Modeling and Analysis of the Interference Potential of Cognitive Radio Devices to Wireless Microphones Operating in TV bands

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2008 International Symposium on Advanced Radio Technologies
Boulder, Colorado
June 04, 2008
Cognitive Radios in TV Bands

- CR = Dynamic Spectrum Access
- TV bands = TVs & wireless microphones

Major roadblock:
Incumbents believe new unlicensed devices would interfere with their devices!
Why wireless microphones?

- Used by
  - Recording studios in TV Broadcast Stations
  - Organizers, performers in concerts, theaters
  - Commentators in sports events
  - Film production crews
- Deployed only for a short time
- Operate in arbitrary unused TV bands
- Thousands out there!
- Interference: audio quality is paramount
Research Goal

To analyze the interference that cognitive radios can cause to wireless microphones.
Traditional Interference Model
Area Loss Analysis: Traditional

![Graph showing Area Loss (%) vs. Interferer Distance (m)]
Cognitive Radio Interference Model
Area Loss Analysis: CR versus Trad.

![Graph showing area loss analysis between CR and Traditional methods.](image)
Results: Varying Interferer Power Levels

5 dB decrease in interferer power: 5-15% decrease in intf.
Results: Different Interferer Bandwidths

5 dB increase in CR bandwidth: 5-15% decrease in intf.
Results: Different Protection Ratios

5 dB decrease in protection ratio: 5-15% decrease in intf.
Protection Ratio – Maximum Area Loss Allowed

![Graph showing the relationship between Protection Ratio (dB) and Max Area Loss Allowed (%) for n=2 and n=4.](image)
Interferer Power – Maximum Area Loss Allowed

![Graph showing Interferer Power vs. Max Area Loss Allowed](image-url)

- **Interferer Power (dBm)**
- **Max Area Loss Allowed (%)**

- **n=4**
- **n=2**

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For < 5% interference, interferer bandwidth > 100 MHz
Detection Range Required – Maximum Area Loss Allowed

For < 5% interference, detection range > 3 times Ro
Inferences: Interference Reduction

- What the Cognitive Radio can do?
  - Improve system design (antenna, bandwidth)
  - Increase detection range
  - Implement power control

- Wireless Microphone System
  - More resilient systems
    (i.e. lower protection ratios)
Future Work

- Multiple interferers
- Network detection: Cooperative CRs
Conclusion

- Cognitive Radio devices can be deployed with minimal harmful interference to wireless microphones
- Requires modest sensitivity for detecting incumbent signals
- Better wireless microphones can help
Thanks for Listening.

Questions ?
Backup Slides follow...
Interference Contour Model

[Diagram of interference contour model with labels T(x,y), R₀, R₁, Rₜ₁, R_{det}, R (0,0), and I(S,0).]
Interference Contour Model

\[
R_T = R_I \left( K^{1/n} \left[ K \left( \frac{R_I}{R_O} \right)^n + 1 \right]^{1/n} \right)
\]

\[
K = \frac{P_t G_{tr} W_i S_{\sigma i} L_s}{Z P_i G_{ir} W_t S_{\sigma t}}
\]
Different Protection Ratios: Trad. Radio

![Graph showing area loss (%) vs. interferer distance (m) for different protection ratios (Z). The graph includes curves for Z=5, Z=10, Z=15, Z=20, Z=25, and Z=30.](image)