Regulatory and Standardization Issues on Cognitive Radio based Maritime B-VHF Communications

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Outline

- Maritime Communications
- MMS Spectrum Status
- CR based B-VHF – Overcoming Spectrum Scarcity
- New Paradigms for Regulatory Roles
- Regulatory and Standardization Issues
- Concluding Remarks
Maritime Communications
Maritime B-VHF Communications System

Significant world sailing activity occurs within 40 miles from cost line

Worldwide shore-based VHF infrastructures supporting voice and low rate services

No alternatives to SATCOM for Broadband Services
Maritime Mobile Service Spectrum Status
Except for Channel 16 (156.80 MHz) and channel 70 (156.525 MHz) and channels 75 and 76 (which are retained as guard bands around channel 16),

None of the other channels are exclusively allocated to the MMS!
MMS Allocated Spectrum in Portugal

What about spectrum for B-VHF...?
Spectrum Availability & Management

New Static Spectrum Assignment

Dynamic Spectrum Allocation
Cognitive Radio

“A radio or system that senses its operational electromagnetic environment and can dynamically and autonomously adjust its radio operating parameters to modify system operation, such as maximize throughput, mitigate interference, facilitate interoperability, access secondary markets.”

Joseph Mitola III
Cognitive Radio based B-VHF
Overcoming Spectrum Scarcity
Take advantage of available technologies...

Cognitive Radio

Multicarrier Modulation Schemes

Existing Shore-based VHF infrastructure
...to build up unavailable solutions!

Designated Spectra

Spectrum Sensing

Primary Users = Assigned Services
Secondary Users = Broadband VHF

NC-OFDM

Radio Picture
It is not trivial, but...
...it is not impossible, as well!
New Paradigms for Regulatory Roles
Spectrum Allocation Strategy

- DSA
- Efficient Allocations
- Fear of Harmful Interference
- Interference Prevention
- Inefficient Allocations
- Static
Spectrum Allocation Strategy

- DSA
- Efficient Allocations
- Interference Prevention
- Inefficient Allocation
- Static
- Fear of Harmful Interference
Back to Foundations...

Future Regulatory Framework

Current Regulatory Framework

- Promote Efficient Use of Spectrum
- Enforce QoS of Spectrum Users
- Remove Barriers throughout Telecomms Sector
- Support Telecomms Business
- (...)
Regulatory and Standardization Issues
Challenges...

Transition Plan

Incumbent Harmful Protection

Static Allocation

International Coordination

Dynamic Allocation

Current Regulatory Framework

Future Regulatory Framework
Incumbent
Harmful Protection
QoS Assurance

Static Allocation

Interference Abolition

- No interference...
- Trust on Regulators practices...

Auditing

Maximization of Usable Capacity

Dynamic Allocation

Interference Tolerance

- Interference is allowed, but...
- Trust on Secondary behavior...?!

QoS Enforcement

- ?
- Trust on Regulators practices...
QoS Enforcement

- Descentralized Spectrum Access Control
- Difficult to Register & Log Opportunistic Users
- Interference is Allowed...
- Identification, classification and Localization of Spectrum Users
- Control Interference Levels
- Assure Incumbents Rights
- Conciliate Demands

- Metrics Definition
- Equipment Certification
Primary’s Side...

Acceptable Level of Interference

- Receiver Sensitivity
- Type of Service (Voice, DSC, data, ...)
- Service Required QoS

Evaluation Metrics?
Secondary’s Side...

Normalization

Detection of Primary Activity (start/stop momentums)

Sense While Use the Spectrum

Spectrum Sensing Evaluation Metrics ?

Sensing Periods Between Transmissions ?
Equipment Certification

**Primary:** Demand for Support of live operations

**Secondary:** Guidance & Assistance to avoid harmful interference

**Primary-Secondary Users’ Confidence Relationships**

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**Regulation**

**Enforcement**

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Certification
Operational Caveats

Common Understanding of Criteria for:
- Operational Requirements
- Spectrum Access Conditions
- (Primary/Secondary) Users Relationships
- Regulatory Authority Roles
Primary Operational Metrics

- Spectrum Sensing Inaccuracy
- Density of Secondaries
- Raise Noise Floor

Outage Probability

Achievable Capacity
Secondary Operational Metrics

- Spectrum Sensing Performance
- Channel State Estimation
- Primary Services Activity

Maximum Achievable Capacity
Transition Plan
Spiral Development

Applied Spectrum

Cognitive Maturity

Design
Implement
Evaluate
Test
Where to search the opportunities?
Evolution on MMS

MMS assigned channels for voice (secondary data on primary voice channels)

Pilot testing on “New technologies” allocated channels (DSA on assigned bands)

Build a little, test a little...
International Coordination & Harmozization
None of the 156-174 MHz channels are exclusively allocated to MMS.

Each National Regulatory Authority can choose which service(s) to license in the band, given that the degree of compatibility between services shall be taken into consideration to minimize harmful interference.

National Regulatory Authority can allow frequency bands to be used for other services, providing that do not cause harmful interference to any service which is operating under an allocation in the Radio Regulations.

Concluding Remarks
Paradigm Shift is Inevitable...

- Interest on Maritime VHF based broadband services

- DSA and CR are pointed as decisive strategies to increase efficiency of electromagnetic radio spectrum usage and overcome its scarcity

- Current regulatory framework it is not only inadequate for emerging radio concepts and technologies, but also a potential barrier to its deployment

- No room for “big bang” approaches. It is necessary to prepare transition phases comprehensively documented, discussed and communicated

- Role of Regulatory Agencies is crucial in the new dynamic and “quasi-chaotic” environment...
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Obrigado!