

Spectrum sharing in 5G experience from 5G-Xcast project

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- 5GPPP 5G-Xcast project (2017-2019)
 - Focus on Media and entertainment and Public Warning verticals
- This presentation illustrates the dynamic spectrum usage scenarios considered in the project from the perspective of:
 - PMSE
 - Demonstrated in EUCNC 2018
 - Video: <u>https://www.youtube.com/watch?v=xfdqTB1Llq0</u>
 - Public Warning
 - Demonstrated in EUCNC 2019
 - Videos: <u>https://www.youtube.com/watch?v=DiQXGm5T5P4</u>, <u>https://www.youtube.com/watch?v=uR7dc5rKxZ4</u>





Introduction

Case 1: Spectrum sharing for PMSE



- Considered scenario: Live sports event
- Mobile network operator (MNO) uses 2.3 GHz band as additional capacity when and where available (secondary user)
- Various types of PMSE equipment operate on the 2.3 GHz band (primary users)
- Spectrum manager orchestrates the operation of all equipment in the area of the event
 - LTE/5G based equipment is directly controlled by the spectrum manager
 - Older PMSE equipment is registered through a reservation system



Picture source: 5G-Xcast project deliverable D2.1. Available online: <u>http://5g-xcast.eu/documents/</u>

• Macro 700 MHz BTS

- 2x Pico 2.3 GHz BTS
 - One for MNO, one for PMSE
- Cellular phones

Trial setup

- To operate in MNO network and as PMSE LTE equipment (live streaming video from the phone)
- Spectrum analyzer
 - To observe the spectrum band
- Spectrum Manager
 - Controls the BTS directly, proprietary PMSE user registers via web-based system









Trial setup







Back (change input) Confirm reservation Queue reservation

Trial procedure

- 1. MNO LTE1 (700 MHz) and LTE2 (2.3 GHz) serving users (web surfing, video streaming)
- 2. PMSE LTE (2.3 GHz) turns on as a rapidly deployable network for PMSE, free spectrum is available for both MNO LTE2 and PMSE LTE
- 3. PMSE user registers to the spectrum manager registration system, on the frequency currently in use for PMSE LTE
- MNO LTE2 limits its transmission power (if necessary) to follow interference limits and the users remain connected to at least B28 (700 MHz) base station
- 5. PMSE LTE changes channel to give space to PMSE
- 6. Proprietary PMSE equipment turns on









- The spectrum manager allocates suitable frequencies for the LTE based equipment and follows the user priority order when spectrum is requested by the incumbent
- Dynamic spectrum management system can control simultaneously various types of devices and they may have differing capabilities and restrictions in their spectrum use
- The presented trial illustrated a mechanism that allows the PMSE stakeholders to gradually upgrade their equipment operating in the band towards LTE/5G
- The same concept can also be applied to other frequency bands where spectrum sharing is allowed, for example for 5G systems coexisting with non-3GPP systems
- More details: T. Jokela *et al.*, "Trial of Spectrum Sharing in 2.3GHz Band for Two Types of PMSE Equipment and Mobile Network," 2018 IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB), 2018, pp. 1-5

Case 2: Spectrum sharing for public warning



- Multimedia Public Warning demonstration targeted the Public Warning vertical. It shows sending public warning multimedia alerts to the user equipment using dynamic spectrum management, multi-link and broadcast technologies.
- The objective is to reach maximal number of recipient rapidly by utilizing combination of broadcast, unicast, dynamic allocation of additional capacity and bonding several carriers
- Combining broadcasting with Dynamic spectrum and multilink provides a mechanism for delivering alerts for masses





Technical description



- The setup consists of equipment for public warning transmission, Dynamic spectrum management and multilink
- The triggering of the PW reception is using Google Firebase Cloud Messaging
- The alert can be transmitted to terminals over LTE broadcast, LTE unicast, and bonded connection (multilink)



Procedure for PW transmission



The alert is set up by the authority

Spectrum management activates the additional spectrum for PW transmission



The alert is transmitted to the device and displayed







- Broadcasting presents a resource efficient mechanism for delivering public warning alerts to large audiences simultaneously
- Dynamic spectrum management allows the authorities to engage additional capacity for public warning when necessary
- Multilink allows to combine the capacity of available networks for transmission of PW alerts
- The demonstrated public warning app uses all available connectivity means to deliver the alert for the user
- For energy efficiency, future physical layer should enable triggering of the multicast/broadcast reception initiated by the network
- More detail can be found in: T. Jokela *et al.*, "Multimedia Public Warning Alert Trials Using eMBMS Broadcast, Dynamic Spectrum Allocation and Connection Bonding," in *IEEE Transactions on Broadcasting*, vol. 66, no. 2, pp. 571-578, June 2020



Thank you! Questions?