

# Sharing Under Licensed Shared Access in a Live LTE Network in the 2.3-2.4 GHz Band End-to-end Architecture and Compliance Results

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*Doriana Guiducci, Claudia Carciofi, Valeria Petrini, Sergio Pompei, Eva Spina, Giuseppe De Sipio, Domenico Massimi, Domenico Spoto, Fabrizio Amerighi, Tommaso Magliocca, Pravir Chawdhry, Seppo Yrjölä, Vesa Hartikainen, Lucia Tudose, Jesus Llorente, Vicent Ferrer, Jose Costa-Requena, Heikki Kokkinen, Luigi Ardito, Pierre-Jean Muller, Massimiliano Ganesin, Fausto Grazioli, Donatella Caggiati*



## Activity overview

- ❑ In 2015, the Italian Ministry of Economic Development (MISE) and the Joint Research Centre of the European Commission (JRC) started a pilot project on the sharing of radio spectrum at **2.3 GHz (3GPP Band 40)**, based on the **Licensed Shared Access (LSA)**.
- ❑ The pilot was developed under the **technical coordination of Fondazione Ugo Bordoni (FUB)** and involves industrial partners from European countries.
- ❑ The **Italian Pilot on LSA was concluded last September** and the final results were presented at a **workshop in Rome at the presence of representatives of the institutions of the EU Member States**.
- ❑ This contribution **complements the previous work presented at the 1st COST IRACON meeting (TD(16)01026) with the final** results obtained in the LSA experiment. On the **web site of the MISE** all the outcomes of the LSA Pilot and the final report are available.

<http://www.sviluppoeconomico.gov.it/index.php/en/news/2033594-licensed-shared-access-lsa-pilot>



# Consortium



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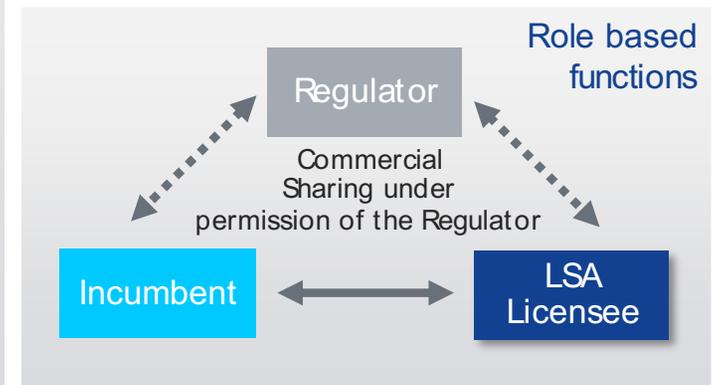
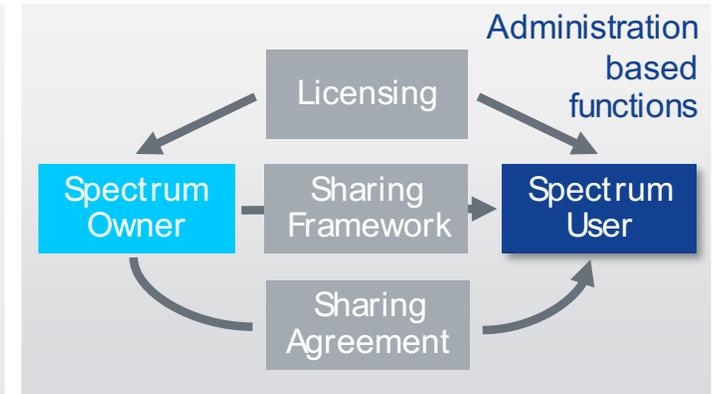
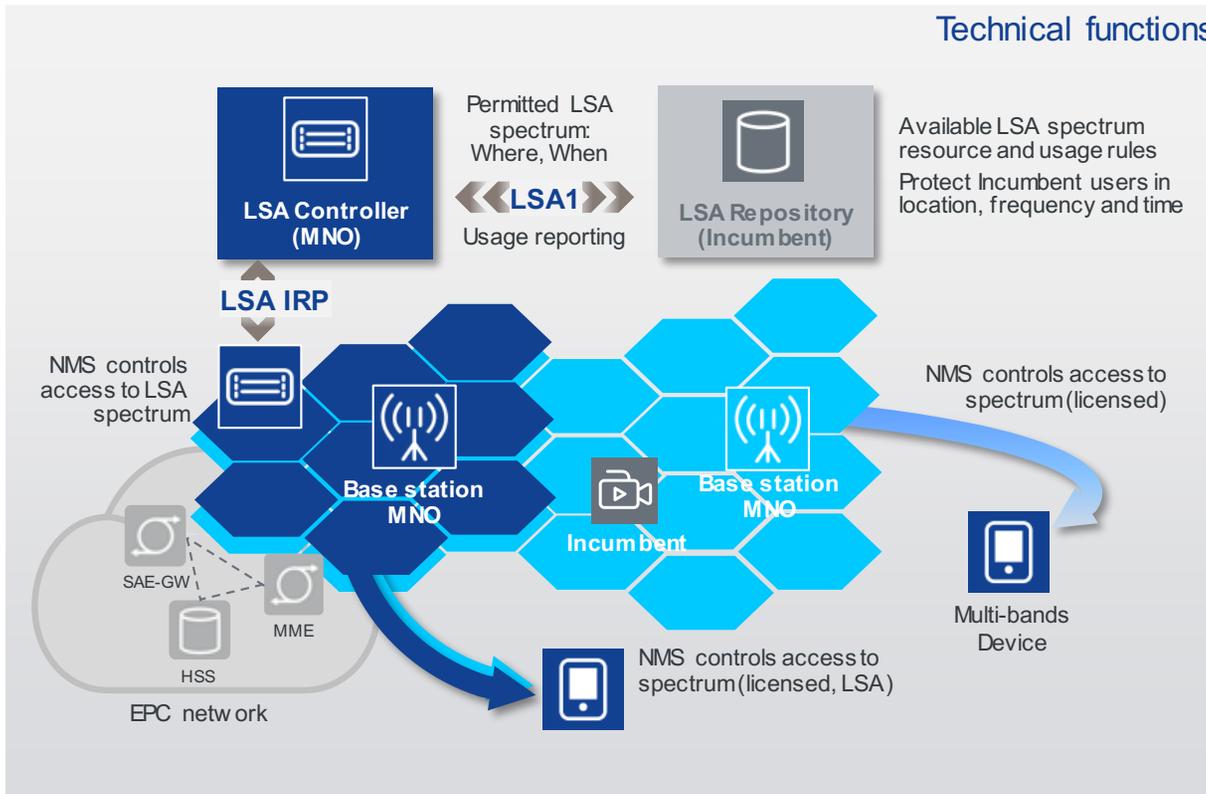


Partners:

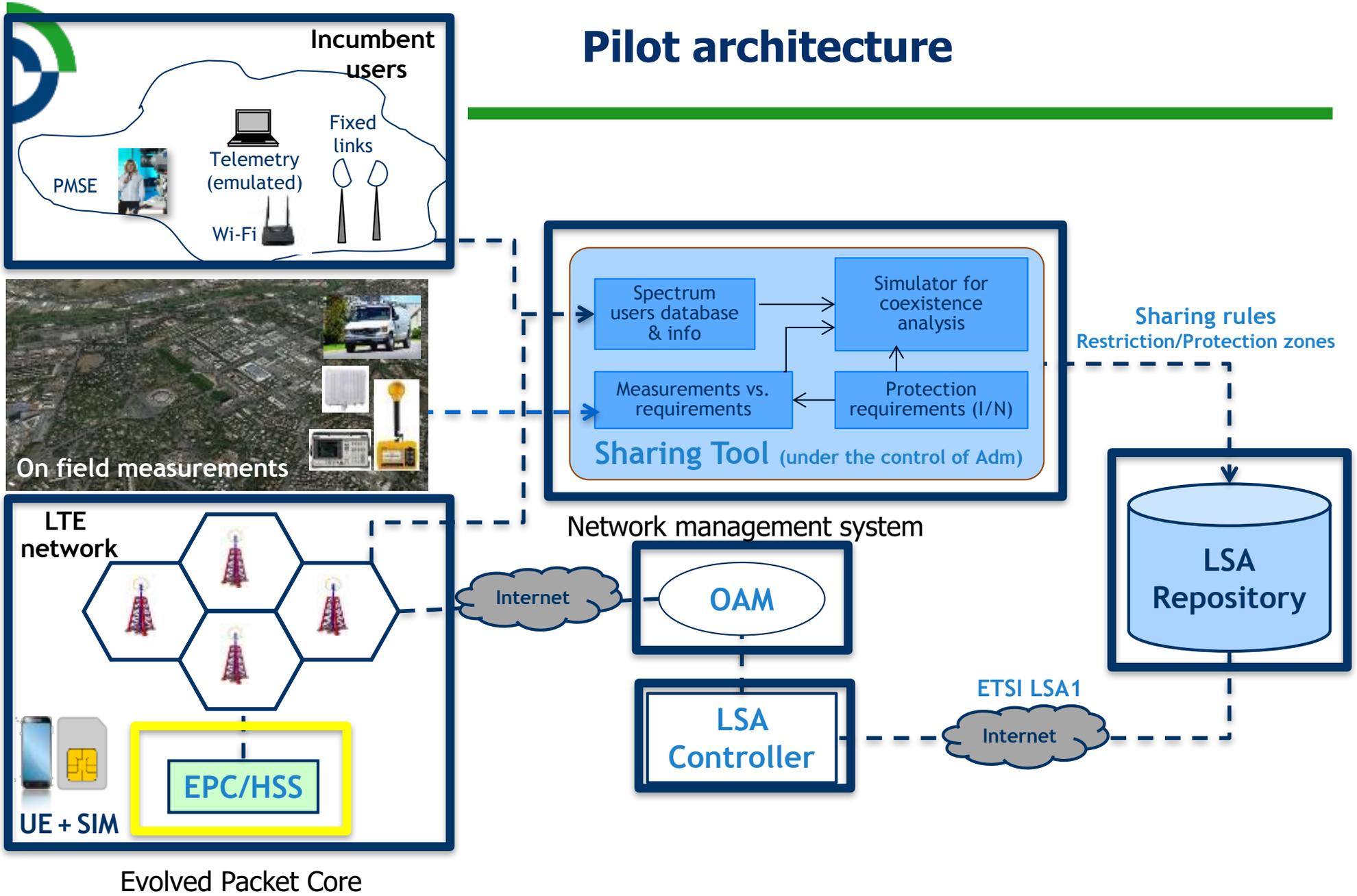




# LSA reference architecture and functions



# Pilot architecture



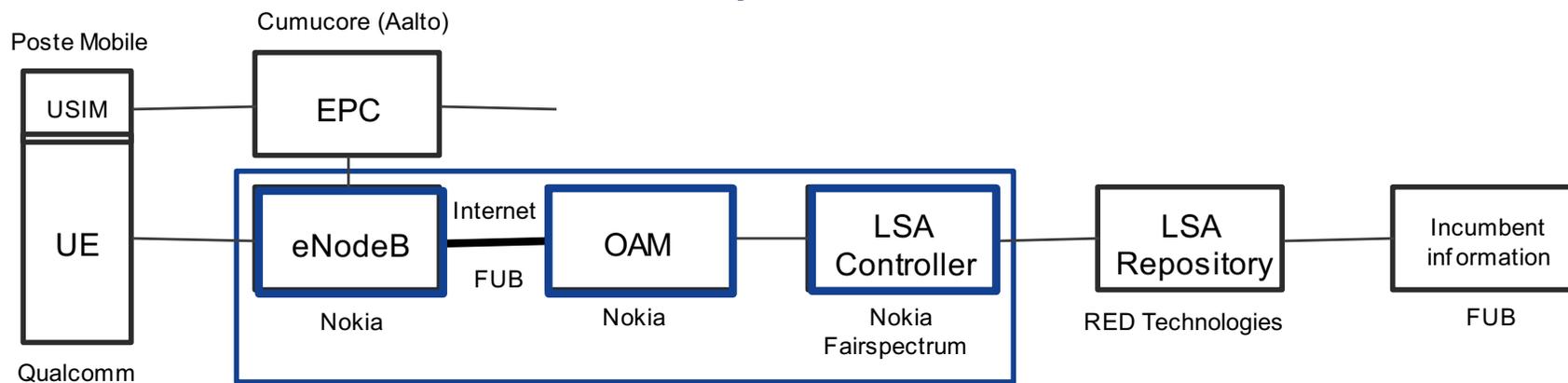


## Pilot elements

- ❑ The pilot was deployed in **Rome**. The different elements of the pilot were provided by different partners and some of them were located **outside Italy**, namely:
  - The Network Management System (OAM) and the LSA controller in **Finland**.
  - The LSA repository in **France**.

Connection among all the pilot elements was granted through the internet.

- ❑ The pilot consists of:
  - 2 outdoor TD-LTE BSs and 5 indoor TD-LTE BSs in the 3GGP Band 40 (1 at the 1<sup>st</sup> and 4 at the 7<sup>th</sup> the floor)

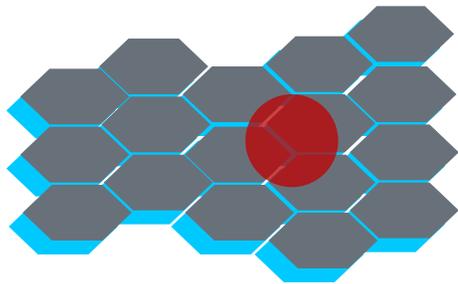




## Definition of the sharing rules

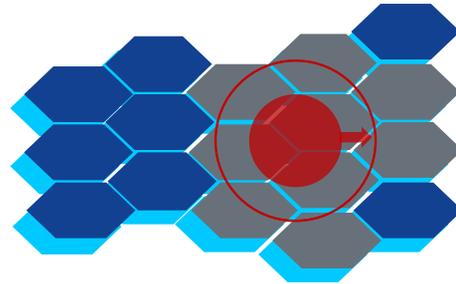
- According to the ECC Report 205 and ETSI standards, the protection of the incumbent users from harmful interference may be realised on a geographical basis defining:
  - **Exclusion Zone (EZ)** is a geographical area within which **interferers are not allowed to have active radio transmitters**. An exclusion zone is normally applicable for a defined frequency range and time period.
  - **Protection Zone (PZ)** is a geographical area within which **victim receivers will not be subject to harmful interference caused by interferer transmissions**. A protection zone is normally applicable for a defined frequency range and time period. It is defined using specific measurement quantities and thresholds (e.g., a mean field strength that does not exceed a defined value dBuV/m/MHz at a defined receiver antenna height above the ground level).
  - **Restriction Zone (RZ)** is a geographical area within which **LSA Licenses are allowed to operate radio transmitters, under certain restrictive conditions** (e.g., maximum EIRP limits and/or restrictions on antenna parameters). A restriction zone is normally applicable for a defined frequency range.

# LC implementation steps and evacuation modes in the operational phase



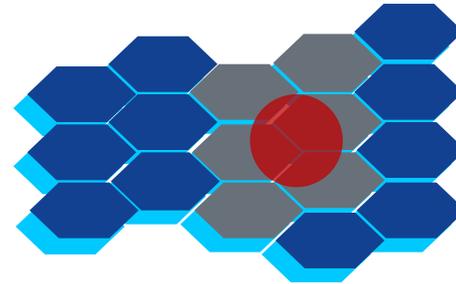
Deactivation of all LSA cells

*Emergency Plan*



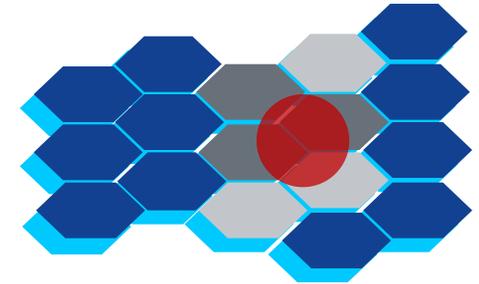
Deactivation of LSA cells within

*Minimum Separation Distance (MSD)*



Deactivation of interfering LSA cells

*Protection Zone Optimization (PZO)*

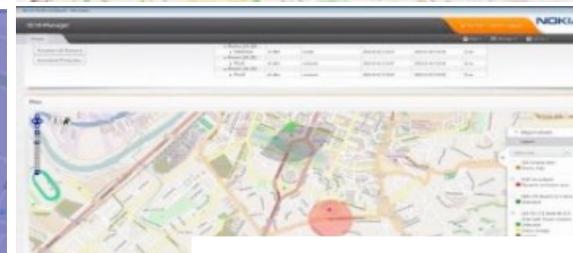
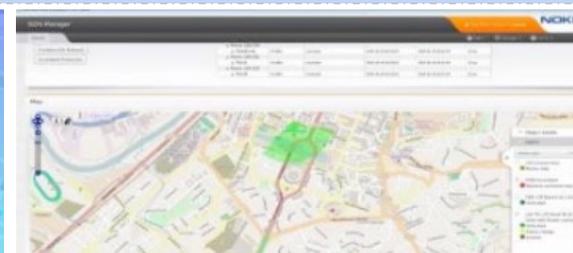
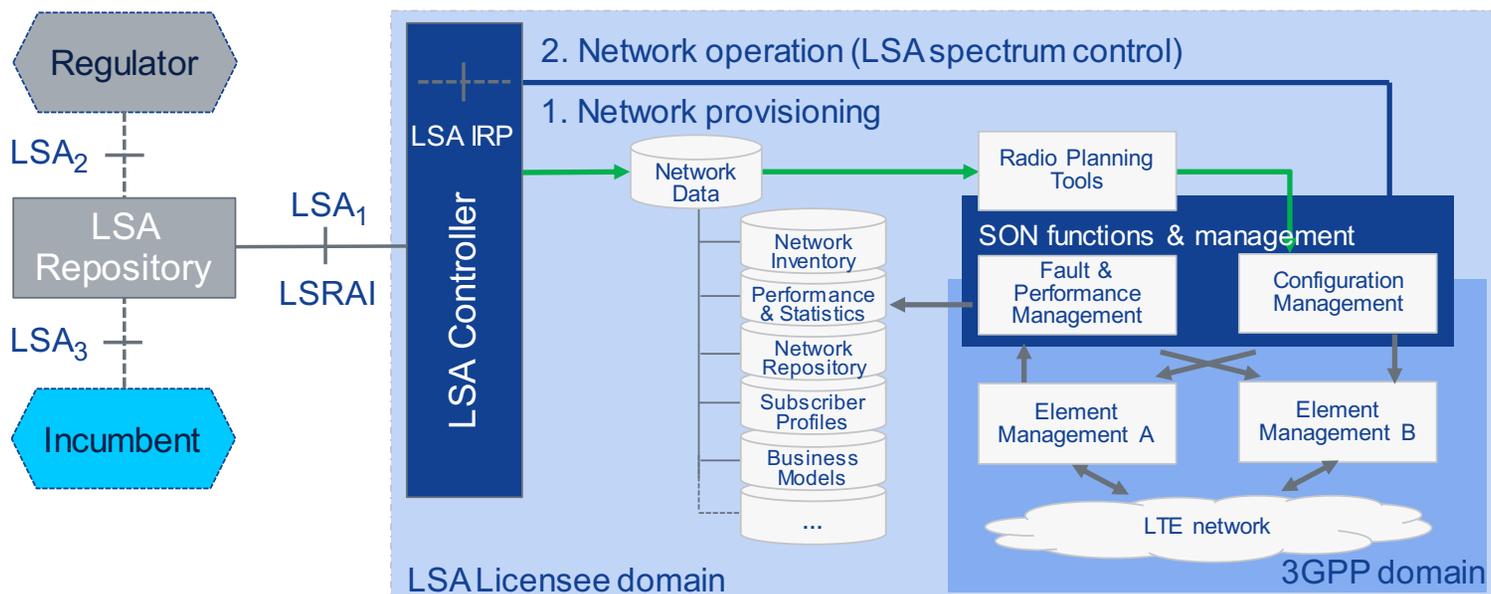


Reconfiguration of interfering cells

*Power Control (PWR)*



# LSA Controller integration with network management system





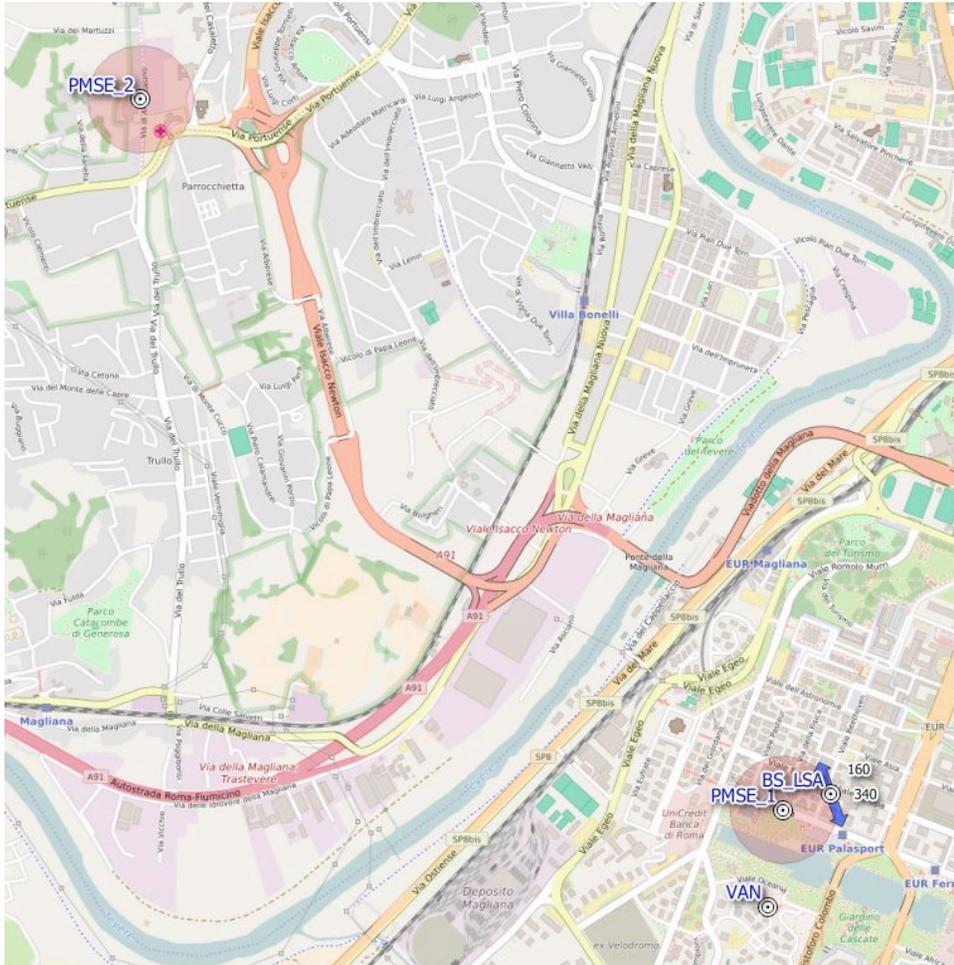
# Results: experimental verifications of the sharing rules



## Protection of PMSE users and channel pre-emption (1)

- ❑ A possible Program Making and Special Event (PMSE) incumbent requests frequency resources in a given location for its operation.
- ❑ Consequent response of the LSA system was assessed by measuring the **evacuation time: the time needed to reconfigure the LTE network, so to make the channel available for PMSE.**
- ❑ The channel pre-emption request issued by the PMSE user was transmitted to the **LSA Repository**, where a **circular protection zone of 200 meter radius** was activated and then communicated to the **LSA Controller**.
- ❑ The **proper configuration** of the LTE network was finally determined and applied to fulfil the pre-emption request from the incumbent PMSE.
- ❑ The LTE nodes (or part of them) were either **switched off** or their **carrier power reduced** to limit interference at the PMSE victim receiver below the set threshold (e.g.,  $I/N = -6$  dB)

# Protection of PMSE users and channel pre-emption (2)



- Approaches and requirements to protect the incumbent users

Incumbent use	Protection approach	Protection requirements
Fixed links (2 MHz bandwidth)	Restriction/ Exclusion zones	I/N = - 10 dB
		Imax = -117.5 dBm
		Emax = -4.9 dBμV/m
PMSE video links (8 MHz bandwidth)	Protection zones	I/N = - 6 dB Imax = -106.9 dBm Emax = 37.6 dBμV/m
Telemetry (10 MHz bandwidth)	Protection zones	I/N = - 6 dB Imax = -106 dBm Emax = 38.6 dBμV/m

- On-spot measurements conducted with a field measurement van.





## Test case A: Location PMSE\_1 (1)

- ❑ The mutual distance and orientation between the PMSE victim receiver, assumed in location PMSE\_1, and the LTE BSs required **both all the outdoor and indoor LTE nodes** to be **switched off**.
- ❑ The evacuation time was measured from the moment when the **LSA Repository receives the channel pre-emption requests** to the moment when the LTE cell statuses were changed (**the LSA Controller receives notification that cell operational status has changed.**)

### Channel preemption

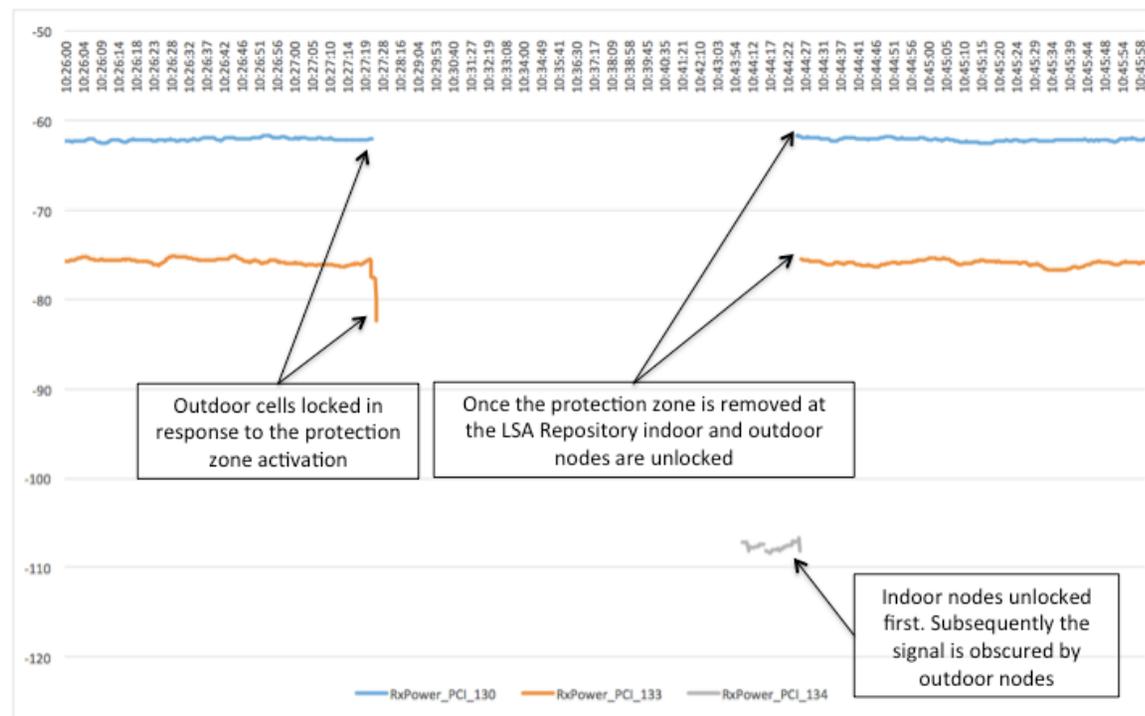
Mean value [s]	36.716441
Median value [s]	36.671325

- ❑ The evacuation time was in all measurements below **40s**.
- ❑ a delay of **400 ms** between the LSA Repository and the LSA Controlled, located in Paris and Helsinki, is included.



## Test case A: Location PMSE\_1 (2)

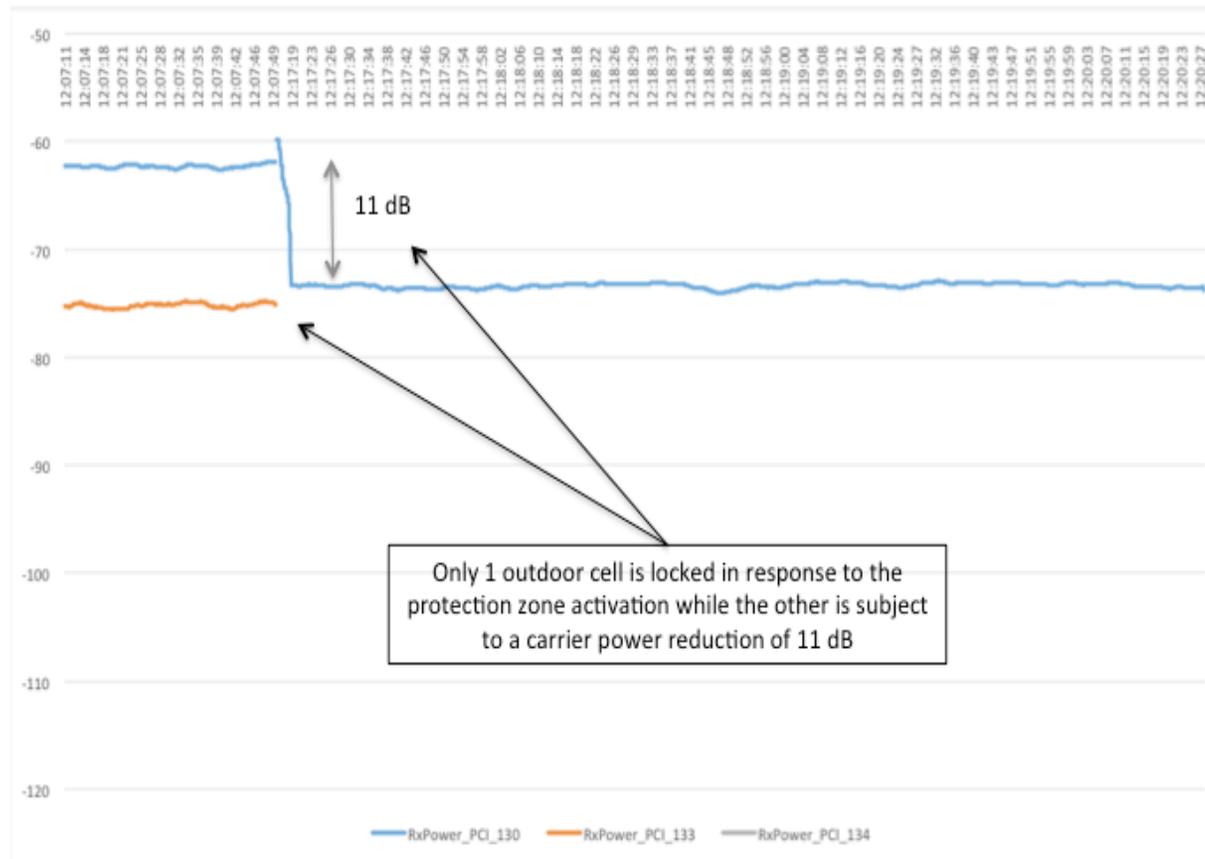
- ❑ The results showed that **outdoor nodes** (PCI 130 and 133) were switched off (**locked**), once the PMSE user issued its request.
- ❑ LTE BSs were then switched back on (**unlocked**), once the PMSE user did not require the LSA spectrum resource, and the related protection zone was released at the LSA Repository.





## Test case B: Location PMSE\_2 with carrier power reduction

- The mutual distance and orientation of the victim PMSE and the LTE interferer was such that, in response to a channel pre-emption request, **only one cell** (PCI 133) was **locked**, while the carrier power of the other outdoor cell (PCI 130) was **reduced by 11 dB**, from the 37 dBm to 26 dBm.



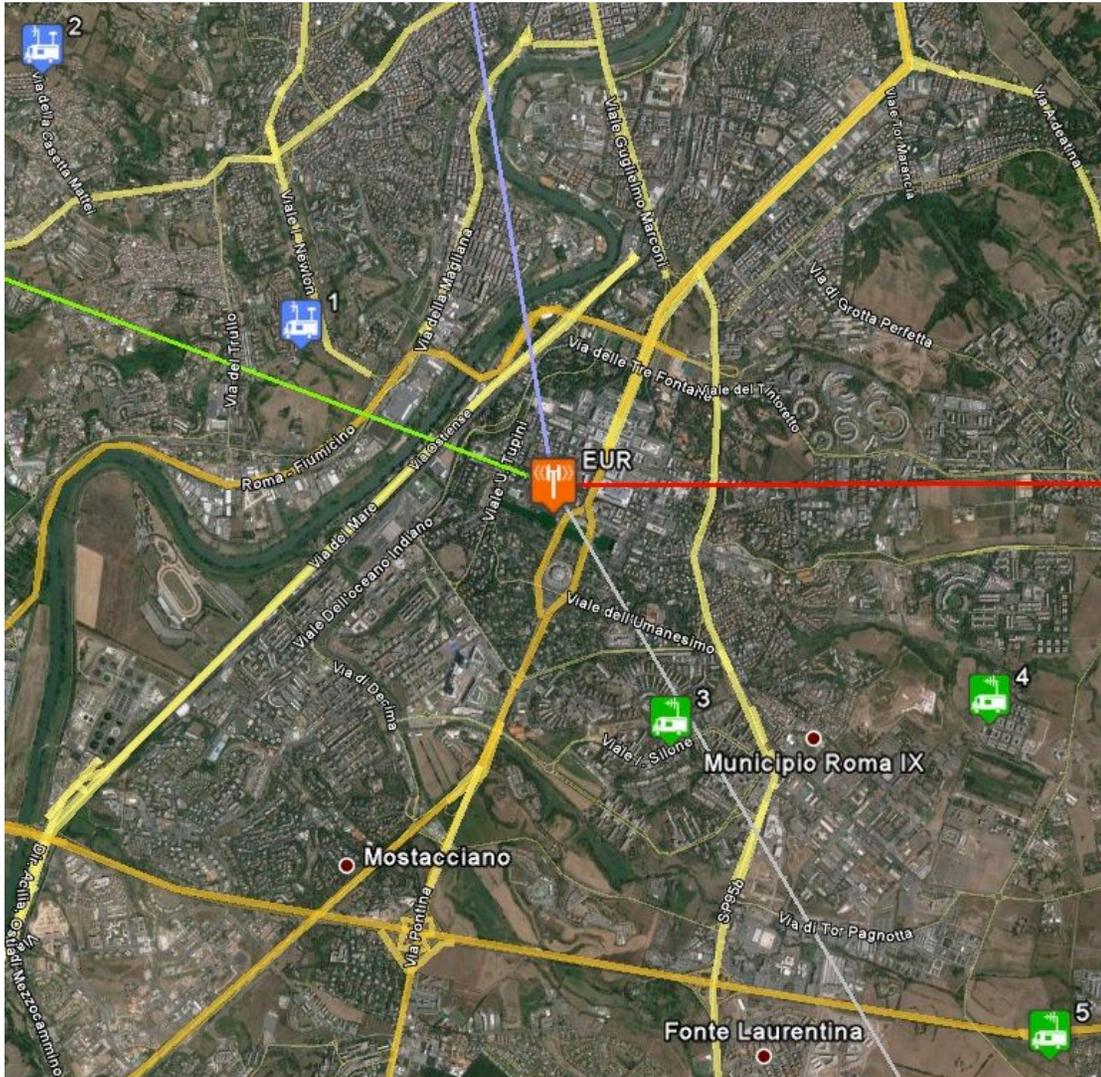


## Compliance with the sharing rules for FS (1)

- ❑ The protection of the incumbent Fixed Service (FS) was based on the **Restriction/ Exclusion Zone** approach.
- ❑ In order to verify the compliance of the LTE nodes' operations with the FS, **several measurements were performed by the MISE with the equipped van in collaboration with FUB and the JRC of the European Commission.**
- ❑ **A very sensitive measurement chain**, such as provided by MISE, was **required to assess very low interference power levels due to the need of verifying a stringent I/N requirement** (i.e., to measure an interference level 6 or 10 dB below the noise floor)



## Compliance with the sharing rules for FS (2)

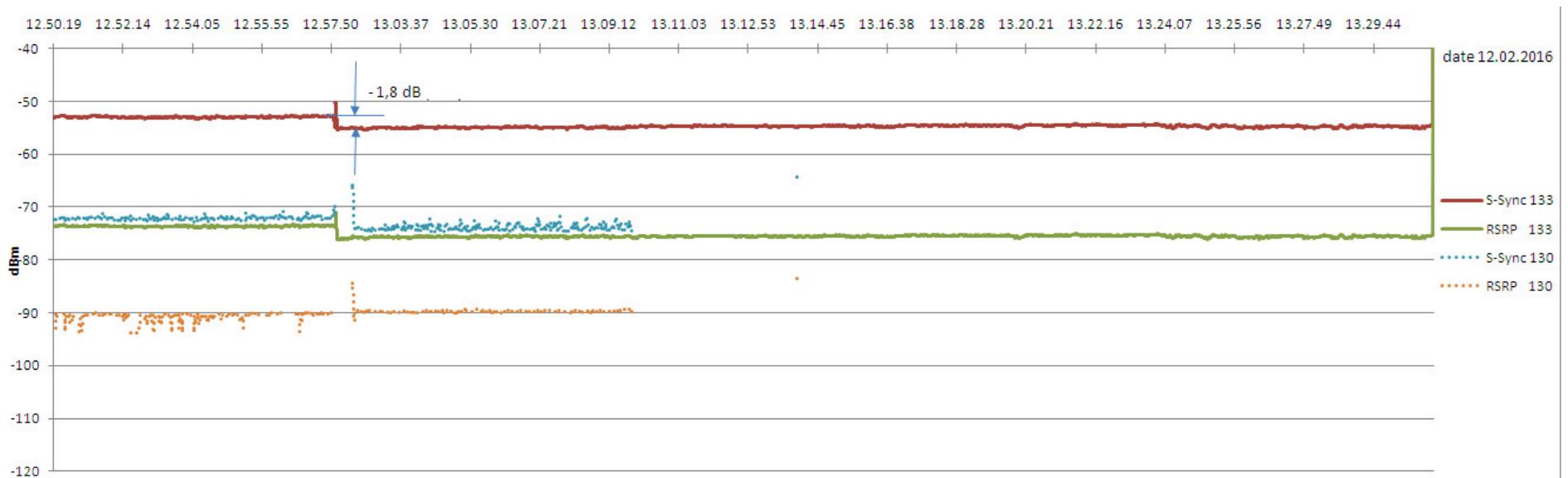


- ❑ Five different positions were identified.
- ❑ Measurement locations were between 2 and 5 km from the LTE BSs.



## Compliance with the sharing rules for FS (3)

- ❑ The LTE signal generated by the outdoor cells was clearly received from location 2.
- ❑ Starting from a configuration where the outdoor cells EIRP was set to 37 dBm, the EIRP restrictions were activated at the LSA Repository and transmitted to the LSA controller.
- ❑ In particular, for the specific pixel where the LTE BSs are placed, the RZs correspond to EIRP restriction of 35.2 dBm. (1.8 dB power reduction).





## Conclusions

- ❑ The Italian LSA pilot was the **first experiment on a large scale** to assess technical and regulatory feasibility of **licensed spectrum sharing in 2.3-2.4 GHz** band through a realistic indoor and outdoor deployment utilizing commercial network elements and real life incumbent data.
- ❑ The **testbed for LSA** was realised in compliance with latest **standards** and **European** and **national regulatory frameworks**.
- ❑ **Co-existence of LTE systems operating under LSA with incumbent use** was validated and found **feasible** in e2e field trials.
- ❑ **Microcells** and **femtocells** layouts might significantly **increase sharing opportunities**.
- ❑ Tests on channel **evacuation** were validated in PMSE use case, in which an incumbent user requests a channel for its operations in a given location. In the Italian pilot set up the evacuation time was **40 seconds**.
- ❑ LSA concept **accelerates** spectrum harmonization, and leverages available LTE technologies to ensure early use and **economy of scale**.

# NOKIA

Thank you  
Questions/discussion?

[seppo.yrjola@nokia.com](mailto:seppo.yrjola@nokia.com)