Cognitive Radios In TV “White Spaces”

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Outline

• “White Spaces”: what, why and when
• Cognitive Radio: applications to TV white spaces.
• Technical Challenges:
  – Sensing and Protocols
• Industry initiatives: IEEE 802.22 & White Space Coalition
• Philips’ involvement
• Conclusions
“White Spaces” In TV Bands

• What are “white spaces”?
  – “Gaps” in frequency-band that will be available when broadcasters give back their analog frequency allocation.

• Why are they useful?
  – TV frequencies have excellent propagation characteristics
    • Well suited for long-range wireless networks.
  – Potential Applications: Rural broadband access.

• When will it be available?
  – February 17, 2009: when transition to digital is complete.

Source: New America Foundation
Availability of “White Spaces” In TV Bands

- Enormous benefits especially for rural areas.
- Unlicensed usage of these bands could lead to an explosion of new applications.

<table>
<thead>
<tr>
<th>Market</th>
<th>No. of Vacant Channels Between Chs 2-9</th>
<th>Percent of TV Band Spectrum vacant After DTV Transition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houston, Texas</td>
<td>17</td>
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<tr>
<td>Minneapolis, Minnesota</td>
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<td>Charleston, West Virginia</td>
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<td>Fresno, Montana</td>
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<td>Columbia, South Carolina</td>
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<td>70%</td>
</tr>
<tr>
<td>Biloxi, Louisiana</td>
<td>22</td>
<td>48%</td>
</tr>
</tbody>
</table>

Source: New America Foundation

Cognitive Radio

Cognitive radio =

flexible re-configurable radio

("quickly adapts transmission characteristics")

+ smarts

("aware of spectrum usage in vicinity, makes intelligent decisions on that basis, and reacts to evolving FCC policies")
Incumbents and Spectrum Sensing

• Incumbents in TV bands:
  – TV broadcasting, using 6 MHz channels (primary users).
  – Wireless microphones, regulated by Part 74, using 200 kHz bandwidth (licensed secondary).

• Spectrum Sensing
  – Periodically and dynamically monitors spectrum to determine availability for use by unlicensed devices on a non-interfering basis.
  – Availability determined by incumbent signal level falling below a predetermined “sensing threshold”: -116 dbm for TV (30 dB below threshold of visibility).

Incumbents have to be protected at all costs

Industry Initiatives: (a) IEEE 802.22

• IEEE 802.22 PAR: “develop a standard for a cognitive radio-based PHY-MAC interface for use by license-exempt devices on a non-interfering basis in spectrum that is allocated to the TV Broadcast Service”.

• Wireless Regional Area Network (WRAN): range: 33 – 100 km, data rates 4 – 20 Mbps.
  • Professionally installed, fixed CPEs.
  • Started in 2005, due for completion in 2008.
  • Broadcasters as well as equipment providers involved.
## Industry Initiatives: (b) White Space Coalition

- Companies: Philips, Microsoft, Google, Dell, Intel etc.
- Objective: Petition FCC to allow the use of *personal/portable devices in the TV white spaces.*
- Applications: whole-home coverage for video streaming etc.
- Status: 2 prototype devices submitted to FCC for testing, one by Microsoft and one by Philips.
  - Results for Philips: “The test results verify the ability of the prototype to reliably detect television channels occupied with DTV signals down to the specified level of -114 dBm.” OET report, July 31, 2007.
- Ongoing field tests to demonstrate sensing ability

## Philips’ Involvement

- Active participant in IEEE 802.22: working draft based on Philips’ proposal.
- Key player in the White Space Coalition: only prototype device tested thus far to meet or exceed specified sensing thresholds.
- Awarded the following:
Conclusions

• TV White Spaces offer an unprecedented opportunity to test new spectrum polices that will change the way future spectrum is allocated.
  – Move away from the existing licensed/unlicensed split to more flexible spectrum use.
• Evolving cognitive radio technology will enable new applications to utilize the increased available spectrum in an optimal way.
  – Match radio resources to application needs.
  – Better interference management.