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[redacted]

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September 9, 1999

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
The Portals, 445 12th Street, S.W.
Washington, D.C. 20554

Re: Northpoint Technology's **Notice of Ex Parte Presentation** Meeting Regarding ET Docket No. 98-206, RM-9147, RM-9245

Dear Ms. Salas:

Northpoint Technology, Ltd. ("Northpoint") hereby submits for filing in the above-referenced docket its notice of a meeting on September 8, 1999. Sophia Collier, Katherine Reynolds and Robert Combs of Northpoint and Antoinette Cook Bush of Skadden, Arps, Slate, Meagher & Flom LLP met with Harold Ng of the International Bureau and Thomas Derenge of the Office of Engineering and Technology to discuss the above-referenced Rulemaking proceeding. A copy of the Northpoint materials discussed in the meeting are attached hereto.

In accordance with Section 1.1206 of the Commission's Rules, the original and one copy of this notice are being filed with the Secretary, and an additional copy is being served on all parties involved. Please date-stamp the attached duplicate upon receipt and return it via the messenger for our records. If

any questions arise concerning this matter, kindly contact the undersigned.

Respectfully submitted,

Antoinette Cook Bush
Counsel for Northpoint
Technology, Ltd.

Enclosures

cc: Sophia Collier
Katherine Reynolds
Robert Combs
Harold Ng (IB)
Thomas Derenge (OET)

Receive antenna gain	34	34 - 38	dBi
Thermal noise floor	-144.1	-144.1	dBW/MHz
Availability objective	99.7	99.7 - 99.995	%

1.1.1 Transmitter Characteristics

The Northpoint Technology employs a transmit antenna with a peak gain of 10 dBi. Transmissions are oriented toward the South, facilitating sharing with geostationary systems. Typical radiation patterns (elevation and azimuth) are given in Figure 1and Figure 2. The typical transmitter tilt is 3 degrees above the horizon, and the typical transmitter height above average terrain (HAAT) is 150 meters.

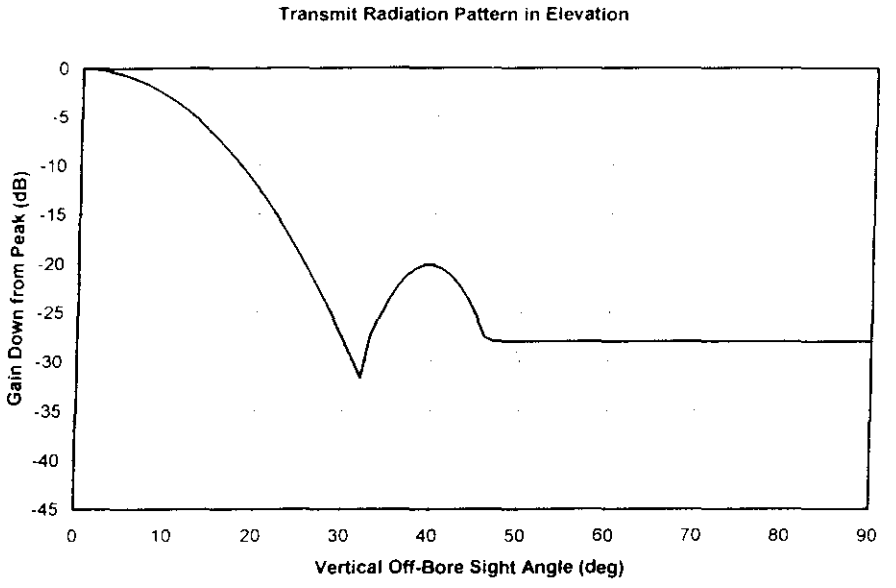


Figure 1. Transmitter Radiation Pattern in Elevation

The equations for computing relative transmit antenna radiation (from Gmax = 10 dBi) in elevation are given in Table 2.

Table 2. Northpoint Transmitter Radiation Pattern in Elevation

Off-Bore Sight Angle	Gain Down from peak (dBi)
$0 \leq \varphi < 32$	$0.031(\varphi)^2$
$32 \leq \varphi < 46.2$	$293.2 + 13.825(\varphi) + 0.175(\varphi)^2$
$46.2 \leq \varphi < 180$	28

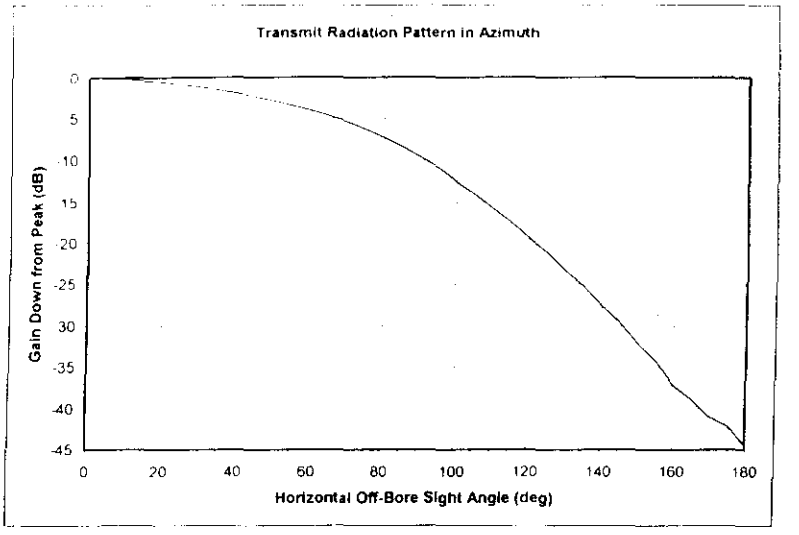


Figure 2. Transmitter Horizontal Radiation Pattern

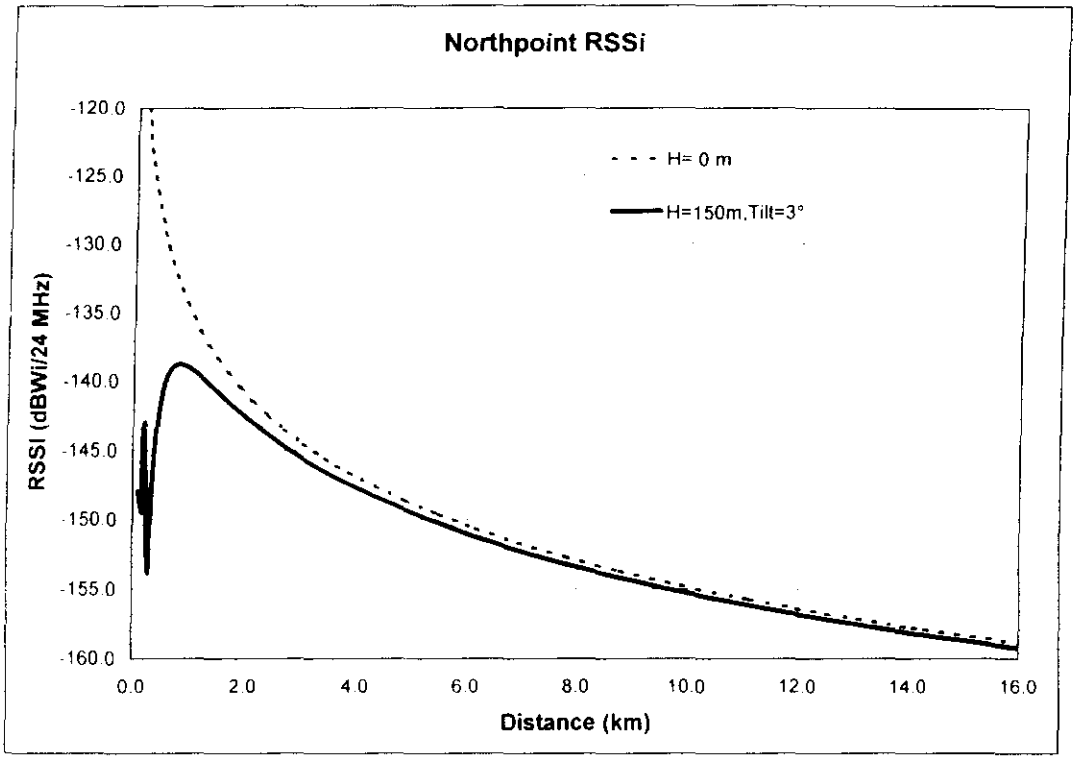


Figure 3. Northpoint Isotropic Signal Level, 24 MHz Bandwidth

Figure 3 depicts the Northpoint isotropic received signal level in a 24 MHz bandwidth, due south of the transmitter, for two cases:

(1) At transmitter height = 0 meters, no tilt

(2) At transmitter height = 150 meters, 3 degrees of beam tilt.

3 NGSO FSS INTERFERENCE INTO NORTHPOINT

In this section, interference from NGSO FSS systems into Northpoint Technology is considered. In section 3.1, the assumptions are identified. In section 3.2, static analysis is performed to identify those systems that have potential for interference into Northpoint. In section 3.3, dynamic analysis identifies the percentage of time for SkyBridge interfering with Northpoint. In section 3.4, the aggregate PFD mask required to protect Northpoint is identified. In section 3.5, means of establishing *terrestrial arc avoidance* are identified.

3.1 Assumptions

The NGSO FSS systems studied in this analysis are identified in Appendix E, including orbit and RF transmitter system assumptions. All the information contained in Appendix E was taken from filings to the FCC, or derived from information therein.

3.1.1 Interference Criteria for Northpoint

Northpoint interference criteria, for time-varying sources of interference, are given in ITU-R document USRCG9A-Int-1. The Northpoint interference criteria are listed in the following table.

Table 10. Northpoint Interference Criteria

I/N Level	Percent of Time
0 dB	0.001
-13	20

3.2 Static Analysis

A static analysis was performed to identify the worst-case I/N, as a function of elevation angle. The Northpoint receiver is at the edge of coverage, with an elevation angle of 0.5 degrees to the Northpoint Transmitter at HAAT = 150 meters. Atmospheric loss per ITU-R model for gaseous absorption is assumed. The I/N ratio is calculated with equation 3.

$$I/N = P + 10*\log(B/b) + Gtx(theta1) - pathloss(x) + Grx(theta2) - gas - N \qquad \textit{(Equation 3)}$$

where:

P	: Transmit power (dBW)
B	: Transmit bandwidth (MHz)
b	: Receive bandwidth (MHz)
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)
gas	: gaseous attenuation (dB)
N	: Noise power of victim receiver.

In the case of NGSO FSS, certain variables (*x*, *theta1*, *theta2*, *gas*, and in some cases *P*) change with elevation angle to the interfering satellite, the remainder are constant. Refer to Figure 13 for a visualization of the interference geometry, which is drawn to scale for *H* = 1469 km (SkyBridge altitude).

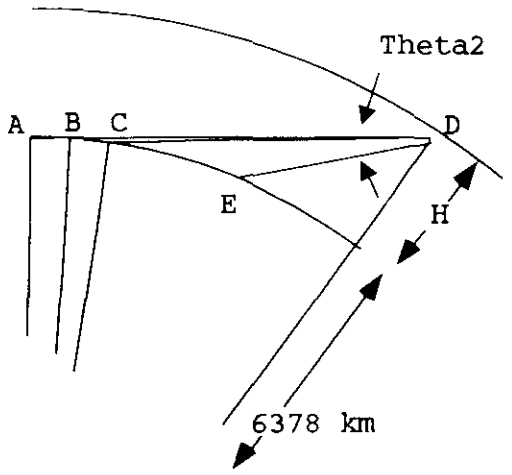


Figure 13. Interference Geometry for NGSO FSS into Terrestrial Services

Table 11 explains the geometry in Figure 13.

Table 11. Interference Geometry for NGSO FSS into Terrestrial Systems

Item	Description
A	Terrestrial Receiver at elevation 0° to interferer
B	Terrestrial Receiver at elevation 5° to interferer
C	Terrestrial Receiver at elevation 10° to interferer
D	Interferer at orbital altitude H
E	NGSO FSS Service Elevation (Elevation angle from NGSO FSS customer to NGSO FSS satellite) (Variable 10 - 90 degrees)
H	Orbital Altitude of Interferer
Theta 2	Off bore-sight angle from NGSO FSS transmitter to victim.

As can be seen in Figure 13, the off bore-sight angle (theta2) can be quite small. For NGSO FSS LEO systems at elevation angles nearing 10 degrees, it is less than one degree. The off-bore sight angle (theta1) is seen to be zero degrees, and so a main-beam on main-beam situation can occur. Using equation 3, interference (I/N) values for NGSO FSS service elevation angles are plotted in Figure 14.

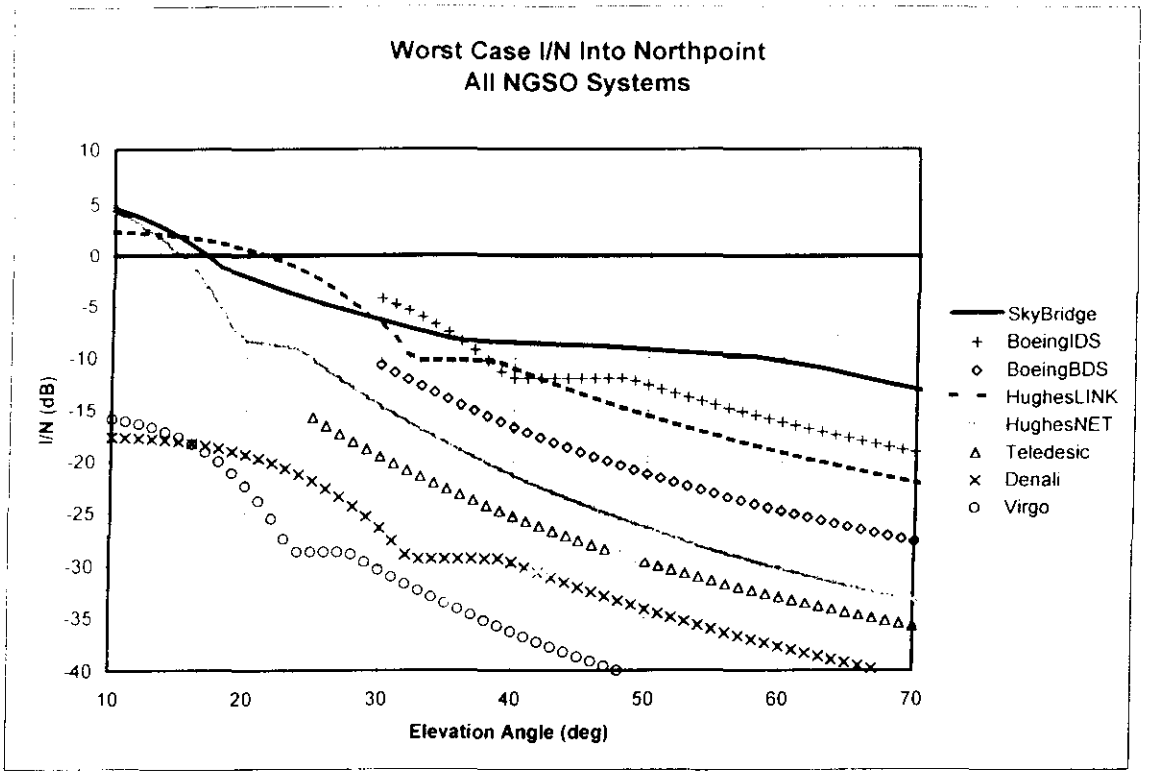


Figure 14. Worst-case I/N into Northpoint Technology

Only three of eight proposed systems could cause interference into Northpoint at an I/N greater than 0 dB (short-term criteria), as shown in Figure 14. The remaining five NGSO FSS systems will not cause a loss of signal in clear air. It is assumed that long term increases in noise temperature are negligible. In the cases of SkyBridge and the two Hughes systems, interference into Northpoint is possible due to the very low discrimination from the NGSO FSS transmitter towards the Northpoint receiver. Dynamic analysis will reveal the extent to which NGSO FSS systems would cause system outages or reduce the system availability of Northpoint Technology (see section 3.3).

Loss of Northpoint service area. Repeated interruption of service will result in a loss of Northpoint service area. As the distance varies between the receiver ant the Northpoint transmitter, the received signal level (RSL) varies due to changes in free space loss. This effect is plotted in figures [TBD]. Within the Northpoint service area, the azimuth angle to the Northpoint transmitter varies up to plus/minus 125 degrees true azimuth. Further, the various NGSO FSS systems operate in orbits with given inclination and orbital altitude chosen by the system designers. The orbital geometry dictates that NGSO FSS operates at certain elevation angles (refer to Appendix C). Loss of signal is possible for only a portion of the Northpoint service azimuths. Of course, any change in system parameters (e.g. satellite inclination angle) or operations (e.g. minimum elevation angle) would change the interference environment from NGSO FSS.

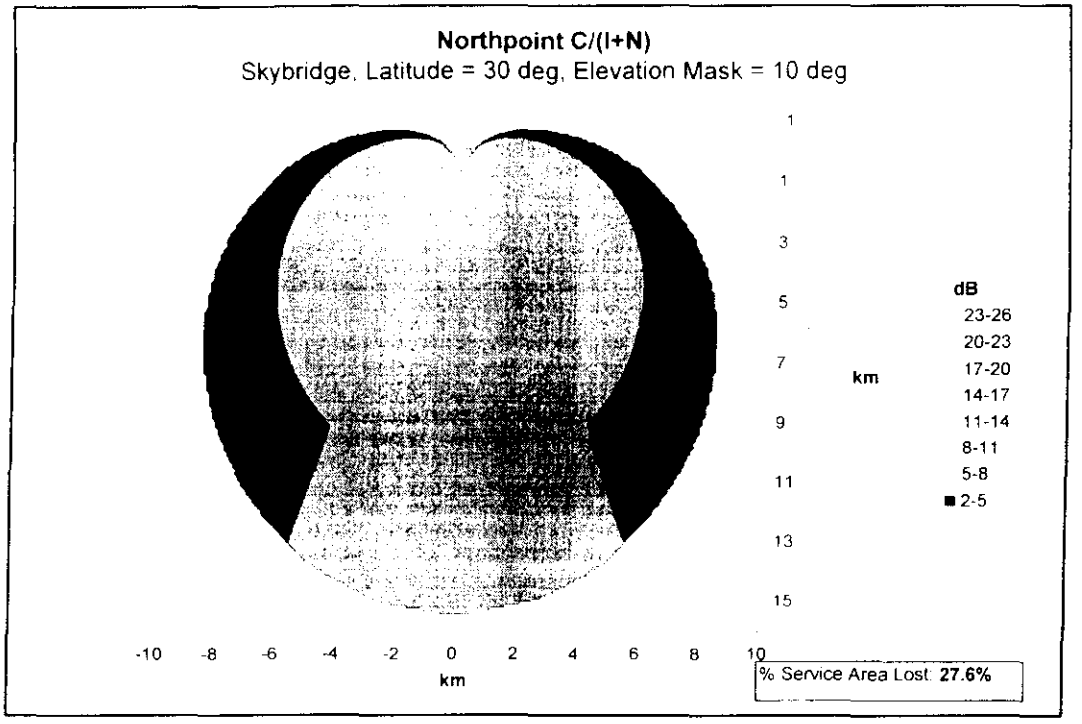


Figure 15. SkyBridge Interference into Northpoint

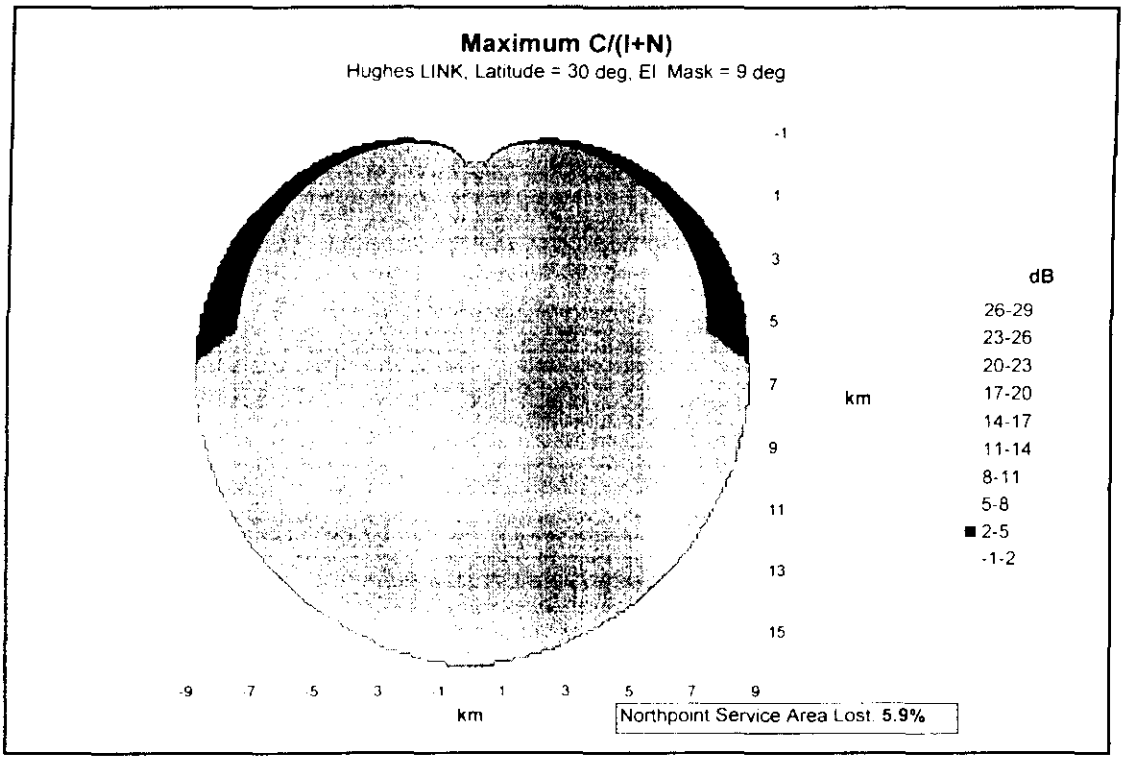


Figure 16. Hughes Link Interference into Northpoint

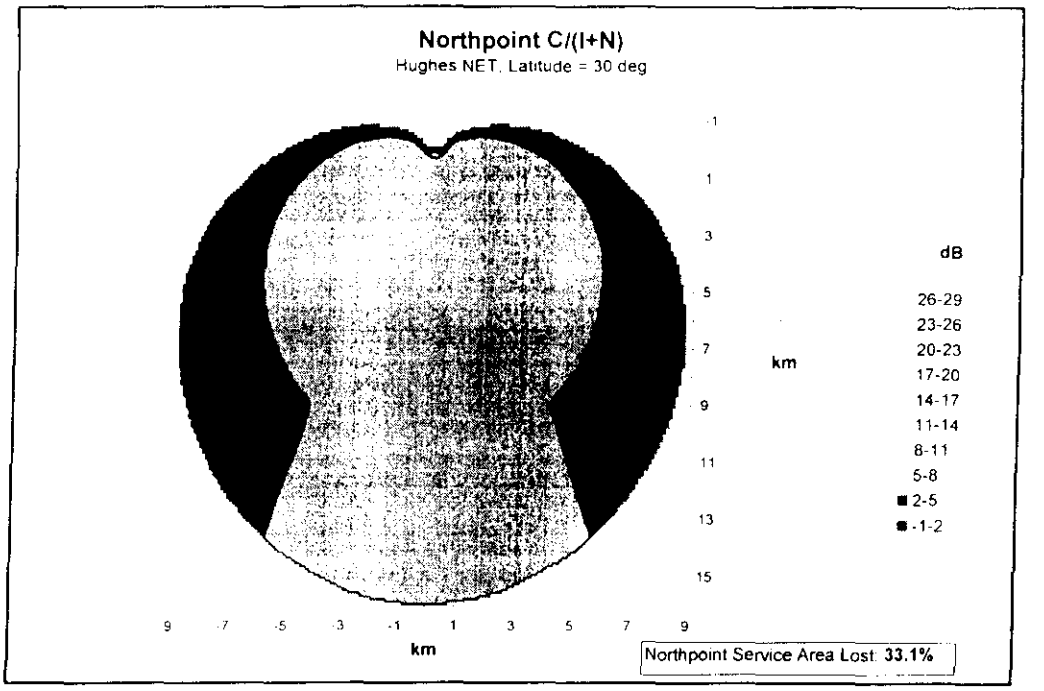


Figure 17. Hughes Net Interference into Northpoint

The previous figures show that a significant portion of the Northpoint service area could be affected by repeated outages from SkyBridge, Hughes Link and Hughes Net systems. The data are summarized in the following table.

Table 12. NGSO FSS Impact on Northpoint Service Area

System	% Northpoint Service Area Affected
SkyBridge	27.6%
Hughes Net	33.1%
Hughes Link	5.9%

3.3 Dynamic Analysis

A number of dynamic analyses were performed to determine the severity of interference into Northpoint. The simulation calculates the I/N ratio using Equation 1. Simulation duration was 4 days at 1 second intervals (345,000 points). Principle assumptions about the SkyBridge satellite system are as listed in Appendix E and Table 13. Northpoint distance from the transmitter was at the maximum service distance, as shown in Figure 8.

Table 13. Interference into Northpoint - SkyBridge Dynamic Analysis Assumptions

System	Parameter	Value	Units
	Frequency	12.5	GHz
	Atmospheric Loss	Per ITU Model	
	U.S. Standard Atmosphere		
SkyBridge			
	Radiation Pattern	Bessel	
	Range Power Compensation	Yes	
	Peak Gain	22.8	dBi
	Minimum 3-dB beamwidth	5.1	deg

Maximum 3-dB beamwidth	18	deg
Maximum number of transmitters per satellite	20	
Target Cell Selection	Highest Elevation Satellite	
GSO Arc Avoidance	Yes	
Cell Diameter	350	km
Northpoint		
Receiver Noise Level	130.3	dBW
Receiver Azimuth to Transmitter	0 to 125	deg
Transmitter Height above ground level	150	meters
Station Latitudes	30, 40	deg
Radiation Pattern	ITU-R F.1245	
Peak Gain	34	dBi

The results of the simulation are presented in Figure 18. As predicted, the interference is severe for azimuth angles between 40 and 125 degrees.

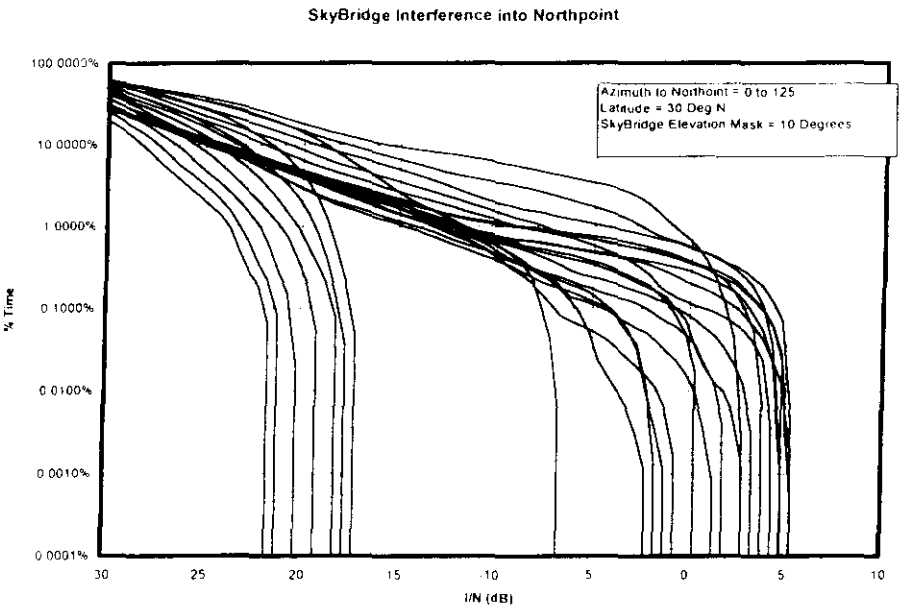


Figure 18. I/N into Northpoint from SkyBridge

Additional information on the two Hughes systems, Hughes Link and Hughes Net (e.g. cell size) is required to perform dynamic analysis on these systems. However, the Hughes Net system shares many characteristics with SkyBridge, and interference is expected to be similar. For Hughes Net, the static analysis in section 3.2 showed that Net operates inside the interference envelope of SkyBridge (see Figure 18). Therefore, it is expected that the interference environment from Hughes Net would be less severe than SkyBridge.

3.4 Power Flux Density Mask to Protect Northpoint

The provisional PFD mask in the 12.2 - 12.7 GHz band is given in the following table.

Table 14. Provisional PFD Limits for given angle of arrival, δ

Angle of Arrival	0-5°	5-25°	25-90°	Units
12.2 - 12.7 GHz	-148	-148+0.5(δ-5)	-138	dB(W/m² 4kHz)

The Interference to Noise ratio (I/N) is calculated from the provisional PFD as follows:

$$I/N = PFD + B + G(1m^2) + G(\delta) - N - gas$$

Where:

- δ : Elevation Angle to Satellite
- I/N : Interference to Noise ratio, dB;
- PFD : Power Flux Density, dBW/m²/4kHz;
- B : Ratio of noise floor reference bandwidth to PFD reference bandwidth, dB;
- $G(1m^2)$: Gain of 1 meter square antenna $= \lambda^2/4\pi$, m², (difference between the spreading loss and the path loss);
- $G(\delta)$: Gain of receive antenna as function of θ in degrees, dBi;
- N : Noise floor in reference bandwidth, dBW.
- gas : Gaseous attenuation (according to ITU-R).

Table 15 provides sample calculations.

Table 15 Sample Calculations of I/N

Item	Symbol	TFMS	Units
Noise floor reference bandwidth	*Bn*	24000	kHz
PFD reference bandwidth	*Bpfd*	4	kHz
Lambda	λ	0.025	meters
Power flux density	*PFD*	-148	dBW/m²/4 kHz
B = 10log(Bn/Bpfd)	*B*	37.8	dB
Gain of 1 m² antenna	$G(1m^2)$	-43.0	dB
Gain of receive antenna	*G*	34	dBi
Noise floor in reference bandwidth	*N*	-130.3	dBW
Gaseous Absorption	*gas*	1.5	dB
Interference to noise ratio	*I/N*	9.6	dB

Thus, the maximum I/N ratio from a single satellite operating at the PFD limit would be 9.6 dB. If peak interference from multiple NGSO FSS systems is independent and is not cumulative, only an additional 10 dB of protection is required at the low elevation angles to prevent loss of synchronization. The maximum PFD that can be tolerated at zero degrees elevation is -158 dBW/m2/4 kHz. To determine an appropriate PFD at other elevation angles with multiple NGSO FSS systems, a further analysis is required.

Preliminary dynamic analysis with SkyBridge shows that for elevation angles greater than 5 degrees, the existing limit is adequate to protect Northpoint technology. Pending further review and the outcome of studies in the ITU-R, the Northpoint PFD mask is listed in the following table:

Table 16. PFD Limit to protect Northpoint Technology

Angle of Arrival (δ)	0-2°	2-5°	5-25°	25-90°	Units
12.2 - 12.7 GHz	-158	-158 + 3.33(δ-2)	-148 + 0.5(δ-5)	-138	dB(W/m²/4kHz)

Plotted in Figure 19. PFD Mask for Northpoint, are the provisional limits, the PFD mask to protect Northpoint and the PFD for SkyBridge. As shown, only a modest reduction in PFD is required, and only below five degrees in elevation. Satellite systems do not provide service below ten degrees in elevation, and such a modest reduction in PFD can easily be met by satellite system designers.

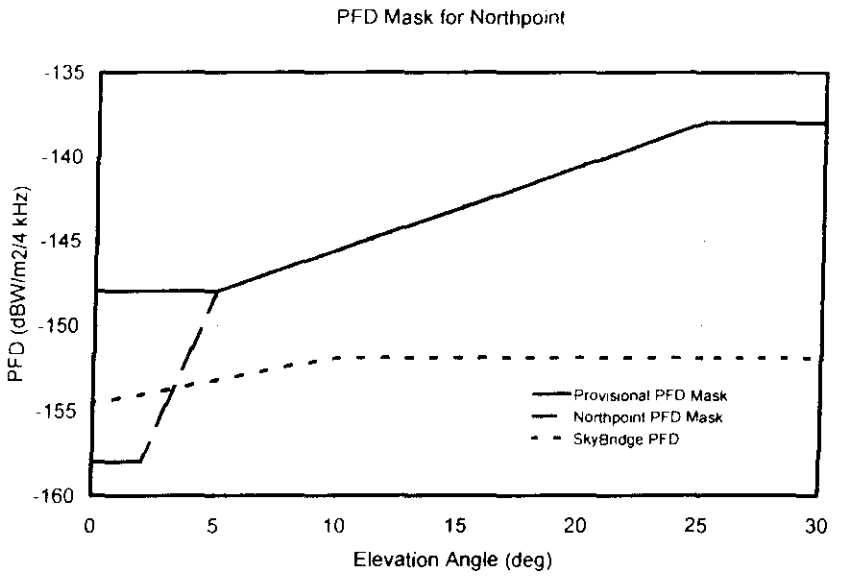


Figure 19. PFD Mask for Northpoint

The following table provides sample calculation for the SkyBridge power flux density level.

Table 17 SkyBridge PFD Calculation

Item	Value	Units
Frequency	12.2	GHz
Lambda	0.025	meters
Power	6.4	dBW
Gain Tx Side	22.8	dBi
EIRP Tx Side	29.2	dBW/22.6 MHz
Rx Bandwidth	0.004	MHz
Tx Bandwidth	22.6	MHz
Bandwidth Ratio	-37.5205	dB
Elevation Angle	10.0	deg
OrbRadius	7847.0	km
PathLoss	-185.4	dB
PFD	-150.6	dBW/m2/4kHz
Atmospheric Degradation	-1.5	dB
PFD	-152.1	dBW/m2/4kHz

In conclusion, this section identified the PFD mask (Table 16) required to protect Northpoint from NGSO FSS transmissions. As shown, only a modest reduction in PFD is required, from the provisional limit, and only below 5 degrees in elevation. As previously stated, NGSO satellite systems do not propose to provide service below 10 degrees in elevation, and such a modest reduction in PFD can easily be met by satellite system designers, as discussed in the following section.

3.5 Terrestrial Arc Avoidance

There are a number of methods to protect Northpoint from interference from NGSO FSS, discussed in the following paragraphs. As previously depicted in Figure 14, a maximum of 5 dB of attenuation is required to meet the short-term I/N. Dynamic analysis with SkyBridge showed that if SkyBridge meets the short-term limit, the long-term limit will also be met.

All of the following methods reduce the power flux density below 5 degrees, an elevation angle that no NGSO FSS proposes to serve under any conditions. Therefore, the reduction methods need not have an impact on NGSO FSS operations. Of the three methods discussed, *reducing the radiation levels* towards elevation angles below 5 degrees appears to have the most merit for co-frequency sharing. *Frequency separation* of course eliminates interference, as does an *increase in the elevation mask* of the NGSO FSS system.

3.5.1 Increase in the elevation mask

One method to meet the PFD limits identified in section 3.4 is to increase the transmit mask in elevation above the 9-10 degrees proposed by Hughes and SkyBridge. By increasing the elevation mask, the power transmitted towards the horizon is reduced. (As shown in Figure 14, the maximum elevation mask for the NGSO FSS systems would be between 15 and 20 degrees.) It should be noted that all the proposed systems, except Hughes and SkyBridge meet or exceed this requirement.

Note that the orbit geometry of these systems dictates a naturally occurring elevation mask. For example, at a latitude of 30 degrees North, all of these systems would operate according to an elevation mask of between 15 and 60 degrees, due to orbit geometry (see figures in Appendix C). Moreover, naturally occurring obscura would require elevation mask greater than ten degrees in some locations. Therefore, such a moderate change in mask would have minimal impact on NGSO FSS systems.

In the case of SkyBridge, the static analysis in section 2.2 predicted that an elevation mask of 18 degrees would sufficiently protect Northpoint. The simulation in section 2.3 was repeated using an elevation mask of 18 degrees, the results are presented in Figure 20. The dynamic analysis confirms that at an elevation mask of approximately 18 degrees, the SkyBridge system meets the interference criteria for Northpoint.

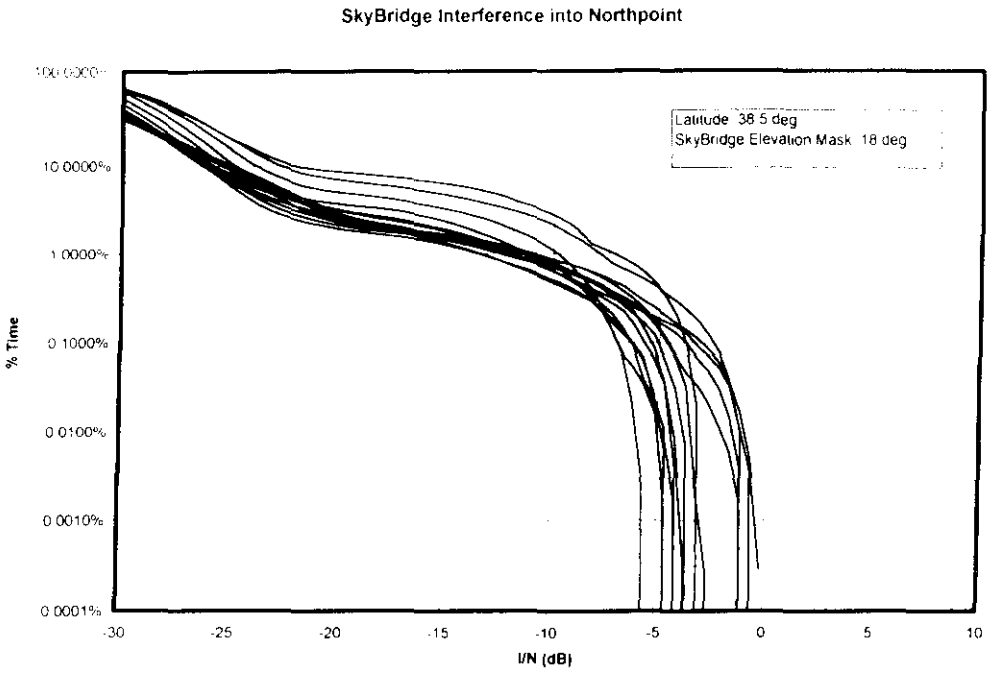


Figure 20. I/N into Northpoint from SkyBridge, Elevation Mask = 18 degrees

3.5.2 Increase Antenna Discrimination Towards the Horizon

Another method for reducing interference would be to increase the antenna discrimination of the NGO FSS antenna in the direction of the horizon. NGSO FSS systems do not offer service below five degrees, and there is no reason not to further attenuate power in this direction. As the typical NGSO FSS system is three-axis stabilized, the installation of shielding on the satellite to reduce radiation in this direction would also be a low-cost solution, and would not affect throughput or availability.

3.5.3 Frequency Separation

A certain method for eliminating interference into Northpoint would be for those NGSO FSS systems that do not offer compatibility with Northpoint to operate in another band. NGSO FSS systems have the option of operating service links in bands outside of the 12.2 - 12.7 GHz band.

3.6 Conclusions

In this section, interference from NGSO FSS systems into Northpoint was analyzed. It was demonstrated that most of the proposed systems (i.e. *Boeing IDS, Boeing BDS, Denali, Virgo, and Teledesic*) would not cause interference into Northpoint. In the cases of the *SkyBridge, Hughes Net* and *Hughes Link* systems, a loss of up to 33% of the Northpoint service area would occur absent some form of *terrestrial arc avoidance*. Co-frequency operation is possible given the implementation of interference mitigation techniques, the most promising of these is *reducing antenna radiation* towards the horizon.

An aggregate PFD mask was also developed. Slight changes in the WRC-97 provisional PFD mask, below 5 degrees in elevation, should protect Northpoint from the aggregate interference of NGSO FSS systems. Further work is required to identify a single entry mask, and is dependent upon the number of proposed systems that will operate and their characteristics. Again, five of the proposed systems (*Boeing IDS, Boeing*

BDS, Denali, Virgo, and Teledesic) would meet the proposed PFD limit by a wide margin and should not cause interference into Northpoint.

It should be noted that it was not possible without additional information to perform a dynamic analysis on the two Hughes systems. However, Hughes Net is so similar to SkyBridge that similar results should apply to Hughes Net. As long as the NGSO FSS systems meet the PFD limit, they should not cause interference into Northpoint.

Spectrum Capacity Comparison: Northpoint and NGSO FSS

- Northpoint seeks to use spectrum use in 12.2 - 12.7 GHz band
  - Potential capacity averages 2.6 GHz in each of 211 TV markets
  - Nationwide capacity of at least 525 GHz
- A number of NGSO systems are also proposed for this band
  - Average potential nationwide capacity of 6.0 GHz per system
  - Combined U.S. capacity of all NGSO is approximately 40 GHz

Northpoint Spectrum Capacity Within 12.2 - 12.7 Band

- Northpoint Technology uses a cellular architecture
  - The full 500 MHz band will be replicated in each of 211 TV markets
  - Nationwide capacity: 211 times 500 MHz = 105 GHz
- Spectrum will be further re-used at least 5 times within market areas
  - Nationwide capacity: 5 times 105 MHz = 525 GHz

NGSO Spectrum Capacity Within the 12.2 - 12.7 Band

	Units	Boeing IDS	Boeing BDS	Teledesic	Hughes Link	SkyBridge	Denali Telecom	Virgo
Service Band	GHz	11.7-12.7	11.7-12.7	11.7-12.7	11.7-12.7	10.7-12.7	10.7-12.7	11.2 - 12.7
Amount of Frequency Sought	GHz	1	1	1	1	1	1	1.5
Minimum Service Elevation	deg	30	30	25	10	10	30	42
Orbit Data		MEO	MEO	MEO	MEO	LEO	Quasi-Geo	Quasi-Geo
Number of Satellites		20	20	30	22	80	15	15 (10 northern)
Number of Satellites Serving USA at any time		4	4	5	5	12	5	(1)
Transmit Bandwidth/Carrier (or transponder)	MHz	166.7	24	250	125	22.8	27 (2)	(1)
Maximum No. Transponders per Satellite		37	5	8	50	24	24 (2)	(1)
Beams per 500 MHz		18.5	2.5	4	25	12	6	(1)
Total Spectrum Use per Satellite in the band 12.2 - 12.7 GHz	GHz	3.1	0.1	1.0	3.1	0.3	0.2	(1)
Maximum Possible Frequency Use in USA Within the 12.2 - 12.7 Band (3)	**GHz**	**12.3**	**0.2**	**5.0**	**15.6**	**3.3**	**0.8**	**4.8**

(1) Virgo asserts 14.25 GHz frequency use per regional area (Application of Virgo, p. 35, 14 Jan '99). The figure given for Virgo is 1/3 of the total regional frequency use.
(2) Denali noted 12 center frequencies of 27 MHz each in the band 10.7 - 12.7 GHz in their APS4/II dated 26 Aug 98.
(3) The bandwidth use of each system was determined by first determining the bandwidth capacity of each satellite, then multiplying by the number of satellites visible in the U.S. For example, in the first column in the table, Boeing IDS has a maximum of 37 beams, 18.5 that would operate in the band 12.2 - 12.7 GHz. Each beam occupies 166.67 MHz, for about 3.1 GHz per satellite. At any given time, approximately 4 IDS satellites would serve the U.S., for 12.3 GHz frequency use.

NGSO Spectrum Capacity Within the 12.2 - 12.7 Band

- A maximum of 3-5 NGSO systems are forecast by ITU working groups
- The combined capacity of the five highest capacity systems approximates 40 GHz

System	Maximum Spectrum Capacity (GHz)
Hughes LINK	15.6
Boeing IDS	12.3
Teledesic	5.0
Virgo	4.8
Skybridge	3.3
Denali	0.8
Boeing BDS	0.2

Northpoint Sharing with NGSO FSS

- Northpoint and NGSO FSS are both primary services
- Each service assumes burden of sharing

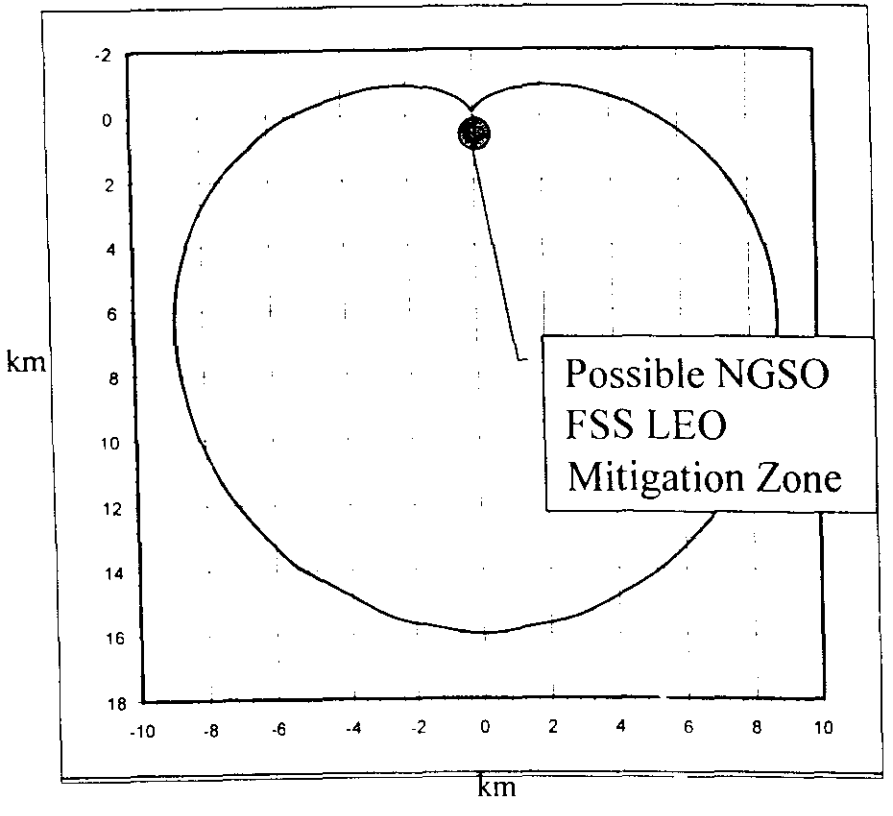
NGSO-Northpoint Sharing Issues Can be Resolved by Coordination

- In small areas near Northpoint transmitters Northpoint may interfere with NGSO transmissions of low elevation NGSO systems

- By using Frequency Diversity, also known as Alternative Beam Assignment, in this coordination area the potential interference can be 100% mitigated with no loss in NGSO service capacity

Quantifying the NGSO-Northpoint Coordination Region

Northpoint Service Area



System	Percent of Northpoint Service Area
Skybridge	8 %
Hughes LINK	2 %
Teledesic	< 1 %
Denali	< 0.1 %
Boeing IDS	< 0.1 %
Boeing BDS	< 0.1 %
Virgo	< 0.1 %

How Frequency Diversity Works

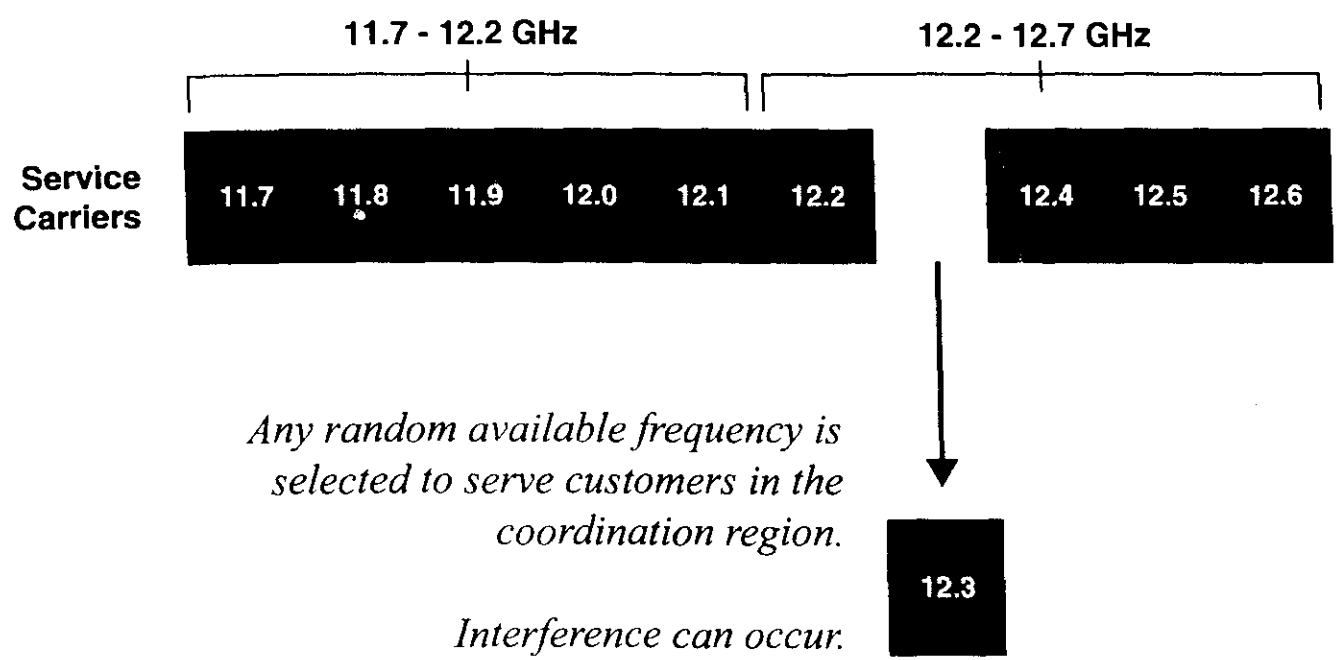
- NGSOs have sought 1,000 MHz of spectrum - from 11.7 to 12.7 GHz - for service links that typically use 6 - 10 beams

- Northpoint will only operate within the upper half of this band - from 12.2 - 12.7 GHz

- Since NGSO FSS select frequencies for each customer up to 100 times per day -- as a matter of course during satellite hand-over -- they can simply select frequencies outside of the 12.2 - 12.7 GHz band to avoid all interference in the small coordination region

Without Frequency Diversity

- When frequency assignments are random - no coordination is achieved



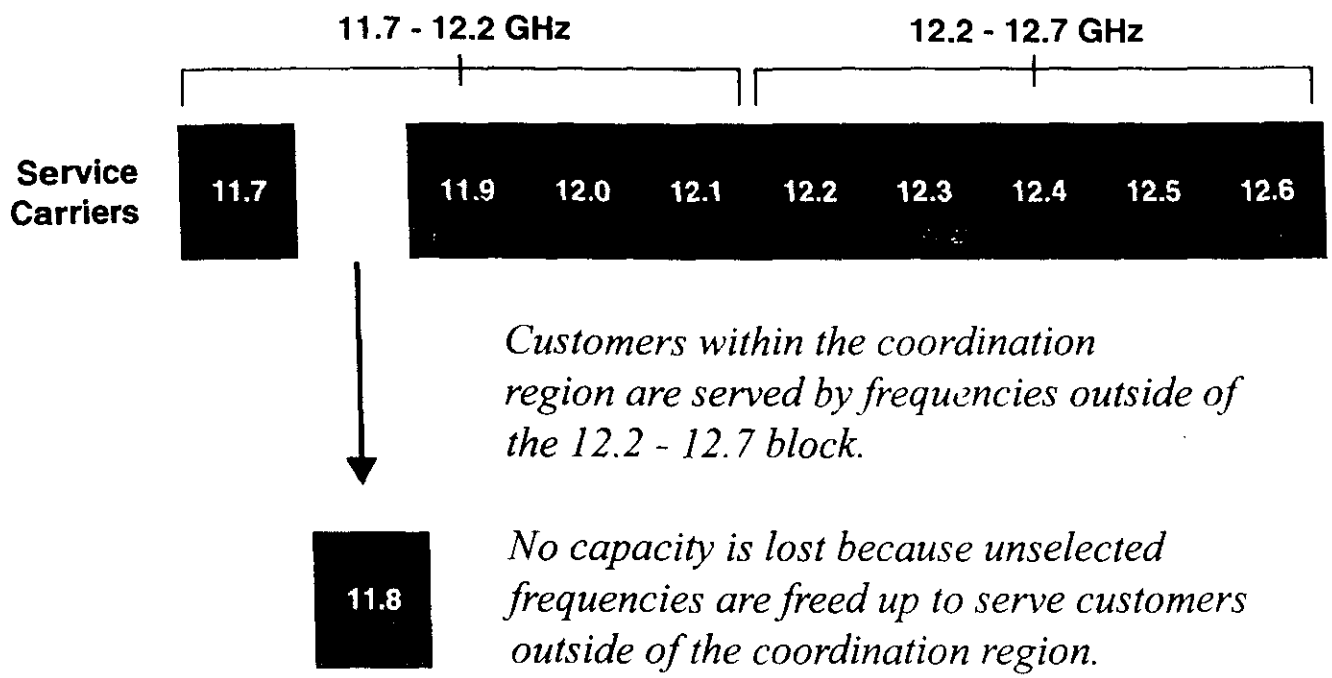
Any random available frequency is selected to serve customers in the coordination region.

Interference can occur.

Conceptual view of a single 1 GHz beam

With Frequency Diversity

- With a "Smart Select" system for frequency assignment, customers in the small coordination region use frequencies outside of 12.2 - 12.7 GHz.



Conceptual view of a single 1 GHz beam

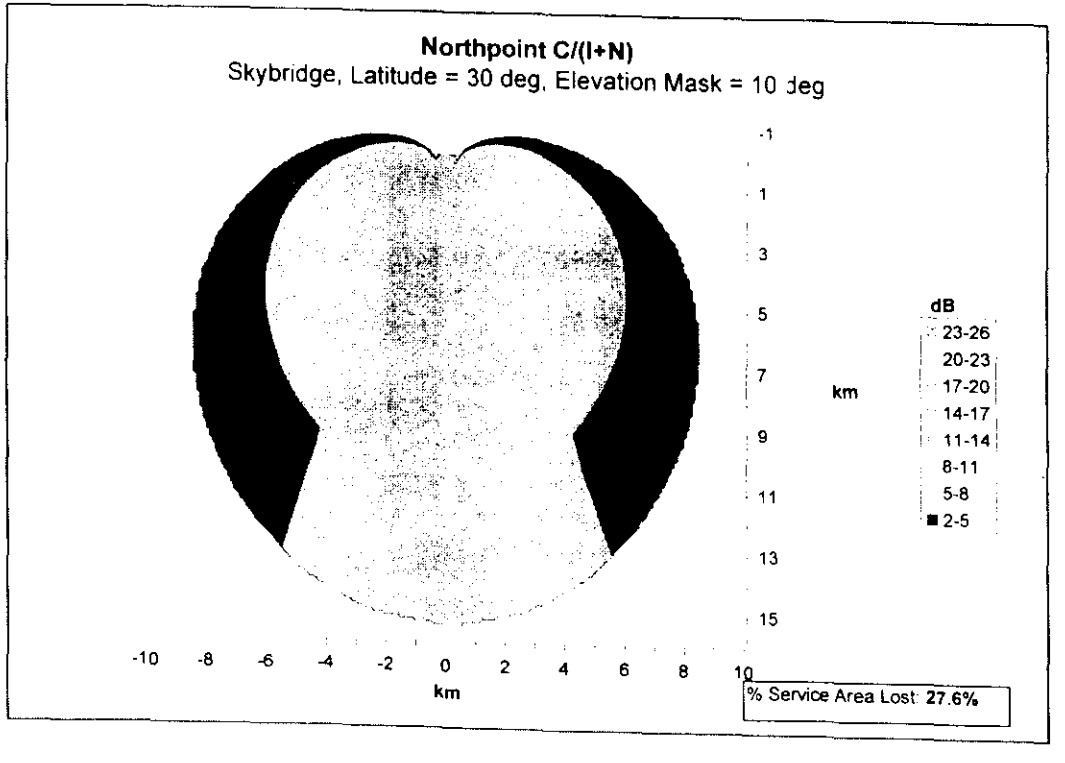
Northpoint Shares the Burden of Coordination with NGSO Operations

- As co-primary services both NGSO and Northpoint have the burden of coordination
- Systems that will need to use Frequency Diversity to coordinate with Northpoint also reduce Northpoint's service area - a shared burden

System	**% Northpoint Service Area Effected**
SkyBridge	27.6%
Hughes Link	5.9%
Denali	>0.1%
Virgo	>0.1%
Boeing	>0.1%
Teledesic	>0.1%

Example:
Skybridge Impact on Northpoint

Increased build out costs due to loss of 27.6% of Service Area



Increased Elevation Angles Another Solution

- Systems that will need to use Frequency Diversity for coordination also have the most significant impact on Northpoint's service area

- Reason: The low elevation angle (10 degrees vs. 25 - 42 degrees) of these systems increases the interaction with Northpoint

Solution: By operating at a higher elevation angle these systems could reduce the need for coordination and have less impact on Northpoint

Effect of 20 degree minimum elevation angle on NGSO FSS coordination area

System	% of Northpoint Service Area
Skybridge	0.76 %
Hughes LINK	0.11 %

Summary

- With Frequency Diversity or increased elevation angles, the Commission can have the flexibility to:
  - Authorize both Northpoint and NGSO FSS applicants regardless of system design
- The United States increases the potential spectrum capacity within the 12.2 - 12.7 band by:
  - At least 525 GHz from Northpoint
  - Up to 40 GHz from NGSO