Cognitive Spectrum Access

William Horne
703-983-6198 • horne@mitre.org

Jeff Poston
703-983-7020 • jdposton@mitre.org

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Problem

- **Improving access to the electromagnetic spectrum is a long-standing challenge**
  - **Communications, navigation, and surveillance systems depend on transmitting, receiving, or measuring energy transferred through the multidimensional spectrum "space"**
  - **Network-centric warfare, emergency response, and other emerging operational concepts require automated, dynamic, and adaptive decision making for spectrum use**
  - **Applying cognitive techniques on "smart radios" may greatly improve spectrum access**

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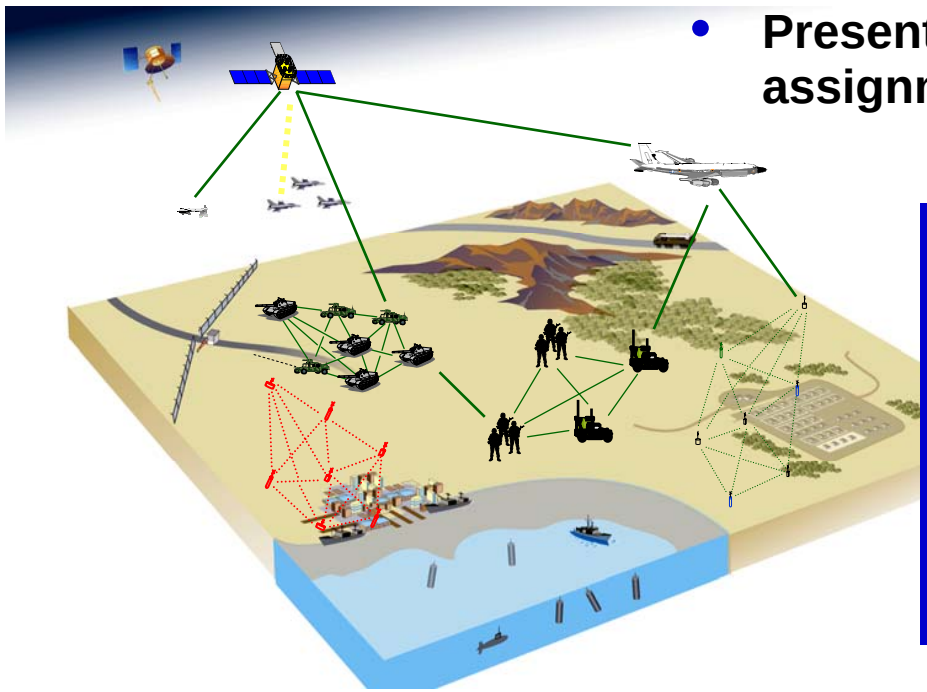
Background

- Complexity of future military and civilian networks requires:
  - Continuous evolution of membership and topology
  - Dynamic link quality and communication needs
  - Large numbers of nodes and connections



- Present static frequency assignments are inadequate

Future Spectrum Access

Automated
Dynamic
Adaptive

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Activities

1) Ontology and Inference Engine Development

- Further develop prototype context-aware architecture, reasoning approaches, and demonstration
- Enhance preliminary spectrum ontology

2) Core Radio Architecture Development

- Develop prototype FPGA/DSP-based platform
- Develop flexible OFDM-based waveform for dynamic spectrum access
- Conduct Outreach and Guidance

3) Application of Cognition in Legacy Wireless Systems (802.11s (Mesh Wi-Fi) Prototype)

- Develop protocol and associated methods for resource sharing based on contextual awareness
- Conduct demonstration of approaches using modified WiFi cards

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Objective

- Develop spectrum access architectures, algorithms, and radio device designs that utilize “cognitive” or “reasoning” techniques to improve access to the electromagnetic spectrum
- Take the software defined radio (SDR) to the next evolutionary step: “smart” radios

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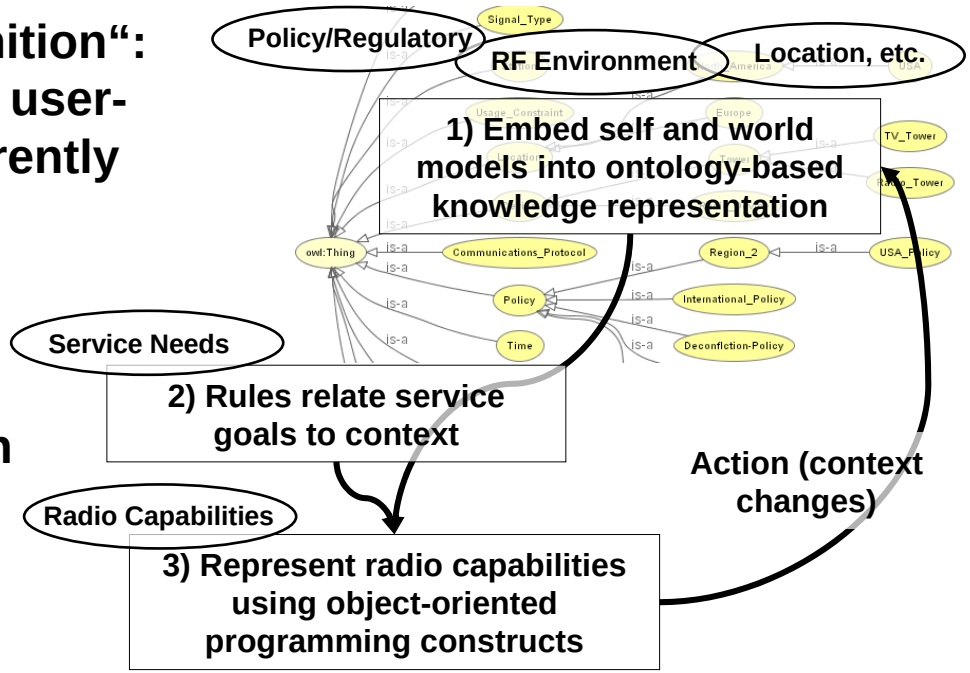
Highlight

- One aspect of "cognition“: ability to respond to user-supplied goals differently under different circumstances

→Candidate Architecture: Leverage interaction between object-oriented software, rules, & context information



Demonstration (software):
Radio uses beacons, but when goals not met or if conflict detected, recommends action

Analyze circumstances causing failure to meet goals
→ find actions that will lead to success
→ initiate cooperation with user to act

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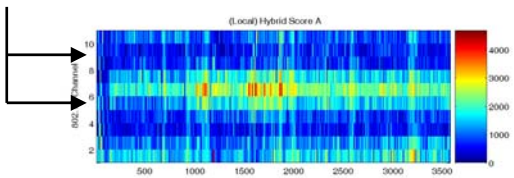
Highlight/Demonstration

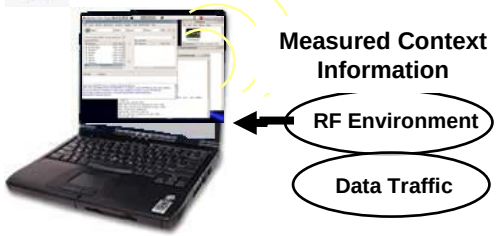
Context-Aware Autoconfiguration of 802.11 Networks

Wireless devices automatically exchange individual measurements and negotiate optimum joint operating configuration (e.g., channel)

User Mission Priority: HIGH
Channels {2–4, 9–11} acceptable



Battery Energy Budget OK




```
{ dataRate(min,

max), . . .}
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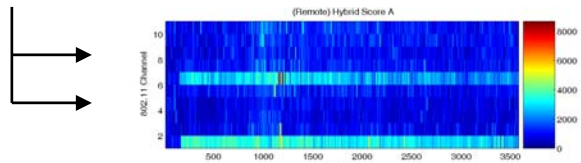
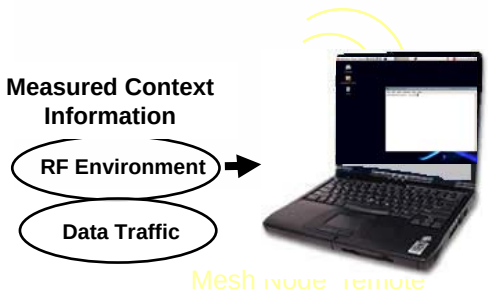
Demonstration:
Exploits existing WiFi (IEEE 802.11) cards to select channel

User Mission Priority: FAIR
Channels {2–5, 7–11} acceptable



Battery Energy Budget EXCELLENT



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Impacts

- Develop system and radio device architectures and techniques:
  - Military Applications: Tactical & Sensor Networks
  - Public Safety & Emergency Communications
  - Aviation
- Help MITRE maintain leadership and be a recognized source in developing “smart” radios
- Influence development of this emerging technology through participation in standards and technology organizations (e.g., IEEE 802.16, IEEE 802.22, etc.)

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Future Plans