

# 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);

# WRC-12

## RESOLUTION 956 (WRC-07)

### **Regulatory measures and their relevance to enable the introduction of software-defined radio and cognitive radio systems**

*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;
- Assessment 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

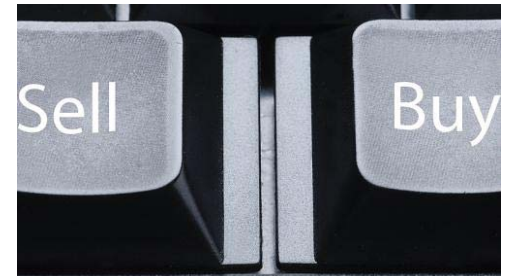
# National regulatory framework – introduction of flexibility

## Collective Use of Spectrum

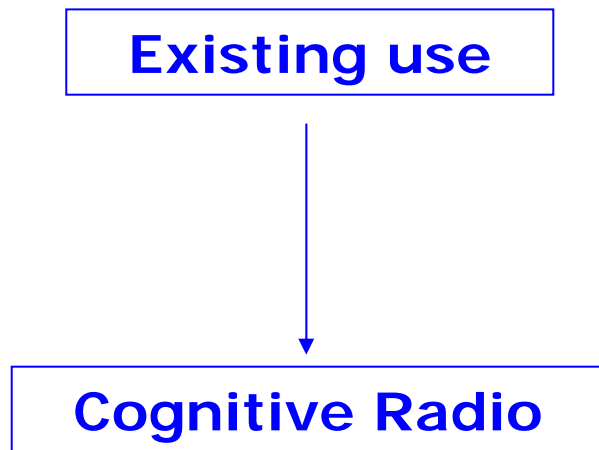
- Smart radios are used with a build in techniques and rules (etiquettes) to reduce interference
- Everybody can use the spectrum as long as the etiquettes are followed.

## Market based access

- Well defined exclusive rights
- Maximum flexibility in the usage
- Secondary market in which these rights can be sold or leased

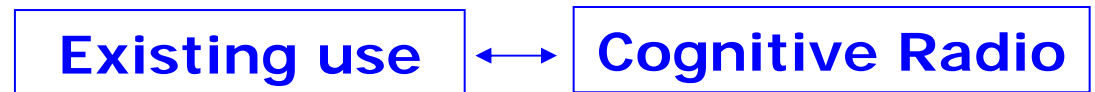


# Two types of sharing



Vertical sharing

(white spot access)



Horizontal sharing

(pooling)

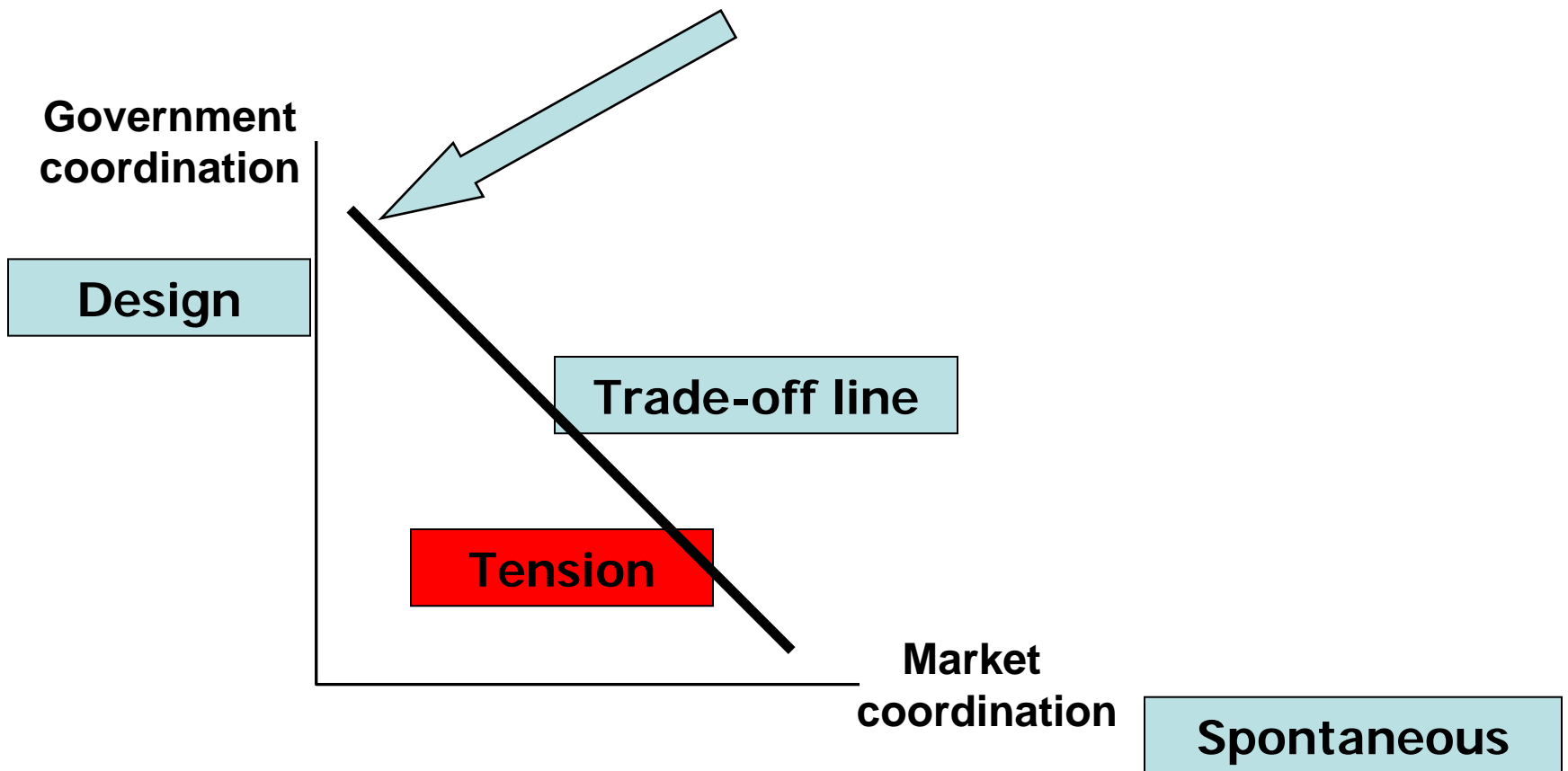
# Regulations should be tailor-made

	<b>Horizontal sharing (spectrum pooling)</b>	<b>Vertical sharing (white spot access)</b>
<b>Market based regime (Closed user group)</b>	Spectrum owners dynamically share spectrum.	Owners of the spectrum grant specific Cognitive Radio's access to their white spots.
<b>Commons regime</b>	All users dynamically share spectrum on an equal footing.	Cognitive Radio's dynamically access white spots from licensed users (OSA).

The role of the regulator will be different in the various scenario's

# Hypothesis on spectrum management

A certain degree of coordination is required



# 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



# 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
  - bussiness 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