5G-Xcast Tutorial
Broadcast and Multicast Communications Enablers for 5G

WP2: 5G-Xcast Use Cases

WP2

Presenter:

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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

- **D2.1: Definition of Use Cases, Requirements and KPIs, Oct. 2017.**
  - Download
  - News

- **D2.2: Technology Delivery against Use Cases, Jan. 2019.**

- **D2.3: Future Work and Longer-Term Use Cases, May 2019.**

3

Table of contents

1. **Introduction to WP2**
2. **Use Cases (UCs) and Requirements**
   2.1 Media & Entertainment (M&E)
   2.2 Public Warning (PW)
   2.3 Automotive (Auto)
   2.4 Internet of Things (IoT)
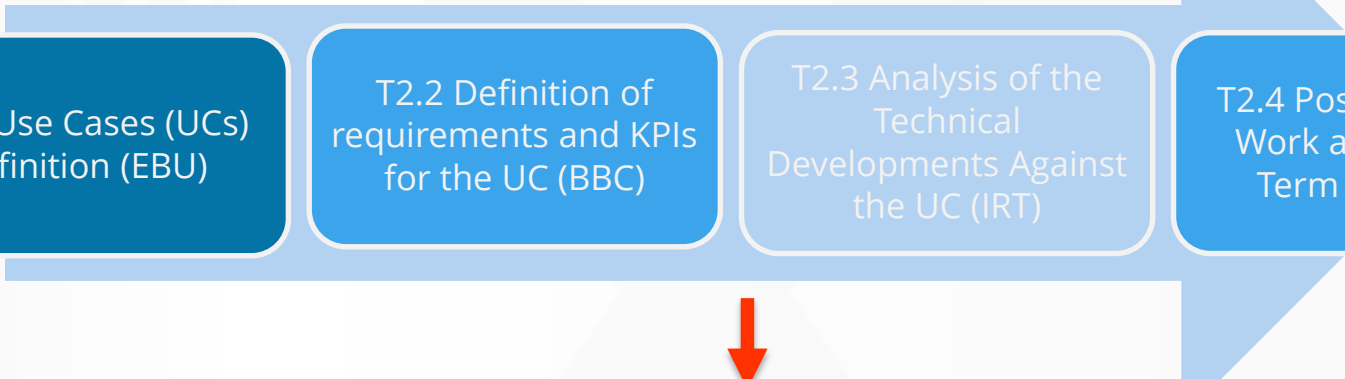3. **Future work**

Table of contents

1. Introduction to WP2

T2.1 Use Cases (UCs) definition (EBU)

T2.2 Definition of requirements and KPIs for the UC (BBC)

T2.3 Analysis of the Technical Developments Against the UC (IRT)

T2.4 Possible Future Work and Longer-Term UCs (TIM)

Task	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24
	Jun.			Sep.			Dec.			Mar.			June			Sept.			Dec.			Mar.		
	2017									2018												2019		
WP2																								
T2.1			D2.1																					
T2.2				D2.1																				
T2.3											D2.2									D2.2				
T2.4																								D2.3

1. Introduction to WP2
Deliverables and milestones

- **Deliverables**

    1. Darko Ratkaj and Andrew Murphy (Eds.) *"Definition of Use Cases, Requirements and KPIs,"* Deliverable 2.1, 5G PPP 5G-Xcast project, Oct. 2017 [1]

    2. Andrew Murphy, Clemens Kunert and Irene Alepuz (Eds.) *"Analysis of the Technical Developments Against the Use Cases"* Deliverable 2.2, 5G PPP 5G-Xcast project, Jan. 2019 [2]

    3. Giovanna D'Aria, Andrew Murphy (Eds) "Future Work and Longer-Term Use Cases" Deliverable 2.3, 5G PPP 5G-Xcast project, May 2019 [3]

- **Milestone**

    – Oct. 2018. Use cases, Requirements and KPIs defined → D2.1

1. Introduction to WP2
Current work

- **The technical Work Packages (WP3-5):**
  - Have interpreted this high-level requirements within each individual area
  - Have prioritized those requirements
  - Are engineering appropriate solutions based on their domain knowledge.

- **We are looking the developments in on-going standardisation, including 3GPP, to make an assessment of the State of the Art of work in the project.**

1. Introduction to WP2
Background: 3GPP Point-to-Multipoint (PTM) UCs
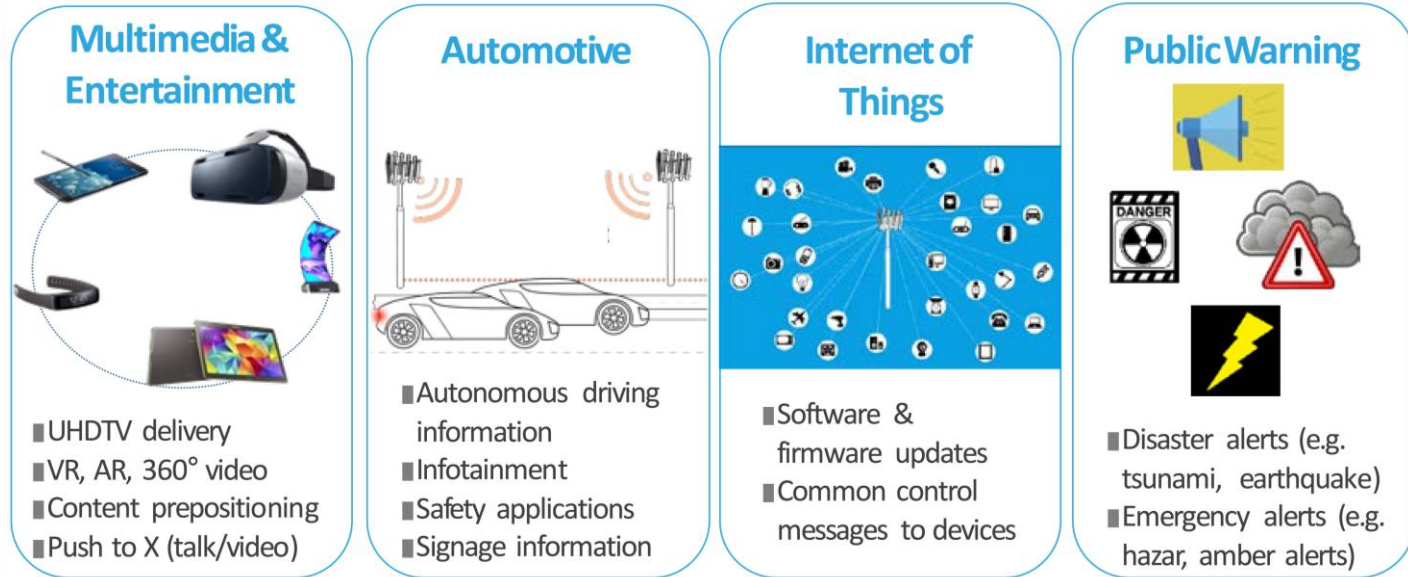
[4]

- **SMARTER Usage scenarios [4] :**
  - Enhanced Mobile Broandband (eMBB)
    - 56 Broadcasting Support.
    - 72 Connectivity Using Satellites.
  - Massive Internet of Things (MIoT)
  - Critical Communications (CriC)
    - 2 Network Slicing
    - 12 Connectivity for drones
    - 72 Connectivity using Satellites.

  - Enhanced Vehicle To Everything (eV2X)
    - 33 Connected vehicles
  - Network Operation (NEO)
    - 2 Network Slicing
    - 36 In-network & device caching.
    - 56 Broadcasting Support.
    - 57 Ad-Hoc Broadcasting
    - 70 Broadcast/Multicast Services using Dedicated Radio Carrier
    - 72 Connectivity Using Satellites.

- **3GPP " Enhancement for TV service" has defined 20 UCs [5]**

Table of contents

1. **Introduction to WP2**
2. **Use Cases (UCs) and Requirements**
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   2.3 Automotive (Auto)

   2.4 Internet of Things (IoT)
3. **Future work**

2. Use Cases

- Verticals:

Multimedia & Entertainment	Automotive	Internet of Things	Public Warning
■ UHDTV delivery ■ VR, AR, 360° video ■ Content prepositioning ■ Push to X (talk/video)	■ Autonomous driving information ■ Infotainment ■ Safety applications ■ Signage information	■ Software & firmware updates ■ Common control messages to devices	■ Disaster alerts (e.g. tsunami, earthquake) ■ Emergency alerts (e.g. hazar, amber alerts)

[7]

- **We have studied the most disruptive UCs where the Point-to-Multipoint transmission will be a more efficient delivery mechanism.**

2. Use Cases

2.1 Media & Entertainment (M&E)

2.1.1 Hybrid Broadcast Service (M&E1)

2.1.2 Virtual/ Augmented Reality (M&E2)

2.1.3 Remote Live Production (M&E3)

2.2 Public Warning (PW)

2.2.1 Multimedia Public Warning Alert (PW1)

2.3 Automotive (Auto)

2.3.1 V2X Broadcast Service (Auto1)
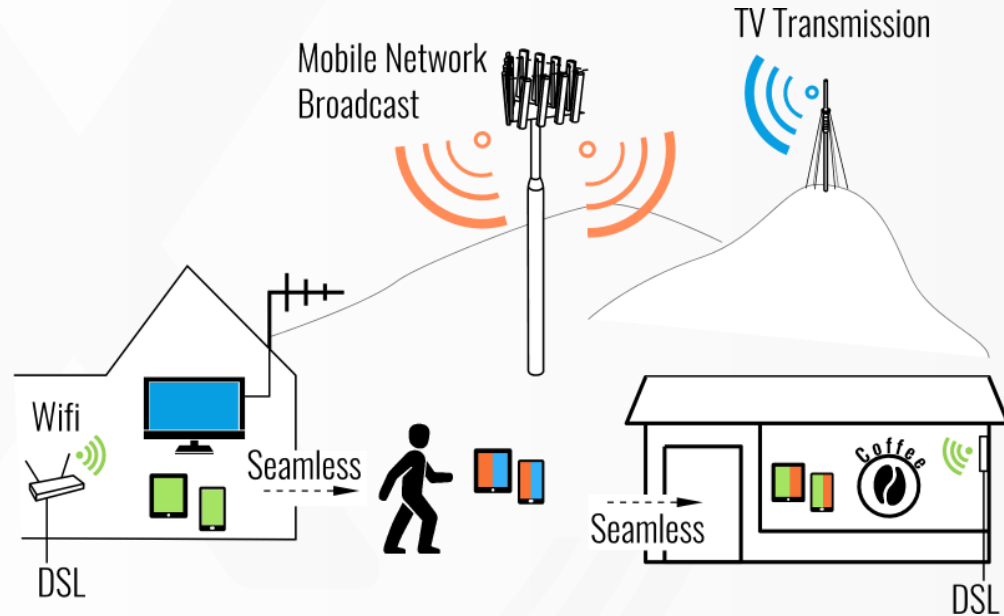
2.4 Internet of Things (IoT)

2.4.1 Massive Software and Firmware Updates (IoT1)

2.1.1 M&E1: Hybrid Broadcast Service

- End users have **seamless access** to **audio-visual content** **both at home and on the move** including **seamless mobility between access networks, and across different types of devices**.

- **Combinations of networks:**
  - fixed broadband;
  - mobile broadband; and,
  - Terrestrial

2.1.1 M&E1: Hybrid Broadcast Service
Main Requirements

5G-Xcast Requirement [1]	3GPP [2, 8]
End users have seamless access to audio-visual content both at home and on the move (R1)	Rel'14: Service continuity is only achieved within a mobile network. Rel'15 NR: has not taken multicast/broadcast capabilities into account.
Dynamic optimisation of the network (R3, R5, R7)	Rel'14: eMBMS is characterized by a static configuration which cannot dynamically adapt to user requirements. Rel-14: is lacking radio channel feedback mechanisms.
Transition between unicast and broadcast and multicast should be allowed during service (R12).	Rel'14: Dynamic adaptation and the change of area between unicast and multicast is not available.

2.1.1 M&E1: Hybrid Broadcast Service
Main Requirements

5G-Xcast Requirement	3GPP [2, 8]
Transmission to different scenarios and network topologies (R14, R28, R30).	Rel'14: Lack of sufficient CP duration and the short range of possibilities
Mobility should be applicable for all ITU mobility classes (R18).	Rel'14: Trade off between SFN network areas and UE speed.
The system should have the possibility to provide audience metrics (R33): including behavioural and QoE reporting in real-time.	Rel'14: Basic UE reports not covering real-time QoS.
Allow the UE to receive content via a broadcast/multicast radio carrier while a concurrent non-broadcast data session is ongoing (R10)	Rel'14: eMBMS allows it

2.1.1 M&E1: Hybrid Broadcast Service
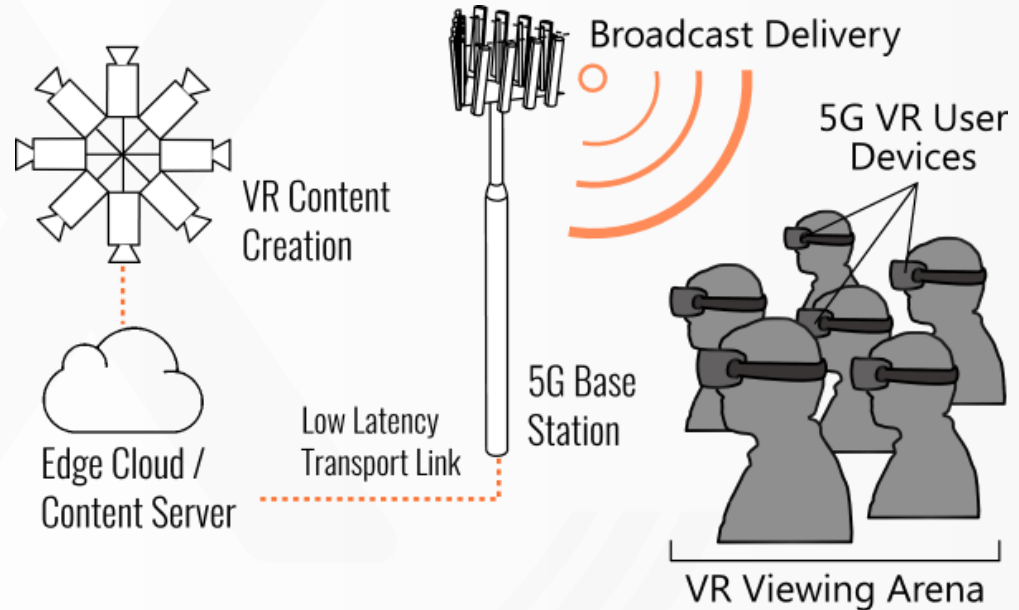## Main Key Performance Indicators (KPIs)

KPI	5G-Xcast KPIs Value	IMT-2020 KPIs Value
Coverage	National coverage >99% of the populated areas, roads and railways	X
Connected density	≥10.000 devices per km^2	1.000.000 devices per km^2 in mMTC
System scalability	10^6 concurrent access links	X
U-plane E2E DL latency	< 50 ms	4 ms
UE speed	500 km/h	500 km/h

2.1.2 Virtual/ Augmented Reality Broadcast

- Disruptive use cases towards **interconnected social experiences.**

- A **multitude of users** should be able to receive **high-quality VR/ AR content** over the air.

- **Key requirements:** high throughput, low latency and high reliability.

VR Content Creation

Edge Cloud / Content Server

Low Latency Transport Link

5G Base Station

Broadcast Delivery

5G VR User Devices

VR Viewing Arena

2.1.2 Virtual/ Augmented Reality Broadcast
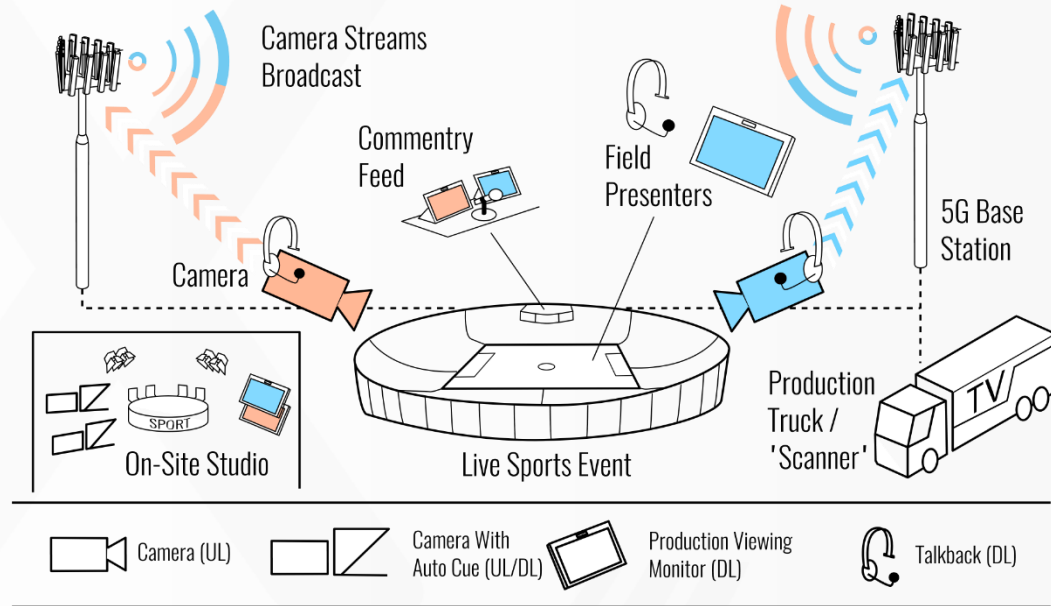## Main Requirements & KPIs

5G-Xcast Requirement	3GPP [2, 8]
Fully immersive VR content would require high data rates in the order of several Gbit/s (R1)	Rel'14: low spectral efficiency limits high data rates due to high overhead in eMBMS and SC-PTM modes.

KPI	5G-Xcast KPIs Value	IMT-2020 KPIs Value
Peak Data Rate	5 Gbps	20 Gbit/s in DL 10 Gbit/s in UL
Connection Density	< 1.000 devices per km^2	1.000.000 devices per km^2 in mMTC
U-plane E2E DL latency	7 ms	4 ms

2.1.3 Remote Live Production

- **Typical production environment**
  - Multiple users often requires the same feed at the same time.
  - Users in different locations.
  - Use different telecom providers
- **The most important capability will be to receive the video feed continuously.**

Camera Streams Broadcast

Commentry Feed

Field Presenters

5G Base Station

Camera

On-Site Studio

SPORT

Live Sports Event

Production Truck / 'Scanner'

TV

Camera (UL) | Camera With Auto Cue (UL/DL) | Production Viewing Monitor (DL) | Talkback (DL)

2.1.3 Remote Live Production
Main Requirements & KPIs

5G-Xcast Requirement	3GPPP Limitations [8]
Very high data rates and reliability to provide high quality audio and video suitable for production processing. (R1)	Rel'14: low spectral efficiency limits high data rates due to high overhead in eMBMS and SC-PTM modes.

KPI	5G-Xcast KPIs Value	IMT-2020 KPIs Value
U-plane E2E DL latency (R2)	< 10 ms	4 ms
Peak Data Rates (R1)	~ 9 Gbps (uncompressed video)	20 Gbit/s in DL 10 Gbit/s in UL
U-Reliability (R3)	10^{-11} Bit Error Rate	$1-10^{-5}$ success probability of transmitting a layer 2 PDU

2. Use Cases

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2.4 Internet of Things (IoT)

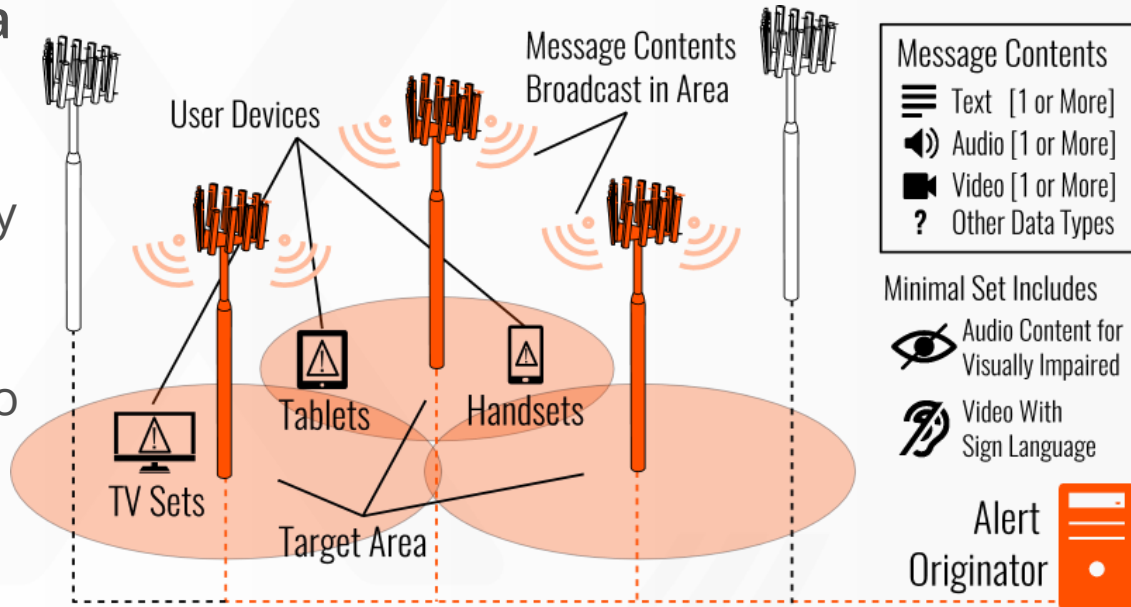2.4.1 Massive Software and Firmware Updates (IoT1)

2.2 Multimedia Public Warning Alert

- **Users are notified with alerts carrying multimedia and manifold information**
  - which improves the effectiveness and reactivity of the users' responses.
  - Message includes multimedia components to convey the message to both able-bodied and disabled people.
  - E.g. AMBERT alert inform users about a missing child

Message Contents Broadcast in Area

User Devices

Tablets — Handsets

TV Sets

Target Area

Message Contents
- ≡ Text [1 or More]
- 🔊 Audio [1 or More]
- 🎥 Video [1 or More]
- ? Other Data Types

Minimal Set Includes
- 👁 Audio Content for Visually Impaired
- Video With Sign Language

Alert Originator

2.2 Multimedia Public Warning Alert
Main Requirements

5G-Xcast Requirement	3GPP [2, 8]
Possible to send multiple types of content : Pictures, text, URL, videos, audios, geographic information (R1, R2, R12)	Rel'14: Rich content type cannot be delivered by Cell Broadcast which is able to deliver only messages with a very small size (e.g. short text).
Designed to not cause a noticeable increase n battery consumption devices (R5).	Rel'15 NR: has introduced the RRC_INACTIVE state, this allows dramatically increased battery life.
It is automatically received by each device within the target area (R6).	Rel'14: Lack of efficient paging mechanism.

2.2 Multimedia Public Warning Alert
Main Key Performance Indicators (KPIs)

KPI	5G-Xcast KPIs Value	IMT-2020 KPIs Value
Connection Density	> 10.000 devices per km^2	1.000.000 devices per km^2 in mMTC
Battery consumption	No additional impact due to PW alert	X

2. Use Cases

2.1 Media & Entertainment (M&E)

2.1.1 Hybrid Broadcast Service (M&E1)

2.1.2 Virtual/ Augmented Reality (M&E2)

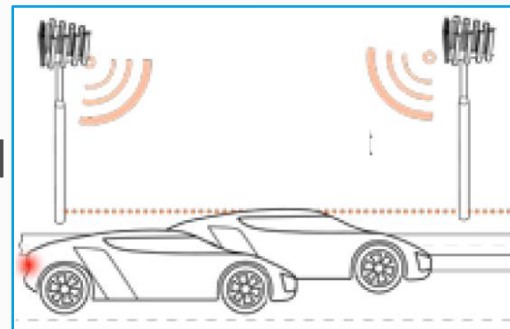2.1.3 Remote Live Production (M&E3)

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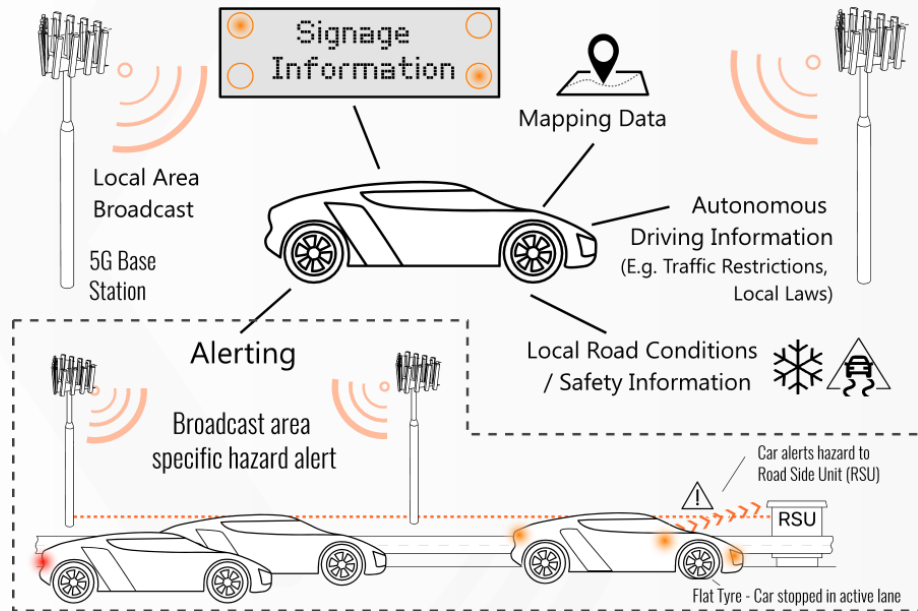
2.4 Internet of Things (IoT)

2.4.1 Massive Software and Firmware Updates (IoT1)

2.3 V2X Broadcast Service

- **V2X applications would require information delivered from the Intelligent Transport System infrastructure to the vehicle**
  - E.g.:
    - Road safety
    - Signage
    - Mapping
    - Autonomous driving
- **One important aspect is that alerts need to be**

Signage Information

Mapping Data

Local Area Broadcast

5G Base Station

Autonomous Driving Information (E.g. Traffic Restrictions, Local Laws)

Local Road Conditions / Safety Information

Alerting

Broadcast area specific hazard alert

Car alerts hazard to Road Side Unit (RSU)

RSU

Flat Tyre - Car stopped in active lane

2.3 V2X Broadcast Service
Main Requirements & KPIs

5G-Xcast Requirement	3GPP [2, 8]
Latency (R1): Low E2E latency (5 ms) (R1).	
Ultra-high reliability (R2)	5G NR features are defined to support it for PTP.
Density (R3): very large density of connected vehicles across different environments: • Urban: 1000 – 3000 vehicles/km^2; • Sub-urban: 500 – 1000 vehicles/km^2; • Highway: 100 – 500 vehicles/km^2.	

KPI	5G-Xcast KPIs Value	IMT-2020 KPIs Value
Connection density	3.000 vehicles per km^2	1.000.000 devices per km^2 in mMTC
U-plane E2E latency	5 ms	1 ms
Reliability	10^{-5} packet loss rate	$1-10^{-5}$ success probability of transmitting a layer 2 PDU

2. Use Cases

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2.1.1 Hybrid Broadcast Service (M&E1)

2.1.2 Virtual/ Augmented Reality (M&E2)

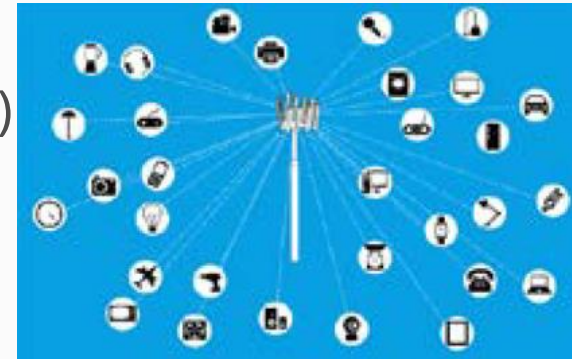2.1.3 Remote Live Production (M&E3)

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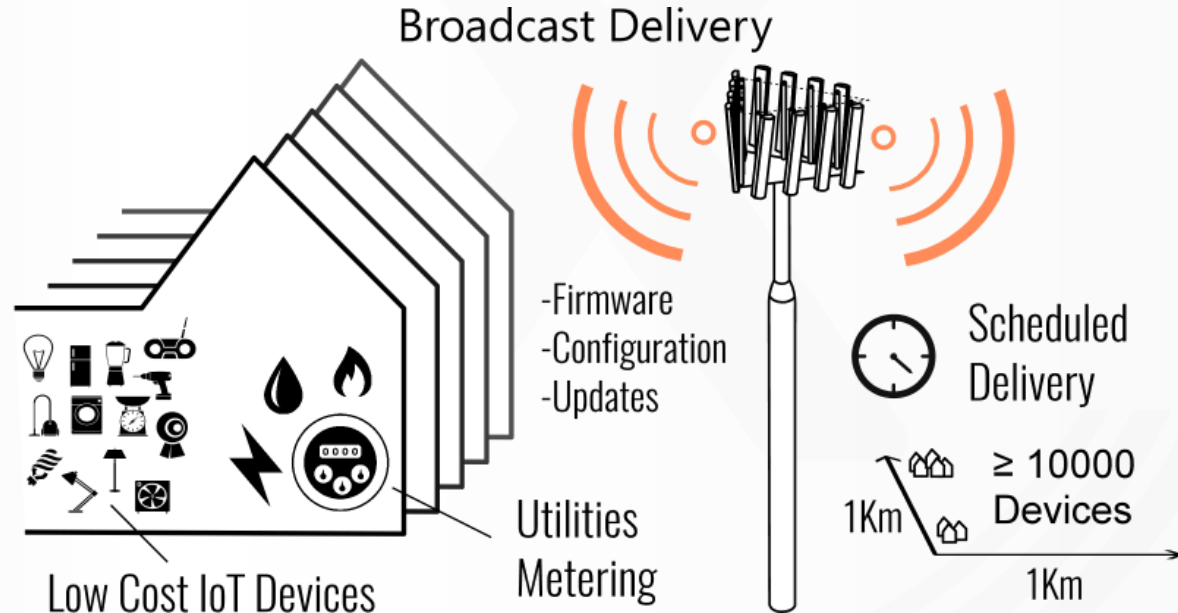
2.4 Internet of Things (IoT)

2.4.1 Massive Software and Firmware Updates (IoT1)

2.4 Massive software and firmware updates

- Based on the **growing amount of data**, the system configuration is adjusted, requiring the **delivery of small configuration updates to all devices**.

Broadcast Delivery

-Firmware
-Configuration
-Updates

Utilities Metering

Low Cost IoT Devices

Scheduled Delivery

1Km   ≥ 10000 Devices

1Km

2.4 Massive software and firmware updates
Main Requirements & KPIs

5G-Xcast Requirement	3GPP [2, 8]
System designed for devices to (R1): • have a long battery life (typically 15 years); • have limited processing capabilities; • have limited storage facilities; and • to wake from standby up at a scheduled time to receive a file delivery.	Rel'15: has discussed mechanisms to decrease power consumption.
System shall support reports on successful delivery from each receiving device (R2).	Rel-14: is lacking radio channel feedback mechanisms.

KPI	5G-Xcast KPIs Value	IMT-2020 KPIs Value
Connection density	>10.000 devices per km^2	1.000.000 devices per km^2 in mMTC
Battery consumption	Up to 15 years	X

Table of contents

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3. **Future work**

3. Future work

- **To validate and verify the technical solutions developed in the project against the requirements.**

- **To Examine to what extent the initial use cases have been met.**

- **To define longer-term use cases:**

  - Identify other use cases that could be enabled through the technology researched within 5G-Xcast.

  - Assess the scope for future work and potential new business models.

References

[1] Darko Ratkaj and Andrew Murphy (Eds.) "*Definition of Use Cases, Requirements and KPIs*," Deliverable 2.1, 5G PPP 5G-Xcast project, Oct. 2017.

[2] Andrew Murphy, Clemens Kunert and Irene Alepuz (Eds.) "*Analysis of the Technical Developments Against the Use Cases*" Deliverable 2.2, 5G PPP 5G-Xcast project, Jan. 2019.

[3] Giovanna D'Aria, Andrew Murphy (Eds.) "", Deliverable 2.3, 5G PPP 5G-Xcast project, May 2019.

[4] 3GPP TS 22.261, v16.1.0, "Service requirements for the 5G system; Stage 1 (Release 16)", September 2017.[5] 3GPP TR 22.816, "3GPP enhancement for TV service", v14.1.0, March 2016[6] IMT-2020 M.2083

[7] D. Gomez-Barquero, D. Navratil, S. Appleby and M. Stagg, "Point-to-Multipoint Communication Enablers for the Fifth-Generation of Wireless Systems", IEEE Communications Standards Magazine, vol. 2, no. 1, pp. 53-59, March 2018.

[8] D. Vargas, D. Mi (Eds), "Performance of LTE Advanced Pro (Rel-14) eMBMS", Deliverable D3.1, 5G PPP 5G-Xcast project, Nov. 2017

Thank You

Any Questions ?