Licensed Shared Access as complementary approach to meet spectrum demands: Benefits for next generation cellular systems

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Presentation Outline

- Introduction: Future Spectrum Demands for Mobile
- LSA Basic Concept
- LSA Advantages
- LSA Business Perspectives
- LSA Stakeholders and Responsibilities
- LSA Legal and Regulatory Considerations
- LSA Technical Realization
- LSA Standardization Efforts
Future Spectrum Demands for Mobile: Where we are heading?
Wireless Data Traffic Growth - 1

- Exponential wireless data growth in the past decade
- Measures to overcome the bottleneck

Higher bps
- Spectrum
  - Carrier Aggregation / Flexible BW
  - Capacity
    - Peak Rates
  - Aggregated Spectrum
  - Multiple Carriers
  - Multiple Bands

Higher bps/Hz
- Space
  - Multiple Antennas
  - Peak Rates
    - DL MIMO up-to 8x8
    - UL MIMO up-to 4x4
    - MU-MIMO

Higher bps/Hz/km²
- Topology
  - Heterogeneous Networks
  - Capacity
    - User experience
    - Pico cells
    - Femto cells
    - Remote Radio Heads
    - Resource Partitioning
    - Cell Range Expansion
Wireless Data Traffic Growth - 2

- Heading towards even faster growth in wireless data consumption in the next decade
  - Industry needs to be prepared for catering 1000x data demand

- What needs to be done to achieve this goal?

- Network densification and spectrum are the key measures
  - Assuming network densification (+ multiple antenna + improved spectral efficiency) cater for ~100x data growth
    - An extremely ambitious goal

- Need for ~10x more spectrum
  - Exclusive spectrum access, most likely very difficult within a reasonable time frame
  - Need for multiple efforts to get access to spectrum
Multiple Efforts to Access more Spectrum

- Award and license of cleared spectrum remains the priority and the mainstream model for broadband mobile communications
  - What if spectrum cannot be cleared within a reasonable time frame, at all times, nationwide, or by a certain date?
- Then we need a **complementary license model** to ensure QoS
- Plus unlicensed shared use for best effort services
LSA Technical Realization:
High-level functional description
LSA Technical Realization: Design Principals

- **Simplicity:**
  - Focus only on necessary components which are sufficient to operate an LSA system
  - No new radio protocol or functionality envisioned

- **Ease and speed of deployment to enable fast time to market**
  - Network-centric design, no change to user terminals (UEs)
    - Avoid lengthy processes for terminal development (standardization, implementation, conformance and performance testing).
  - UEs only need to support additional LSA bands
    - Leverage on already existing network and terminal equipment, by targeting bands for LSA already designated for IMT (e.g. 2.3-2.4GHz).

- **Technology Neutrality:**
  - Agnostic to any cellular technology
    - Already given by the simplicity principal
  - However, no guarantee that any technology satisfies requirements set by incumbent
  - LTE assumed in the following for illustration purposes
LSA Technical Realization: Functional Architecture

- Just an example, not representing the only possible architecture
Functional Architecture: LSA Repository

- A secure database containing the relevant information on spectrum use by the incumbent
  - information on the spatial, frequency and time domains
  - Maximum interference level

- May add safety margins and deliberate distortions to the actual use data in order to mask the true activity of the incumbent
  - Defense operations, emergency services, etc.
  - Interference management
  - Network security and privacy

- Might be country-specific and under the purview of the National Regulation Authority, due to the sensitive nature of incumbent’s data

- May be directly managed by the Administration/NRA or the incumbent, or be delegated to a trusted third party
Functional Architecture: LSA Controller

- Computes LSA spectrum availability based on
  - Rules built upon LSA rights of spectrum use
  - Information on the incumbent’s use provided by the LSA Repository

- Connected to the LSA Repository through a secure and reliable interface

- One or multiple LSA Controllers per country.

- Can interface with one or multiple LSA Repositories and with one or multiple LSA networks.

- May be managed by the Administration/NRA, the LSA licensee(s) or a trusted third party.
Functional Architecture: OA&M

- Corresponds to the Operations, Administration & Maintenance of mobile networks

- Takes care of the actual management of the LSA licensed spectrum
  - Translates the information on spectrum availability obtained from the LSA Controller into Radio Resource Management commands.

  - Transmits the RRM commands to base stations in the LSA licensee’s network.
    - For enabling UEs to access the LSA spectrum or
    - For ordering UEs to hand off seamlessly to other frequency bands as appropriate depending on LSA spectrum availability, QoS requirements, data rates, etc.
    - For allowing BSs to tune to different channels or to power down.
LSA Operation: Occupying Spectrum when Available

- When indicated by the LSA controller, OA&M system instructs the relevant BSs to enable transmission in the LSA band,
  - Load balancing algorithms in the RAN make use of newly available resources and transfer devices to the new band, based on need.

- Can be achieved by using different techniques, depending on UEs’ connection mode and capabilities (below for LTE)
  - Idle mode UEs:
    - Neighbor list update in system information (SIB) based on RAN broadcast data

  - Connected mode UEs:
    - RAN initiates inter-frequency handover to LSA band
      » UE measures LSA channel and reports RSRPs of corresponding LSA BSs
      » Inter-frequency HO command sent to UE

  - Rel-10 connected mode UEs:
    - RAN initiates component carrier set reconfiguration for carrier aggregation UEs.
LSA Operation: Vacating Spectrum when Needed

- The granted time period for the operation in the LSA band expires, or there is the urgent need to give back the LSA band:
  - Load balancing algorithms in the RAN ensure that UEs are transferred back to the underlying licensed band

- Can be achieved by using different techniques, depending on UEs’ connection mode and capability (below for LTE)
  - Idle mode UEs:
    - RAN indicates in SIB changes in LSA frequencies and bars using this frequency

  - Connected mode UEs:
    - RAN initiates handover procedures to transfer UEs back to the underlying licensed band.

  - Rel-10 connected mode UEs:
    - RAN reconfigures UEs to stop operating in a carrier aggregation mode.
    - The UE continues its normal operation within the underlying licensed band
LSA Standardization Efforts:

ETSI TC RRS
LSA Standardization - 1

- A system for updating, maintaining and providing the conditions for spectrum access needed to be specified
  - LSA system requirements and functional architecture
  - Interfaces between the components of LSA system
  - Mechanisms and protocols necessary for LSA system operation

- Several international standards projects currently working on this

- ETSI TC RRS started in May 2012 with Developing a Technical Report:
  - A System Reference Document (SRdoc) for mobile broadband services in the 2300 MHz – 2400 MHz band under LSA regime with the objective to outline
    - expected usage scenarios
    - technical characteristics and parameters necessary to describe the spectrum needs and performance requirements for the deployment of mobile broadband services under LSA regime
    - high level functions required to manage/comply with the requirements for the deployment of mobile broadband services under LSA regime
LSA Standardization - 2

- **SRdoc main goal**
  - Provide CEPT FM PT52 with data required to develop an ECC Decision for a harmonized use of 2.3-2.4 GHz by mobile and fixed communications networks including
    - least restrictive technical conditions and an appropriate frequency arrangement
    - regulatory provisions based on LSA ensuring the long term incumbent use of the band in the territory of the administrations that wish maintain such use

- **Next steps**
  - development of detailed technical specs for LSA systems
    - Requirements
      » Definition of technical and non-technical aspects required in the first stage by incumbent users, and relevant authorities and in the second stage by MNOs, equipment and device vendors
    - Functional architecture
      » Definition of different logical entities and their respective functionalities
      » Definition of interfaces between standardized logical entities and external entities
    - Potentially protocol details of the interfaces (e.g. data content and security procedures).
Thank You!