Classification of business scenarios for spectrum sensing

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Insights on how the technology will be used, provides input for the development of the technology
Agenda

- 1. Concept
  - Which concept of spectrum sensing is used?
- 2. Parameters
  - What are the key differentiators between sensing scenarios?
- 3. Classification
  - What are the main categories of sensing scenarios?
- 4. Conclusions

1. Concept

- Concept of “SPECTRUM SENSING” used:
  - Sensing environment, enabling cognitive and dynamic spectrum management
  - RF Tuning range (100Hz – 6 GHz)
  - Fast sensing (29.5 ms – 88.5 ms)
  - Very low power consumption (7.8 mJ)
  ⇒ Ideal for implementation in terminals
2. Parameters

- Why parameters?
  - To distinguish between multiple scenarios in which spectrum sensing can be used

- Why distinguish between multiple scenarios?
  - Multiple ways of how spectrum sensing is used
  - Multiple settings/sectors (telecom, logistics, health, home,…)

  => When evaluating spectrum sensing in business model or regulatory way, distinct conclusions can be drawn and different steps can be taken for distinct scenarios

Parameters used:

- Ownership
- Exclusivity
- Tradability
- Neutrality
2. Parameters

- Ownership:

Ownership of a license and thus, the right of use for a given frequency band conferred by a regulatory authority, which still differs from ownership of spectrum.

- Exclusivity:

Addresses the question whether or not frequency bands are exclusively assigned to a licensee. A regulator can decide to assign a specific frequency band for every licensee, thus making the frequency band exclusive. If the regulator would decide to group multiple frequency bands in a spectrum pool and make it available for multiple licensees, there would be no exclusivity.
2. Parameters

- Tradability:

Whether or not it is permitted to switch between different operators' frequency bands. If tradability is allowed, an operator can buy or lease a licensee’s frequency band. However, if tradability is either not allowed, or impossible, the use of the frequency band is restricted to the licensee itself.

- Neutrality:

technology neutrality in licensed spectrum bands. Some frequency bands may be open to a variety of radio access technologies, while others only allow one specific technology.
3. Business classification

3A. Unlicensed scenario
3A. Unlicensed scenario

Situation:
Experiments have shown that Zigbee throughput severely drops when interfered by WiFi => loss of valuable/time critical data

SS can provide:
- Very fast “way out”
- Ideal channel selection
- => multiple users and technologies can coexist

Key actors: Unlicensed users, (Regulator)
Regulatory focus: little reform needed

3B. Single-RAT Pool scenario
3B. Single-RAT Pool scenario

Open spectrum for LTE

Situation:
Operators with license share spectrum pool

SS can provide:
- Optimal sharing
- Ideal channel selection
=> multiple operators can coexist within band

Key actors: Licensed operators, Regulator

Regulatory focus: licensing, clear rules to protect compatibility, protect access, regulate fair distribution vs. “hoarding”, a priori technological rules

Issues: what is fair distribution? Are frequencies actually used to serve customers?

3C. Multi-RAT Market scenario
3C. Multi-RAT Market scenario

**Emergency service**

**Situation:**
- PPDR frequency band allocation not adapted to real needs

- SS can provide
  - ROI on license
  - Push secondary users
  - Extra frequencies if needed

- New idea
  - Bigger band, but permitting secondary users

**Routine Situation:**

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<th>400 MHz</th>
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<td>Situation</td>
<td>Too much</td>
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**Crisis Situation:**

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**Key actors:** Primary and Secondary user

**Regulatory focus:** mostly bilateral agreements, but some regulations needed:
- guarantees (sensing technology, pushing technology, reliability), pricing

**Issues:** Which operator can tolerate an occasional ‘push’?

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3C. Multi-RAT Market scenario

**TV White Spaces**

**Situation:**
Very valuable frequencies (good propagation characteristics) are unused since digital switch over

- SS can provide
  - Secondary users know all available frequencies
  - Primary users have ‘no interference’ guarantee
  - Extra bandwidth, good QoS, offload possibilities for Secondary user

**Key actors:** Primary and Secondary user

**Regulatory focus:** is sensing adequate? Vs. alternatives like geolocation DB
3D. Single-RAT Market scenario

Secondary market LTE

Situation:
Operators can lease out parts of their band to other operators
SS can provide:
- Availability information
- Avoiding harmful interference

⇒ Enabling:
- Offloading of its own over-utilized bands, better coverage to its clients on the competitor’s network, better QoS (Sec. User)
- ROI on license (Prim User)

Key actors: Primary and Secondary user
Regulatory focus: bilateral agreements
Issues: control of market? New actors (brokers)? Who can access the market?
3E. Flexible Operator scenario

Femtocells

**Situation:**
Sense femtocell and seamlessly switch + femtocells don’t interfere
SS can provide:
- Availability information
  - Enabling:
  - Offloading of its macrocells, reduced OPEX, customer lock-in (Operator)

Higher data rates, guaranteed coverage, reduced data fee?, innovative applications possible? (End-user)

**Key actors:** Licensed operator and end-user
**Regulatory focus:** no reform needed
**Issues:** femtocell: open to multiple operators?
3F: Static Spectrum scenario

4. Conclusions

- Distinct spectrum sensing scenarios exist
- They call for a distinct approach
  - Regulation
    - Reform needed?
    - Requirements
  - Business models
    - New actors? New roles? Interactions?
    - Different outcome of viability evaluation of business models
  - Technology
Contact

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3B. Multi-RAT Pool scenario
3B. Multi-RAT Pool scenario

Multiple technologies of multiple licensee's sharing one common spectrum pool

=> Still unrealistic?