FORECAST 2017 - 20th Anniversary

All you want to know about the 5G-Xcast project

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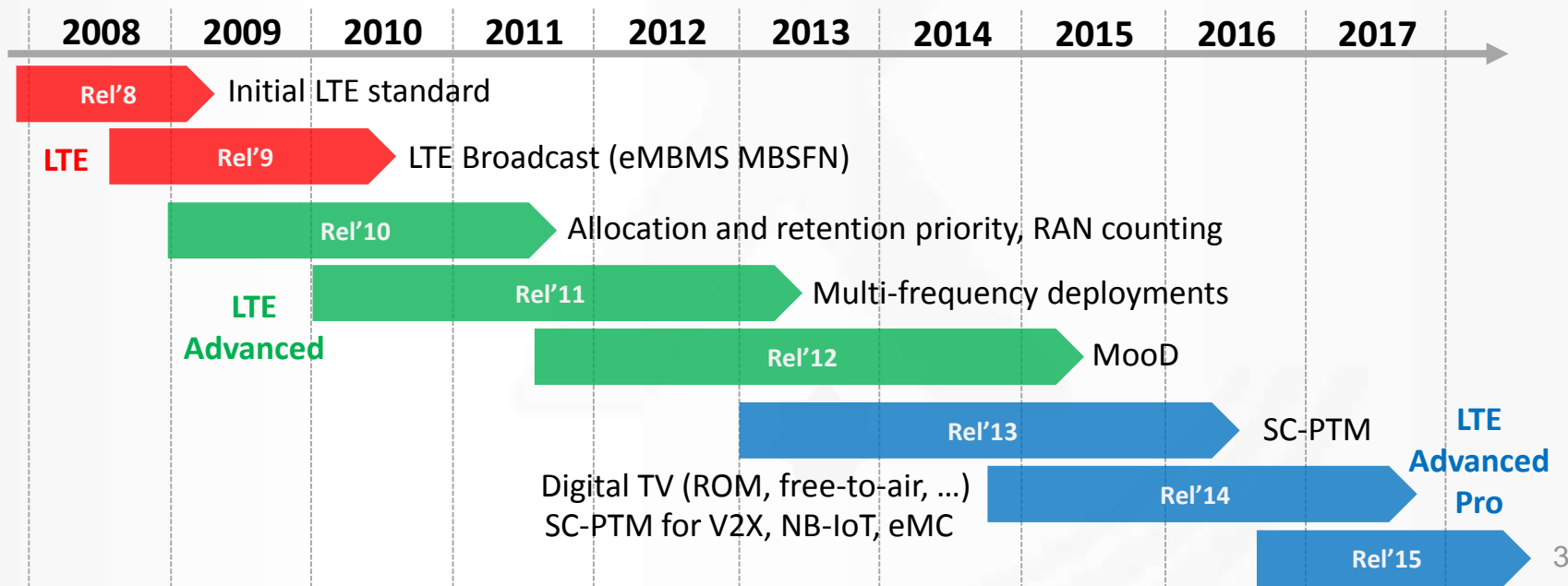24 Nov. 2017, Geneva, Switzerland

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- Introduction
  - 5G, IMT2020 and 3GPP – annex slides
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- eMBMS Evolution in 4G LTE
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- The 5G-Xcast Project
- Outlook on 5G Broadcast

PTM Evolution in 4G

- **Two major trends from Rel'12 enhancements:**
  - **Dedicated broadcast networks for TV services**
  - **PTM as RAN delivery optimization feature**

2008 2009 2010 2011 2012 2013 2014 2015 2016 2017

LTE
- Rel'8 — Initial LTE standard
- Rel'9 — LTE Broadcast (eMBMS MBSFN)

LTE Advanced
- Rel'10 — Allocation and retention priority, RAN counting
- Rel'11 — Multi-frequency deployments
- Rel'12 — MooD

LTE Advanced Pro
- Rel'13 — SC-PTM
- Digital TV (ROM, free-to-air, …)
- SC-PTM for V2X, NB-IoT, eMC
- Rel'14
- Rel'15

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PTM in 4G LTE

- **Originally included in Rel'9 (eMBMS), based on 3G MBMS from Rel'6**
- **It has been significantly enhanced in the latest releases of LTE-Advance Pro for different types of communications:**
  - Television services (EnTV) – based on broadcasters' requirements
  - Critical communications
  - Vehicular communications
  - Machine-type communications
- **Two major trends and main technology enhancements:**
  - **Dedicated broadcast networks for TV services**
    - Receive only, shared network infrastructure, external interface towards content providers, …
  - **PTM as delivery optimization feature**
    - MooD, SC-PTM, …
- **But built on top of an initially conceived basic and static TV-like service**
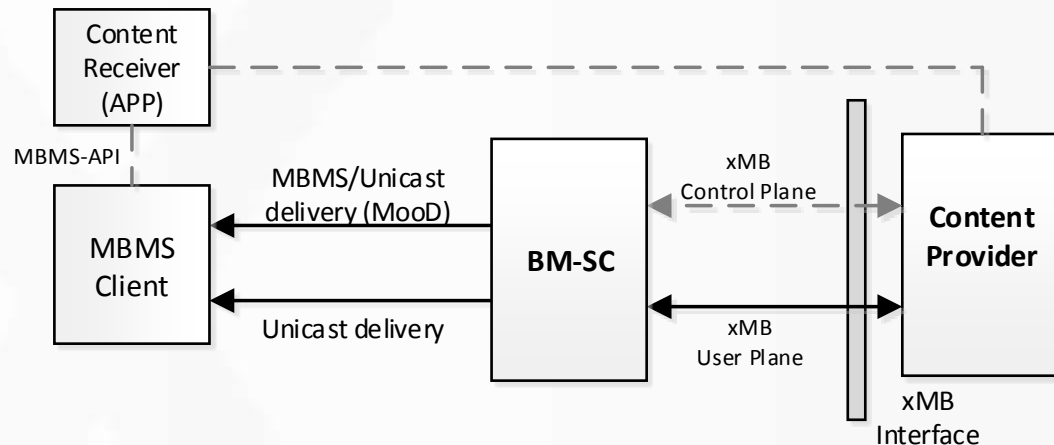 - Following LTE backwards-compatibility design principle

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Rel'14 EnTV - towards stand-alone eMBMS broadcast networks

- **Radio Enhancements**

  - **Dedicated carriers** with up to 100% MBMS allocation
  - **Self-contained system information** and synchronization signals
 - **200 µs long cyclic prefix** to support large inter-site distances

- **Architecture Enhancements**

  - **Receive-Only Mode** (ROM) for devices without SIM card or 3GPP subscription
  - New service types to enable **free-to-air** content broadcast that can be received by ROM devices and also **interactive services**
  - **Open standardized broadcasting application programming (xMB) external interface** towards the TV content providers to simplify access to complex eMBMS procedures
  - **Transport-only (pass-through) MBMS bearer service type** to use the eMBMS network as content delivery platform in the native format without transcoding
  - **Shared networks among several MNOs** to avoid broadcasting the same content at the same time over different networks

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What will 5G bring?

- 5G will **not only** provide **one order of magnitude increase** in **peak data rates**
- It is being designed to meet very challenging technical requirements to support new use cases derived from several vertical industries, not just for mobile broadband
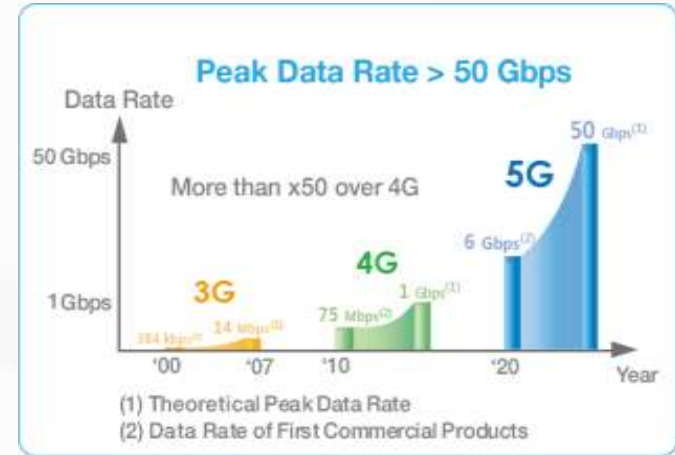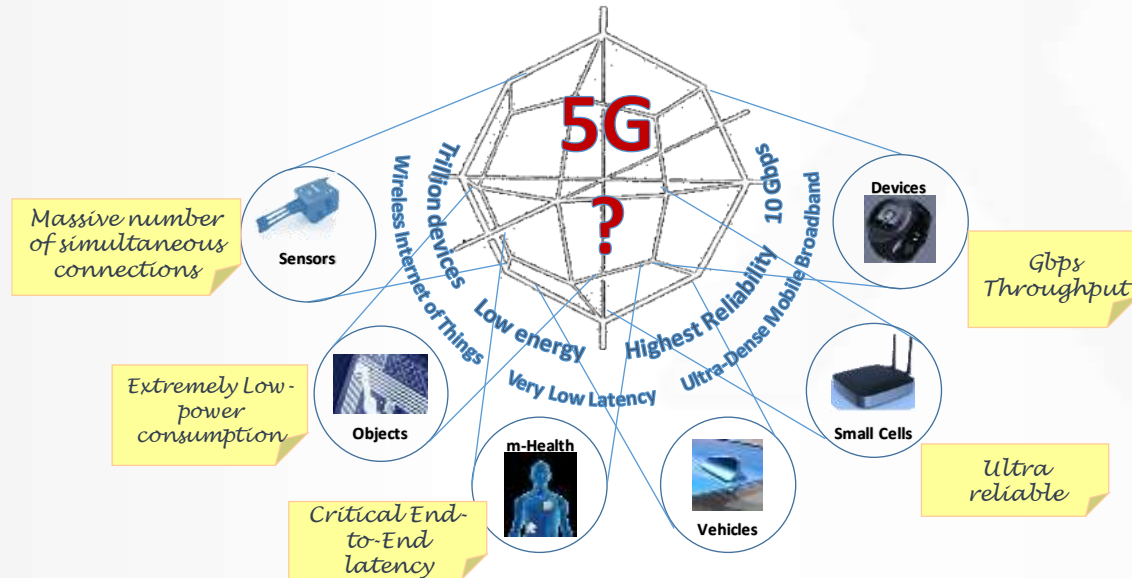
ITU IMT-2020 Minimum Technical Performance Requirements (I/II)

KPI	Minimum Requirement
Peak Data Rate	20 Gpbs DL 10 Gbps UL
Peak Spectral Efficiency	30 bps/Hz DL 15 bps/Hz UL
User experienced data rate	100 Mbps DL; 50 Mbps UL
5th percentile user spectral efficiency	0.225 bps/Hz DL eMBB in dense urban (0.12 rural)
Average spectral efficiency	9/7.8/3.3 bit/s/Hz/TRxP for eMBB hotspot/urban/rural
Area traffic capacity	10 Mbit/s/m2 in the Indoor Hotspot for eMBB
Bandwidth	at least 100 MHz; 1 GHz above 6 GHz

Broadcast in 5G

Broadcast/Multicast Point-to-Multipoint (PTM) transmissions are key in many 5G use cases, but they have not been considered in the first release of 5G (Rel'15)

MULTIMEDIA & ENTERTAINMENT	CONNECTED AUTOMOTIVE	INTERNET OF THINGS	PUBLIC WARNING AND SAFETY
UHDTV delivery VR, AR, 360° video Content prepositioning Push to X (talk/video)	Autonomous driving information, Infotainment Safety applications, Signage information	Software Updates Common Control Messages	Disaster alerts (e.g. tsunami, earthquake) Emergency alerts (e.g. hazar, amber alerts)

UNPRECEDENT COMMUNICATION CAPABILITIES

**OPPORTUNITY** FOR THE **CONVERGENCE** OF **FIXED, MOBILE** AND **BROADCAST NETWORKS**

5GXCAST 5G Broadcast Vision

PTM AND **CACHING** AS **BUILT-IN NETWORK DELIVERY OPTIMISATIONS, NOT** AS A **SERVICE,** FOR **ALL**

NETWORK SLICING FOR **BROADCAST SERVICES**

5G XCAST Convergence Vision

The **converged media delivery architecture of 5G-Xcast over fixed broadband, mobile broadband and terrestrial broadcast networks** allows a **seamless, uninterrupted service** to be offered to the users as they move.
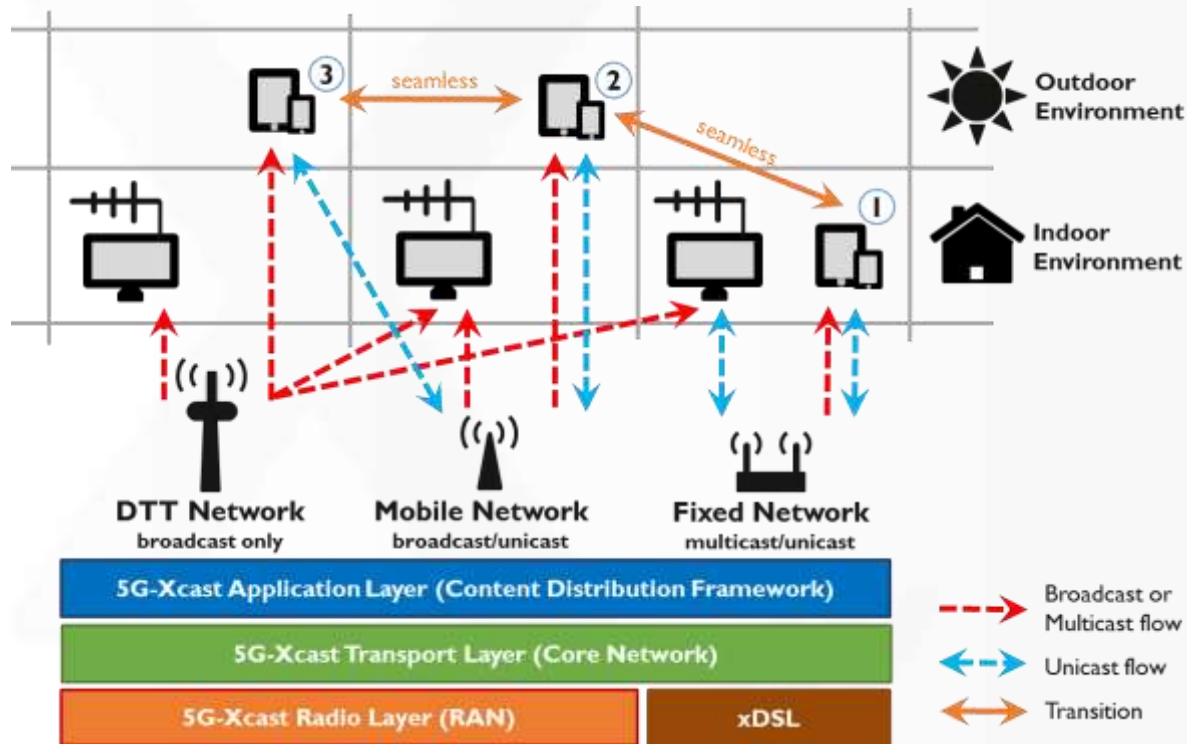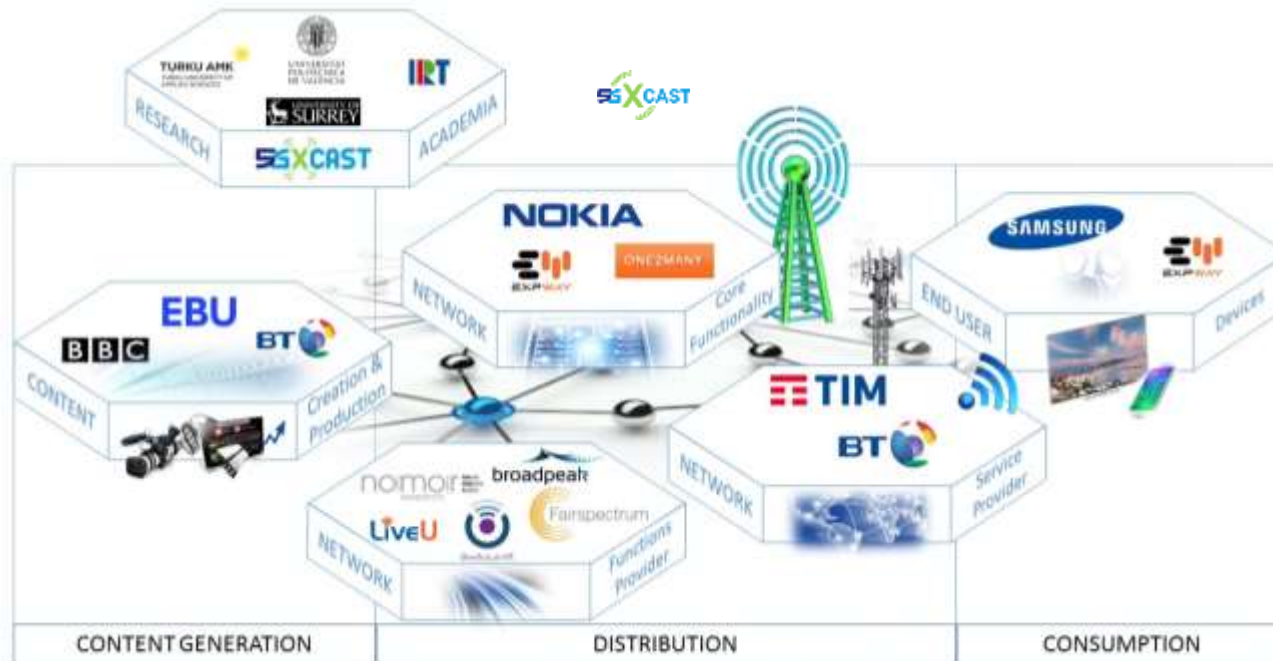
Basic Information about 5G-Xcast

- **Title: Broadcast and Multicast Communication Enablers for the Fifth-Generation of Wireless Systems (5G-Xcast)**
- **Research and Innovation Action project from** 5G-PPP Phase-II
- **Starting and end date:** June 2017 – May 2019 (24 months)
- **18 partners of 9 countries**
- Website: www.5g-xcast.eu

Consortium

Media & Entertainment Value Chain

5GXCAST Technical Challenges / Our Focus

USE CASES
Identify and define requirements and KPIs for: **Media, Automotive, IoT** and **Public Warning**

BROADCAST PTM RAN
Comprehensive and holistic, design will include the **radio interface,** RAT **protocols** and RAN **architecture**.

CONVERGED CORE NETWORK
Combining **fixed, mobile and broadcast** networks. Using mix of **unicast, broadcast transport** and **caching** capabilities.

CONTENT DISTRIBUTION FRAMEWORK

Network-agnostic, combining unicast, multicast, broadcast and caching for **dynamic network resource optimisation**.
Simple interface between content service provider and network operator

PROOF-OF-CONCEPT PROTOTYPES

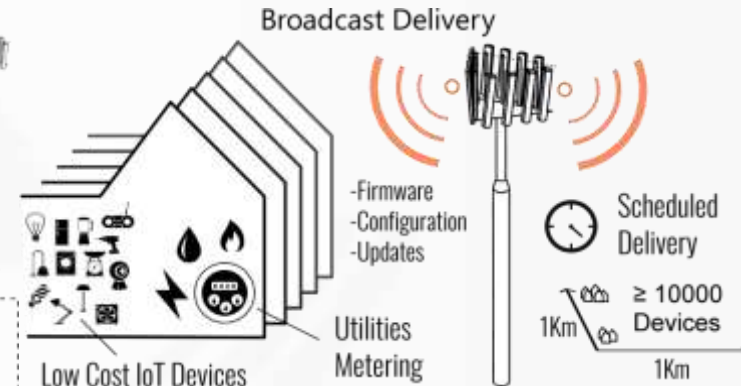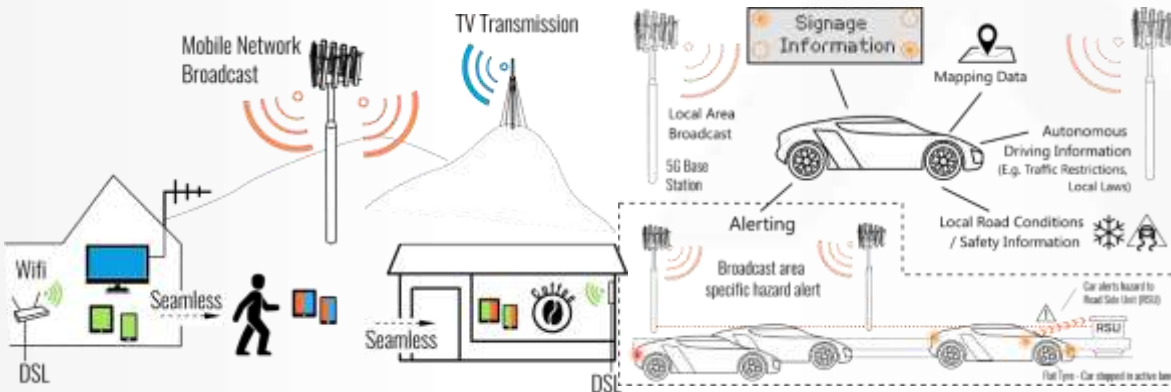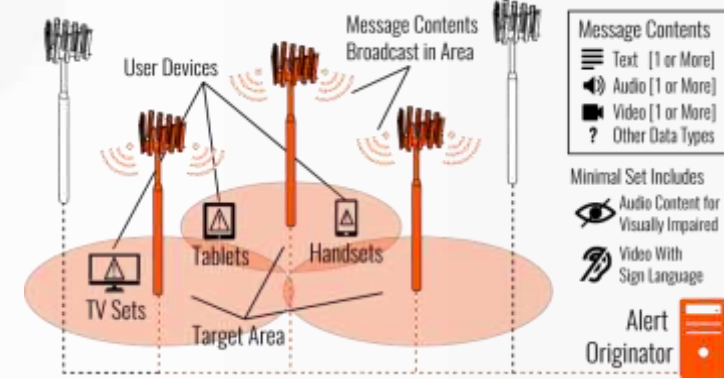For the **5G-Xcast radio, transport** and **application layer** key components

Test-Beds

5GIC (Surrey, UK)
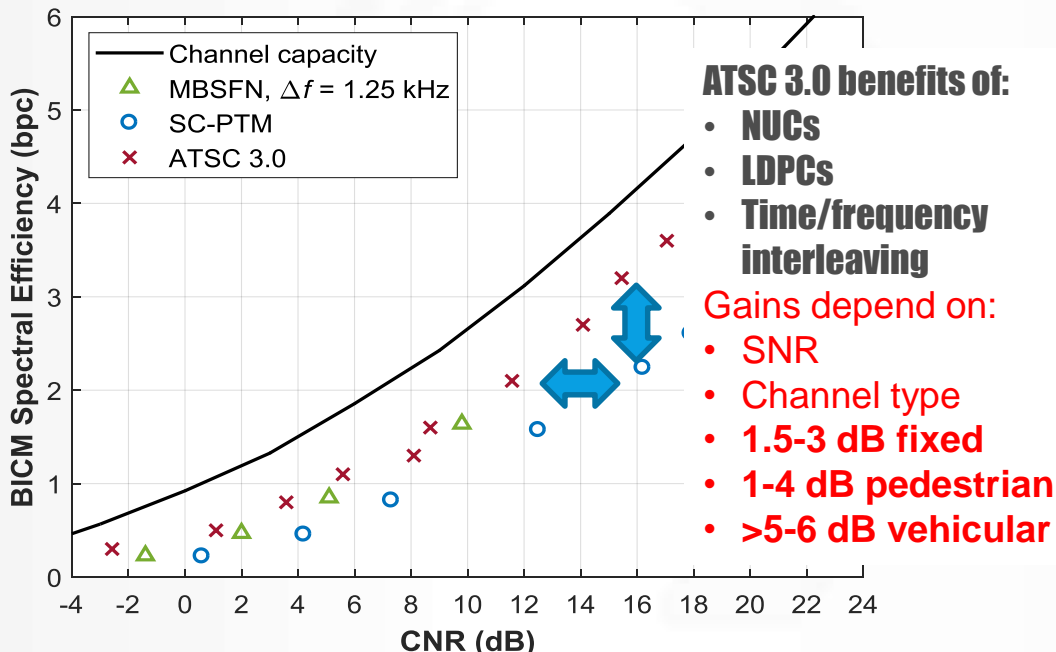IRT (Munich, Germany)
TUAS(Turku, Finland)

WP2 Use Cases

- **D2.1 published:** Definition of 5G use cases for PTM transmissions for media, PW, automotive and IoT verticals, with high-level requirements
- **Next step:** technology evaluation and use case refinement in cooperation with the technical WPs
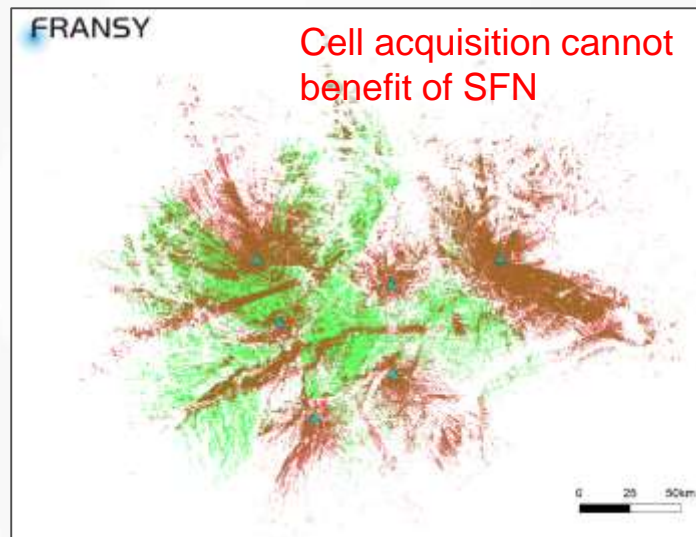
http://5g-xcast.eu/2017/10/31/deliverable-d2-1-definition-of-use-cases-requirements-and-kpis-now-available/

WP3 RAN Benchmark illustrative results

5GXCAST

- Comparison eMBMS vs. ATSC 3.0 physical layer

ATSC 3.0 benefits of:
- NUCs
- LDPCs
- Time/frequency interleaving

Gains depend on:
- SNR
- Channel type
- **1.5-3 dB fixed**
- **1-4 dB pedestrian**
- **>5-6 dB vehicular**

- Performance analysis of eMBMS Rel'14

Cell acquisition cannot benefit of SFN

Signaling -6 dB SNR; Data 0.5 dB SNR

■ CAS   ■ MBSFN   ■ CAS+MBSFN

- **Public deliverable D3.1 available in December**

- On-going: evaluation of the performance of 4G LTE in IMT2020 test environments and assess the benefits of PTM (intended exercise for the 5G-Xcast radio interface)

WP3 RAN 5G PTM Air Interface

- **Following 3GPP Rel'15 New Radio progress and building a link-layer simulator**
  - **Numerology** only allows 15 kHz minimum carrier spacing
  - Rel'14 7.5 kHz and 1.5 kHz also possible that allow longer CPs
- **Basic extension from PTP to PTM – minimal additions**
  - Pilots, gNBs synchronization, SFN coordination, numerology, resource allocation …
- **Additional technologies – trade-off gain vs. additional complexity**
 - NUCs, time interleaving, MIMO, NOMA, AL-FEC at the MAC layer, …
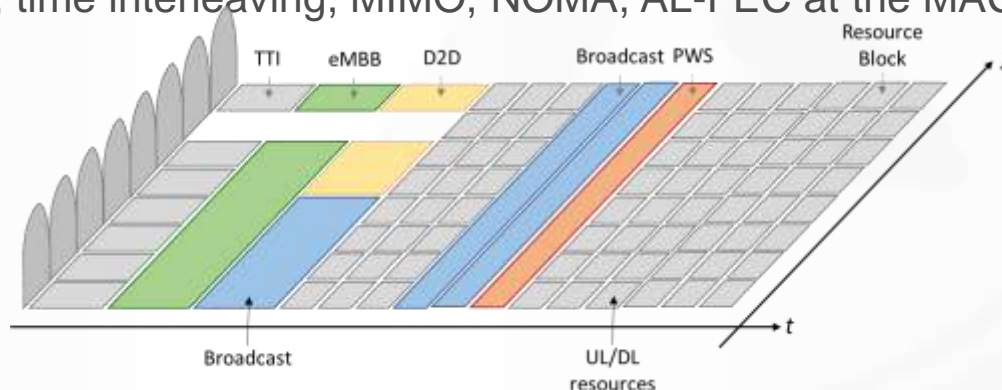
WP4 Converged Core Network

- **Achievements:**
  - Identification of the limitations of eMBMS Rel'14
  - Identification and analysis of new functionalities and technologies for improvement
    - Converged autonomous MooD, multilink, MEC, PW for multimedia data
  - Identification of different types of network convergence
    - Radio Access Convergence, Convergence of 3GPP and Non-3GPP Access, Overlay Convergence, 5G Converged Core
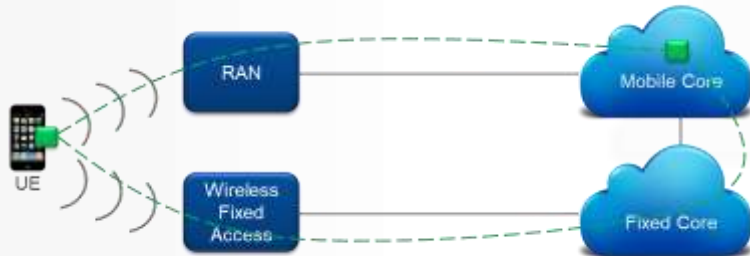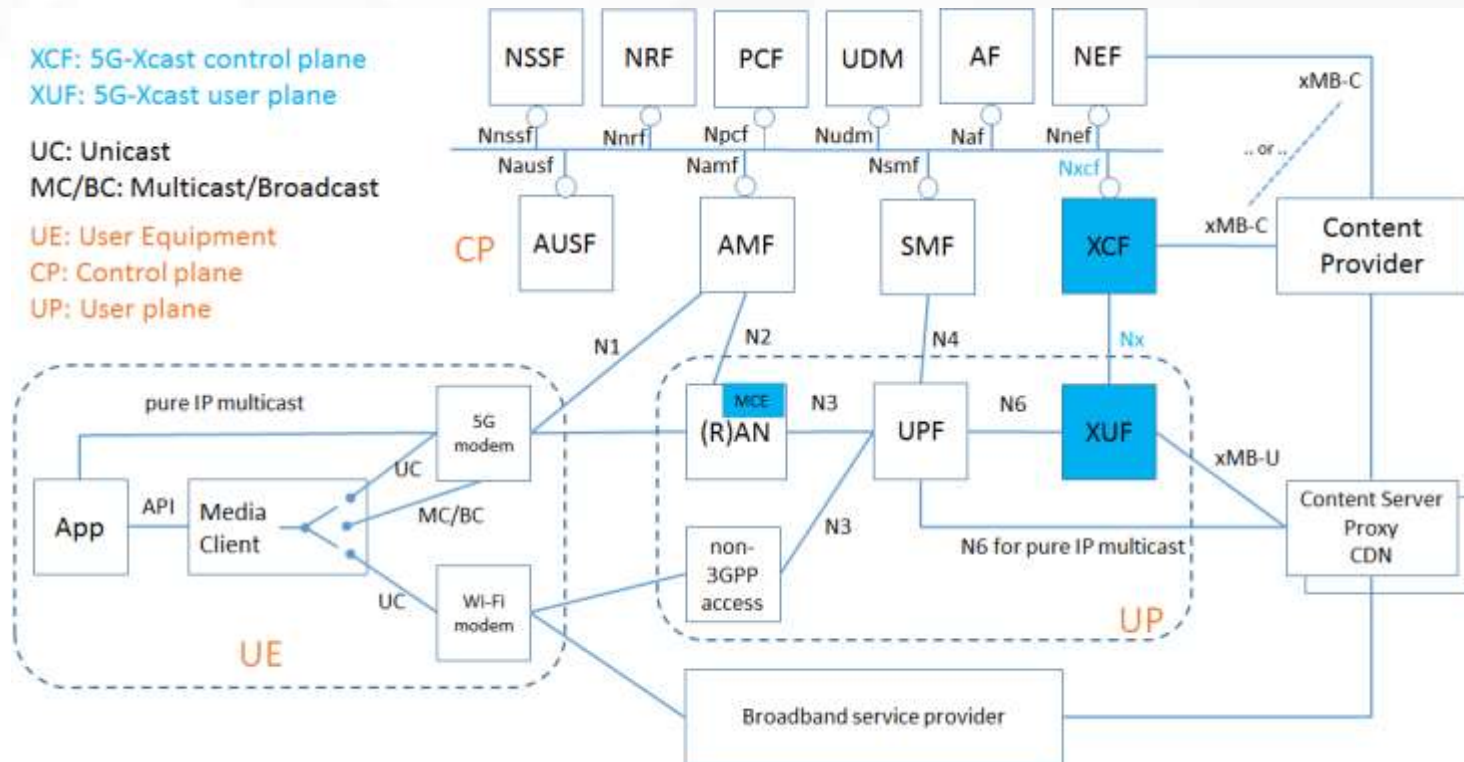
Convergence of 3GPP and non-3GPP Access

Converged 5G core

WP4 5G-Xcast Mobile Core Network

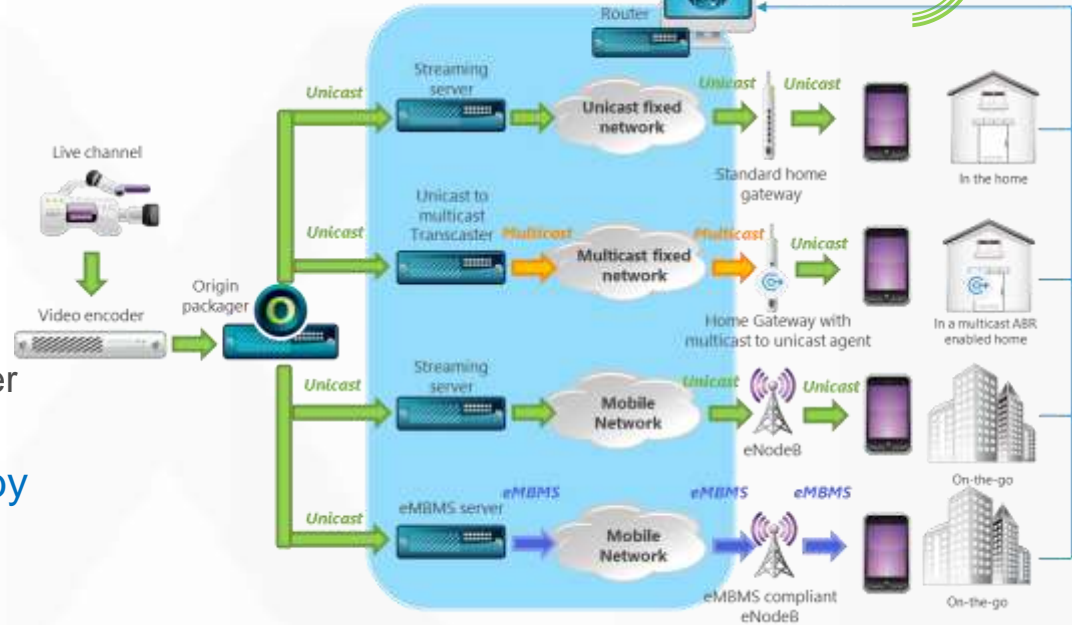**On-going work:**

- **Mobile PTM network architecture based on 3GPP 5G service-based architecture**
  - NFV/SDN
  - Network slicing
- **Future contribution to 3GPP 5G_Media_Distribution**

XCF: 5G-Xcast control plane
XUF: 5G-Xcast user plane

UC: Unicast
MC/BC: Multicast/Broadcast

UE: User Equipment
CP: Control plane
UP: User plane

- **Rel'15 full 5G core network due in June 2018**

WP5 Content Distribution

- Content delivery vision
  - Design principles:
    - PTM and caching as internal network optimization
    - Simple APIs
    - Application layer intelligence over network signaling
  - D5.1 deliverable to be released by the end of November!

- On-going work:
  - Combination of MooD (mobile network) and ABR multicast (fixed network) in the same converged system

- **More details in presentation on "*Unified content delivery on fixed and mobile networks*" by Steve Appleby (BT) WP5 leader**

WP6 Test-Beds
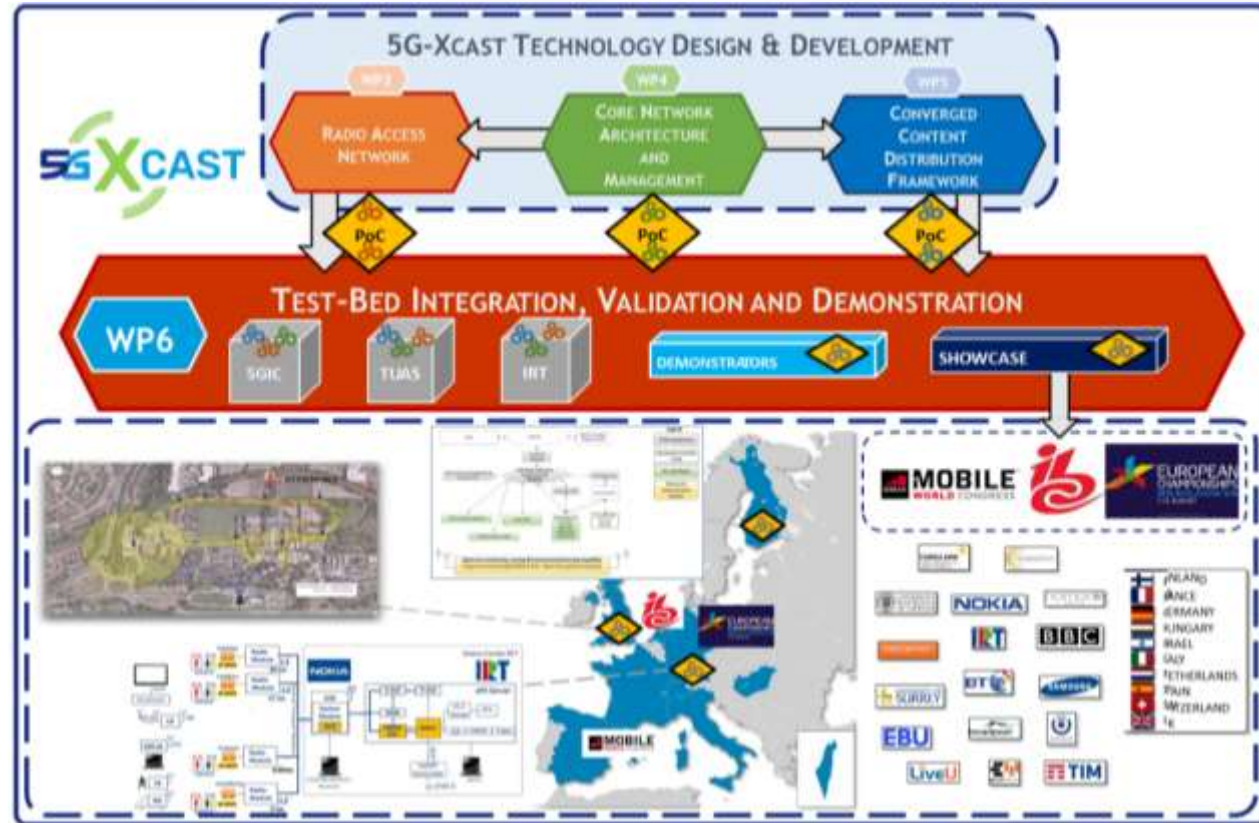
- **Test-beds**
  - 5GIC, IRT, TUAS
- **Large-scale demonstrations**
  - Object-based broadcasting
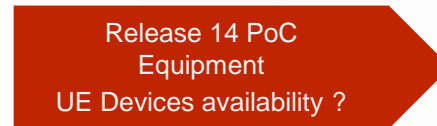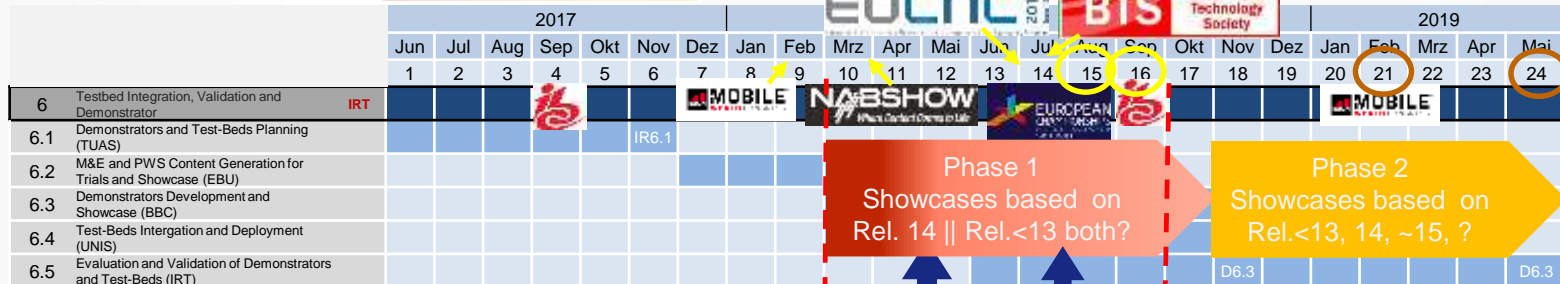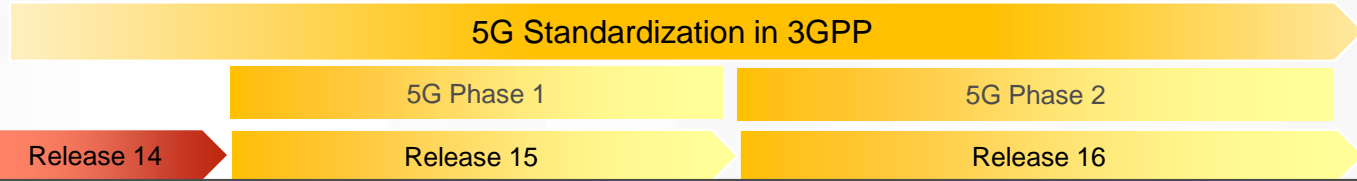 - Hybrid broadcasting
  - Public warning
- **Small-scale demonstrations**
  - IBC 2018, EUCNC 2019
- **Showcase**
  - European Championships 2018

WP6 Roadmap - Development plan

5G Standardization in 3GPP

5G Phase 1	5G Phase 2

Release 14	Release 15	Release 16

5G-xCast

5G-Xcast WP6 Phase 1	5G-Xcast WP6 Phase 2

5G-Xcast WP6 Phase 1 & Phase 2 Planning

			2017																		2019			
			Jun	Jul	Aug	Sep	Okt	Nov	Dez	Jan	Feb	Mrz	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Jan	Feb	Mrz	Apr	Mai
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
6	Testbed Integration, Validation and Demonstrator	IRT																								
6.1	Demonstrators and Test-Beds Planning (TUAS)							IR6.1																		
6.2	M&E and PWS Content Generation for Trials and Showcase (EBU)																									
6.3	Demonstrators Development and Showcase (BBC)																									
6.4	Test-Beds Intergation and Deployment (UNIS)																									
6.5	Evaluation and Validation of Demonstrators and Test-Beds (IRT)																			D6.3					D6.3

Phase 1 Showcases based on Rel. 14 || Rel.<13 both?

Phase 2 Showcases based on Rel.<13, 14, ~15, ?

Release 14 PoC Equipment UE Devices availability ?

Relevant Use case and Content Generation

„Global 5G event"

Final 5G-Xcast demo

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WP7 Dissemination & Standardization

- **Dissemination**
  - Public deliverables, scientific papers, presentations:
    - http://5g-xcast.eu/documents/
  - News and events
    - @5Gxcast tweet for live updates
    - http://5g-xcast.eu/news-events/
  - Videos
    - https://youtu.be/daFOf30NG2U
  - One-day tutorial and workshop at IEEE BMSB 2018
- **Standardization**
  - 3GPP
    - 5G_Media_Distribution, Study on MBMS User Services for IoT, eMBMS and Mission Critical Services, Study on the Wireless and Wireline Convergence for the 5G system architecture,
  - DVB (WiB, ABR multicast)
  - Broadband forum

5G Broadcast Outlook Summary

- **Broadcasters interest** in 3GPP technologies is increasing
  - EBU broadcast requirements taken into account in Rel'14 (EnTV) but not 100% clear that eMBMS can be fully deployed in existing HPHT DTT broadcasting infrastructure
  - Rel'14 has a long legacy from Rel'8 – detailed gap-analysis required (e.g. CAS)
  - 5G is an **opportunity** for broadcasters to define a **5G broadcast mode** using the latest 3GPP technology
- Many 5G **use cases require PTM** transmissions, not just TV broadcast
  - Treat **PTM transmissions and caching** as **delivery optimization tool**
- 5G Broadcast **not included** in the first 5G release (Rel'15) and probably not the second (Rel'16)
  - **Good opportunity in Rel'17 for a solution for all relevant verticals**, but important to **ensure forward-compatibility**
- 5G-Xcast is performing **pre-standardization investigations on 5G Broadcast**, and will also seek **consensus building for 3GPP activities**

Thank You

# IEEE International Symposium on Broadband Multimedia Systems and Broadcasting

June 6th – 8th 2018, Valencia, Spain

Tutorial on 5G Broadcast. Several workshops on 5G.
Tracks: Multimedia Broadband and Broadcasting Systems; Multimedia Services, Quality and Content; Multimedia Processing; Multimedia and Broadcast Transmissions

www.mcg.upv.es/bmsb2018/   **CfP Deadeline:** 22nd Dec (1000 word extended abstract)
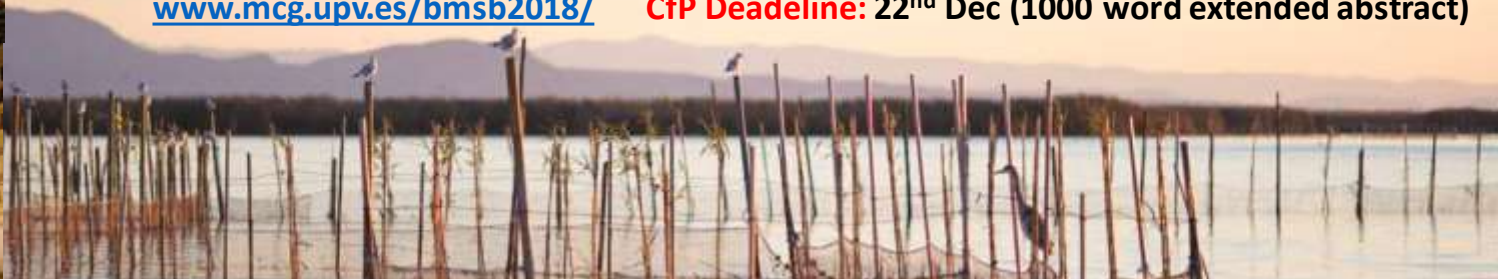
5G Driven by New Use Cases and Designed for New Vertical Industries

5G-PPP White Paper, "5G Vertical Sectors," Feb. 2016

ITU IMT-2020 Key Capabilities and Usage Scenarios
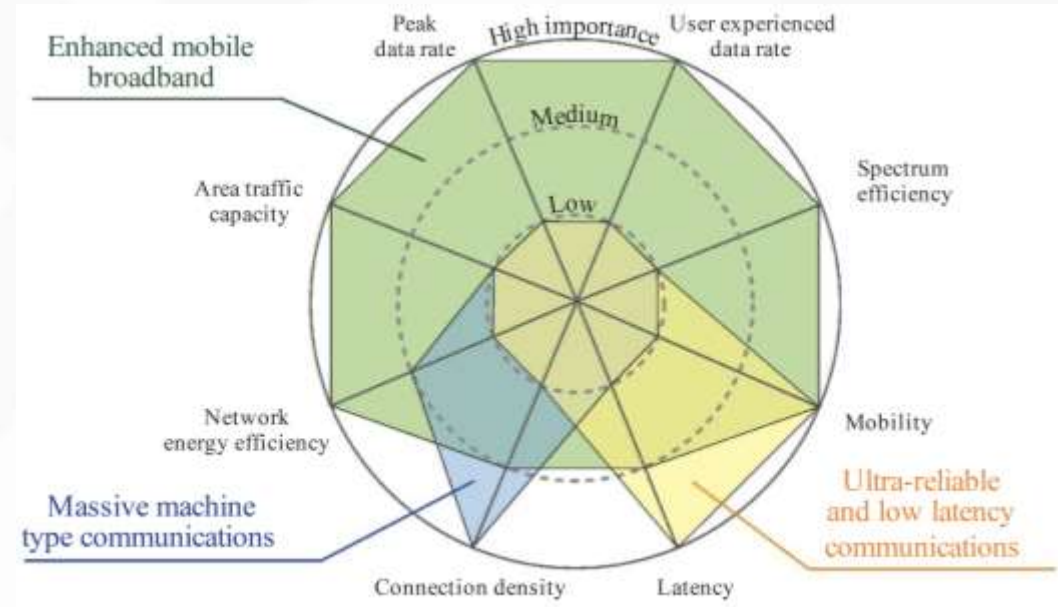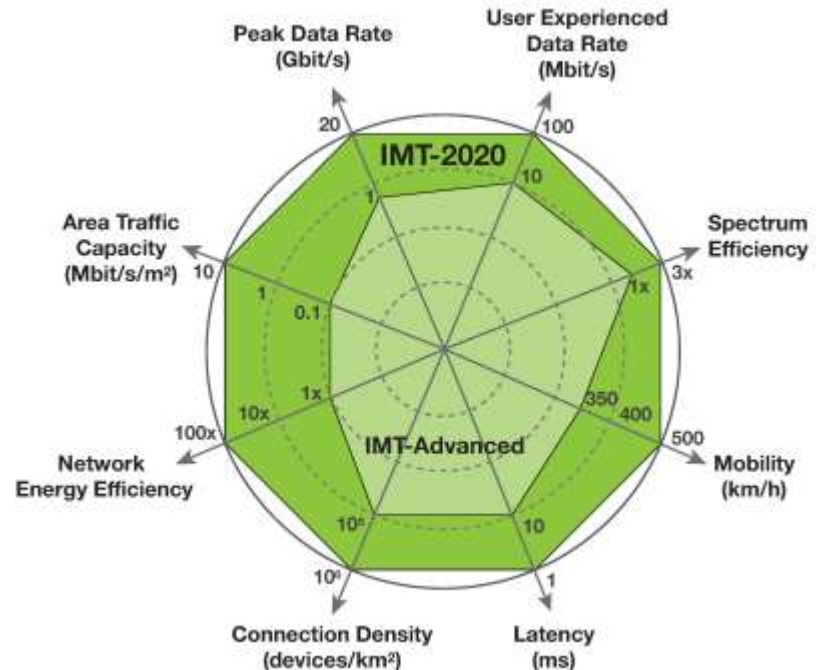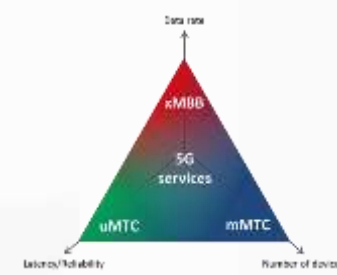
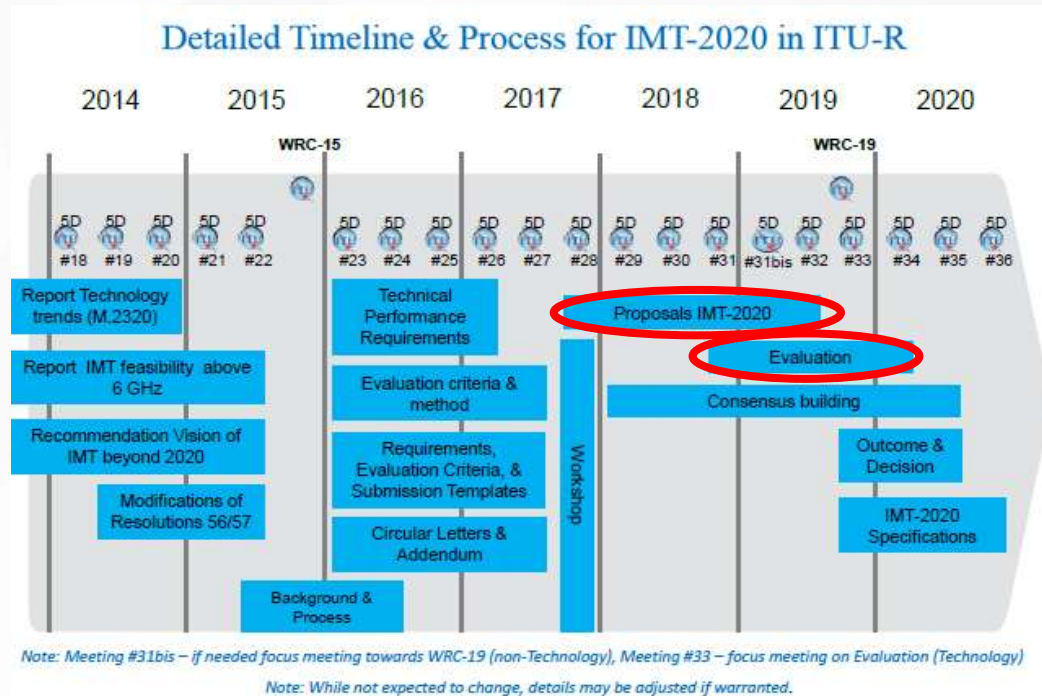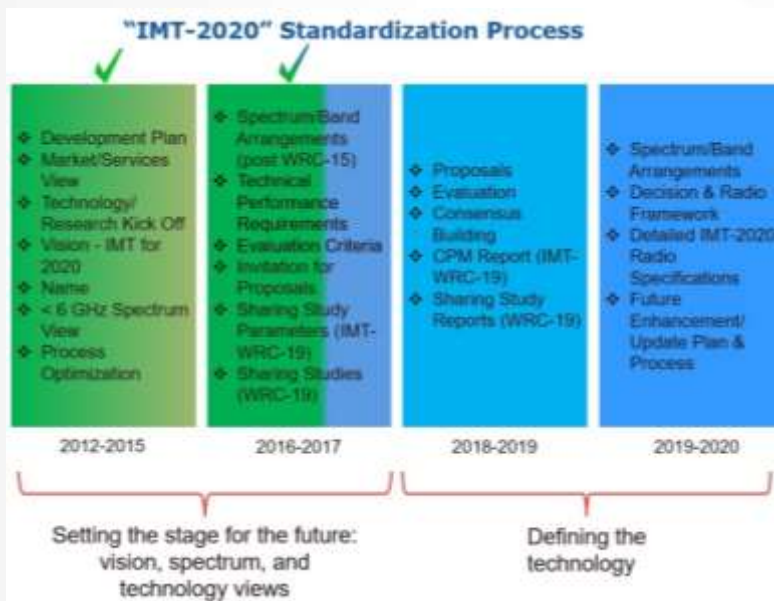# ITU IMT-2020 Minimum Technical Performance Requirements (II/II)

| KPI	Minimum Requirement
Latency	User plane latency: • 4 ms for eMBB; • 1 ms for URLCC Control plane latency: • 20 ms (10 ms encouraged)
Connection density	1.000.000 devices per km2
Reliability	$1-10^{-5}$ success probability of transmitting a layer 2 PDU of 32 bytes within 1 ms in channel quality of coverage edge for URLLC
Mobility	Up to 500 km/h
Mobility interruption time	0 ms
Energy efficiency	High sleep ratio and long sleep duration for eMBB

ITU IMT-2020 Timeline

- **Proposal submission opened in October 2017 and closes in July 2019**

"IMT-2020" Standardization Process

Detailed Timeline & Process for IMT-2020 in ITU-R

Note: Meeting #31bis – if needed focus meeting towards WRC-19 (non-Technology), Meeting #33 – focus meeting on Evaluation (Technology)

Note: While not expected to change, details may be adjusted if warranted.

5G in 3GPP

A GLOBAL INITIATIVE

❖ 3GPP started in March 2017 the normative work for 5G in **Rel'15**, while continue working in LTE-Advanced Pro

❖ 3GPP Rel'15 will aim the first phase of 5G deployments in 2020

  – A.k.a. **New Radio (NR)**

❖ 3GPP Rel'16 will target the ITU IMT-2020 submission

• **3GPP plans to submit both LTE-Advanced Pro and New Radio as IMT-2020 candidates**

  – 5G NR for eMBB and URLLC

  – LTE-based NoB-IoT and eMC for mMC
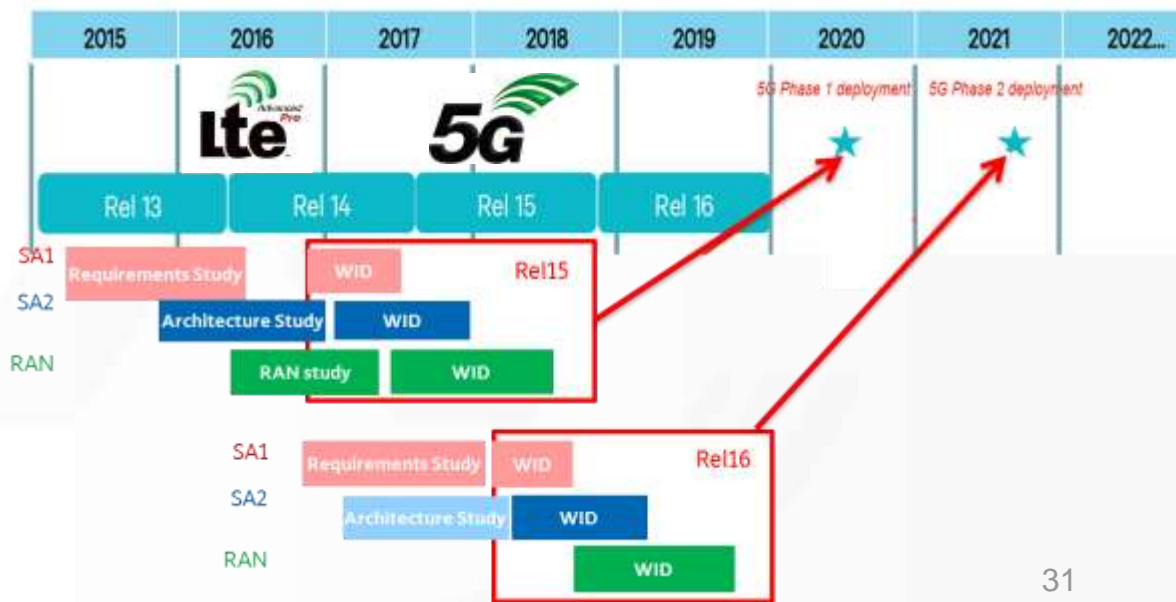
5G Service-based reference arquitecture

- **Authentication Server Function (AUSF)**
- **Access and Mobility Management Function (AMF)**
- **Data Network (DN)**
- **Unstructured Data Storage Function (UDSF)**
- **Network Exposure Function (NEF)**
- **NF Repository Function (NRF)**
- **Network Slice Selection Function (NSSF)**
- **Policy Control function (PCF)**
- **Session Management Function (SMF)**
- **Unified Data Management (UDM)**
- **Unified Data Repository (UDR)**
- **User plane Function (UPF)**
- **Application Function (AF)**
- **User Equipment (UE)**
- **(Radio) Access Network ((R)AN)**
- **5G-Equipment Identity Register (5G-EIR)**
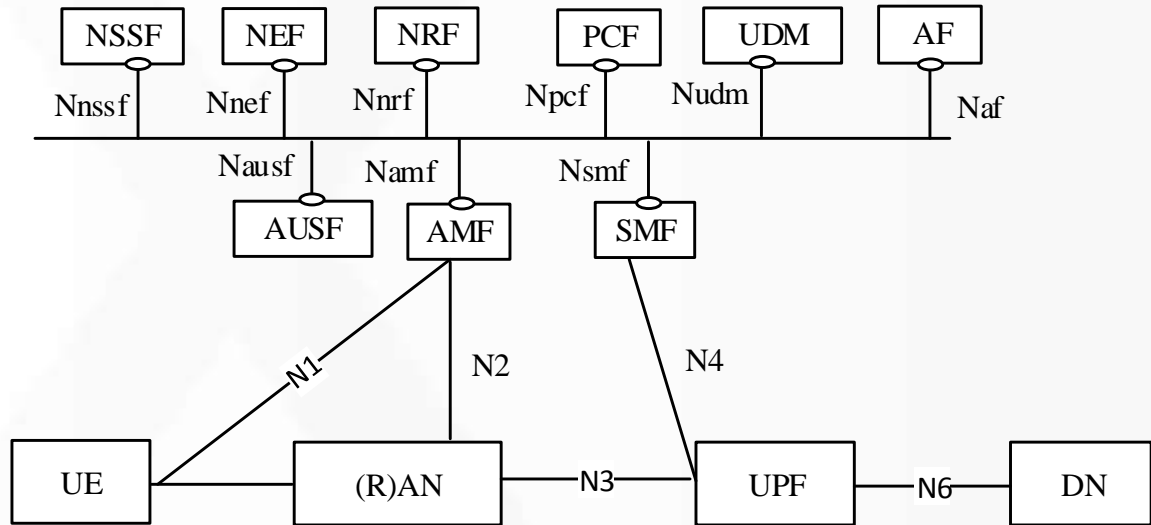
5G-Xcast Consortium

- Universitat Politècnica de València (UPV)
- Nokia Solutions and Networks OY
- Nokia Solutions and Networks Management International GmbH
- British Broadcasting Corporation (BBC)
- British Telecommunications Public Limited Company (BT)
- Broadpeak
- BundlesLab Kft
- Expway
- Fairspectrum OY
- Institut für Rundfunktechnik GmbH (IRT)
- LiveU Ltd.
- Nomor Research
- One2Many
- Samsung Electronics (UK) Limited
- Telecom Italia
- Turun Ammattikorkeakoulu OY (TUAS)
- Union Européenne de Radio Télévision (EBU)
- University of Surrey 5GIC

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