

# The Italian Pilot on the Licensed Shared Access in the 2.3-2.4 GHz band Presentation of the results

Rome, 23<sup>rd</sup> September 2016

## The Pilot on Licensed Shared Access in Italy

Measurement campaigns and main results – Part 1



**Doriana Guiducci**  
Fondazione Ugo Bordoni  
**Technical Coordinator of the LSA Pilot**



# Pilot leaders and partners



European  
Commission

JOINT RESEARCH  
CENTRE



*Ministero dello Sviluppo Economico*



**FUB**  
Fondazione Ugo Bordon  
Research and Innovation

Technical Coordinator:

Partners:

**Poste**  
mobile

**QUALCOMM**<sup>®</sup>

**NOKIA**

**ATHONET**

Fairspectrum

**RED**  
TECHNOLOGIES

**Cumucore**

**FUB**  
Fondazione Ugo Bordon  
Research and Innovation

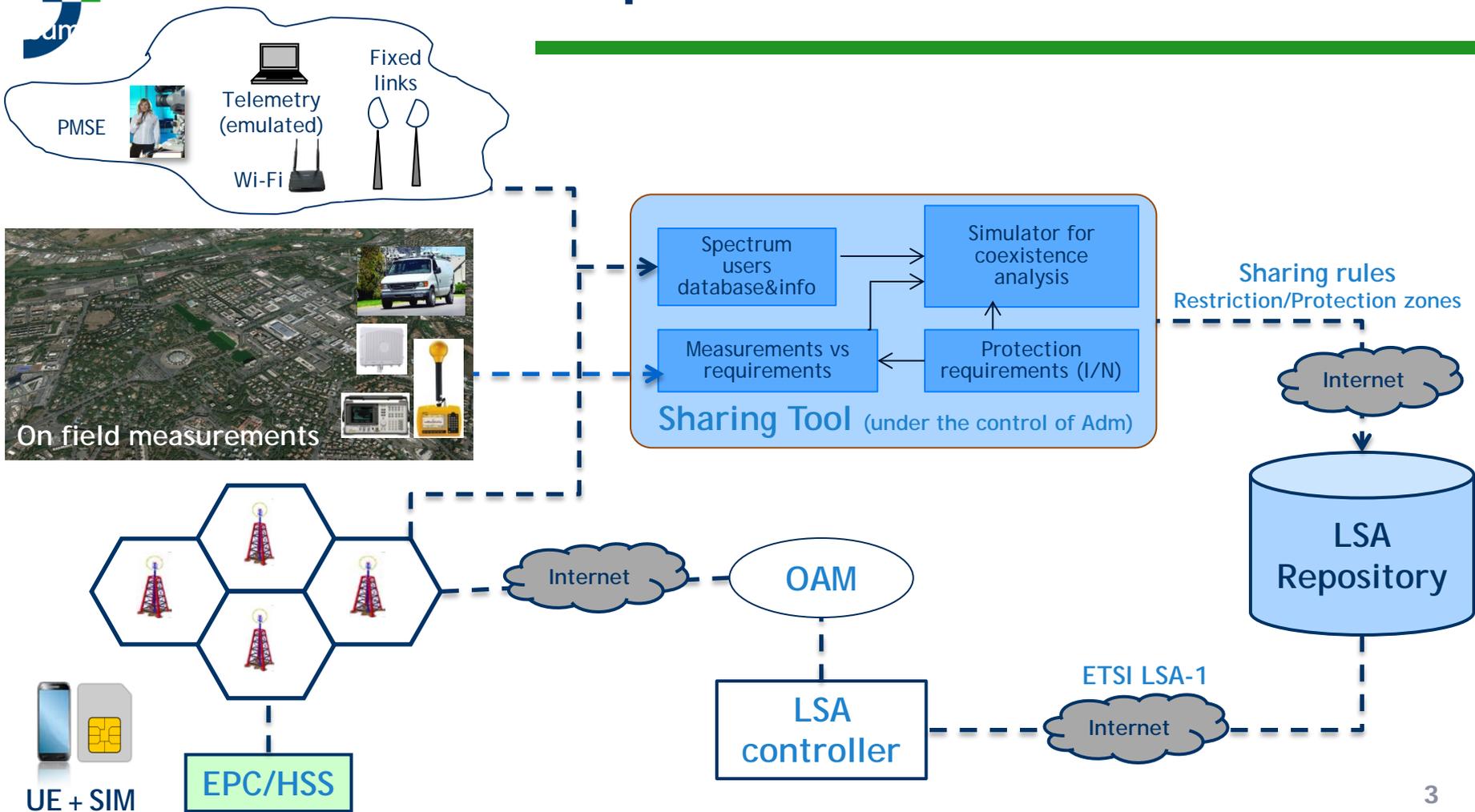


The Italian Pilot on the Licensed Shared Access in the 2.3-2.4 GHz band  
Presentation of the results

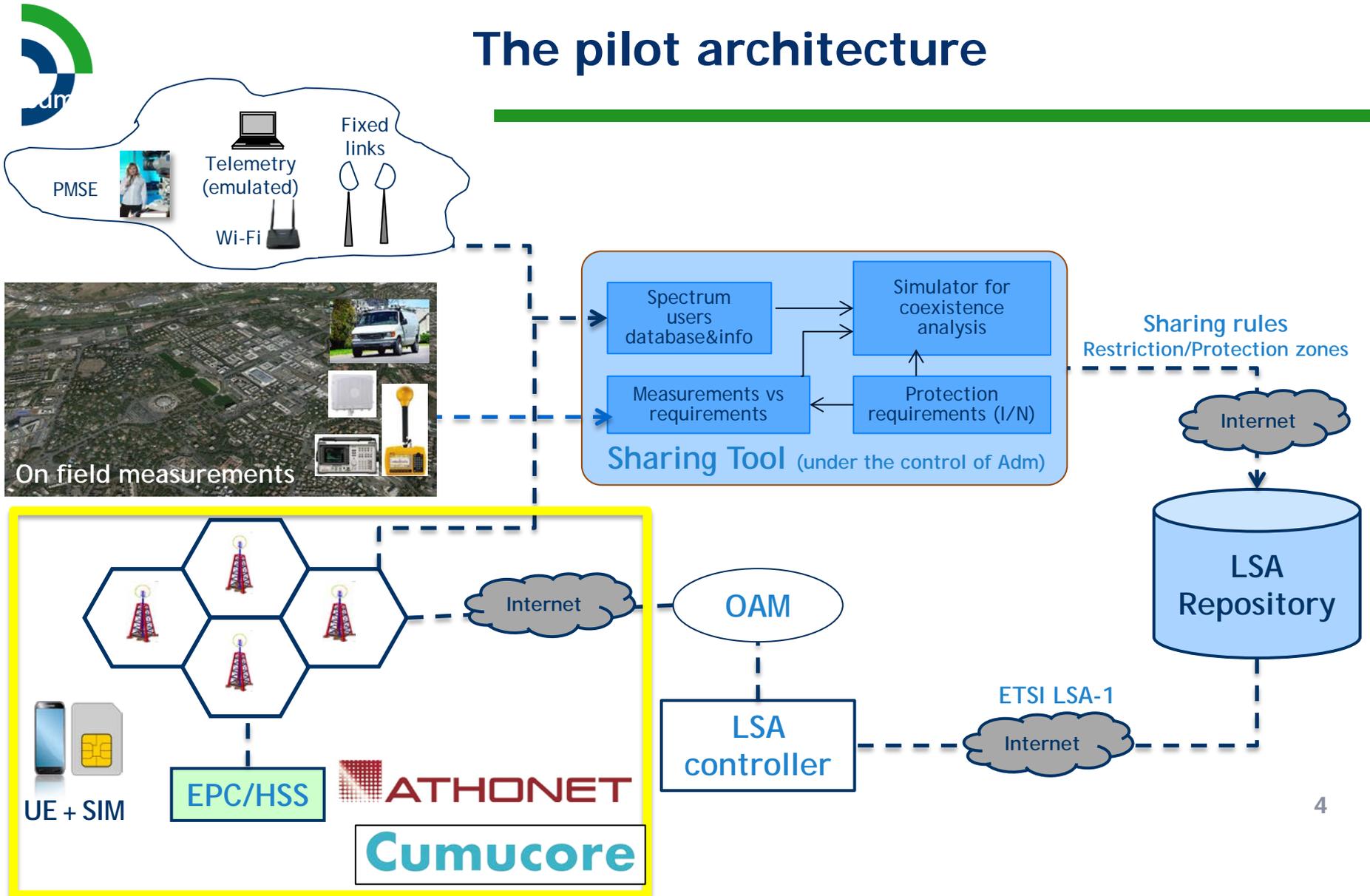
Rome, 23 Sept 2016



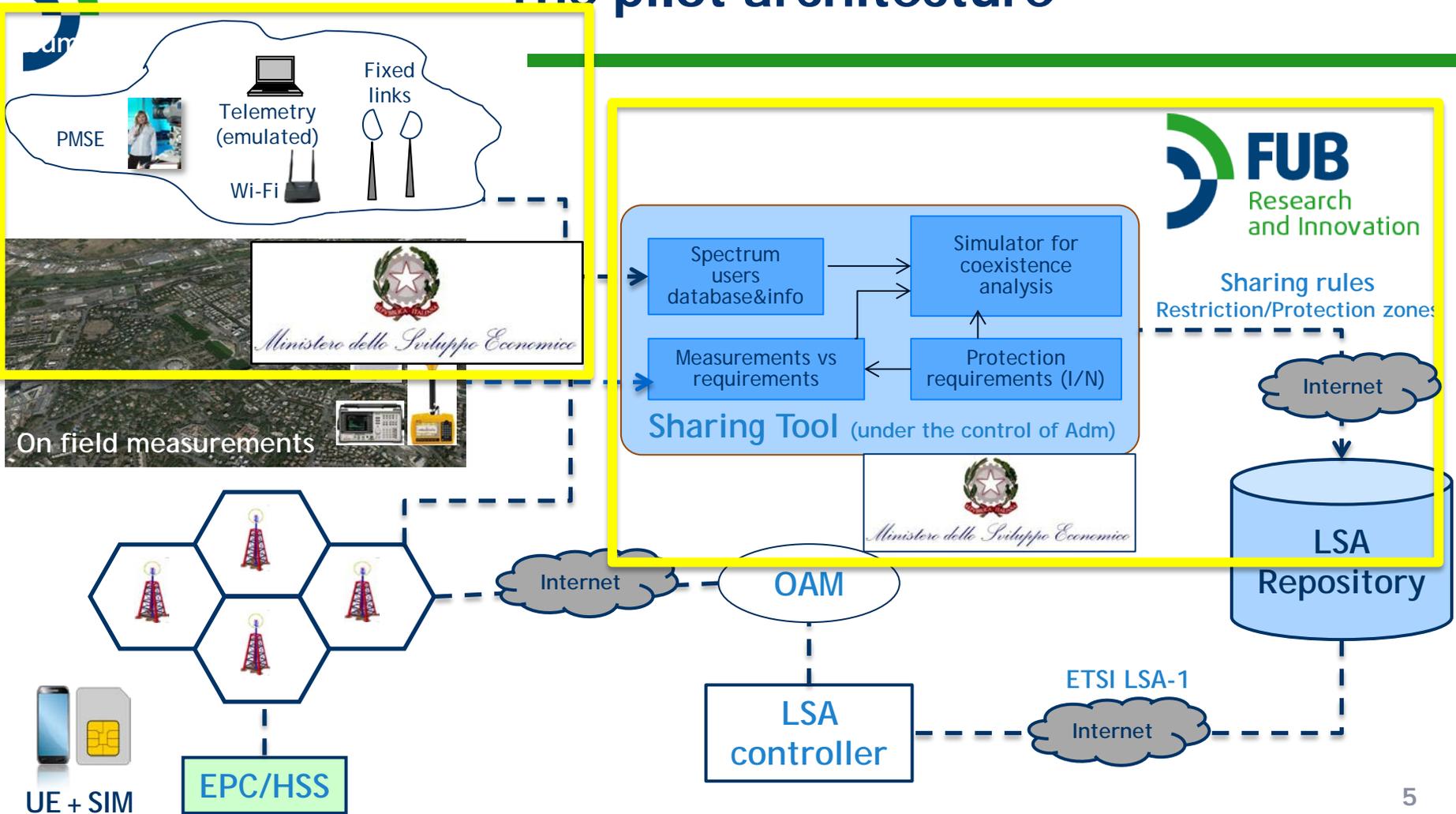
# The pilot architecture



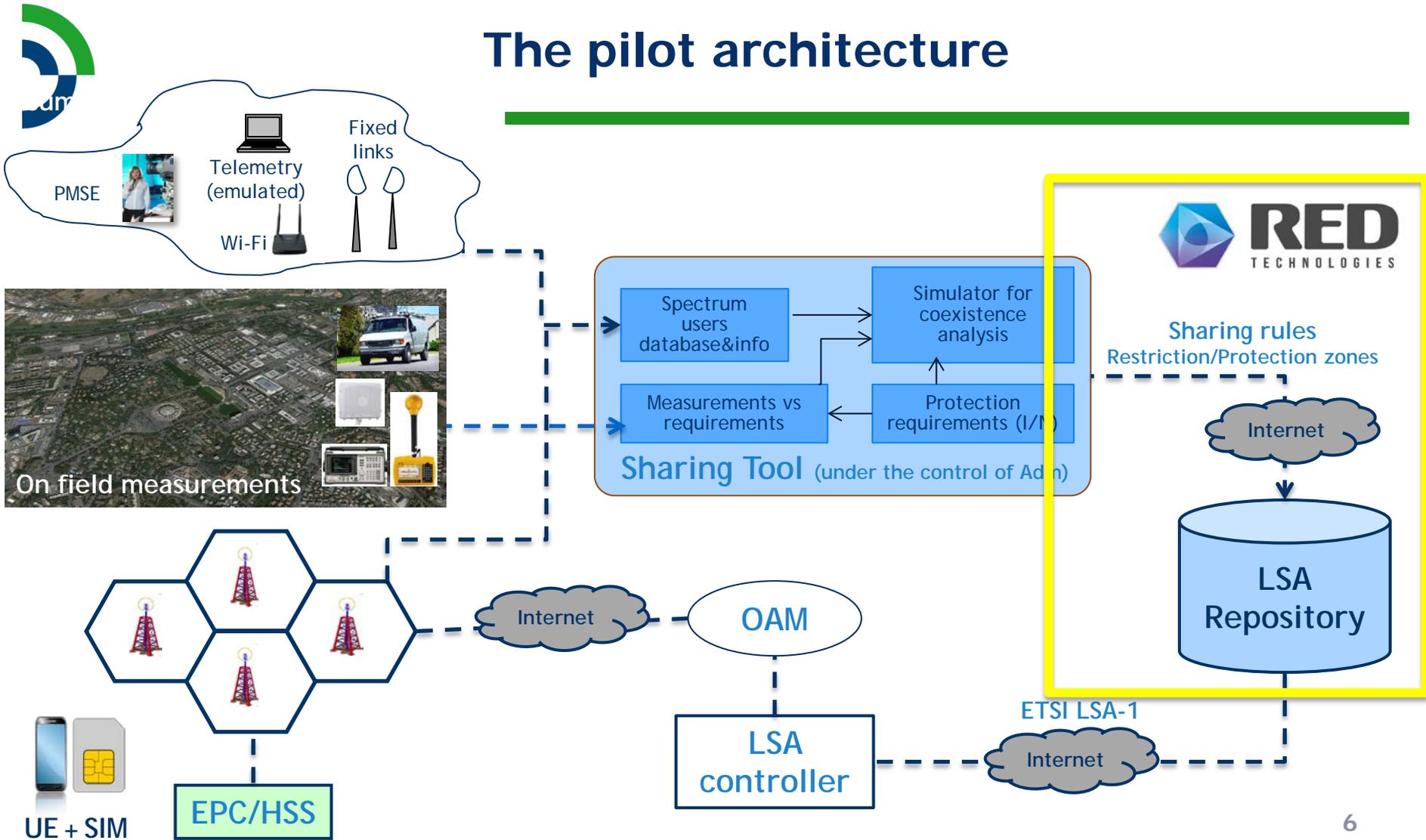
# The pilot architecture



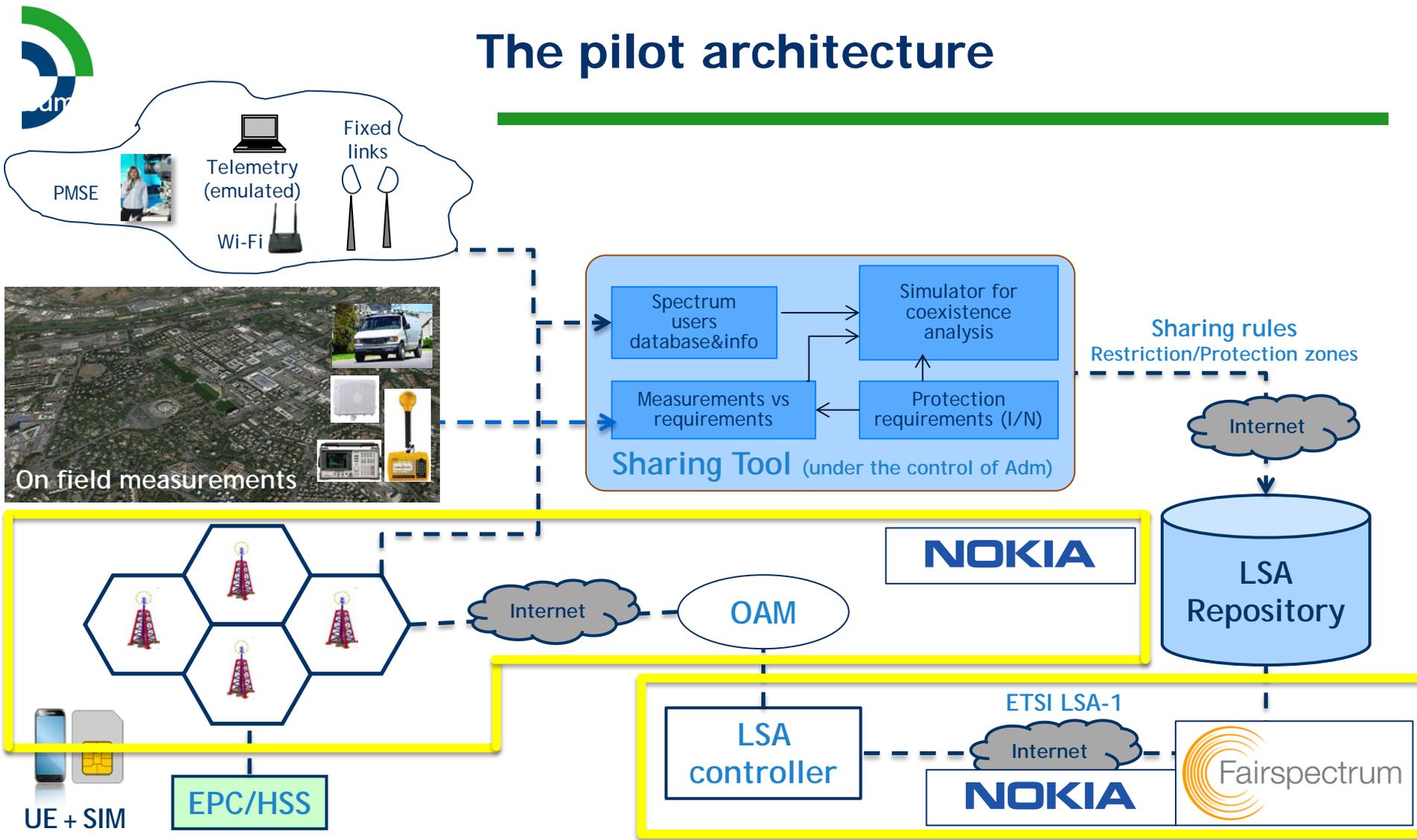
# The pilot architecture



# The pilot architecture

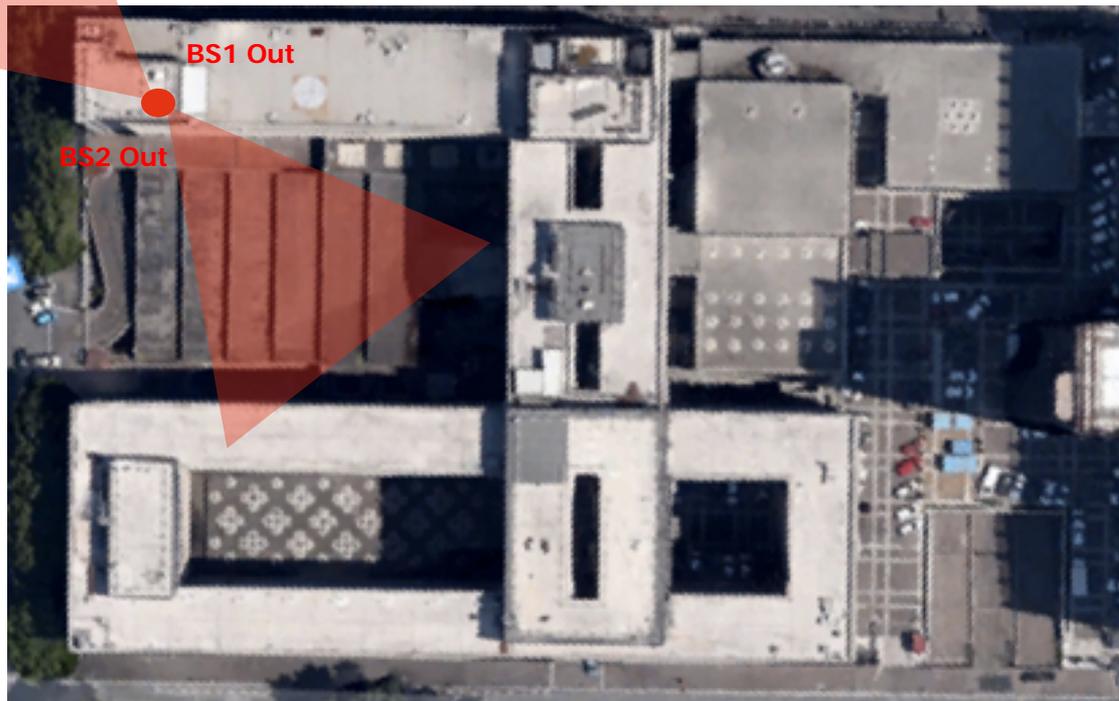


# The pilot architecture





# Outdoor BSs



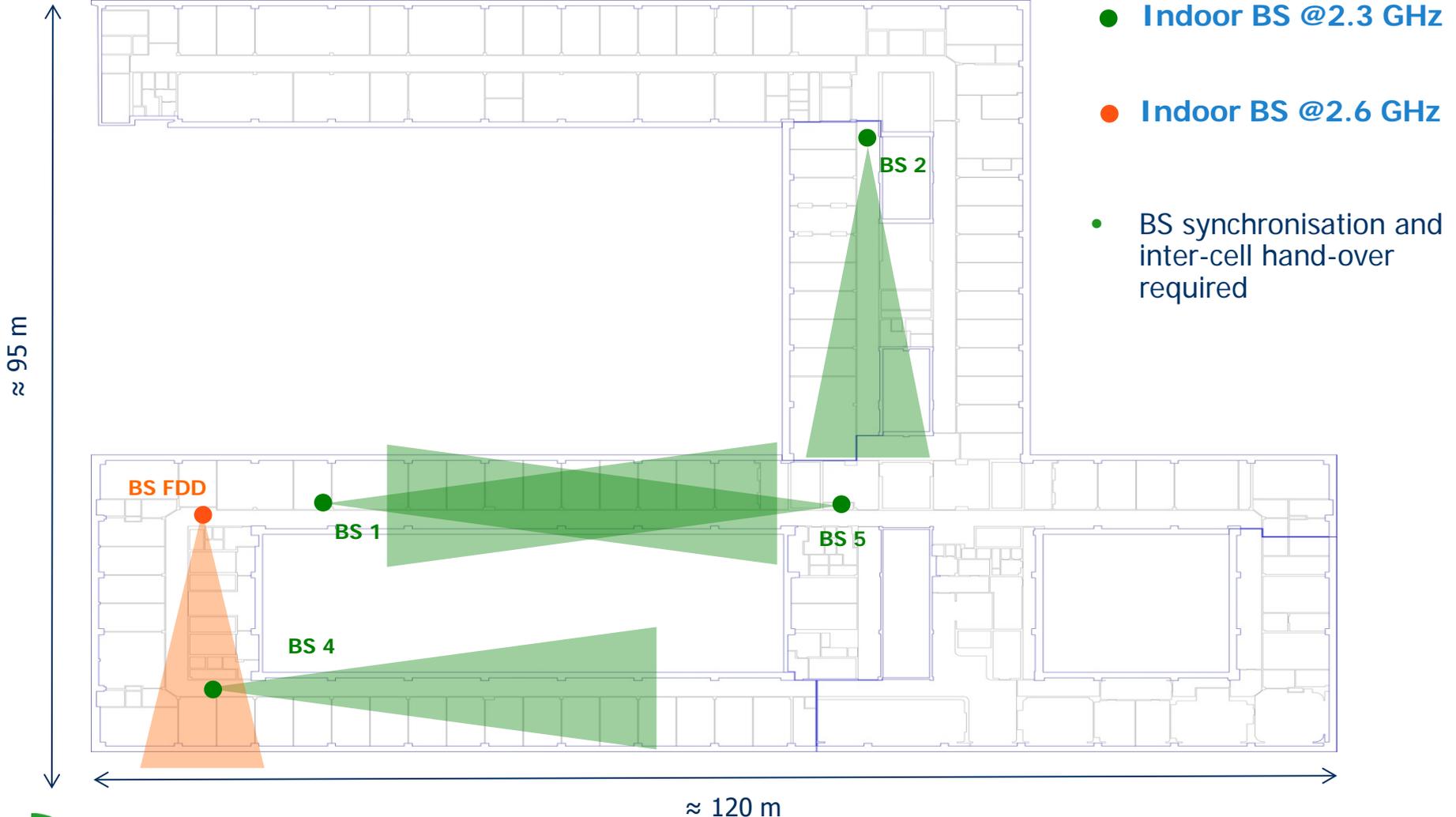
- Outdoor coverage is obtained through **2 outdoor cells** placed on the building rooftop.
- BS properly located to allow coexistence with equipment on the rooftop
- BS synchronisation and inter-cell hand-over required

● Outdoor BS @ 2.3 GHz

The aerial view of the MISE Premises in Rome (EUR area)



# Indoor BS at 7<sup>th</sup> floor



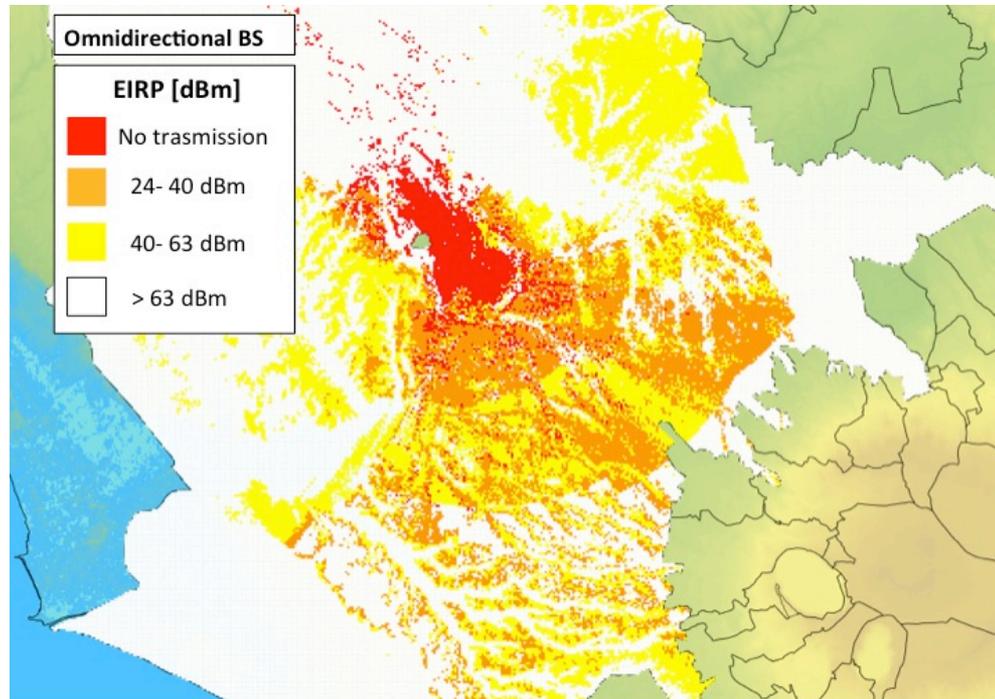


# Protection criteria and requirements

**“I/N” criterion.** The value of the maximum permitted interference is defined in relation to the thermal noise floor. For example, for a target rise of 1 dB in the noise floor, the value of interference would need to be 6 dB below the thermal noise floor.

Parameter	Fixed Service	PMSE	Telemetry
Receiver Noise Figure, NF [dB]	3.5	4	4
Noise Floor[dBm]	-107.47	-100.95	-99.98
I/N requirement[dB]	-10	-6	-6
Maximum allowable interference power, $I_{\max}$ [dBm]	-117.47	-106.95	-105.98
Measurement bandwidth [MHz]	2	8	10
Measurement height [m]	At victim Rx	3	15

# Example of a computed restriction zone

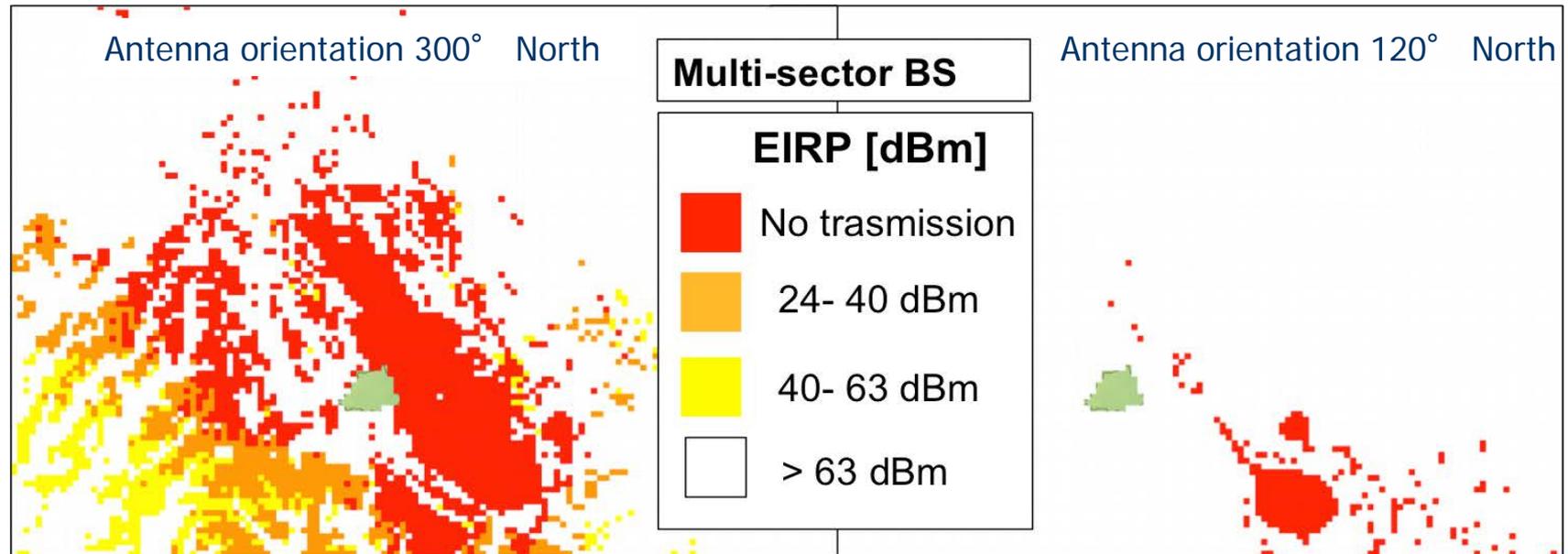


Restrictions and Exclusion Zones are computed to protect Fixed Service while complying with confidentiality constraints

EIRP restrictions become more stringent as colours from yellow turn to red.

- EIRP restrictions are computed considering **all the potentially affected fixed links** (co-channel and adjacent channel interference).
- **Terrain profile** is taken into account.

# Restriction zones with multi-sector base stations



- Maximum permitted EIRP computed for each BS sector would lead to:
  - relaxation of the restrictions for sectors with a limited impact on the victim receivers
  - more flexibility in the deployment of the mobile system
  - **increase of sharing opportunities**



# Restriction zones for different mobile network layouts

	No restriction	63-40 dBm	40-24 dBm	Exclusion
Macro $h \leq 30$ m	64.50%	21.50%	11.20%	2.80%
Micro $h \leq 10$ m	89.9 %	5.15 %	3.17 %	1.78 %
Femto $h \leq 6$ m (indoor)	96.15 %	2.8 %	0.51 %	0.54 %

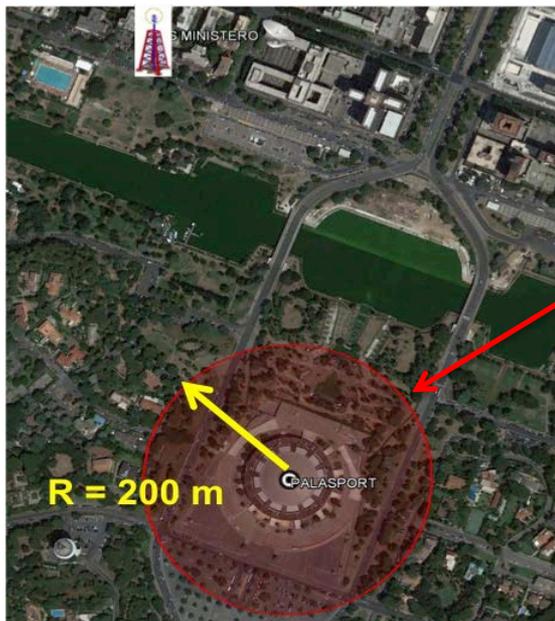
*Grey shaded boxes refers to unusual combination of EIRP and antenna height in typical network layouts*

- Restrictions and exclusions conditions are less stringent considering micro or femto cells layout
- Different network layouts can increase sharing opportunity



# PMSE and Telemetry: Protection Zones

## PMSE (videolinks)



The mean field strength, within the protection zone, shall not exceed a defined value in  $\text{dB}\mu\text{V}/\text{m}/\text{MHz}$  at a defined receiver antenna height above ground level



## Telemetry (emulated)





# Verification of compliance

Various tests have been planned and executed within the LSA Pilot

Scope	Tests
Functional tests	Coverage (outdoor drive tests and indoor walk tests) EIRP pattern Hand-over Speed tests Channel preemption (evacuation time) Carrier power reduction
Regulatory compliance	Compliance with the sharing rules EMF exposure Propagation model

*\* In progress*

# The Ministry's setup for drive tests



Measurement height equal to 1.8 m

## Equipment

- ❑ Omnidirectional Antenna
- ❑ Cable Suhner sucoflex 100, total loss 1.5 dB @2340 MHz.
- ❑ Network analyzer R&S TSMW with software ROMES4
- ❑ Spectrum analyzer Anritsu MS2720T



The Italian Pilot on the Licensed Shared Access in the 2.3-2.4 GHz band  
Presentation of the results

Rome, 23 Sept 2016

# Drive tests: signal from outdoor cells



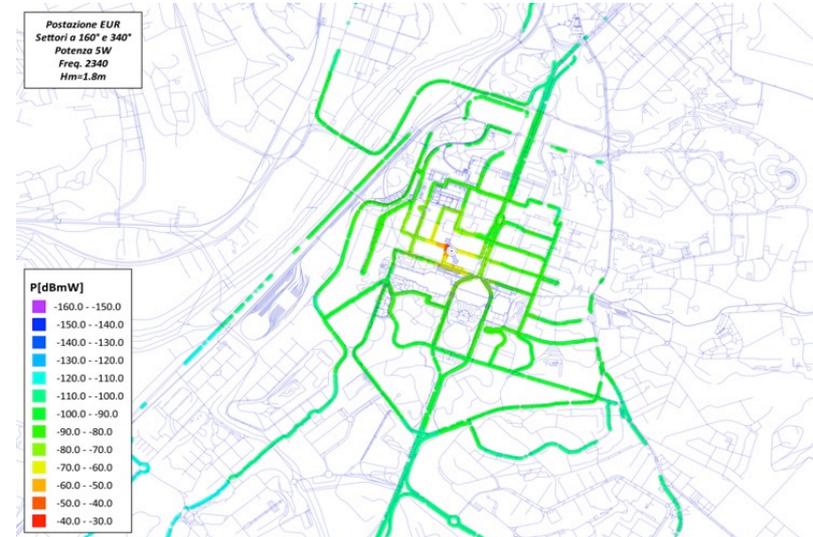
Interference levels originated from the outdoor BSs are still above the protection requirement as far as 1.5 km away from the BSs site.



# Propagation model



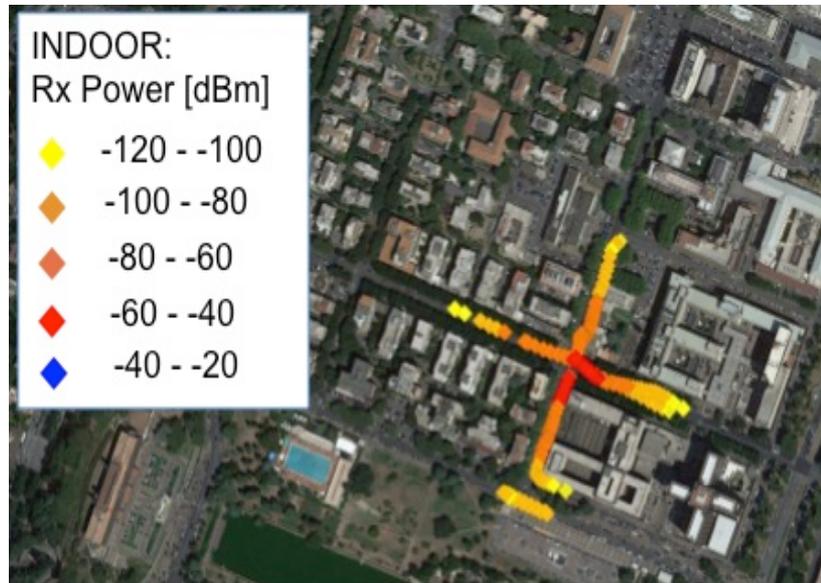
Measurements



Simulations

- A number of propagation models were adopted (ITU-R P.452, ITU-R P.1546, ITU-R P.526 (for diffraction effects), COST231...)
- The COST 231 model best fits the measurements with:
  - mean error as low as 2.35 dB
  - standard deviation equal to 9.37 dB

# Drive tests: signal from indoor cells



**Indoor cell at the ground floor**

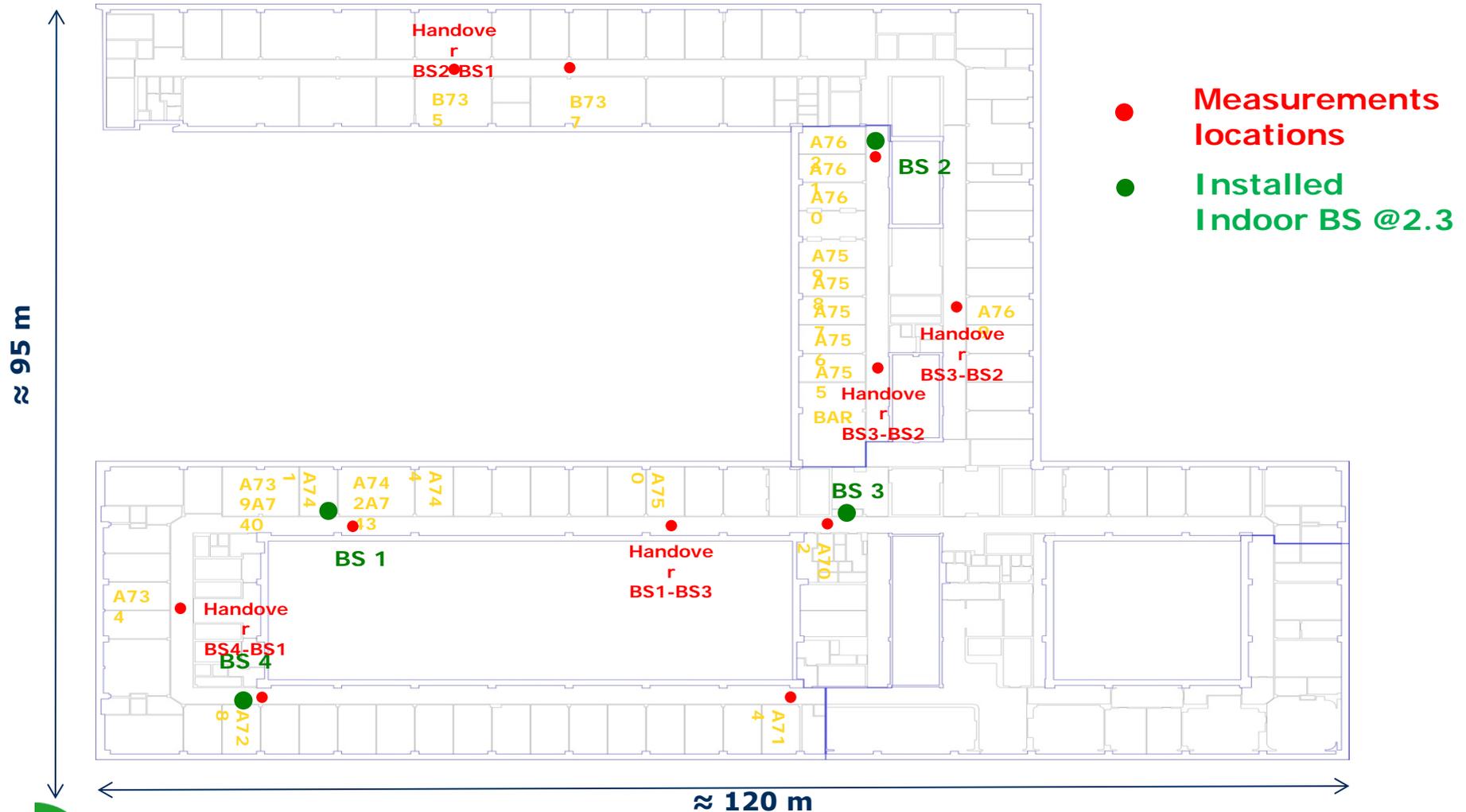


**Indoor cell at 7th floor**

- Femto-indoor installations affect a very limited area in the surrounding of the Ministry's premises.

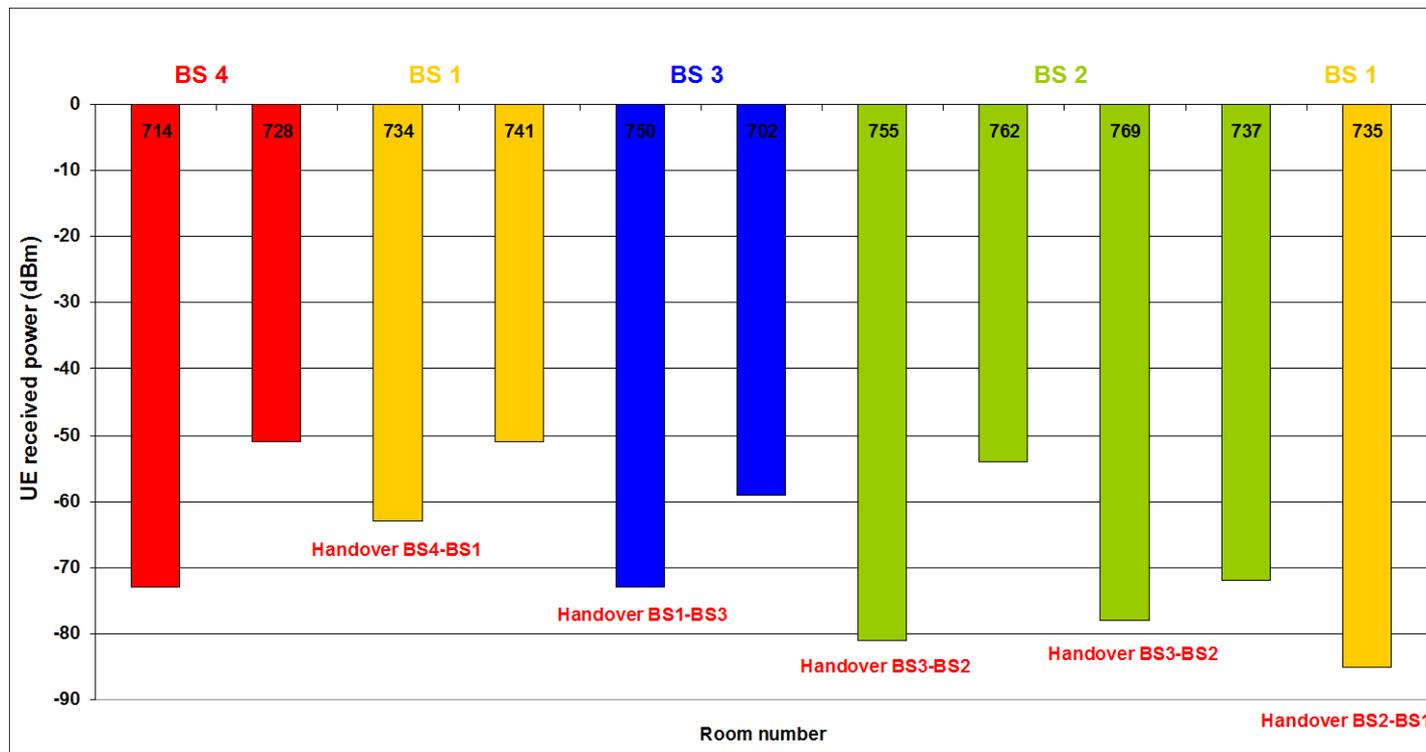


# Speed tests and handover measurements in indoor





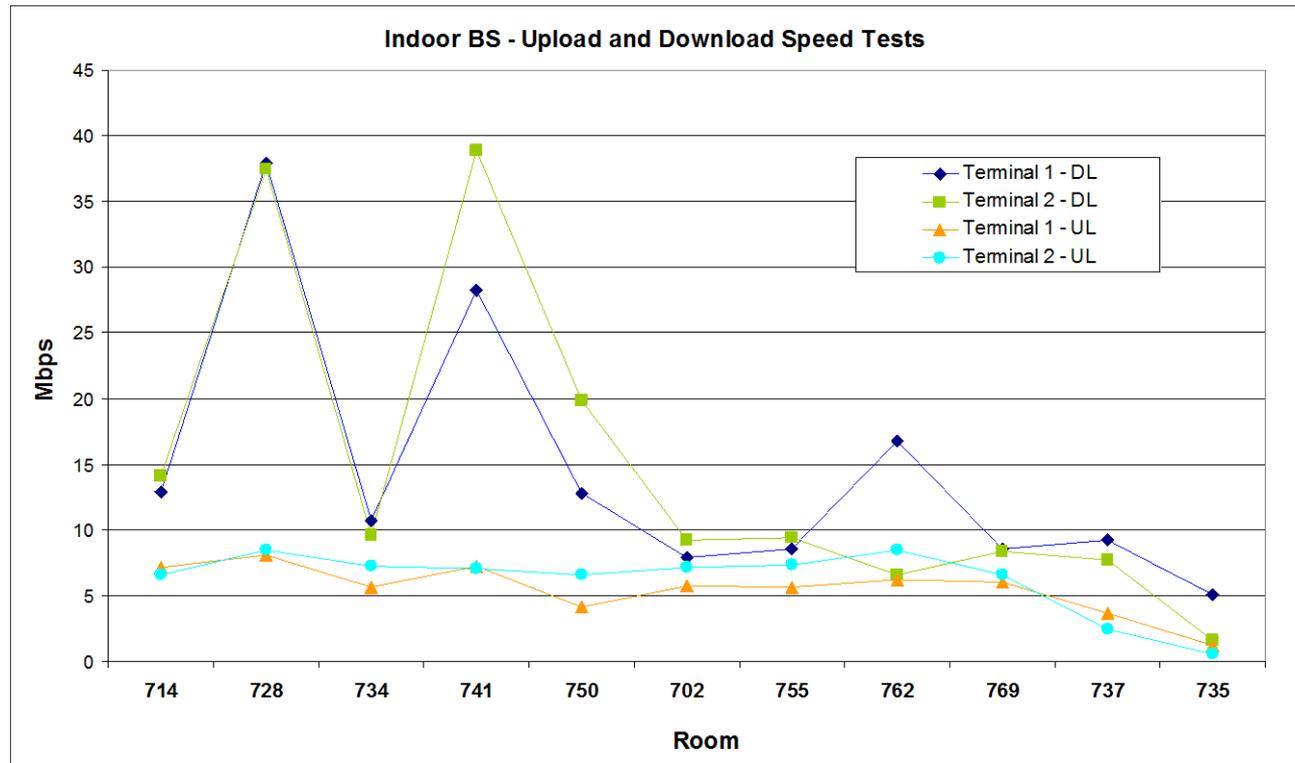
# Handover results



- ❑ Remarkable signal variability in the range – 75 dBm to – 50 dBm
- ❑ Handover test have been successfully completed and a hysteresis margin of about 10-15 dB can be inferred

# Speed tests results

## Upload and download bit rate (Mbps)



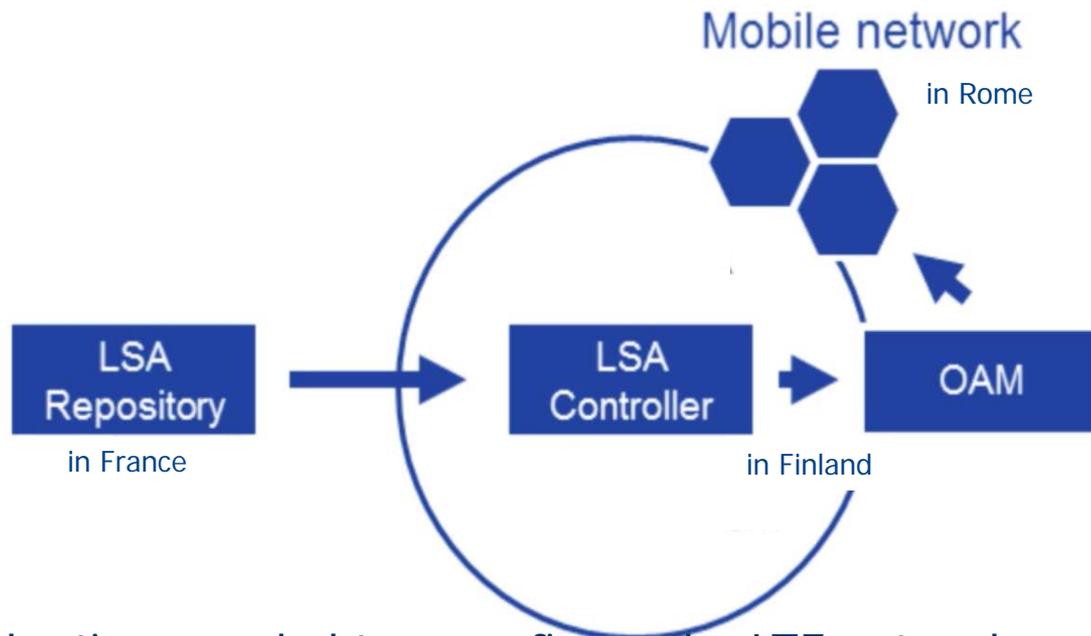
- ❑ A strong fluctuation of the measured download bit rate has been registered in the different locations
- ❑ Upload speed is lower but more stable



# Channel preemption - Evacuation time



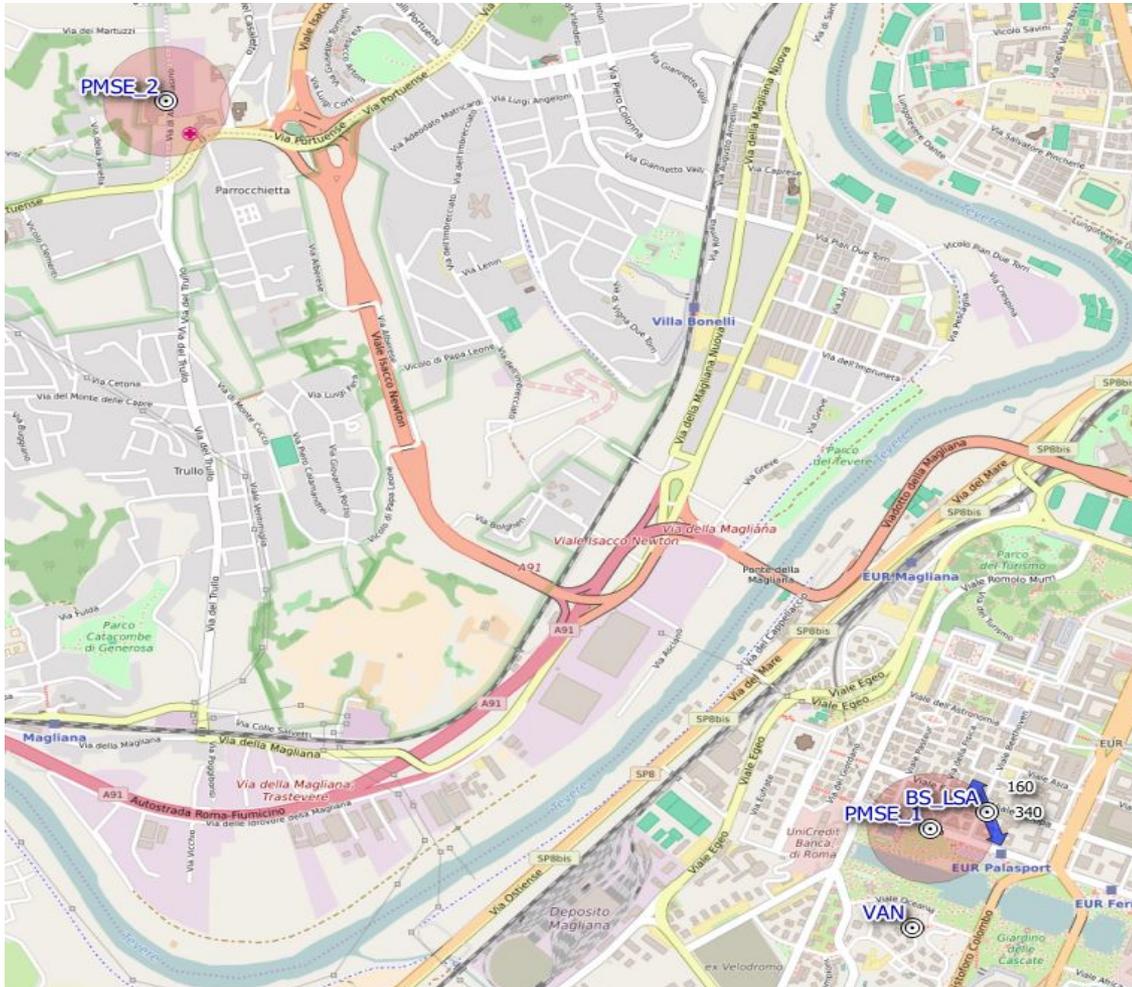
PMSE issues a channel preemption request that is communicated to the LSA Repository



The evacuation time is the time needed to reconfigure the LTE network so to make the channel available for the PMSE user.

It has been measured from the moment when the LSA Repository receives the channel preemption requests to the momento when the LTE cells status is changed, meaning that the LSA Controller receives notification that cell operational status has changed.

# PMSE locations for channel preemption tests



- ❑ Two test positions selected
- ❑ On-field measurements in support of the tests. Any variation on the outdoor signal could be detected. Occasionally, also the indoor signal was measured (i.e. if not obscured by outdoor signals).



# The Ministry's mobile lab



Measurement height up to 4.5 m

## Equipment

- ❑ Network analyzer R&S TSMW with software ROMES4
- ❑ Spectrum analyzer Anritsu MS2720T
- ❑ Test receiver R&S ESMD with software ARGUS



The Italian Pilot on the Licensed Shared Access in the 2.3-2.4 GHz band

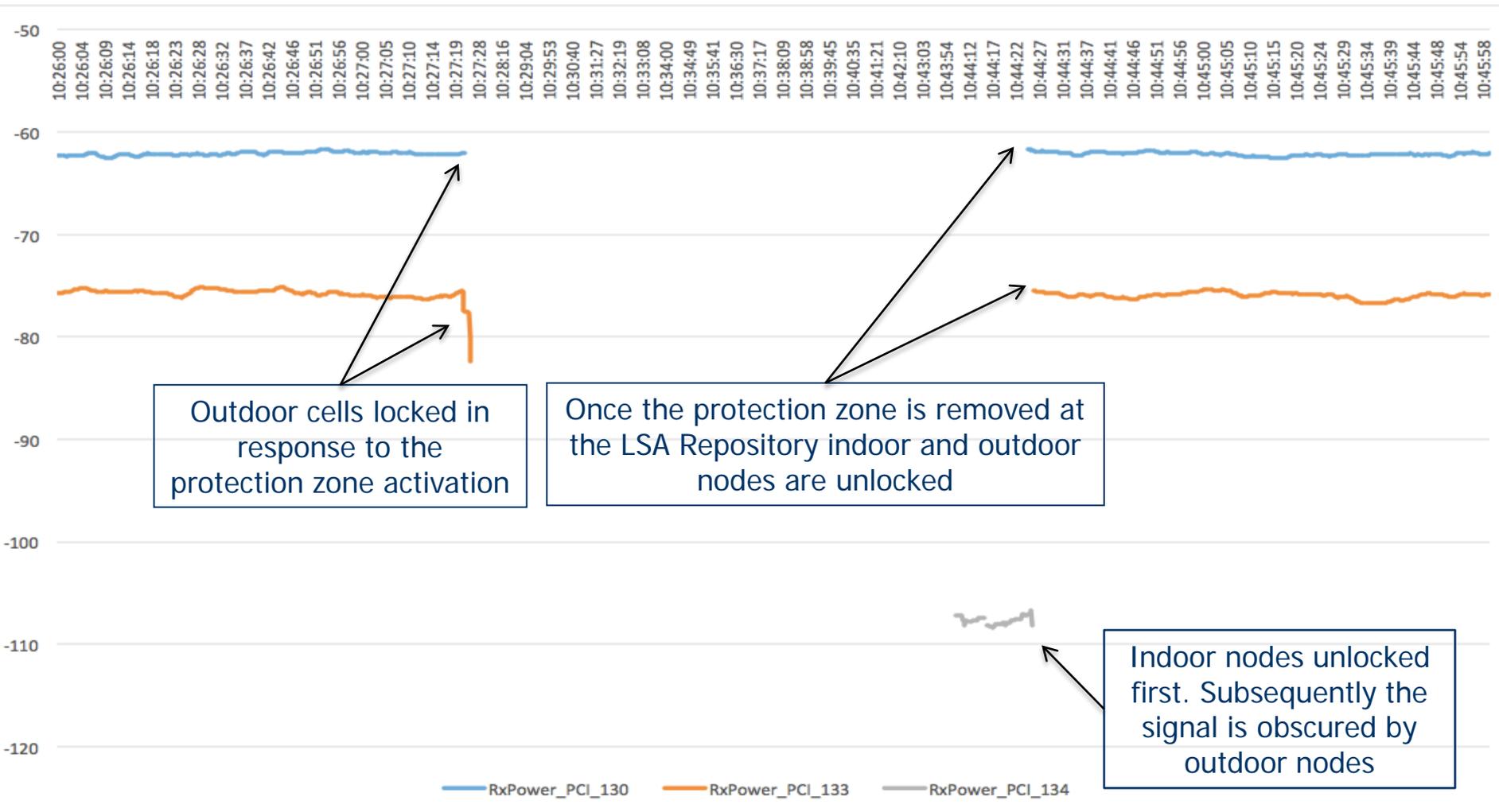
25

Presentation of the results

Rome, 23 Sept 2016



# Test Case 1 – All cells locked



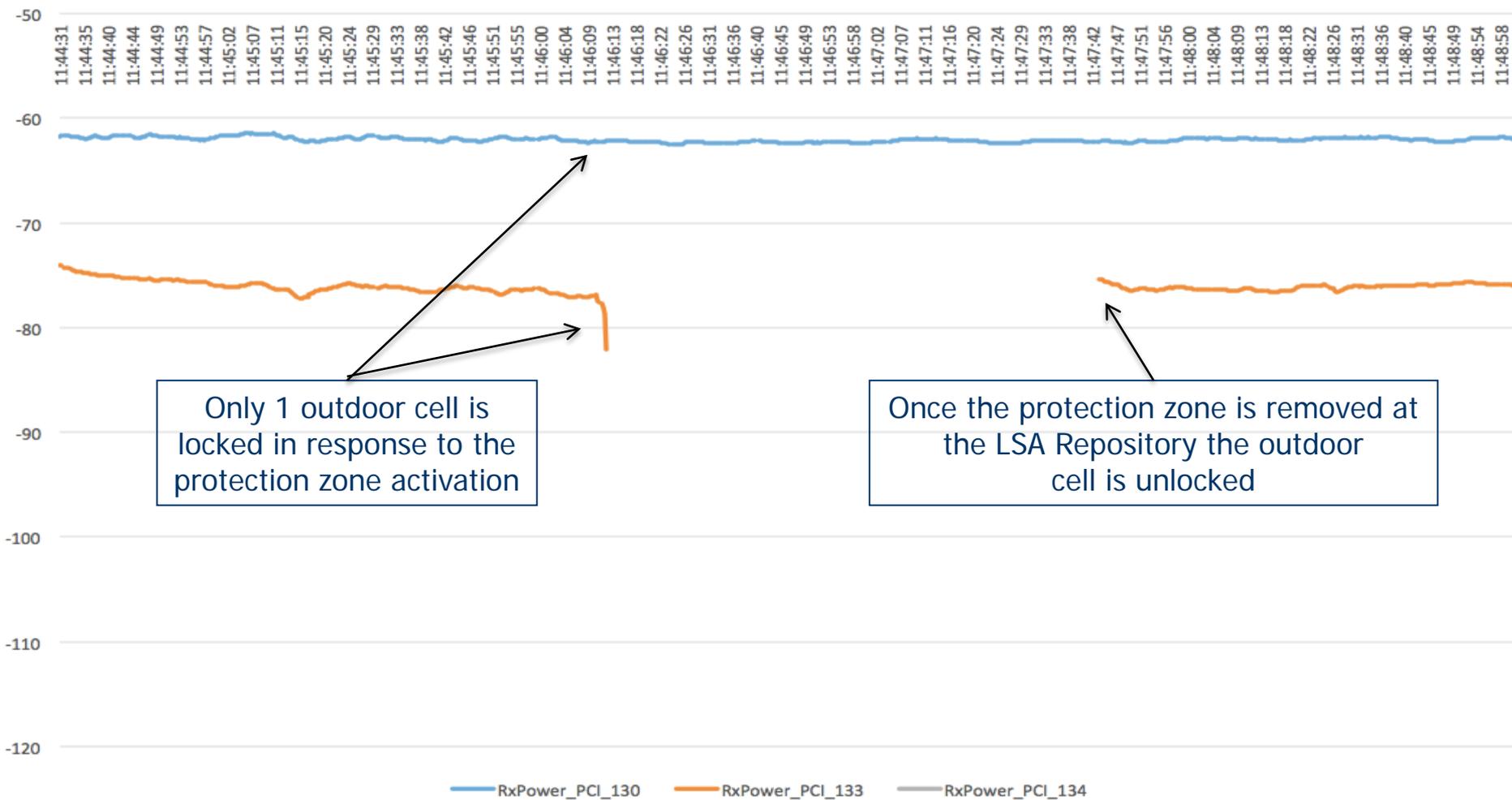
Outdoor cells locked in response to the protection zone activation

Once the protection zone is removed at the LSA Repository indoor and outdoor nodes are unlocked

Indoor nodes unlocked first. Subsequently the signal is obscured by outdoor nodes



## Test Case 2 – Only one sector locked

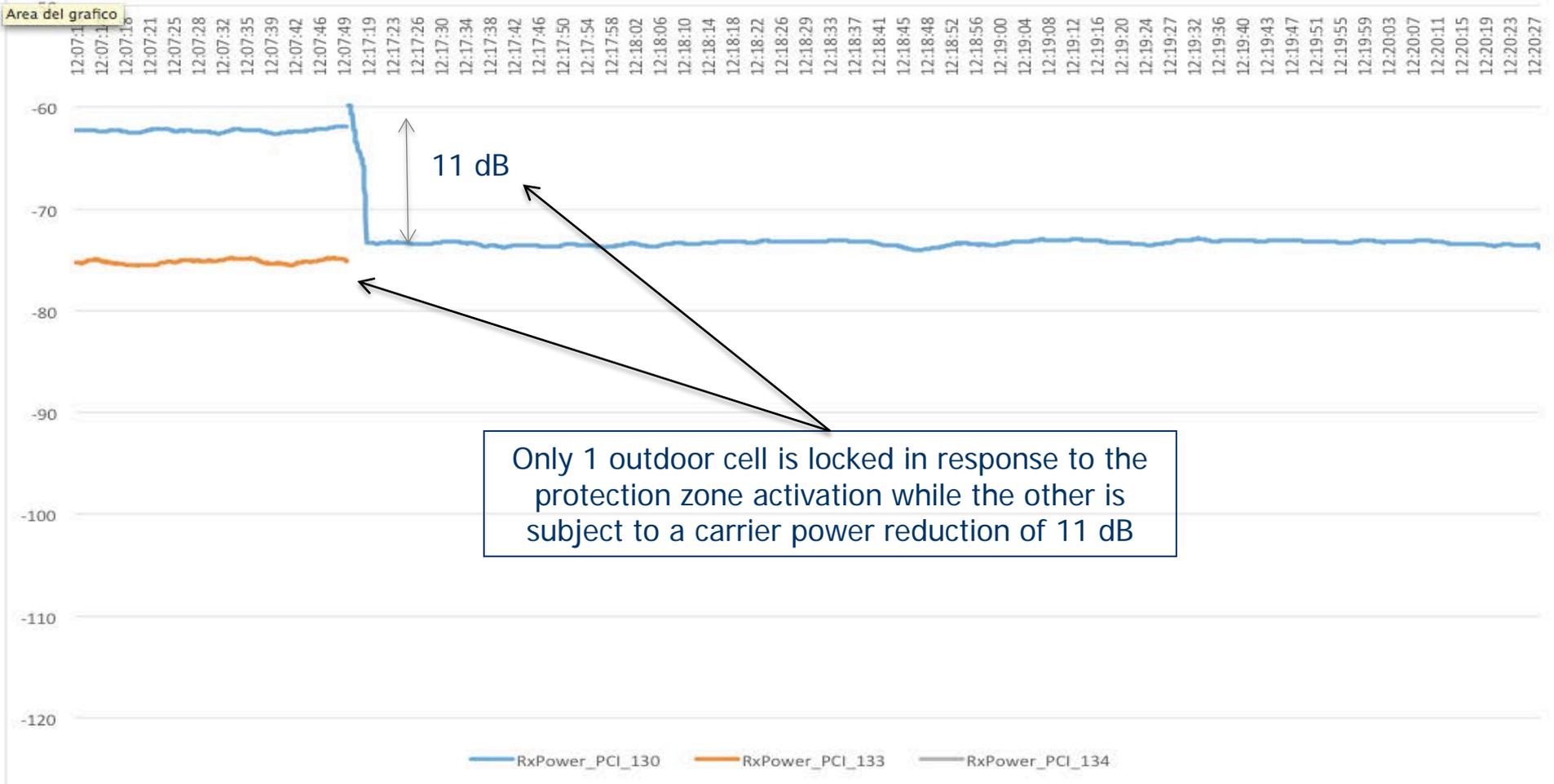


Only 1 outdoor cell is locked in response to the protection zone activation

Once the protection zone is removed at the LSA Repository the outdoor cell is unlocked



# Test Case 3 – Carrier power reduction





## Evacuation time assessment

- ❑ Measured evacuation time is always below 40 seconds
- ❑ The evacuation time does not depend on the activation/deactivation of carrier power reduction features.

Average Evacuation Time [s]	
Test case 1	36.716441
Test case 2	35.778847
Test case 3	35.646237



## Compliance with the sharing rules – Fixed Service

- ❑ The MISE van was located next to a FS receiver in the area of Rome.(exact location is confidential).
  - The sensitivity of the measurement equipment is adequate to verify I/N requirements.
  
- ❑ Although field predictions would indicate an interference level slightly below the target value (e.g.  $I/N < -6$  dB), the measurement equipment could not detect any interference.
  - Unavoidable inaccuracies of predictions (e.g. due to unexpected severe obstruction of the propagation path which generally occurs in dense urban environments) play a significant role, against the need of detecting such low signals.

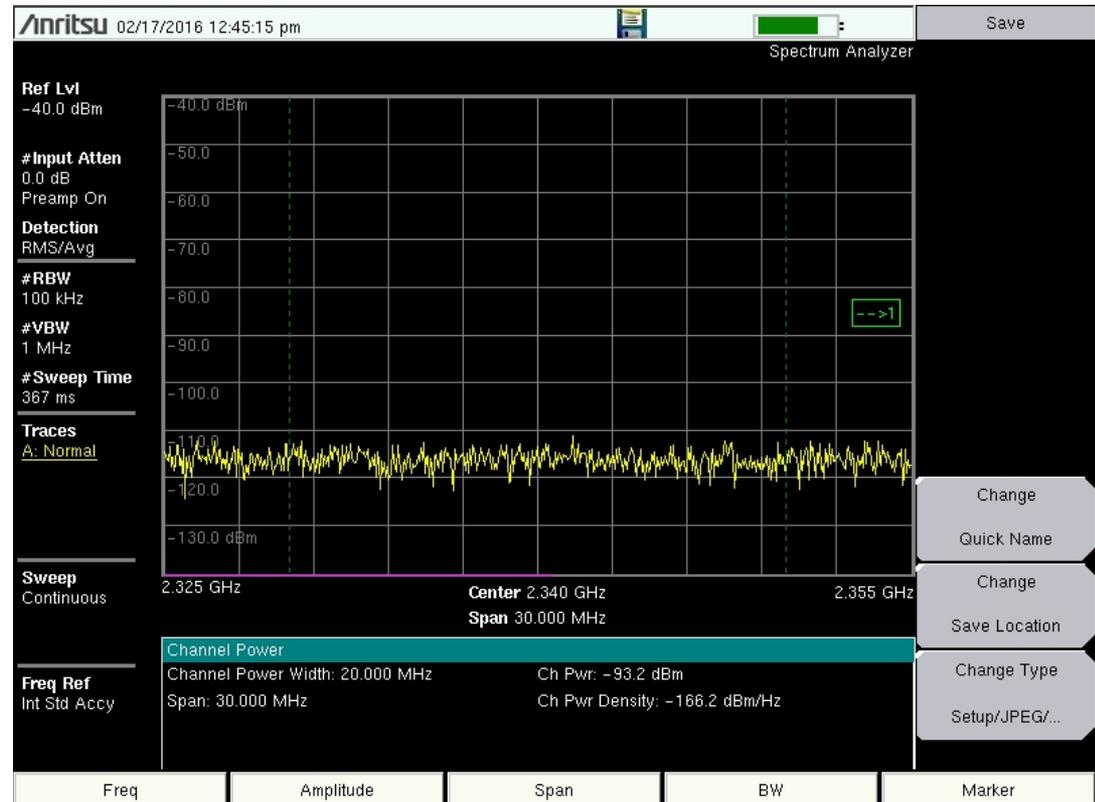


# Measurements of the noise level

- ❑ In the absence of the LTE signal, the Noise Floor was characterised to estimate how the measured values would differ from the noise floor levels for the various victim receivers (e.g. -101 dBm for PMSE in 8 MHz)

Measurements performed with the spectrum analyser:

- Poorer sensitivity wrt the network analyser used to measure interfering LTE signals.
- At the observed location the measured noise floor was "only" -93.2 dBm.
- Equipment sensitivity was reached but values are still far from the victim receiver noise floor.

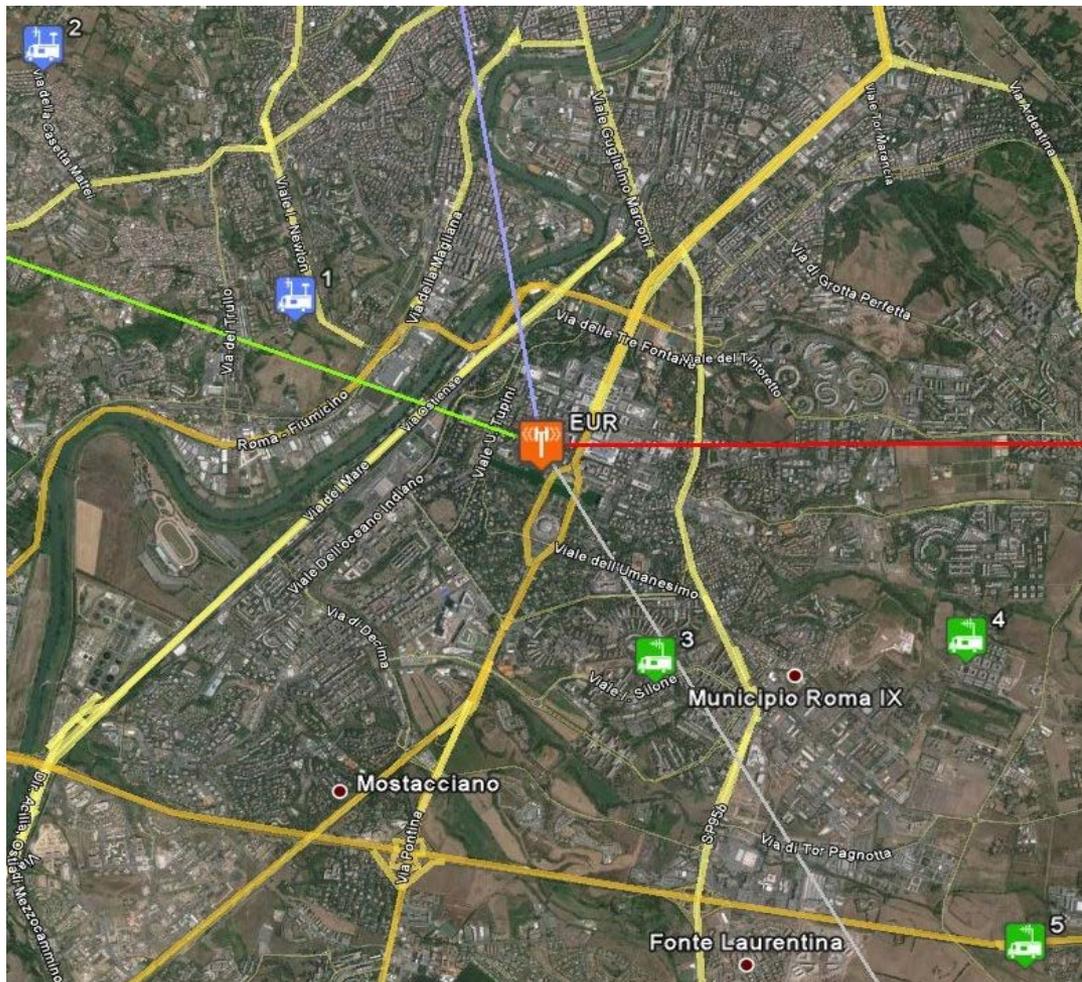


The Italian Pilot on the Licensed Shared Access in the 2.3-2.4 GHz band  
Presentation of the results

Rome, 23 Sept 2016



# Measurement locations for tests on FS



Compliance with the I/N requirements was verified by assessing the system response to the application of the restrictions needed to protect the FS.



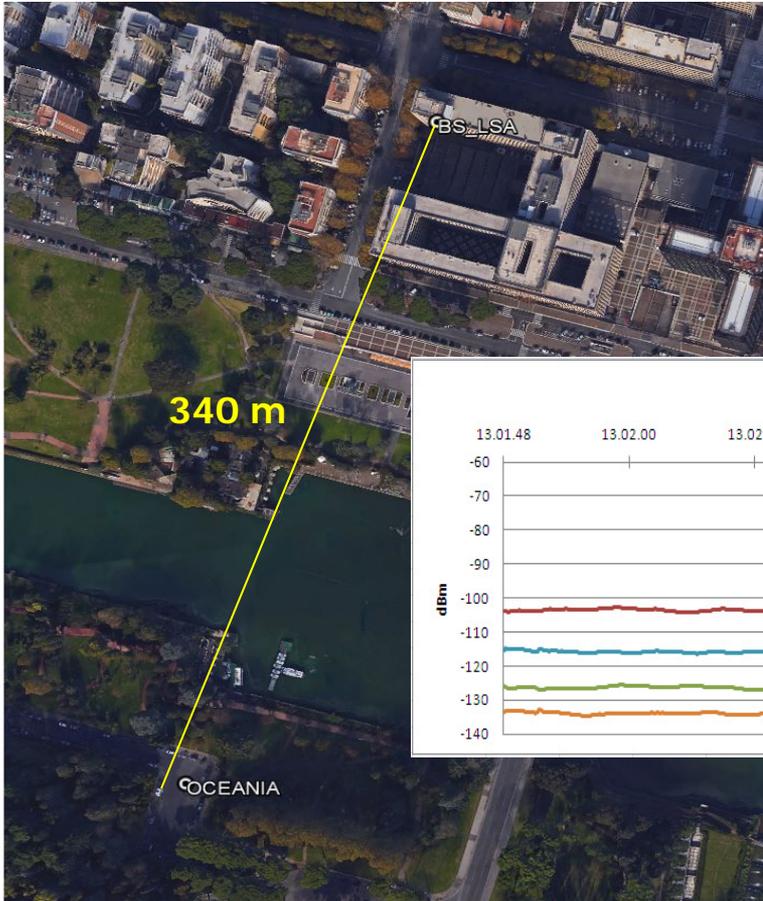
# Compliance with the BS



The Restrction zone is activated and EIRP reduced consequently

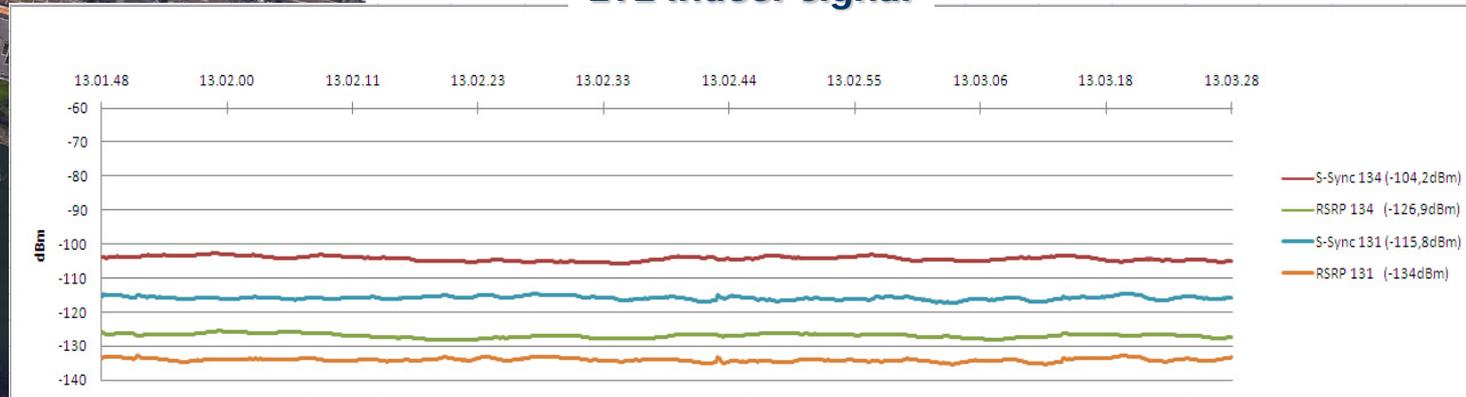


# Measurement locations for tests on PMSE



Measured Noise Level (without LTE)  
equal to -93.2 dBm in 20 MHz

## LTE indoor signal



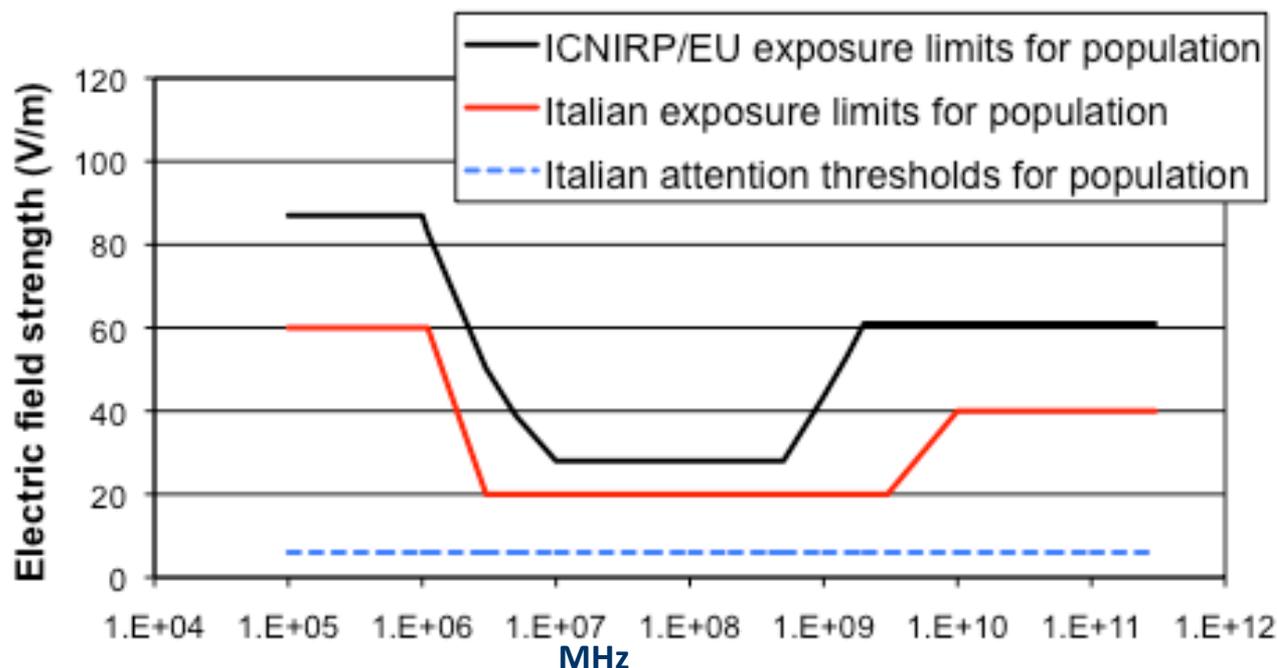
$$\text{LTE Power} = \text{S-Sync} + 12.9 \text{ dB} \quad \text{or}$$

$$\text{LTE Power} = \text{RSRP} + 30.8 \text{ dB}$$



# The Italian Regulation on EMF exposure

- ❑ The Italian law is based on **3 different protection levels**, expressed in terms of **radiometric quantities** (e.g. average effective electric field):
  - **Exposure levels**, aimed at ensuring protection against acute health effects
  - **Attention thresholds** for the protection against possible long-term effects
  - **Quality targets**, which realises, in fact, the *prudent avoidance* approach

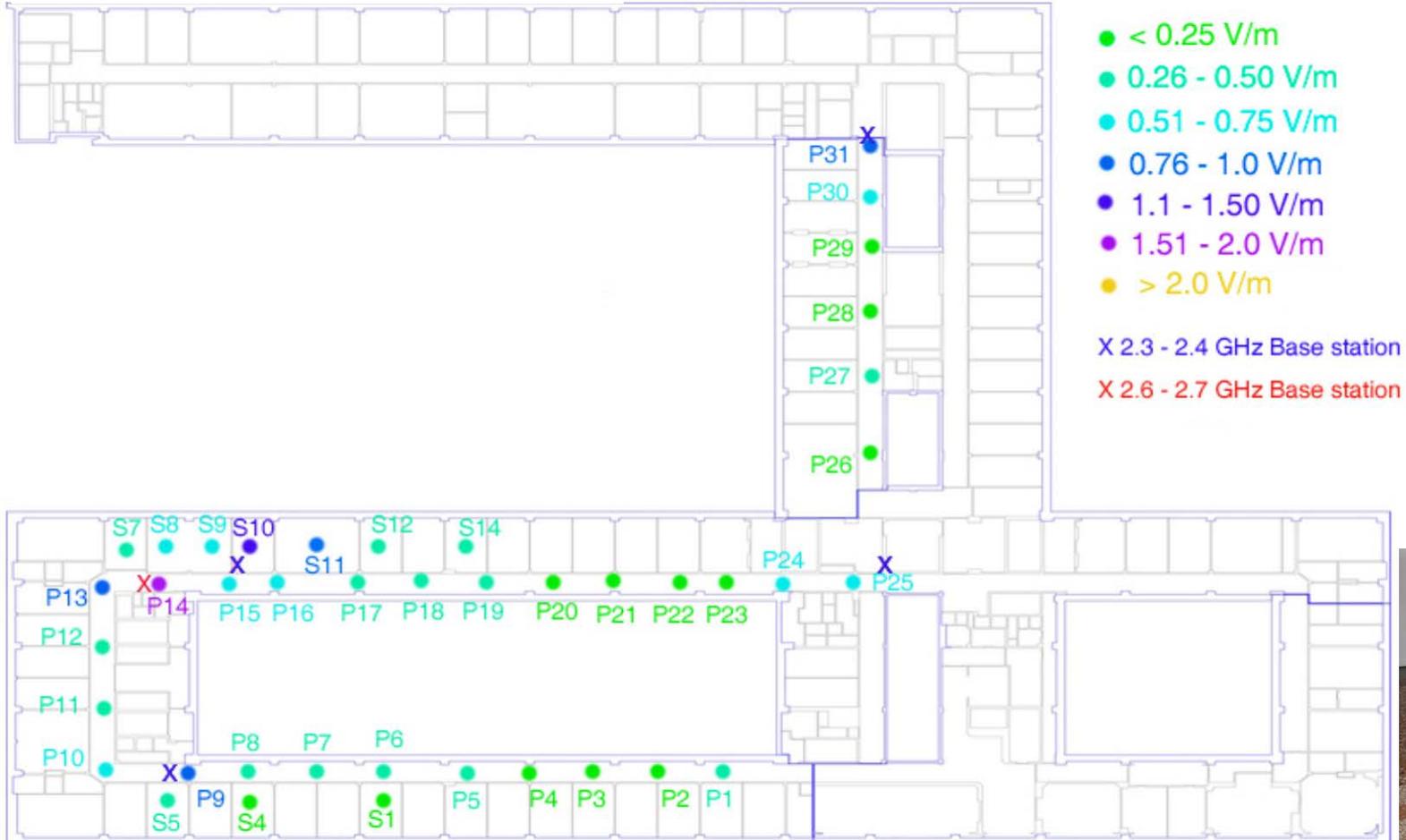


All the 3 different protection levels set limits well below ICNIRP thresholds (e.g. 6 V/m irrespective of the frequency)



# EMF Exposure Measurement

LTE BSs operated in test mode



Narda SRM 3000





## Major remarks

- ❑ The Italian LSA pilot is 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
- ❑ The testbed for LSA was realised in compliance with standards as well as European and national regulatory framework.
- ❑ Coexistence of LTE systems operating under LSA with incumbent uses has been demonstrated as feasible, applying proper sharing rules also verified with experimental measurements.
  - It has been pointed out that microcells and femtocells layouts might significantly increase sharing opportunities.
- ❑ Verification of compliance with sharing conditions has been tested on-field. It emerged that proper measurement procedures and setup may be challenging.
- ❑ Tests on channel evacuation were realised considering a possible incumbent PMSE user requesting a channel for its operations in a given location.
  - The evacuation time is always below 40 seconds



## Future Directions

The pilot allowed to verify the possibility of a shared use of the 2.3-2.4 GHz band to cater for the ever-increasing request of broadband wireless connectivity.

- ❑ This concept can be extended to other portions of spectrum. The first obvious candidate for this is the the 3.4-3.8 GHz band which may already respond to some specific 5G needs, as it provides opportunities for systems requiring large bandwidth.
- ❑ In the medium term, tests of 5G-like signals can be performed also at mm-waves, imposing the relevant restrictions (e.g. frequency availability, EIRP limitations) to protect incumbent uses and allow coexistence for non-exclusive uses.



---

**Thanks for your attention!**

**Doriana Guiducci**

Fondazione Ugo Bordononi (FUB)

Viale del Policlinico, 147

00161 Roma

[www.fub.it](http://www.fub.it)

Tel. +39 051 846854

e-mail: [dguiducci@fub.it](mailto:dguiducci@fub.it)