

Cognitive Tools and Systems

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Topics

- **Cognitive Toolbox**
- **Systems and the future**

Cognitive Toolbox

- **Spectrum Sensing**
- **Policy Engine**
- **DFS (Dynamic Frequency Selection)**
- **Channel Characterization & Adaptation**
- **TPC (Transmit Power Control)**
- **Software Solutions**

Spectrum Sensing

- **The ability of the device to characterize the frequencies (bands) over which it is capable of operating**
- **Includes the concept of signal analysis or identification**
- **Provides input to interference mitigation algorithms**

Policy Engine

- **Has two major functions:**
 - **To check sensed environment against regulatory requirements**
 - **Set limits of operation based on selected spectrum**

Dynamic Frequency Selection

- Radios ability to choose a channel/frequency optimized for the desired payload
- Can include multiband operation
- Can be application/operation driven

Channel Characterization

- Channel error rate
- Channel model correction
- Channel usage

Transmit Power Control

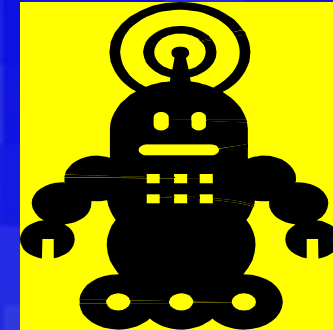
- Radio implementation controls output power of the device
- For TV NPRM should be based on adjacent channel power
- Provides ability to optimize devices transmit power based on connectivity

Software Based Radios

- **Flexible solutions**
 - “Tiered” implementations possible with the same hardware
- **Field upgradeable**
 - Provides the possibility of a “renewable” solution for misbehaving systems
 - Activate functions after product ships
- **Separation of radio system functions from applications**
- **Provides a path to single skew solutions**

Advantages of Intelligence

- **Spectrum sharing**
 - Protection of licensed users
 - Interference avoidance
 - Optimized spectrum usage
- **Device function optimization**
 - TPC
 - Frequency band selection based on application
- **Connectivity optimization**
 - Better connectivity map (selection of AP)
 - Better handoff negotiation
 - MAC adaptation (i.e. fragmentation threshold, etc.)



Existing Cognitive Solutions

- **Tobacco**
 - HF ship-shore system using spectrum sensing, channel characterization, automatic freq. selection and TPC
- **ALE**
 - Commercial HF standard incorporating spectrum sensing, channel assessment and automatic frequency selection
- **Trunk radio**
 - Multiple proprietary standards operating in VHF/UHF, mobile bands for automatic channel assignment
- **Cellular/PCS**
 - Multiple standards incorporating geolocation, automatic channel assignment, routing and TPC

The Next Cognitive Opportunity

- **UHF Band**

- Television bands are proving ground for opportunistic-use policies
- Success in this spectrum will give regulators greater flexibility in sharing licensed spectrum with unlicensed devices
- The UHF band is both valuable and attractive from a propagation & power perspective

Summary

- **Cognitive & policy based radio solutions will be the norm for the future**
- **Foundation is software based radios**
- **Allows optimized use of spectrum and network capabilities**
- **Major advantage is field upgradeability**

Backup

