The SDRF Contribution to ITU Question ITU-R 241/8: Cognitive radio systems in the land mobile service

James Neel

Co-chair, Cognitive Radio Work Group

Document Background

- Industry Canada proposed to the ITU RadioCommunication Study Groups (Working Party 8A) to study role of cognitive radio
- Intended for completion by 2010
- Initial Questions:
  - What are the operational implications (including privacy and authentication) of cognitive radio systems?
  - What are the cognitive capabilities that could facilitate coexistence with existing systems in the mobile service and in other radiocommunication services, such as broadcast, mobile satellite or fixed?
  - What spectrum-sharing techniques can be used to implement cognitive radio systems to ensure coexistence with other users?
  - How do cognitive radio systems promote the efficient use of the radio spectrum?

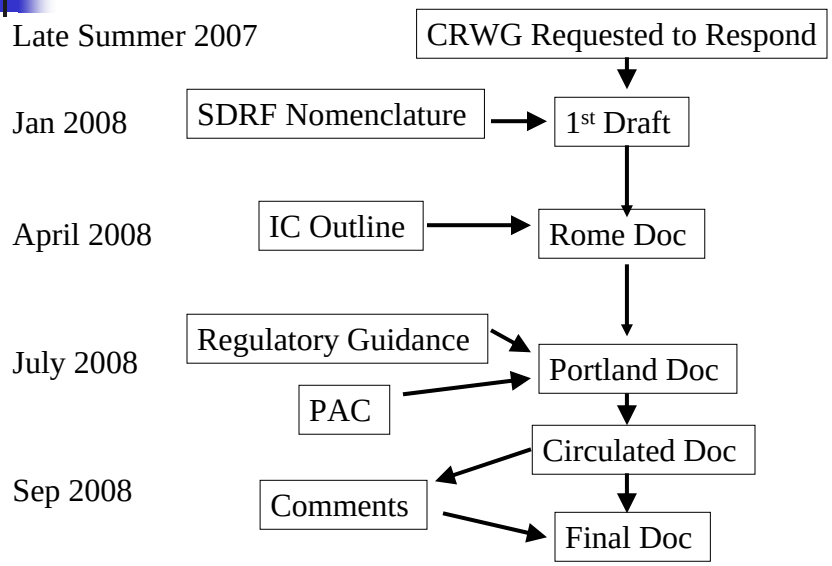
Questions cont.

- What is the ITU definition of cognitive radio systems?
- What are the closely related radio technologies (e.g. smart radio, reconfigurable radio, policy-defined adaptive radio and their associated control mechanisms) and their functionalities that may be a part of cognitive radio systems?
- What key technical characteristics, requirements, performance and benefits are associated with the implementation of cognitive radio systems?
- What are the potential applications of cognitive radio systems and their impact on spectrum management?

CRWG Objectives in Response

- Emphasize significant potential benefits / value of cognitive radio
- Emphasize that cognitive radio is not “pie-in-the-sky” research
- Avoid precluding future technical developments
- Identify potential issues raised by cognitive radio
- Emphasize importance of SDR to cognitive radio
- Promote SDRF positions

CRWG Timeline



Document Breakdown

1,2 Introduction / Scope (1 pg)
3 Related Documents (0.2 pg)
4 Definitions (1 pg)
5 Description / Benefits (7 pg)
6 Related Techs (3 pg)
7 Applications (2 pg)
8 Operational Implications (8 pg)
9 Coexistence (7 pg)
10 Conclusions (2 pg)
App 1 Japan (17 pg)
App 2 Europe (6 pg)
App 3 CPC (10 pg)
App 4 World (4 pg)
App 5 DoD (5 pg)

SDRF wrote ~ 47 out of 74 pages

Contributors and Major Commenters

Contributors

- Ihsan Akbar (Tyco Electronics)
- John Armantrout (JPEO / JTRS)
- Danjela Cabric (UCLA)
- Apoorv Chaudri (Motorola)
- Cindy Cook (Industry Canada)
- Pete Cook (Hypres)
- Bruce Fette (GDC4S)
- John Fitton (Harris)
- Jason Galetti (JPEO / JTRS)
- Vince Kovarik (Harris)
- Michael Lukin (TTP Group)
- David Maldonado (L3-Nova)
- Joe Mitola (Stevens Institute)

Contributors

- Michel Ndi (Industry Canada)
- James Neel (CRT)
- Tim Newman (Virginia Tech)
- Keith Nolan (Trinity College)
- Michael Pursley (Clemson)
- Jim Rodenkirch (DTI)
- Qun Shi (ITT)
- Chad Spooner (NWRA)
- Youping Zhao (SSC)

Major Commenters

- Stephen Blust (AT&T)
- Takuzo Fuji (Hitachi Kokusai)

Section 4: Definitions

- Included material from SDRF cognitive radio nomenclature document
  - SDRF / IEEE CR definition (existing)
  - Adaptive Radio
  - Intelligent Radio
  - Cognitive Control Mechanism
  - Policy
  - Policy-based Radio

Section 5: Description and Benefits of Cognitive Radio

- Key textbooks
- Key characteristics of a CR (from SDRF nomenclature document
  - Aware, perception, adjustable, autonomous
- Benefits
  - Interoperability
  - Coexistence
  - Simplified management
  - Improved Spectral efficiency via dynamic access
  - Improved APIs
  - Dynamic regulatory compliance
  - Self-correction / fault tolerance
  - Enhanced QoS management
  - Improved RRM
  - Advanced networking techniques
  - Extended Coverage
  - Graceful degradation
  - Application-based power-tuning
  - Enhanced / Simplified Public Access

Section 6: Related Technologies

- Goals for section:
  - Show that cognitive radio is a natural evolution of existing techniques
  - Assess the technology readiness levels (TRL)
  - Show that many supporting techs are in use now
- Topics:
  - Software Radio
  - Reconfigurable Radio
  - Smart radio
  - Policy-based radio
  - Smart Antennas
  - Adaptive Modulation and Coding
  - Dynamic Frequency Selection
  - Dynamic Channel Allocation / Assignment
  - Transmit Power Control
  - Cognitive Pilot Channel

Section 7: Applications

- Intricately linked with benefits, so somewhat repetitive with Section 5's benefits
  - Much longer initially, folded into Section 5
- Topics
  - Existing cognitive network discussion
  - Radio Resource Management

Section 8: Operational Implications

- Security considerations
  - Special need to secure policy
  - Likelihood of emergence of a Policy Management Infrastructure (PMI) that mimics many of the functions of the existing Policy Key Infrastructure (PKI)
  - Need for testing / conformance
  - Need for audit logs
- Spectrum management considerations
  - Need standardized policy engine components
  - Need standardized languages and protocols
  - Need standardized testing
  - Need for CRs to understand operating conditions (white vs gray spaces) and to quantify potential impact
  - Infrastructure requirements

Section 9: Facilitating Coexistence

- Discussion of use of radio environment maps in coexistence
- Differences between coexistence with legacy systems and cognitive systems
- Brief discussion of TPC

Section 10: Conclusions

- Mostly summary material
- Takeaways
  - Cognitive radio functions will be key to a dramatic improvement in spectrum usage efficiency in some bands.
  - Premature for specific regulations
  - ITU should
    - Encourage further study of cognitive radio
    - Encourage national spectrum regulators to anticipate approaches that will facilitate innovation and deployment of cognitive radios
      - Spectrum sharing test beds
    - Support, monitor, contribute to policy language standardization activities
  - If CPC is adopted, then spectrum should be harmonized.

Appendix 3: Comments on the Cognitive Pilot Channel

- **Rationale**: Various parties asked that we specifically comment on the CPC in the ITU response
- **Topics**:
  - Concept and motivation (from white paper)
  - Related technologies (802.21, information databases)
  - Suggestions / Assessments
    - Network association (limit to location requirement)
    - Cost (need for hierarchical because of spectrum cost)
    - Bandwidth efficiency (leverage existing techs, use hierarchical model)
    - Security
      - Inviting target for mischief
      - Include anti-jam
      - Include authentication services

Appendix 4: CR Research Around the World

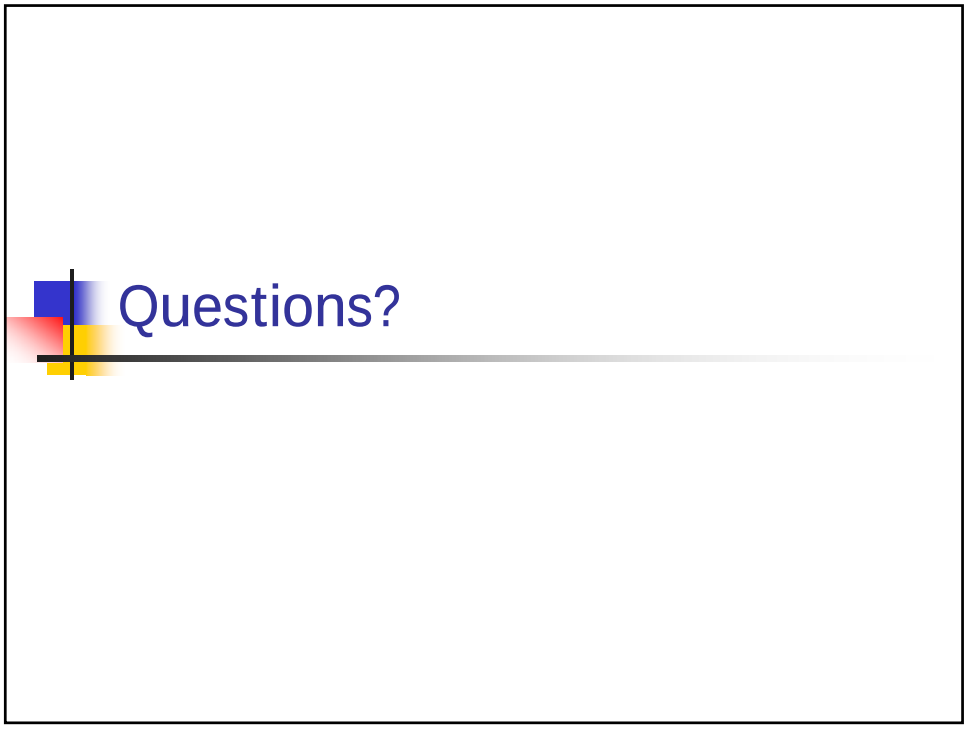
- **Rationale**: Emphasize the broad basis of research around the world
- **Topics**:
  - Wireless @ Virginia Tech
  - Carnegie Mellon
  - Clemson
  - Northwest Research Associates
  - Others:
    - Hanyang, Kansas, Trinity College, Northeastern
    - GDC4S, SSC, Thales, Adapt4, BBN, Harris
    - 26 universities at SDRF 08
    - 35 companies from around the world

Appendix 5: CR ConOps Discussion (CR and military)

- **Rationale**: International spectrum regulations impact military
- **Topics**:
  - Need for interoperability between DoD (e.g. national guard) and first responders in major disaster responses
  - Steps being taken to improve interoperability
  - How cognitive radio can improve interoperabilty / communications performance in a joint disaster response

Future Document Work

- Oct 2008
  - ITU currently considering proposed changes to last draft (Industry Canada Outline)
- Oct 2008 – Mar 09
  - CRWG developing document to “Quantify technical benefits of cognitive radio”
- Mar 09 – May 09
  - Address any comments / changes in ITU doc
  - Use new SDRF doc to reference technical claims in doc


Questions?