

eXtended Reality in 5G

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Content



- Introduction on 3GPP and 5G
- Definitions around XR
- 5G Media Streaming Architecture and Edge Compute extensions
- Study on Extended Reality on 5G
- XR Traffic characteristics
- Glass-based AR and MR over 5G

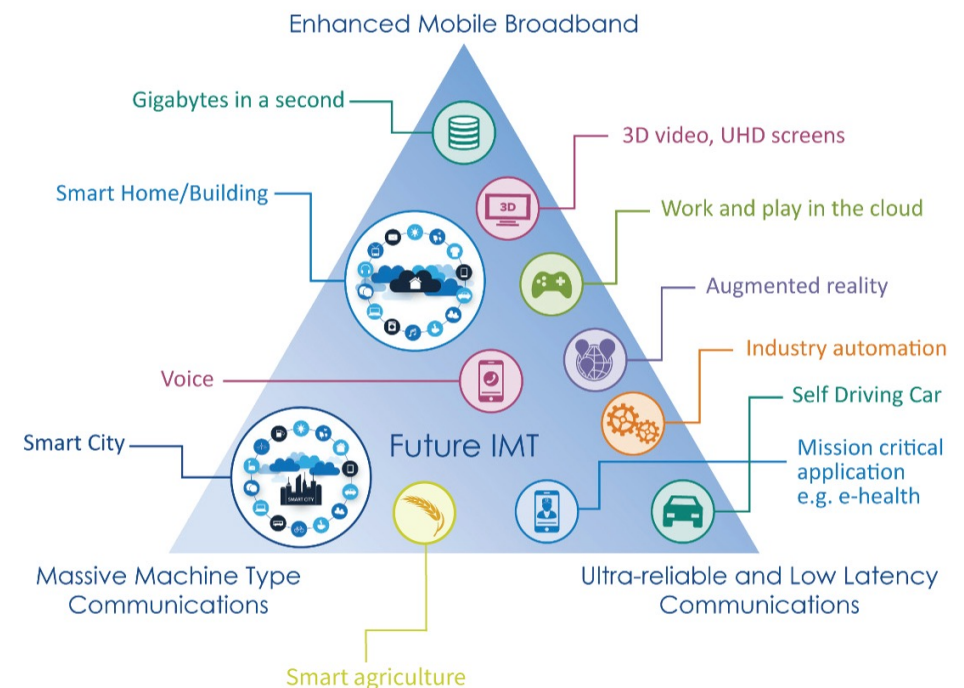
3GPP and 5G

5G – brings new growth



Perfect storm of technology trends:

- Availability of a reliable low latency radio and a fully flexible network
- Artificial Intelligence and Automation
- Device revolution for Augmented Reality and Virtual reality
- The Vertical industries going cellular



3GPP 5G Timeline



Release timing

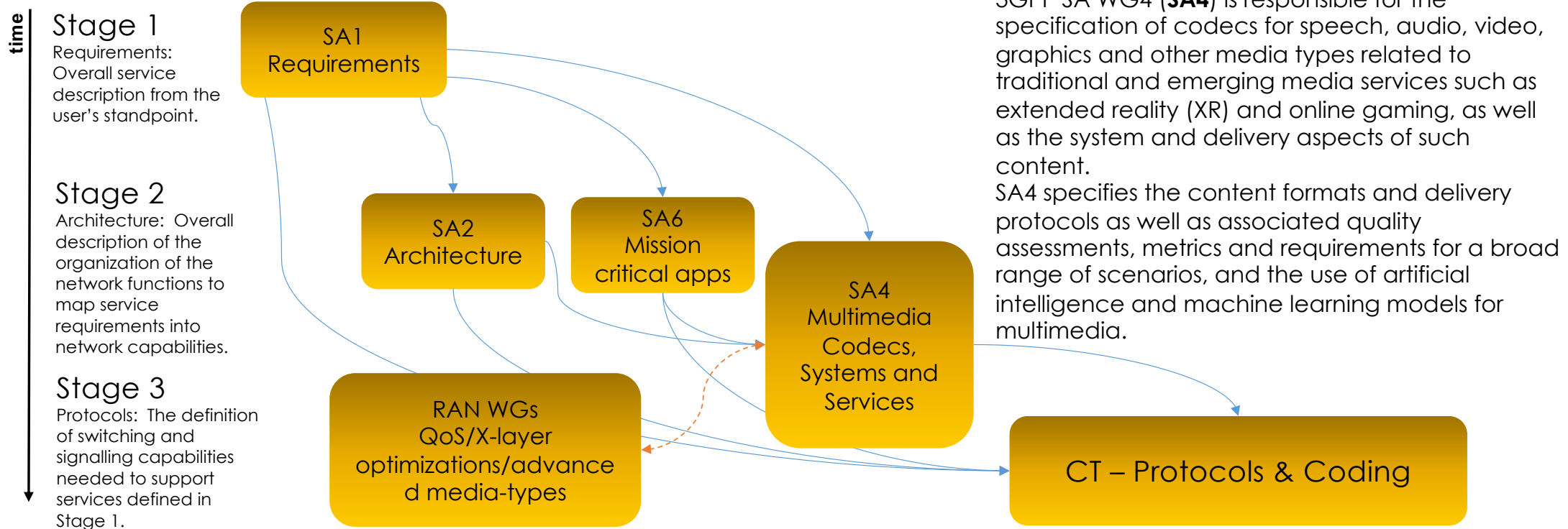


Phases for the normative 5G work:

- Phase 1 (Rel-15) addresses the more urgent subset for commercial deployments
- Phase 2 (Rel-16) Completes the 3GPP IMT 2020 submission (ITU-R) and addresses all identified use cases & requirements...
- Release 17 brings enhancements to 5G
- Release 18 is also known as “5G-Advanced”



Three stage approach / SA4



3GPP SA WG4 (**SA4**) is responsible for the specification of codecs for speech, audio, video, graphics and other media types related to traditional and emerging media services such as extended reality (XR) and online gaming, as well as the system and delivery aspects of such content. SA4 specifies the content formats and delivery protocols as well as associated quality assessments, metrics and requirements for a broad range of scenarios, and the use of artificial intelligence and machine learning models for multimedia.

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3GPP XR related activities

- 2018: Rel-15 / 5G Phase 1: 3GPP SA4 TR 26.918 provides an introduction to Virtual Reality and 3GPP TS 26.118 defines Virtual Reality Media Profiles for omnidirectional 3DoF media.
- 2019: Rel-17 – 3GPP SA1 - Stage 1 – Service requirements evaluated by 3GPP SA1 in 3GPP TR 22.842 on Network Controlled Interactive Service (NCIS) including e.g. VR and Cloud gaming and new service requirements defined in 3GPP TS 22.261 (5G Service requirements).
- 2020: Rel-16 - 3GPP SA4 Study on eXtended Reality (XR) in 5G (FS_5GXR) documented in TR 26.928.
- 2020: Rel-17 – 3GPP SA2 - Stage 2 - 5G System Enhancement for Advanced Interactive Services (5G_AIS) resulted in New standardized 5QI values for Advanced Interactive Services in 3GPP TS 23.502.
- 2021: Rel-17 – 3GPP SA4 Study on Typical Traffic Characteristics for XR Services and other Media (FS_XRTraffic) documented as addition to existing TR 26.925. To be used in support of 3GPP RAN1 activities and to be completed in Dec. 2021.
- 2021: Rel-17– 3GPP RAN1 *Study on XR (Extended Reality) evaluations for NR ('New Radio')*. To be completed Dec. 2021: considerations on device power consumption, capacity, coverage and mobility
- 2021: Rel-17 – 3GPP SA4 Study on 5G Glass-type AR/MR Devices (FS_5GSTAR). To be documented in TR 26.998 and completed in December 2021.

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New 5QIs

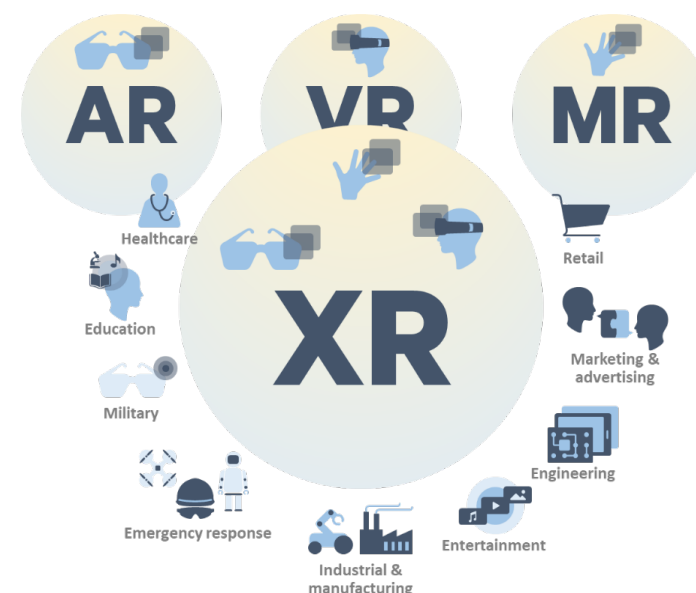
Table 5.7.4-1: Standardized 5QI to QoS characteristics mapping

5QI Value	Resource Type	Default Priority Level	Packet Delay Budget (NOTE 3)	Packet Error Rate	Default Maximum Data Burst Volume (NOTE 2)	Default Averaging Window	Example Services
87		25	5 ms (NOTE 4)	10^{-3}	500 bytes	2000 ms	Interactive Service - Motion tracking data, (see TS 22.261 [2])
88		25	10 ms (NOTE 4)	10^{-3}	1125 bytes	2000 ms	Interactive Service - Motion tracking data, (see TS 22.261 [2])
89		25	15 ms (NOTE 4)	10^{-4}	17000 bytes	2000 ms	Visual content for cloud/edge/split rendering (see TS 22.261 [2])
90		25	20 ms (NOTE 4)	10^{-4}	63000 bytes	2000 ms	Visual content for cloud/edge/split rendering (see TS 22.261 [2])

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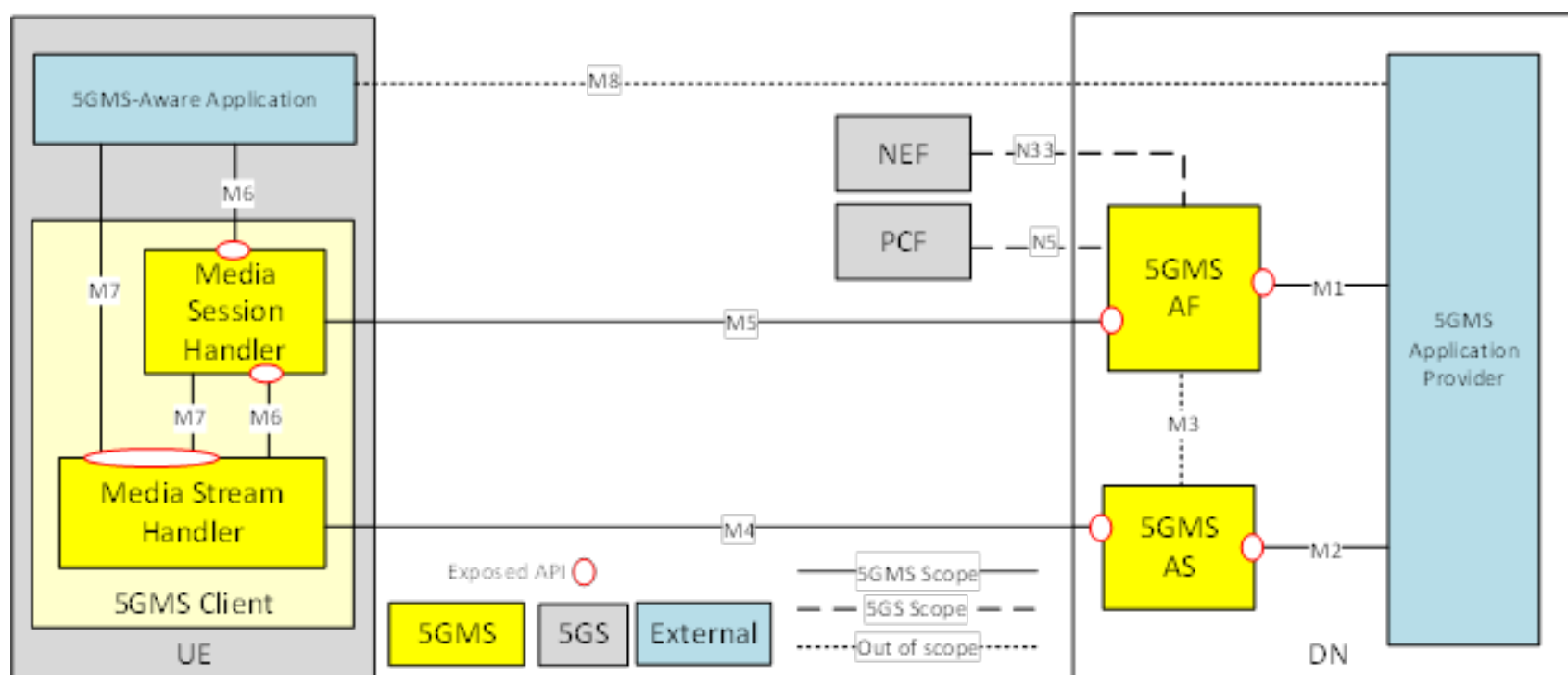
Definitions

- « Extended reality (XR) refers to all real-and-virtual combined environments and associated human-machine interactions generated by computer technology and wearables. It includes representative forms such as augmented reality (AR), mixed reality (MR), and virtual reality (VR) and the areas interpolated among them» (TR 26.928)
- Virtual reality* (VR) is a rendered version of a delivered visual and audio scene;
- Augmented reality* (AR) is when a user is provided with additional information or artificially generated items or content overlaid upon their current environment;
- Mixed reality (MR) is an advanced form of AR where some virtual elements are inserted into the physical scene with the intent to provide the illusion that these elements are part of the real scene.

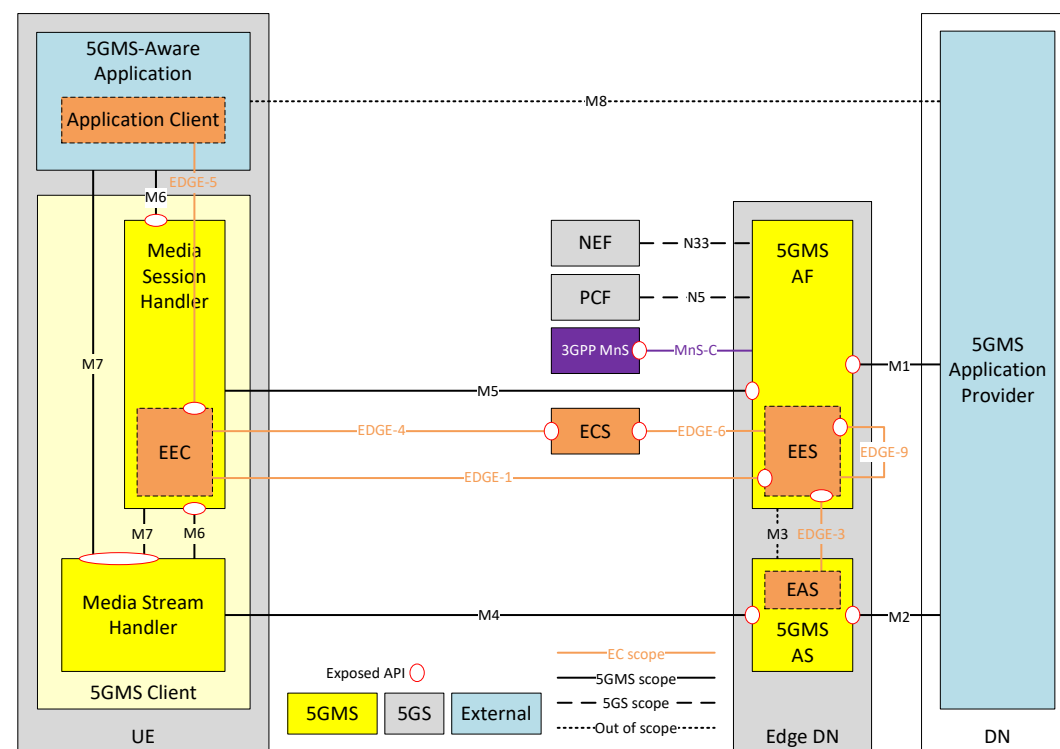
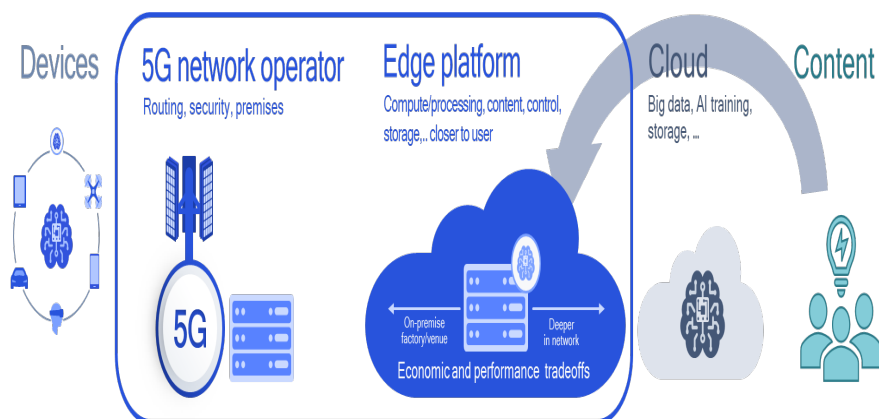


5G Media Streaming (5GMS)

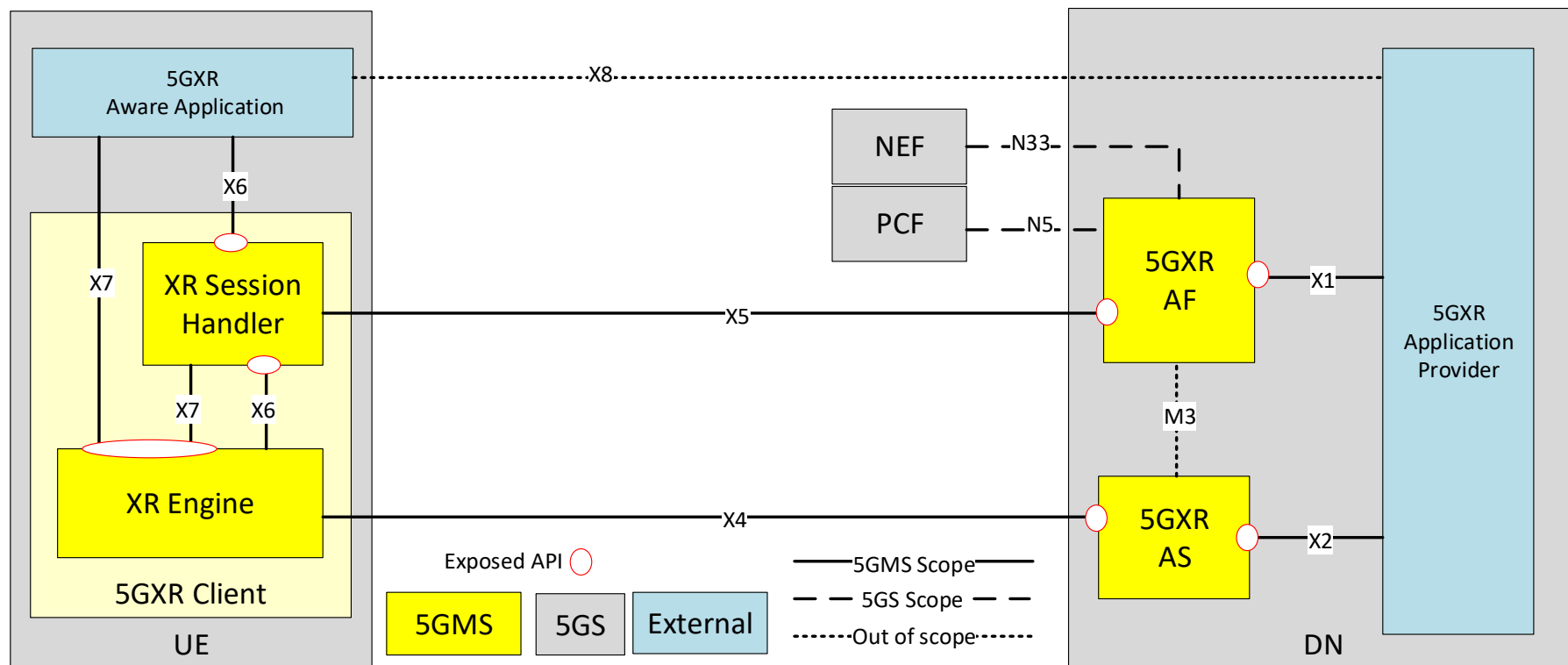
5G Media streaming architecture



Potential Edge computing extensions



Study phase XR architecture mapping



Study on eXtended Reality (XR) in 5G

FS_5GXR

Initial study on XR over 5G



📶 Study:

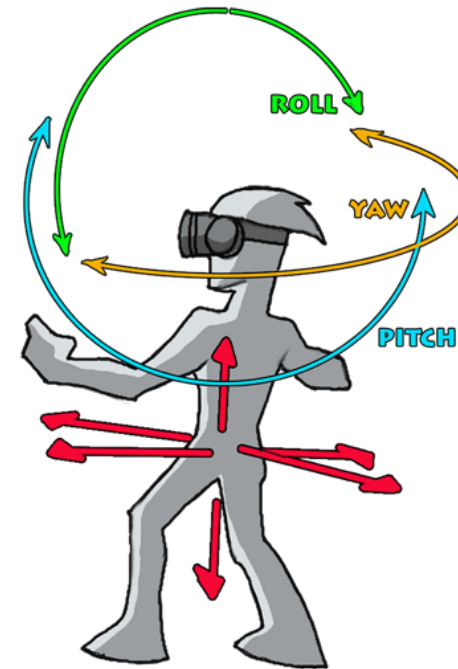
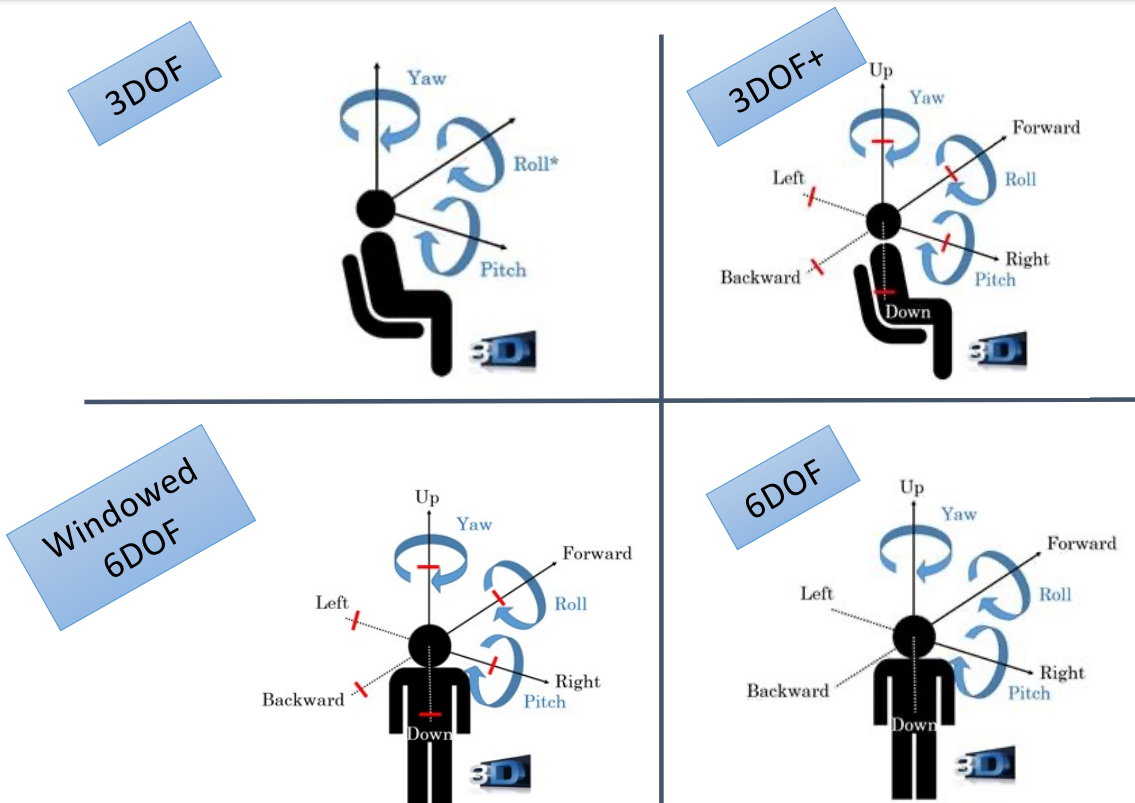
- Define Extended Reality and Terms in 3GPP, including quality-of-experience with XR services
- Collects the technologies in the context of XR and their potential relation to 5G System
- **Collects 23 use cases in the context of XR and 5G** that are analyzed in terms of potential specification needs
- Breaks down the use cases in architectures, functions and interfaces
- Create **specific conclusions on normative work in Rel-17**
- Support other 3GPP groups on the definition of system and radio specifications for XR

📶 Detailed Technical Report completed in March 2020

- TR 26.928: http://www.3gpp.org/ftp//Specs/archive/26_series/26.928/26928-g00.zip

📶 The first comprehensive output from 3GPP on XR – Rel-16 (!).

Terms and Definitions



Presence

Tracking

Meshes

SLAM

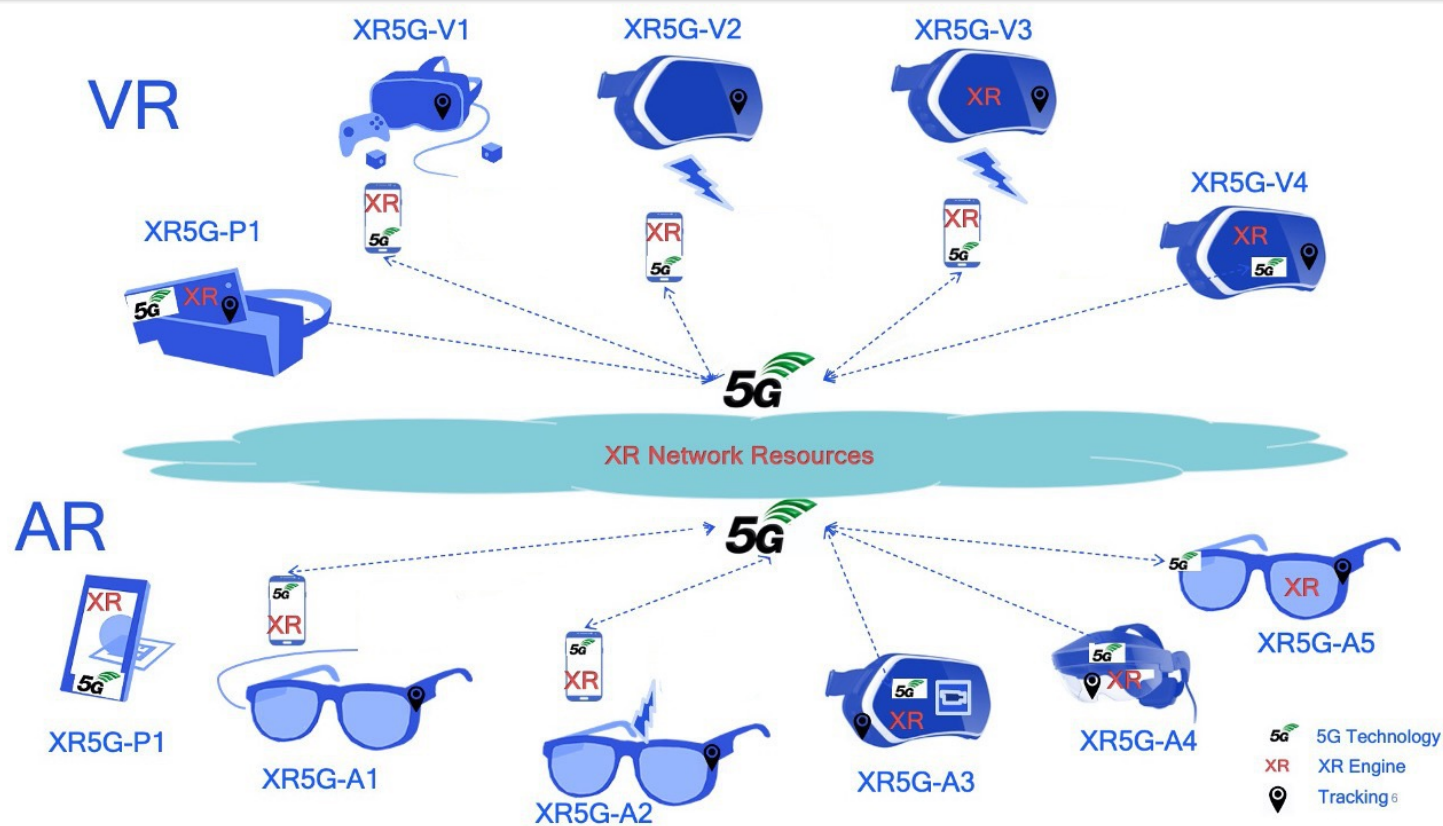
Point Cloud

Time Warp

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No	Use Case	Type	Experience	Delivery	Device
1	3D Image Messaging	AR	3DoF+, 6DoF	Upload and Download	Phone
2	AR Sharing	AR, MR	6DoF	Local, Messaging Download and Upload	Phone
3	Streaming of Immersive 6DoF	VR	3DoF+, 6DoF	Streaming, Interactive, Split	HMD with a controller
4	Emotional Streaming	2D, AR and VR	2D, 3DoF+, 6DoF	Streaming Interactive, Split	Phone and HMD
5	Untethered Immersive Online Gaming	VR	6DoF	Streaming, Interactive, Split	HMD with a Gaming controller
6	Video Game Live Streaming	VR	6DoF	Streaming, Split	2D screen or HMD with a controller
7	Real-time 3D Communication	3D, AR	3DoF+	Conversational	Phone
8	AR guided assistant at remote location (industrial services)	2D video + AR	6DoF (2D + AR)	Local, Streaming, Interactive, Conversational	5G AR Glasses, 5G touchscreen computer or tablet
9	Police Critical Mission with AR	AR, VR	3DoF to 6DoF	Local, Streaming, Interactive, Conversational, Group Communication	5G AR Glasses/Helmet, VR camera/microphone, Audio stereo headset, 5G accurate positioning
10	Online shopping from a catalogue – downloading	AR	6DoF	Download	AR Glasses, Rendering system, Tablet (or smartphone), Capture device
11	Real-time communication with the shop assistant	AR	6DoF	Interactive, Conversational	AR Glasses, Rendering system, Tablet (or smartphone), Capture device
12	360-degree conference meeting	AR, MR, VR	3DoF	Conversational	Mobile / Laptop
13	3D shared experience	AR, MR, VR	3DoF+, 6DoF	Conversational	Mobile / Laptop
14	6DOF VR conferencing	VR	6DoF	Interactive, Conversational	VR gear with binaural playback and HMD video playback, Call server
15	XR Meeting	AR, VR, XR	6DoF	Interactive Conversational	Phone, HMD, Glasses, headphones
16	Convention / Poster Session	AR, VR, MR	6DoF	Interactive, Conversational	Phone, HMD, AR Glasses, VR controller/pointing device, headphones
17	AR animated avatar calls	AR	2D, 3DoF	Conversational	Phone, HMD, Glasses, headphones
18	Online shopping from a catalogue – downloading	AR	6DoF	Download	AR Glasses, Rendering system, Tablet (or smartphone), Capture device
19	Front-facing camera video multi-party calls	AR	3DoF	Conversational	Smartphone with front-facing camera, headset
20	AR Streaming with Localization Registry	AR, Social AR	6DoF	Streaming, Interactive, Conversational	AR glasses with binaural audio playback support
21	Immersive 6DoF Streaming with Social Interaction	VR and Social VR	3DoF+, 6DoF	Streaming, Interactive, Conversational, Split	HMD with a controller
22	5G Online Gaming Party	VR	6DoF	Streaming, Interactive, Split, D2D	HMD with a Gaming controller
23	Spatial Shared Data	AR	6DoF	Streaming, Interactive, Conversational, Split	HMD, AR Glasses

Device types



Latencies and Delays



Details in Clause 4.2.2 of TR 26.928

➤ The **roundtrip interaction delay** is therefore the sum of the *Age of Content* and the *User Interaction Delay*.

- **User interaction delay** is defined as the time duration between the moment at which a user action is initiated and the time such an action is taken into account by the content creation engine.
- **Age of content** is defined as the time duration between the moment a content is created and the time it is presented to the user.

➤ Latency Requirements

- Ultra-Low-Latency applications: roundtrip interaction delay threshold of at most **50ms latency**.
- Low-Latency applications: roundtrip interaction delay threshold of at most **100ms latency**.
- Moderate latency applications: roundtrip interaction delay threshold of at most **200ms latency**.
- Non- critical latency applications: roundtrip interaction delay threshold higher than 200ms latency.

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5G XR Proposed Standardization Areas



In the short-term:

- Develop a flexible XR centric device reference architecture as well as a collection of device requirements and recommendations for XR device classes based on the considerations in clause 7.2. Device classes should include VR device for 6DoF streaming and XR online gaming (XR5G-V4), as well as AR devices (XR5G-A1, XR5G-A4 and XR5G-A5) => **FS_5GSTAR**
- Develop a framework and basic functionalities for Single-Buffer Split Rendering for Online Gaming according to the considerations in clause 7.4 => **FS_EMSA**
- Document typical XR traffic characteristics in TR26.925 based on the initial considerations in this report, in particular clause 7.7 and support other 3GPP groups in designing systems for XR services and applications => **FS_XRTraffic**
- Address simple extensions to MTSI to support basic XR conversational services based on the considerations in clause 7.5 ==> **Ongoing work item ITT4RT**
- Study detailed functionalities and requirements for glass-type AR/MR UEs with standalone capability according to clause 7.6 => **FS_5GSTAR**

Study on Typical Traffic Characteristics for XR Services and other Media

FS_XRTraffic

Background

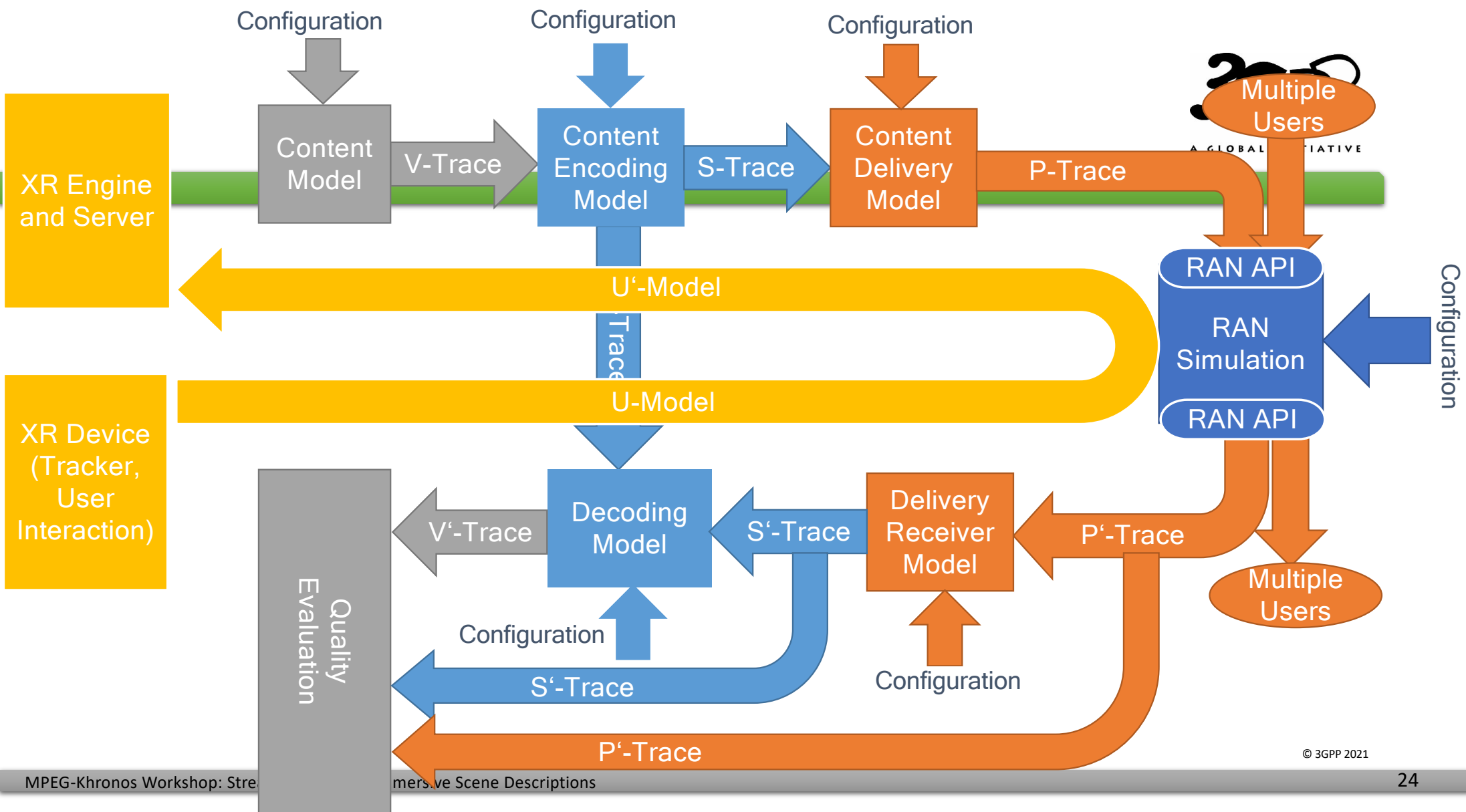


Activity launched in May 2020.

The objective of the study includes :

- Collect and document traffic characteristics including for different services, but not limited to
 - Downlink data rate ranges
 - Uplink data rate ranges
 - Maximum packet delay budget in uplink and downlink
 - Maximum Packet Error Rate,
 - Maximum Round Trip Time
 - Traffic Characteristics on IP level in uplink and downlink in terms of packet sizes, and temporal characteristics. XR Services and Cloud Gaming based on the initial information documented in TR26.928 including.
- Provide the information from above including the following services
 - Simple Single Buffer split rendering for online cloud gaming
 - Cloud Gaming
 - Other Traffic Models

Why is it not trivial to obtain such numbers?



Study on 5G Glass-type AR/MR Devices

FS_5GSTAR

Study context and objectives



- Study launched in July 2020 with the following objectives
 - Provide formal definitions for the functional structures of AR glasses,
 - Describe key use cases for AR services over 5G based on in TR 26.928.
 - Describe the architecture for media flow relevant to the use cases.
 - Identify media (exchange) formats and profiles and where media processing functions occur.
 - Identify necessary content delivery transport protocols and capability exchange mechanisms.
 - Identify key performance indicators and quality of experience factors.
 - Identify relevant radio and system parameters (required bitrates, latencies, loss rates, range, etc.) to support the identified AR use cases and the required QoE.

Glass type devices

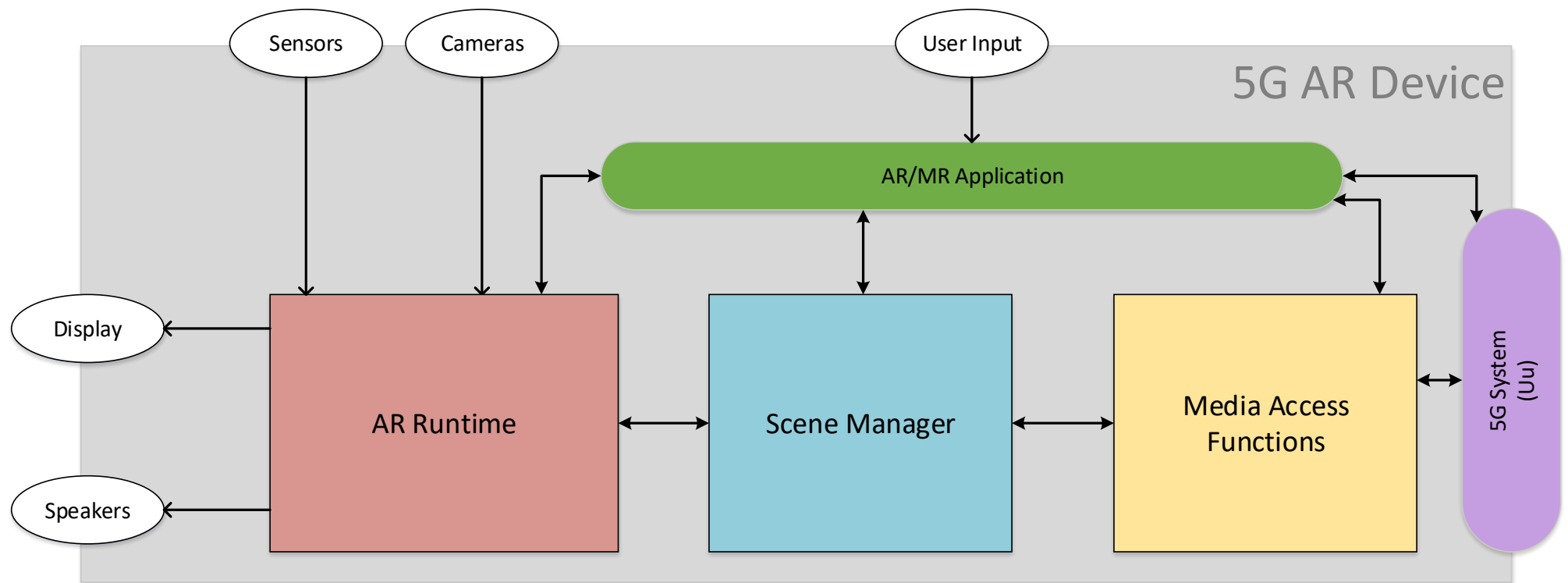


Device Type Name	Reference	Tethering	5G Uu Modem	Basic AR Functions	AR/MR Functions	AR/MR Application	Power Supply
5G Standalone AR UE	1: STAR	N/A	Device	Device	Device/Split ¹⁾	Device	Device
5G EDGe-Dependent AR UE	2: EDGAR	N/A	Device	Device	Split ¹⁾	Cloud/Edge	Device
5G WireLess Tethered AR UE	3: WLAR	802.11ad, 5G sidelink, etc.	Tethered device (phone/puck)	Device	Split ²⁾	Tethered device	Device
5G Wired Tethered AR UE ³⁾	4: WTAR	USB-C	Tethered device (phone/puck)	Tethered device	Split ²⁾	Tethered device	Tethered device
1) Cloud/Edge 2) Phone/Puck and/or Cloud/Edge 3) Not considered in this document							

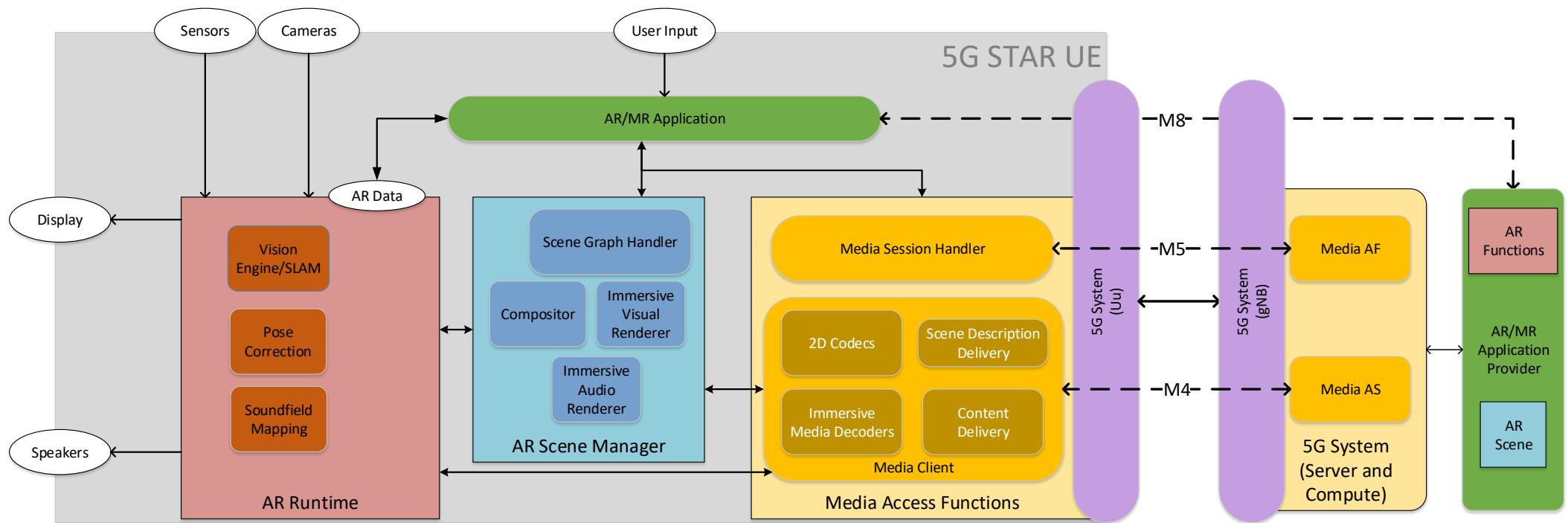
Use cases for Glass-based AR

No	Use Case
1	3D Image Messaging
2	AR Sharing
3	Real-time 3D Communication
4	AR guided assistant at remote location (industrial services)
5	Police Critical Mission with AR
6	Online shopping from a catalogue – downloading
7	Real-time communication with the shop assistant
8	360-degree conference meeting
9	XR Meeting
10	Convention / Poster Session
11	AR animated avatar calls
12	AR avatar multi-party calls
13	Front-facing camera video multi-party calls
14	AR Streaming with Localization Registry
15	5G Shared Spatial Data
16	AR remote cooperation
17	AR remote advertising
18	Streaming of volumetric video for glass-type MR devices
19	AR Conferencing
20	AR IoT

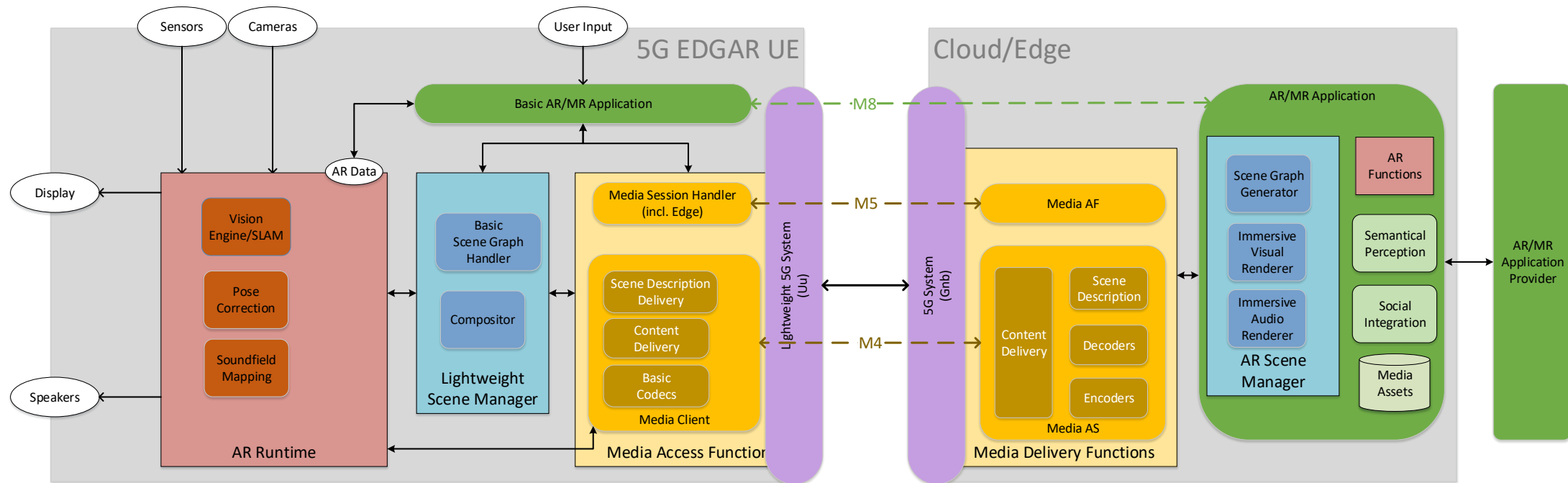
5G AR device functions



Mapping to the 5G architecture



Mapping to the 5G architecture



Still to be done



- Refine the procedures and call flows
- Complete the identification of the content formats and codecs
- List the KPIs and relevant QoE parameters
- Connect with the study on Streaming Architecture extensions For Edge processing (FS_EMSA)

Next steps in XR

Release 18 - 5G Advanced

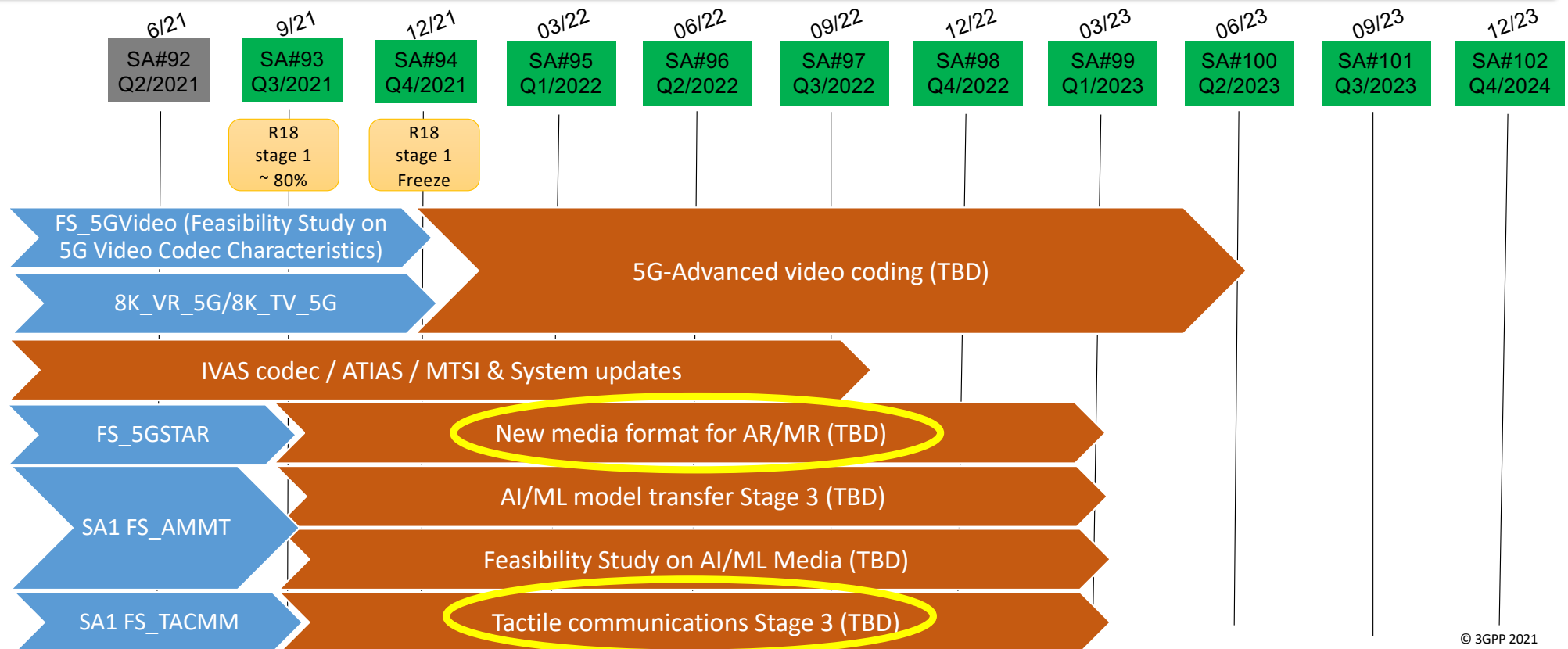
SA4 Rel-18 Workshop (17th August 21)



- **New Immersive media types and formats definition**
 - 5G video codec & IVAS codec (including ATIAS, Multimedia telephony/MTSI/System support)
 - New media including AR/MR media and sensory input (e.g. Haptics)
 - QoE metrics for these new media types
 - AI-based media enhancements
- **XR (AR/VR/MR and Cloud Gaming) Services**
 - Desire for a unified framework to support all such new services on 5G Core/RAN/UE
 - Should enable collaboration between MNOs and third-party service providers, support OTT services in 5G, follow 5G Media streaming example
 - Unified framework proposed: 5G-RTC architecture
 - For conversational service, consider MTSI extension (DC-MTSI)
- **Media Distribution enhancements**
 - Universal Access / Free to Air
 - Hybrid/Unicast/Broadcast/Multicast media delivery improvements as appropriate
 - Enhancing quality of traditional media (e.g. 2D video with UHD HDR, 8K)
 - Media handling of Personal IoT networks
- **Support Architecture evolutions**
 - Uplink enhancements : A/V Production, Media Contribution
 - Edge Compute: split rendering, network-based media processing
- **Approaches for Rel-18**
 - Focus on 5GMS adoption and stability
 - Establish a consistent Rel-18 plan to address 5G-Advanced service requirements
 - Make sure we focus on commercially relevant features
 - Provide implementation support: Tooling/Software/Interop
 - Leverage deployed multimedia technologies
 - Proposal under discussion to define a Service Media Enabler framework

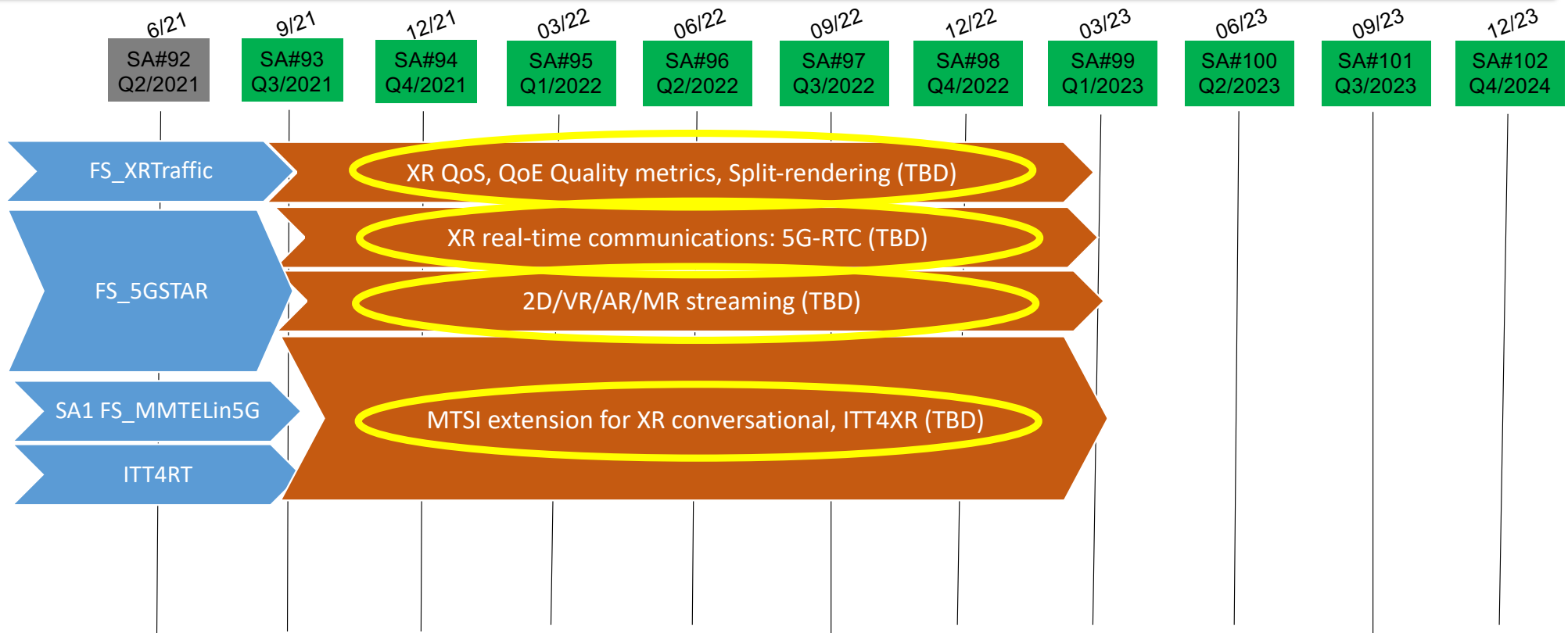
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New Immersive media types and formats definition



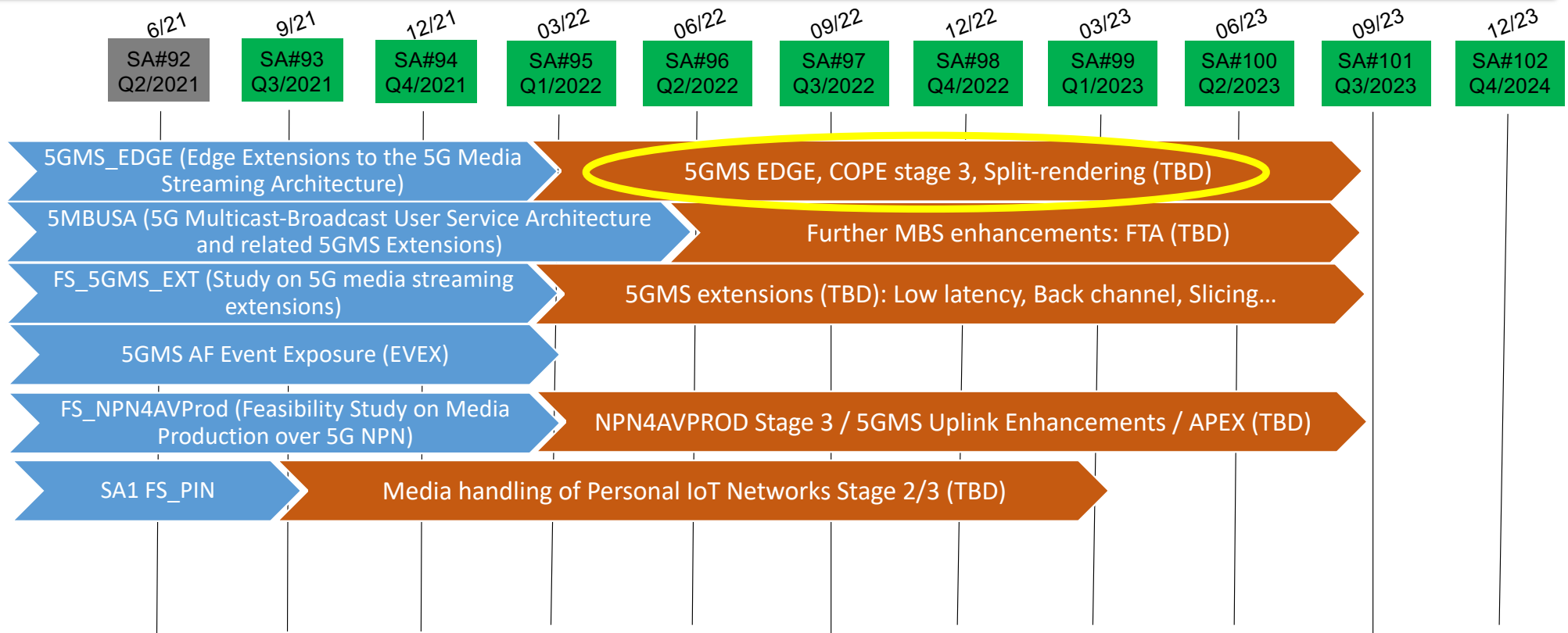
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XR (AR/VR/MR and Cloud Gaming) Services



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Media distribution enhancement & Architecture evolution



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Thank You!



Next steps

- 2nd SA4 Rel-18 workshop (tentative: 3rd Nov. 2021)
 - For collecting more inputs
 - For adding details of identified items
 - Identify the priorities as a result
- 60% agreed Rel-18 plan at SA4#116-e (Nov. 2021)
- 100% agreed Rel-18 plan at SA4#117-e (Feb. 2022)



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Focus on 3GPP SA4

Focus on XR-related activities

