

Wireless Microphones and the White Spaces

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- Perspective on FCC Order
- Use Cases and User Expectations
- Interference protection mechanisms:
database and spectrum sensing
- Database requirements
- Spectrum sensing requirements



- Perspective on FCC Order
 - Commission should incorporate rigorous and transparent testing for hybrid geolocation/sensing devices
 - Commission should reject attempts to roll back wireless microphone protections (requirements for database use, sensing, power ceilings, adjacent channel conditions, exempt channels, channel designation for personal/portable devices)
 - Geolocation Database requirements must be tightened



Wireless Microphone Use Cases

- Electronic News Gathering (ENG), Sports, Entertainment Venues, Movie Making, Theaters, Schools, Houses of Worship, Meeting Rooms in Corporate, Government, and Public Facilities, and Law Enforcement Activities
- Additional Uses: Interruptible Fold Back (IFB) Monitors, In Ear Monitors, Wireless, Intercoms, and Wireless Assist Video Devices (WAVDs)





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FedEx Field

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The Majestic Theatre – New York City

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Hope Church – Memphis, TN

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User Expectations

- Wireless microphones are at the “front end” of the audio chain, so user expectations are very high
- Noise and dropouts are not tolerated
- Audiences demand crystal clear, real time, uninterrupted audio



More User Expectations

- The number of systems in simultaneous operation can exceed 200 for large productions (e.g., the Super Bowl™)
- Battery life: >8 Hours
- Transmitter antenna: Internal
- Mechanically rugged and reliable
- Operational lifetime: 5-10 years



Coexistence with TV Band Devices

4 Watts
BROADBAND



100 milliWatts
BROADBAND



“Fixed”



“Personal/Portable”

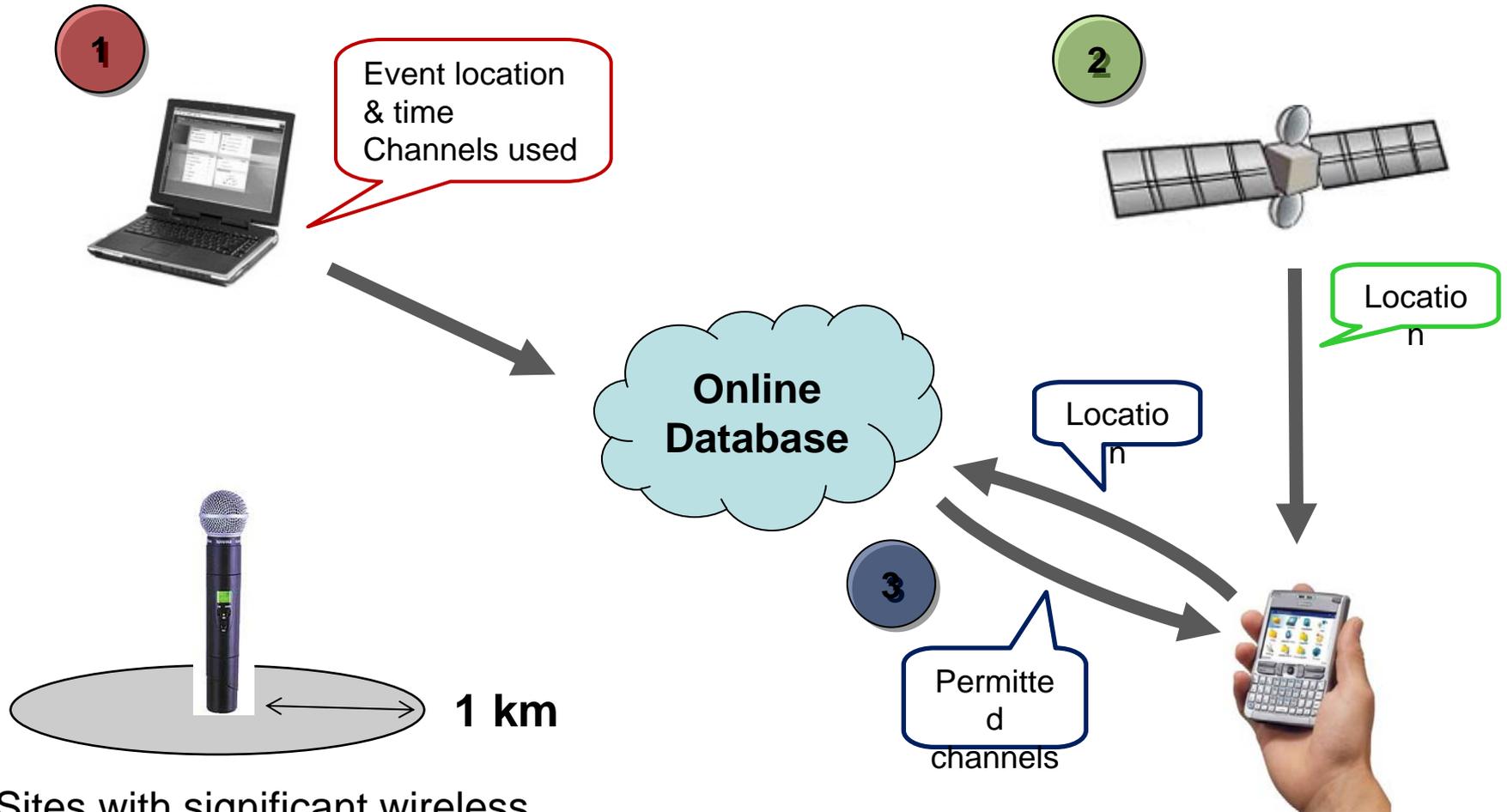


Interference Protection Techniques

- Geolocation + database
- Spectrum sensing
- Protected Channels
- Benefits from power limits, channel scheme, etc.



Geolocation + Database



“Sites with significant wireless mic use at well-defined times and locations”

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Database Concerns

- The database must protect all wireless microphone users without discrimination
- The database must be accurate and up to date!
 - If there are multiple databases, they must be synchronized frequently
- TVBDs must query the database at least once an hour or whenever there are changes
- TVBDs must shut down if they lose connectivity to the database



Geolocation Concerns

- Geolocation accuracy must be significantly better than 100m
 - An uncertainty of 100m is comparable to the working range of most wireless microphones
- TVBDs must shut down if they don't know where they are
 - Geolocation devices typically do not work indoors
 - “A man walks into a theater wearing a TVBD...”



Spectrum Sensing

- A TVBD scans spectrum at its location; detects and avoids TV & wireless mics
 - Must check TV channel for 30 seconds before transmitting
 - Must re-check TV channel once/minute
 - When a wireless mic is detected, the TVBD must vacate the channel within 2 seconds
- Future TVBDs could use spectrum sensing only, IF they pass more rigorous performance tests



Making Spectrum Sensing Work

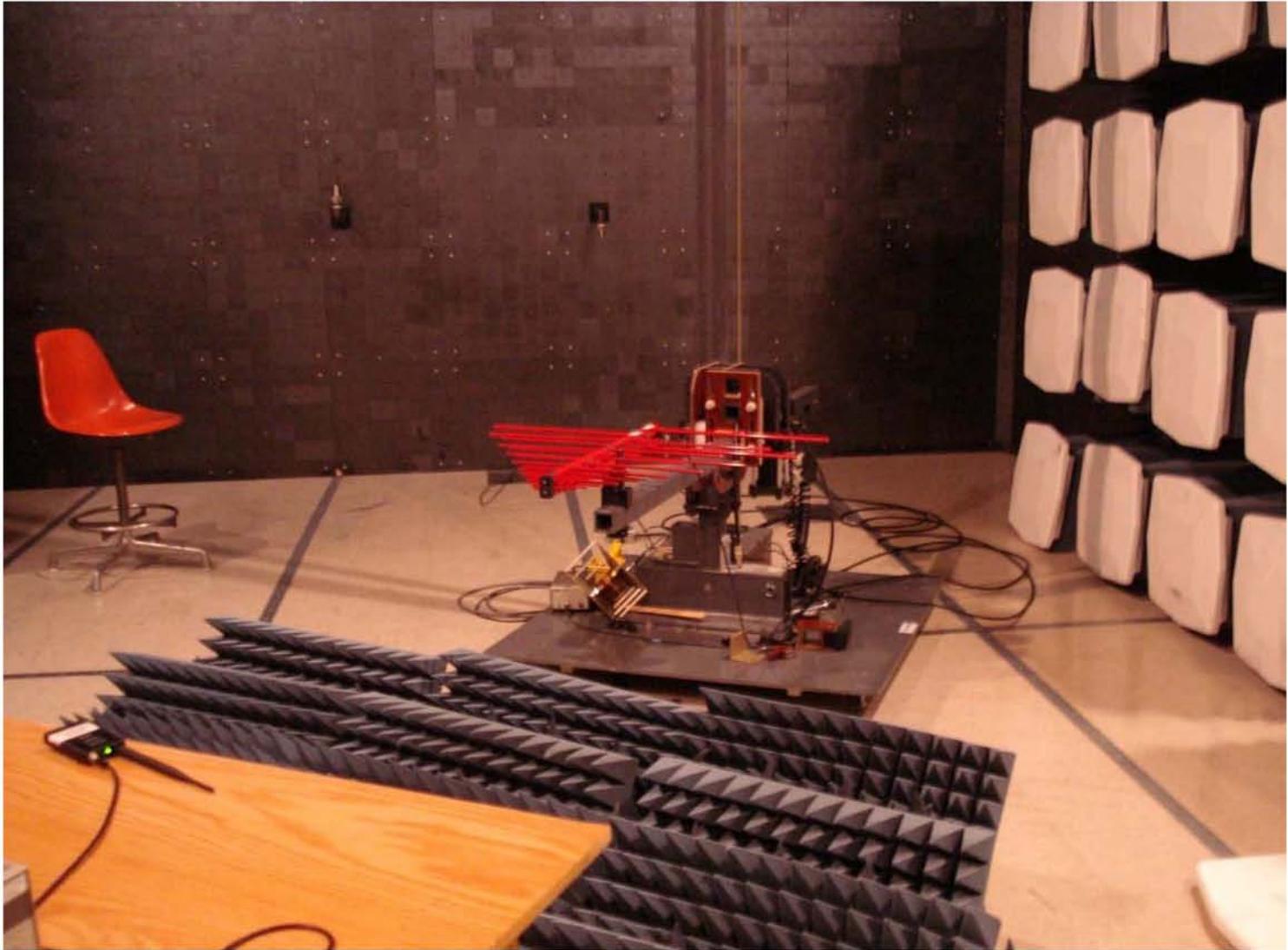
- Required sensing threshold: -114 dBm
- Appropriate sensing bandwidth: 200 kHz
- The sensing threshold requirement is determined by:
 - The required D/U ratio at wireless microphone *receiver*
 - The ERP of the TVBD in comparison to the wireless microphone
 - The ability of the TVBD to sense correctly in a channel that is adjacent to a strong DTV signal



Making Spectrum Sensing Work

- “Network” (cooperative) sensing is required to mitigate “hidden node” problems
 - The path between the wireless microphone and the TVBD is *not* reciprocal!
 - The wireless microphone transmitter and receiver are physically in different locations
 - The path from the wireless microphone transmitter to the TVBD may be obstructed





Making it work here in the lab is one thing...

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Making it work here in the real world is another!

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Protected Channels

- 'Protected Channel' = TVBD operation
 - Channels adjacent to occupied TV in lower VHF and 14-20
 - Two additional channels in 13 11 cities where Public Safety uses channels 14-20
- Some wireless microphone use will migrate to these protected channels when feasible BUT, these channels are entirely inadequate to support all existing uses



Summary

- Making use of the TV “White Spaces” is a noble goal, *but*
- It’s tricky to implement without causing interference to important incumbent services!
- The FCC has adopted a reasonable framework that requires the use of both Geolocation/database and spectrum sensing techniques

