



SDR & Cognitive Radio Applications for Public Safety Communications

SDR '10 Public Safety Workshop 2010

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communications

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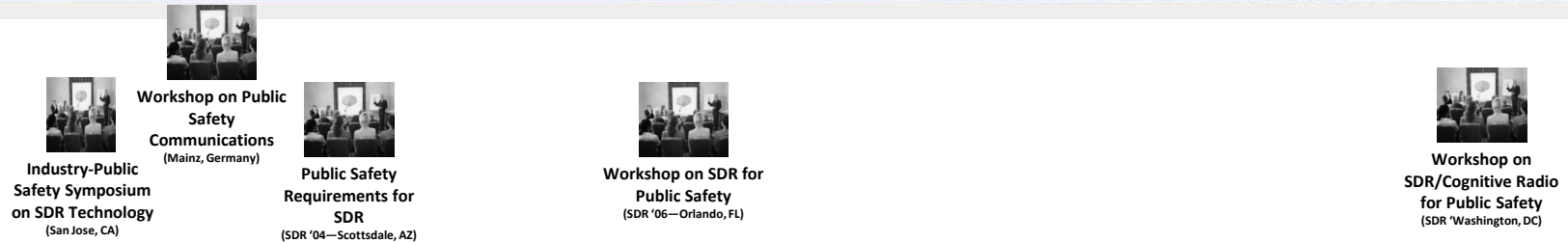
- **Background**
- **How public safety can benefit from cognitive radio?**
- **The usual caveats**
 - **L-3 Communications activities funded by the National Institute of Justice under grants 2007-IJ-CX-K013 and 2010-IJ-CX-K023**
 - **The opinions, findings and conclusions or recommendations expressed in this publication/program/exhibition are those of the author(s) and do not necessarily reflect the views of the Department of Justice (DOJ) or the National Institute of Justice (NIJ)**

Public Safety Special Interest Group

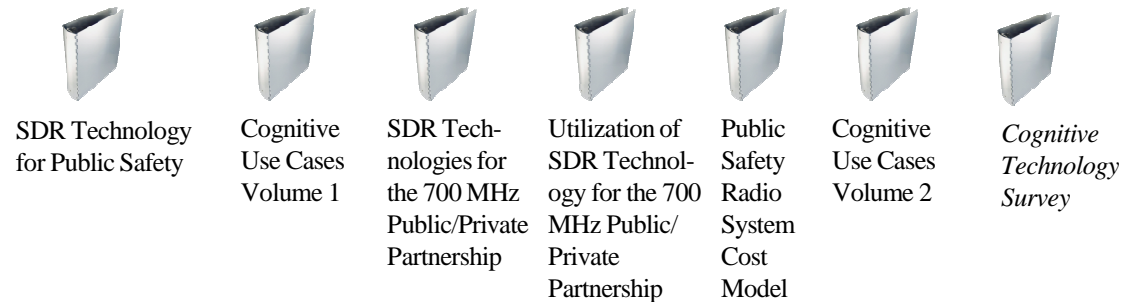
- **Part of the Forum's User Requirements Committee**
- **Representation includes public safety organizations, traditional public safety LMR vendors, software developers, operators, commercial companies, regulators, military**
- **Formed in 2004 to facilitate the transition of SDR/CR technology into the public safety domain**

Public Safety SIG Activities

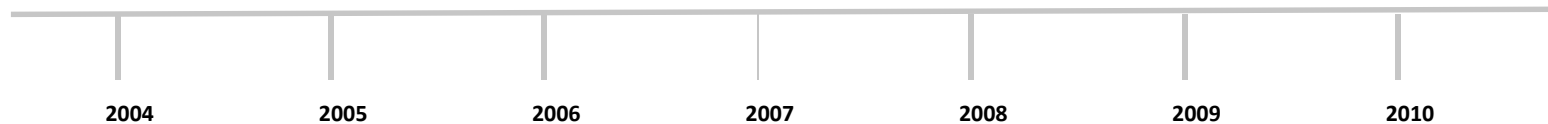
Workshops



Reports



- Identify key benefits / issues of use of SDR in public safety
 - How cognitive radio technology can benefit public safety
 - SDR/CR technology that support shared public/private networks
 - Analyze cost-benefit tradeoffs
 - Roadmap inputs



Current Project: Technology Survey

- **Identify technology developments that can provide functional capabilities identified in use case documents**
- **Identify technology maturity**
- **Identify “low hanging fruit”, current gaps, dependencies, staging**
- **Identify common technology solutions across multiple domains (e.g., public safety, military, commercial)**
- **Identify regulatory and operational (policy, procedural, training, etc.) challenges and barriers to technology deployment and adoption**
- **Input to:**
 - **WInnF roadmap work**

- **Objective: identify use cases and operational requirements for cognitive capabilities in public safety radio systems**
- **Methodology: review scenarios, determine situations in which cognitive capabilities potentially improve communications**
 - London bombing 7/7/05
 - Chemical plant explosion scenario

Approach for each scenario

- **Define timeline of incident and response events**
- **Identify points in timeline in which cognitive capabilities could enhance communications**
- **Use cases defined in terms of the following parameters of the scenario and changes introduced by the use of cognitive radio technology**
 - Physical
 - Network
 - Procedural
 - Regulatory
 - Chronological
- **Analyze these use cases in terms of the technical, regulatory, and procedural issues that need to be addressed to achieve the enhanced communications**
- **Analyze issues that apply to all use cases**

- **Consolidate results of use case documents**
 - Extract desired functional capabilities from use cases
 - Combined functional capabilities from both scenarios
 - Consolidated similar capabilities
 - Organized into major categories
- **Solicit inputs on technologies that can address the functional capabilities (Request for Information)**
- **Integrate with WInnF Roadmap Wiki**

Applications of SDR/CR [1/7]

- **Interoperability for Public Safety**
 - **Interoperability Between Public Safety Agencies**
 - "Smarter" gateway devices
 - Multiband Radios
 - Interoperability between P25 and TETRA
 - All Other Public Safety Inter Agency Interoperability Innovations
 - **Interoperability Between Public Safety and non-Public Safety Agencies**
 - Prioritization Between Public Safety and non-Public Safety Communications sources
 - Integration of non-Public Safety sources into the Incident Command (and NG911)
 - Integrity of Communications in a mixed source incident

Applications of SDR/CR [2/7]

- **Coverage Improvement**

- **Ad Hoc Means of Coverage Extension** when infrastructure devices are lost such as tunnel coverage devices or base station sites
- **Interference Mitigation** for situations where coverage is being limited by interference
- **Link Budget Improvement** for situations where noise is the limiting factor on coverage, not interference.
- **Network Diversity** for situations where a network is available that would not normally be used, but in this case provides an adequate link

Applications of SDR/CR [3/7]

- **Spectrum Utilization Optimization & Dynamic Spectrum Access**
 - Identify situations that meet threshold criteria for initiating dynamic spectrum access
 - Identify network capacity and loading
 - Dynamically optimize the priority of communications transmissions
 - Dynamically optimize/control access priority per subscriber unit
 - Automatically adjust network operations to accommodate significant changes traffic volume
 - Accommodate direct communication between first responders and non-first responders
 - Release use of spectrum by public safety users as the emergency communications as short-term requirements decline
 - Allocate additional spectrum in the most effective manner consistent with regulations and policy
 - Identify spectrum resources that can be utilized.
 - Adjust utilization based on defined regulations and policy

Applications of SDR/CR

- **Communicate Reconfiguration Information**
 - Query/exchange information among the network infrastructure and end user radios
 - Identify and communicate accessible spectrum resources that can be utilized to offload some calls based on real-time identification of available spectrum.
 - Optimize variables based on predicted signal and interference levels for all subscribers
 - Reconfigure [subscriber and/or network equipment] to access additional spectrum resources when required.
 - Rapidly adjust air interface transmit power, waveforms, frequencies, filtering, and receiver attenuation (based on network & end user radio commands)
 - Specify and reconfigure as appropriate transmit and receive parameters on a transmission or message sequence basis
 - Reconfigure/Program radios over the air
 - Ensure integrity of the over the air process
 - Use a standard method for transmission of network information.

Applications of SDR/CR

- **Manage Communications Resources**
 - **Monitor network resource allocation & associated issues**
 - Anticipate network resource allocation issues
 - Provide an effective display of current conditions and generate appropriate alarms
 - **Provide information about the RF environment at a user's location.**
 - Geolocate network nodes
 - Predict signal and interference levels at every potential subscriber location

- **Support Incident Command**

- Identify a "meeting point" for incoming responders to register and receive configuration information
 - Small scale peer-to-peer communication
 - Formalized to support incident command
- Associate users, radios, and user roles [e.g., roles within a NIMS construct].
 - Define explicitly [i.e., in a machine-interpretable form] user roles within an incident response structure
 - Store in a machine-interpretable form a user's credentials
 - Authenticate a user as qualified for a specific role
 - Define appropriate radio capabilities as associated with a user's role
- Dynamically reconfigure communications capabilities (both subscriber and network capabilities) using criteria based on both the user's current role, and incident policy
 - Mitigate impact of reconfiguration on ongoing communications
 - Minimize bandwidth required to accomplish reconfiguration information

Applications of SDR/CR

- **Rollback Configuration Changes**
 - Store [previous] device configuration information
 - Recognize when a device reconfiguration results in a degraded capability
 - Restore [or rollback] the device capabilities to a previous configuration including a default configuration and the configuration of the device prior to the incident

- **Begin filling in technology information via Wiki**
- **Prepare an RFI for public dissemination to solicit inputs on technology solutions**

- **There are applications of SDR/CR technology that can benefit public safety beyond spectrum access**
- **Will require technical, regulatory, and SOP development**
- **The paradigm shift**
 - **Today incident response is constrained by available communications capabilities**
 - **Tomorrow communications capabilities will be configured to meet the evolving requirements of incident response**
- **First responder communications is a means, not an end**

- Questions
- Contact information:
 - Fred.Frantz@L-3com.com
 - Additional information about the CommTech program
 - <http://www.ojp.usdoj.gov/nij/topics/technology/communication/welcome.htm>
 - Additional information about the Wireless Innovation Forum (and location of reports)
 - www.wirelessinnovation.org