



Shared Spectrum Company Briefing



802.19.1 Workshop – Panel B

July 16, 2010

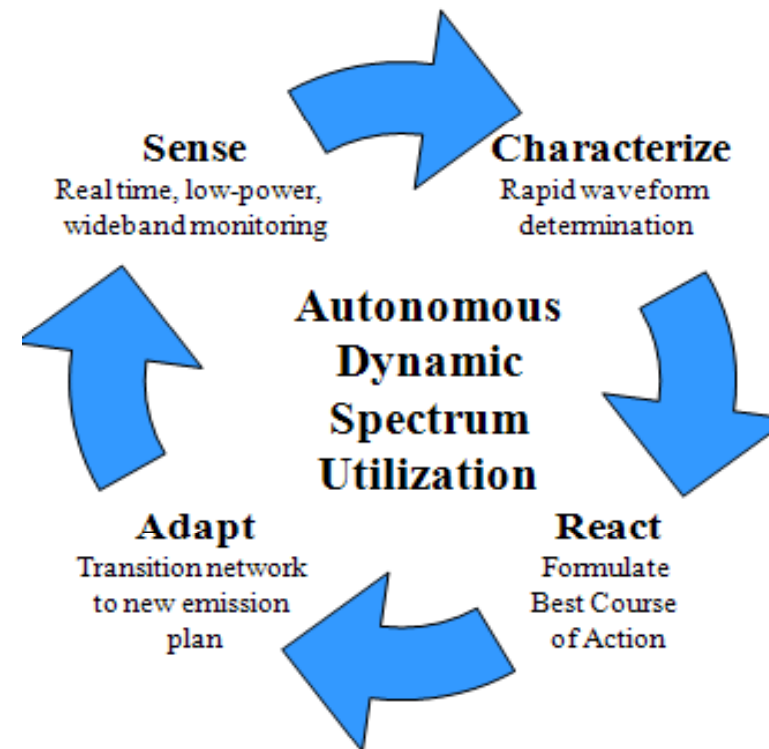
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SSC DSA Technology

Cognitive radio that ***senses, detects and adapts*** to available spectrum through user-defined ***policies***

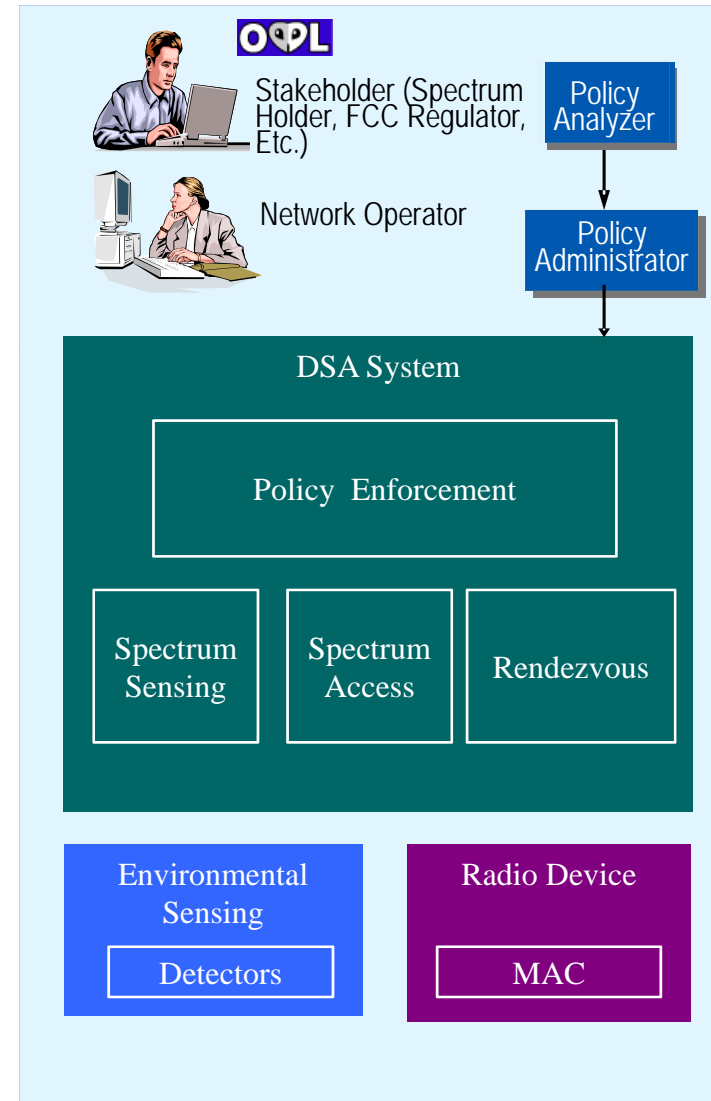
- Efficiently and safely uses encumbered spectrum
- No connection or modification with legacy systems
- Proven interference avoidance technique
- High communication availability and reliability
- Avoid intended/unintended interference
- Selects “best” frequency
- Enables robust spectrum pooling with peer users





DSA Software Architecture

- **Ultra-sensitive detectors** identify unused spectrum
- **Sensing scheduler** manages which detectors are used, what frequency the devices use, and when the detectors and tuner/modems operate
- **Spectrum access** components generate and analyze spectrum occupancy measurements to provide estimate of spectrum environment
- The **Rendezvous** discovery and connection management algorithms select which channels to use
- The **Policy** ensures that each DSA radio adheres to the spectrum access control policy rules
- The **Policy Administrator** securely disseminates policy updates
- The **Policy Analyzer** authors and validates policies





Interference/Coexistence Management

- SSC's DSA solution:
 - Continually senses available channels
 - Clear channels are candidate channels
 - Detects & avoids channels with “non-cooperative” signals and interference
 - Works in accordance with user-defined policies from numerous stakeholders



DSA Policy Rule Types

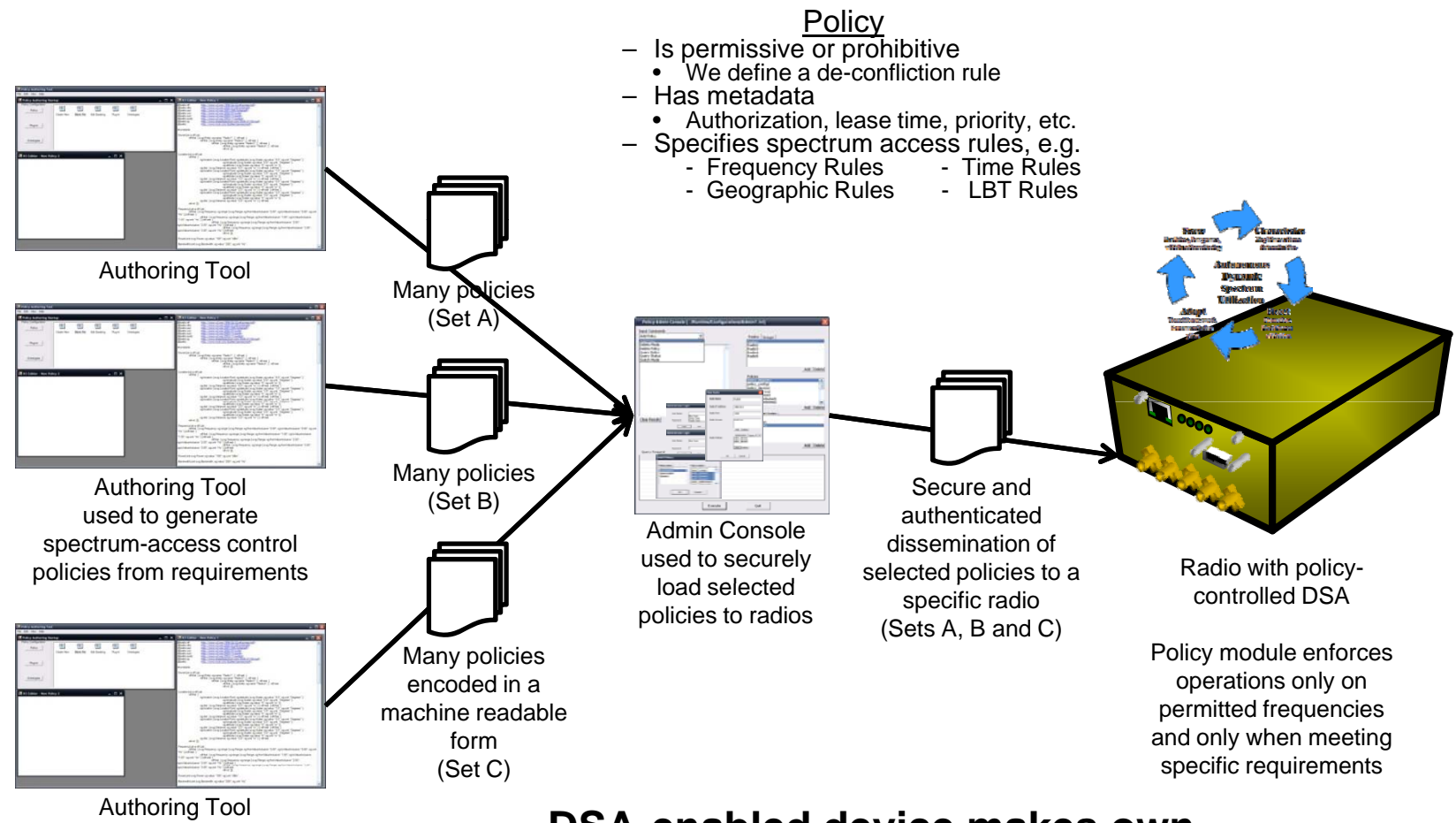
Listen-Before-Talk based types
LBT – Same up and downlink frequencies
LBT – Different, but known, up and downlink frequencies
LBT – Different, but known, up and downlink frequencies, band plan known
LBT – TV band (TV detector)
Spatial types
Geographic border field strength limits
Database geographic/TV coverage area based
Temporal types
Time of Day restrictions
Authorization for finite time duration (with periodic renewals)
Device based types
Device Capability - Ability to measure second and third harmonic
Device Capability - DSA TX power spectrum density limit
Adjustable I/N Limit for any policy (- 6 dB (insignificant interference impact to Primary users), 20 dB (medium amount of interference impact to peer DSA nodes))

Connectivity based types
Beacon reception required to use band
Connectivity requirement for any policy (can use certain bands only if connected to Spectrum Manager)
Group Behavior based types
Type 1 Group Behavior - Abandon channel if any node within certain range detects Non-cooperative signal
Type 2 Group Behavior - Determine DSA TX power based on estimated interference probability (used Belief, Disbelief, and Ignorance estimates fused with Dempster-Shafer Theory)
Node Identify restrictions (e.g., use while airborne prohibited, use only in fixed applications, Red Cross use only)
Distributed Control based types
Automated policy updates if feedback indicates that existing policy is insufficient for non-interference operations
Automated policy updates notification of policy revocation or update by policy authority



Sample SSC Policy Architecture

Policy-Based Controls Draw on Principles Currently Employed Manually by Spectrum Managers



- Policy
- Is permissive or prohibitive
 - We define a de-confliction rule
 - Has metadata
 - Authorization, lease time, priority, etc.
 - Specifies spectrum access rules, e.g.
 - Frequency Rules
 - Time Rules
 - Geographic Rules
 - LBT Rules

DSA-enabled device makes own spectrum decisions



Sample Spectrum Management Projects

- Policy
 - Numerous projects underway to refine and extend to various platforms
- Distributed Sensing
 - Developed distributed sensing method that creates spectral maps and addresses the hidden node problem
- Radio Spectrum Planning
 - Developed algorithm that merges radio/sensor measurements and automatically improves spectrum management tool database
- RF Encroachment
 - Building software tool to predict man-made signals & RF noise levels