5G-Xcast Tutorial

Broadcast and Multicast Communications Enablers for 5G

WP6: Test-Bed Integration, Validation & Demonstration

WP6

Presenters:

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Disclaimer

The current presentation shows **work in progress**, supported in part by the European Commission under the 5GPPP project 5G-Xcast (H2020-ICT-2016-2 call, grant number 761498).

The content is not yet approved nor rejected, neither financially nor content-wise by the European Commission. The approval/rejection decision of work and resources will take place **at the Mid-Term Review Meeting planned in September 2018 and the Final Review Meeting**, after the monitoring process involving experts has come to an end.

Public Deliverables

- **D6.2**: Development of Showcase and Demonstrators, Feb. 2019.
- **D6.3**: Test-Beds Integration and Deployment, Feb. 2019.
- **D6.4**: **Final Evaluation and Validation**, May 2019.

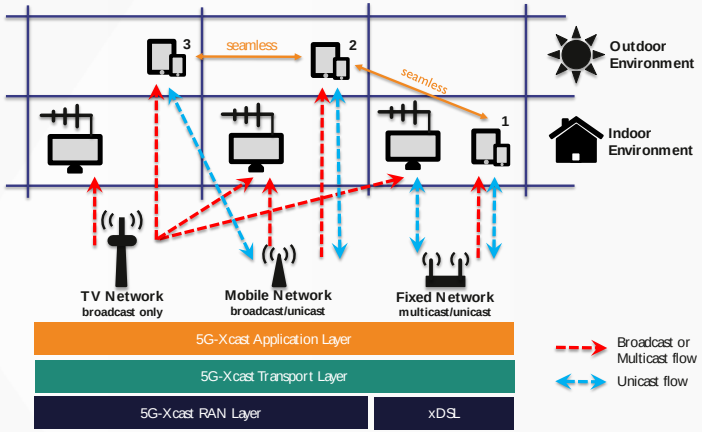
Contents

1. Introduction

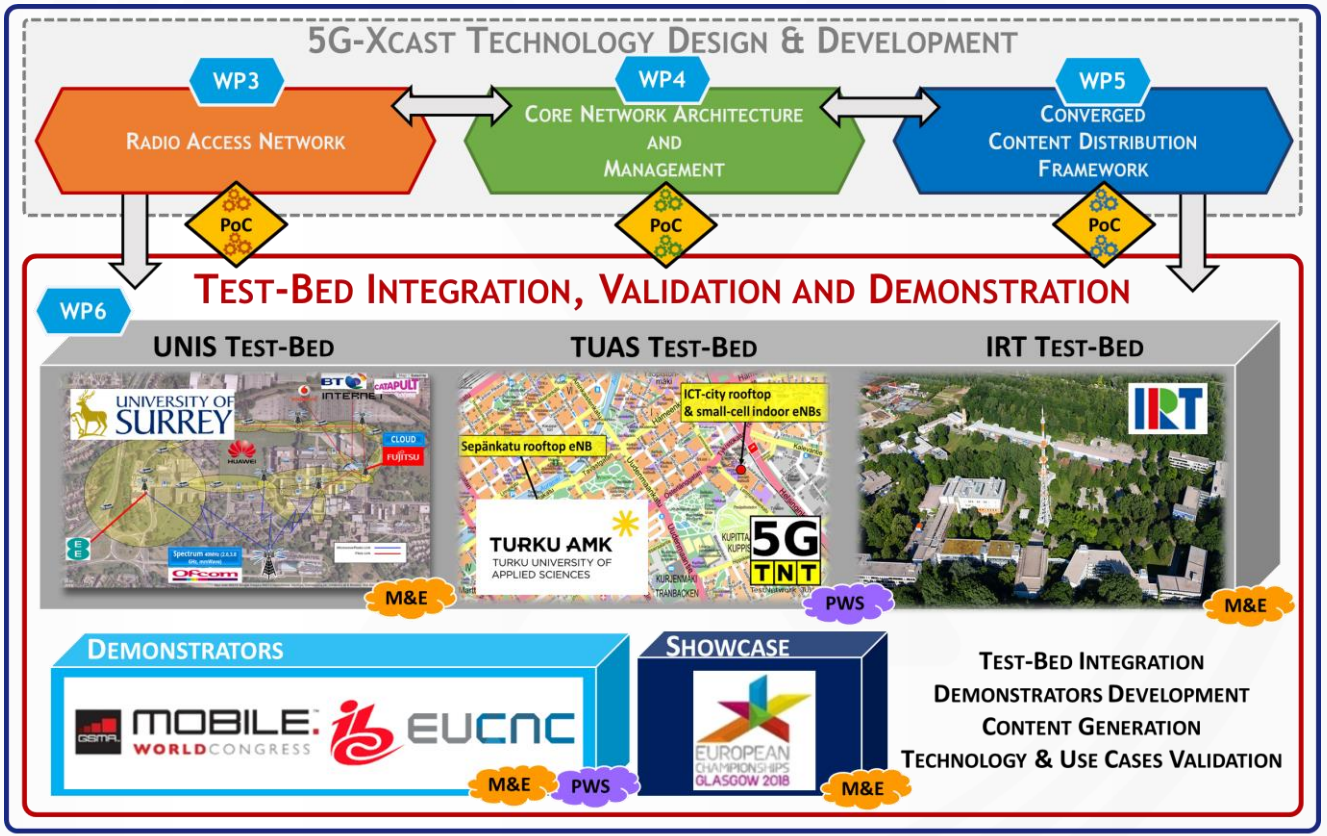
- **Plan demonstration of M&E and PWS use cases in coordination with technical WPs (WP3, WP4, WP5)**
  - Trials on Test-Beds
  - Demonstrators for public events
  - Showcase
- **Validation of the concepts addressed in the project and the technology enablers**

1. Scope of the Demonstrations

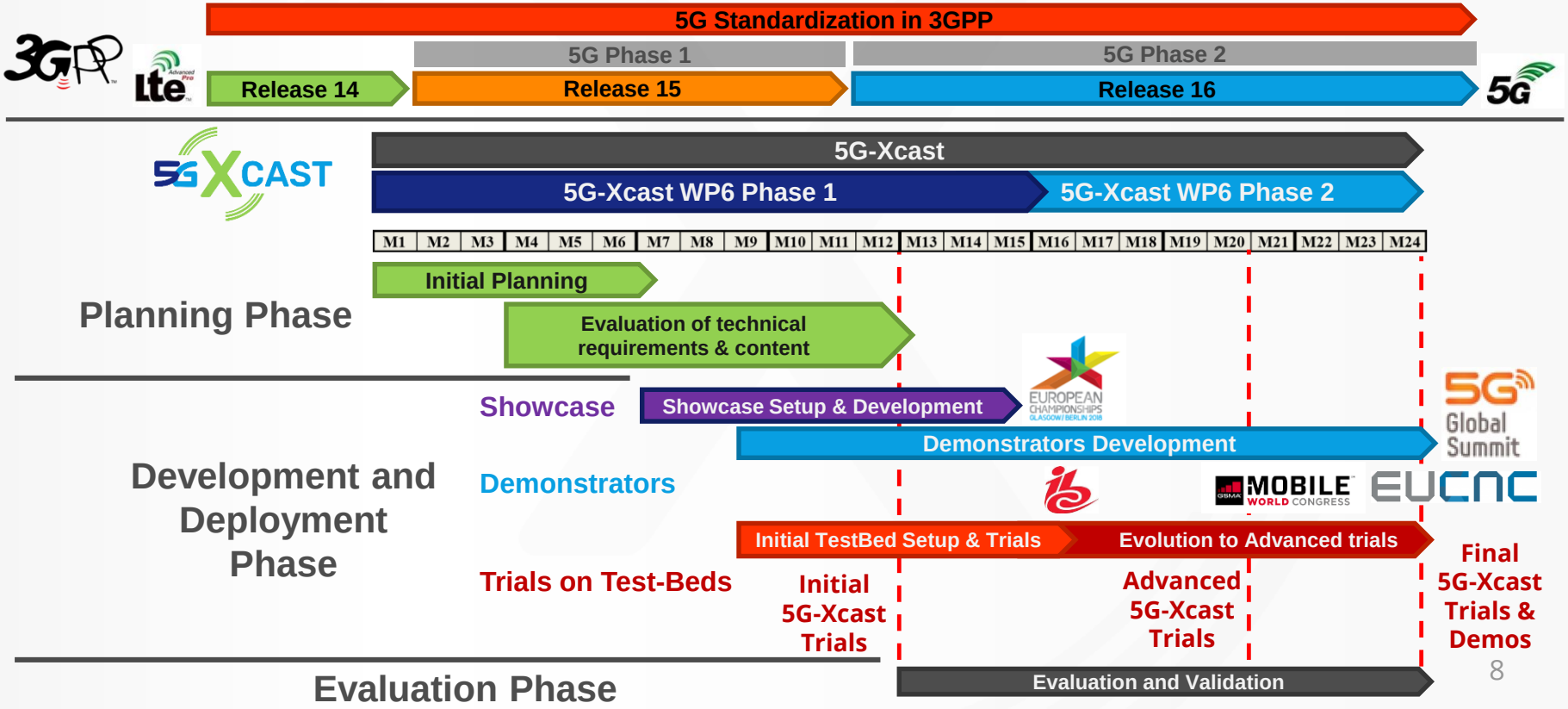
- **Media & Entertainment**
  - Hybrid Broadcast Service
  - Object-based Broadcasting
- **Public Warning**
  - Amber Alert
  - Multimedia Public Warning Alert
- **Spectrum utilization**



1. Introduction - Overview



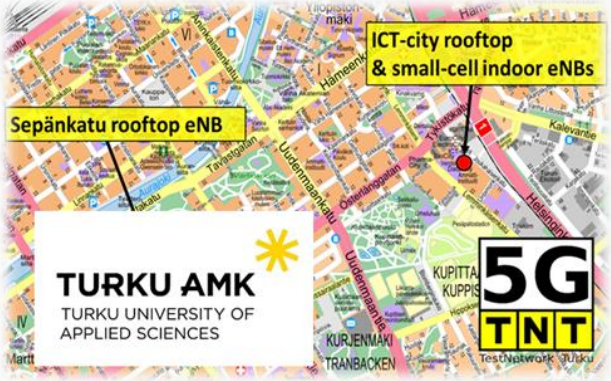
1. Introduction - Roadmap



2. Trials on Test-Beds

Hybrid Broadcast Service

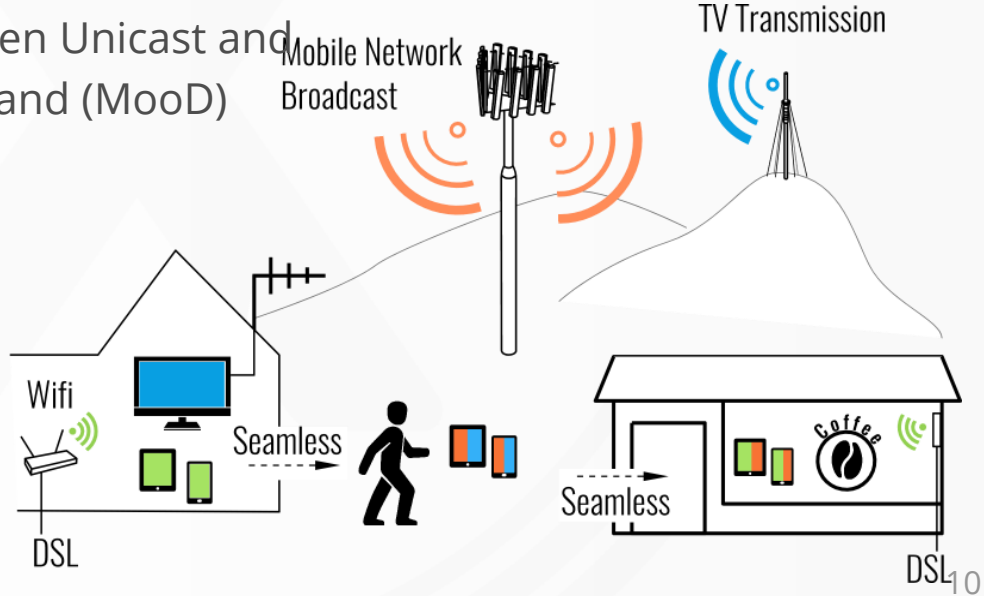
Object-based Broadcasting



Public Warning and Spectrum Sharing

2. Trials: Hybrid Broadcast Service

- **Trials in IRT Test-bed around Hybrid Broadcast Service**
  - Concurrent reception of Broadcast + Unicast
  - Use of Multiple Networks (Multi-Link) and Seamless Transitions
  - Traffic migration between Unicast and MBMS via MBMS On-Demand (MooD)

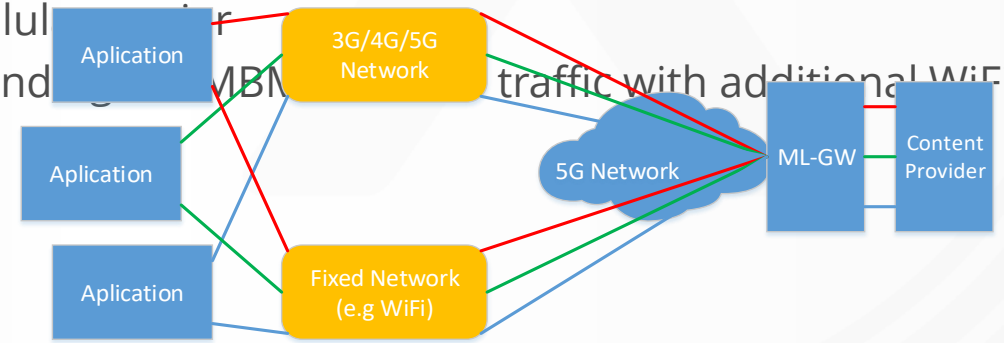


2. Trials: Hybrid Broadcast Service

- **Concurrent Reception of Unicast + Multicast content**
  - Extension of HbbTV-like service which is based on Broadcast + Unicast Wired connection to a fully wireless solution based on mixed unicast/multicast radio allocation
  - Testing of available delivery modes RTP, DASH
  - Characterization of CNR, Capacity for available transmission modes
  - Initial trials in the context of EU championships showcase development

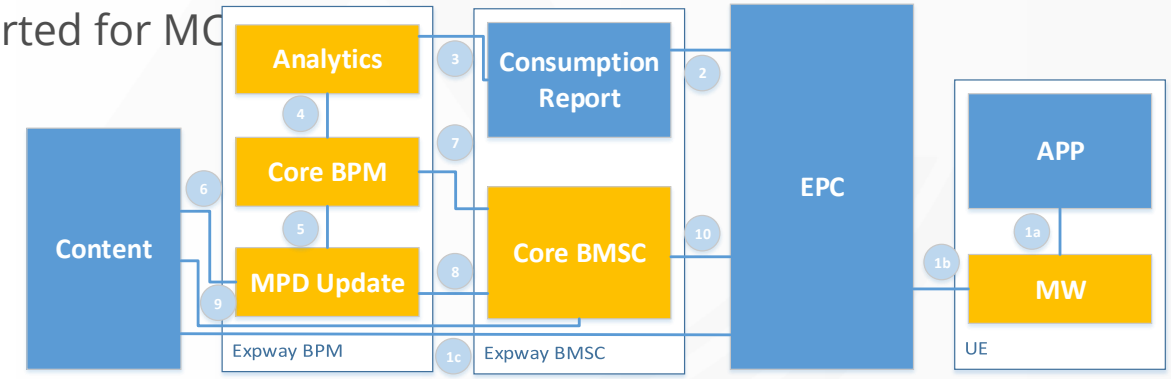
2. Trials: Hybrid Broadcast Service

- Use of Multiple Networks (Multi-Link) and Seamless Transitions
  - Bonding of a cellular network link with another link of the same operator.
  - Bonding of a cellular network link of one operator with a WiFi network link of another operator.
  - Bonding of eMBMS session traffic with additional unicast traffic via cellul
  - Bond MBM traffic with additional WiFi network li



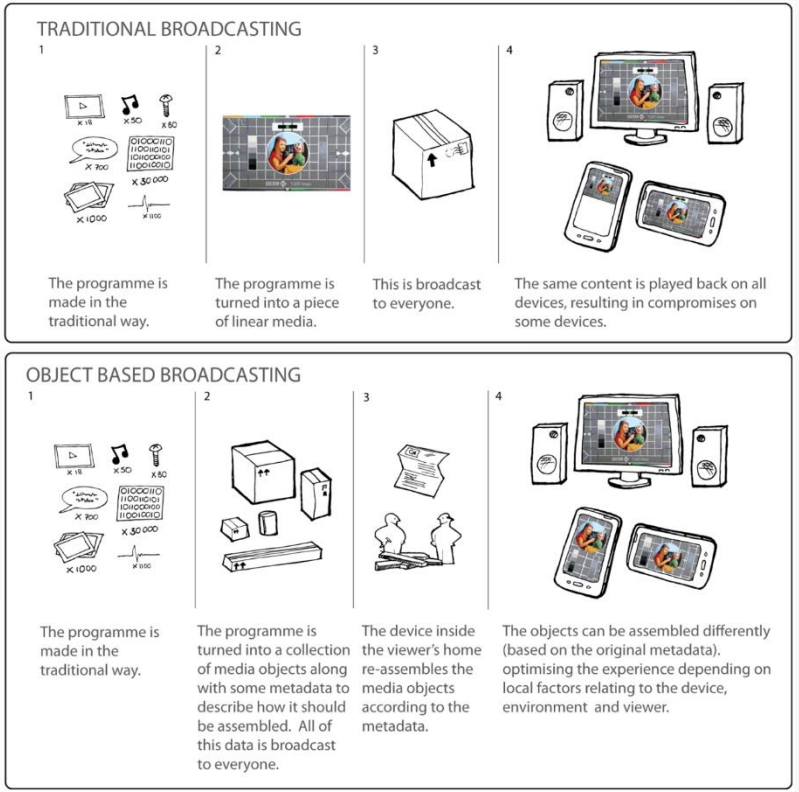
2. Trials: Hybrid Broadcast Service

- Traffic Migration via MBMS On-Demand (MooD)
  - The UE is equipped with a MW that periodically delivers Consumption Reports to the network
  - A decision is taken whether the transmission should be switched to eMBMS due to popularity or remain as unicast.
  - The manifest for DASH content is updated according to unicast or multicast
  - BMSC is started for MC



2. Trials: Object Based Broadcasting

- **Object-based Broadcasting (OBB) is the concept of delivering different 'objects' separately to the user**
  - This allows the experience to be tailored to an individual's environment, device or preferences
- **Objects could include**
  - Picture elements, sound sources, text, access services e.g. subtitles and signing
- **OBB map onto the 5G-Xcast solution**
  - Delivery of different elements over broadcast or multicast or unicast
  - Combination of unicast and multicast or broadcast → better efficiency and flexibility?
  - OBB scale with the available network capabilities?



2. Trials: Object Based Broadcasting

- **BBC R&D's *Forecaster* object-based user experience as its basis**
  - Linear weather forecast delivered as a number of component objects
- **The experience allows the user to choose different objects to display and adapts to different screen environments**
  - Portrait vs. landscape viewing on a mobile device
- **The particular objects that *Forecaster* consists of along with their intended bearer are**
  - Video of the presenter (multicast)
  - Audio narration (multicast)
  - Map tiles (unicast)
  - Overlap graphics (unicast)
  - Subtitle text (unicast)
  - Signing for the hard of hearing (multicast)

2. Trials: Object Based Broadcasting

5G-Xcast solution for OBB

- **With a Forecaster or general programme composed of different objects:**
  - Some objects will be used by a majority of users, such as the main video stream;
  - Others, such as the subtitles, may be of interest to a smaller subset of users.
- **IP unicast to deliver all objects to users?**
  - This conventional way → there is potential inefficiency in delivering identical copies of common objects across the network.
- **In the context of the 5G-Xcast solution:**
  - The availability of both point-to-multipoint unicast and point-to-multipoint multicast/broadcast
  - The possibility to deliver those objects of general interest to multiple users over multicast/broadcast with more personalised or less-used objects delivered over unicast.

2. Trials: Public Warning

- Public Warning (PW) in LTE is specified in the Cell Broadcast Service specification (3GPP TS 23.041).
- Cell Broadcast allows sending limited size text messages to UEs in a specific area.
- A Cell Broadcast Entity (CBE) is an entity on which PW messages are composed by a message originator and submitted to the Cell Broadcast Centre (CBC).
- UE is triggered to receive the cell broadcast message using paging. They then acquire SIB1 which contains the scheduling information for SIB12; SIB12 contains the cell broadcast message.
- Used, amongst others, in USA (WEA/CMAS), Canada, Chili, The Netherlands, Japan (ETWS), Taiwan, Philippines, New Zealand.

2. Trials: Public Warning

Limitations of the current state-of-the-art

- **Capacity in 4G cell broadcast is too limited to send multi-media (max size of binary message is 1230 octets)**
- **Lack of mechanism to trigger MBMS reception in the UE**
- **Lack of dynamic configuration for MBSFN. MBMS Service Area and MBSFN Area are statically preconfigured in the LTE network. This may work for services in planned location but may not work in unplanned areas.**
- **Lack of feedback on eMBMS session management. The BM-SC doesn't know if MBSFN or SC-PTM is chosen for MBMS, nor does the BM-SC know if the involved eNBs are participating in the broadcast. This introduces uncertainty.**
  - MBSFN and SC-PTM are different, non-compatible, broadcast mechanisms

2. Trials: Public Warning

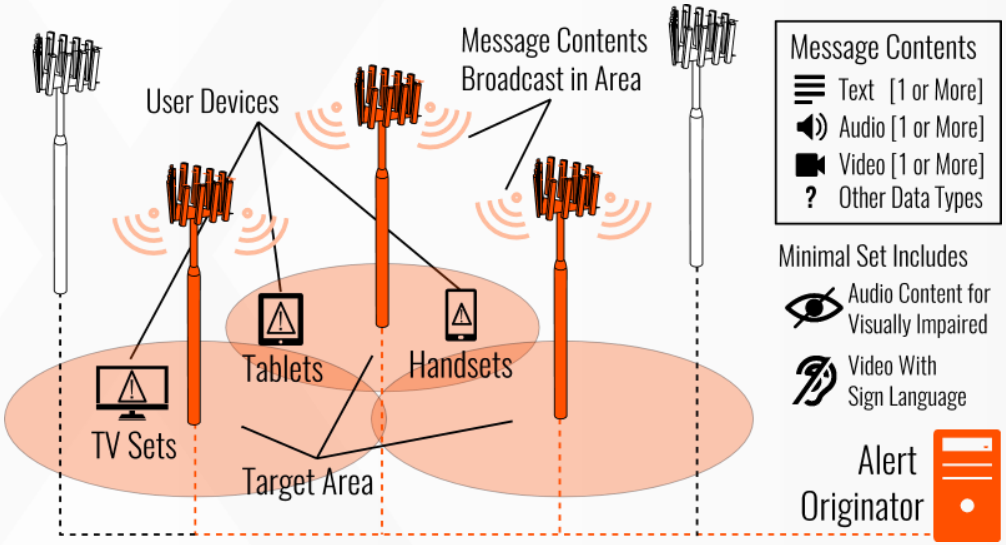
5G-XCAST Public Warning use case description

- **"In the Multimedia public warning alert, users are notified with alerts carrying multimedia and manifold information, which improves the effectiveness and reactivity of the users' responses. "**
  - Map of affected area
  - A picture of the lost/kidnapped child
  - Alert in textual format
  - Alert in audio format for visual disabled persons
  - Alert in video with sign-language for hearing disabled persons
- **The digital structure of a message encompasses several types of alerts, including Amber Alert (missing child)**
- **Every message includes at least a minimal set of multimedia components used to convey the message to both able-bodied and disabled people (text, audio, video with sign-language)**
- **Depending on the type of alert, this use case can be time critical.**
- **The alert is send to a targeted location. Within that targeted location, all users need to be notified promptly.**

2. Trials: Public Warning

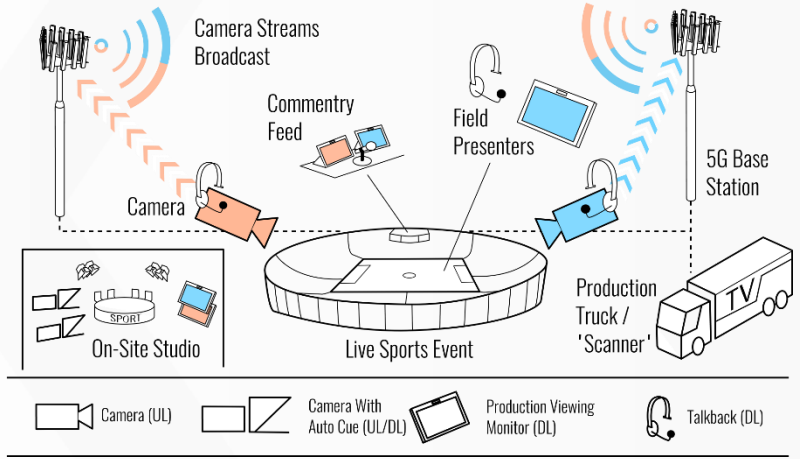
Targets:

- To trial transmission of multimedia public warning messages with eMBMS (current implementations on cell broadcast are text-only)
- To trial transmission of the messages in the area affected by the alert (not the whole network)



2. Trials: Spectrum

- The target is to illustrate and develop mechanisms for efficient spectrum use for 5G using dynamic spectrum sharing in bands where it is possible
- Considered scenarios for the demonstrations and trials are: PMSE (Programme making and special events) and PPDR (Public protection and disaster relief)
- Considered scenarios present cases where the use of primary users (PMSE and PPDR) is not very frequent and thus spectral resources could be used by secondary users when available, and released back to primary users when required



2. Trials: Spectrum

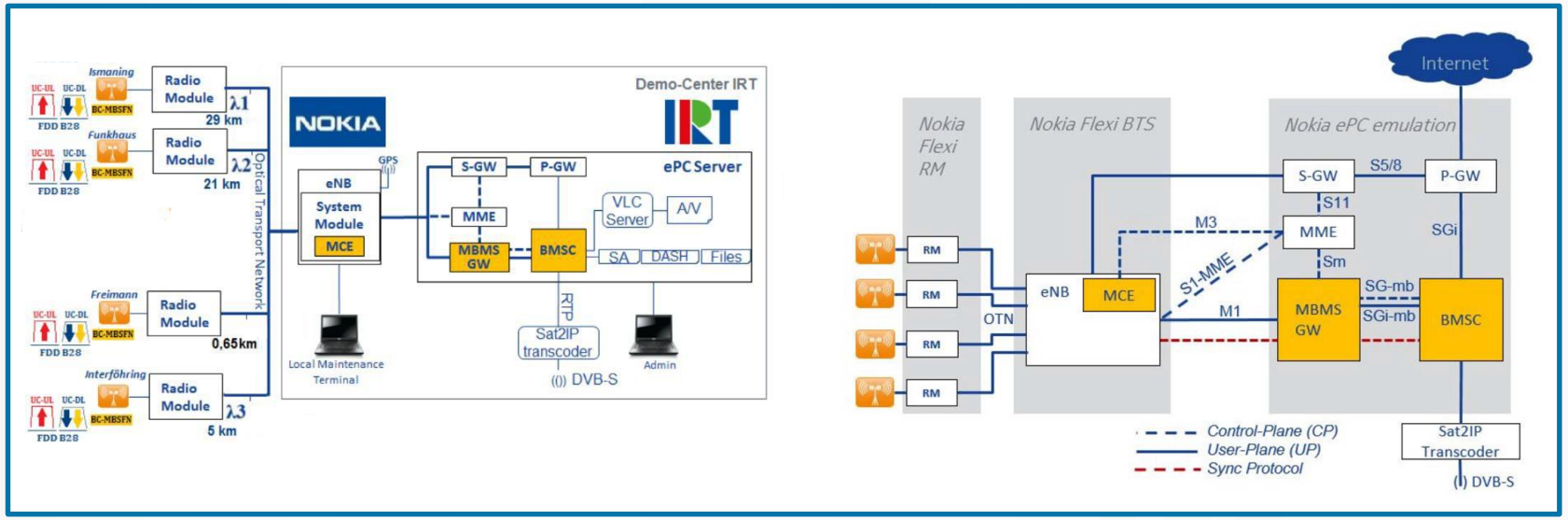
- **Planned main features to be demonstrated are**
  - Dynamic spectrum use on different frequency bands
    - 2.3 GHz band between Mobile network, private LTE network and PMSE trialed in January and May 2018
    - 3.5 GHz band between Mobile network, PPDR, Military
    - 700 MHz band
  - Dynamic priority order of users
  - Evolution of LSA (Licensed Shared Access)

3. IRT testbed

- Testbed video: https://www.youtube.com/watch?v=-8SuUSKjaOY

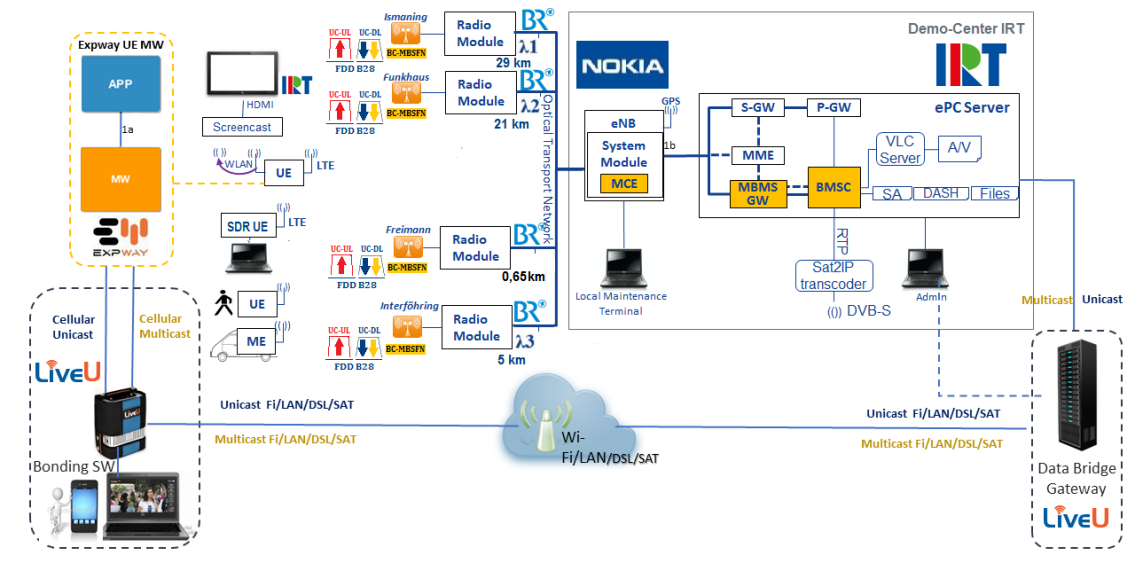
3. Test-Bed Overview

- eNB and ePC solutions provided by Nokia (pre-5G)
- Solutions from 5G-Xcast partners to be implemented on the top
  - Coordination required between IRT/Nokia and partners in order to know the requirements (on both sides) for integrating equipment/solutions



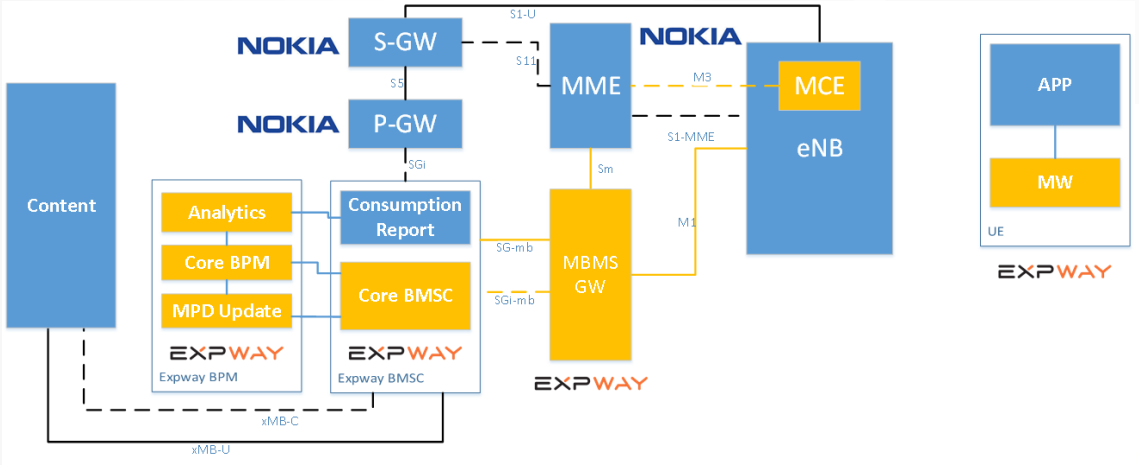
3. Initial Implementation of HBS

- **Multi-Link implementation**
  - On-going implementation between IRT/LiveU/BLB
  - Testing on the Bonding mechanism with unicast LTE + WiFi
  - Extension to eMBMS+ WiFi



3. Trials on Hybrid Broadcast Service

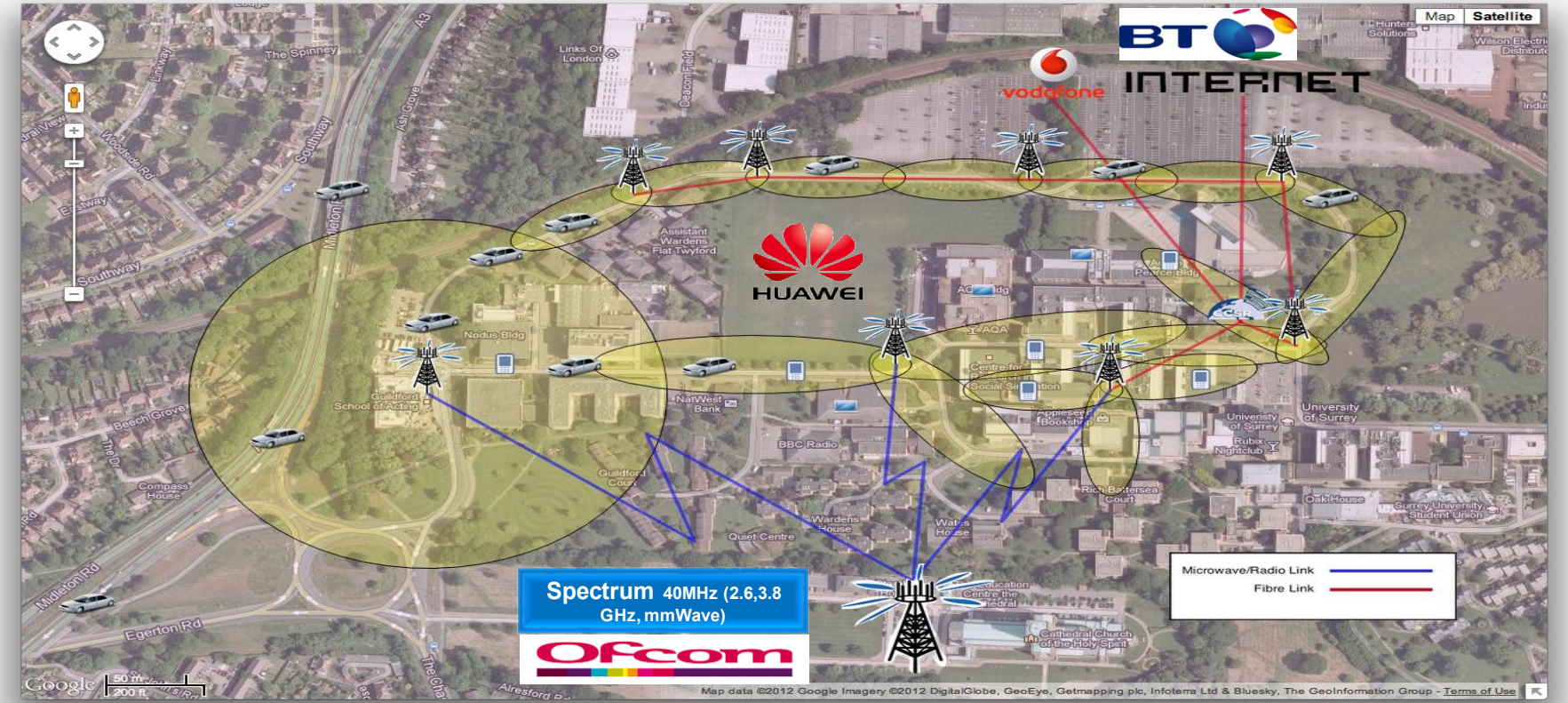
- **3GPP Mood implementation**
  - On-going implementation between Nokia+Expway+IRT
  - Requirement to run components of the EPC in a virtualized environment
  - Entities from Expway to be implemented and connected to EPC components



3. 5GIC Surrey Testbed

- Testbed video: https://www.youtube.com/watch?v=QXYT5yt2aZw

3. 5GIC Test-Bed Network

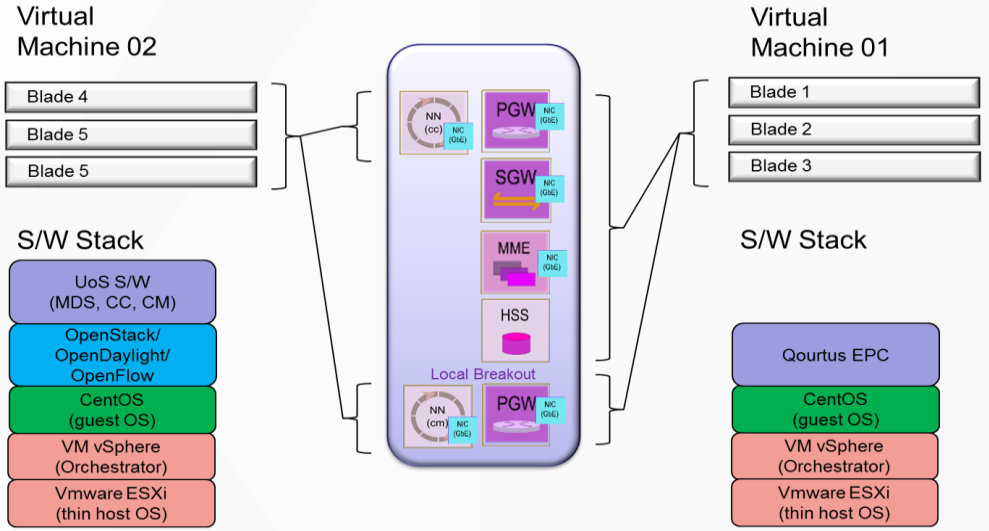


3. 5GIC RAN Test-Bed

- **5GIC test-bed brings RAN the flexibility to offer both outdoor and indoor services**
  - Extended CP, Carrier Aggregation, etc
- **The outdoor RAN test-bed spans over a geographical area of 4km^2 covering dense urban, urban, rural and motorway**
  - 3 Macro Cell Base Stations: Radio Platform with 8T8R RRU (20Watts) and AAS (RRH)
  - Dense Small-cells: 41 small cells with Cloud BBU Baseline + Programmable Baseband
- **The indoor RAN consists of 6 small cells to support LTE-A or Wi-Fi**

3. 5GIC LTE Core

- **5GIC 4G LTE Core Network with Software Defined Network (SDN), Network Functions Virtualisation (NFV) and Mobile Edge Computing (MEC) capabilities**
- **The existing 3G/4G Architecture is hierarchical and rigid:**
  - The core network architecture is difficult to implement in a flexible manner.
  - The protocols are processing intensive and there is no inherent user security.
  - Quality of Service is rarely implemented beyond Voice & Data classification (= one size fits all).
  - Control and User plane are still not separated (slow access, poor mobility support, poor user performance)



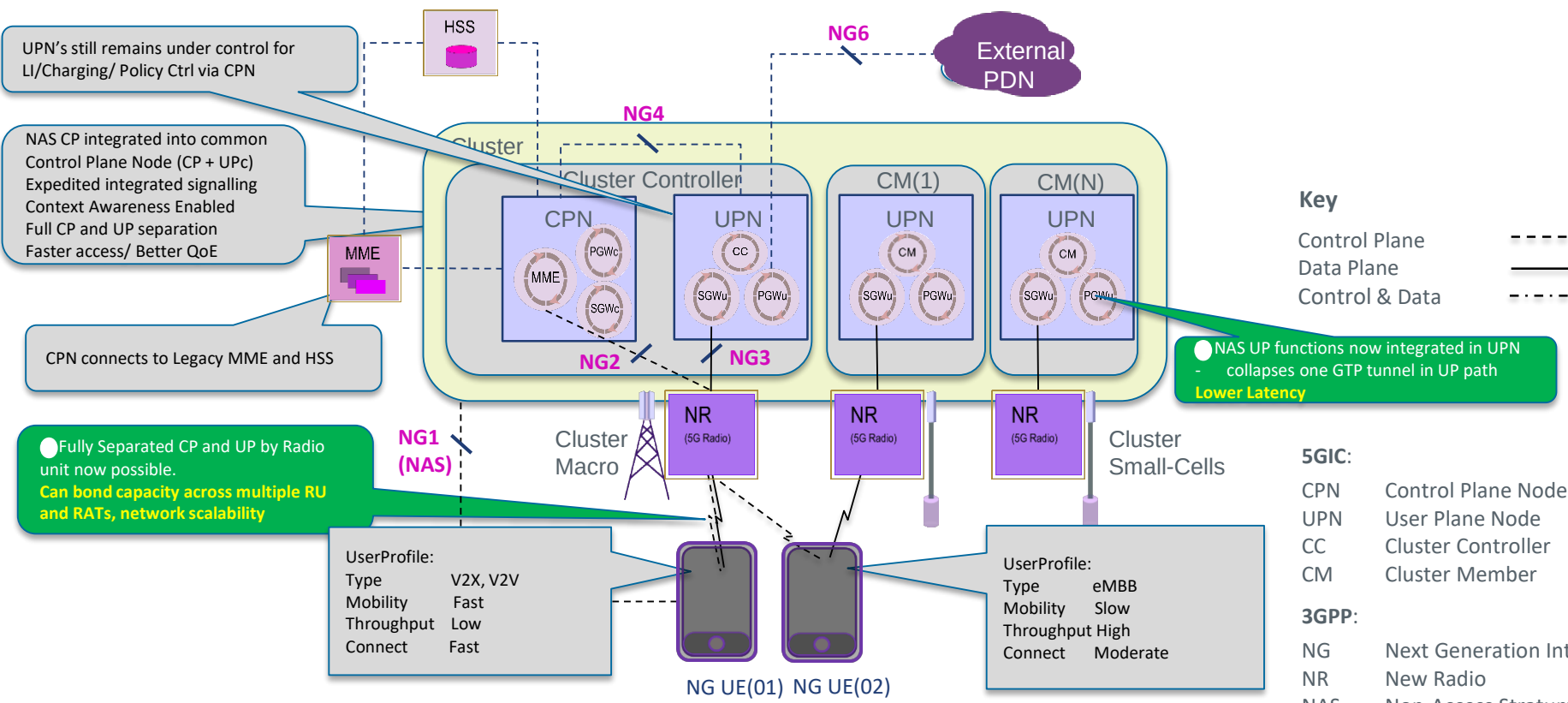
3. 5GIC Flat Distributed Cloud

- The 5GIC has designed a Fully Virtualised and Componentised Network Sliced architecture. Network entities can be scaled in and Scale out, due to virtualised implementation. The 5GIC Flat Distributed Cloud (FDC) solution operates as dynamic ‘Clusters of Infrastructure” which can be dynamically re-arranged: Horizontally by Topology/ User Population load and Vertically by Network Slicing according to User Context(s).

- The architecture involves a simple ‘Association’ based Control Plane, separated from UP which gives faster access, better performance and simple, stakeholder based scalable security. The network is Context Aware and able to select Internet/ intranet breakout point and re-direct traffic according to Context and Content/ Applications requested by the user(s).

- Among the key innovation is the realisation of a Control Plane Node where the NAS CP is integrated with common control signalling (CP + UPc). This expedited integrated signalling allows Context Awareness and Full CP and UP separation. This improves access speed and Quality of Experience

3. 5GIC Flat Distributed Cloud



Key

Control Plane	------
Data Plane	———
Control & Data	-·-·-·-

5GIC:

CPN	Control Plane Node
UPN	User Plane Node
CC	Cluster Controller
CM	Cluster Member

3GPP:

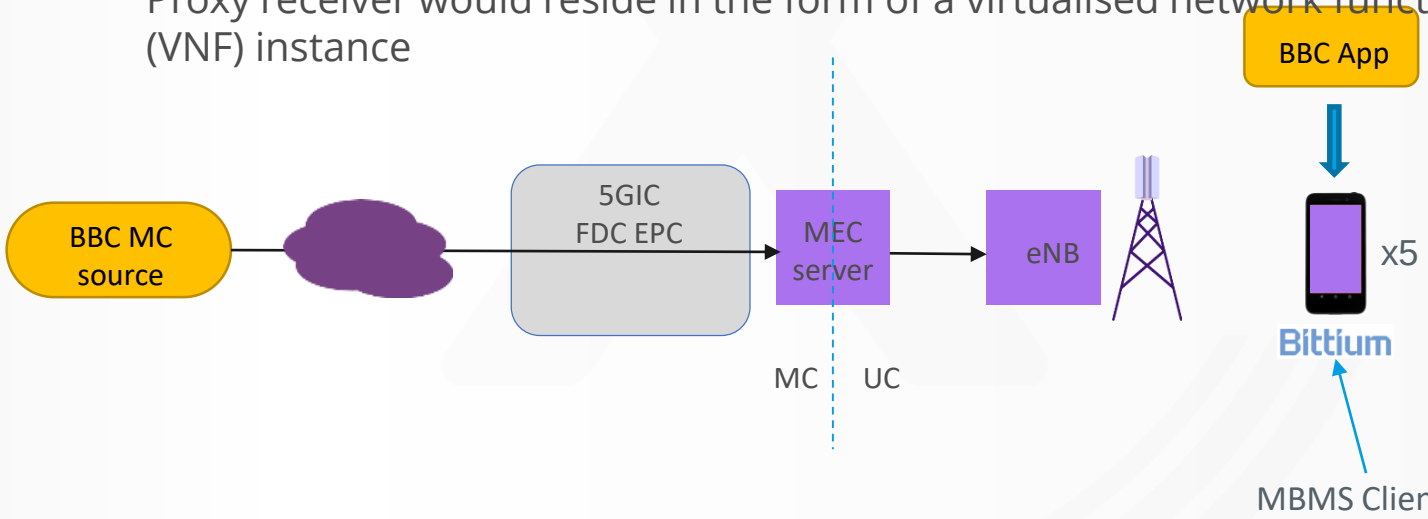
NG	Next Generation Interfaces
NR	New Radio
NAS	Non-Access Stratum

4. Object based Broadcasting

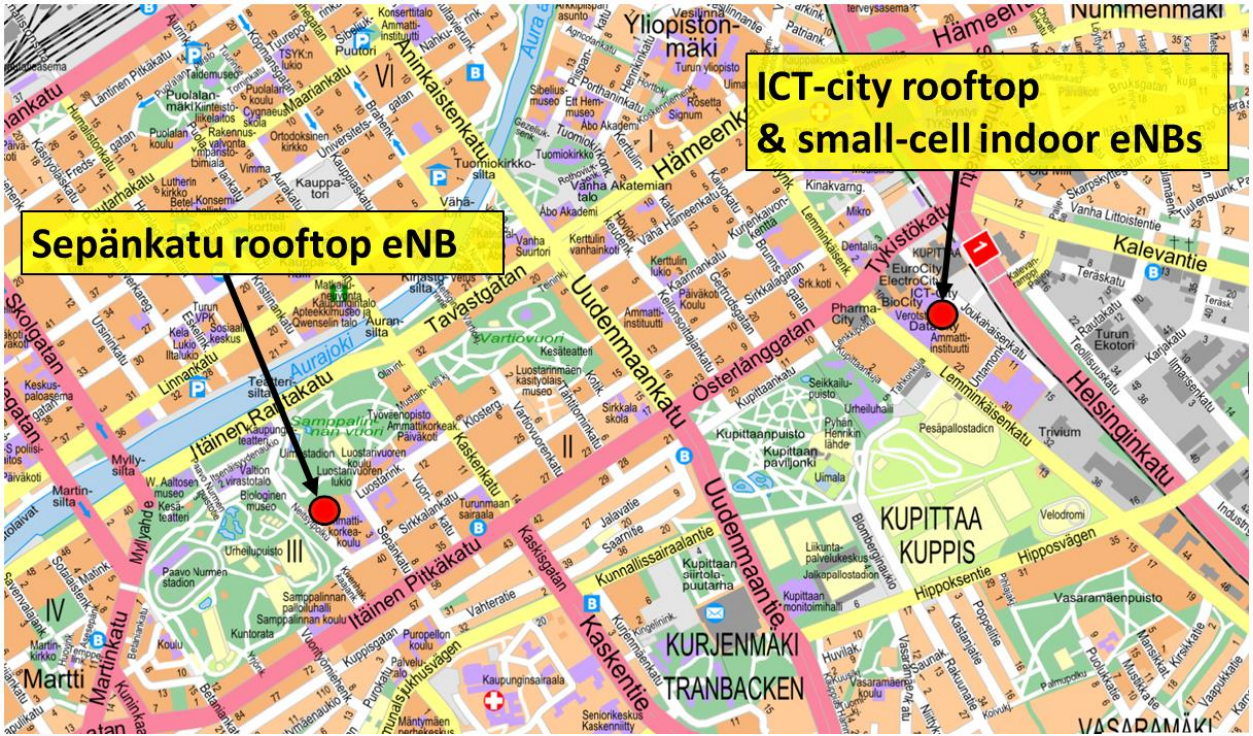
- **Challenges within the context of 5G-Xcast OBB solution:**
  - To re-package the audio and video objects into MPEG-DASH media segments as appropriate
  - To build a mechanism to deliver OBB objects (for Forecaster or general programmes) that require it over multicast.
- **Dynamic Adaptive Streaming over Multicast (DASM)**
  - A DASM Head-end system delivers objects to a population of DASM Client Proxy receivers.
  - The objects are structured as HTTP resources and are sent via source-specific IP multicast using HTTP over QUIC over UDP.

4. Solution approach

- **To deliver objects (in this case video/audio segments) over multicast across the Surrey test-bed from a BBC multicast (DASM) source**
  - Content source to 5GIC CN + MEC to UE via unicast HTTP; DASM Client Proxy receiver would reside in the form of a virtualised network function (VNF) instance

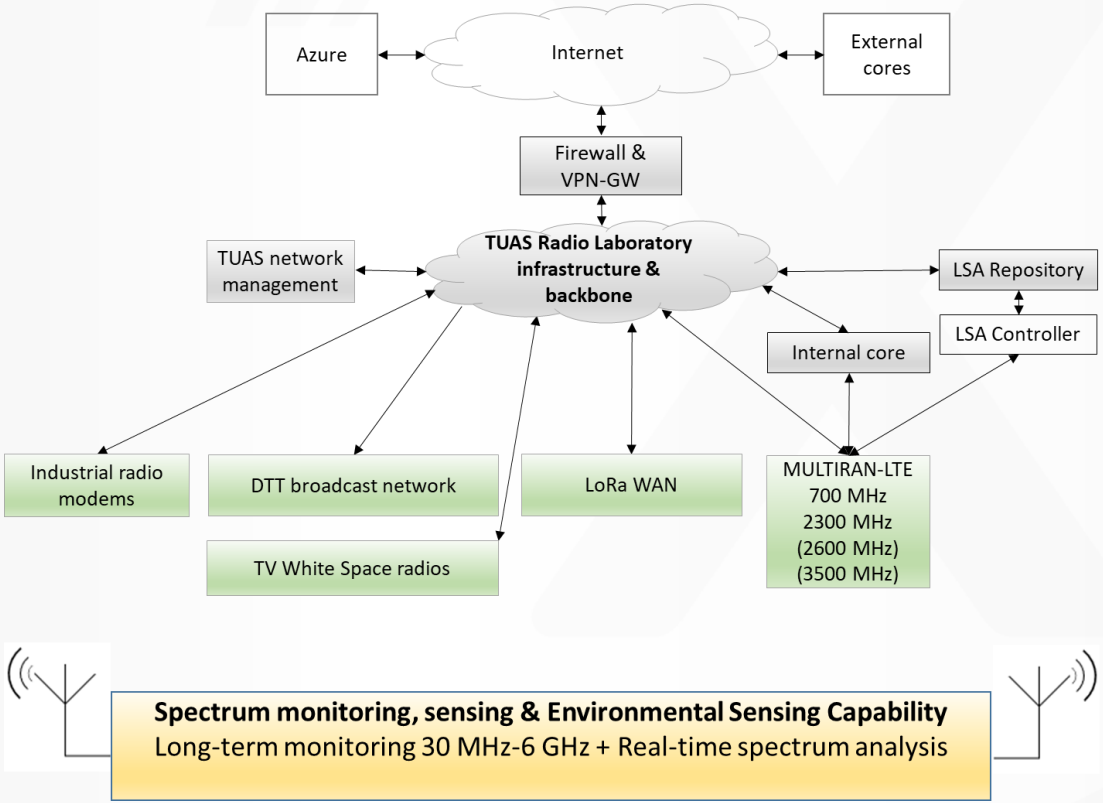


3. 5GTNT Turku Testbed



Twitter: @5GTNT

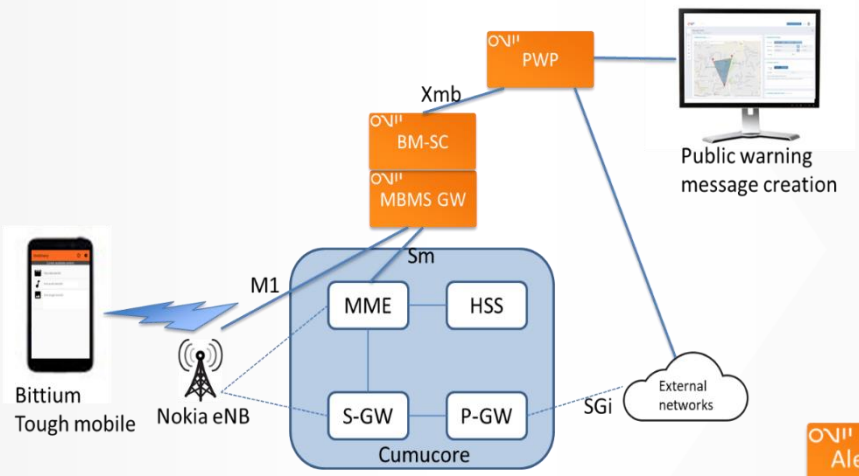
3. Technologies supported

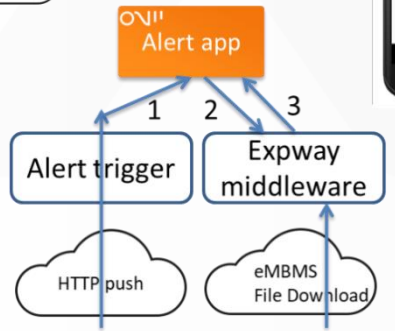


Legend

- TUAS equipment
- Equipment outside TUAS
- Air interfaces
- Spectrum measurement system

3. Features for public warning

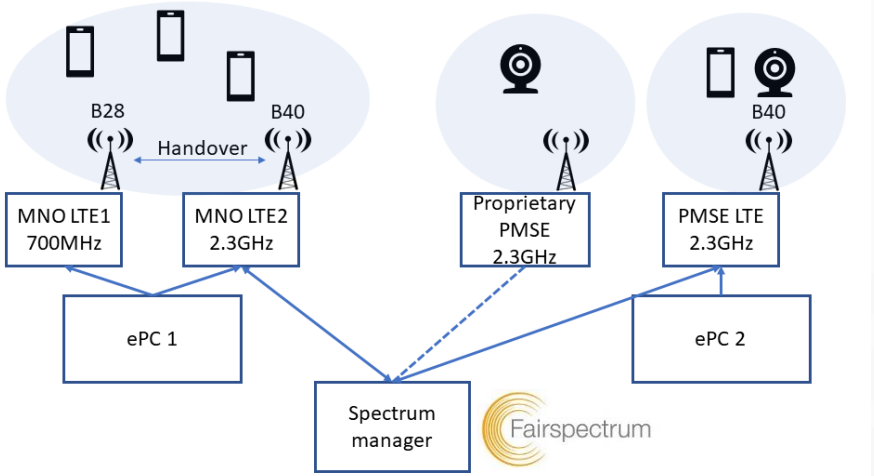




1: App receives alert trigger
2: App requests eMBMS middleware to fetch content
3: Middleware delivers content to app
4: App displays the content according to the configuration

3. Features for spectrum trials

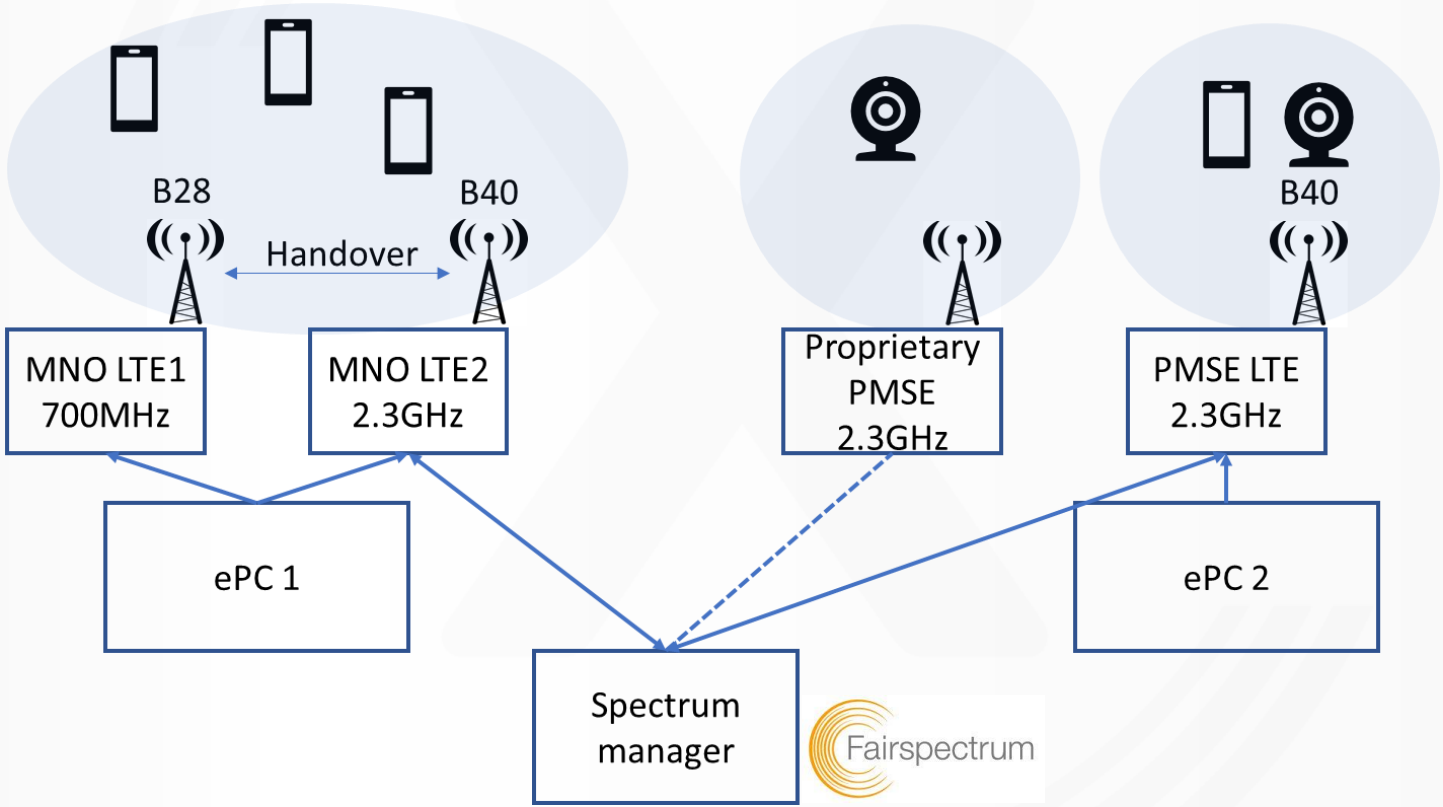
- Main component required for the trials is the spectrum manager from Fairspectrum
- Basic setup built for the trials is shown for 2.3 GHz below. Setup can be altered for different frequencies and use cases with another set of base stations (& UEs)



4. First spectrum trials (Jan. & May 2018)

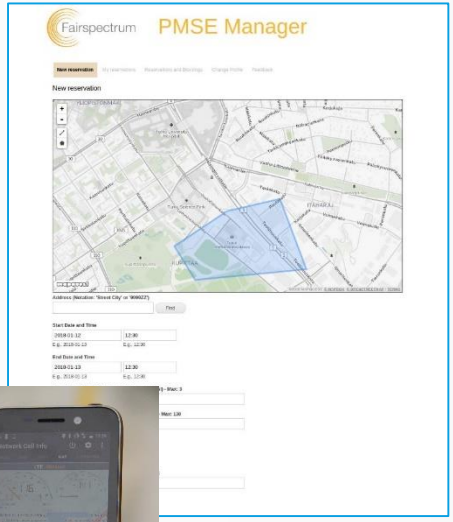
- Spectrum sharing demonstration/trial performed in Turku January (in laboratory) and May 2018 (on the field)
- To trial utilization of shared 2.3 GHz band for MNO, traditional PMSE using proprietary (non LTE/5G) technology and PMSE using rapidly deployable private LTE network
- Aim to demonstrate utilization of LTE radio for PMSE allowing smooth shift for PMSE stakeholders towards new PMSE equipment
- Paper will be presented on BMSB conference (tomorrow)

4. Setup for the laboratory trial

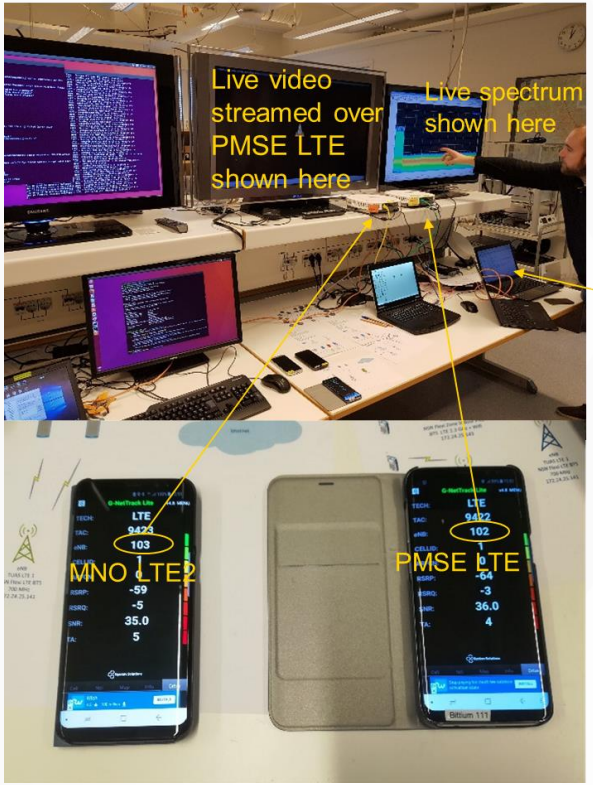


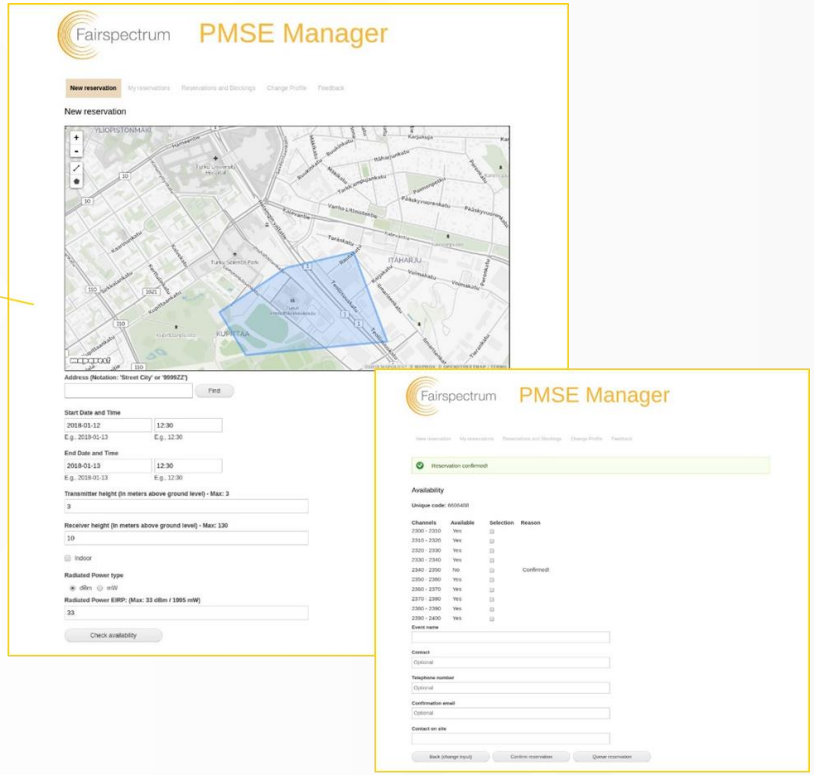
4. Trial equipment

- **Equipment:**
  - Nokia flexi 700 MHz macro & 2xNokia 2.3GHz pico basestations
  - Cumucore EPC for “MNO” & Bittium LiteEPC for rapidly deployable network
  - Commercial terminals: Samsung S8, HTC, Bittium Tough Mobiles
  - Fairspectrum Spectrum manager
  - DVB-T/T2 transmitter to emulate traditional PMSE equipment



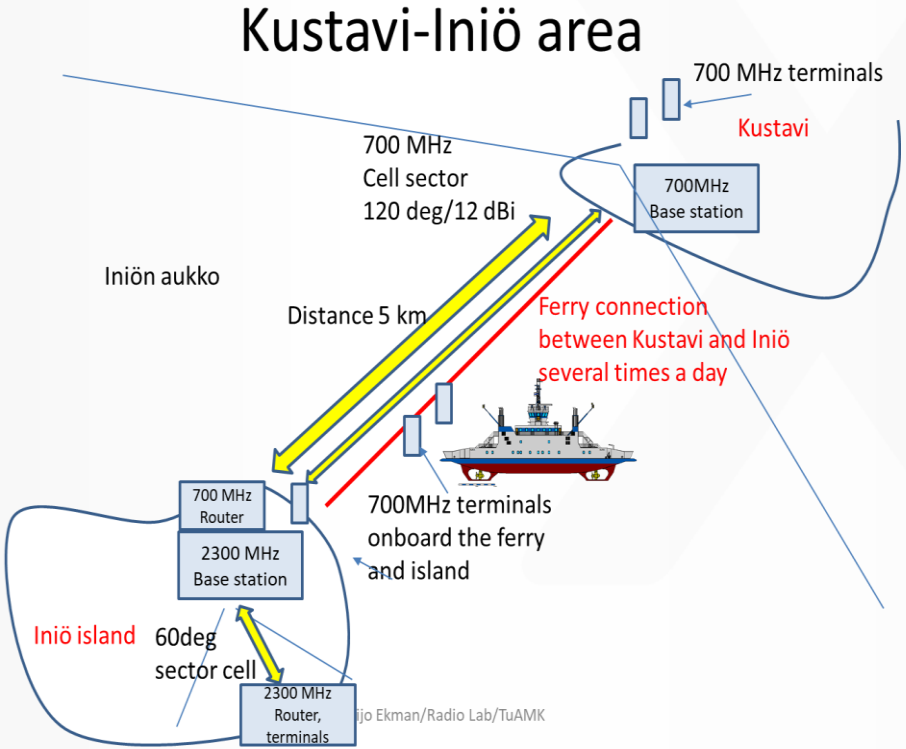
4. Picture of the setup





4. Spectrum trial video

4. Setup for field trials



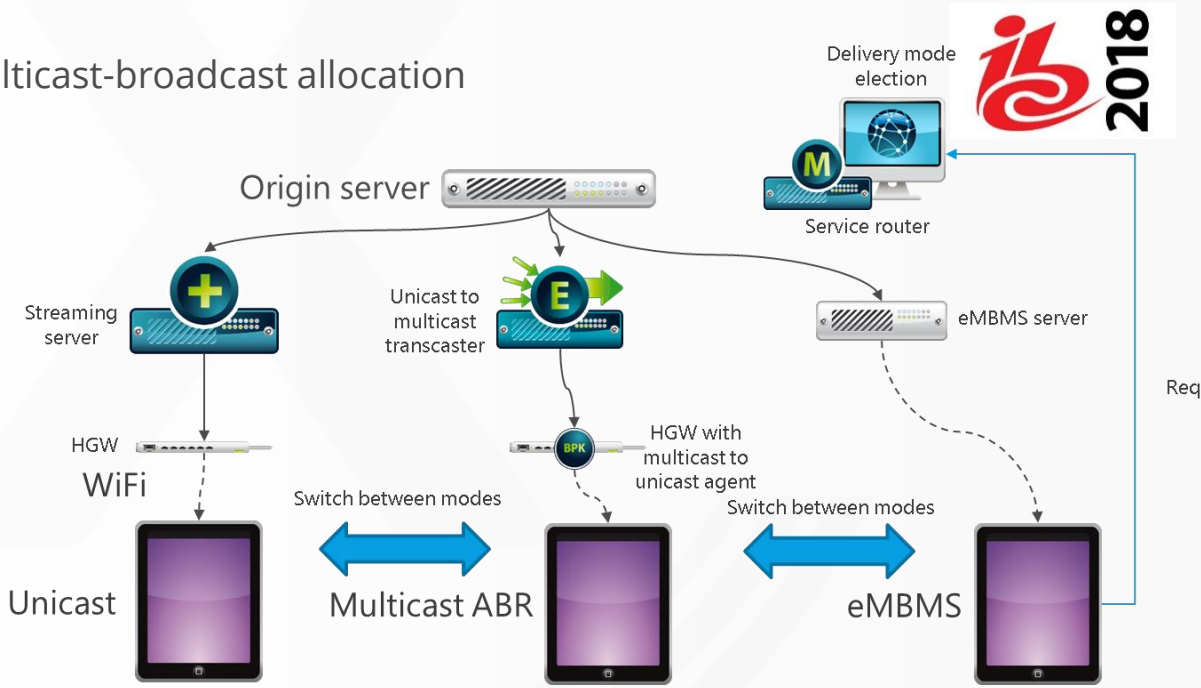
4. Field trials

4. Observations

- **The trials shows that a dynamic spectrum management system can control simultaneously various types of devices and they may have differing capabilities and restrictions in their spectrum use**
- **It takes some time (depending on the firmware version) for the used base stations to setup at the new frequency and have core network connections up and running**
  - In real usage scenario for PMSE, however, it is not expected that the operating frequency of the systems would be constantly altered during the event
- **Field trials verified that the setup for rapidly deployable network even in remote locations is operational (and could be suitable as well for example for PPDR in case of an emergency)**

4. Demonstrators

- **On-going planning of demonstrators for relevant industry events**
  - RAN optimization
  - Dynamic unicast-multicast-broadcast allocation



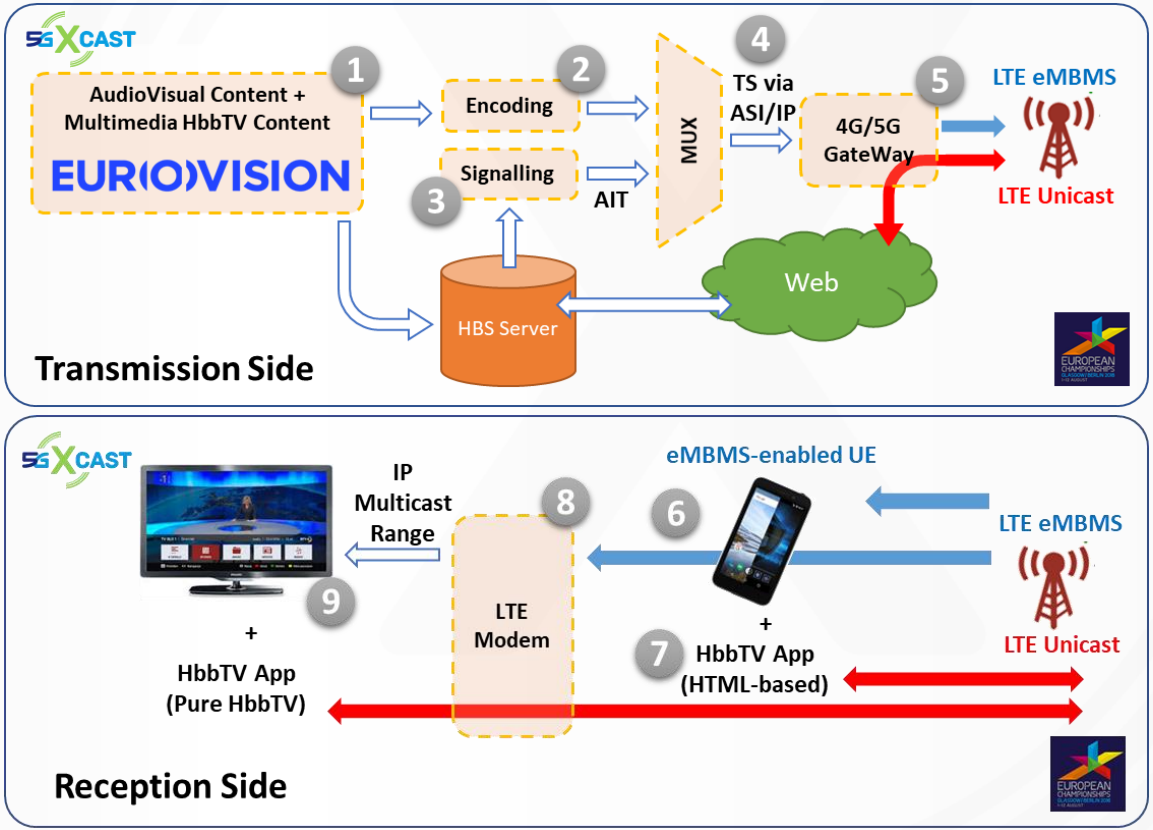
4. Showcase

- European Championships 2018
  - 2 to 12 August
- Massive audience event
- Enhanced user experienced exploiting Hybrid Broadcast Service use case

Broadcast + Unicast delivery to smartphones and TV se

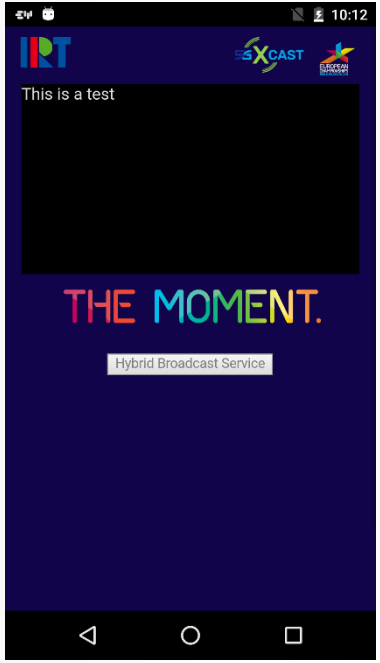
EUROPEAN CHAMPIONSHIPS GLASGOW / BERLIN 2018

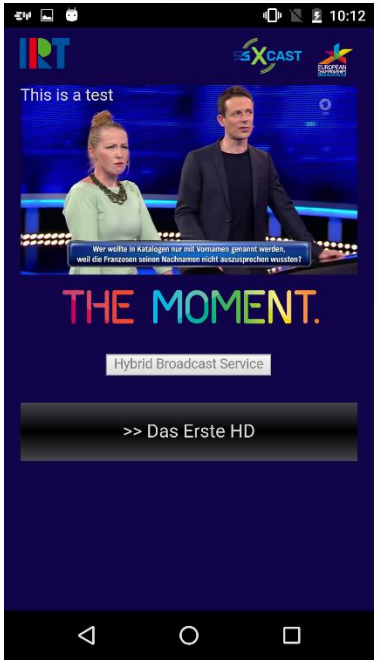
4. Showcase

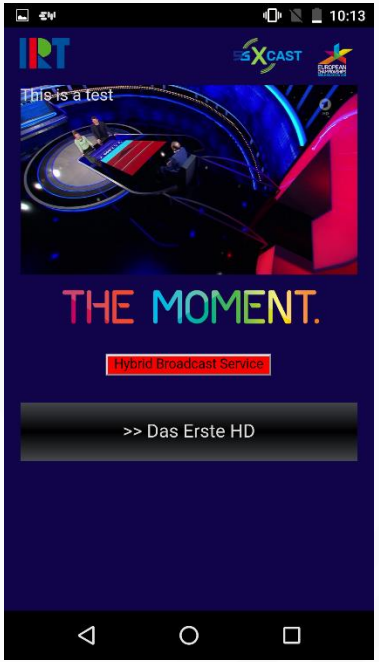

AudioVisual Content +
Multimedia HbbTV Content
EUR(O)VISION
1
Encoding
2
Signalling
3
AIT
MUX
4
TS via
ASI/IP
4G/5G
GateWay
5
LTE eMBMS
LTE Unicast
HBS Server
Web
Transmission Side
IP
Multicast
Range
9
+
HbbTV App
(Pure HbbTV)
LTE
Modem
8
6
eMBMS-enabled UE
+
7
HbbTV App
(HTML-based)
LTE eMBMS
LTE Unicast
Reception Side

4. Showcase

- Initial development of smartphone app with HBS functionality







5. Conclusions

- Testbeds and equipment are getting ready for the trials and demonstrations
- Extensive trialing will be during the second half of the project
- Stay tuned to follow the activities
  - http://5g-xcast.eu/
  - Twitter: @5Gxcast
  - Youtube: 5GXcast channel

Thank You

Any Questions ?