Network Interference Server

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Proposed New Methods

- **Open Access**
  - [Noam, Benkler, Shepard, Reed]
  - Agile radios will dynamically share a commons

- **Spectrum Property Rights**
  - [Coase ... Hazlett, Faulhaber+Farber]
  - Owners can buy/sell/trade spectrum
  - Flexible use, flexible technology, flexible divisibility, transferability
Spectrum Research
Opportunity or Dilemma?

- Approaches/methods/solutions depend strongly on radio technology

- Technical Approaches in this project:
  - Friedman: IT + Cooperation
  - Spasojevic: Complex Coding
  - Rose: Adaptive transmitters
  - Mandayam: Wideband transmission by energy constrained devices

- Dilemma:
  - Focus on practice or fundamental theory?
Internet Motivation

- Few technology assumptions
  - Links carry bits.
  - Routers forward packets
  - Users get an IP address, gateway, nameserver addresses
  - Applications “interfere” in the network

- Network is useful despite (because of?) simplicity
  - “TCP-like” solutions
Internet-based Spectrum Policy Server can help to coordinate wireless networks

- needs connection to Internet even under congested conditions (...low bit-rate OK)
- some level of position determination needed (...coarse location OK)
- spectrum coordination achieved via etiquette protocol centralized at server
Network Interference Server (NIS)

[Project with S.C. Mau, R. Roy]

Goals

- Use coarse measurements to identify spectrum users and facilitate sharing
- Avoid radio technology assumptions.
  - Users can listen
  - Users have clocks
  - Users have low bit rate IP access
  - Users may not understand each others radio transmissions
NIS Methodology

- New users get an NIS address
  - Analogous to DNS nameserver address
- Users send activity traces to NIS server
- NIS maintains database of activity traces
Coarse Activity Traces

- **Packet Time Scale**
- **Slotted Time**
  - Slot time $\geq 1$ ms
- **1 Bit Feedback per Slot**
  - Tx ON or OFF
  - Traces generate $< 1$ kb/s
- **Traces over 10 sec:**
  - Random vectors, length 10,000
Measurement Traces

- **Nodes:**
  - make measurement traces
    - received power measurements in each slot
  - measurement traces sent to NIS

- **NIS:**
  - searches database for correlated activity traces
  - Notifies nodes of signal space neighbors
NIS Philosophy

“Don’t worry about invisible aliens”
  “Interference” may be orthogonal to measurements
    Example: UWB for 802.11
  A measurement trace is a projection of all signals onto the signal subspace the node can measure.

Incentives for invisibility?
NIS Potential Actions

- **Share wireless node descriptors?**
  - From wireless node descriptor database

- **Coordinate comm. between nodes?**
  - Application layer protocol for communication between nodes hidden from each other
  - No need for common radio signaling

- **Mediate spectrum sharing among nodes?**
NIS Issues

- **Coarseness of measurements?**
  - Activity trace resolution 1 µs, 1ms, 1s?

- **Activity trace update frequency?**

- **NIS database compression/searching**
  - Organizing traces to save space, facilitate fast searches.