

LSA FIELD TRIAL WITH ENHANCED LSA CONTROLLER POWER CONTROL CONCEPT ALGORITHMS

WInnComm 2016, Mar 16, 2016

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Outline

Introduction

Research objectives

Overview of Licensed Shared Access (LSA) concept

LSA field trial environment

Trial set up and workflow

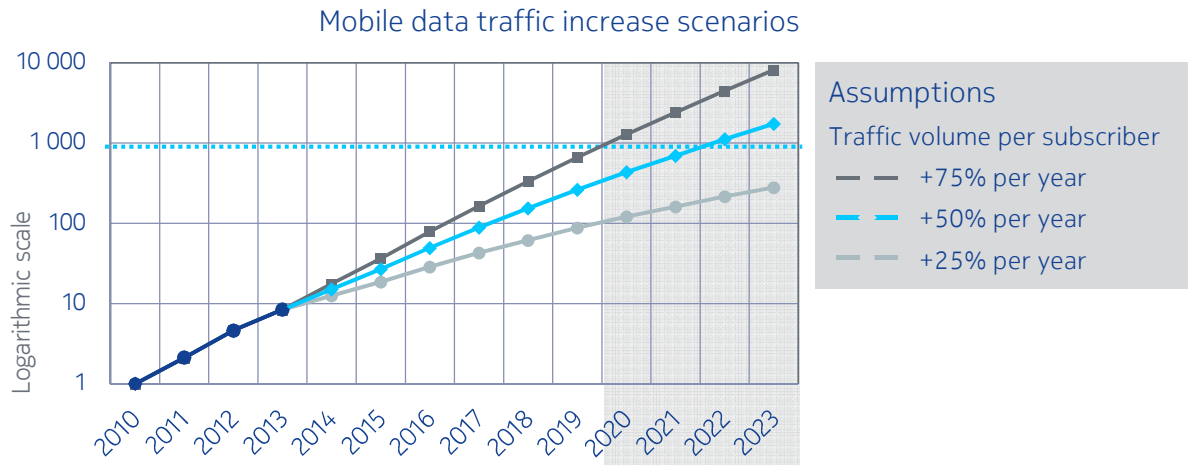
Performance validation

Conclusions

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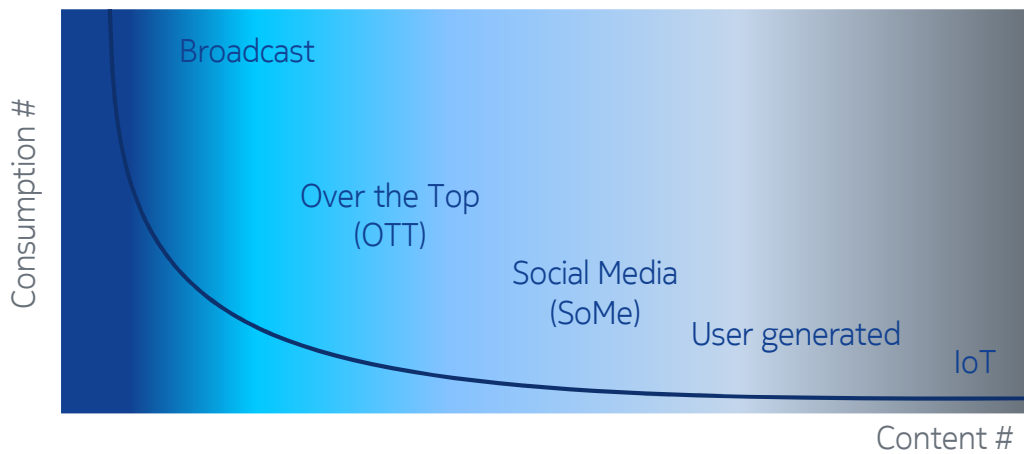
Mobile traffic is expected to grow exponentially until 2020



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Traffic pattern is changing
Long tail of media content, services and devices



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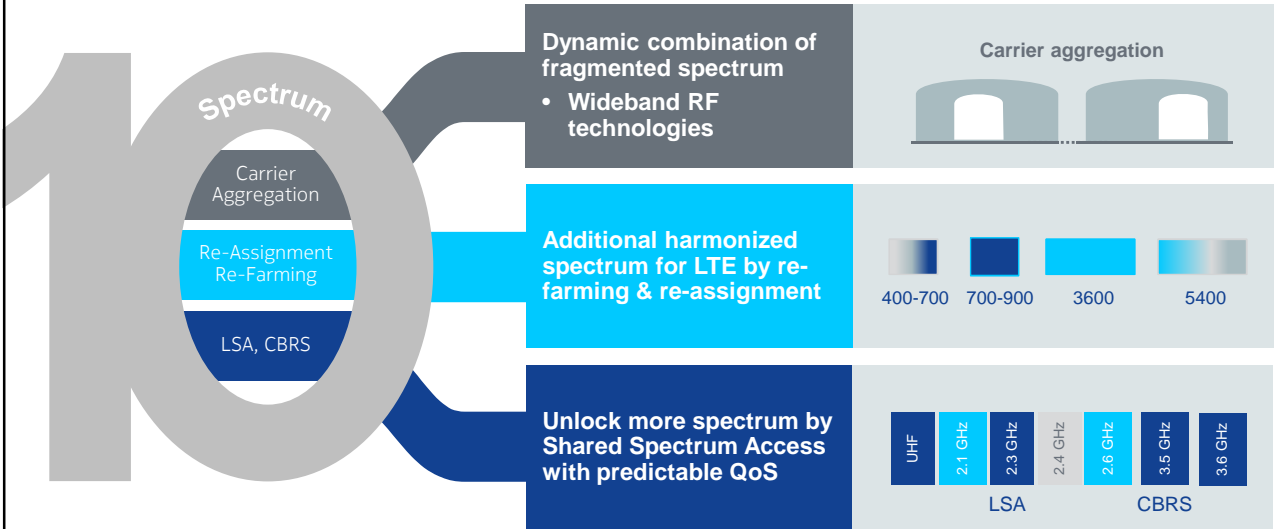
Spectrum Sharing touch key trends shaping mobile broadband industry



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Spectrum sharing unlocks more quality spectrum use for Mobile Broadband 10x spectrum for Nokia 1000x capacity vision



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For internal use

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Harmonization and global standards drive economies of scale

Spectrum usage models



**Mainstream approach
auctions
of cleared spectrum**

Exclusive use
ensures
Quality of Service



**Complementary
license model**
Licensed Shared Access

Exclusive shared use
exclusive use on a *shared* and *binary*
basis in time, location, and/or frequency
with incumbent (government, defense etc.)
predictable Quality of Service

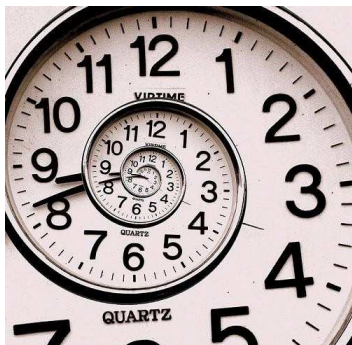


**Shared approach
unlicensed
(Wi-Fi, LTE-U, ...)**

Shared use
unpredictable
Quality of Service

LSA enables faster access to harmonized QoS spectrum

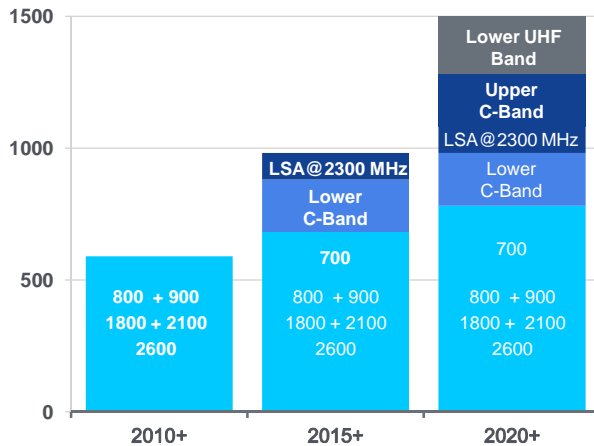
Increasing delays in making harmonized
spectrum available for mobile broadband



Spectrum band	6 years	8 years	10 years	more
900 MHz	████████			
2.1 GHz	████████████████████			
2.5/2.6 GHz	██			
2.3 GHz	██			

Spectrum roadmap for mobile broadband European example

Total Amount of Spectrum / MHz



- 470-698 MHz convergence and shared use between Broadcast and Broadband
- Shared use in C-band will enable wider bandwidths for dedicated small cell layers
- Licensed Shared Access (LSA) will unlock additional spectrum for LTE
- Additional Spectrum shall be allocated and put into use quickly
- Exclusive Spectrum Access has top priority
- Dynamic combination of fragmented spectrum through Carrier Aggregation

**Licensed +
Licensed Shared Access**

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Research objectives

Introduce LSA controller implemented as a part of Self Organizing Network solution fully integrated into commercial Operations, Administration and Management system.

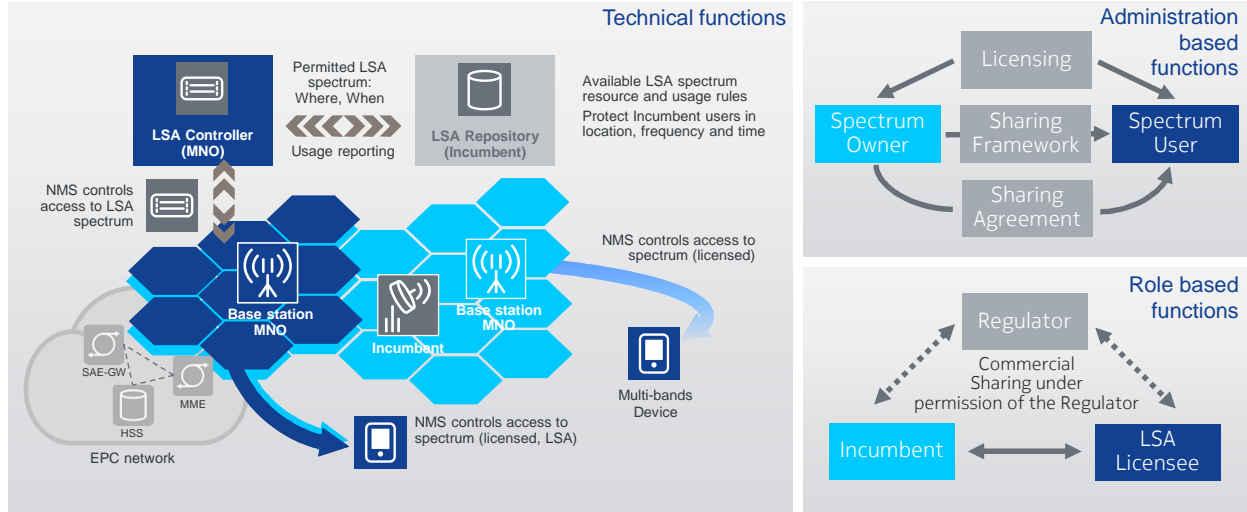
Validate LSA Controller with novel Power Control incumbent protection algorithms to maximize LSA spectrum resource availability while ensuring incumbent protection.

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LSA concept

Licensed Shared Access functional model

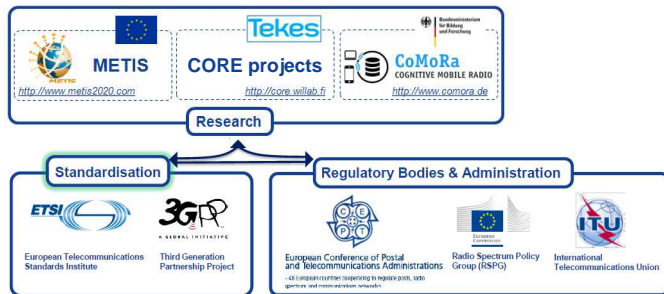


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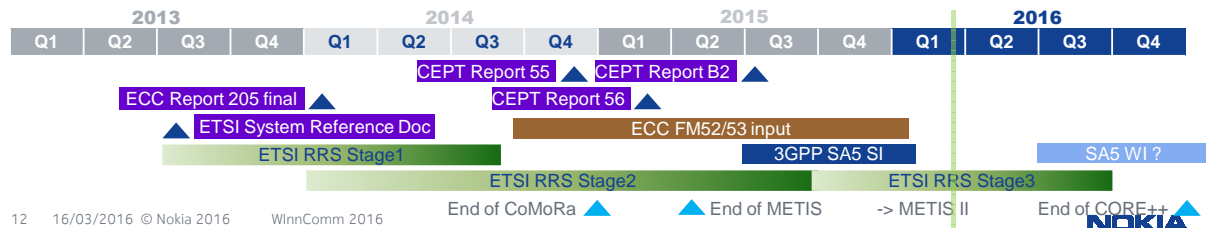
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LSA is progressing on all levels in Europe

Research – standardization – regulatory bodies and administration



LSA 2.3 GHz timeline

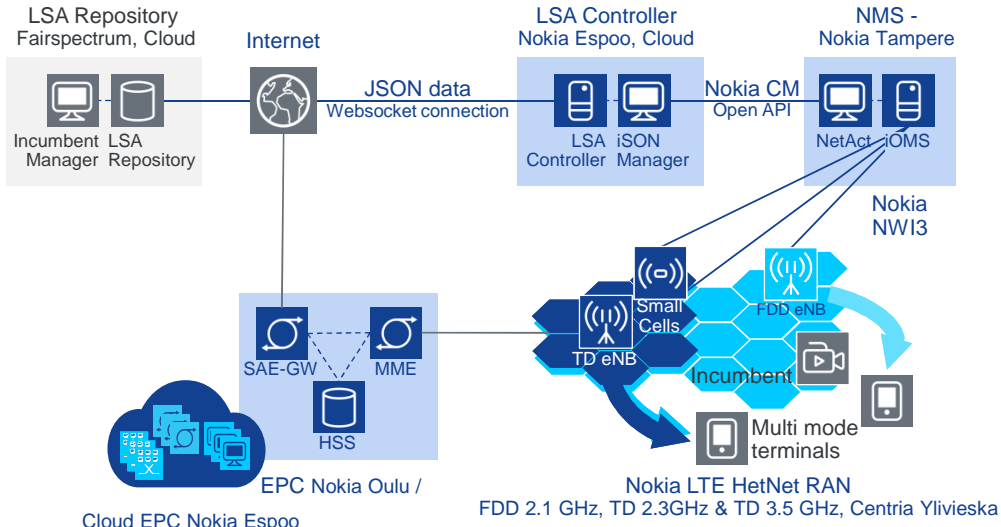


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Finnish CORE++ LSA trial environment 2016

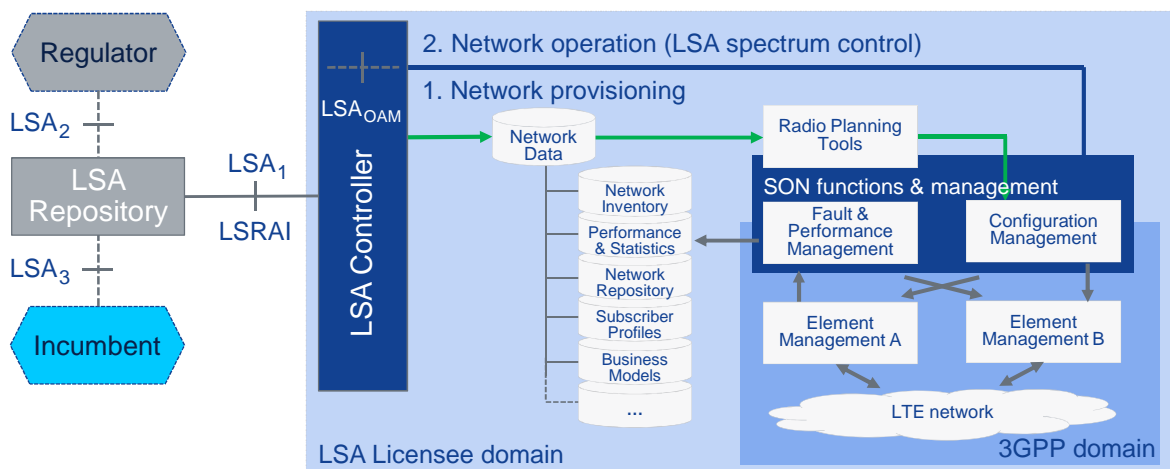
Trial uses global and available LTE technologies to ensure economies of scale and early use



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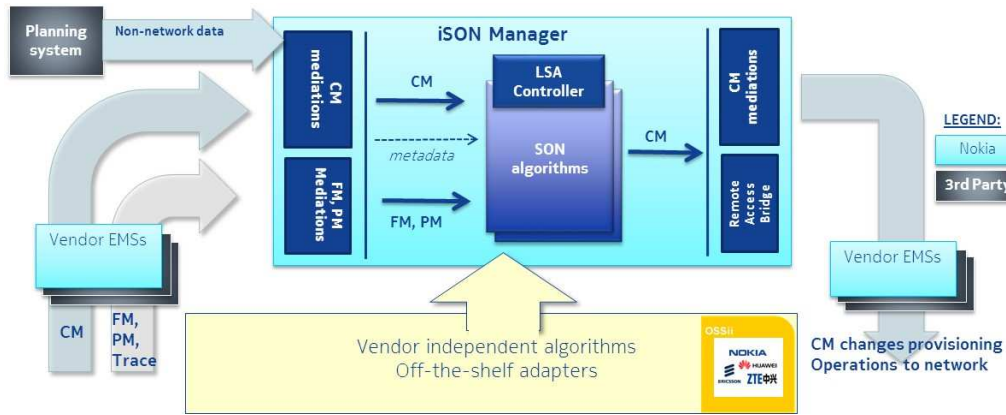
LSA and network's Operation, Administration and Management (OAM)

LSA leverages available OAM and Self-Organizing Network (SON) platforms and functionalities



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LSA demo controller build on multivendor capable iSON manager platform

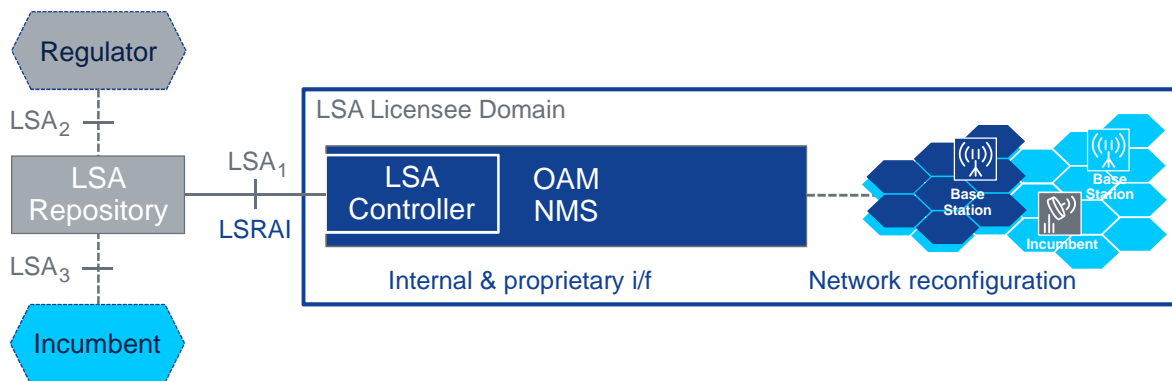


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LSA and network's Operation, Administration and Management (OAM)

3GPP SA5 study TR 32.855 scenario 2: LC as part of the OAM



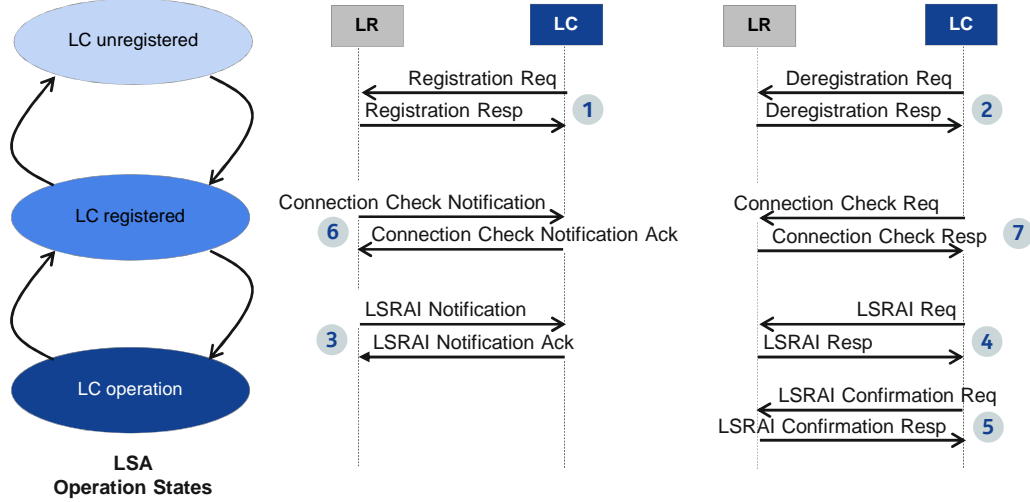
LSA controller is part of the OAM. LSA controller performs the configuration decisions (some or all) internally and communicates actual configuration attributes (TX power, antenna downtilt, etc...) to the corresponding functional blocks.

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LSA system Architecture - High level procedures

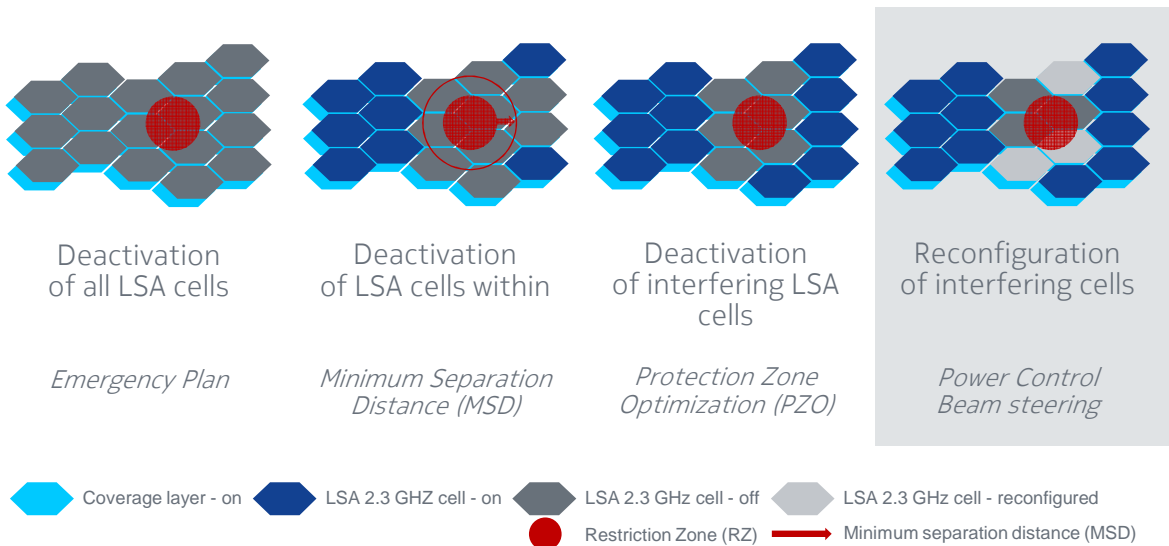
ETSI RRS TS 103 235



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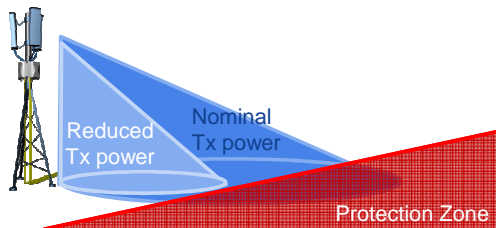
Operational phase : LC implementation steps and evacuation modes



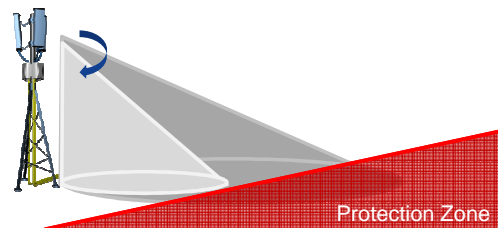
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How to avoid the interference without locking the cell ?



Base Station TX
power optimization



Antenna Tilt
control / Beam
Steering

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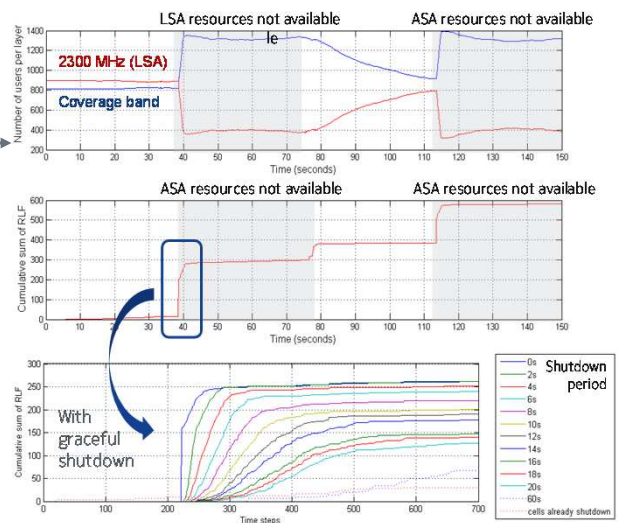
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How to avoid radio link failures when locking cells?



The users connected to interfering cells will experience a Radio Link Failure (RLF) when these cells are locked with Hard Shutdown.

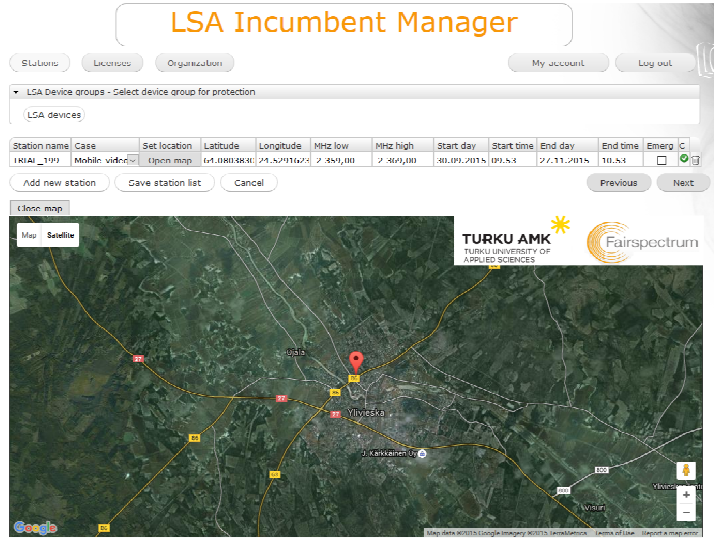
In the **Graceful Shutdown** Tx power is reduced stepwise during a certain period. This allows users to be handed over to other cells, reducing the number of RLFs.



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The LSA Incumbent Manager graphical interface



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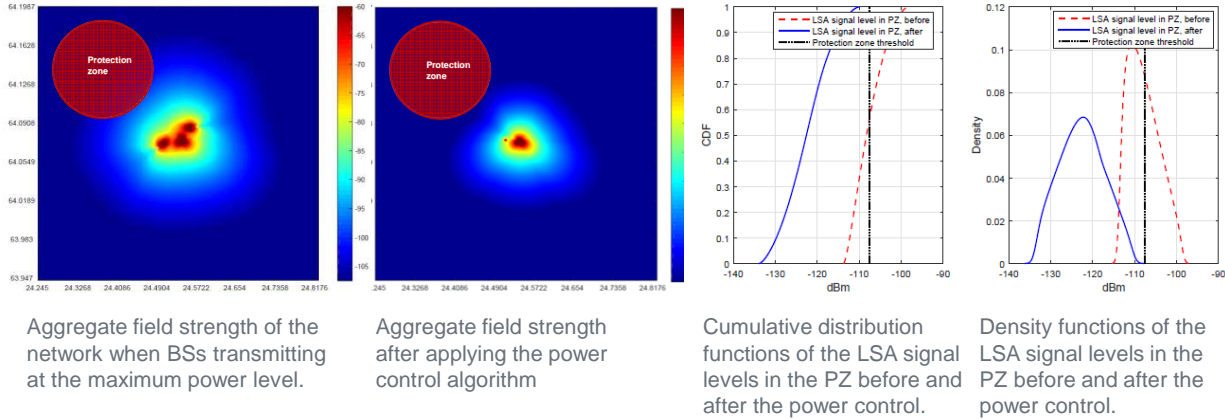
LSA trial network status view in the LC UI Example of the power control algorithm method - ongoing PWRCtrl configuration



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Power control algorithm maximize the LSA capacity



SON LSA Controller's objective is to maximize the average received signal power in the MNO network (outside the PZ) given the constraint on the allowed interference level in the incumbent protection zone, and the constraints on the feasible values of the transmit power levels.

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Source: "Field Trial of Licensed Shared Access (LSA) with Enhanced LTE Resource Optimization and Incumbent Protection," DySpan Sept. 2015

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LSA field trial performance measurement results

Table 1. LSA band reconfiguration measurement results

	Meas point	MSD (s)		PZO (s)		PWR (s)	
		Time	SD	Time	SD	Time	SD
1. Incumbent request via IM	LSA IM	0		0		0	
2. LC receives Incumbent info from LR	LC	0,27	0,03	0,32	0,03	0,41	0,03
3. NMS starts re-configuration command	NMS	0,98	0,08	4,10	0,75	4,48	0,92
4. BS / cell on LSA band is re-configured	LSA band	20,75	1,56	23,48	1,30	58,02	1,49
5. NMS starts PWR conf.	NMS					64,82	0,89
6. NMS notify LC plan commission completed	LC	34,47	1,08	37,72	1,25	95,26	1,71
7. Incumbent user receives confirmation to IM	LSA IM	35,49	1,02	38,64	1,22	96,19	1,48
8. ENB reboot	eNB					463,9	0,46

Table 2. Total measured execution times of system element

Execution time [s]	e2e			component		
	MSD	PZO	PWR	MSD	PZO	PWR
NMS (GS)			33,42			33,42
NMS (reconfig.)	33,54	33,77	63,77	33,54	33,77	30,35
LC	34,94	37,98	95,40	1,40	4,21	31,63
LR	35,49	38,64	96,19	0,54	0,66	0,78
eNB rebooting			463,9			367,7
Algorithm calculation				0,29	0,31	0,34

The average evacuation time to no interference for the PZO was 24s and the graceful PWR reconfiguration 58 s Including the Graceful Shutdown (GS) option with took 33s

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Conclusions

LSA field trial with enhanced LSA controller power control concept algorithms

- Trial successfully demonstrated that TD-LTE network licensee can take 3GPP band 40 (2.3-2.4 GHz) into LSA use and vacate it when requested by the incumbent.
- Dynamic availability of the LSA spectrum resource can be managed with commercially available radio network complemented by integrated LSA controller and LSA repository.
- The LSA Controller was developed as a SON feature within commercial OAM system.
- Power Control algorithms were tested to maximize LSA spectrum resource availability for the licensee while ensuring incumbent protection.
- Measurement results revealed that the evacuation operation can be done in a way that fulfills typical PMSE service incumbent's requirements.
- Comparing to the previous LSA trials, the OAM integrated LSA controller reduced overall operations delay approximately 31% in evacuation cases and increased reconfiguration phase delay by 88% when graceful shutdown + power control was utilized.

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Acknowledgment

This work has been done in the LASS, CORE++ research projects within the 5thGear program of Tekes - the Finnish Funding Agency for Technology and Innovation.

The authors would like to acknowledge the project consortium members: VTT Technical Research Centre of Finland, University of Oulu, Centria University of Applied Sciences, Turku University of Applied Sciences, University of Turku, Aalto University, Fairspectrum, Anite, Finnish Defense Forces and Finnish Communications Regulatory Authority.

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Thank you
Questions/discussion?

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