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The Debate over TV "White Space" Spectrum

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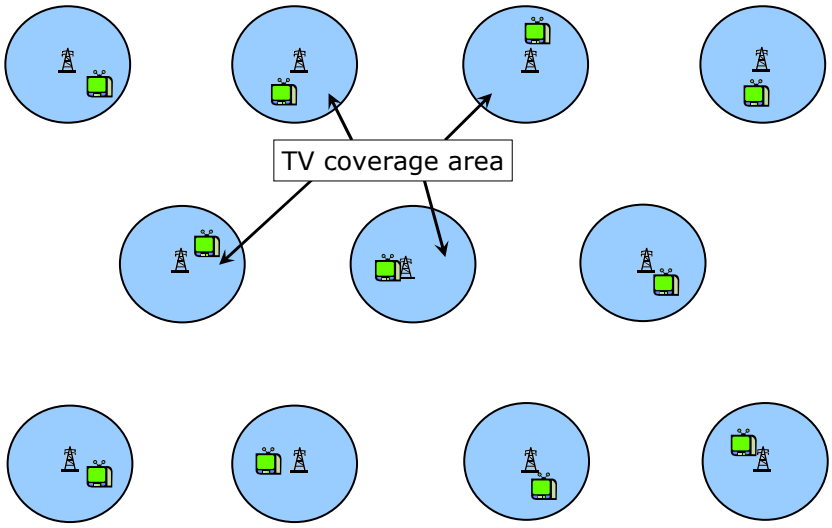
White Space



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TV Bands as a Home for Cognitive Radio

- TV has outstanding properties for spectrum sharing
  - TV transmitter locations are fixed and known
  - TV modulation schemes are known and homogeneous
- And poor properties for spectrum sharing
  - For some applications, it is possible to increase noise with *no* adverse effects whatsoever
    - e.g. fixed transmitter, fixed receiver, current SNR >> receiver threshold
  - But this is problematic with TV
    - Broadcast locations and power are set
    - Broadcasters and viewers hope for maximum coverage area.
- How do we balance a desire to let devices operate in the white space with a desire to protect TV coverage area?
  - Allowing transmitters into a band always causes interference
  - **When does *interference* constitute *harmful interference* to TV?**

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Tradeoffs: A Quantitative Example (from Peha & Igarashi, 2005)

- Assume TV towers are
  - as close together as regulations allow
  - transmitting at max allowable power
  - analog NTSC
- Build cellular system in the white space
  - Minimum cell size = 1.7 km^2
  - 3-cell-reuse pattern, no sectorization
  - 33 connected subscribers per km^2
  - Design parameters selected to minimize impact on TV while serving cellular subscribers.
- Consider only co-channel interference

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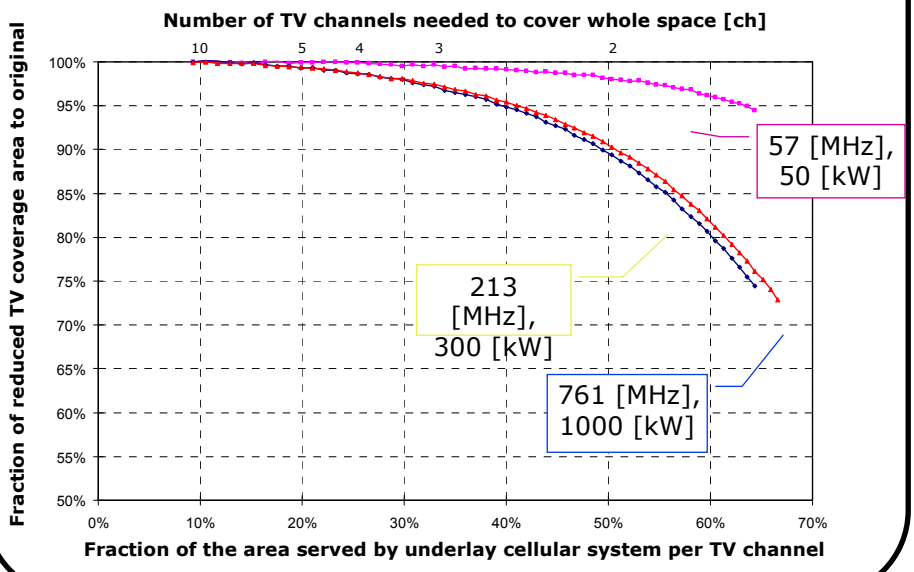
Tradeoffs: A Quantitative Example



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Tradeoffs: A Quantitative Example

- At 213 MHz, if cellular operates in one third of area, TV coverage is reduced by 3%
- The good
  - Three "full" 6 MHz TV bands can cover almost the entire area
  - Assuming 10 kHz voice channels, this would require 1.7 MHz of dedicated spectrum.
- The bad
  - Roughly 3% of households lose TV service
- Is this trade good or bad?

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Not Just TV

- There are other co-channel interference concerns
  - Wireless microphones
  - In select municipalities, public safety communications systems
    - More problematic for portable/mobile secondary devices
    - What will secondary applications be?
  - In channels 2-4, TV interface devices
    - e.g. VCRs, DVD players, cable set-top boxes
- Interference concerns in adjacent channels
  - Other TV bands
  - radio astronomy

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The FCC Will Decide the Issue

- May 2004 NPRM
  - FCC asks whether unlicensed devices should be allowed to operate in TV white space
- October 2006 First Report & Order / FNPRM
  - FCC rules that low-power devices can operate in the white space after the DTV transition (Feb 2009). Not before.
  - Perhaps still time to change this policy decision, if they wish.
- The FCC left many issues unresolved
  - Will secondary systems be licensed or unlicensed?
    - Unlicensed could allow more devices, greater spectrum utilization
    - Licensed could allow interference protection, guaranteed QOS
  - How will secondary systems avoid interference with TV?

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Interference Avoidance Approaches

- Users check locations
  - Device locations placed in public database when deployed
  - Device-owners can be contacted to tear down system where necessary
- Devices check locations
  - Device has GPS
  - Database that indicates where access is possible
    - Must check database periodically?
- Dynamic sharing using cognitive radio
  - Device senses environment, estimates interference, determines whether transmission is possible

- What are the exact technical requirements for secondary devices?
- How well will this work?
- What should the FCC do?

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Today's Panel

- Kiran Challapali, Philips Research
- Bruce Franca, Association for Maximum Service Television (MSTV)
- Chuck Jackson, Jackson Telecom Consulting
- Kyute Lim, Georgia Institute of Technology
- Jon Peha, Carnegie Mellon University

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