lec 7.01: Cognitive Radio

Software Defined Radio(SDR): a collection of hardware and software technologies that enable reconfigurable system architectures for wireless networks and user terminals (SDR Forum)

Cognitive radio (CR): a radio that is aware of and can sense its environment, and can make decisions about its operating behavior based on that information and pre-defined objectives (IEEE 1900.1)

Cognitive Radio

A transceiver that is aware, adaptive, and capable of learning from experience

Aware

- Of the Radio Frequency (RF) environment
- Of its own capabilities
- Of the policies to be followed
- Of local (link) and global (network) objectives
- Of network conditions
- Of other users priorities and authorizations

Adaptive

- Transmit power control
- dynamic waveform selection
- dynamic spectrum access
- block edge masks
- routing
- negotiation of waveforms and protocols

Learning

- Weighted table lookup
- Machine learning algorithms

Evolution

Conventional Radio

- Traditional RF design
- Traditional Baseband design

Software Radio

Conventional Radio +

- Software Architecture

- Reconfigurability
- Provisions for easy upgrades

Cognitive Radio (CR)

SDR +

- Intelligence
- Awareness
- Learning
- Observations

Adjustables

- Frequency of operation
- Power
- Waveform

Measurers

- Occupied Bands
- Signal Strength
- Neighbour List

Learning part CR will have modules such as

- Objective function
- Cognitive Engine
- Policies

These will influence the kinds of adjustments made based from the information being gathered by its measurement tools.

Desirable features of a CR

1. Wideband
2. Make use of any waveform
3. Flexible Architecture
4. High Performance and low power consumption
5. Straightforward use and innovation
6. Robust
7. Access to suitable frequency spectrum segments

SW/RF front end separation

Front end deals with frequency, filtering, and power

Software handles waveforms and protocols

CR applications

- Dynamic Spectrum Access (DSA)
- Cooperative Medium Access and cooperative communications
- Opportunistic switching among available wireless networks
- Adaptive selection of available radio resources
- Increased interoperability of different systems

Overlay: Opportunistic use of fallow spectrum

Underlay: Non-Interfering use of spectrum

Players is spectrum access

- IEEE
- Regulators (FCC, OfCom, ComReg)
- US department of defense (DoD)
- Industry

FemtoCells

Small cellular base stations for residential/business installation, sharing 2g/3g/4g access

ease of deployment and low price point are major issues as femtocells are a mass market device. This means that radio planning must be automated (Cognitive Radio). The networks must be self-organizing

Self-organising networks

Can automatically extend change configure and optimise their topology, coverage, channel allocation and other operating parameters

- excellent scalability
- excellent robustness

Cross layer issues

- Spectrum Management requires information regarding QoS requirements, transport, routing, scheduling and sensing
- Spectrum sharing requires cooperative techniques for interference mitigation considering current channel capacity and may require feedback to/from application.
- Spectrum handoff where application, transport and network layers may be made aware of spectrum mobility
- Channel aware topology and routing

Acronyms

- SDR: Software Defined Radio
- CR: Cognitive Radio
- RF: Radio Frequency
- DSA: Dynamic Spectrum Access