

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

■ 2. Parameters

- **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.

■ 2. Parameters

■ 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.



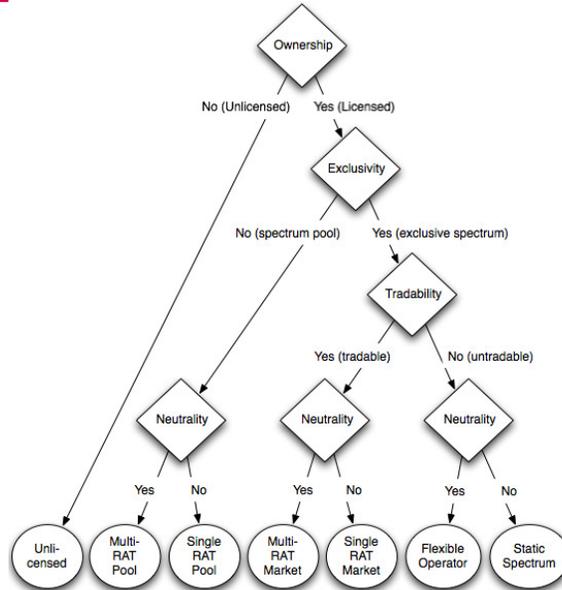
■ 2. Parameters

■ Neutrality:

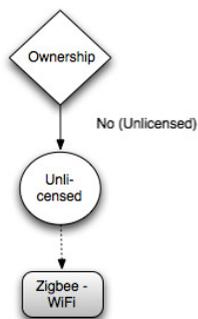
technology neutrality in licensed spectrum bands. Some frequency bands may be **open to a variety of radio access technologies**, while others only allow one specific technology.



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

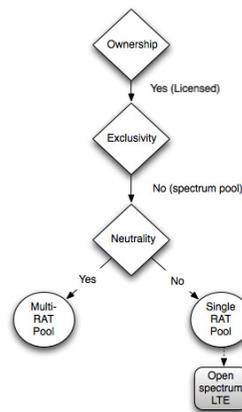
SS can provide:

- 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

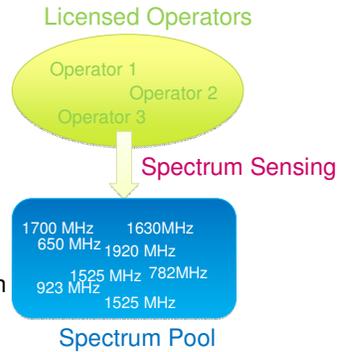
Open spectrum for LTE

Situation:

Operators with license share spectrum pool

SS can provide:

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

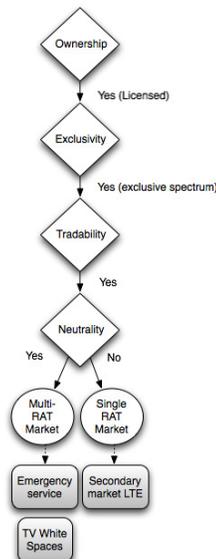


Key actors: Licensed operators, Regulator

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:



Crisis Situation:



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'?

3C. Multi-RAT Market scenario

TV White Spaces

Situation:

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

•SS can provide

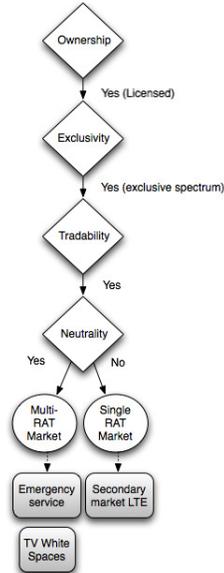
- Secondary users know all **available** frequencies
- Primary users have **'no interference'** guarantee
- Extra bandwidth, good QoS, offload possibilities for Secondary user



Key actors: Primary and Secondary user

Regulatory focus: is sensing adequate? Vs. alternatives like geolocation DB

3D. Single-RAT Market scenario



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)

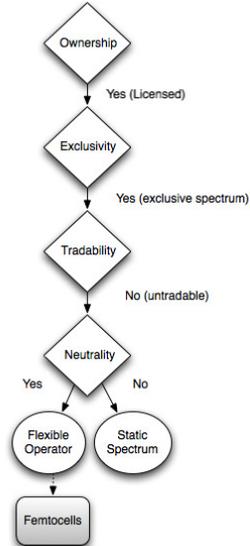


Key actors: Primary and Secondary user

Regulatory focus: bilateral agreements

Issues: control of market? New actors (brokers)? Who can access the market?

3E. Flexible Operator scenario



3E. Flexible Operator scenario

Femtocells

Situation:

Sense femtocell and seamlessly switch
+ femtocells don't interfere

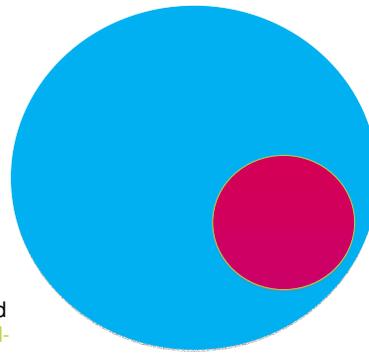
SS can provide:

-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)

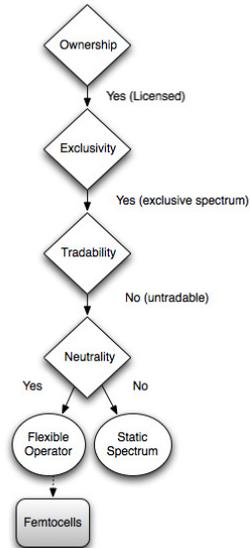


Key actors: Licensed operator and end-user

Regulatory focus: no reform needed

Issues: femtocell: open to multiple operators?

3F: Static Spectrum scenario



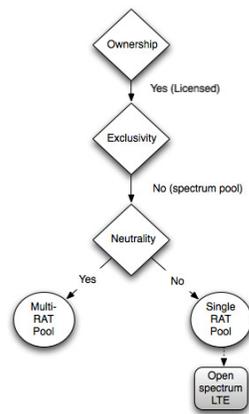
4. Conclusions

- 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**?