Cognitive Radio, the market and the regulator

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Need for cooperation

research

industry

regulators
What regulatory problems are there?

- Exclusive rights in most bands
- Rights restricted to a single service or technology
- Significant parts of the spectrum are hardly used
- Slow response to changes in market and technology

Cognitive Radio can be used to facilitate more dynamic access to spectrum
What needs to be done?

• More flexibility:
  • in the use of frequencies
  • in the assignment of frequencies

• Possibilities to use white spots
  • Conditions for opportunistic spectrum access
    • Spectrum sensing limit
    • Transmitter parameters

• Access to reliable information on the use of spectrum
  • Pilot channel
  • Database

➢ Who’s going to do it?
  • ITU: Worldwide harmonisation
  • Regional organisations (e.g. CEPT/Europe)
  • National spectrum management authority
International regulations - WRC 2012

- **WRC-12 Agenda Item 1.19** to consider regulatory measures and their relevance, in order to enable the introduction of software-defined radio and cognitive radio systems, based on the results of ITU-R studies, in accordance with Resolution 956 (WRC-07);
REGULATORY MEASURES AND THEIR RELEVANCE TO ENABLE THE INTRODUCTION OF SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO SYSTEMS

RESOLUTION 956 (WRC-07)

considering

i) that some studies indicate usefulness to have means to assist in the determination of the local spectrum usage, such as wireless or wired access to a database or to other networks;

j) that some studies indicate a possible need for a worldwide harmonized cognitive supporting pilot channel with a bandwidth less than 50 kHz, whilst other studies indicate that the availability of a database could support access and connectivity, and therefore support the use of these systems,

resolves to invite ITU-R

1 to study whether there is a need for regulatory measures related to the application of cognitive radio system technologies;
Some observations

• CR technology is NOT a radio service

• Any radio system may implement CR technology

• Administrations may already allow the introduction of CR

• Frequencies or frequency bands (tuning range) for specific applications implementing CR could be harmonized, as necessary, on world wide basis in ITU-R Recommendations or regionally.

• The possible harmonization of a Cognitive Pilot Channel (CPC) could be tackled in the standardization arena

⇒ No Change to the Radio Regulations is required for CR.
What could there be done in the ITU?

• More flexibility in the international Radio Regulations
  • **WRC-12 Agenda item 1.2**: taking into account the ITU-R studies carried out in accordance with Resolution 951 (Rev.WRC-07), to take appropriate action with a view to enhancing the international regulatory framework;

• Assessent on the **possibilities** of CRS within the various services
Regional aspects - Europe

What is done?

- More flexibility in the use of spectrum
- Study on the Use of Cognitive Radio in the TV bands
  - Based on spectrum sensing (OSA)
  - Amount of white space is limited
    - Tight broadcast planning
    - TV band also used for Program Making and special Event Services
    - Harmonised subband for fixed/mobile use

What more can be done?

- Harmonized introduction
- Availability and reliability of information on usage
- Standardized access to this information
National regulatory framework - introduction of flexibility

Collective Use of Spectrum

• Smart radios are used with a build in techniques and rules (etiquettes) to reduce interference
• Everybody can use the spectrum as long as the etiquettes are followed.

Market based access

• Well defined exclusive rights
• Maximum flexibility in the usage
• Secondary market in which these rights can be sold or leased
Two types of sharing

- **Existing use**
  - Cognitive Radio

- **Vertical sharing**
  - (white spot access)

- **Horizontal sharing**
  - (pooling)
Regulations should be tailor-made

<table>
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<tr>
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<th>Horizontal sharing (spectrum pooling)</th>
<th>Vertical sharing (white spot access)</th>
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<tbody>
<tr>
<td><strong>Market based regime (Closed user group)</strong></td>
<td>Spectrum owners dynamically share spectrum.</td>
<td>Owners of the spectrum grant specific Cognitive Radio’s access to their white spots.</td>
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<tr>
<td><strong>Commons regime</strong></td>
<td>All users dynamically share spectrum on an equal footing.</td>
<td>Cognitive Radio’s dynamically access white spots from licensed users (OSA).</td>
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The role of the regulator will be different in the various scenario’s
Hypothesis on spectrum management

A certain degree of coordination is required

- Government coordination
- Design
- Trade-off line
- Tension
- Market coordination
- Spontaneous
Step 1: Gaining experience

Opportunistic Spectrum Access

- Designate a band for opportunistic access
- Define technical conditions for the Cognitive Radio devices
  a) Strict enough to keep the interference below an acceptable level
  b) Not too tight to keep opportunities
  c) Realistic, given the current state of technology

- CRs will need to adapt to future developments of the primary use(rs) in the band

⇒ Continued need for cooperation between the regulator and industry
Opportunities for OSA

- Not too wide band with rather static users
  - UHF broadcasting band?
    - PMSE
  - More controlled environment:
    - Satellite band
      - BWA in the 3.4 – 3.8 GHz range

- Limited usage:
  - No guarantees for spectrum access
  - Likelihood of interference

- Suitable for:
  - Low power devices
  - Military systems
Step 2: CR as enabler for a commons

More limited role for regulators:
  • Designate the band to allow usage on a cognitive basis;
  • Enforcement.

Role for industry:
  • Standardize etiquettes to promote fair sharing of spectrum resources among CR devices

Usage
  • Ad-hoc networking
Step 3: a more fluid market for spectrum

- Regulator
  - Define the framework for trading and (sub)leasing
    - Well defined exclusive licenses granted to primary users or brokers
    - As few usage restrictions as possible

- Active coordination between users
  - Possibility to earn money with unused spectrum
  - Possibility for a spot market and long term contracts
  - Possibility for distribution of access based on actual use
    - Can even be used to ease cross border coordination
  - Sharing based on acceptable interference
    - QoS part of the negotiations

- Possibility for higher quality services

Harmful interference
Accepted interference
Permitted interference
Background noise
A more fluid market

• CR can be used to make the market more fluid:
  • Creation of a real-time market
    • No barriers to instant trading
    • Introduction of easements
  • Information about ownership
  • Monitoring information of actual usage
  • Dispute resolution mechanism
  • Active enforcement
Concluding remarks

- Huge potentials for an increased efficiency
- CR can be used to realize a more flexible spectrum management regime
- CR can be used in both a spectrum commons and an exclusive rights regime

- Many aspects still unclear, e.g.
  - technology
  - (access to and reliability of) information on spectrum usage
  - business case

- Careful introduction on a case-by-case basis
Concluding remarks 2

Stepwise approach to introduce cognitive radio

1. Opportunistic Spectrum Access is a good first step
2. Creation of a spectrum commons
3. Creation of a more fluid market for spectrum

⇒ Need for co-operation between regulators, research and market players

⇒ Need to think in possibilities instead of restrictions
Questions