

Spectrum Management Tools and Techniques 2020 -Trial for an outlook to the next decade



Cédric Gonzalez
LS telcom SAS, France

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Modern Spectrum Management and transition from Analogue to
Digital Broadcasting - Trends and Technologies**

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Agenda

- **Challenges Ahead**

- **Possible Cure's**
 - ▶ **Flexible Licensing:**
Need for Smart Monitoring Systems
 - ▶ **Exempt, Temporary and Micro Cell Licensing:**
Need for Self Managing Devices & Band Databases
 - ▶ **Improved Spectrum Management Systems**

- **Summary**

Rising Spectrum Demand

- **Modified user demands and habits...**

- ▶ Open Broadband access everywhere, Fixed, Nomadic and Mobile



- ▶ High Definition TV



- ▶ Still rising mobile communication demand



- ▶ Event Communication increases rapidly



- ▶ New Services coming up

Other requirements ...

▶ Non Civilian Usage increases:

- Remote control of robots and vehicles
- Video surveillance
- Tactical Communication



▶ Health issues

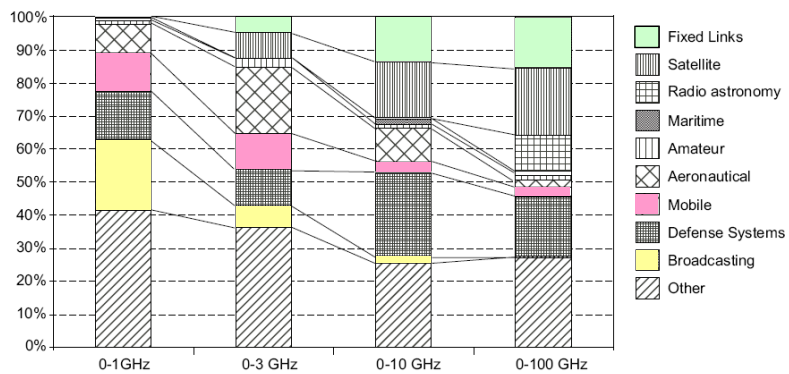


▶ Carbon Balance



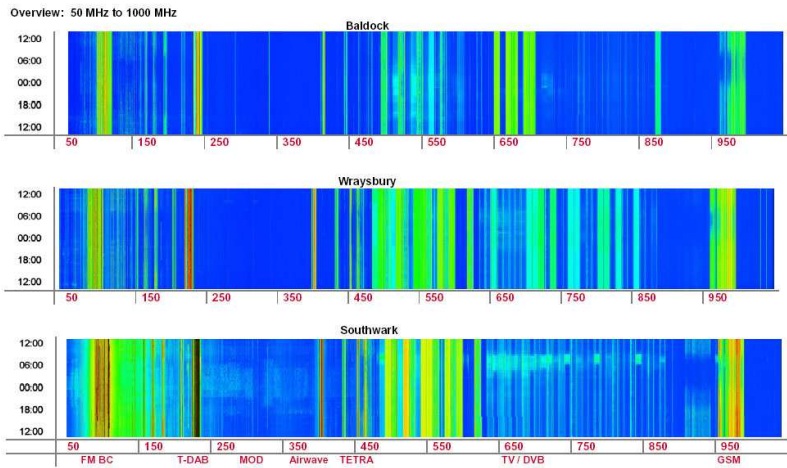
We need smart methods to manage and use our Spectrum more efficiently !

Spectrum Consumption per Service





Where is Spectrum consumed?



Possible Cure: Flexible Licensing

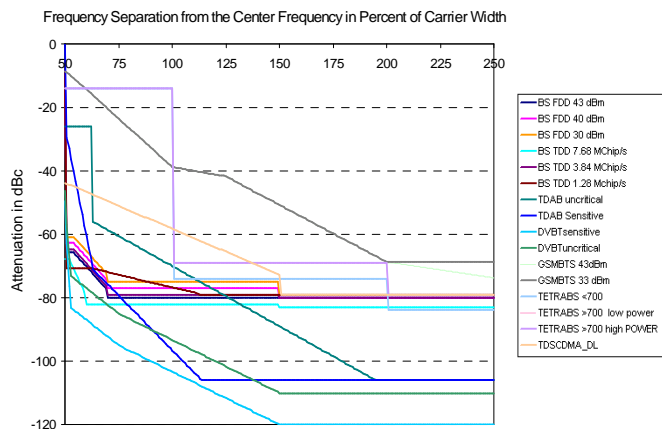




- **Technology and Service Neutral Licenses**
 - ▶ Frequencies and whole Spectrum shall be granted for arbitrary technology as long as band masks are obeyed
 - ▶ Method to overcome technology blocking of granted licenses
 - ▶ Problem is to keep the definitions general
 - Encouraging change of technology
 - Avoiding interference in adjacent bands and regions
 - ▶ Better Analysis and Measurement coverage may be required
 - ▶ Inter-Service Co-Ordination may be complex



■ **Technology Neutral Licenses: Band masks**



▪ **Spectrum trading and secondary usage**

- ▶ Re-Sale of granted frequency space will be widely in place

- ▶ Allowing Re-Use of assigned Spectrum when business models do not pay out or demand is gone

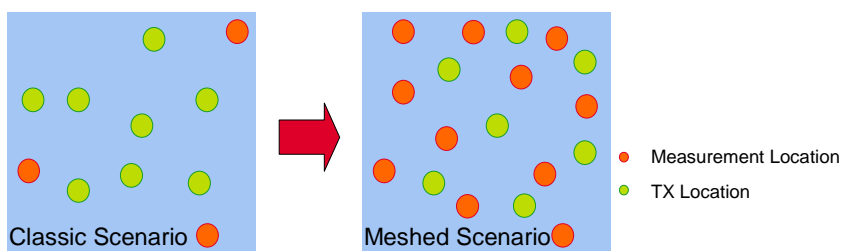
- ▶ Very different models in place and under discussion
 - Simple trade of complete frequency or spectrum block
 - Sub-Use of residual Spectrum (not for high availability services)
 - Time Slot defined use

To ensure Quality of service, the monitoring needs to be improved !

Needed Support: Smart Monitoring Devices
allowing
“Interactive Frequency Assignment”

▪ **Distributed Spectrum Monitoring Systems**

- ▶ Small, IP based units with Omni, Directed or DF Antennas
- ▶ Units are usually programmable, often based on an embedded Windows or Linux System
- ▶ Reduces the effort of mobile campaigns and is permanently available
- ▶ Costs usually substantially lower than for standard equipment
- ▶ Provides permanent sensing capabilities with a narrow mesh



▪ **Distributed Spectrum Monitoring Systems: Examples**



Agilent N6841



Thales TRC 6200



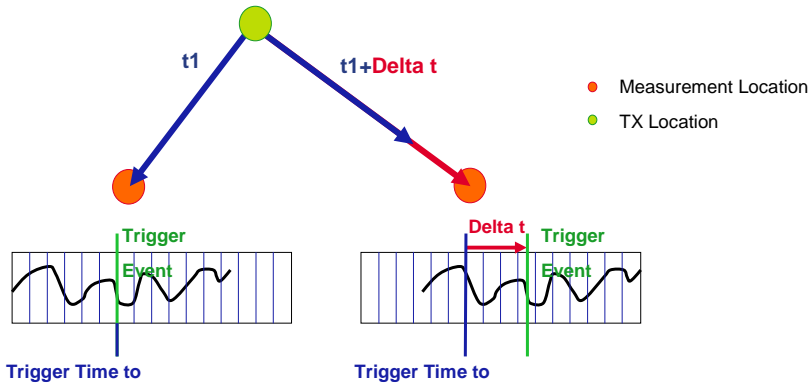
CRFS RFeye



R&S UMS120

▪ **Time Difference on Arrival**

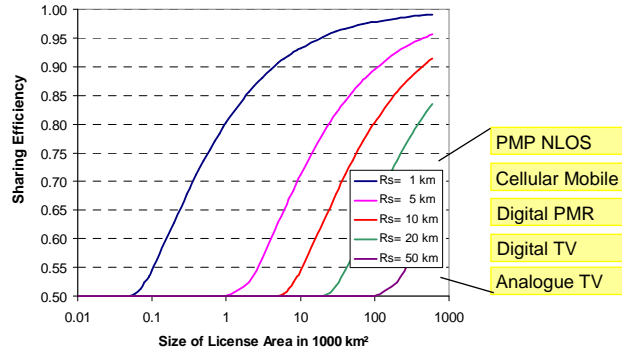
- ▶ Location without directive antennas
- ▶ Very efficient in Cities
- ▶ Needs at least 3-4 stations for successful location analysis



Possible Cure:
Exempt, Temporary and Micro Cell
Licensing

Possible Cure: Microcell Licensing

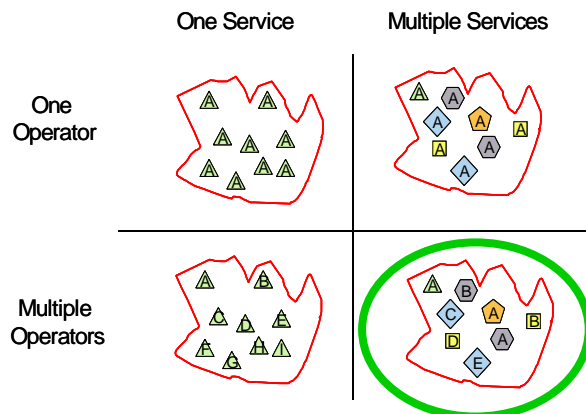
Elimination of Neighbourhood Problems



→ Micro cell structures are more spectrum efficient

Possible Cure: Modified Band Packing

- Filling in add on services in free time or free locations



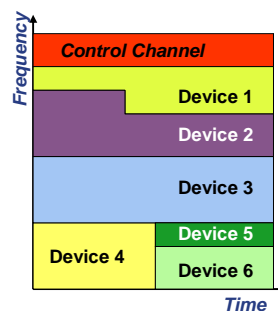
This method requires Self Managing Devices or a Real Time Manager !

Needed Support: Self Managing Devices allowing “Fully Automated Frequency Assignment”

Self Managing Devices (1/2)

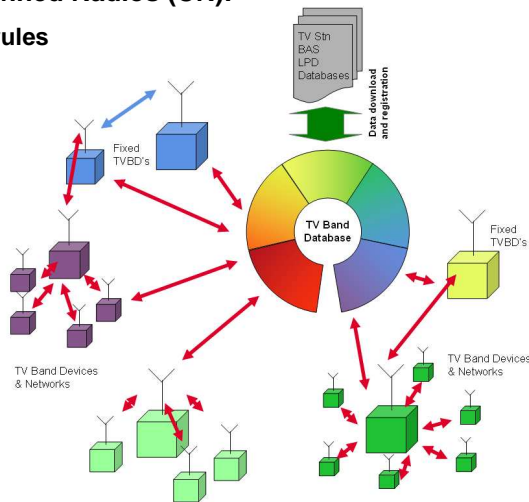
- **Cognitive-Software Defined Radios (CR) according FCC:**

- ▶ Frequency Agility
- ▶ Dynamic Frequency Selection (DFS)
- ▶ Adaptive Modulation
- ▶ Transmit Power Control (TPC)
- ▶ Location Awareness
- ▶ Negotiated Use



▪ **Cognitive-Software Defined Radios (CR):**

- ▶ **Defined distribution rules**
- ▶ **Soft-regulator**
- ▶ **Control channel**
- ▶ **Defined Protocol**



Needed Support: Band Databases

allowing

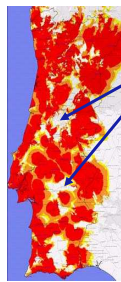
“Real Time Frequency Assignment”

Band Databases (1/2)

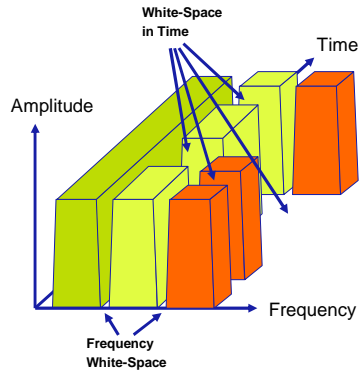


White-Space databases

- ▶ Where are which frequencies and which services when in use
- ▶ Is the frequency open for secondary usage
- ▶ Is use negotiable?
- ▶ At which costs and restrictions?



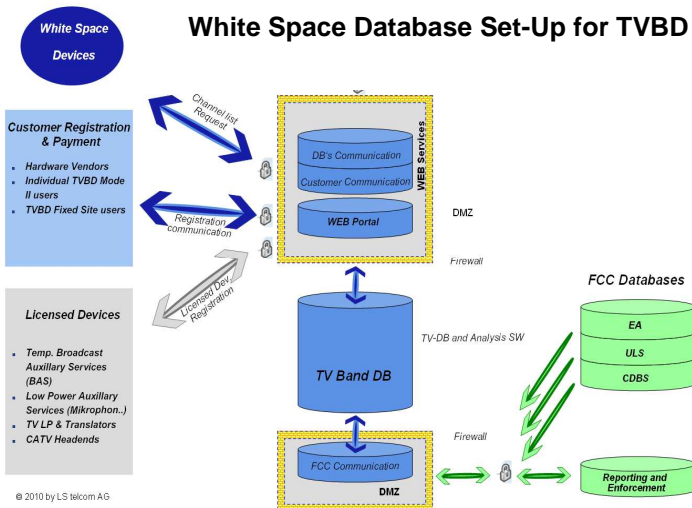
Local White-Space



Band Databases (2/2)



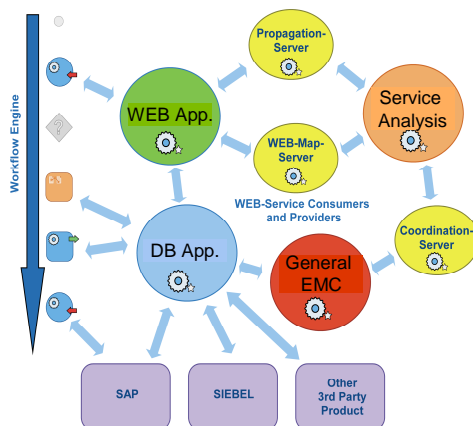
White Space Database Set-Up for TVBD FCC



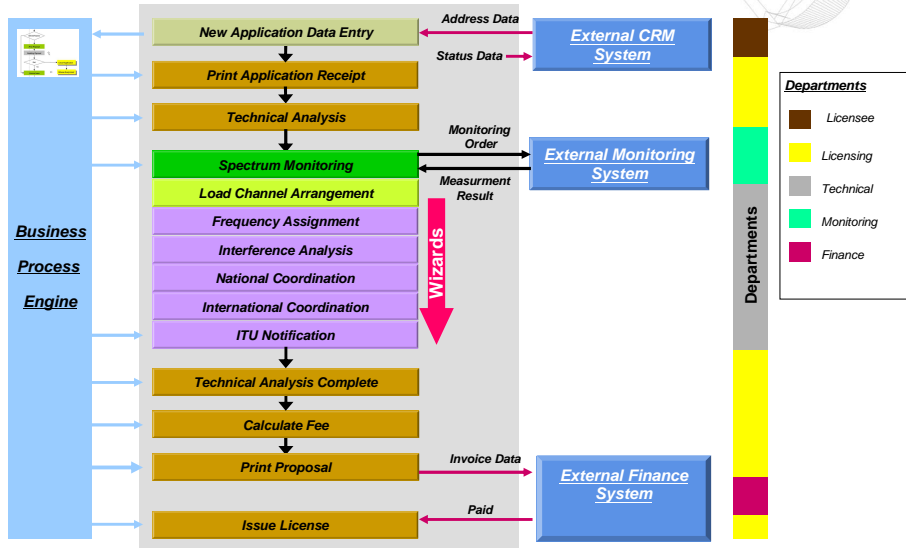
Possible Cure: Improved Spectrum Management Systems

Improved SMS: WEB serviced tools

- **Service Oriented Architecture allows smarter interactions**
 - ▶ Automated Processes can be realized much easier

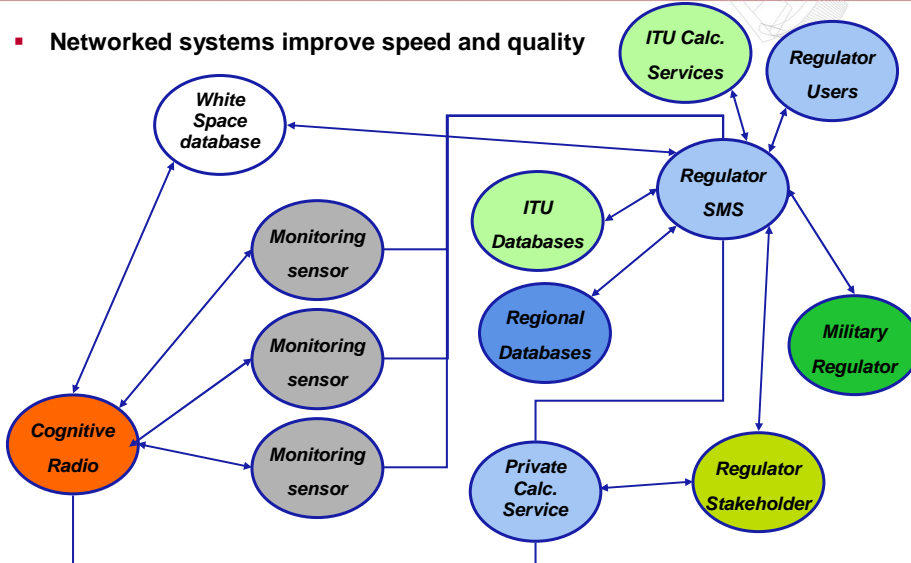


Improved SMS: Fully automated processes



Improved SMS: WEB serviced networks

- Networked systems improve speed and quality



Summary

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- **There will be significant changes in Policy and Technology**
- **Licensing will face**
 - ▶ Technology neutrality
 - ▶ Spectrum Trading
 - ▶ Secondary/White Space usage
- **Cognitive Radio is under way but will unfold its significance not before the mid of the next decade due to price and availability**
- **Monitoring will become a more important role in frequency assignment**
- **White Space Databases will speed up frequency assignment**
- **Future SMS Software might look different:**
 - ▶ More involved entities
 - ▶ Usage of Web services will better link the world
 - ▶ Interactive licensing will become a common mean



Thank You for your attention!
Any Questions?