Wireless Innovation Forum
Working Party 5A Seminar on Cognitive Radio Systems and the use of White Spaces

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Wireless Innovation Forum

- Non-profit "mutual benefit corporation" dedicated to advocating for the innovative use of spectrum, and advancing radio technologies that support essential or critical communications worldwide.

- Forum members bring a broad base of experience in Software Defined Radio (SDR), Cognitive Radio(CR) and Dynamic Spectrum Access (DSA) technologies in diverse markets and at all levels of the wireless value chain.

- The Forum acts as the premier venue for its members to collaborate to achieve these objectives, providing opportunities to network with customers, partners and competitors, educate decision makers, develop and expand markets and advance relevant technologies.

Outline – 8 Key Areas

1. Cognitive Pilot Channel/Cognitive Control Channel
2. Geolocation databases
3. Applicability to different bands
4. Sensing – secondary user coexistence. Potential fallback.
   1. Maintain research focus
   2. Complementing database approach
5. Receiver guidelines
6. Tech/Service neutrality
7. Blended infrastructure approach
8. Licensing models e.g. LSA/ASA

Cognitive Pilot/Control Channels

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CPC/CCC

Concept has not gained traction since the conclusion of the E^2R and E^3 projects

Argument for CPC/CCC has been muted by a number of factors:

- Geolocation database approaches
- Complementary wireless technologies with potential for control channel type utility e.g. WiFi, LTE
- Shift from technology-specific spectrum usage to technology and service neutrality i.e. away from a dedicated physical channel for CPC/CCC
- Security issues
  - Not using a single dedicated physical channel/point of failure

CPC/CCC

1. Sensing to perform signal detection and classification, which may be cooperative to help mitigate hidden node issues,

2. The use of databases based on geographical information and known primary user emitter characteristics

3. Pilot channels to distribute environmental information and help the bootstrapping problem

4. Direct information sharing among secondary devices and between primary and secondary systems.

To improve robustness, a combination of these techniques can be utilised.

CPC/CCC

- If adopted, the CPC should not be essential for operation
- Embedding CPC signals in strong fixed signals e.g. radio, TV, may reduce the impact of jammers
    - Deploy as a private CPC with logical channels and introduce redundancy
- CPC should include authentication measures
    - Digital certificates, signatures, extensible authentication protocol (EAP), 802.1x
- Should be considered as a complement to geolocation databases
    - Point to multipoint node broadcast and push/pull notifications
- Leverage existing deployed technologies
    - LTE, WiFi, etc.

Geolocation Databases

Rationale for focusing on sensing and geolocation databases

Geolocation Databases

- The term geo-location database emerged from the early development of TVWS. The database is part spectrum manager, part policy manager, and part coexistence manager.

- Database deals with spectrum usage policies, which may have nothing to do with actual spectrum use.

  - National quiet zones and satellite earth receiver stations, which don't involve transmission so a sensing radio can never identify them

- Networked and synchronized databases accessed with device location information

  - Emerged as a critical technology for enabling and managing spectrum access e.g., 700MHz TVWS and 3.5 GHz Notice of Proposed Rule Making and Orders (NPRM)

  - Towards gathering real-time spectrum information and awareness from many distributed users

  - Simplifies the integration and application of non-spectrum domain information into spectrum management decisions, and such a solution should scale well over time.

Geolocation Databases

The possibility of a catastrophic single-point of failure implies that the system should have redundancies built in:

- The possibility of disparate information leading to conflicting and potentially difficult to trace decisions means that these multiple redundant databases should be well-synchronized.
- Spectrum sharing systems leveraging networked databases have a greater need for secure communications and authentication due to the potential for impacting a large number of systems.
- Furthermore, as with all databases, there exists the possibility of incomplete or erroneous information.

Applicability to different frequency bands

Applicability to different frequency bands

- The under-utilisation of spectrum is not a band-specific problem; spectrum is underutilized in several frequency bands where these bands also have the potential for spectrum sharing through CRS means

- FCC Notice of Proposed Rule-Making and Order on the use of small cells in the 3.5GHz band
  - Offers an additional example of a multi-tiered licensing and usage framework where usage models and power levels depend on the geographical deployment area.

Sensing

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Sensing

- The use of spectrum sensing technologies to better enable cooperative, opportunistic access should not be discounted in future regulatory and system planning

- Technologies for spectrum sensing include both non-cooperative (e.g. matched filters, energy detection, cyclostationary analysis, wavelet analysis, and covariance detection) and cooperative sensing.

- Multiple independent observations may be useful in identifying hidden nodes, minimizing false alarms, and may provide more accurate signal detection.

Receiver Guidelines/Specifications

The traditional transmitter-centric approach is insufficient

Receiver Guidelines/Specifications

- The traditional regulatory focus on transmitter emissions is insufficient to properly operate a cognitive radio system within and across band allocations

- Receiver characteristics should be included as part of the analysis of spectrum allocations.

- Defined protection approaches are a function of the receiver parameters such as sensitivity, blocking and protection ratios

- Specific form of these receiver characteristics will vary on the service and type of CRS being considered.
    - Database driven CRS systems that are sharing spectrum with well defined fixed users may be able to pre-compute protection zones as a function of frequency and location based on the transmitter and receiver performance characteristics

Receiver Guidelines/Specifications

- Potential benefit for increasing spectrum usage efficiency and reducing risk for new market entrants

- Receiver parameters play a fundamental role because the defined protection approaches are a function of the receiver parameters e.g. sensitivity, blocking and protection ratios

- Argument that there is little or new economic penalty for improving receiver performance in new products
  - Due to improvements in technology and manufacturing processes

- Protection of an existing wireless communications system with poor receiver performance could hamper the introduction of a new technology/service

- Receiver parameters included in harmonised standards
  - Would impact equipment specifications and motivate the market to comply

Technology/Service Neutrality

Addressing the technical aspects regarding on on-going push towards technology and service neutrality with regards to spectrum regulation

Technology/Service Neutrality

- Technology and service neutrality is required to further enable innovative and efficient use of spectrum
    - Increased neutrality could result in increased innovation
- Mandating specific technology restrictions negatively impacts continued use of second-generation commercial wireless technology
    - e.g. GSM
- No reason exists today for precluding operators from using other air interfaces within these bands such as LTE, IEEE 802.11af or proprietary air interfaces.
    - Supported by move towards SDR basestation technology, active sharing, network as a service platform
- Optimal use of radio spectrum is more likely to be secured if the market, and not the regulator, decides what technology or service should be provided in a particular frequency band

Blended Infrastructure Approach

Addressing the need to consider a blended infrastructure.

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Blended Infrastructure

- A blended infrastructure approach will increase in dominance over the coming years.

- It is unlikely that a single technology/standard will be able to provide sufficient capacity and coverage within the land mobile sector.

- The use of CRS should therefore be considered as a complement to existing network deployments e.g. LTE, and how best to leverage the advantages of cognitive radio systems in this context.

Blended Infrastructure

TV white space

Messaging/cellular phones

Mobile comms & media
Voice/Video over IP
LTE
High bandwidth + low latency

RF Mesh
In-building environmental controls, security

WiFi

Medical, home area networks

GSM/GPRS

M2M – high density sensing & measurement applications, low bandwidth, bursty

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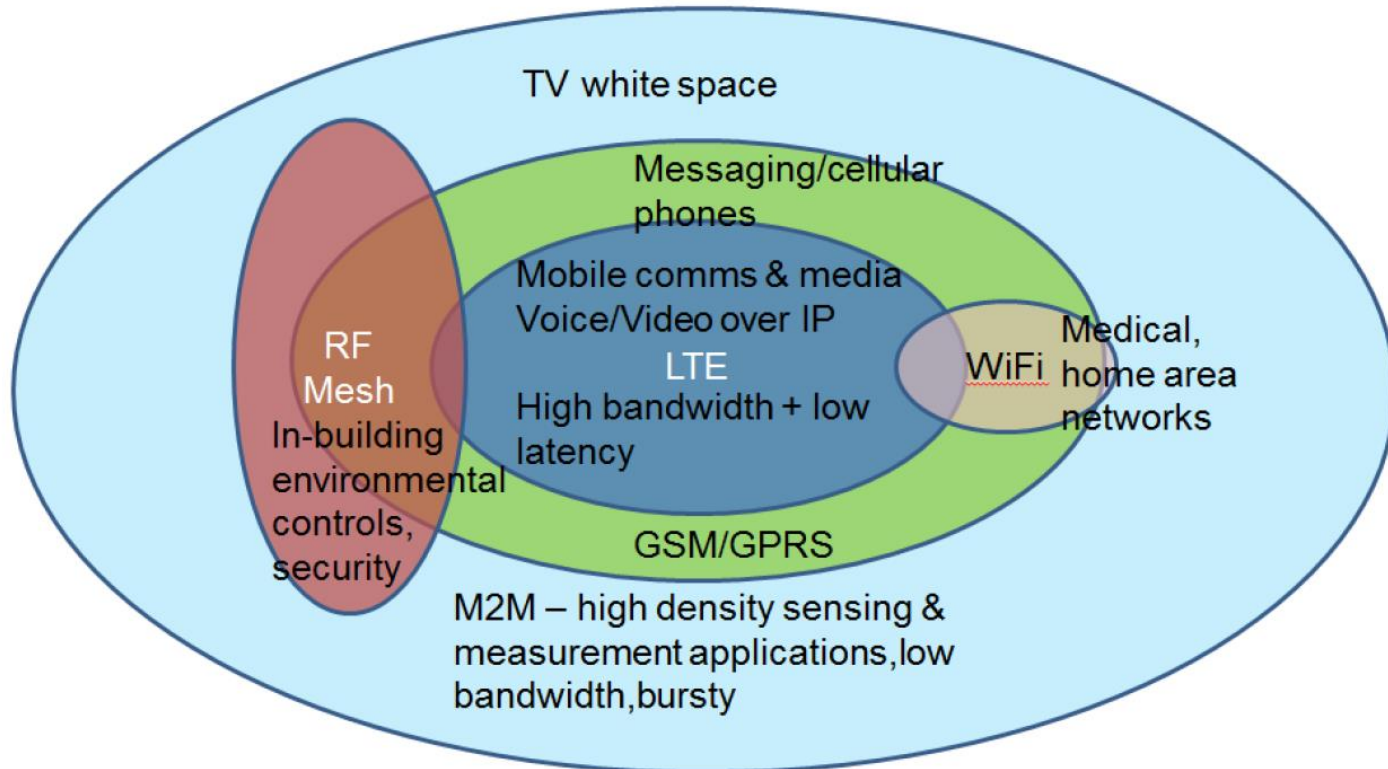
Licensing Models

Addressing the technical implications associated with emerging licencing models.

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Licensing Models

- The need for dedicated spectrum for essential and critical communications will remain.
    - Dedicated spectrum is critical to the development and operation of essential and critical communications systems.
    - Without a business case founded on dedicated spectrum, commercial operators will not be able to make the large investments necessary to deliver national broadband wireless services as called for by regulators

- Regulatory models should include combinations of licensed and unlicensed, sharing and hierarchical, cooperative and co-existent domains for the optimal utilization of spectrum
- Integration of unlicensed access models and establishment of new spectrum sharing regulations, including increased tolerance of nominal levels of interference where appropriate

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Further Information

http://www.wirelessinnovation.org/Document_Library