
# European LSA and US three-tier spectrum sharing models

WInnComm Europe 2015, 6th October 2015

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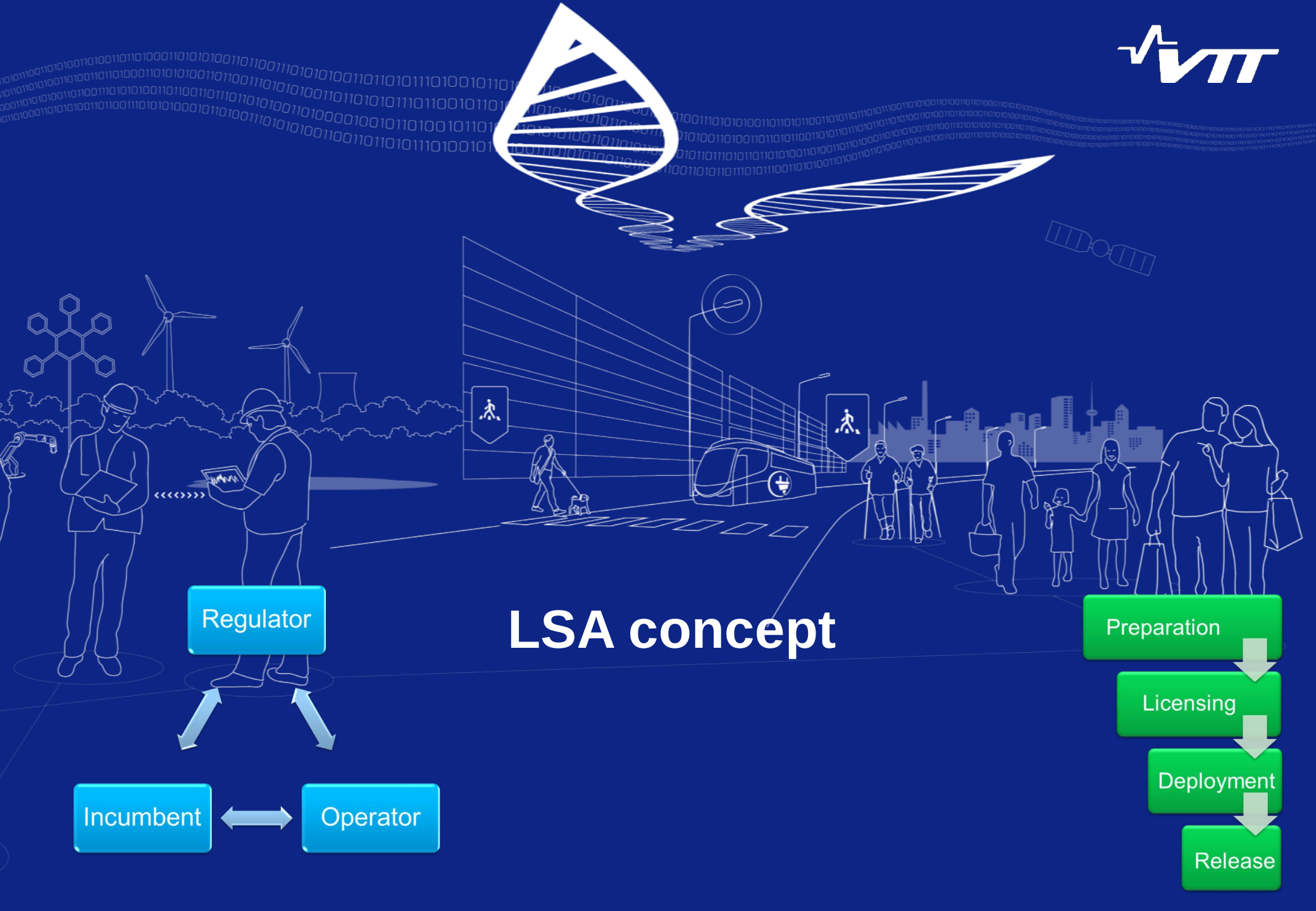
# Outline

- LSA concept
- Finnish LSA research in 2.3-2.4 GHz band
- Towards US three-tier model


Regulator
LSA concept
Preparation
Licensing
Deployment
Release
Incumbent
Operator

# LSA concept

- A regulatory concept from the European Commission (EC) to introduce any radio system to a frequency band with existing usage.
- Sharing is based on the LSA license issued by the regulator and the sharing framework agreed between stakeholders.
- LSA licenses are with limited duration and/or area on spectrum bands underutilized by incumbent.
- Incumbent spectrum user maintains higher level usage rights and may reclaim the band or parts of it at any location, at any time.

# Regulation and standardization activities on LSA in 2.3-2.4 GHz band

- EC: LSA definition, Standardization mandate to ETSI, Regulation mandate to CEPT; harmonized conditions in the future

- CEPT: LSA framework, harmonised technical and regulatory conditions for 2.3 GHz band, implementation examples

- ETSI RRS: Use cases, system requirements, architecture and functions, information flows, procedures, interfaces; protocols in the future.

➢ European regulatory framework ready to allow mobile operations in 2.3 GHz band using LSA


# Finnish LSA research in 2.3-2.4 GHz band

# Finnish CORE research project continuation

## CORE (2011-2012)

- LTE trial environment development
- QoS based decision making
- Cognitive radio system (CRS) research
- WARP offloading trials

## CORE+ (2013-2014)

- World's first Licensed Shared Access (LSA) live trials
- CRS work at ITU-R and LSA work at CEPT
- Active Antenna System (AAS) field trials
- LSA business scenarios and models

## CORE++ (2015-2016)

- Application of LSA to public safety and special applications
- LSA evolution towards three-tier CBRS model

Tekes

Trial

5thGear

# Approach for LSA

- Business studies
- Technical studies
- Live end-to-end trials
- Contributions to regulation at CEPT and ITU-R
- Alignment with ETSI standardization


…in collaboration with industry, research and other stakeholders.

# Finnish LSA trial group

Centria
RESEARCH AND DEVELOPMENT

TURUN AMMATTIKORKEAKOULU
TURKU UNIVERSITY OF APPLIED SCIENCES

VTT

CWC
Oulu

NOKIA

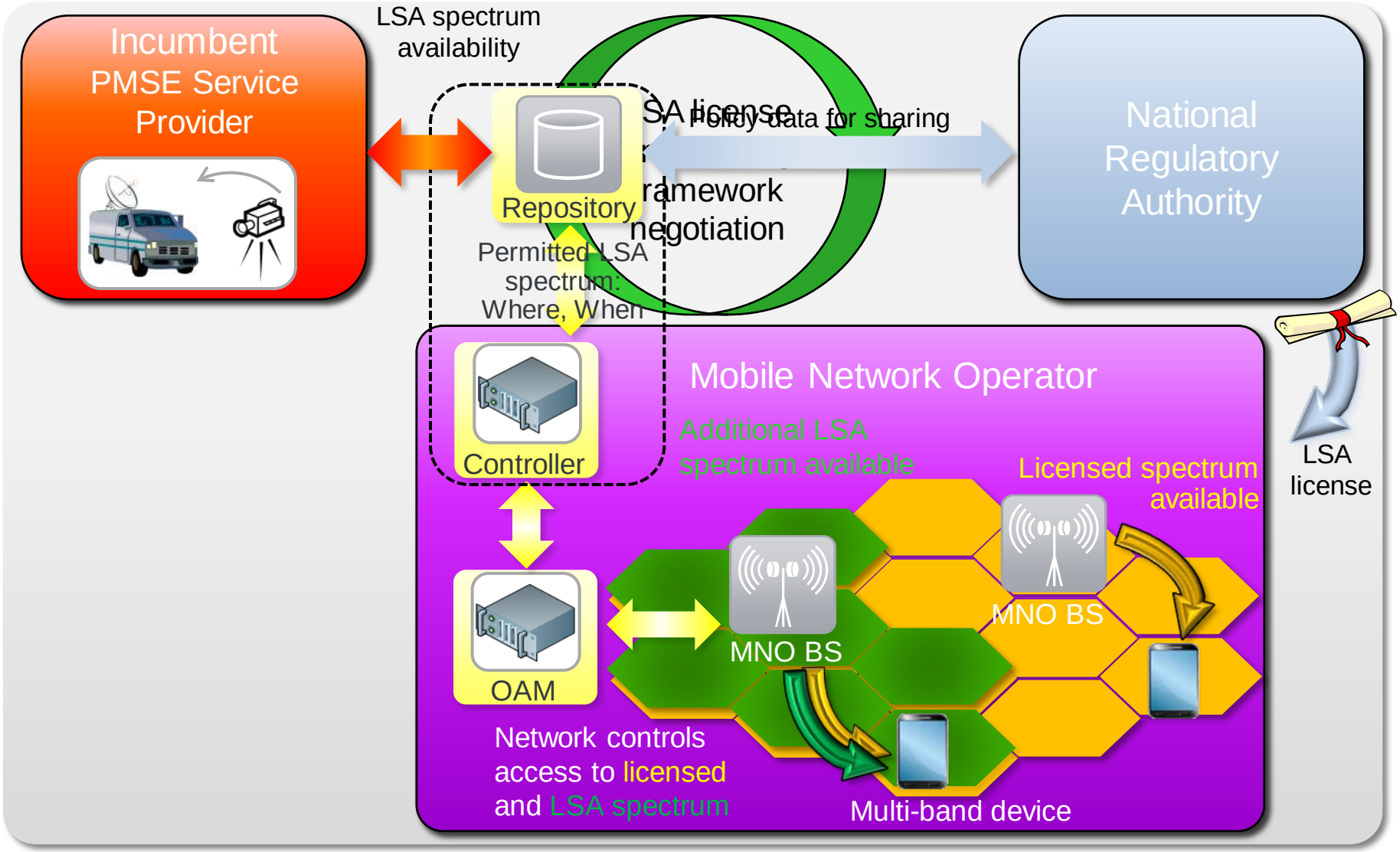
Fairspectrum

Viestintävirasto
Finnish Communications
Regulatory Authority

Tekes

5thGear

# Key stakeholders and activities in LSA



# Evolution of the Finnish LSA trial

Flexibility

**The World's first LSA trial**

Live BS at 2.3 GHz
LSA band evacuation
Handover to WiFi
QoS measurements

**Enhanced equipment**

Multiple BSs/sectors
Commercial OAM and core network
LSA Repository
Incumbent manager

**Expanded network**



Visualization
Multiple technologies
TD-FDD handovers

**Incumbent representation**

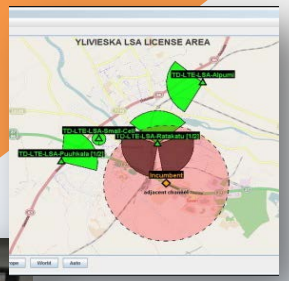
Multiple incumbents (types, adjacent /co-channel)
LTE protection
Emergency evacuation

**Small cell**

Small cell
Changing incumbent location

**Mobile incumbent**

Tracking of mobile incumbent

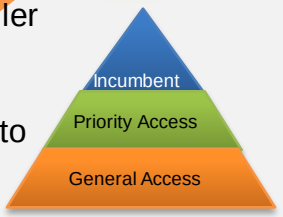


**SON LSA controller**

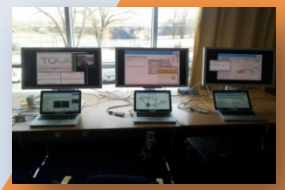
LSA controller as SON solution integrated to OSS

**Towards three-tier model**

Dynamic sharing




**LSA evolution**



WWRF meeting
4/2013 Finland

LSA Trial workshop
9/2013 Finland

IEEE DySPAN
4/2014 USA

Mobile Asia Expo & CrownCom
06/2014
China & Finland

ETSI workshop
12/2014 France

ECC meeting
7/2015 Finland

IEEE DySPAN
9/2015 Sweden

IEEE Globecom
12/2015 USA

CORE+ project

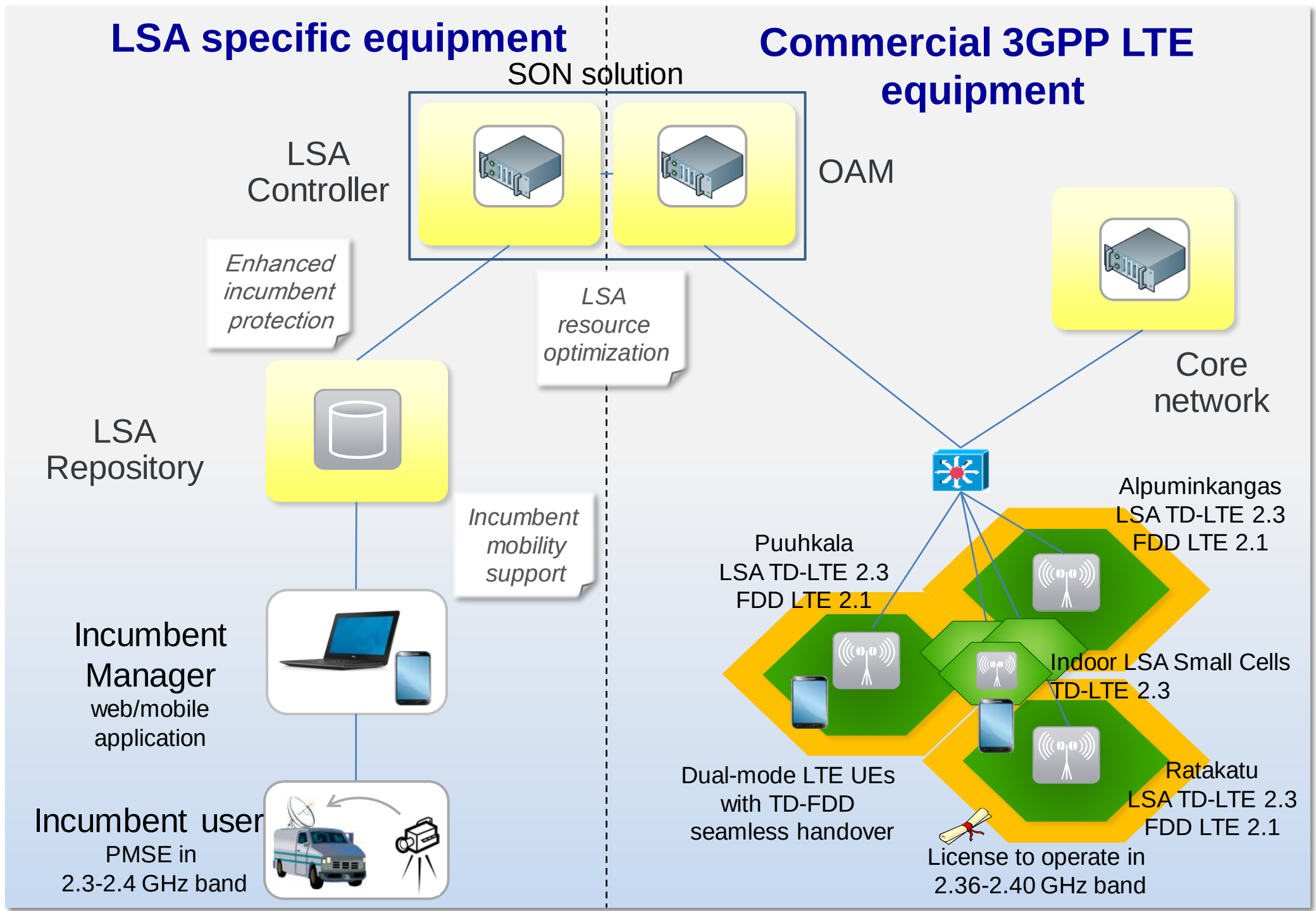
Tekes

Trial

5thGear

CORE++ project

2013 2014 2015 2016

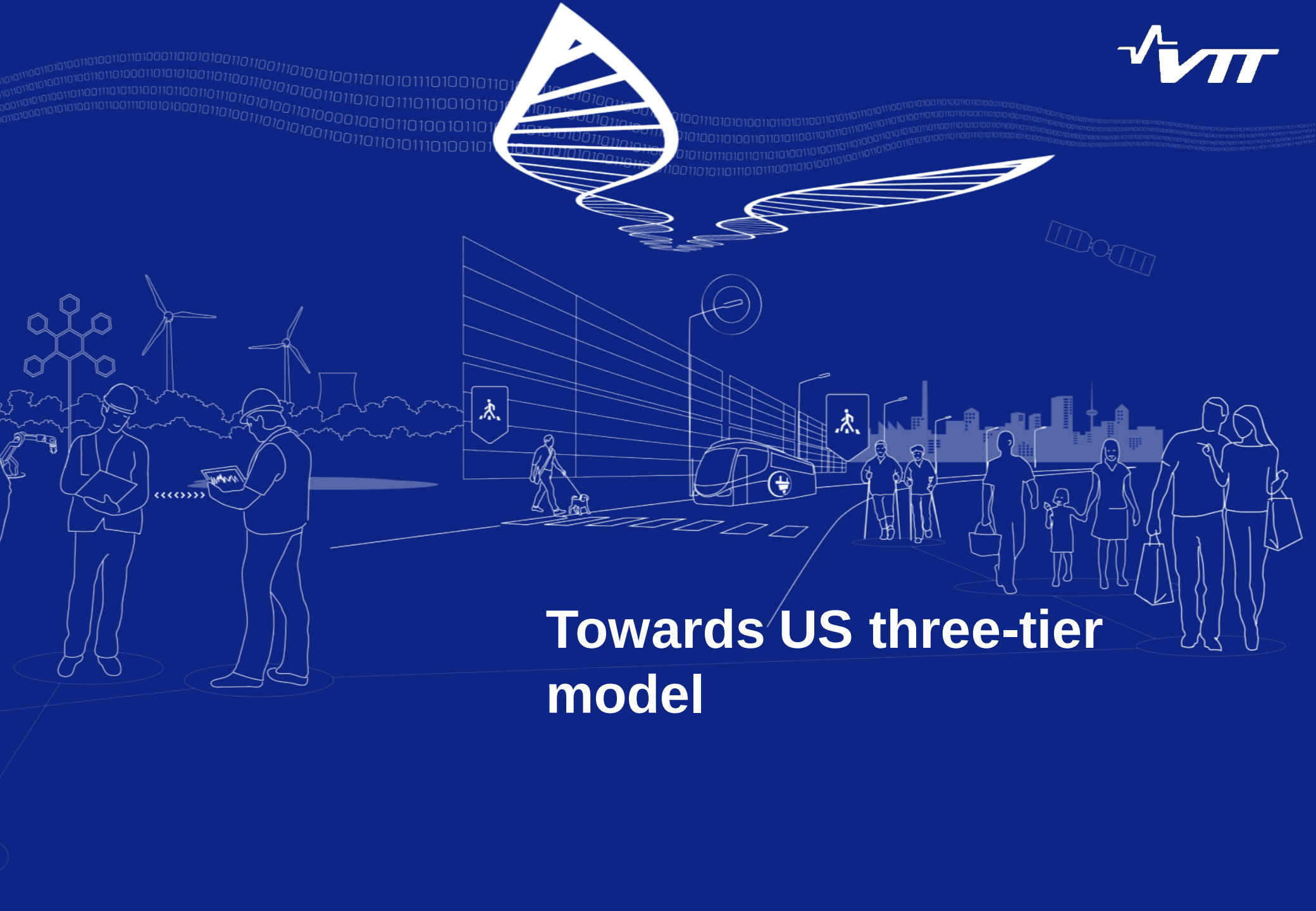

LSA specific equipment
Commercial 3GPP LTE equipment
SON solution
LSA Controller
OAM
Enhanced incumbent protection
LSA resource optimization
Core network
LSA Repository
Incumbent mobility support
Alpuminkangas
LSA TD-LTE 2.3
FDD LTE 2.1
Puuhkala
LSA TD-LTE 2.3
FDD LTE 2.1
Indoor LSA Small Cells
TD-LTE 2.3
Incumbent Manager
web/mobile application
Dual-mode LTE UEs with TD-FDD seamless handover
Ratakatu
LSA TD-LTE 2.3
FDD LTE 2.1
Incumbent user
PMSE in 2.3-2.4 GHz band
License to operate in 2.36-2.40 GHz band

# LSA status in Europe

- Finnish LSA research in the 2.3 GHz band is:
  - Aligned with standardization: ETSI RRS
  - Contributed regulation: ECC groups (FM52 and FM53), EC, ITU-R WP5A and ITU-R WP1B
  - Showcased in academic, industry, regulation and standardization events in Europe, US and Asia
  - Published in leading scientific forums

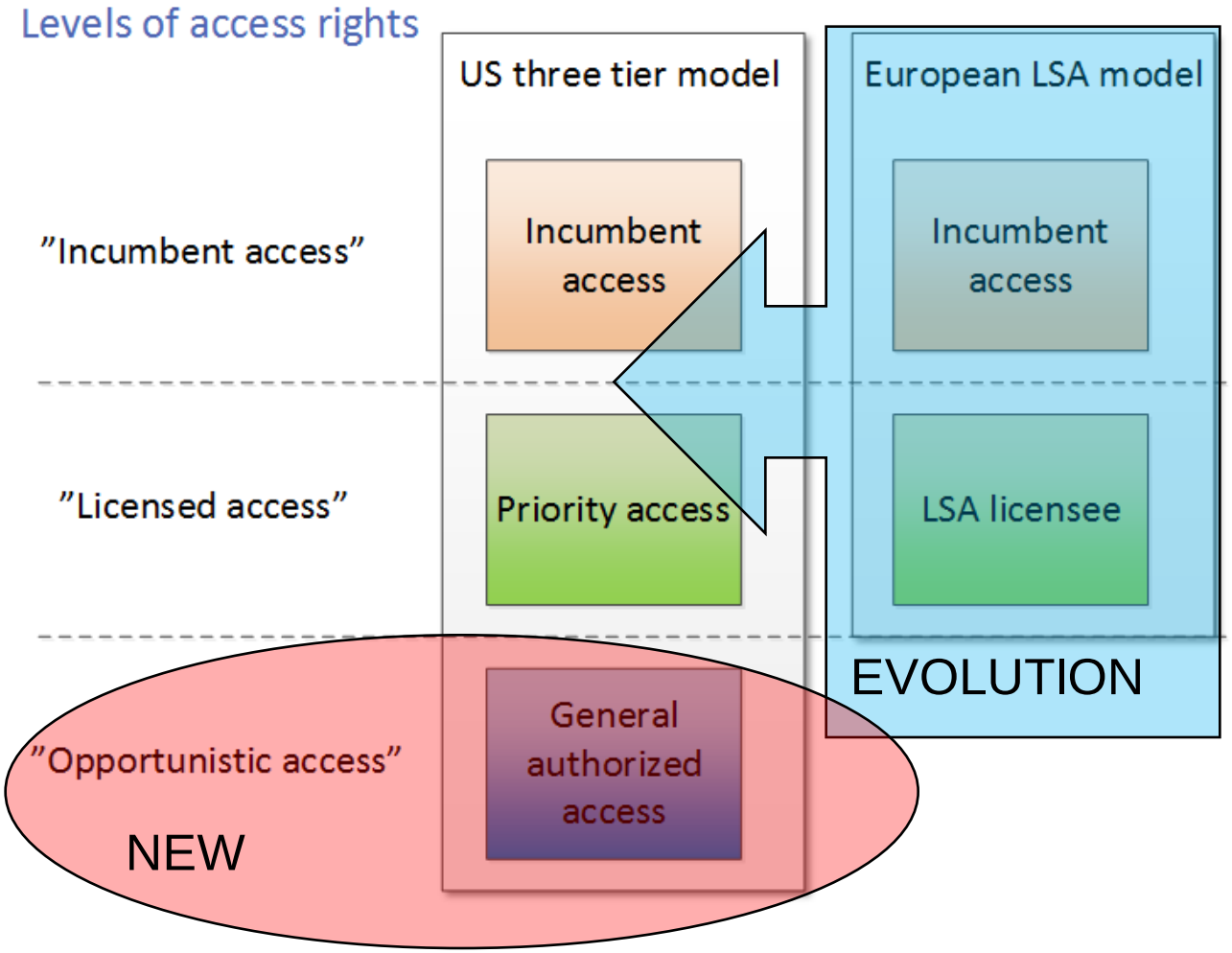
  ➢ Feasibility of LSA in 2.3 GHz band for sharing between mobile communication system and incumbents demonstrated

- Next topic in Europe is application of LSA to 3.6-3.8 GHz band

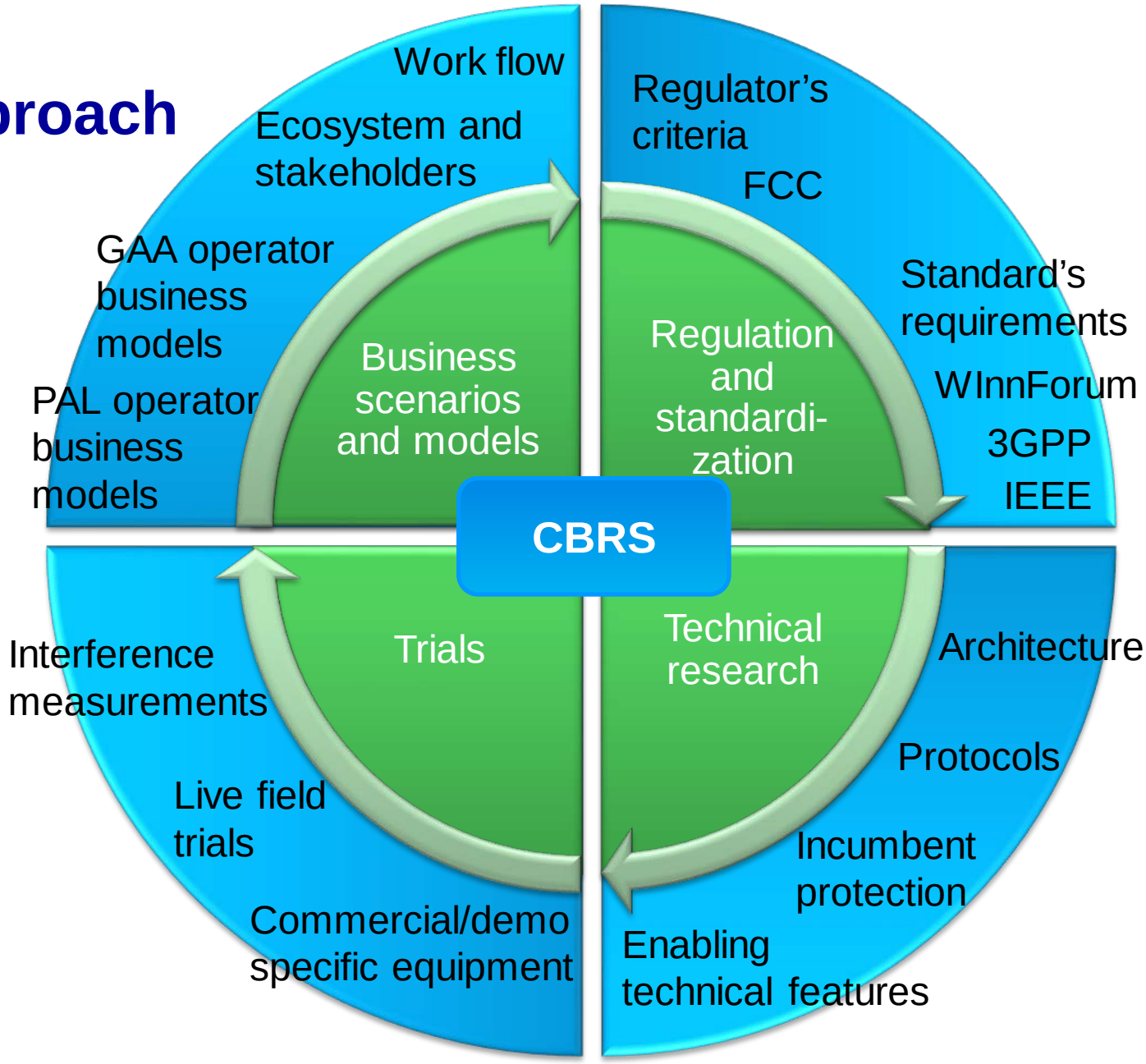


# Towards US three-tier model

# LSA and Three-tier CBRS model



# Approach


Work flow
Ecosystem and stakeholders
GAA operator business models
PAL operator business models
Business scenarios and models
Regulator's criteria
FCC
Standard's requirements
WInnForum
3GPP
IEEE
Regulation and standardi-zation
CBRS
Interference measurements
Live field trials
Commercial/demo specific equipment
Trials
Technical research
Architecture
Protocols
Incumbent protection
Enabling technical features

# Advantages of LSA and CBRS concepts

- LSA concept:
  - simple
  - a high degree of legal certainty
  - low impact to the systems
  - simple enforcement
  - deployment in a short timeframe
- CBRS concept:
  - flexible
  - promote competition
  - foster innovation
  - efficient spectrum utilization

# Conclusions

- LSA concept allows sharing between mobile communication networks and incumbents with predictable QoS conditions
- Finnish end-to-end ecosystem live trials have developed the LSA concept and demonstrated its feasibility in 2.3 GHz for LTE networks sharing with wireless cameras
  - Next application area in Europe is 3.6-3.8 GHz band
- US three-tier CBRS is a more complex sharing model that goes beyond LSA by introducing the third tier of opportunistic access providing a rich ecosystem and more dynamic operations
  - Lessons learnt from LSA development

# Selected publications


- S. Yrjölä, P. Ahokangas, M. Matinmikko. Evaluation of recent spectrum sharing concepts from business model scalability point of view. IEEE DySPAN conference, Stockholm, Sweden, 2015. *Best policy paper award*.
- M. Mustonen, M. Matinmikko, M. Palola, T. Rautio & S. Yrjölä. Analysis of requirements from standardization for Licensed Shared Access (LSA) system implementation. IEEE DySPAN conference, Stockholm, Sweden, 2015.
- J. Kalliovaara, T. Jokela, R. Ekman, J. Hallio, M. Jakobsson, T. Kippola & M. Matinmikko. Interference measurements for Licensed Shared Access (LSA) between LTE and wireless cameras in 2.3 GHz band. IEEE DySPAN conference, Stockholm, Sweden, 2015.
- M. Mustonen, M. Matinmikko, M. Palola, S. Yrjölä & K. Horneman. An evolution towards cognitive cellular systems: Licensed Shared Access (LSA) for network optimization. *IEEE Communications Magazine*, May 2015.
- M. Mustonen, T. Chen, H. Saarnisaari, M. Matinmikko, S. Yrjölä & M. Palola. Cellular architecture enhancement for supporting the European Licensed Shared Access concept. *IEEE Wireless Communications*, June 2014.
- M. Matinmikko, H. Okkonen, M. Palola, S. Yrjölä, P. Ahokangas & M. Mustonen. Spectrum sharing using licensed shared access: The concept and its workflow for LTE-advanced networks. *IEEE Wireless Communications*, Vol. 21, No. 2, April 2014, pp. 72-79.
- M. Palola, M. Matinmikko, J. Prokkola, M. Mustonen, M. Heikkilä, T. Kippola, S. Yrjölä, V. Hartikainen, L. Tudose, A. Kivinen, J. Paavola & K. Heiska, “Live field trial of Licensed Shared Access (LSA) concept using LTE network in 2.3 GHz band,” IEEE DySPAN, McLean, VA, 1-4 April 2014.
- M. Matinmikko, M. Palola, H. Saarnisaari, M. Heikkilä, J. Prokkola, T. Kippola, T. Hänninen, M. Jokinen & S. Yrjölä, "Cognitive Radio Trial Environment: First Live Authorized Shared Access-Based Spectrum-Sharing Demonstration," *IEEE Vehicular Technology Magazine,* vol.8, no.3, pp.30-37, Sept. 2013.


More information: http://core.willab.fi/

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