# Field Trial of Citizens Broadband Radio Service (CBRS) / Spectrum Access System (SAS)

Pekka Aho (VTT), Marko Palola (VTT), Tero Kippola (Centria), Marjo Heikkilä (Centria), Marko Mäkeläinen (University of Oulu), Tuomo Hänninen (University of Oulu), Lucia Tudose (Nokia), Vesa Hartikainen (Nokia), Seppo Yrjölä (Nokia), Arto Kivinen (TUAS), and Jarkko Paavola (TUAS)

***Abstract*— This demonstration presents a field trial of the latest US spectrum sharing concept for mobile broadband. The proposed demonstration is part of the Finnish spectrum sharing trial continuum that started in 2013 with the World's first Licensed Shared Access (LSA) trial. The demonstration is now expanded towards the US three-tier Citizens Broadband Radio Service (CBRS) model for 3.5 GHz band that introduces an additional more dynamic sharing layer in addition to the two layers available in the LSA model. The trial is implemented based on the Federal Communications Commission (FCC's) definitions and Wireless Innovation Forum (WInnF) Spectrum Sharing Committee's recommendations. The trial consists of commercial LTE network components like 3.5GHz base stations, user equipment, network management system, and core network. Additional spectrum sharing specific components are developed on top of the LTE system including Domain Proxy and advanced algorithms for Spectrum Access System (SAS) to enable frequency allocation for the CBSDs. Both the standalone and operator driven CBSDs are considered. Our trial gives a unique opportunity to see live how a commercial LTE network adapts to the SAS frequency allocation. Furthermore, performance and latency measurements (e.g. evacuation time) are performed based on the real life behavior of the network.**

***Keywords—field trial; live demonstration; spectrum sharing; spectrum regulation; Quality of Service***

## I. Introduction

Spectrum sharing trials are extremely timely as the recent regulation and standardization efforts in Europe and the US have focused on making new spectrum available for mobile broadband systems through sharing. In Europe, Licensed Shared Access (LSA) concept has gained significant interest in industry and academia and is currently being standardized in ETSI and promoted in spectrum regulation in European Commission (EC) and European Conference of Postal and Telecommunications Administrations (CEPT) [1,2]. In the US, Federal Communications Commission (FCC) has adopted new spectrum sharing concept called Citizens Broadband Radio Service (CBRS) [3], which have been further defined by Wireless Innovation Forum (WInnF). The proposed demonstration will showcase the US CBRS model that includes incumbent access and priority access and introduce an additional layer of lower priority users. This new three tier model is implemented on top of the environment developed for our previous LSA demonstrations [4,5].

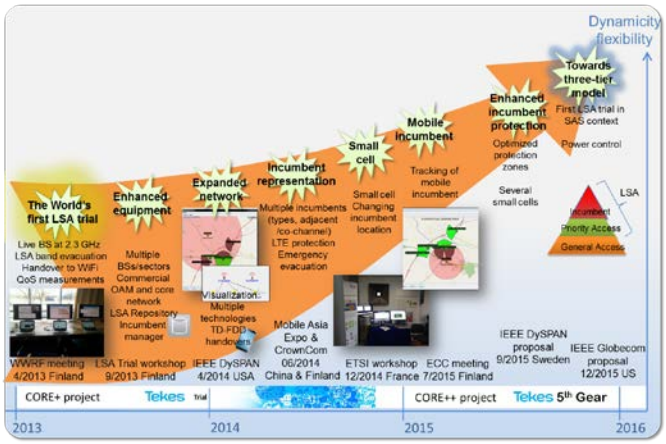
Building on top of the pioneering work of the Finnish Cognitive Radio Trial Environment (CORE++) project [6] consortium on LSA in Europe, the demonstration is now expanded towards the US three-tier CBRS concept. The new concept will enable spectrum sharing and flexible use of spectrum in the 3.5 GHz band. Three tiers are: (1) incumbent licensees; (2) Priority Access licensees (PAL); and (3) General Authorized Access (GAA). The first tier consists of the incumbent federal users (military radars) and fixed satellite service (FSS) operators, previously the sole users of the spectrum in question. These incumbents will have complete interference protection from the two lower CBRS tiers. The second tier is PAL which is entitled to interference protection from GAA CBSDs. The third tier, GAA, is opportunistic license free tier, but all devices operating in the band are required to be authorized.

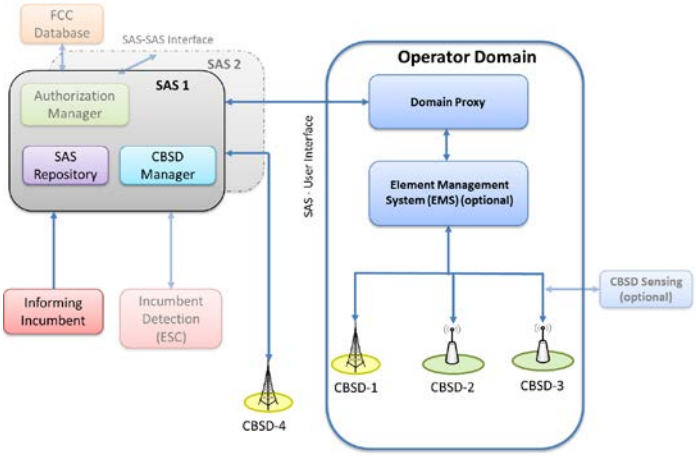
In order to facilitate dynamic spectrum access in CBRS system, we need Spectrum Access System (SAS), which is highly automated frequency coordinator, taking care of authorization and management of CBRS spectrum. SAS is responsible to protect higher tier CBSDs from harmful interference and maximize frequency capacity for all CBSDs.

The demonstration consists of commercial LTE network components including 3.5GHz base stations, user equipment, network management system and core network. Trial network is using the Finnish Communications Regulatory Authority issued test license for 3.5GHz band (LTE band 42). Additional spectrum sharing specific components are developed on top of the LTE system including SAS server, Domain Proxy and a standalone CBSD that is managed locally without connection to the core network. Novel and advanced algorithms for SAS will be presented in the demonstration. The demonstration will follow the standards and recommendations given by WInnF and with the demonstration we aim to contribute to the on-going standardization process.

CBSD can belong to operator network or they can operate as standalone CBSD, depending on the usage scenario. In our demonstration, Domain Proxy that is integrated to the network management system, will take care of communicating with SAS and pass the commands to CBSDs which belong to operator network. In the case of standalone CBSD, the basestation is managed locally and CBSD has to communicate with the SAS to get spectrum access information. In our trial, we have implemented a standalone SAS client that communicates with SAS and manages the operation and frequency of the basestation. The Incumbent Detection (ESC) is implemented by detecting radio pulses that simulate military radar and SAS reacts to the arriving incumbent user by automatically evacuating PAL and GAA users from the required spectrum.

We give a live demonstration to the audience on how a commercial LTE network adapts to the new spectrum sharing system. The visualization tools are used to demonstrate the operations of the different trial components to the audience. The actual live trial environment is running in Finland and it is shown and controlled remotely from the conference venue. The visualizations show the locations of the LTE network and incumbent on the map and corresponding activities when the incumbent appears. Performance and latency measurements of the trial system can also be shown to the audience.




## References


[1] ETSI. Mobile broadband services in the 2 300 MHz – 2 400 MHz frequency band under Licensed Shared Access regime. ETSI RRS System reference document. TR 103 113, V. 1.1.1. July 2013.

[2] ECC Report 172. Broadband Wireless Systems Usage in 2300-2400 MHz. March 2012.

[3] Draft ECC Report 205. Licensed Shared Acces.

[4] 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 Veh. Techol. Mag., vol. 8, no. 3, Sept. 2013, pp. 30-37.

[5] M. Palola et al. Live field trial of Licensed Shared Access (LSA) concept using LTE network in 2.3 GHz band. IEEE DySPAN 2014.

[6] CORE++ project web page [Online]. Available: http://core.willab.fi.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