What is Harmful Interference in the Digital Age?

- FCC rules define harmful interference as “serious degradation” or “repeated interruption” to a radiocommunication service. (S 2.1)
- Analog television services - static or snow on the screen.
- Digital technologies are more robust than analog - provide a consistent, high quality user experience over a wider range of operating values.
- Harmful interference to digital services – abrupt failure with a very brief (seconds only) transition time between perfect reception and outage.

Carrier to Interference Ratio (C/I)

- Interference - the signal of one service is sufficiently strong that it overpowers the other signal and causes an outage.
- The relative strength of one signal to another is calculated as a ratio of “Carrier to Interference” (“C/I”) using a logarithmic scale called decibels (“dB”).
- DBS - outage occurs at C/I ratios between 3.5 – 6.5 dB.
- 10% “increase in unavailability” is equal to approximately 20 dB C/I

The Decibel Scale (dB)	
dB	Ratio
0	1 to 1
3	1 to 2
7	1 to 5
10	1 to 10
17	1 to 50
20	1 to 100
28	1 to 600
30	1 to 1,000
40	1 to 10,000

A scale commonly used to measure the ratio of one signal power to another

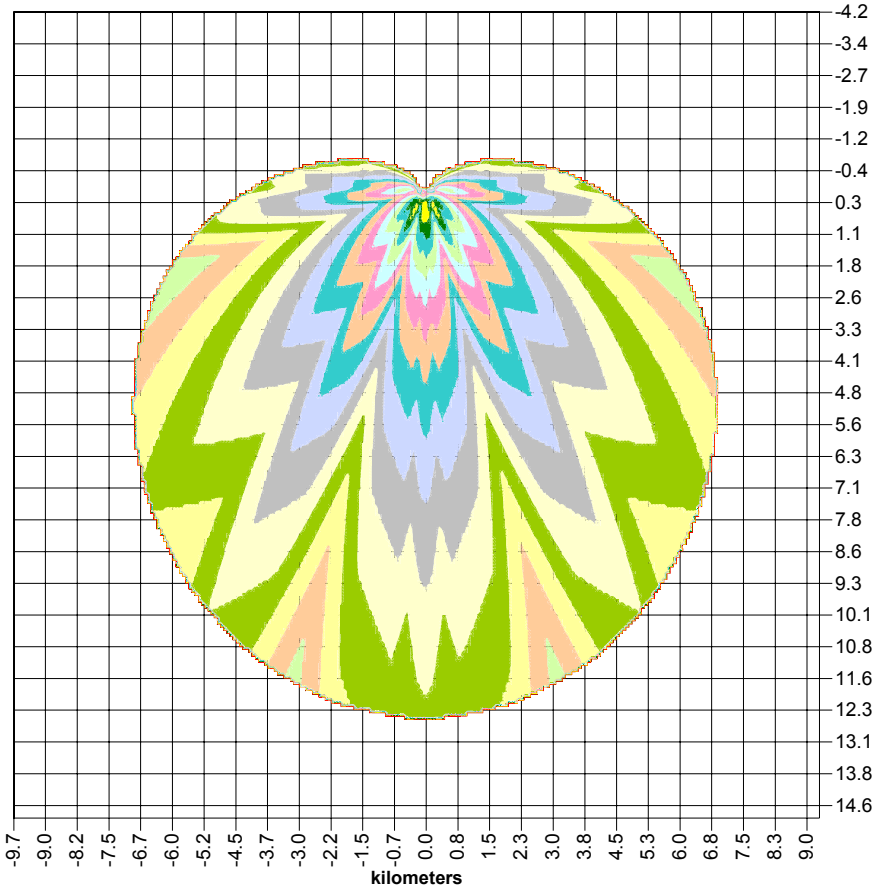
Contours Define Mitigation Regions in Spectrum Sharing Studies

- “Contour” diagrams plot the degree of overlap between signals and highlight any “mitigation zones” – areas where the overlap exceeds a targeted C/I ratio.
- Contours diagrams account for:
  - Specific system characteristics (transmit and receive antennas etc.)
  - “Free space loss” - the fact that when a radio signal doubles its distance its intensity is quartered
    - Signals near the transmitter are dramatically higher than signals even 100 yards away.
- When spectrum is shared, signals emanate from several sources, each with a different strength due to differences in original power and distance from its source.
- Contour maps make it easy to visualize and understand these factors.

Special Issues In Satellite and Terrestrial Sharing Contours

- Satellite signals - fairly uniform across a service area.
- Terrestrial signals are much closer to their source transmitter and therefore show a much greater degree of variability across the service area.
- When satellite and terrestrial signals are plotted together, the highest terrestrial power will be in the immediate vicinity of the transmitter.
- Summary of areas of agreement:
  - No interference potential during clear air – potential for concern is on rain days only (increased unavailability).
  - Interference concern is confined to a contour around Northpoint transmitter.

Example of Contour Plot



0.0-2.0	2.0-4.0
4.0-6.0	6.0-8.0
8.0-10.0	10.0-12.0
12.0-14.0	14.0-16.0
16.0-18.0	18.0-20.0
20.0-22.0	22.0-24.0
24.0-26.0	26.0-28.0
28.0-30.0	30.0-32.0
32.0-34.0	34.0-36.0
36.0-38.0	38.0-40.0
40.0-42.0	42.0-44.0
44.0-46.0	46.0-48.0
48.0-50.0	

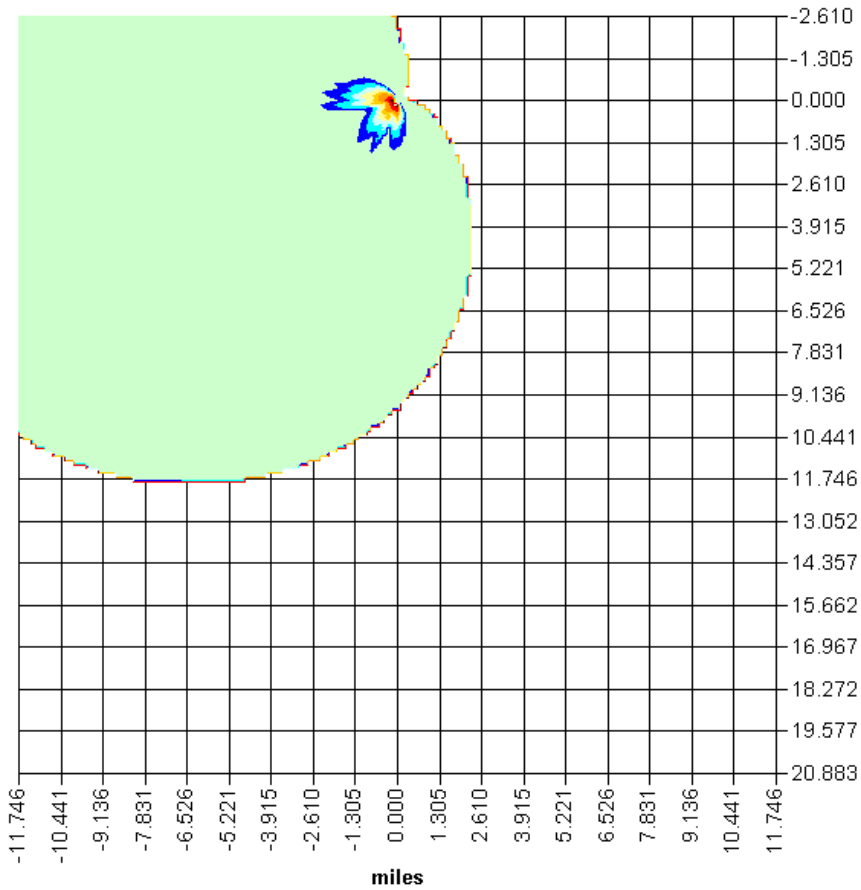
C/I Contours in Washington, DC
Satellites: 119W, 110W, 101W, 61.5W

Northpoint Parameters
EIRP = -17.5 dBW
HAAT = 200 ft
Antenna Pattern = 10

Contour -- Area
20 dB -- 0.44 sq mi
16 dB -- 0.07 sq mi

Examples of Contour Optimization

Sample Site 1: Without Northpoint Optimization



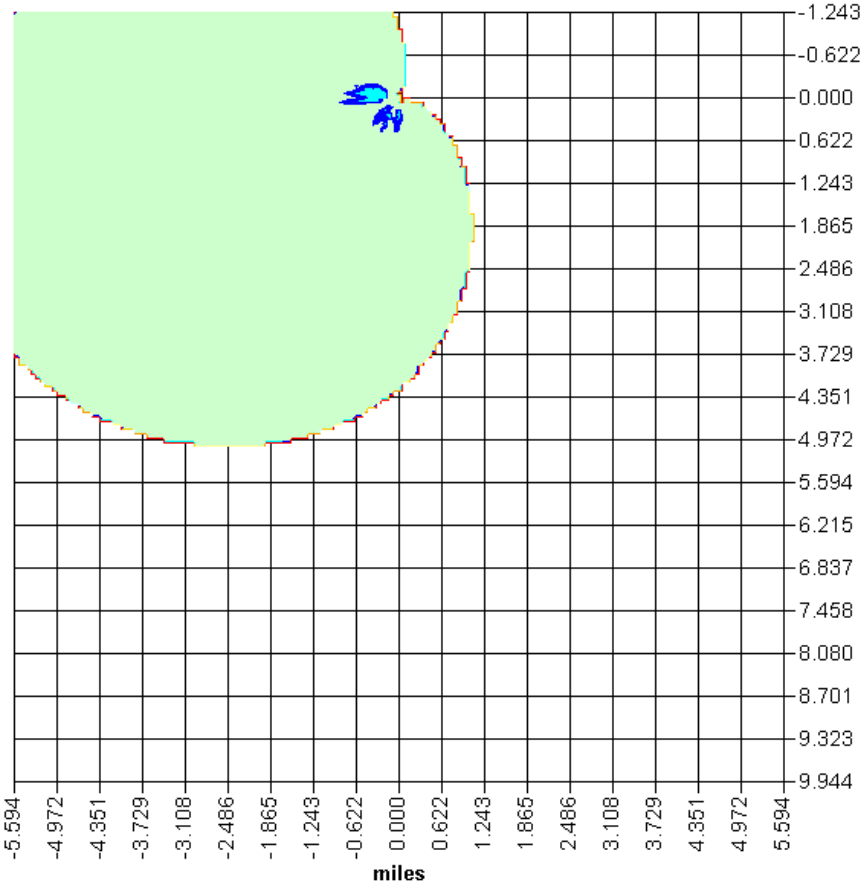
0.0-2.0	2.0-4.0
4.0-6.0	6.0-8.0
8.0-10.0	10.0-12.0
12.0-14.0	14.0-16.0
16.0-18.0	18.0-20.0
20.0-22.0	22.0-24.0
24.0-26.0	26.0-28.0
28.0-30.0	30.0-32.0
32.0-34.0	34.0-36.0
36.0-38.0	38.0-40.0
40.0-42.0	42.0-44.0
44.0-46.0	46.0-48.0
48.0-50.0	

C/I Contours in Washington, DC
Satellites: 119W, 110W, 101W, 61.5W

Northpoint Parameters
EIRP = -11 dBW
Bearing = 245 Degrees
Tilt = 0 Degrees
HAAT = 50 ft
Antenna Pattern = 17

Contour -- Area
20 dB -- 2.1 sq mi
7 dB -- 0.1 sq mi

Sample Site 1: With Northpoint Optimizations



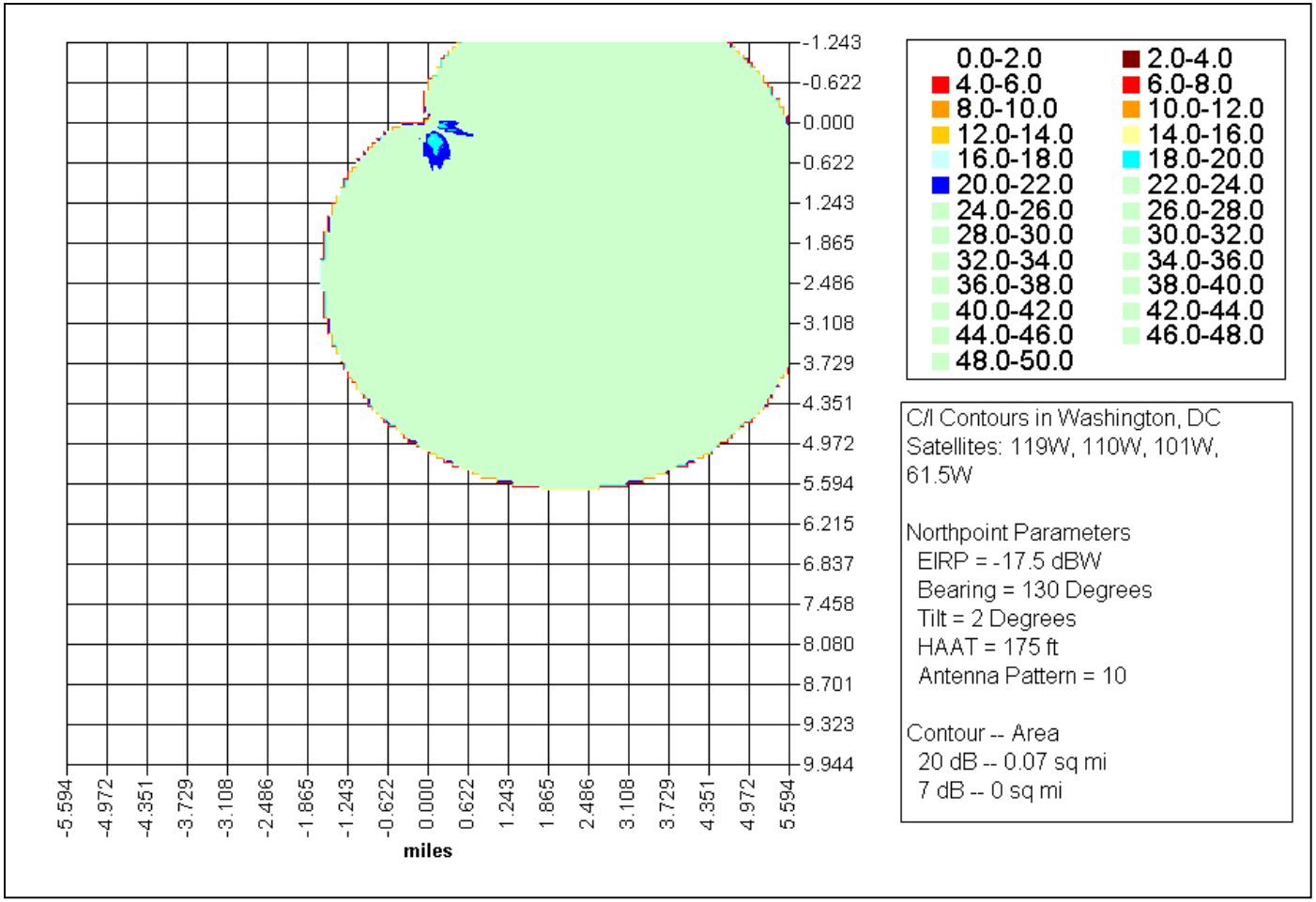
0.0-2.0	2.0-4.0
4.0-6.0	6.0-8.0
8.0-10.0	10.0-12.0
12.0-14.0	14.0-16.0
16.0-18.0	18.0-20.0
20.0-22.0	22.0-24.0
24.0-26.0	26.0-28.0
28.0-30.0	30.0-32.0
32.0-34.0	34.0-36.0
36.0-38.0	38.0-40.0
40.0-42.0	42.0-44.0
44.0-46.0	46.0-48.0
48.0-50.0	

C/I Contours in Washington, DC
Satellites: 119W, 110W, 101W, 61.5W

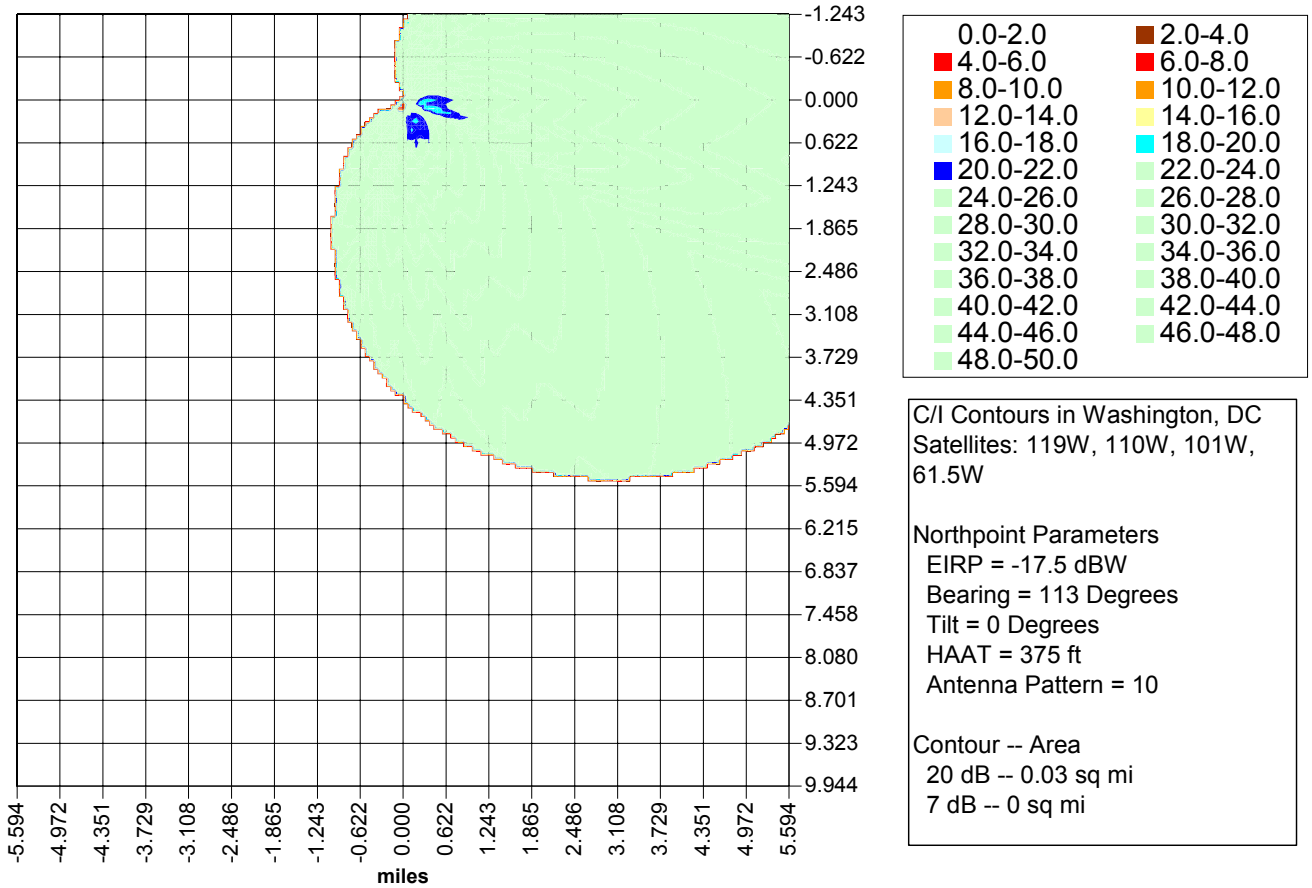
Northpoint Parameters
EIRP = -17.5 dBW
Bearing = 245 Degrees
Tilt = 2 Degrees
HAAT = 175 ft
Antenna Pattern = 10

Contour -- Area
20 dB -- 0.1 sq mi
7 dB -- 0 sq mi

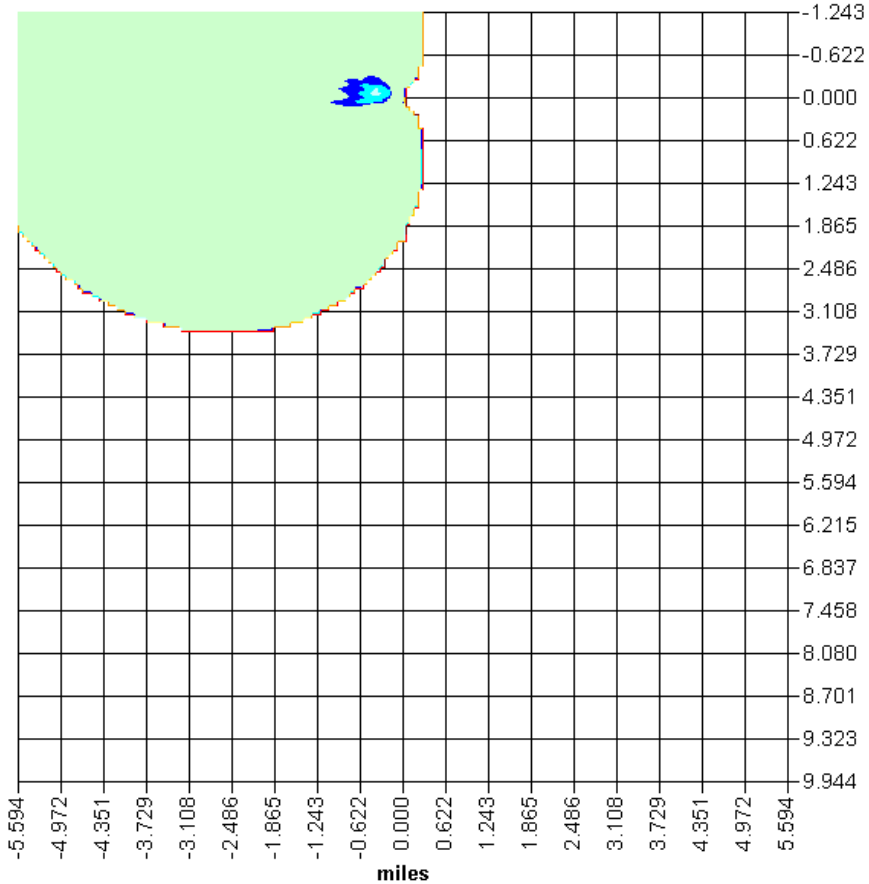
Sample Site 1 – Demonstration of Moving the Mitigation Zone



Northpoint Deployment at USA Today During Washington Operations in 1999



Tampa: Transmitter Bearing = 270 Degrees



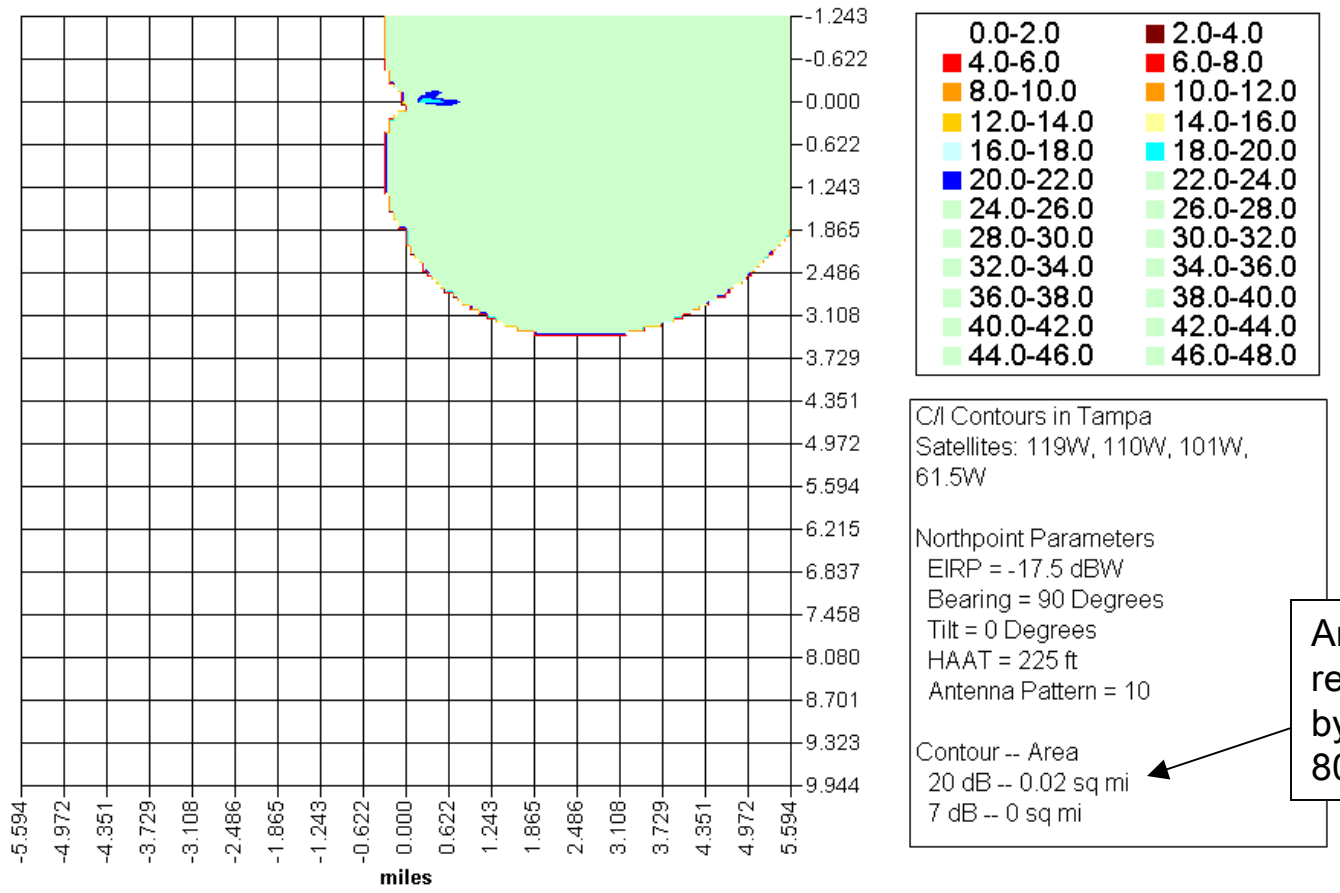
0.0-2.0	2.0-4.0
4.0-6.0	6.0-8.0
8.0-10.0	10.0-12.0
12.0-14.0	14.0-16.0
16.0-18.0	18.0-20.0
20.0-22.0	22.0-24.0
24.0-26.0	26.0-28.0
28.0-30.0	30.0-32.0
32.0-34.0	34.0-36.0
36.0-38.0	38.0-40.0
40.0-42.0	42.0-44.0
44.0-46.0	46.0-48.0

C/I Contours in Tampa
Satellites: 119W, 110W, 101W, 61.5W

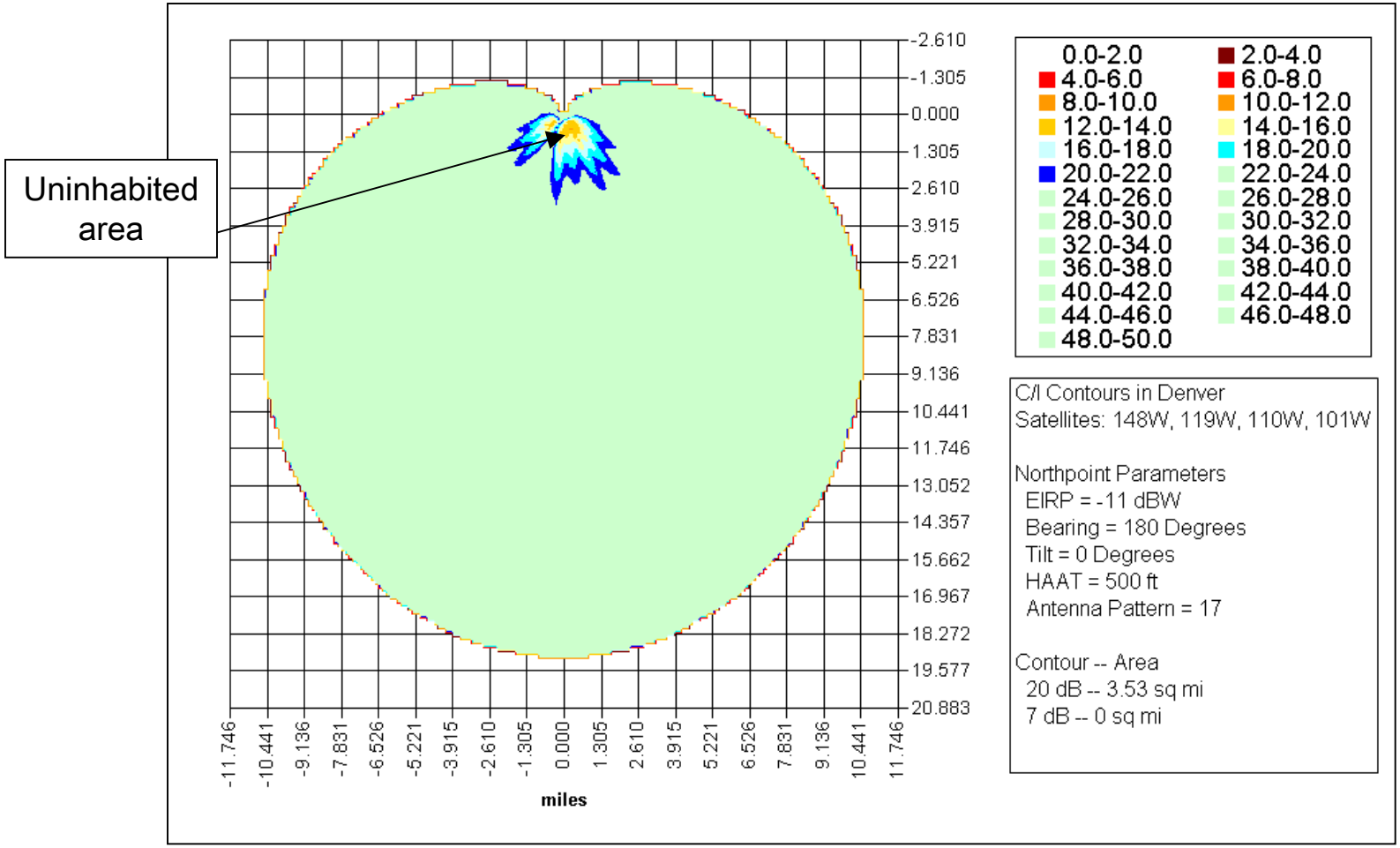
Northpoint Parameters
EIRP = -17.5 dBW
Bearing = 270 Degrees
Tilt = 0 Degrees
HAAT = 225 ft
Antenna Pattern = 10

Contour -- Area
20 dB -- 0.11 sq mi
7 dB -- 0 sq mi

Tampa: Transmitter Bearing = 90 Degrees Demonstration of Using Rotation to Reduce Mitigation Zone



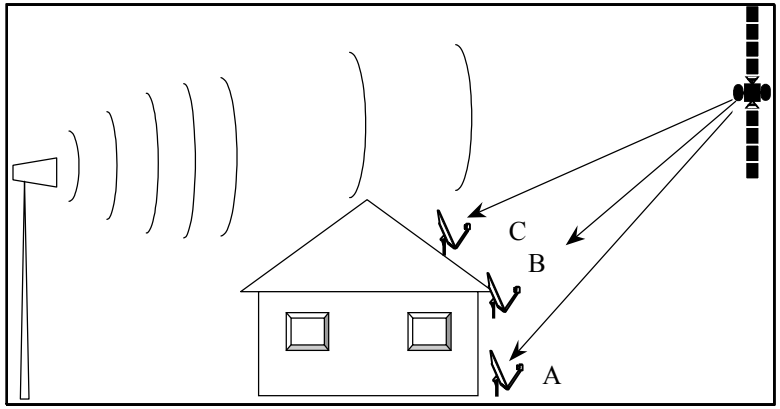
Rural Area: Transmission from a Mountain



Natural Shielding – A Real World Factor Present at 86% of All DBS Consumers

- Contour maps are drawn in an idealized way - as if the earth were flat.
  - Real landscapes have natural features that significantly reduce the potential for interference.
- Most DBS dishes are located on porches, chimneys, low points on roofs, etc., with an obstacle between the Northpoint transmitter and the consumer dish.
- A national consumer survey of DBS consumers* conducted for Northpoint in July 1999 showed that 86% of all DBS dishes have natural shielding from a Northpoint signal.

86% of satellite dishes are positioned as shown



* Bennett, Petis & Blumenthal