Using the identifying information of Section 15.711(e) to facilitate coexistence of incompatible whitespace protocols

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Key Language from 08-260

- 15.711 (e)
  - "Fixed TVBDs shall **transmit** identifying information. The identification signal must conform to a standard established by a recognized industry standards setting organization. The identification signal shall carry sufficient information to **identify the device** and its **geographic coordinates**."
- 15.713 (e1)
  - "Fixed and Mode II TVBDs must provide their **location** and **required identifying information** to the TV bands **database** in accordance with the provisions of paragraph (b) of this section."

Assumptions

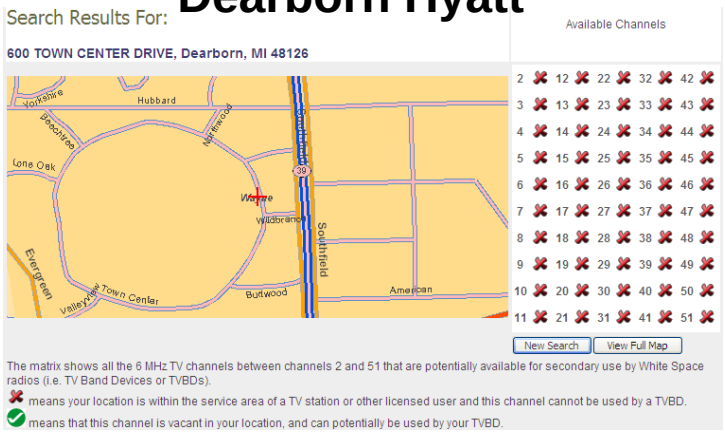
- If a device broadcasts information according to yet to be specified 15.711 (e) standard, it could also be recovered
- If a device can send information to the database, could also receive information

Quick Simulation Notes

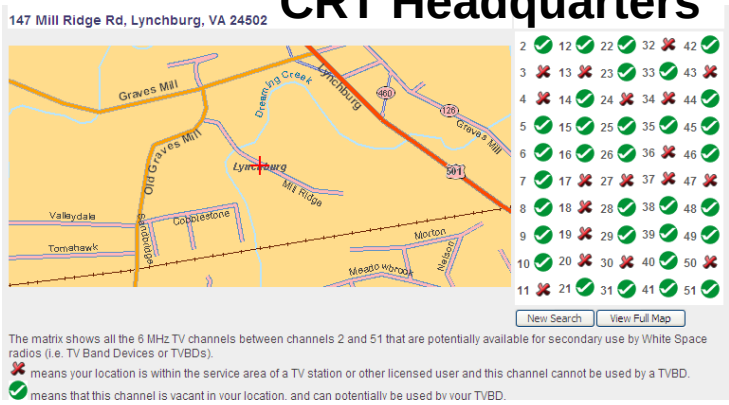
- Channel choices don't correspond to a particular location
  - Hyatt has no white space!
  - 32 km of border
- Algorithms / math
  - Distributed greedy non-cooperative algorithm
  - See J. Neel, "Synthetic Symmetry for Cognitive Radio Networks," SDRF 07.
  - Don't think presentation takeaways are specific to algorithms
- Lots of simplifying assumptions in simulation model
  - Not looking at physical implementation details
  - Intended value is emphasis on information value

Screen caps from ShowMyWhiteSpace.com

Dearborn Hyatt

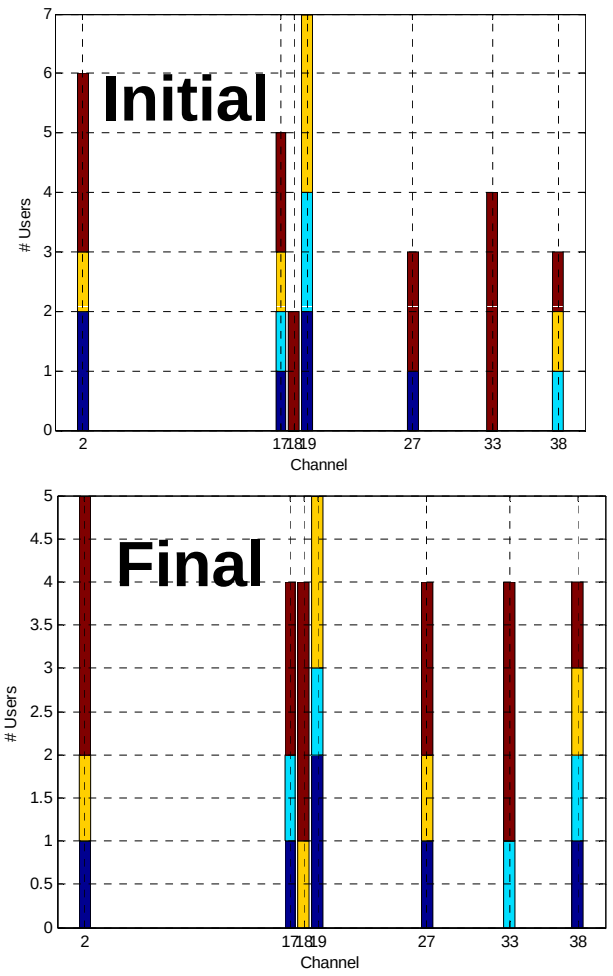


CRT Headquarters



Sharing among similar networks

- Assume it doesn't matter which class of devices operate in the same band
  - 4 classes of devices
  - 7 channels
  - 30 devices
- ID sufficient to equally distribute channels in close range



Dissimilar Networks

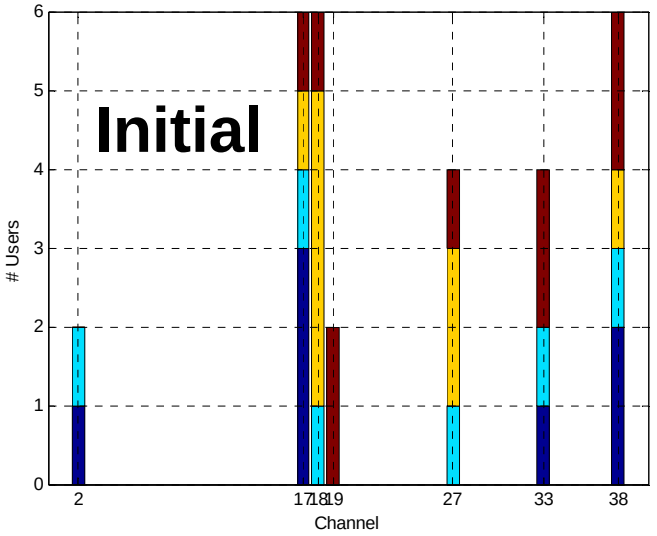
- Not all networks coexist well
  - Polite with aggressive spectrum use
- Assume IDs are sufficient to identify device class

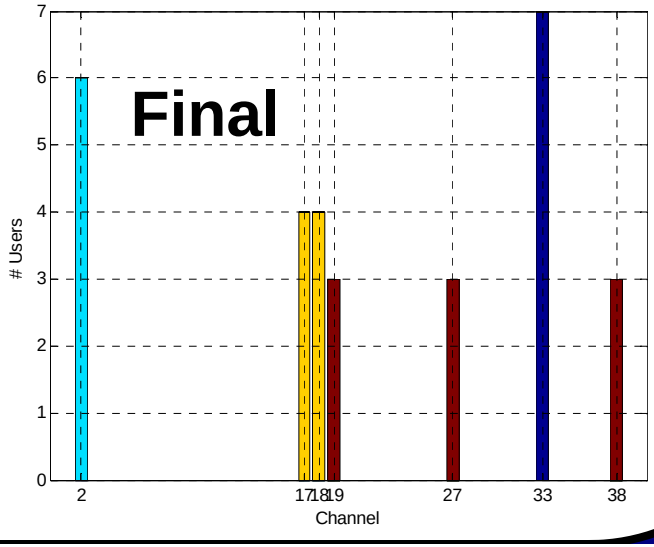
$$A = \begin{bmatrix} 1 & \varepsilon & \varepsilon & \varepsilon \\ \varepsilon & 1 & \varepsilon & \varepsilon \\ \varepsilon & \varepsilon & 1 & \varepsilon \\ \varepsilon & \varepsilon & \varepsilon & 1 \end{bmatrix}$$

class (columns) / type (rows)

$$\varepsilon = 0.01$$

- Intuition – indifferent to being in band with 100 of same type or 1 of different type
- Easily self-segregate
  - Not necessarily equitable
  - Assuming protocol-specific coexistence protocol for timeslot management



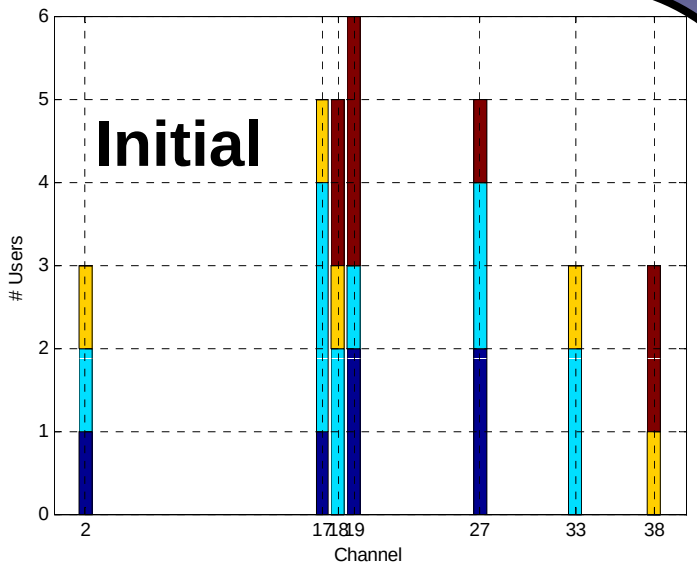


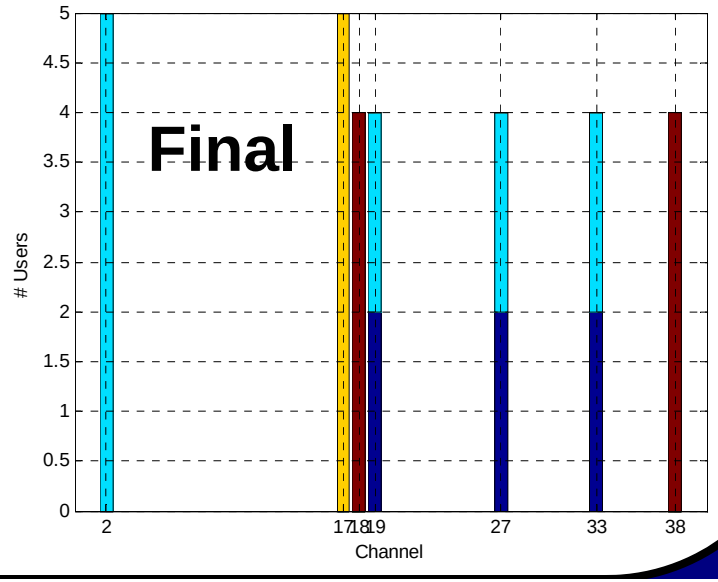
Mix of similar and dissimilar networks

- Assume some dissimilar networks coexist well
  - e.g., a common 802 coexistence standard

$$A = \begin{bmatrix} 1 & 1 & \varepsilon & \varepsilon \\ 1 & 1 & \varepsilon & \varepsilon \\ \varepsilon & \varepsilon & 1 & \varepsilon \\ \varepsilon & \varepsilon & \varepsilon & 1 \end{bmatrix}$$

$$\varepsilon = 0.01$$

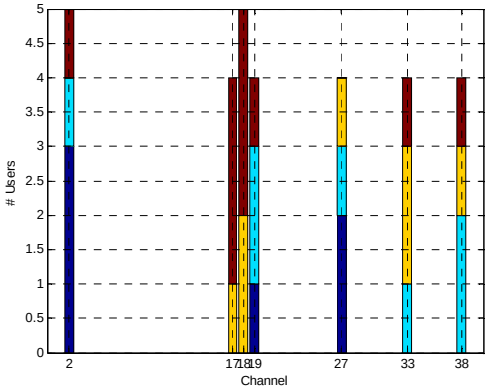




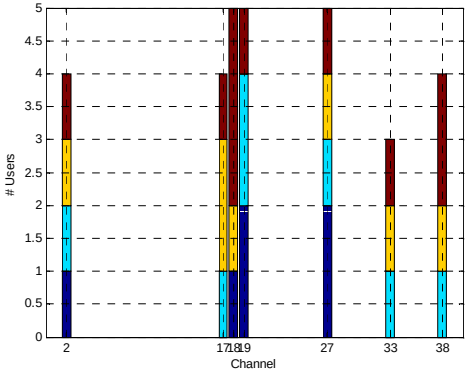
Location helps reduce interference

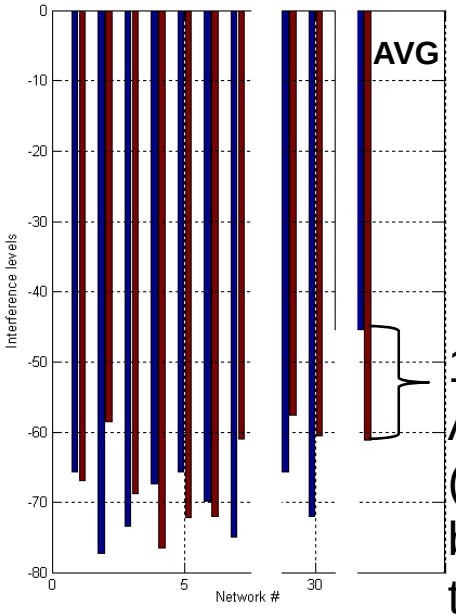
- Use location information to ensure frequency reuse
  - Minimize co-channel interference
- Could be explicit
  - Location ID
- Could be inferred / done implicitly
  - Received power and known
  - Generally less accurate than providing location

ID Only (No classes)

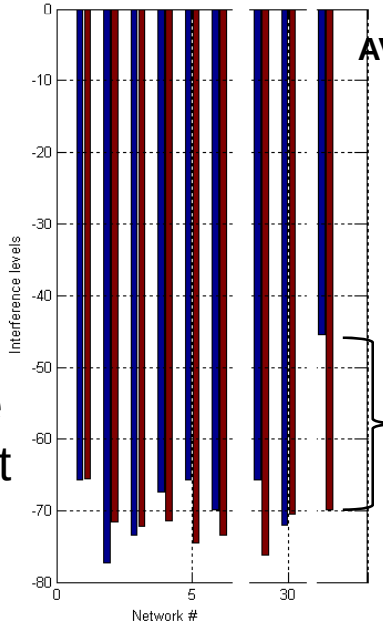


Location + ID without classes





15 dB Average (may not be typical)

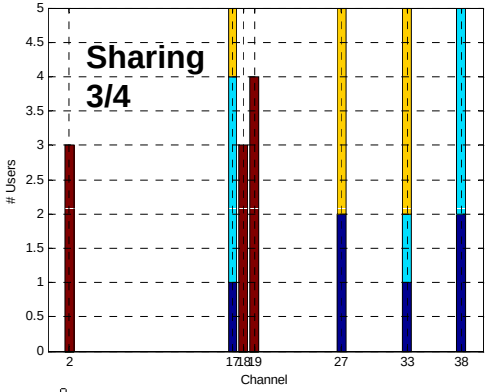


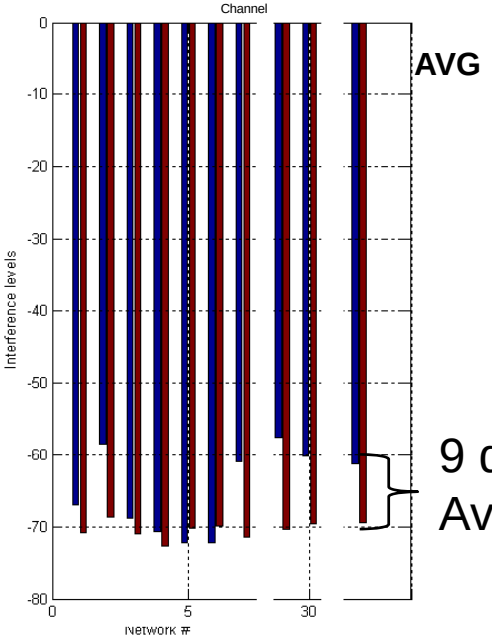
25 dB Average

Separating by class reduces capacity

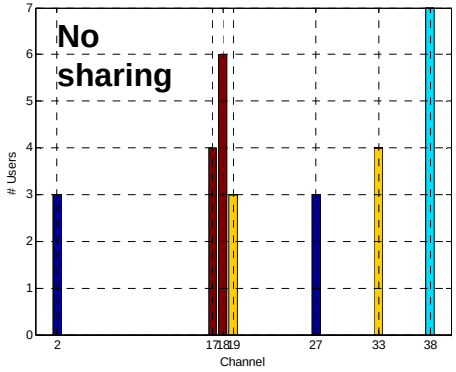
- Trunking gains matter
- Put up with the bad “neighbor” as much as possible
- Need to study tradeoffs when defining coexistence standard

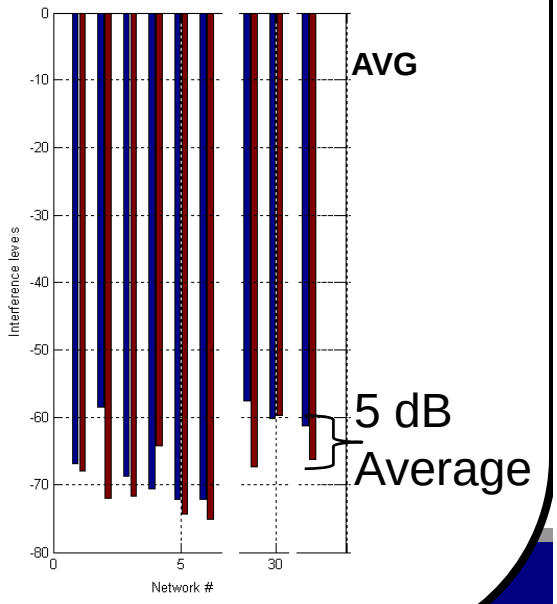
Location + ID with classes





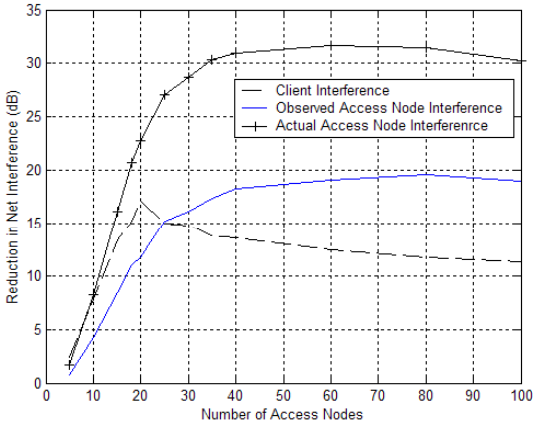
Location + ID with classes

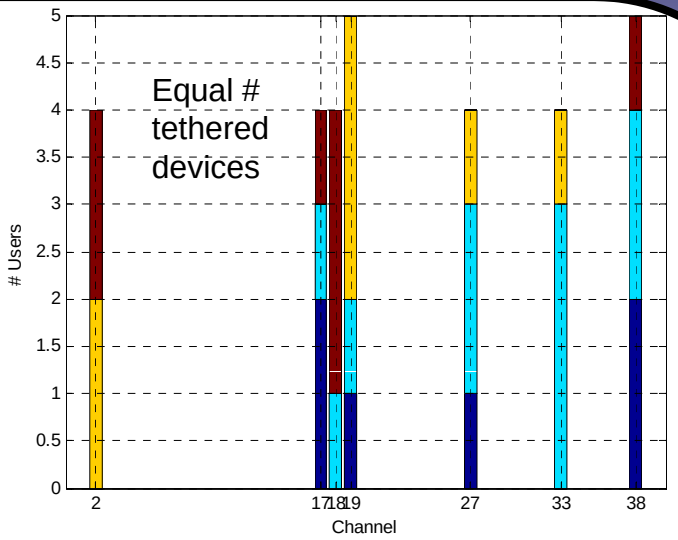


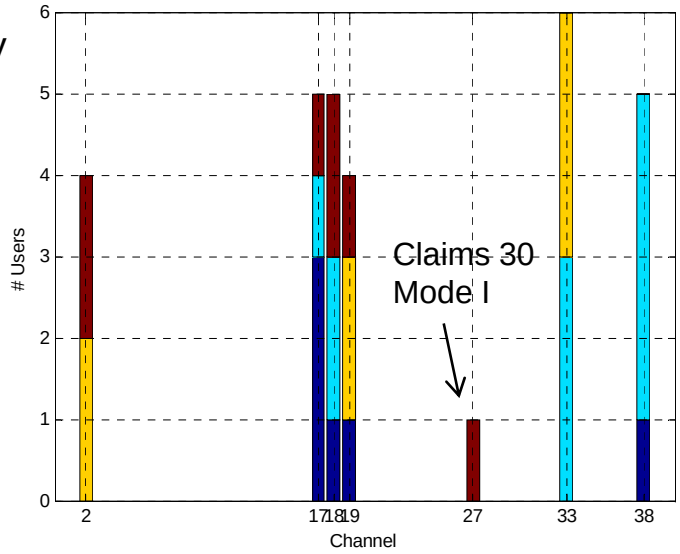


Prioritized Access for Tethered Devices

- Mode I devices tether to Mode II or Fixed devices
  - Implies close proximity
- Could influence coexistence process by also broadcasting / sharing # of tethered devices
  - Not currently required
  - Weight distance metrics by # of tethered devices
- Tethered devices factored in without revealing precise locations
- Could also consider traffic loading
  - Perhaps not as amenable due to greater variability
- Tethered device performance likely suffers by not explicitly considering location







Presentation Take Aways (1/2)

- Identification critical to avoiding “catastrophic” channel sharing
- Location information gives significant gains to system capacity
  - Depends on accuracy, currently within ~50m
- Leverage “free” information where it’s available
  - ID and location currently only regularly provided via 15.711(e) for interferer identification
    - Not for Mode II devices though
    - Likely need to add broadcast requirement
  - Shared database with location / id access (which happens for could also work if extended
    - More frequent access / updates, possible info from tethered devices
    - Could be pushed instead of pulled if changes are infrequent

Presentation Take Aways (2/2)

- Assumed two step-coexistence process
  - Distributed sort of fractious networks into different channels (frequency deconfliction)
    - Can sort themselves out without direct coordination
  - Coordinated coexistence of compatible networks within channels (transmission time deconfliction)
- Limit frequency deconfliction to when it's absolutely necessary
  - Limits trunking gains
- Can account for tethered radios without revealing locations
  - Weighted fairness needs mechanism for broadcasting weights if weights are situationaly dependent