

Space Data's Comments on Interference Noise Temperature

Proceeding 04-256

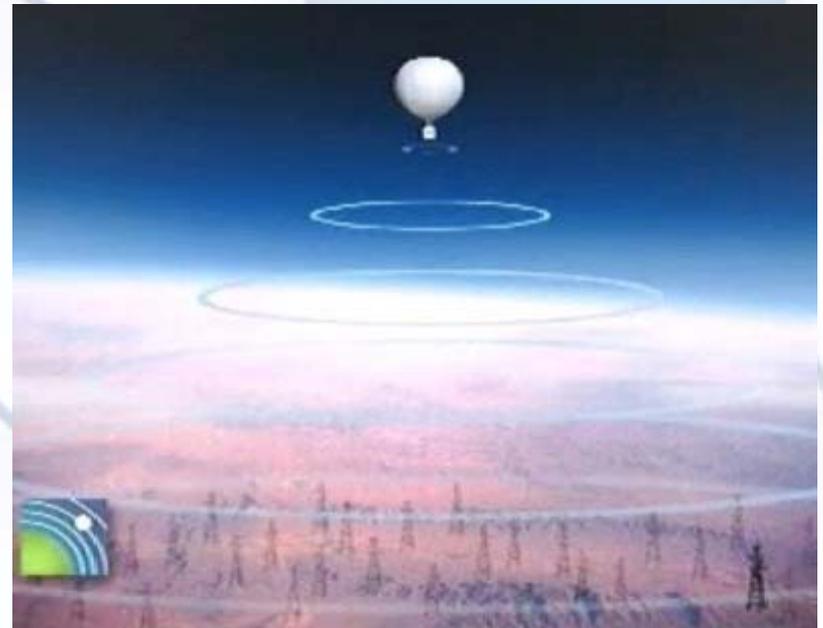
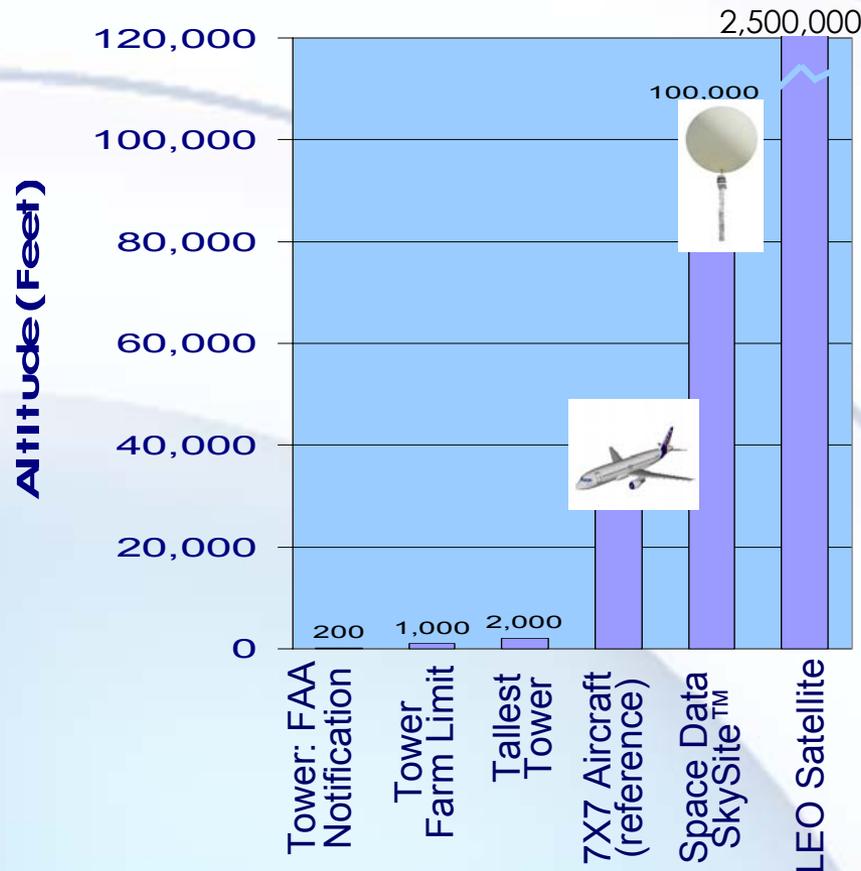
Presented to FCC
Office of Engineering and Technology
June 10, 2004

Overview

- Space Data Summary
- Interference Noise Temperature
- Operating characteristics of Stratospheric Platforms
- Geographic fragmentation of CMRS spectrum largely bars Stratospheric Platforms due to difficulties in obtaining consensus among all licensees in a block
- Most of CMRS spectrum lies fallow in most areas simply due to demographic realities
- Interference Noise Temperature licensing approaches should be applied to future (NOT EXISTING) CMRS licensing schemes to create a nationwide channel suitable for Stratospheric Platform Technologies

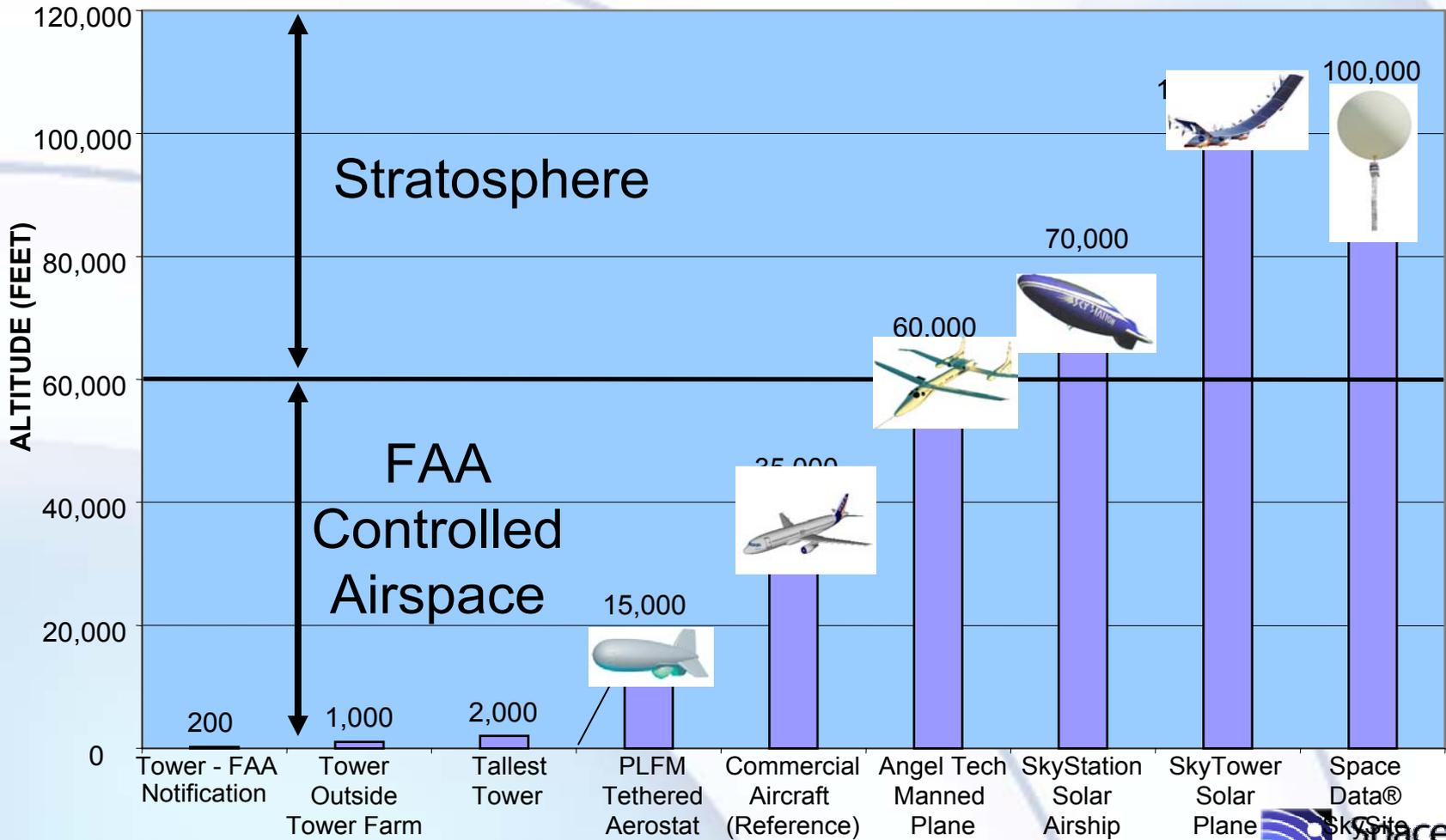
SkySite[®]: A 20-mile-high “Tower” Providing Rural Coverage

One SkySite[™] = 250 Towers & users keep same device



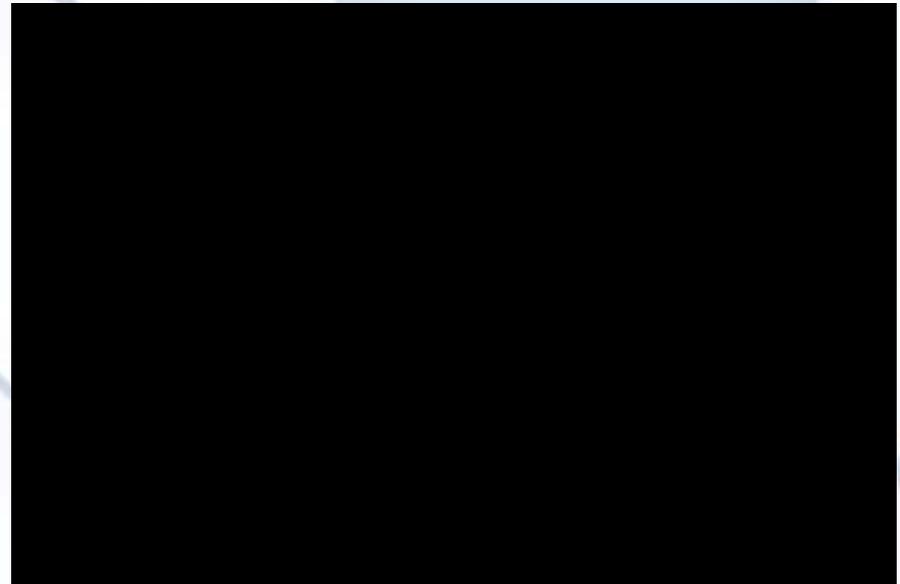
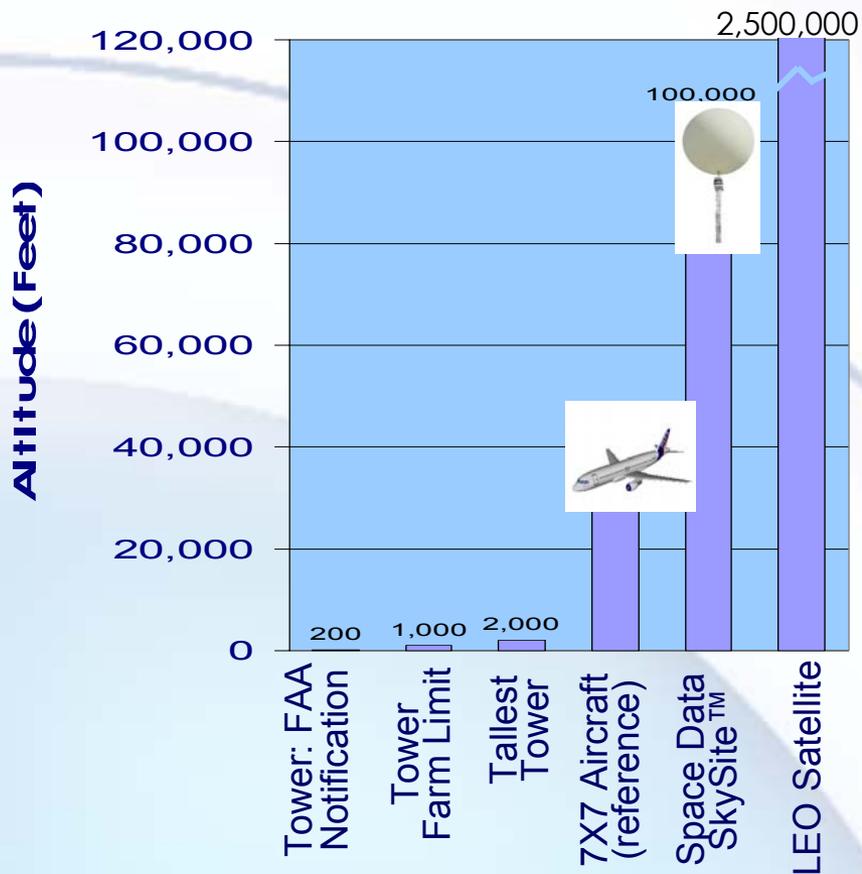
Many Stratospheric Platforms

One SkySite™ = 250 Towers & users keep same device



SkySite™ is a 20-mile-high “Tower” that Solves Rural Coverage

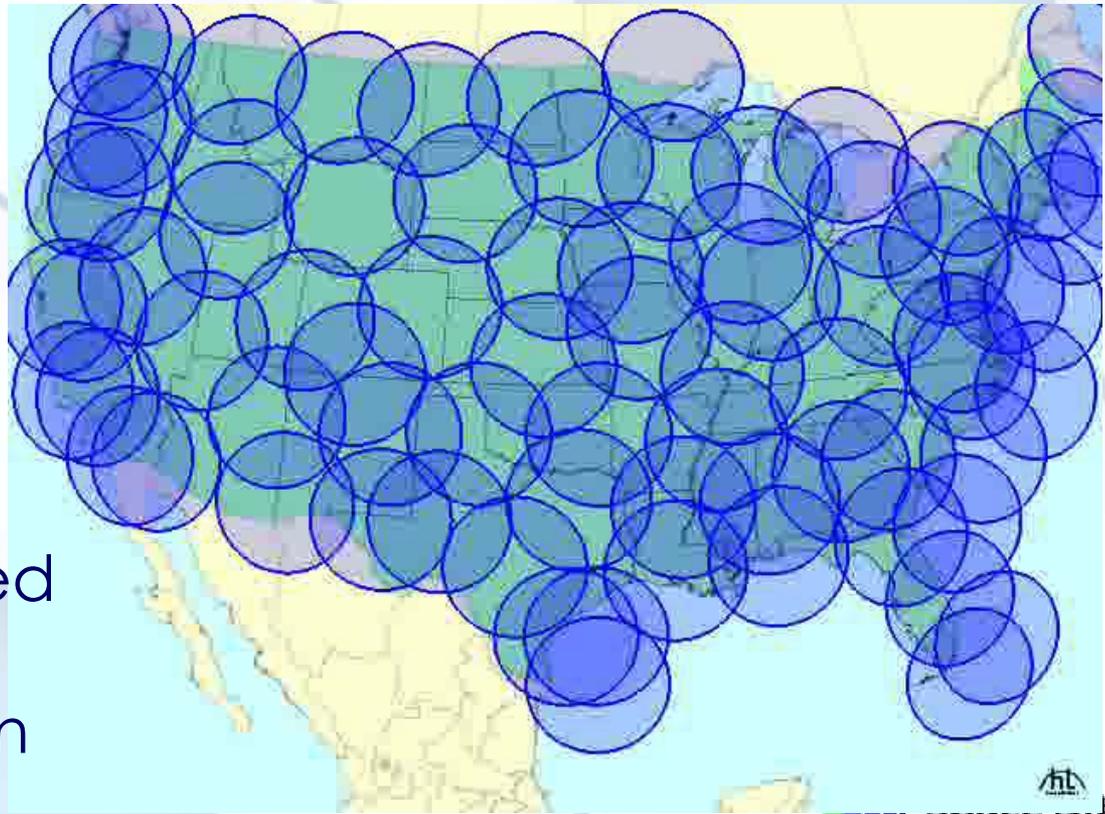
One SkySite™ = 250 Towers & users keep same device



Space Data's Coverage Solution

Wireless repeaters on weather balloons at 100,000 ft provide complementary coverage to towers

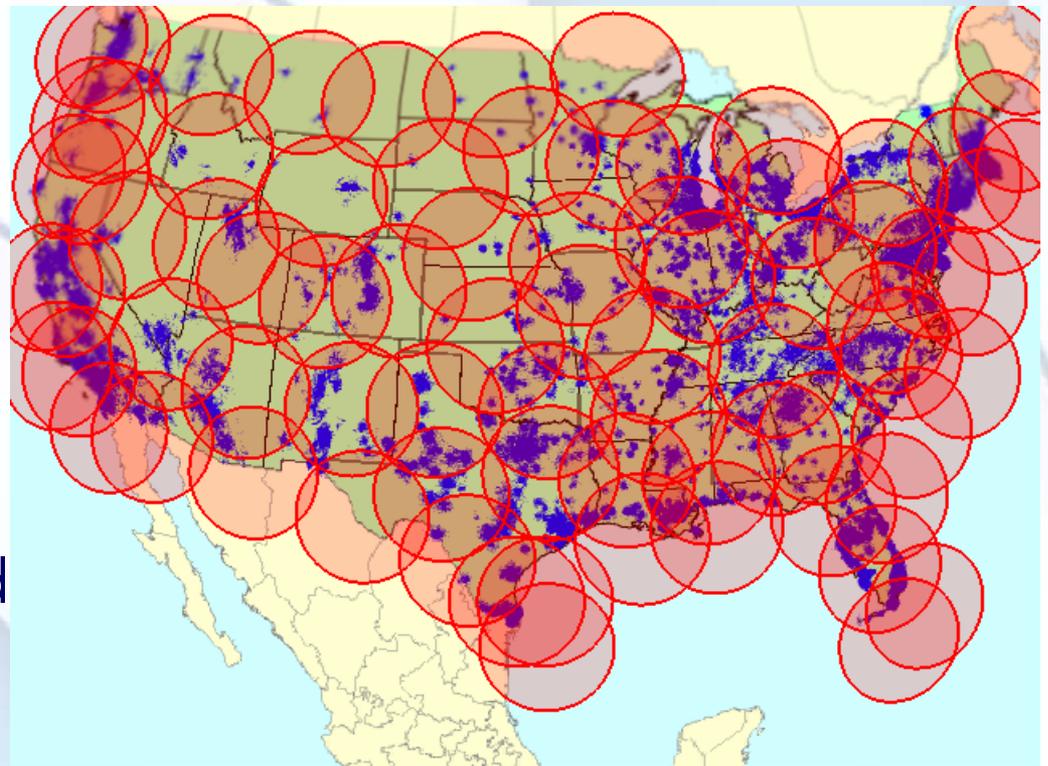
- Uses inexpensive user devices
- Roaming onto towers for urban coverage
- Environmentally Benign & Safe
- FCC/FAA approved
- Leverages 60+ yrs of weather balloon operations



Space Data's Coverage Solution

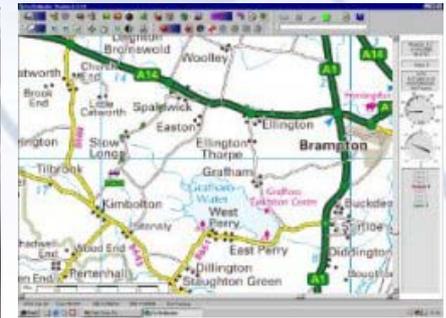
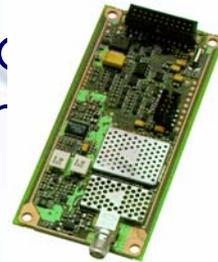
Wireless repeaters on weather balloons at 100,000 ft provide complementary coverage to towers

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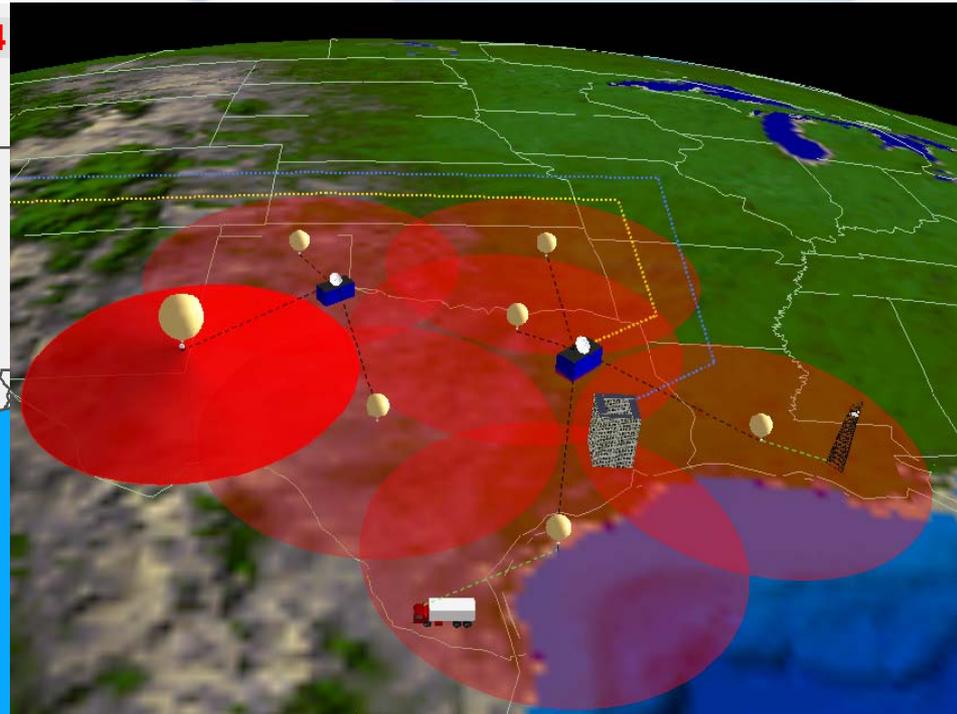
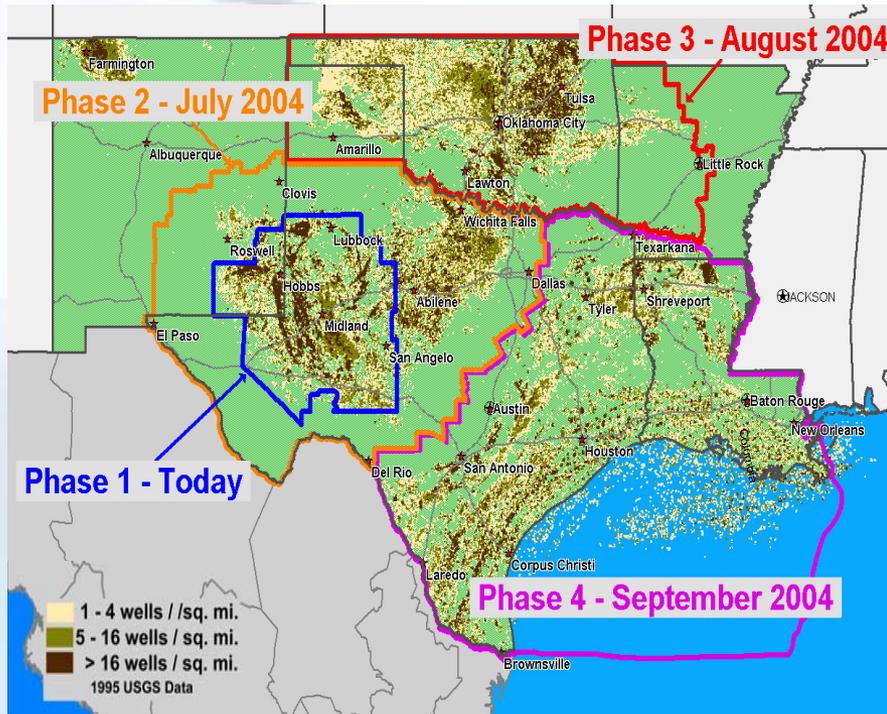
Initial System Applications

- Telemetry
 - Oil wells & pipelines
 - Irrigation control
 - Remote security
 - Telematics
 - Road side assistance
 - Air bag notification
 - Location services
 - Asset tracking
 - GPS Vehicle Location
-
- 2-way wireless email
 - Text messaging
 - Enterprise application



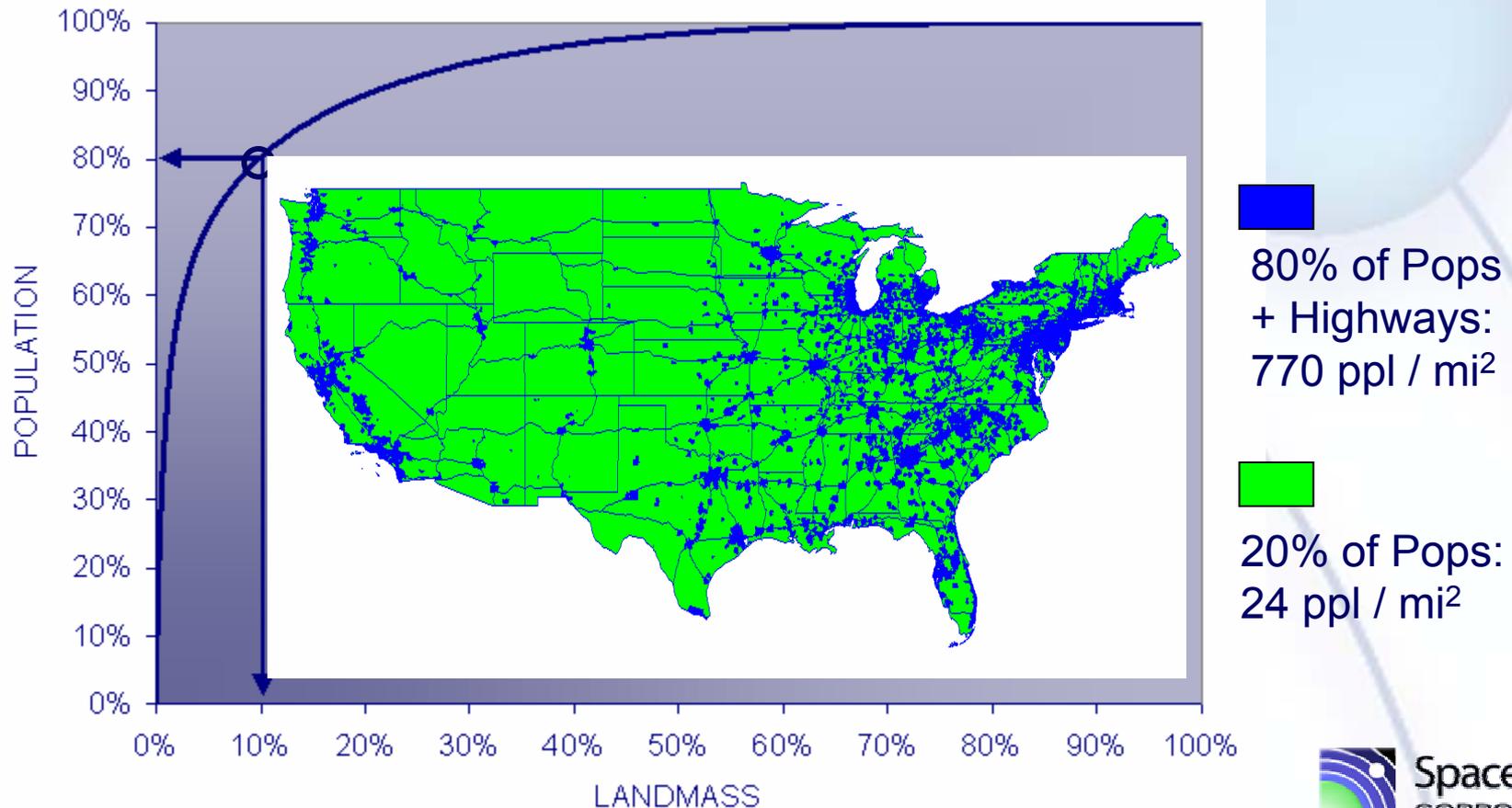
Initial M2M/Messaging Coverage

- Initial Region: 7 sites Nationwide: 70 sites
- First region is oil and gas areas losing CDPD in 2004
- Targeting enterprises with well monitoring, asset tracking, and field personnel communication needs



The Reality of Demographics

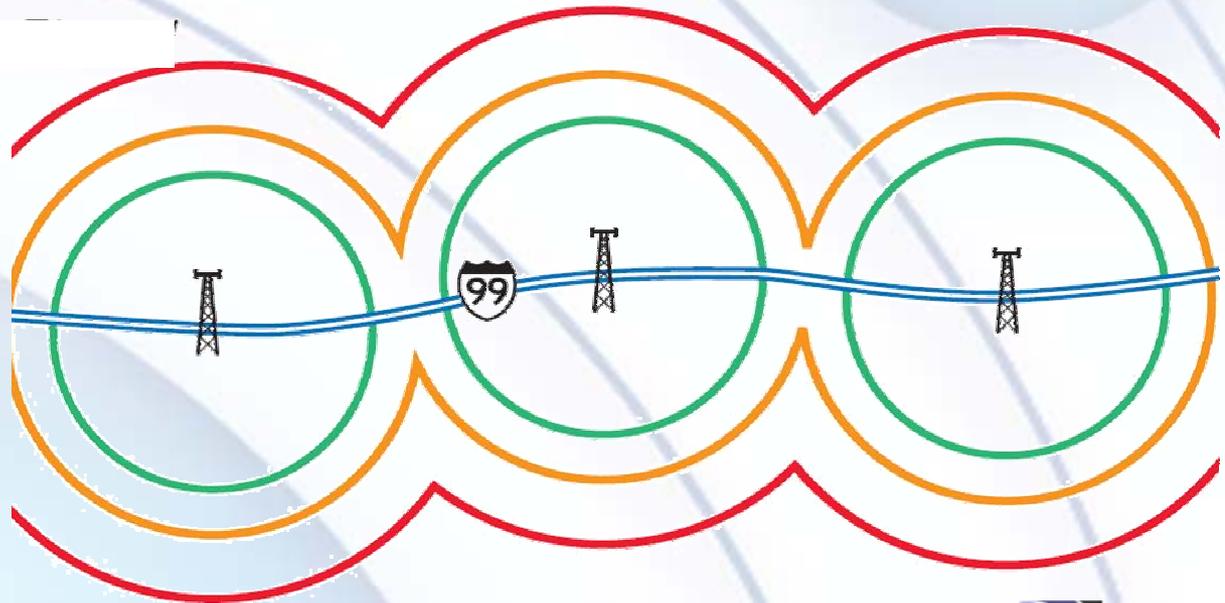
- 80% of population lives in 10% of landmass by ZIP codes
- Carrier's Choice: Build 10X more towers or ignore sparsest 20%?



Coverage is getting Worse in Rural America

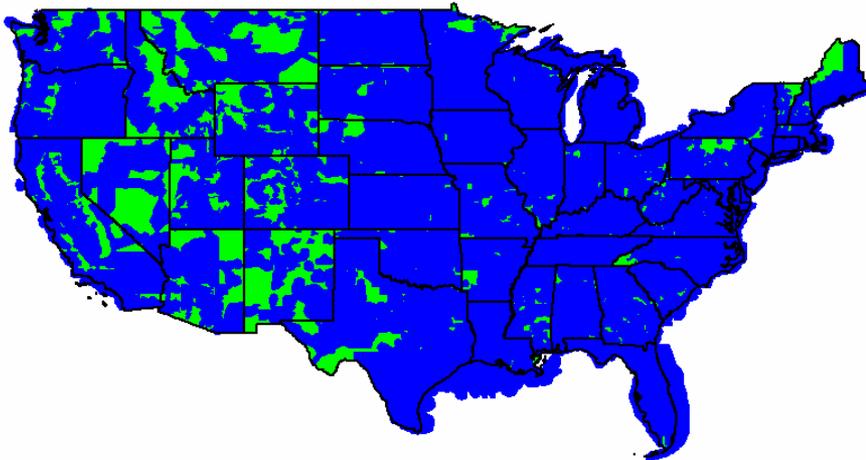
- As wireless penetration goes from 50% to 70+%, driving design case is providing enough capacity to service Manhattan
 - Engineers increase the data rate to increase capacity, which physics dictates reduces the coverage

- Example:
3W analog coverage in Red,
0.6 W handset coverage in Orange,
new digital phone coverage in Green

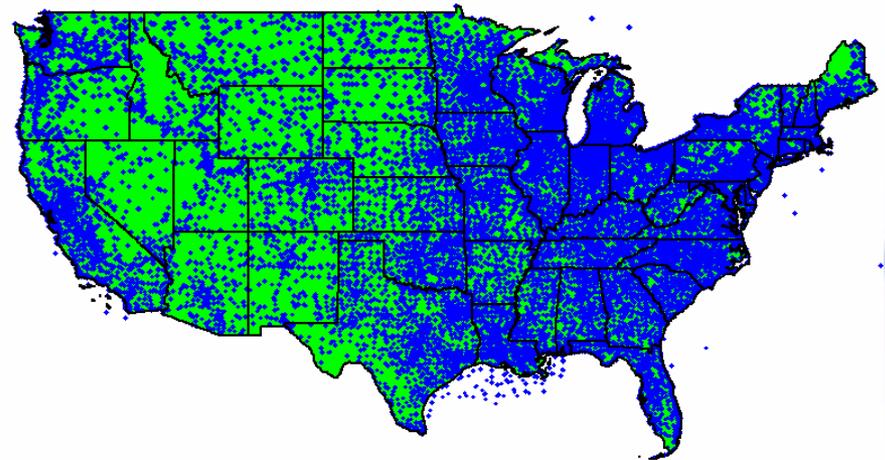


Rural Coverage May Get Worse

- Aug 2002: FCC puts 5 year sunset on AMPS requirement
 - Many rural areas build for 3W analog coverage and may require 3X towers to maintain same footprint for handsets
 - Carriers likely to discontinue analog upon sunset
- Oct 2002: ATT announces will discontinue CDPD in 2004



3 W bag phone (1991 earthen)

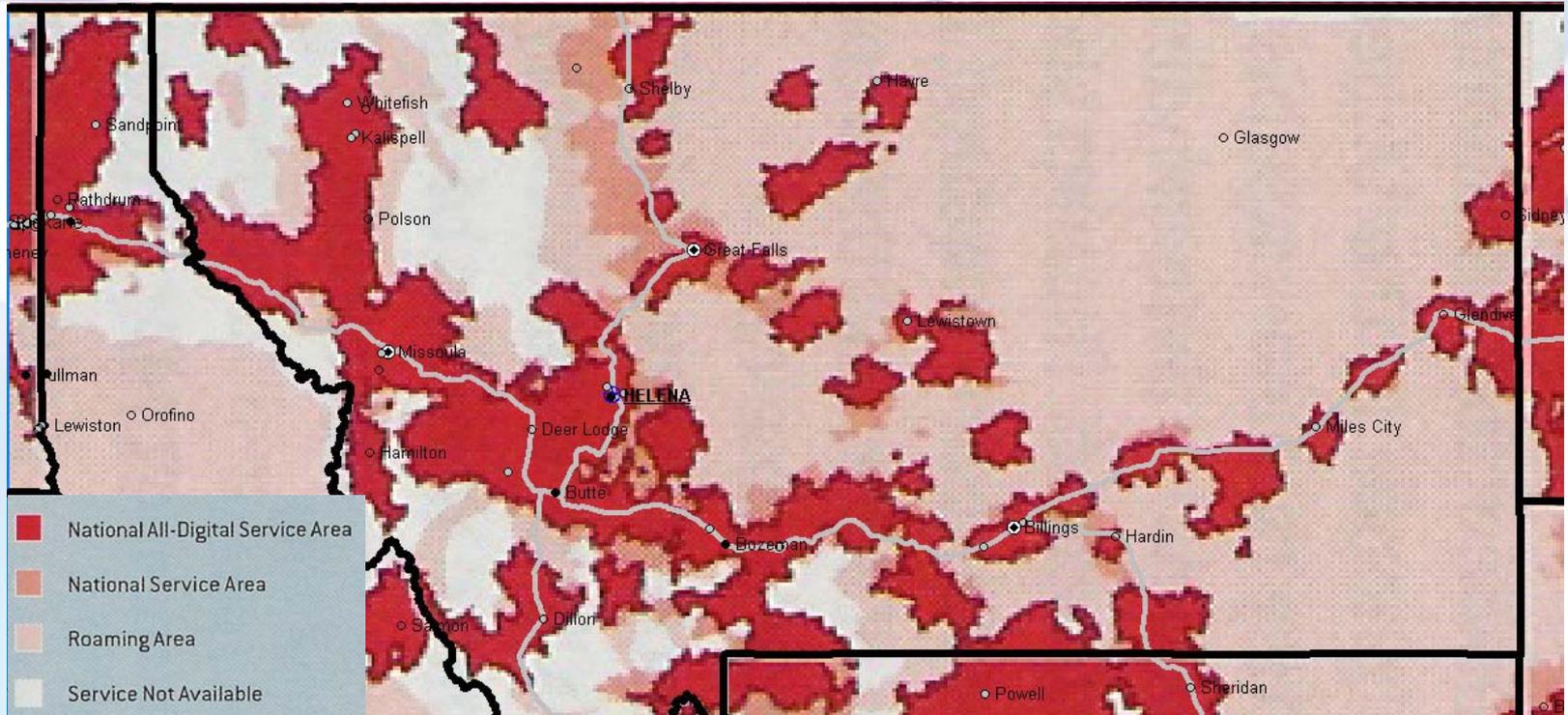


Best case coverage with
1/2 W handheld phone (75% area)

Source: Telecom Mapping Comp. and FCC ULS cellular database
with 25 mi diameter - assumes no topography or scatter losses

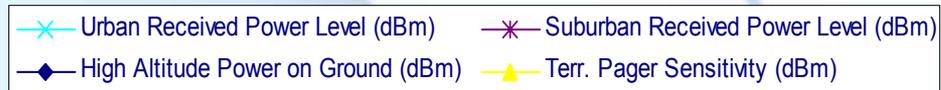
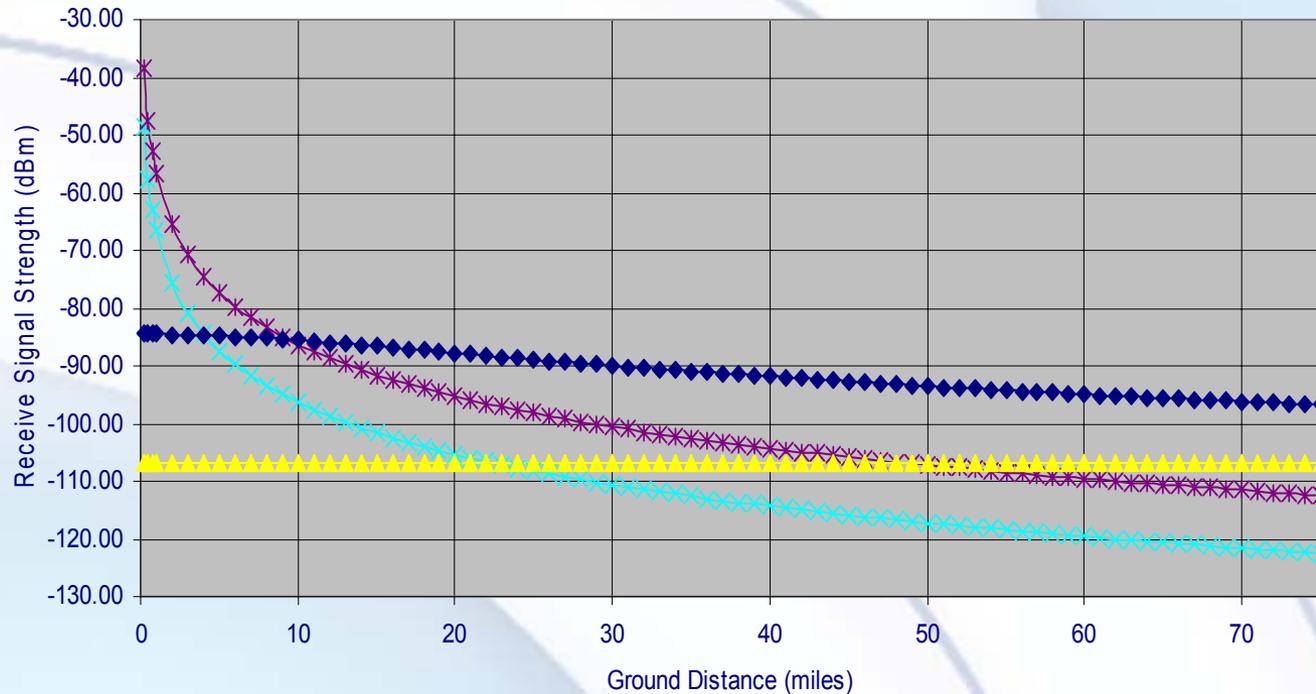
Real-World Example of Coverage Shrinkage

- Verizon's Coverage in Montana shows coverage reduction when 3W Analog (Roaming Area), was overlaid by 0.6W Analog (National Service Area), then was overlaid by Digital (National All-Digital Service Area)



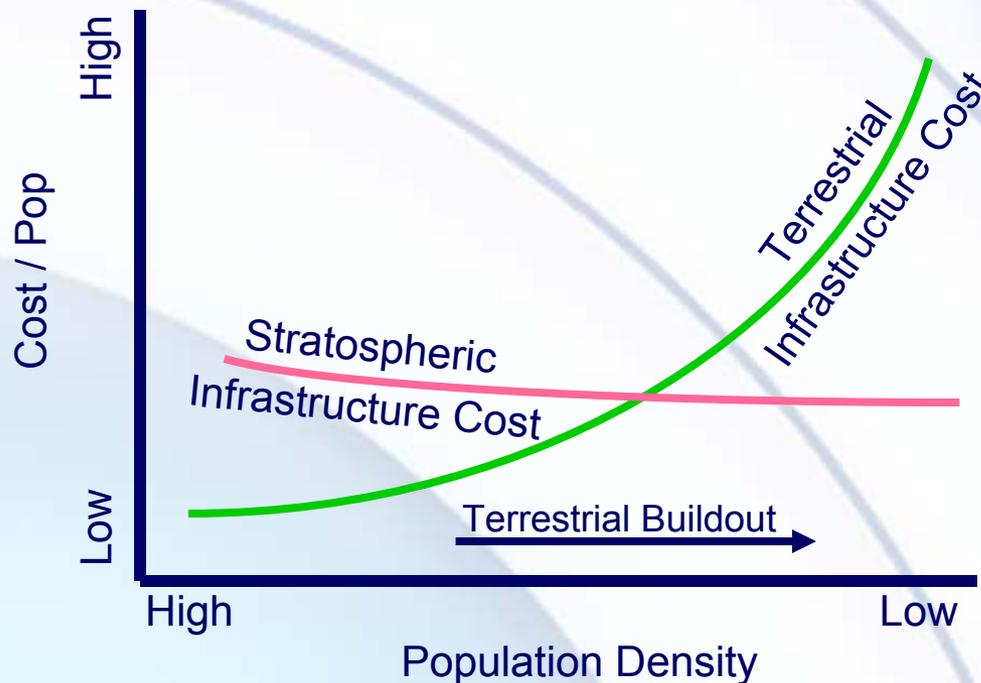
Propogations Difference Between Towers and Stratospheric Platforms

- Unlike towers: signal level is uniform / falls off slowly
 - Coverage radius 90-180 miles, 0 degree horizon = 390 miles



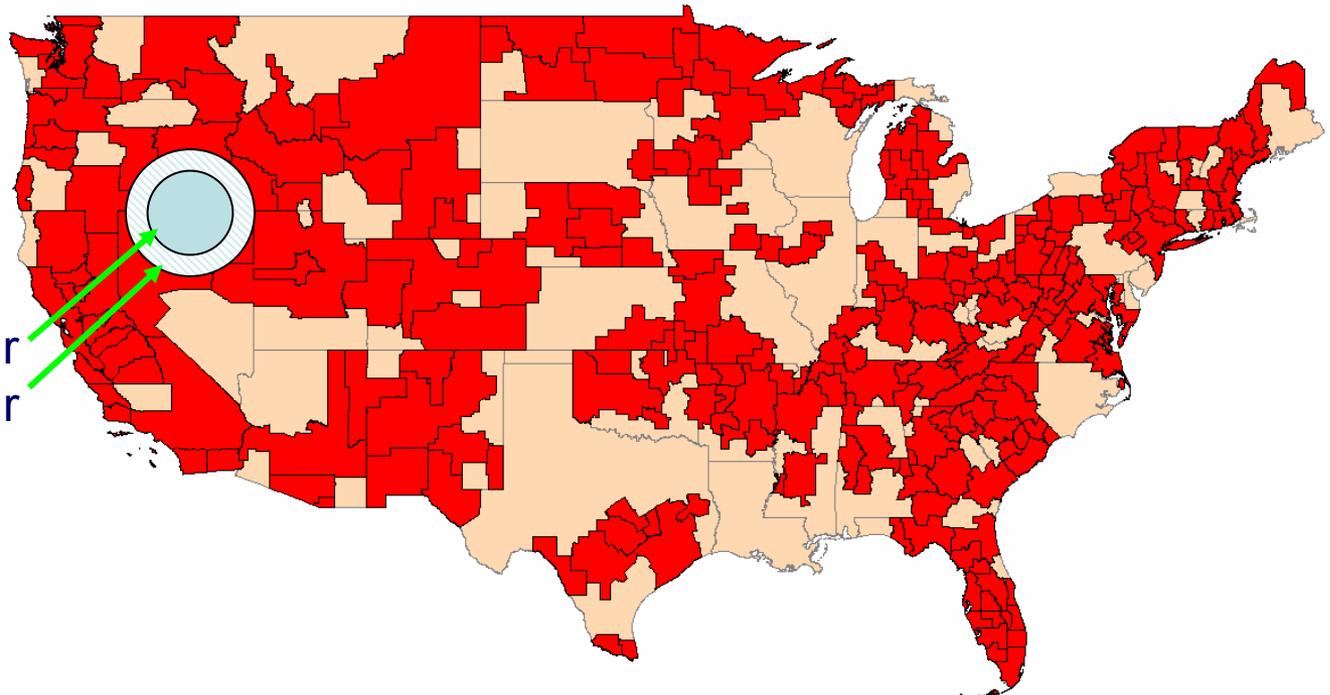
Complements Tower Coverage

- Tower cost / pop increases as pop. density decreases
- SkySite™ cost / pop increases as pop. density increases
 - Higher pop. densities require more power / capacity



Wide Area Licenses Needed

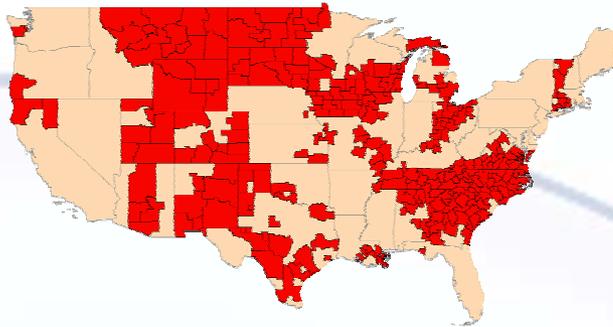
- Current PCS and Cellular licenses are too geographically fragmented by technology and ownership to operate
 - 493 Basic Trading Areas or 735 Cellular Market Areas



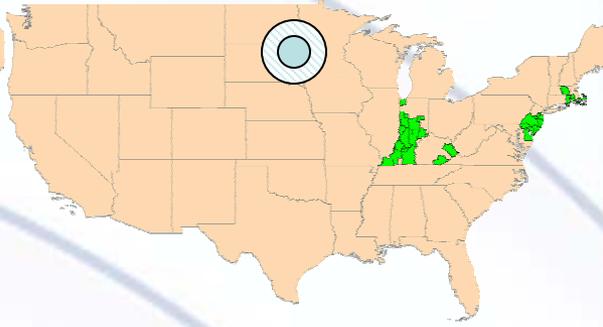
Service Contour
Interference Contour

Cellular Spectrum by Technology Deployed

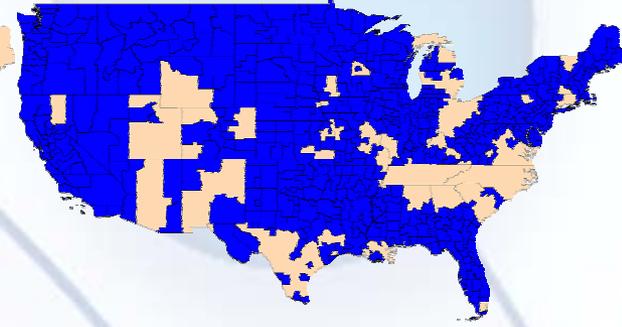
CDMA - A Block



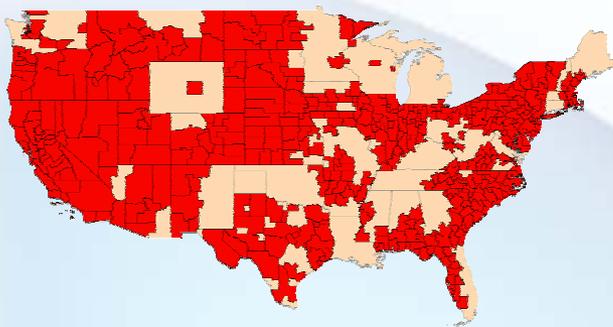
GSM - A Block



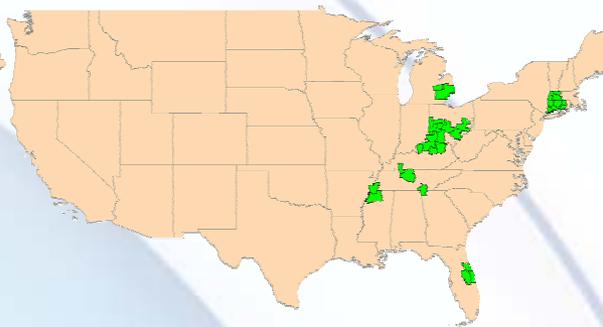
TDMA - A Block



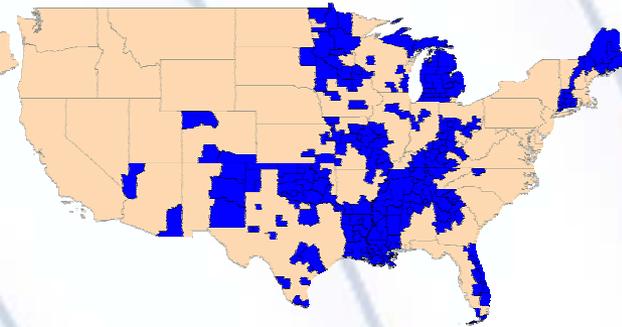
CDMA - B Block



GSM - B Block

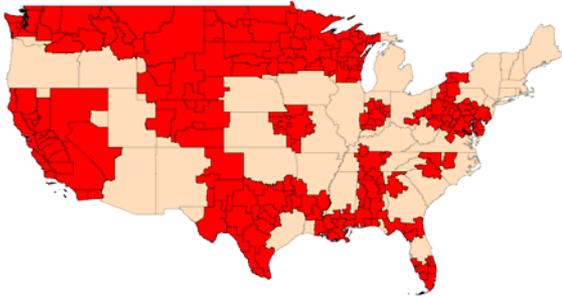


TDMA - B Block

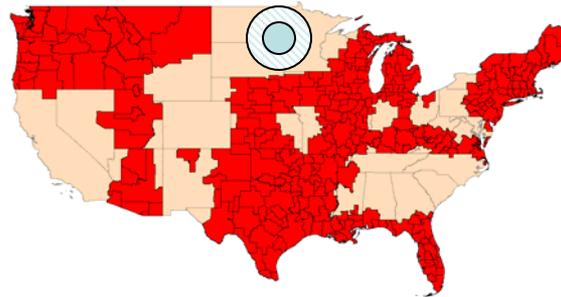


CDMA BTAs for BPCS Spectrum

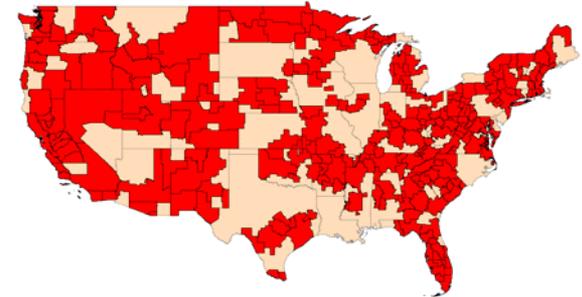
A Block



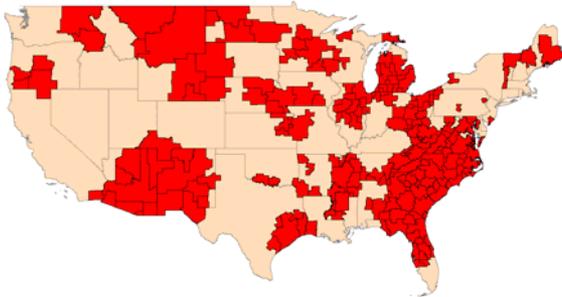
B Block



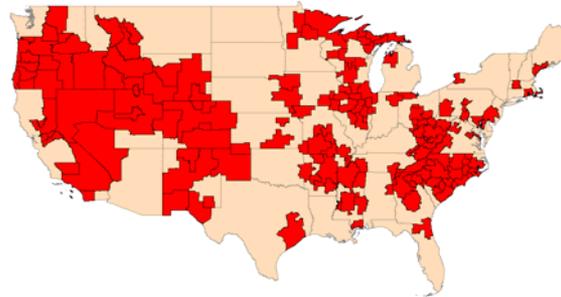
C Block



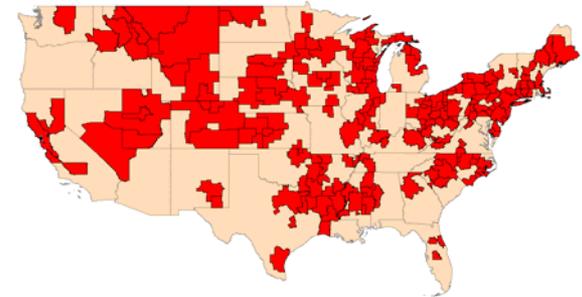
D Block



E Block

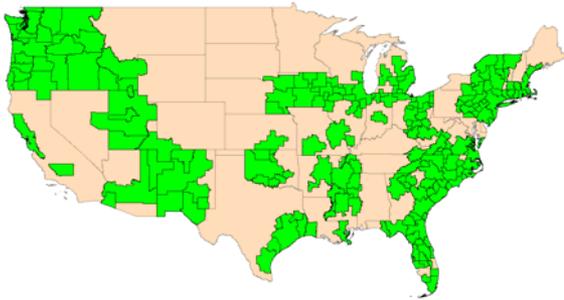


F Block

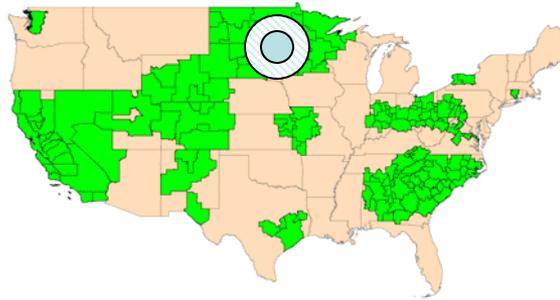


GSM BTAs for BPCS Spectrum

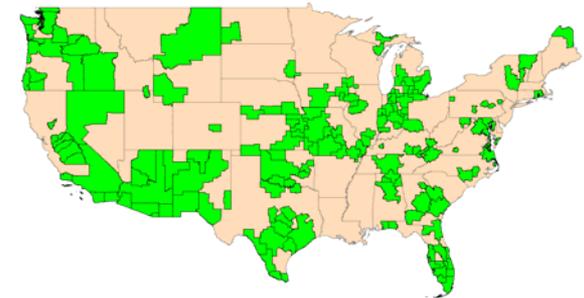
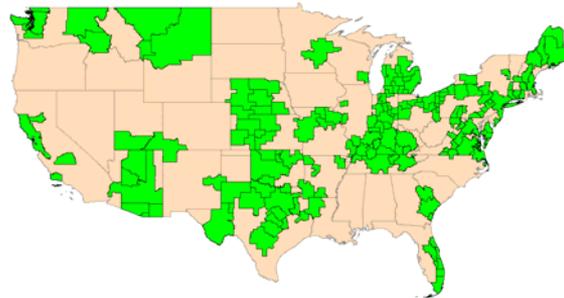
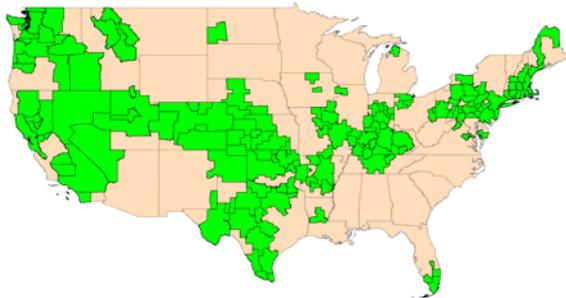
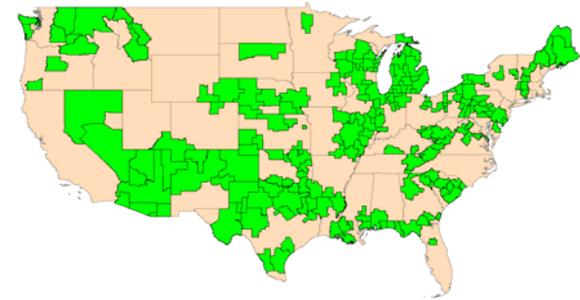
A Block



B Block

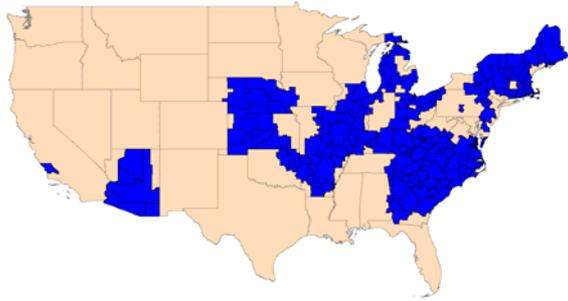


C Block

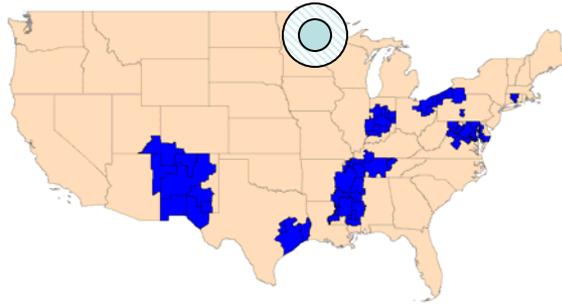


TDMA BTAs for BPCS Spectrum

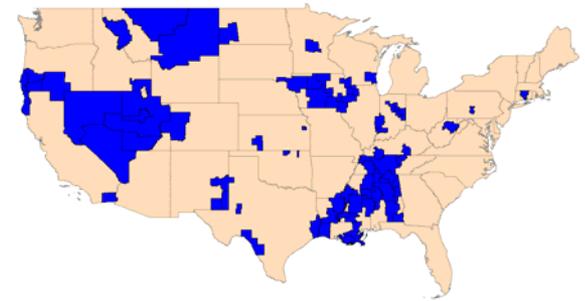
A Block



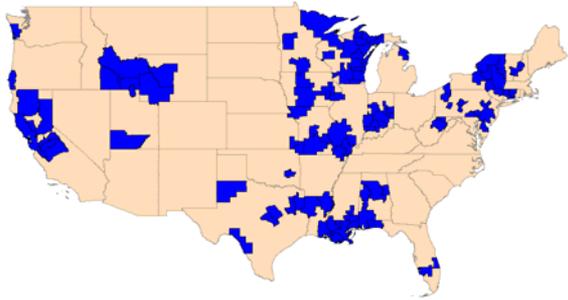
B Block



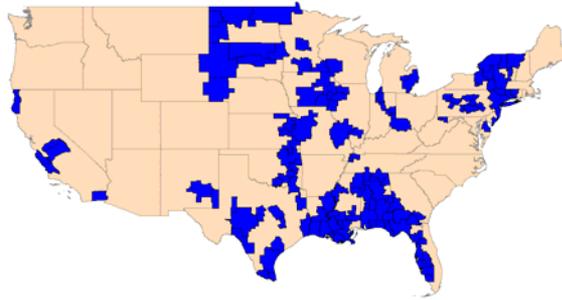
C Block



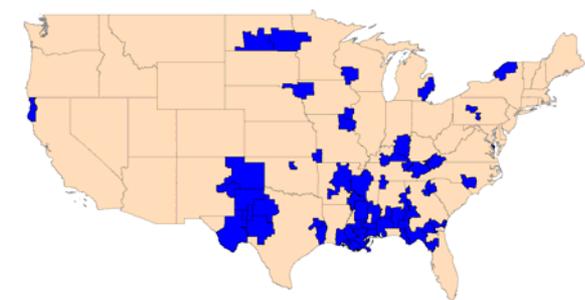
D Block



E Block

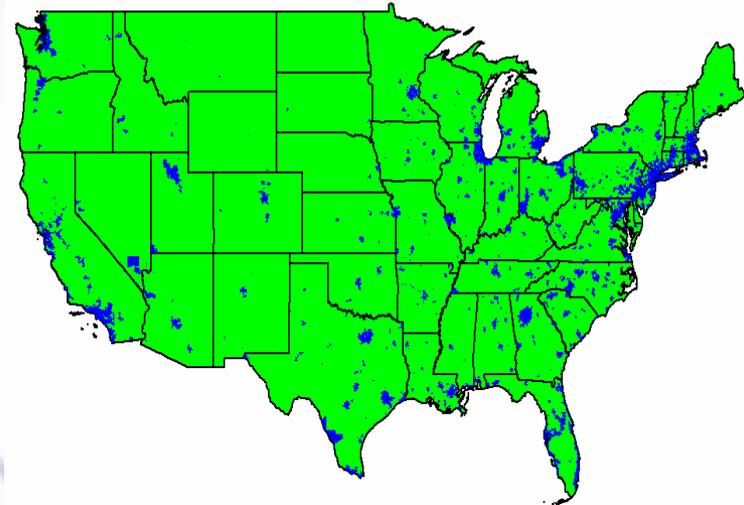


F Block



Most Spectrum Lies Fallow in Most Areas

- Carrier with 30 MHz of PCS spectrum uses less than 10 MHz outside suburbs leaving 20 MHz fallow in 95% of the land area
- Example: PCS carrier using CDMA minimum capacity sites (omni)
 - Assume: 2% blkng, 0.025 Erl/sub, 16 traffic ch / RF ch, 28 M total subscribers = 10% avg. mkt. pen.
 - 10 MHz = 4 RF channels / site = 64 traffic channels = 52.5 Erl = 2100 subs = 21,000 people / site
 - Coverage: radius = 5 miles
hex area = 65 sq. mi.
 - Pop. Density = 323 ppl / sq. mi.
 - < 5% of US land area



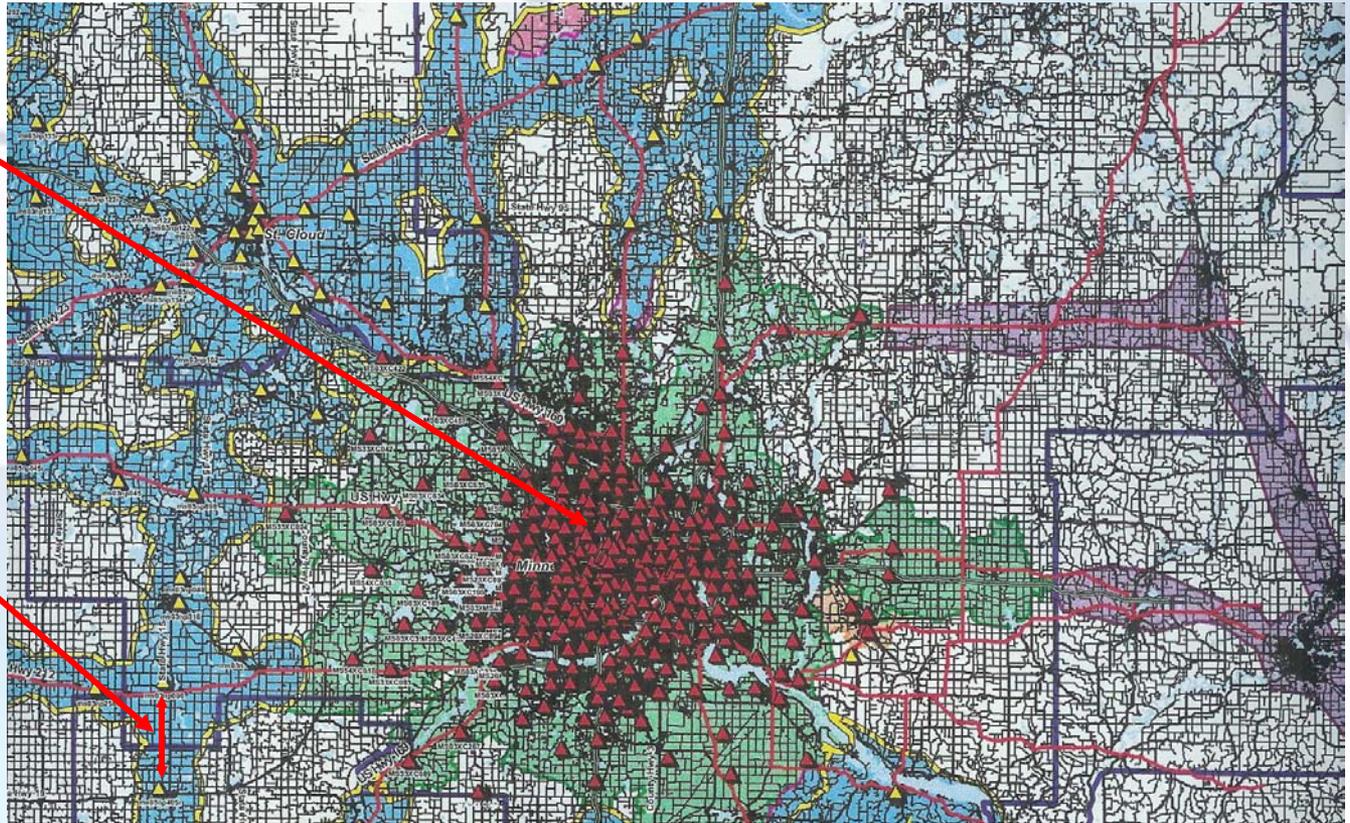
■ > 10 MHz Needed
■ > 20 MHz Fallow

Differences in Tower Densities Exist between Urban & Rural Areas

- Example of 1900 MHz CDMA coverage map

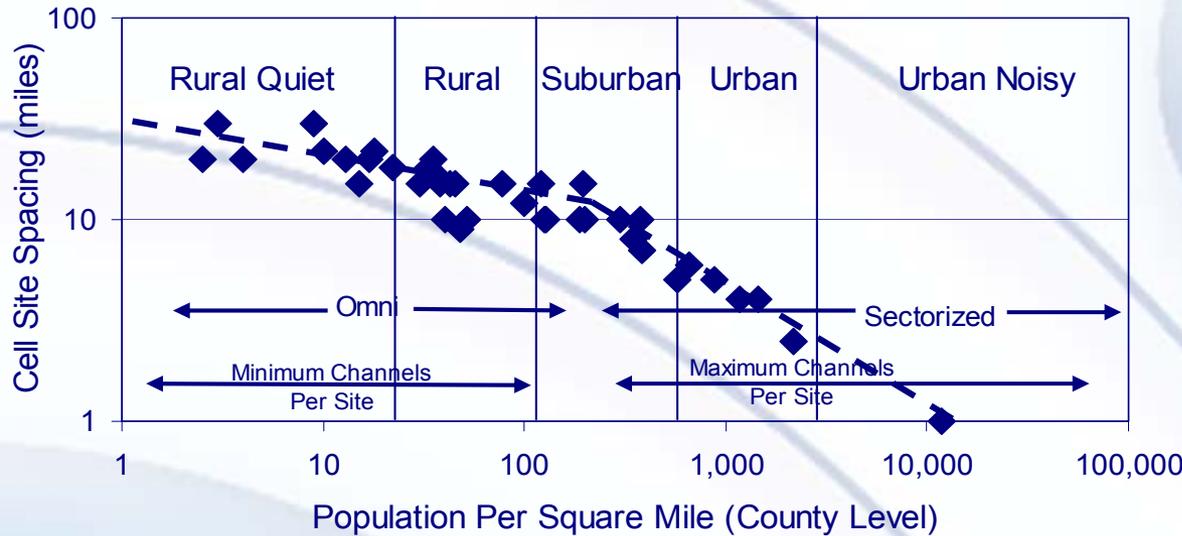
Fractions of a mile between towers in urban areas

10 Miles between towers in rural areas



Terrestrial Cell Site Spacing, Ambient Noise & Penetration Margin Vary by Pop. Density

Cell Site Spacing Versus Population Density



Rural Signals can be 21 dB lower than Urban

10 dB less building penetration loss

Urban : 18 dB

Rural: 8 dB

Market Type	Population Density Range (ppl/ sq. mi.)	Percent of Population	Percent of U.S. Area	Received Ambient Noise + Interference Floor
Rural Quite	0 - 20	3.7	49	-120 dBm
Rural	20 - 100	18.5	35	-118 dBm
Suburban	100 - 500	30	13	-115 dBm
Urban	500 - 2500	35.2	2.8	-107 dBm
Urban Noisy	2500 & up	12.6	0.2	-100 dBm

Summary statistics from the table:

- Rural Quiet and Rural: 22% of Population, 49% of U.S. Area
- Suburban, Urban, and Urban Noisy: 48% of Population, 3% of U.S. Area

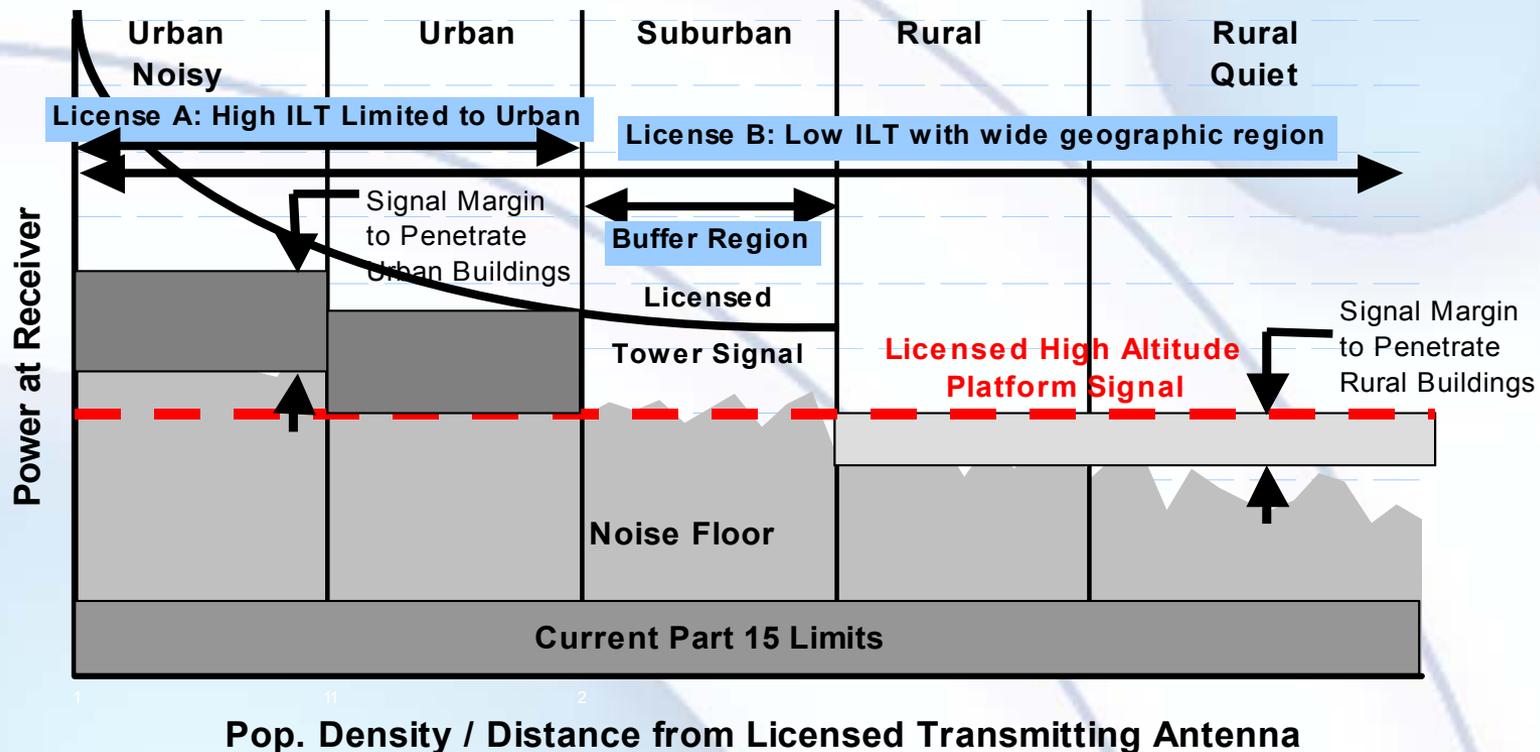
11 dB difference between urban and rural



Source: In the Matter of AirCell, Inc. Petition, Pursuant to Section 7 of the Act for a Waiver Of the Airborne Cellular Rule, Or In the Alternative, For a Declaratory Ruling, Dated October 9, 1997, page 46 and Appendix A page 25.

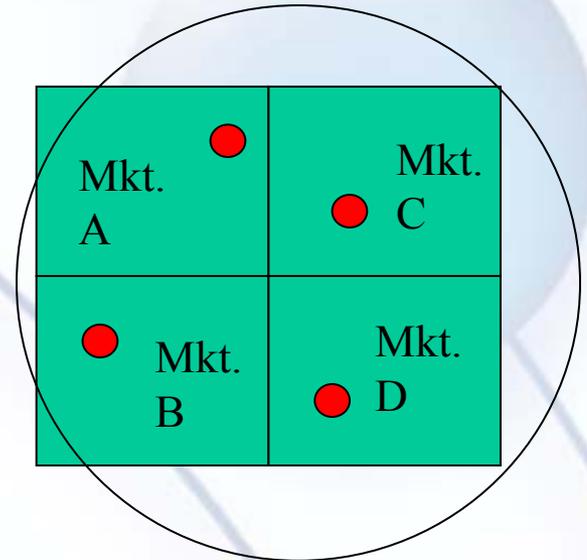
Potential to Share Spectrum between Rural and Urban Users

- License same spectrum twice using interference temperature



Proposed Interference Noise Temp. based Licensing Approach

- For instance, instead of one 30 MHz block, break into two and auction 10 MHz sub-block to two licensees who share the same channel
- Since auctioning 10 MHz twice, likely to result in higher auction proceeds



Market Area	Current Approach	Proposed Approach
493 BTAs	License 1: 30 MHz Block A in each BTA	License 1: 20 MHz Block A1 in each BTA plus 10 MHz Block A2 that is limited in high density areas only (i.e., where Population Density is > 500 ppl/sq. mi.)
Nationwide	None	License 2: 10 MHz Block A3 Nationwide

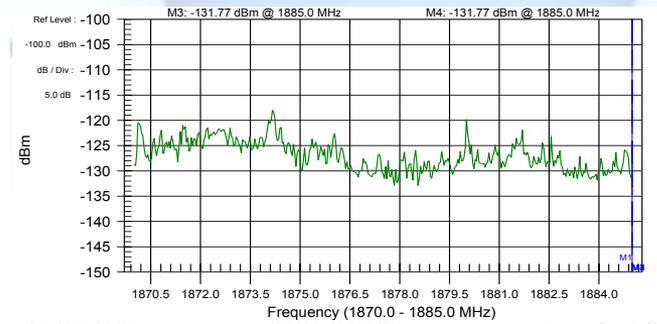
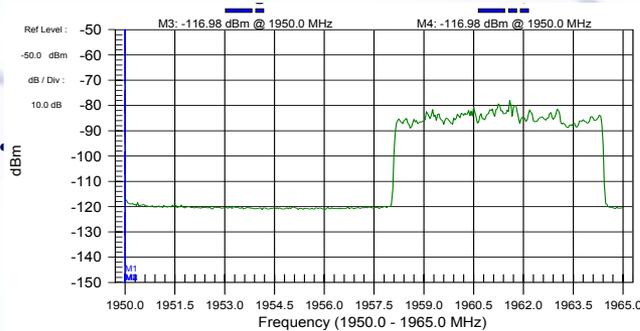
Technical Parameters are Key

- Need to split off enough spectrum for overlay to provide adequate capacity for fill-in service
 - Est. needs is 100 voice paths in 180 mi. diameter
 - Bandwidth required depends on reuse, vocoder ...
 - Less than terrestrial mobile system since fill-in only
- Need to define:
 - Power level at ground sufficient for rural users yet low enough so as not to interfere with licensee 1 in urban areas
 - Power control algorithm to ensure user devices on licensee 1 in urban areas do not interfere with licensee 2 reception
 - Likely same as currently being planned for CDMA
 - Changing from 800 Hz to 2 kHz power control updates increases CDMA capacity by 50%

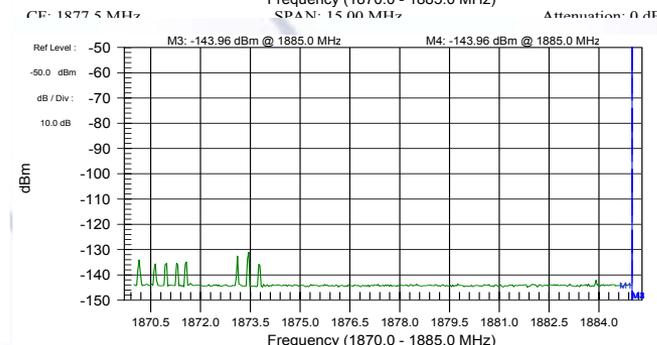
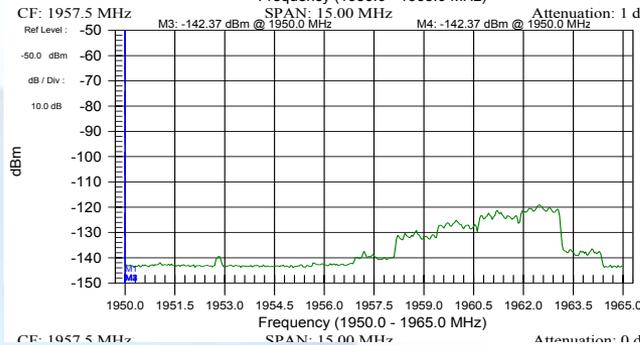
Current Power Control Approaches Adequate for Sharing User Band

- Spectrum Analyzer Plots from 60 miles SE of NYC at 29,000 feet altitude shows 6 CDMA channels deployed but no interference on user band

- In Times Sq.



- In The Air

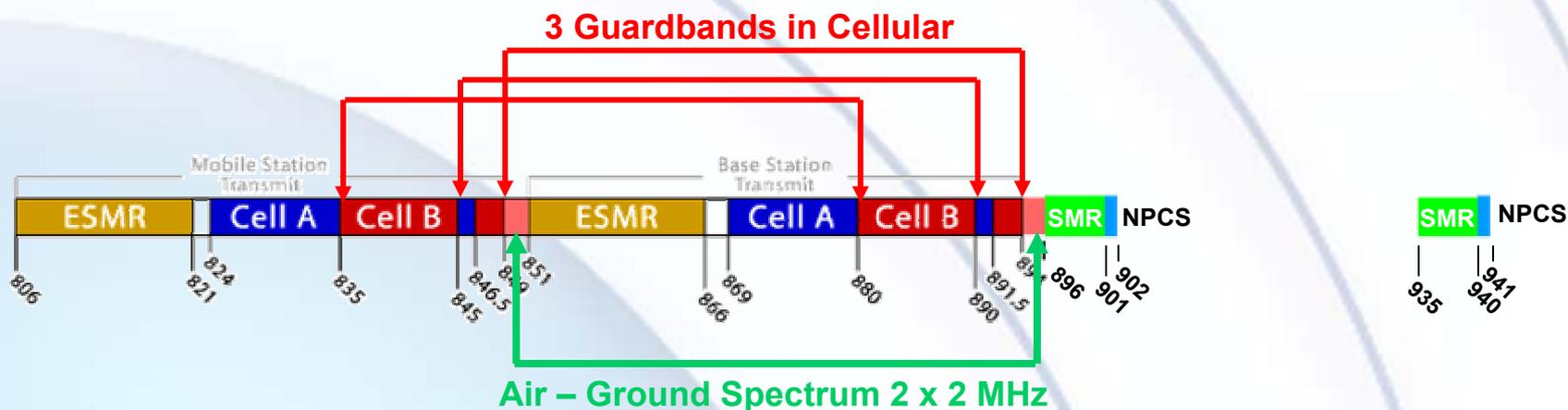


PCS B Blk. Fwd. Ch.

PCS B Blk. Ret. Ch.

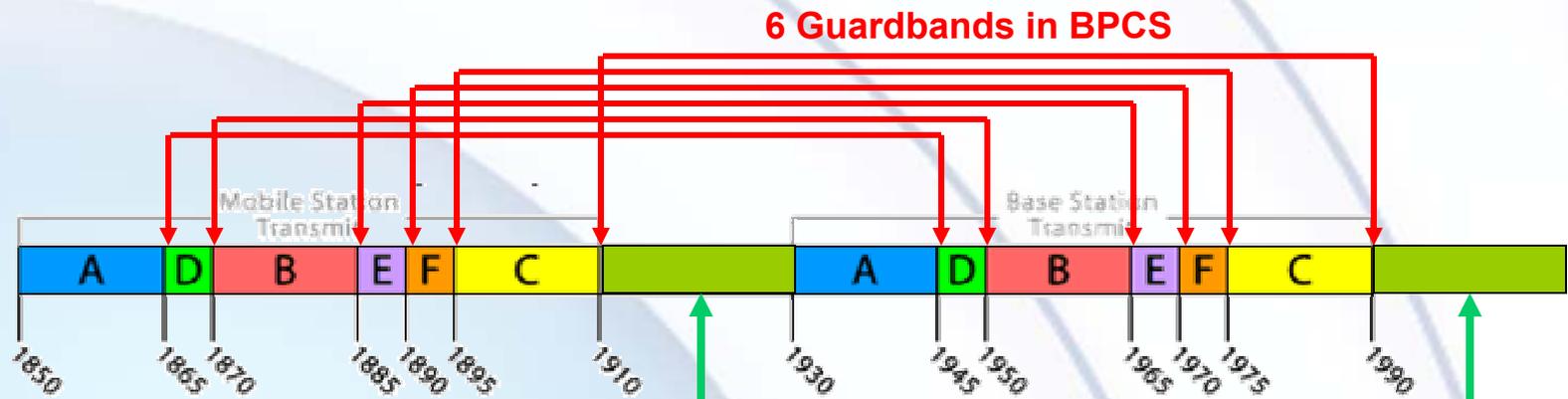
Guardbands + ATG offer Potential Spectrum

- Guard bands are useful as “landing strip” registration channels
 - Can be used without interference because uniform low level of high altitude signal at the ground
- Air-Ground spectrum is adjacent to existing device spectrum and thus relatively simple to modify devices to work
 - Nationwide Channels: up to 1 CDMA or 10 GSM



Guardbands + Unlic. PCS Spectrum for Existing Devices

- Guard bands are useful as “landing strip channels”
 - Existing user devices typically already tune to these freq.
 - Can be used without interference because uniform low level of high altitude signal at the ground
- Unlicensed PCS spectrum is adjacent to existing device spectrum and thus relatively simple to modify devices to work
 - Nationwide Channels: up to 15 CDMA or 100 GSM



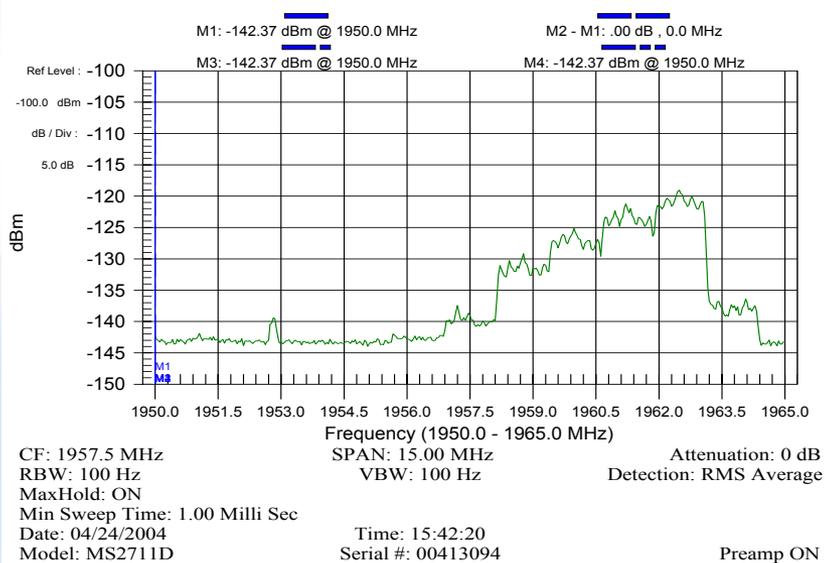
Unlic PCS / Adv Wireless Services Spectrum 2 x 20 MHz

Summary

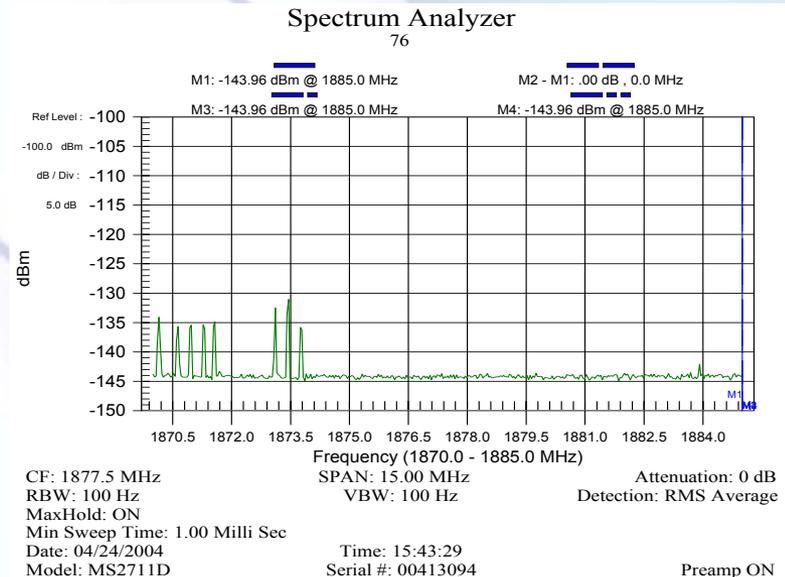
- After 20 years coverage gaps still exist
- Only foreseeable grand solution: increase tower height
- High altitude wireless platforms near commercial use in messaging as demonstration of platform capability
- High altitude platforms need wide area overlay licenses on existing (or at least adjacent) user subscriber bands
- Auctioning some frequencies twice on a sharing basis should bring in higher auction proceeds
- Opportunities exist to enable high altitude coverage by licensing low interference temperature nationwide overlays on otherwise fallow spectrum

Current Power Control Approaches Adequate for Sharing User Band

- Spectrum Analyzer Plots from XX miles SE of NYC at 29,000 feet altitude shows 6 CDMA channels deployed but no interference on user band



PCS Forward Channel



PCS Return Channel