECTV, the link into Seattle was designed with a required C/(N+I) of 8 dB and an EIRP of 49 dBW. Under these circumstances, the availability is calculated to be 99.7%, not 99.9228%, as shown in the link budget in the annex to this report. As noted above, the availability objective for the BSS is 99.7%.

As the Commission is aware, it is common to include 2-3 dB of margin for hardware performance in new satellite links with untested technology. Fortunately, the mass manufacture of BSS set-top box and antenna equipment provides a consistent hardware performance, and the 3 dB margin for hardware performance is not required. In place of this margin, what DIRECTV would like to claim is that higher availability levels such as 99.99228%, and lower EIRP levels, such as 48 dBW require protection, which Northpoint contends that they do not.

3.2 CRITERIA TO EVALUATE HARMFUL INTERFERENCE FROM NORTHPOINT INTO BSS.

In the 1994 report on terrestrial interference, DIRECTV states that a 20% increase in unavailability (of 99.7%, or about 5 hours per year) would be serious degradation.[16] However, in the 2 March 1999 comments, DIRECTV asserts that more than a 2% increase in unavailability (of 99.9228%, or 0.14 hours per year) should be assigned to a single Northpoint system, a criterion 35 times more stringent than stated in the 1994 report. DIRECTV asserts this is "equivalent to one NGSO-FSS system" and that this 2% would come from the 10% already accepted by the BSS industry from NGSO-FSS, which is not possible, because that 10% is acceptable interference from NGSO-FSS. There are a number of problems with using this standard to evaluate terrestrial systems.

1. The DIRECTV proposal assumes multiple Northpoint systems in the band, as shown in the comments of Northpoint Technology on 2 March 1999, multiple Northpoint systems cannot share the band.
2. This NGSO-FSS standard is "acceptable interference," not "harmful interference".

[13] Table 2.2.1-2 on Page 8 of DIRECTV comments.
[14] Page 8 of 1994 report.
[15] Page 2 of 1994 report.
[16] Page 23 of the 1994 report.

3. There are fundamental differences between NGSO-FSS systems and terrestrial systems. NGSO-FSS systems cause interference that varies in time, but is constant across a given cell. Background noise from Northpoint is constant in time, but varies across the cell.[17]
4. It is clear that a 10% increase in unavailability is not serious, and it does not follow that this is the upper bound.
5. The DIRECTV computation of "increase in unavailability" is based upon a moving target, an availability objective that varies throughout the country. The problem with this assumption is clear. It creates one standard in Seattle and another standard in Miami. In other words, it states that one hour of outage in Seattle is far more important than one hour of outage in Miami. The reality is that the one hour of additional outage should be judged uniformly, as opposed to how close to zero the base availability is.

Table 4. Comparison of percent degradation of

City	Case 1	Case 2
Availability Objective	99.92%	99.7%
Unavailability	0.08%	0.3%
Hours of outage per year	7	26.3
Increase caused by one hour of additional outage	7.1%	1.9%

6. The NGSO-FSS criterion is not fully agreed to. While the 10% degradation of unavailability appears to be acceptable, the development of EPFD limits to meet this criterion are not final, and there appear to be contentious issues to resolve.

Clearly, the standard that Northpoint is to be held to is that it should not cause harmful interference. It is also clear that the BSS industry has deemed that the level of interference generated by the aggregate NGSO-FSS (a 10% increase in unavailability) is not harmful interference; it is accepted interference.

What is an appropriate criterion for Northpoint? While it is clear that any level of interference below the accepted interference from NGSO-FSS is not harmful, it is not the "necessary and sufficient" litmus test for determining what is and is not serious degradation, or harmful interference. Moreover, an appropriate standard to determine the criteria for terrestrial systems would take into account the variation in background noise across a given area.

[17] Background noise from Northpoint, while not harmful, is at a peak within 1 km of the Northpoint transmitter, and drops off rapidly as the separation distance increases.

Variation in noise across a given area.

This aspect must be considered when evaluating interference from Northpoint into BSS. Although the criterion suggested by DIRECTV is inappropriate for Northpoint, Figure 3 shows how Northpoint compares to this standard. Figure 3 was generated by calculating the C/I into BSS every 0.1 kilometer on a 20 by 20 km grid, or 40,000 points. The equation used to calculate the C/I ratio is:

$$C/I = C - P + Gtx(theta1) - pathloss(x) + Grx(theta2)$$

where:

C	: BSS Carrier Power, including losses for pointing and gaseous absorption (dBW)
P	: Northpoint Transmit power (dBW)
theta1	: off-bore sight angle to victim from transmitter
Gtx(theta1)	: Gain of transmit antenna in direction of victim (dBi)
x	: distance from transmitter to victim (km)
pathloss	: free space loss (dB)
theta2	: off-bore sight angle to transmitter from victim
Grx(theta2)	: Gain of victim antenna in direction of transmitter (dBi)

The cumulative C/I information was collected, and is presented in Figure 6 of this report. Then, using the DIRECTV link budget for US GSO 1(a), (reproduced in the annex to this report) the relation between C/I and increase in unavailability was determined for each C/I. Only points included in the Northpoint service area were considered.

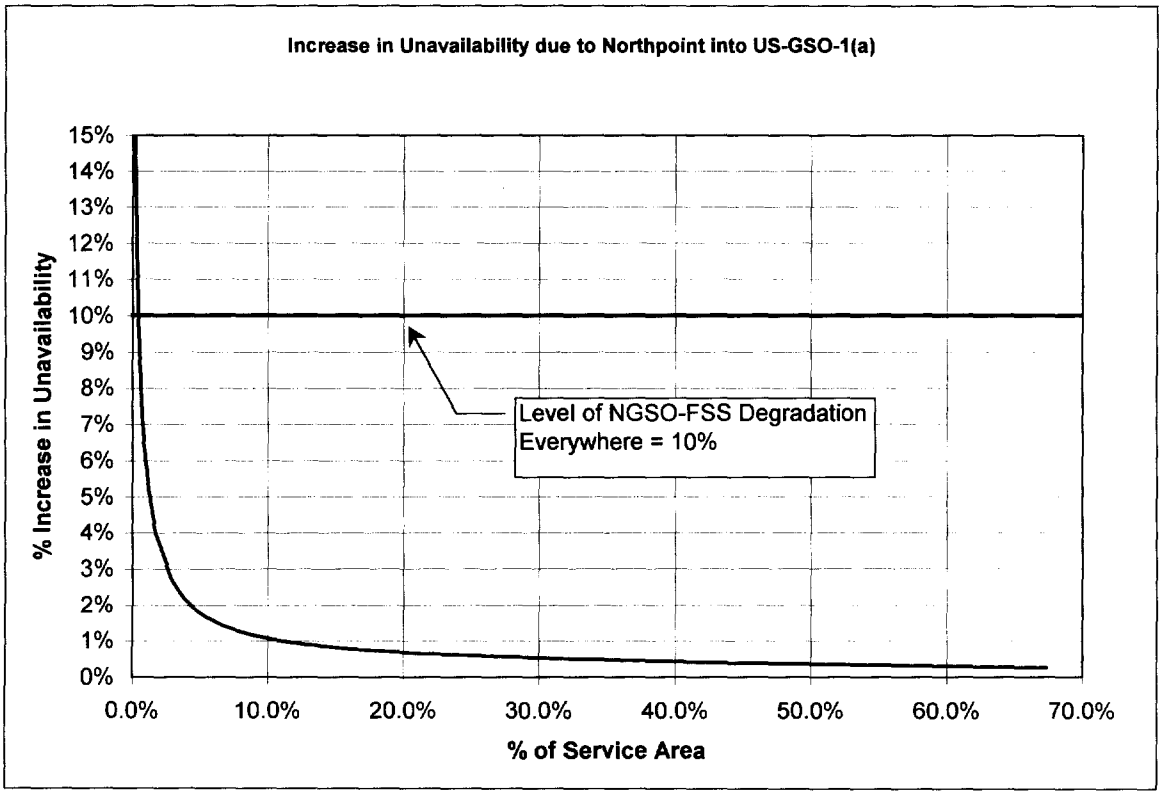

Figure 3. Variation in Unavailability Degradation Across the Service Area

As can be seen in this figure, Northpoint exceeds DIRECTV's own recently suggested criterion in less than 0.5% of the service area. From Figure 3, it is clear that the variation in the service area must be taken into account. Moreover, although any interference will be mitigated by natural shielding, this is not taken into account in Figure 3. As shown in Figure 4, if 75 - 90% of the homes are naturally shielded, the area where the DIRECTV criterion is exceeded is between 0.05% and 0.1%, a very small area indeed. Finally, it must be pointed out that interference inside of this 0.1% area can easily be mitigated by localized techniques, such as shielding, or repositioning of the antenna out of line-of-sight of the Northpoint transmitter.

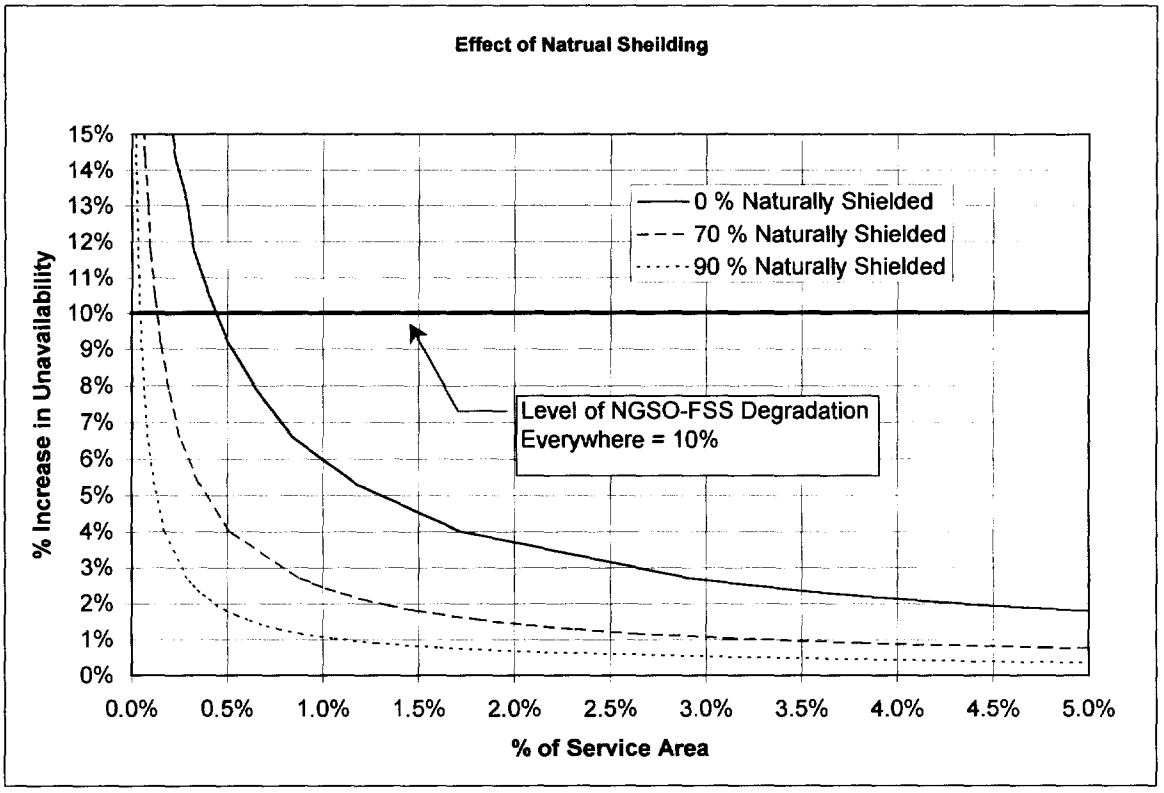

Figure 4. Effect of Natural Shielding

To determine an appropriate standard for such terrestrial systems, as an initial note, the BSS system has an availability objective of 99.7%. Thus, it can be asserted that any interference that does not degrade the BSS signal below this level cannot be termed "serious degradation". Northpoint more than meets this test.

For a refinement, we can turn to DIRECTV as a reference. In the 1994 report, DIRECTV describes a 20% increase in unavailability, (of 0.3%) about 5 hours per year as serious degradation. (How DIRECTV can now suggest that 0.14 hours per year is now the standard by which sharing with terrestrial systems should be judged is unclear. This level is 35 times more stringent than DIRECTV itself told the Commission in 1994.)

The Commission should reject the latest DIRECTV proposal, and maintain contact with the 1994 standard proposed by DIRECTV. However, the 1994 proposal does not take into account the area-varying nature of terrestrial interference. Northpoint proposes the following criteria to be met for terrestrial systems of the Northpoint type. Terrestrial systems should:

1. Not degrade BSS availability below the target 99.7%.
2. Not decrease the availability more than 0.006% for the average BSS customer.
3. Not decrease the availability more than 0.06% for any BSS customer.

The above criteria meet the "serious degradation" test, and thus are not harmful. Moreover, these criteria can be applied uniformly throughout the country. The criteria refer to decrease in availability, as opposed to referencing a moving target of unavailability. The first criterion ensures that BSS can provide the public with an appropriate level of service, even beyond the availability objective. The second criterion insures the average increase in unavailability (2.0% of 0.3% outage = 0.006%) will be less than 2%. The third criterion provides that the peak increase in unavailability (20% of 0.3% = 0.06%) will be below 20%.

3.3 NORTHPOINT WILL NOT CAUSE HARMFUL INTERFERENCE INTO BSS.

Northpoint Technology far exceeds the test for not causing harmful interference. It should be stressed that Northpoint is very concerned about protection of the BSS systems, as described to the Commission and likewise to the public in general. As has repeatedly been demonstrated, and as further demonstrated below, Northpoint will never cause a loss of signal in clear air, and Northpoint will never cause serious degradation of the BSS signal.

Implementation of the Northpoint system will meet or exceed by a wide margin all the criteria for serious degradation.

Criterion 1: Never degrade the BSS availability below 99.7%. This fact is clear when one examines the plot in Figure 5. This figure presents the actual performance of DIRECTV, and the impact of terrestrial interference. Note carefully that the BSS availability is not seriously degraded, even in 100% of the service area. In fact, in the locations where BSS availability is lowest, i.e. the Gulf Coast, Northpoint degradation is also the smallest in these areas. Moreover, this analysis does not account for the effect of natural shielding, which will protect an estimated 90% of BSS customers from any interference. The figures for peak interference were generated using the peak C/I ratio. Northpoint maintains a C/I of at least 24 dB in 99% of the service area, the C/I of 24 dB was used for the 99% line.

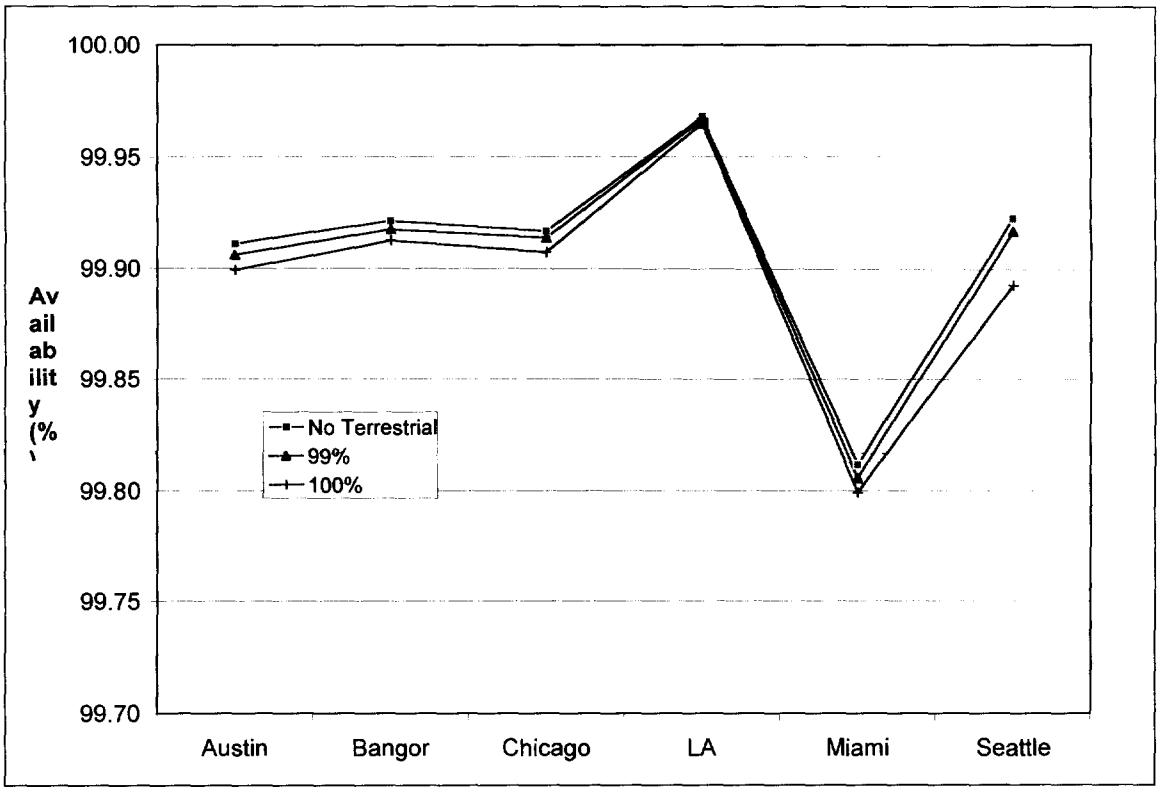

Figure 5. Impact of Terrestrial Interference in Various Cities

Criterion 2: Cause an average increase decrease in availability of less than 0.006%. The C/I ratio in Seattle, Washington in the Northpoint service area is shown in Figure 6. This CDF was determined by calculating the C/I ratio at every point in the Northpoint service area on a 0.1 km grid (10,000 points) and plotting the density. An EIRP of -19.5 dBW was used in this analysis to compare to the reduced EIRP level (48 vs. 49 dBW) that DIRECTV is claiming, and because the local conditions in Seattle, Washington should allow for a slightly lower EIRP. Note that a 2 dB delta on Northpoint EIRP would move the curve to the left or right by 2 dB, and this will not materially affect the results of the analysis.

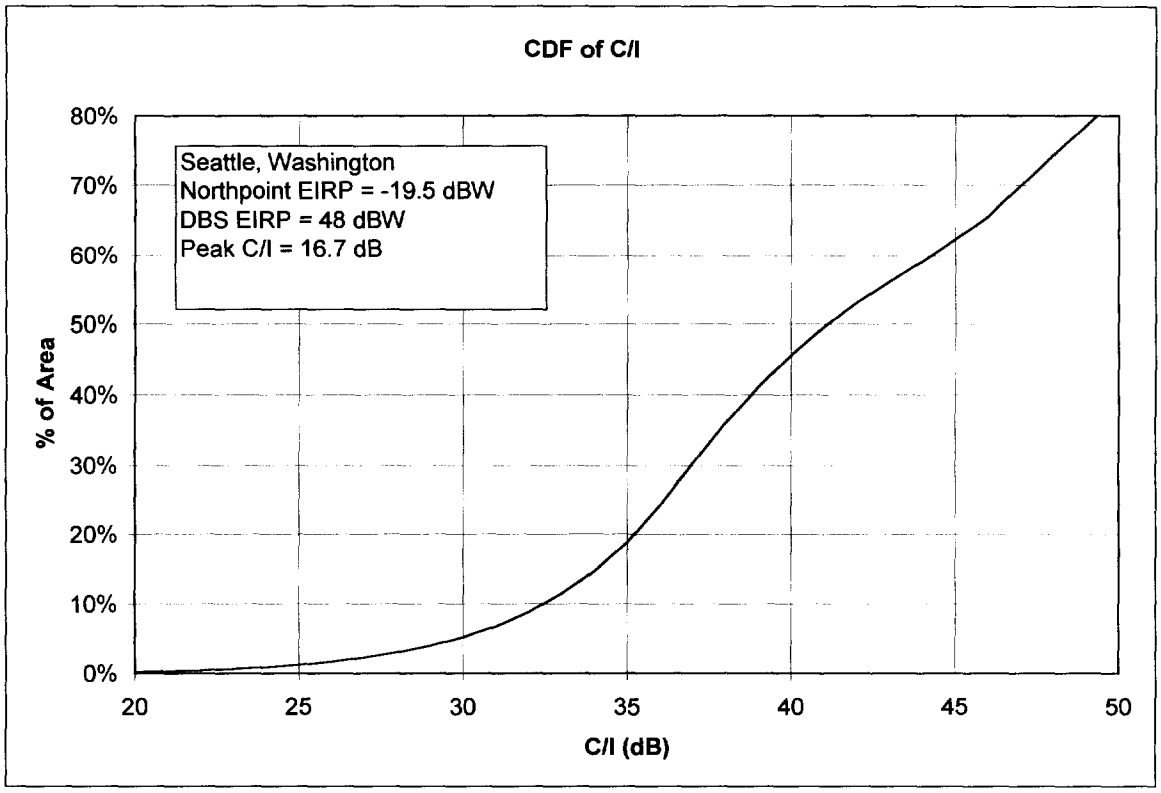

Figure 6. C/I into BSS Throughout the Service Area

The average degradation from Northpoint into BSS in the case of Seattle, Washington is shown in Figure 7. Note the average C/I ratio is 41.6 dB, and the average decrease in availability is less than 0.0002%.

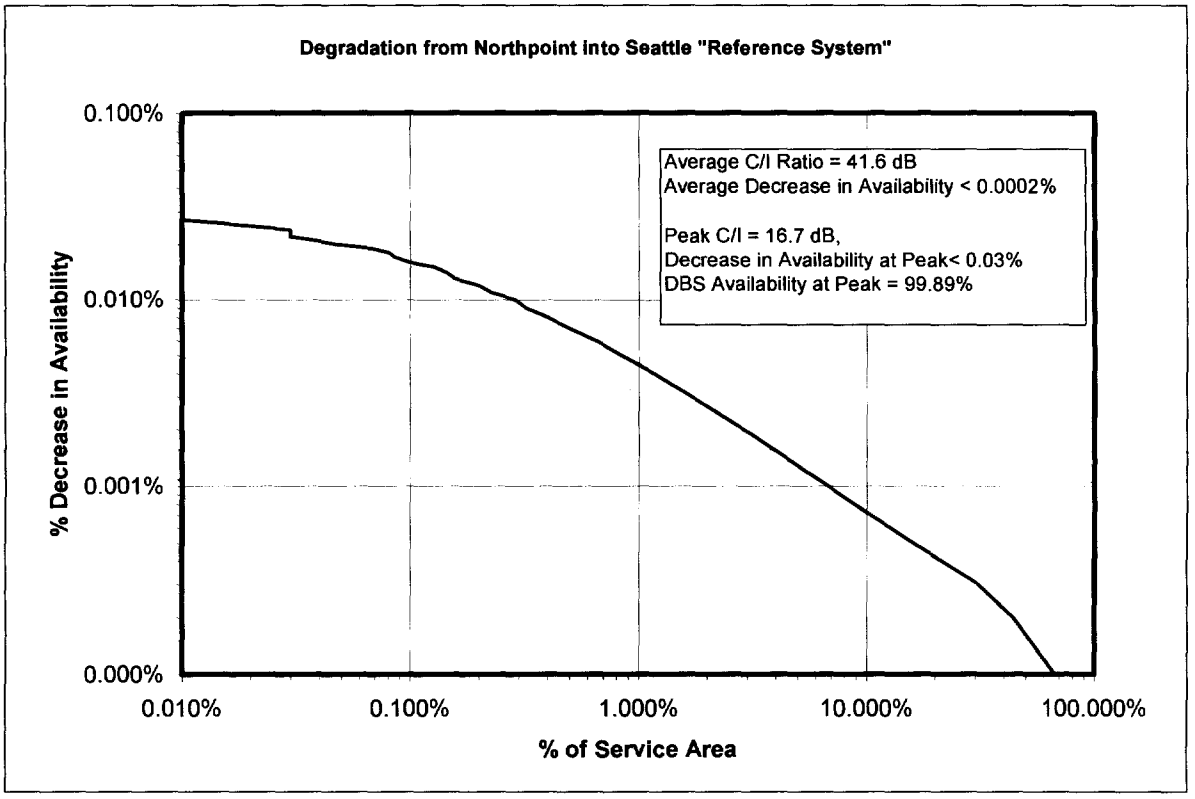

Figure 7. Impact of Northpoint

Criterion 3: Cause a peak degradation of availability of 0.06% in 100% of the service area. Also as seen in Figure 7, the peak degradation is 0.03%, (or 2.6 hours per year of degradation) meeting the criteria. It should be noted that any interference inside of a 1% area can be mitigated through localized techniques, such as shielding, or repositioning the customer antenna out of the line-of-sight of the Northpoint transmitter.

3.4 AGGREGATE INTERFERENCE FROM NGSO-FSS AND NORTHPOINT IS NOT HARMFUL

The aggregate degradation from the introduction of both Northpoint and NGSO-FSS will not be serious. The maximum interference from NGSO-FSS, whether one or ten systems will be a 10% degradation in unavailability. When one includes the 10% degradation from NGSO-FSS, one finds the combination of NGSO-FSS and Northpoint is also not serious. The results are plotted in Figure 8.

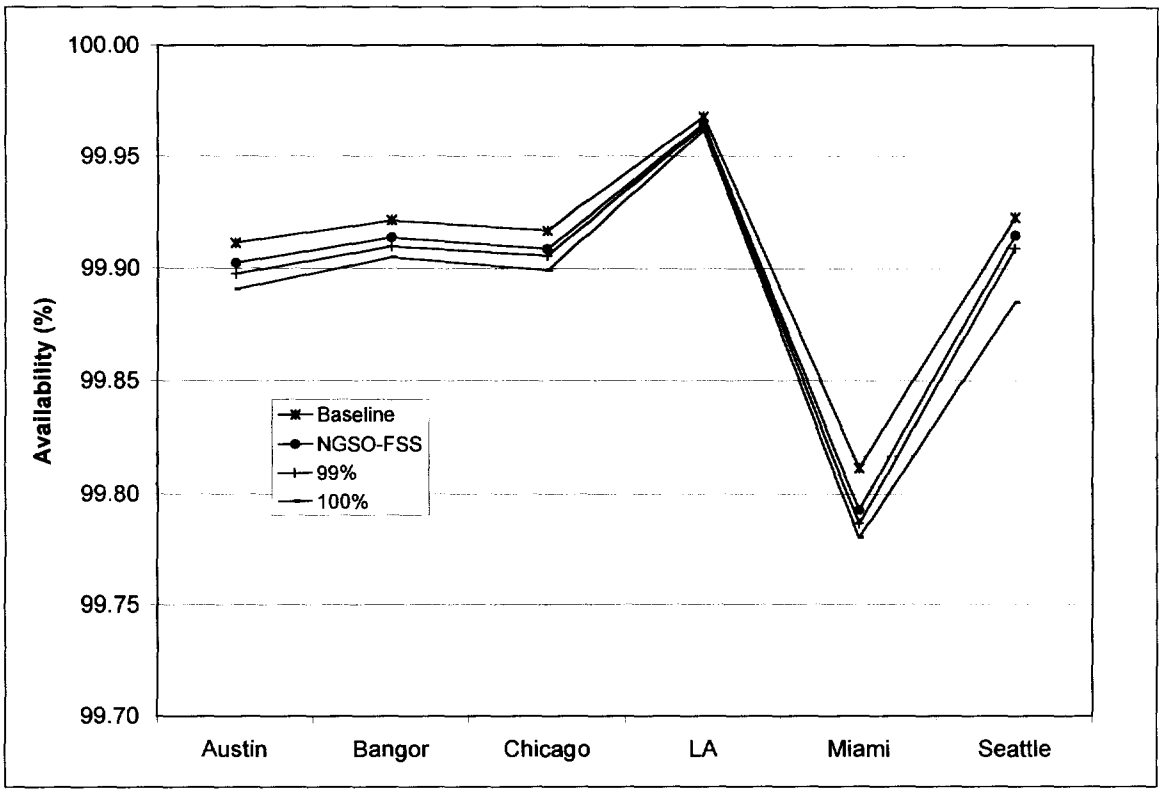

Figure 8. Impact of Terrestrial Interference in Various Cities

The top two lines in Figure 7 show the actual performance of BSS as a baseline, and then with NGSO-FSS 10% degradation in unavailability. Additional Northpoint availability degradation is shown in the next two lines, in 99% of the service area, and in 100% of the service area. None of the degradation can be called serious.

3.5 CRITICISM OF DIRECTV REVIEW OF TEST DATA

DIRECTV presents criticisms of Northpoint's Austin testing in section 3.0 beginning on page 18 of their comments. A review of the DIRECTV presentation provides serious doubt as to the validity of this analysis.

In section 3.1.2, DIRECTV claims that the 8 MHz test does not provide a robust demonstration, but DIRECTV provides no reason why it would not do so. Actually, it does, because the key is the amount of power, or noise, in the receiver bandwidth. The same amount of power was in the BSS receiving bandwidth, because the Northpoint signal was at the center of the DIRECTV channel.

In section 3.2.1, DIRECTV presents a description of the signal meter, and a table of "Typical Signal Meter Reading." In this section, it is asserted that the clear sky C/N ratio of DIRECTV in Austin is 11.4 dB, given an EIRP of 51.4 dBW. The author then goes on to describe the signal meter as if it were a calibrated instrument that could then be used

for C/N+I measurements. What is very clear from the DIRECTV comments of 2 March 1999 is that something is very wrong with this assumption.

On page 26 of this same document, in table 3.2.3-1, DIRECTV asserts the signal meter readings reveal the actual C/N+I to be as high as 12.4 dB. Since in section 3.2.1, DIRECTV asserts the clear sky C/N to be no greater than 11.4 dB, there is a large discrepancy. There are only several possible sources for this error:

- The DIRECTV table that relates signal strength to C/N (Section 3.2.1) is wrong;
- The EIRP of the BSS satellite towards Austin is higher than 51.4 dBW;
- The noise floor of the receiver is lower than 125 °K, providing higher C/N ratio.

Wherever the error lies, clearly the use of table 3.2.3-1 is inappropriate for passing quantitative judgement C/N. The signal strength meter can be used for qualitative evaluations, as Northpoint did in their testing. It is not a calibrated instrument, and should not be used for quantitative measurements.

3.6 REFUTATION OF UNSUBSTANTIATED COMMENTS.

Several commenters made unsupported claims that Northpoint would cause harmful interference to BSS. In this section, those claims are refuted. The implementation of Northpoint Technology will not cause harmful interference to the BSS industry. Northpoint will never cause a loss of signal in clear air, and Northpoint will not seriously degrade the BSS signal.

3.6.1 Northpoint will never cause a loss of signal in clear air

This fact is never disputed by any opponents of Northpoint. In fact, there is substantial clear-air margin that prevents interference for C/I as low as 6 dB. Northpoint will provide far greater isolation than this value.

3.6.2 Background noise contribution from Northpoint will not seriously degrade BSS.

Various comments were submitted to the Commission regarding the impact of Northpoint Technology on BSS systems.

- Some commenters asserted, without doing any analysis themselves, that Northpoint's operations would cause serious degradation in the clear sky margin, resulting in "unacceptably large increases in BSS signal unavailability."[18]

None of the comments defined the term "unacceptably large". As previously identified in section 3 of this report, Northpoint will not degrade the BSS signal availability more than 0.003% on average, and not more than 0.06% anywhere. In no case will the degradation

[18] March 2, 1999 comments of SBCA at 7, Echostar at 11.

cause BSS availability to drop below 99.7%. Such degradation cannot be serious, and therefore it will never be "unacceptably large".

- Some commenters suggested that multipathing from Northpoint will cause interference into BSS.[19]

None of the opponents to Northpoint have ever substantiated this claim. As clearly specified in the Reply Comments of 5 May 1998, and in the Austin Test results submitted to the Commission 20 Jan 1999, multipath interference will not occur..

First, any reflected energy will be attenuated, and will not be at full power.

Second, for multipathing to cause interference, the reflected energy from Northpoint would need to be received on the boresight of the BSS receive antenna. If the boresight is pointed at a reflecting source, then it is not pointed at the BSS satellite.

Third, common reflecting sources such as buildings are vertical, and thus not nearly perpendicular to the path between the BSS satellite and the BSS receive antenna. Because the angle of incidence equals the angle of reflection, the reflection can not be in the main lobe of the BSS antenna. Reference the depiction in Figure 9.

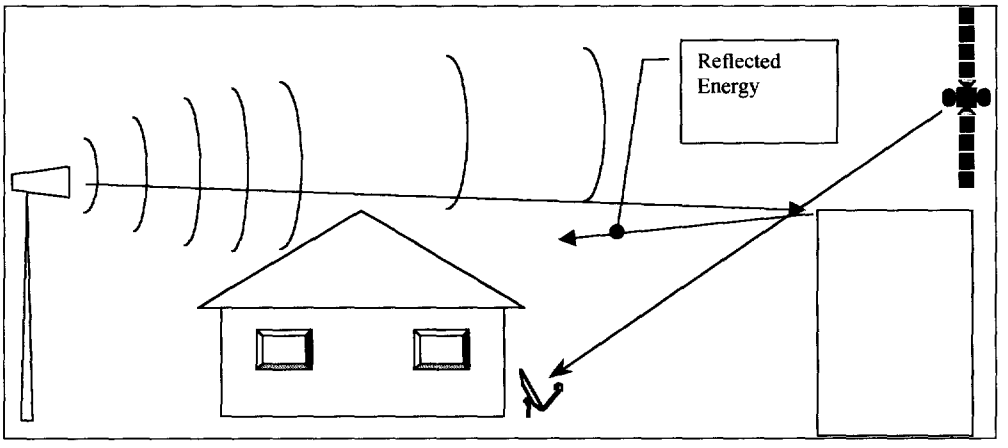

Figure 9. Multipath Geometry

- Recent studies in the JTG 4-9-11 have shown that 45 cm diameter terminals have a significant side lobe that would point toward the Northpoint transmitter.[20]

The antenna patterns specified in the reference document have been taken into account in the interference studies performed by Northpoint. The antenna patterns used in the JTG 4-9-11 study do have a side lobe with a peak gain of 3 dB relative to isotropic, or -31 dB relative to peak. However, for this side lobe to be pointed at the Northpoint transmitter, the receiver would need to be at a distance of between 200 and 400 meters from the Northpoint transmitter, almost directly below the transmitter tower. At this distance, the off bore-sight angle from the Northpoint transmitter is between 40 and 70 degrees, and

[19] March 2, 1999 comments of Telesat Canada at 9.
[20] March 2, 1999 comments of Telesat Canada at 9.

the Northpoint signal is attenuated more than 28 dB down from peak. Therefore, this side lobe is not a source of interference from Northpoint transmissions.

- One commenter asserted that achieving an acceptable antenna height to reduce interference will be difficult because zoning regulations will restrict Northpoint transmitters to the same kinds of locations as cellular and PCS services.[21]

Again, this argument is unsupported. Northpoint transmit antennas are significantly smaller than either cellular or PCS, thus easier to site. Moreover, with a mean separation of 10 kilometers, or 7 miles, Northpoint has requirement for an order of magnitude far fewer towers than either cellular or PCS services. With this requirement for fewer locations, finding sites with appropriate height will not impede Northpoint operations.

- One commenter argued that aggregate interference from the fully deployed system is severely underestimated.[22]

This argument is presented without supporting evidence, and can easily shown to be false. For this argument to have any validity, the peak effective Northpoint signal level would need to rise more than 1 dB. The Northpoint transmitters are separated by at least 10 km. Assuming the worst case alignment, and ignoring natural shielding, energy from a second Northpoint transmitter will be 15 dB below the peak Northpoint receive level. This would increase the effective Northpoint power level less than 0.06 dB, or less than a 3% increase, and far less than a 1 dB increase. When the nominal separation of 16 km is taken into account, the increase is less than 1%.

Moreover, note that the average C/I ratio is over 40 dB. Even if there was complete overlap of two systems (which is an unrealistic assumption) then the average C/I ratio would still be only 37 dB.

- "Under normal operating conditions, many BSS antennas have been installed using less than precise measurements, but function properly."[23]

Opponents used this argument to explain why the clear-sky margin of BSS cannot be disturbed, but actually, it demonstrates the opposite. The reason that BSS antennas still function properly although improperly installed is that there is significant excess margin in the BSS link, far beyond a 1 degree pointing error loss. This allows proper function with less than precise measurements, i.e., pointing to the BSS satellite.

- Some commenters claimed that Northpoint's power control will not work.[24] If it does work, then it needs to be tested in other geographic areas.[25]

As explained in the Northpoint comments of 2 March 1999, Northpoint does not believe it needs to use power control to mitigate interference, because other techniques are available to mitigate interference inside of a 1% area, should that be necessary.

---

[21] March 2, 1999 comments of USSB at 10.
[22] March 2, 1999 comments of Sullivan Telecommunications Associates (STA) at 10.
[23] March 2, 1999 comments of USSB at 11.
[24] March 2, 1999 comments of STA at 10 (footnote).
[25] March 2, 1999 comments of USSB at 9.

4 NORTHPOINT AND NGSO-FSS SERVICES CAN COEXIST ON A CO-PRIMARY BASIS.

4.1 NONE OF THE NGSO-FSS SUBMITTED CRITERIA FOR COORDINATION.

Even though the Commission expressly requested input on this topic, none of the NGSO-FSS submitted any interference criteria for sharing with co-primary terrestrial services.

4.2 SHARING BETWEEN NGSO-FSS AND OTHER SERVICES IN THE BAND 12.2 - 12.7 GHZ IS FUNDAMENTALLY DIFFERENT THAN PREVIOUS INSTANCES OF SHARING BETWEEN FSS AND TERRESTRIAL SERVICES.

Opponents present no technical information in their comparison of the 12 GHz band to the 18 and 28 GHz bands. Instead, they rely upon historical Commission actions and present arguments that Northpoint is "likely to" and "surely will" inhibit NGSO-FSS. As explained in section 2, the 18 and 28 GHz proceedings are fundamentally different from the 12 GHz band, and the analysis performed in those bands does not apply to the 12 GHz band.

Some comments included blanket statements that sharing between point-to-multipoint fixes services and NGSO-FSS ubiquitous user terminals is not feasible.[26] However, as demonstrated in the Northpoint comments of 2 March, the coordination area between Northpoint and NGSO-FSS is less than 0.2 kilometers in the case of several NGSO-FSS systems, and never larger than a few kilometers. Within these areas, NGSO-FSS systems have the option of utilizing alternate beam assignments to serve these customers, as fully explained in the March 2, 1999 comments of Northpoint Technology.

In the 12.2 - 12.7 GHz band, the coordination area would be smaller than a metropolitan zip code. In fact, zip codes could be used to identify the NGSO-FSS customers that potentially need to be assigned to alternate frequencies.

5 CONCLUSION

Northpoint Technology is a viable concept. It offers a viable means of providing the public with an alternative choice in television reception, and it is a viable sharing technology.

In this report, it was shown that the unsubstantiated criticisms of Northpoint Technology are without technical merit. Northpoint is unlike any previously analyzed terrestrial system. Point-to-point microwave systems transmit with one million (1,000,000) times the power of Northpoint, and are randomly oriented.

[26] March 2, 1999 comments of Virtual Geosatellite LLC at 26.

On the other hand, the analysis presented by DIRECTV, while recognizing the unique nature of Northpoint in some respects, is seriously flawed. The errors include:

- Ignoring polarization isolation (3 dB error)
- Assuming higher gain towards Northpoint than exists (2-16 dB error)
- Assuming the Northpoint analysis from 1998 was performed on faded Northpoint signals (3.5 dB error).

These flaws present invalid picture of the sharing environment between Northpoint and BSS. DIRECTV misrepresents both the Northpoint and DIRECTV systems in claiming that over 50% of the service area will cause serious degradation of the signal.

- Proposing a sharing criterion, (one-fifth of a level of accepted interference) that is 35 times more stringent than previously identified by DIRECTV, and bears no relation to avoidance of harmful interference.

It is also shown that the margin for error in the DIRECTV link budget (1.35-2.5 dB) is much larger than the criteria suggested by DIRECTV (0.03 dB link degradation from Northpoint). Although the DIRECTV criterion is unreasonable, Northpoint meets it in 95% of the service area, not the 50% claimed by DIRECTV. Moreover, DIRECTV's criterion is based upon a moving target of unavailability that varies across the country. Using the DIRECTV criterion, 0.14 hours of outage in Seattle would be more serious than 2 hours of outage in Miami.

In this report, appropriate criteria were defined that are well within the definition of harmful interference, and account for the variation of C/I in the service area. These criteria are:

1. Not cause an average decrease in availability of more than 0.006%.
2. Not cause a peak decrease in availability of more than 0.06%.
3. Not cause the availability to drop below 99.7% in either case.

Moreover, these criteria are more stringent than those suggested by DIRECTV in its 1994 report to the Commission on this subject, and Northpoint far exceeds these criteria. It is understood that Northpoint will never cause a loss of signal in clear air; this is not disputed by any party.

The average C/I ratio from Northpoint into BSS is over 40 dB. While the peak C/I may be as high as 17-20 dB in a very small area, the C/I ratio is greater than 24 dB in over 99% of the area.[27] Respondents also ignore natural shielding, which, when taken into account, will naturally eliminate all interference in the nearly all cases.

[27] See March 2, 1999 comments of Northpoint Technology.

A composite BSS/NGSO-FSS/Northpoint sharing scenario is presented. It is shown that the aggregate of interference from both NGSO-FSS and Northpoint does not cause serious degradation, and thus is not harmful.

Finally, NGSO-FSS claims that analysis of much higher powered terrestrial systems should be applied to the 12 GHz band is refuted, and the sharing approach identified by Northpoint in the March 2, 1999 comments is unchallenged.

Annex

Table 5. Link Budgets for BSS @ 101W

	Austin	Bangor	Chicago	Los Angeles	Miami	Seattle	units
EIRP	51.0	50.0	51.0	50.0	54.0	48.0	dBW
Downlink Path Loss	205.71	206.14	205.95	205.83	205.74	206.10	dB
Elevation Angle	54.6	29.3	39.3	46.3	52.0	31.3	deg
% Availability	99.90%	99.90%	99.90%	99.90%	99.70%	99.92%	%
Atmospheric Loss	-0.08	-0.13	-0.12	-0.09	-0.08	-0.13	dB
Rain Loss	-2.9	-2.2	-2.6	-1.1	-3.6	-1.4	dB
Rain Temp Increase	-3.3	-2.8	-3.1	-1.8	-3.6	-2.1	dB
Pointing Loss	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	dB
Ground G/T	13.0	13.0	13.0	13.0	13.0	13.0	dB/K
Bandwidth	-73.8	-73.8	-73.8	-73.8	-73.8	-73.8	dB
Boltzmann's	228.6	228.6	228.6	228.6	228.6	228.6	dBW/Hz-K
Downlink C/N (Thermal)	6.5	6.2	6.7	8.7	8.5	6.8	dB
Uplink C/N	24.2	24.2	24.2	24.2	24.2	25.0	dB
Crosspol	22.5	21.8	21.9	22.8	22.1	25.0	dB
Adjacent Satellite Interference	25.0	25.0	25.0	25.0	25.0	25.0	dB
Total C/(N+I)	6.3	6.0	6.5	8.3	8.1	6.6	dB
Terrestrial Interference	99.0	99.0	99.0	99.0	99.0	99.0	dB
Total C/(N+I)	6.3	6.0	6.5	8.3	8.1	6.6	dB
C/N Required	5.0	5.0	5.0	5.0	5.0	5.0	dB
Link Degradation from Terrestrial	0.00	0.00	0.00	0.00	0.00	0.00	dB
Residual Margin	1.3	1.0	1.5	3.3	3.1	1.6	dB

Table 6 US-GSO 1(a) Link Budget as presented by DIRECTV

Line			USA	USA	USA	USA	USA
	BSS Assignment characteristics	**Units**	**US-GSO 1(a)**	**US-GSO 1(a)**	**US-GSO 1(a)**	**US-GSO 1(a)**	**US-GSO 1(a)**
	System Characteristics						
4	Frequency	GHz	12.700	12.700	12.700	12.700	12.700
5	Availability objective	%	99.9228	99.9213	99.9189	99.9151	99.9074
6	Outage Hours	Hours per Year	6.77	6.90	7.11	7.44	8.12
7	Increase in outage hours		0.000	0.135	0.338	0.677	1.353
8	Percentage increase in unavailability			2	5	10	20
9	**Calculated availability due to rain up and downlink (Rec P 618-5)**	%					
10	**Calculated availability due to rain downlink (Rec P 618-5)**	%					
11	**Calculated availability due to rain uplink (Rec P 618-5)**	%					
12	Receiver noise Bandwidth	MHz	24	24	24	24	24
13	Modulation type		QPSK	QPSK	QPSK	QPSK	QPSK
14	C/I due to other GSO BSS networks	dB	20.7	20.7	20.7	20.7	20.7
15	C(faded)/I(unfaded) due to Northpoint required for Percentage increase in unavailability	dB	99	27.1	23.6	20.6	17.8
16	**Clear sky C/I due to Northpoint required for Percentage increase in unavailability**	**dB**		**28.6**	**25.1**	**22.1**	**19.2**
17	*Clear sky feeder link C/N+I*	*dB*	*24.2*	*24.2*	*24.2*	*24.2*	*24.2*
18	C/N+I required at operating threshold	dB	5.0	5.0	5.0	5.0	5.0
19	Clear sky C/N+I margin above operating threshold (1)	dB	3.6	3.6	3.5	3.4	3.1
20	**Total Clear sky C/N+I margin above operating threshold (1)**	dB		29.3	25.1	22.1	19.2
21	**Available clear sky downlink rain margin above threshold**	dB					
22	**Available clear sky uplink rain margin above threshold**	dB					
23	C/N+I total link for 99.7% of the time	dB					
24	C/N+I margin above operating threshold for 99.7% of the time	dB	1.51	1.47	1.42	1.34	1.20
25	C/N+I total link margin above operating threshold for 99.7% of the time	dB					
26	**Space station characteristics**						
27	Longitude	°	101W	101W	101W	101W	101W
28	Satellite e.i.r.p. in the direction of the earth station	dBW	48	48	48	48	48
29	**Earth station characteristics**						
30	Receive antenna diameter	cm	45	45	45	45	45
31	*Receive antenna efficiency*	*%*	*70*	*70*	*70*	*70*	*70*
32	On-axis antenna gain at receiver input	dBi	34	34	34	34	34
33	**On-axis antenna gain at antenna output**	**dBi**					
34	Off-axis antenna gain characteristics		App 30, An. 5	App 30, An. 5	App 30, An. 5	App 30, An. 5	App 30, An. 5
35	Clear sky receive system noise temperature at receiver input	K	125	125	125	125	125
36	Clear sky receive system noise temperature at antenna output	K					
37	*Clear sky G/T*	*dB/K*	*13*	*13*	*13*	*13*	*13*
38	Total pointing loss	dB	0.5	0.5	0.5	0.5	0.5
39	Location of earth station						
40	Latitude	°	47.6	47.6	47.6	47.6	47.6
41	Longitude	°	122.3W	122.3W	122.3W	122.3W	122.3W
42	Altitude	km	0.08138945	0.08138945	0.08138945	0.08138945	0.08138945
43	Rain climatic zone		D	D	D	D	D
44	Elevation angle	°	31.5	31.5	31.5	31.5	31.5

45	**Propagation characteristics**						
46	*Slant path*	*km*	*38500*	*38500*	*38500*	*38500*	*38500*
47	*Free space loss*	*dB*	*206.2*	*206.2*	*206.2*	*206.2*	*206.2*
48	*Atmospheric absorption*	*dB*	*0.20*	*0.20*	*0.20*	*0.20*	*0.20*
49	Rain attenuation for 99.7% of the time	dB	0.797	0.797	0.797	0.797	0.797
50	*Noise increase due to rain for 99.7 % of the time*	*dB*	*1.427*	*1.427*	*1.427*	*1.427*	*1.427*
51	Wanted pfd received at earth station	dB(W/m2)					
52	Rain attenuation for availability percentage of time	dB	1.520	1.506	1.487	1.456	1.399
53	*Noise increase due to rain for availability percentage of time*	*dB*	*2.266*	*2.253*	*2.234*	*2.203*	*2.146*
54	**Downlink budget clear sky**						
55	*C/N thermal clear sky downlink*	*dB*	*8.902*	*8.902*	*8.902*	*8.902*	*8.902*
56	*C/N+I clear sky downlink*	*dB*	*8.624*	*8.563*	*8.487*	*8.358*	*8.133*
57	*C/N+I clear sky total link*	*dB*	*8.506*	*8.446*	*8.373*	*8.247*	*8.028*
58	Clear sky C/N downlink margin above operating threshold	dB	3.902	3.902	3.902	3.902	3.902
59	Clear sky C/N+I downlink margin above operating threshold	dB	3.624	3.563	3.487	3.358	3.133
60	Clear sky C/N+I total margin above operating threshold	dB	3.506	3.446	3.373	3.247	3.028
61	**Downlink budget 99.7% of the time**						
62	*C/N thermal for 99.7% of the time, downlink*	*dB*	*6.68*	*6.68*	*6.68*	*6.68*	*6.68*
63	*C/N+I for 99.7% of the time, downlink*	*dB*	*6.51*	*6.47*	*6.42*	*6.34*	*6.20*
64	C/N margin above operating threshold for 99.7% of the time, downlink	dB	1.68	1.68	1.68	1.68	1.68
65	C/N+I margin above operating threshold for 99.7% of the time, downlink	dB	1.51	1.47	1.42	1.34	1.20
66	**Downlink budget for availability percentage of time**						
67	*C/N thermal for availability percentage of time, downlink*	*dB*	*5.12*	*5.14*	*5.18*	*5.24*	*5.36*
68	*C/N+I for availability percentage of time, downlink*	*dB*	*5.00*	*5.00*	*5.00*	*5.00*	*5.00*
69	C/N margin above operating threshold for availability percentage of the time, downlink	dB	0.1154	0.1421	0.1809	0.2427	0.3565
70	**C/N+I margin above operating threshold for availability percentage of the time, downlink**	dB	0.000	0.000	0.000	0.000	0.000
71	**Total Link Degradation due to Northpoint**			**0.027**	**0.065**	**0.127**	**0.241**
72	**Feeder link earth station characteristics**						
73	Frequency	GHz	17.7	17.7	17.7	17.7	17.7
74	Maximum uplink power control						
75	Minimum feeder link earth station eirp	dBW	78.0	78.0	78.0	78.0	78.0
76	Latitude	°	39.7	39.7	39.7	39.7	39.7
77	Longitude	°	105.0	105.0	105.0	105.0	105.0
78	Altitude	km					
79	Rain climatic zone		E	E	E	E	E
80	Elevation angle	°	43.8	43.8	43.8	43.8	43.8
81	Rain attenuation for 99.97% of the time	dB	3.00	3.00	3.00	3.00	3.00
82	Rain attenuation for availability percentage of time	dB					
83	**Characteristics of the space station receiver**						
84	Satellite receive noise temperature	K	616.6	616.6	616.6	616.6	616.6
85	Satellite receive antenna gain in the direction of the feeder link station	dB	32.2	32.2	32.2	32.2	32.2
86	Automatic gain control setting						
87	C/I due to other GSO BSS networks	dB	30.0	30.0	30.0	30.0	30.0
88	C/I from other assignments in the Plan	dB					
89	C/I from other GSO FSS systems	dB	30.0	30.0	30.0	30.0	30.0

90	**Uplink budget**						
91	*Atmospheric absorption*	*dB*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*
92	*Slant path*	*km*	*38500*	*38500*	*38500*	*38500*	*38500*
93	*Free space loss*	*dB*	*209.1*	*209.1*	*209.1*	*209.1*	*209.1*
94	*C/N thermal clear sky*	*dB*	*27.5*	*27.5*	*27.5*	*27.5*	*27.5*
95	C/N+I clear sky	dB	24.2	24.2	24.2	24.2	24.2
96	C/N thermal uplink for 99.97% of the time	dB					
97	C/N+I uplink for 99.97% of the time	dB					
98	Available clear sky uplink rain margin above threshold	dB					

Footnote 1: For US-GSO D5, rain effects are not relevant.
Footnote 2: See the antenna gain pattern mask in attachment 1 to document 4-9-11/165 Corr.1
Footnote 3: See "test results template" in Figure 4 of ITU Document 4-9-11/172-E, 25 June 1998.

Table 7. US-GSO 1(a) Link Budget using assumptions in 1994 Report on Terrestrial Interference

		USA
BSS Assignment characteristics	**Units**	**US-GSO 1(a)**
System Characteristics		
Frequency	GHz	12.500
Availability objective	%	99.7000
Outage Hours	Hours per Year	26.30
Increase in outage hours		0.000
Percentage increase in unavailability		
Calculated availability due to rain up and downlink (Rec P 618-5)	%	
Calculated availability due to rain downlink (Rec P 618-5)	%	
Calculated availability due to rain uplink (Rec P 618-5)	%	
Receiver noise Bandwidth	MHz	24
Modulation type		QPSK
C/I due to other GSO BSS networks	dB	25
C(faded)/I(unfaded) due to Northpoint required for Percentage increase in unavailability	dB	99
Clear sky C/I due to Northpoint required for Percentage increase in unavailability	**dB**	
Clear sky feeder link C/N+I	*dB*	*24.2*
C/N+I required at operating threshold	dB	8.0
Clear sky C/N+I margin above operating threshold (1)	dB	2.2
Total Clear sky C/N+I margin above operating threshold (1)	dB	
Available clear sky downlink rain margin above threshold	dB	
Available clear sky uplink rain margin above threshold	dB	
C/N+I total link for 99.7% of the time	dB	
C/N+I margin above operating threshold for 99.7% of the time	dB	0.00
C/N+I total link margin above operating threshold for 99.7% of the time	dB	
Space station characteristics		
Longitude	°	101W
Satellite e.i.r.p. in the direction of the earth station	dBW	49
Earth station characteristics		
Receive antenna diameter	cm	45
Receive antenna efficiency	*%*	*72*
On-axis antenna gain at receiver input	dBi	34
On-axis antenna gain at antenna output	**dBi**	
Off-axis antenna gain characteristics		App 30, An. 5
Clear sky receive system noise temperature at receiver input	K	125
Clear sky receive system noise temperature at antenna output	K	
Clear sky G/T	*dB/K*	*13*
Total pointing loss	dB	0.3
Location of earth station		
Latitude	°	47.6

Longitude	°	122.3W
Altitude	km	0.08138945
Rain climatic zone		D
Elevation angle	°	31.5
Propagation characteristics		
Slant path	*km*	*38479*
Free space loss	*dB*	*206.1*
Atmospheric absorption	*dB*	*0.13*
Rain attenuation for 99.7% of the time	dB	0.797
Noise increase due to rain for 99.7 % of the time	*dB*	*1.427*
Wanted pfd received at earth station	dB(W/m2)	
Rain attenuation for availability percentage of time	dB	0.797
Noise increase due to rain for availability percentage of time	*dB*	*1.427*
Downlink budget clear sky		
C/N thermal clear sky downlink	*dB*	*10.314*
C/N+I clear sky downlink	*dB*	*10.169*
C/N+I clear sky total link	*dB*	*10.002*
Clear sky C/N downlink margin above operating threshold	dB	2.314
Clear sky C/N+I downlink margin above operating threshold	dB	2.169
Clear sky C/N+I total margin above operating threshold	dB	2.002
Downlink budget 99.7% of the time		
C/N thermal for 99.7% of the time, downlink	*dB*	*8.09*
C/N+I for 99.7% of the time, downlink	*dB*	*8.00*
C/N margin above operating threshold for 99.7% of the time, downlink	dB	0.09
C/N+I margin above operating threshold for 99.7% of the time, downlink	dB	0.00
Downlink budget for availability percentage of time		
C/N thermal for availability percentage of time, downlink	*dB*	*8.09*
C/N+I for availability percentage of time, downlink	*dB*	*8.0*
C/N margin above operating threshold for availability percentage of the time, downlink	dB	0.0905
C/N+I margin above operating threshold for availability percentage of the time, downlink	dB	0.003
Link Degradation due to Northpoint		
Feeder link earth station characteristics		
Frequency	GHz	17.7
Maximum uplink power control		
Minimum feeder link earth station eirp	dBW	78.0
Latitude	°	39.7
Longitude	°	105.0
Altitude	km	
Rain climatic zone		E
Elevation angle	°	43.8
Rain attenuation for 99.97% of the time	dB	3.00
Rain attenuation for availability percentage of time	dB	
Characteristics of the space station receiver		
Satellite receive noise temperature	K	616.6
Satellite receive antenna gain in the direction of the feeder link station	dB	32.2

Automatic gain control setting		
C/I due to other GSO BSS networks	dB	30.0
C/I from other assignments in the Plan	dB	
C/I from other GSO FSS systems	dB	30.0
Uplink budget		
Atmospheric absorption	*dB*	*0.5*
Slant path	*km*	*38500*
Free space loss	*dB*	*209.1*
C/N thermal clear sky	*dB*	*27.5*
C/N+I clear sky	dB	24.2
C/N thermal uplink for 99.97% of the time	dB	
C/N+I uplink for 99.97% of the time	dB	
Available clear sky uplink rain margin above threshold	dB	

Footnote 1: For US-GSO D5, rain effects are not relevant.
Footnote 2: See the antenna gain pattern mask in attachment 1 to document 4-9-11/165 Corr.1
Footnote 3: See "test results template" in Figure 4 of ITU Document 4-9-11/172-E, 25 June 1998.

BOB COMBS & ASSOCIATES
TELECOMMUNICATIONS CONSULTING

PO BOX 3089, FALLS CHURCH VA 22043

TEL: (703) 288-5123
FAX: (703) 288-5124

CERTIFICATION

1. My name is Robert Combs, and I am president of BCA International, a telecommunications consulting firm.

2. I have an ME in Systems Engineering from the University of Virginia, 1992; and a BS in Aerospace Engineering (Cum Laude) from the University of Texas (Austin), 1986.

3. I hereby certify that I am the technically qualified person responsible for the preparation of the Technical Annex to the Reply Comments of Northpoint Technology.

4. The Annex, and the technical information contained in the Reply Comments, are complete and accurate to the best of my knowledge.

Dated: April 13, 1999

Robert Combs