Simulcast Forum XXI
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Simulcast – Antennas Patterns

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Antenna Patterns

- Antenna patterns
- Control interference through patterns
- Don’t guess, calculate
- Coverage versus interference
- Implementation
Audio Control

- Received decoded audio signals at the mobile device must be within 30 degrees of each other. How does this relate to timing?
  - Using 1000 Hz as a reference
    - $\frac{360 \text{ degrees}}{30 \text{ degrees}} = 12$
    - $1000 \text{ Hz} = 1 \text{ ms period}$
    - $\frac{1 \text{ ms}}{12} = 83 \text{ us}$
  - Note this is at 1000 Hz! At 2000 Hz the maximum is 42 us. At 200 Hz = 420 us
Coverage and timing

- Capture Effect
  - The ability of an FM detector to “switch” between one FM signal and other of different amplitudes
  - Narrower the deviation the less capture effect. Narrowband needs about 15 dB.

- Overlap areas are those where the receiver is not being “captured” by one transmitter. This is where managing the signal delay matters. It is not the distance between transmitters.
RF Signal Propagation

- RF travels at 5.4 microseconds per mile
- Seems like a short time but the miles add up!
  
  - 10 miles = 54 us
  - 20 miles = 108 us
  - What was our maximum delay difference? 83 us!
Definition of Units – Decibel (dB)

- A decibel is a convenient convention for the comparison of relative power levels
  - $10 \times \log_{10}(P_1/P_{Ref}) = \text{dB}$
  - $10 \times \log_{10}(0.001/1) = -30 \text{ dBW}$
  - $10 \times \log_{10}(0.001/0.001) = 0 \text{ dBm}$
- If you double the power you get 3 dB increase
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- Antenna gain conceptual diagram

Thanks to Chris Palmer of Greentree Communications for the graphic.
Real life antenna pattern

- Antenna patterns are complex

DB Spectra VHF Antenna

Unity Gain Pattern
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- How much protection or improvement are you really getting?

Sinclair Folded Dipole
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- Offset patterns only slightly helpful
- 800 MHz antennas can have sharper patterns
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- Higher frequency antennas often have higher gain, can make the problem worse.
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- Near Far Problem

Large signal from remote site
Small signal from local site
Math Time!

20 miles = 105,600 feet

3º - 3dB
10º - 10 dB
15º > -15 dB

If a unity gain antenna is used

0º = -6 dB
3º = -6 dB
10º = -6 dB
15º = -6 dB
45º = -15 dB

Distance = Tan (90-Ant Angle) X (Elevation)
Antenna Downtilt

- How much is enough? More than you think!
Antenna System

- Is your antenna vertical?
- Are you in a null area?
Does it make a difference?

- Downtilt clearly increases signal levels near the site. Signal difference plot 10 degrees of downtilt
Planning

- When performing coverage predictions use the correct pattern for your antenna
- Experiment with different antenna patterns
- Use antenna patterns, power levels, and timing to adjust the system
- Think about what will make the biggest difference to achieve 15 dB of level difference
- Talk to the antenna manufacturers about special antennas or things they might not have in their catalog
Questions?

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