XR over 5G,
3GPP latest developments around immersive media

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VRIF Second VRIF Online Event – 22nd April 2021

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Content

- 3GPP and 5G
- 3GPP SA4 activities around XR
  - The Study on Extended Reality over 5G
  - XR Traffic characteristics
  - Glass-based AR services
  - VR 360 Streaming in 8K
  - Immersive Teleconferencing and Telepresence

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3GPP and 5G

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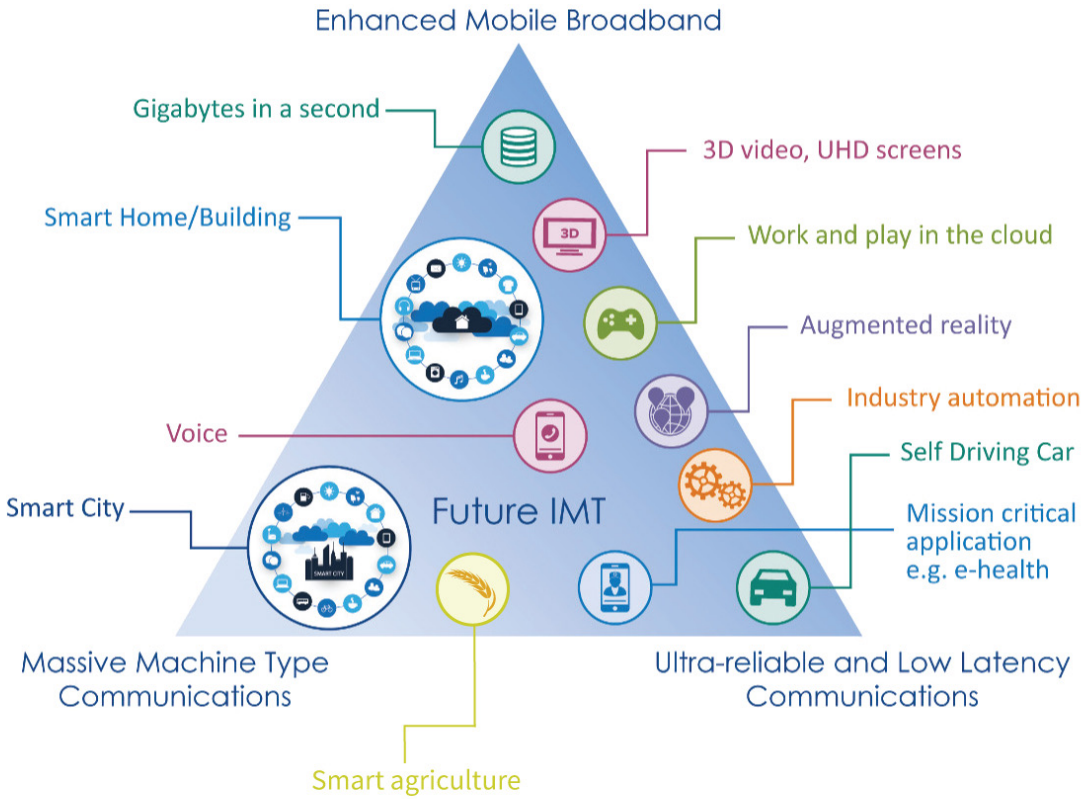
5G – brings new growth

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



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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 and Release 18 are 5G Releases too…

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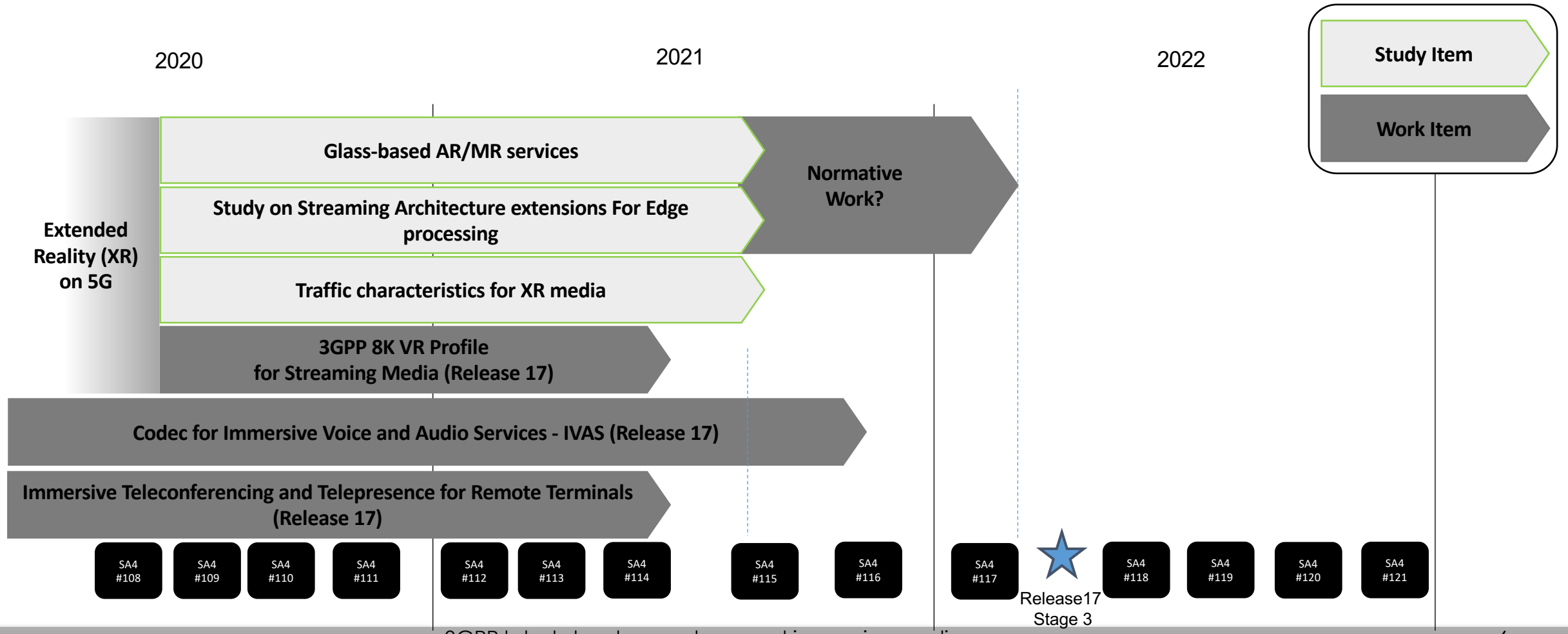
Focus on 3GPP SA4
Focus on XR-related activities



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FS_5GXR

Study on eXtended Reality (XR) in 5G

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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 (!).

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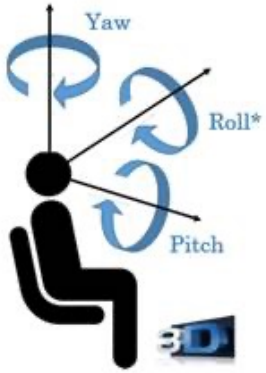
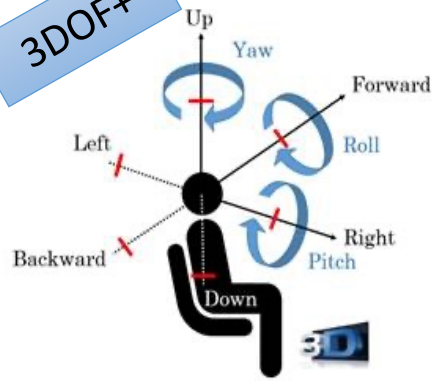
Terms and Definitions

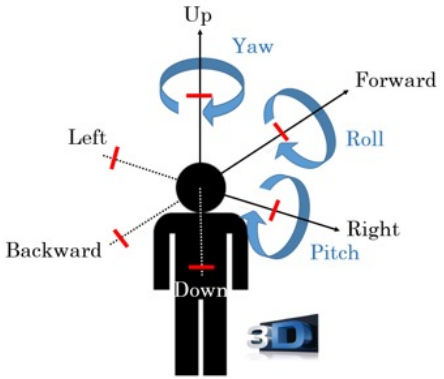
3DOF



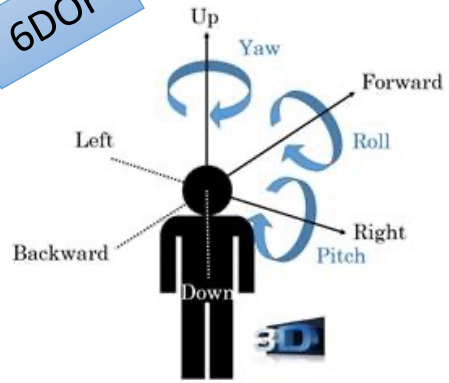
3DOF+

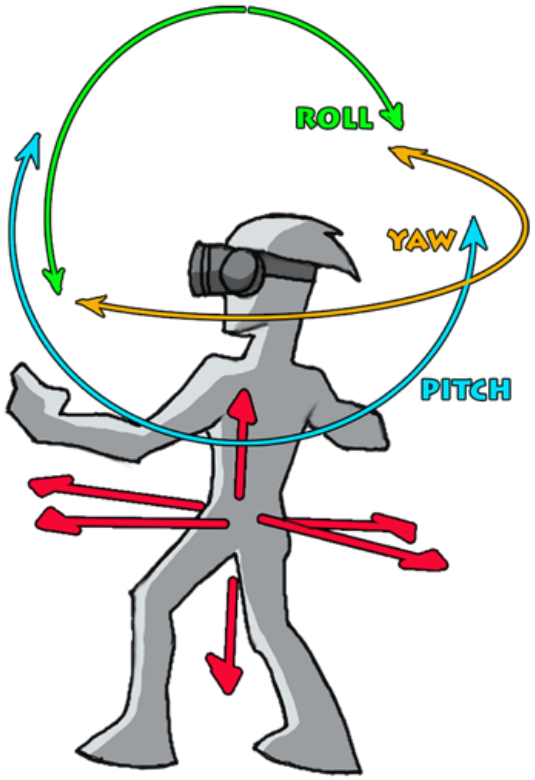


Windowed 6DOF



6DOF





Presence

Tracking

Meshes

SLAM

Point Cloud

Time Warp

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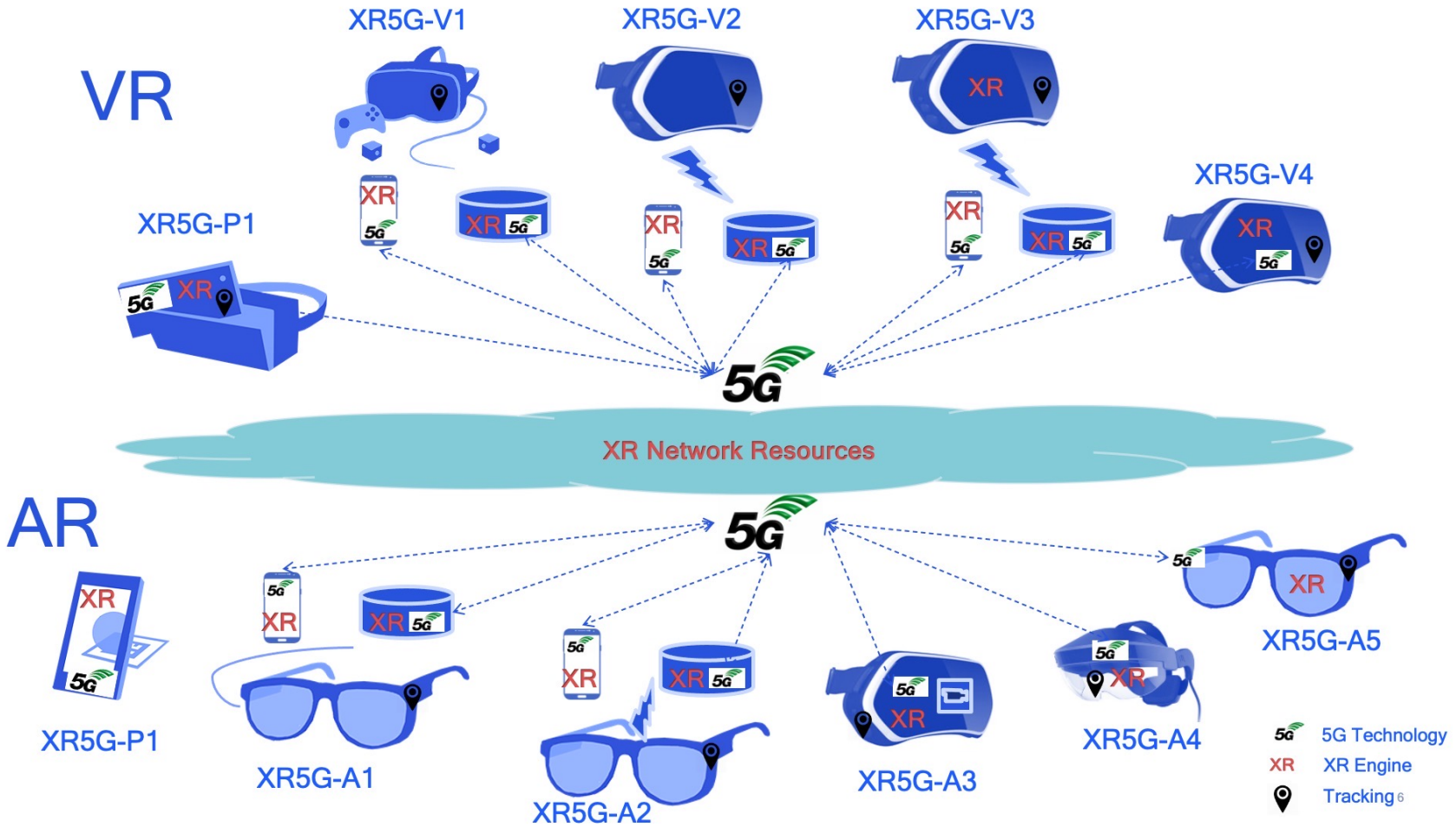
No	Use Case	Type	Experience	Delivery	Device
1	3D Image Messaging	AR	3DoF+, 6DoF	Upload and Download	Phone
2	AR Sharing	AR, MR	6DoF	Local, Messaging Download and Upload	Phone
3	Streaming of Immersive 6DoF	VR	3DoF+, 6DoF	Streaming, Interactive, Split	HMD with a controller
4	Emotional Streaming	2D, AR and 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,	HMD, AR Glasses


VR
XR5G-V1
XR5G-V2
XR5G-V3
XR5G-V4
XR5G-P1
XR
5G
XR Network Resources
AR
XR5G-P1
XR5G-A1
XR5G-A2
XR5G-A3
XR5G-A4
XR5G-A5
5G Technology
XR Engine
Tracking 6

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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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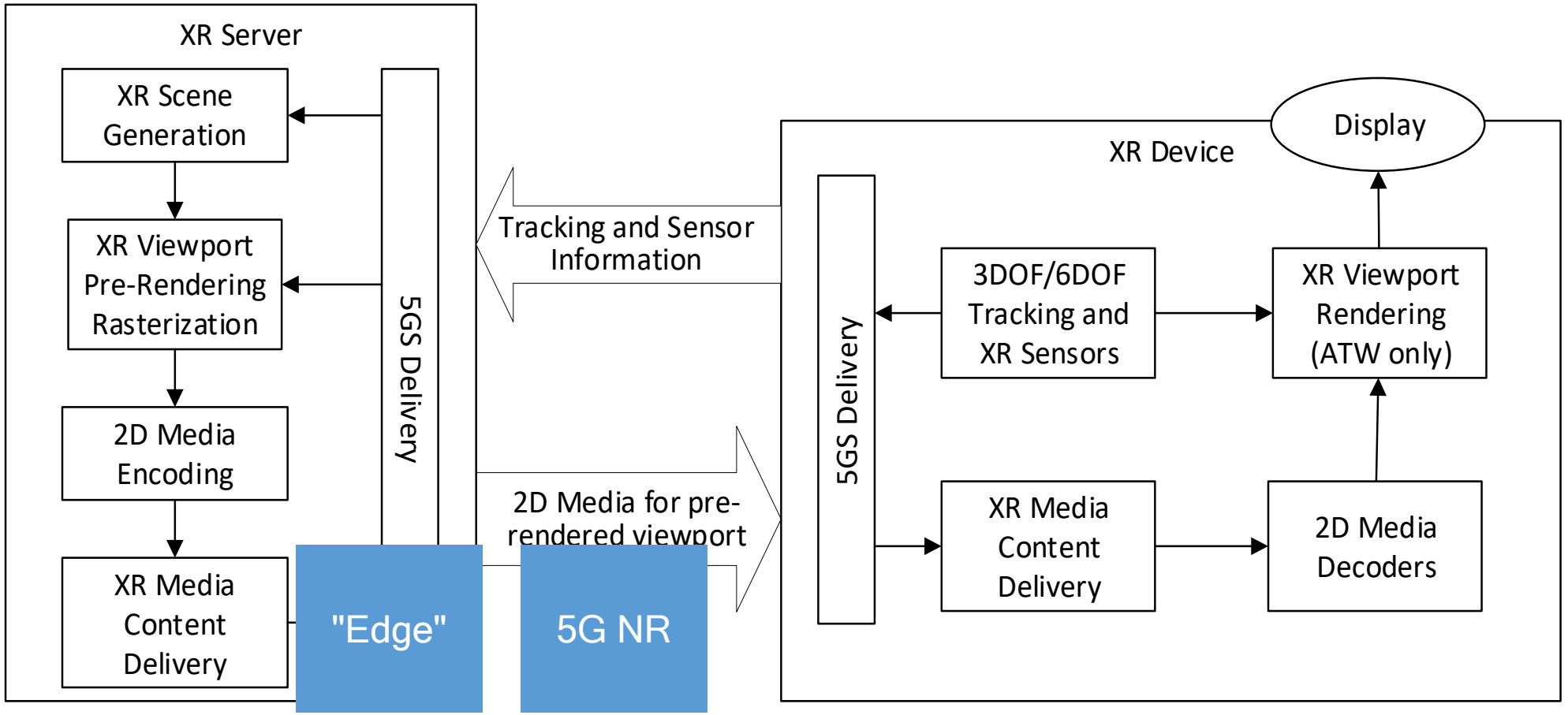
Split Rendering Architecture

Example: Split Rendering



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5GXR 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

Source sample text

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FS_XRTraffic

Study on Typical Traffic Characteristics for XR Services and other Media

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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?

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Example Configurations/Parameters

- Game:
  - Type of game, state of game, multi-user actions, etc.
- Formats:
  - Rastered video signal
- Encoder configuration
  - Codec, bitrate, rate control, slices, low-latency encoding, error resilience, intra, etc.
- Content Delivery Sender
  - RTP options, Rate control, error resilience, etc.
- Content Delivery Receiver
  - Feedback, Error Concealment, Post correction
- Transport Layer Assumptions
  - Loss rates, necessary delays, bitrates
- Quality Metric
  - Packet losses, slice losses, etc.

- Latency from rendering in the network to device display is typically in the range of 50-60ms
- Latency for pose is lower typically 20ms, but Asynchronous Time Warp can be applied to compensate for the latest pose in the device

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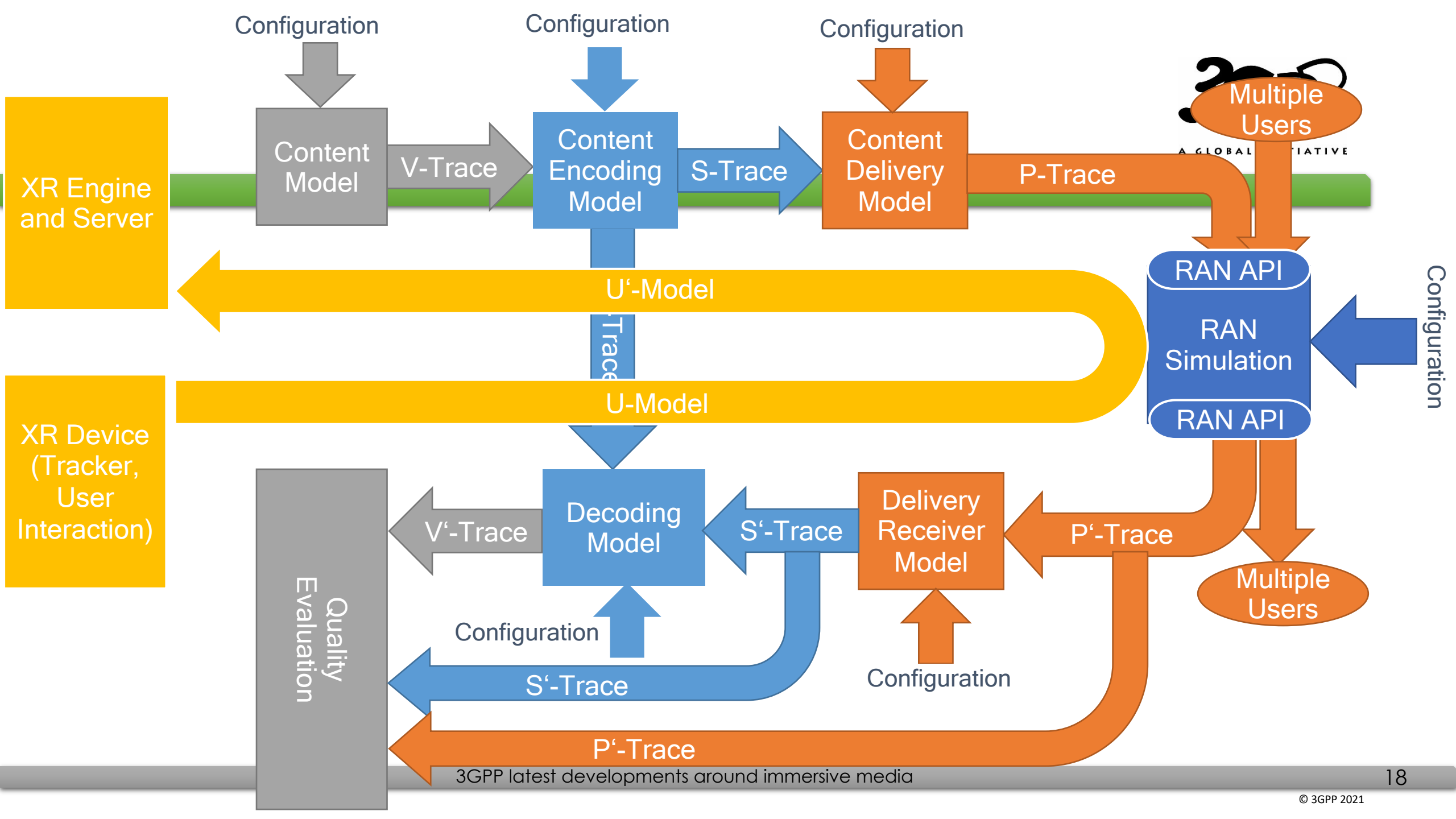
Configuration
Configuration
Configuration
Multiple Users
XR Engine and Server
Content Model
V-Trace
Content Encoding Model
S-Trace
Content Delivery Model
P-Trace
RAN API
U'-Model
RAN Simulation
Configuration
U-Model
RAN API
XR Device (Tracker, User Interaction)
Quality Evaluation
Decoding Model
V'-Trace
S'-Trace
Delivery Receiver Model
P'-Trace
Multiple Users
Configuration
Configuration
S'-Trace
P'-Trace

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FS_5GSTAR

Study on 5G Glass-type AR/MR Devices

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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.

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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

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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

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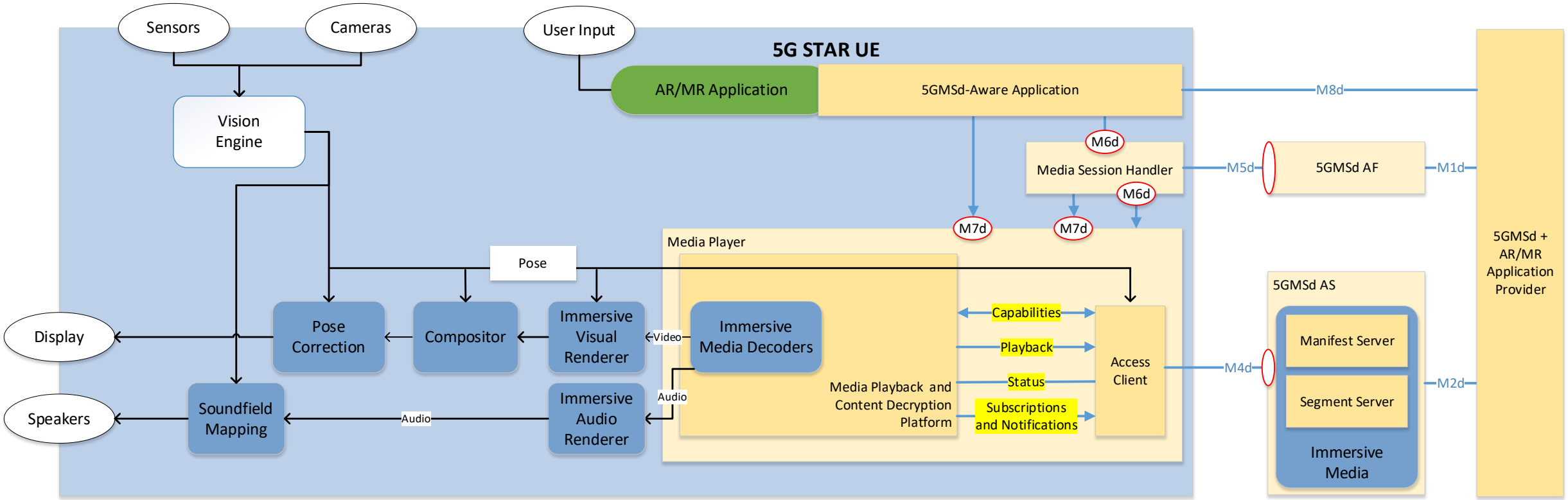
Mapping to the 5G architecture



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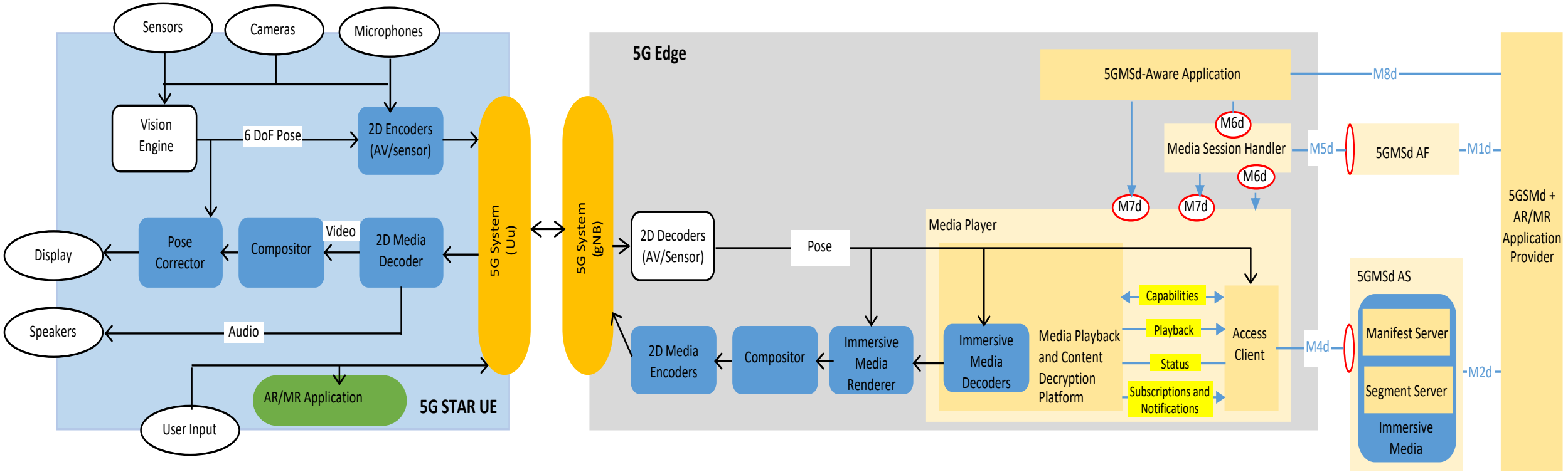
Mapping to the 5G architecture



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Still to be done

- Refine the procedures and call flows
- Identify 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)

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8K 360 VR

8K 360 VR operating point for streaming services

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8K 360 VR

- New 8K 360 VR operating point being defined in 3GPP TS 26.118
  - Enables the delivery of 8K resolution for viewport independent streaming
- Ongoing work focused on the addition on HLG support
- Addition of VR 360 typical traffic characteristics for 8K delivery (thank you VRIF!)
- 5G Media Streaming service (5GMS) will reference this operation point by recommending its support.

Operation Point name	Decoder	Bit depth	Typical Original Spatial Resolution	Frame Rate	Colour space format	Transfer Characteristics	Projection	Rotation	RWP	Stereoscopic
Basic H.264/AVC	H.264/AVC HP@L5.1	8	Up to 4K	Up to 60 Hz	BT.709	BT.709	ERP w/o padding	No	No	No
Main H.265/HEVC	H.265/HEVC MP10@L5.1	8, 10	Up to 6K in mono and 3K in stereo	Up to 60 Hz	BT.709, BT.2020	BT.709	ERP w/o padding	No	Yes	Yes
Flexible H.265/HEVC	H.265/HEVC MP10@L5.1	8, 10	Up to 8K in mono and 3K in stereo	Up to 120 Hz	BT.709, BT.2020	BT.709, BT.2100 PQ, BT.2100 HLG	ERP w/o padding, CMP	No	Yes	Yes
Main 8K H.265/HEVC	H.265/HEVC MP10@L6.1	10	Up to 8K in mono and 6K in stereo	Up to 60 60 Hz for 8K and 120 Hz for 4K	BT.709, BT.2020	BT.709, BT.2100 PQ, BT.2100 HLG	ERP w/o padding	No	Yes, but restricted to coverage	Ye
NOTE: This table only provides an informative high-level summary and is not considered to be exhaustive. The specification text in the remainder of clause 5.1 refines the table and takes precedence over any information documented in the table.										

Draft

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ITT4RT

Immersive Teleconferencing and Telepresence for Remote Terminals

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The Immersive Teleconferencing and Telepresence for Remote Terminals

- Provide the support for immersive communications on top of the 3GPP MTSI (Multimedia Telephony Services over IMS) and Telepresence services
- Objectives to define
  - Audio and Video codec configurations
  - Constraints on media elementary streams and RTP encapsulation formats
  - Recommendations of SDP configurations for negotiating of immersive video and voice/audio capabilities.
  - An appropriate signaling mechanism, e.g., RTP/RTCP-based, for indication of viewport information to enable viewport dependent media processing and delivery

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ITT4RT Phase1 just completed

- Basic real-time 360-degree video and limited support for immersive voice/audio delivery framework
- Architecture and Interfaces for ITT4RT sender and receiver clients
- Immersive 360-Degree Video Support, codec configurations,
- Media configurations, SDP configurations for negotiating of immersive video, picture packing, overlay and 360-video grouping in SDP
- Overlay configuration: Sphere-relative overlay and viewport-relative overlay
- 360-degree fisheye video support; Camera calibration parameters; RTCP signaling for viewport information
- Only mono and dual audio support as specified in 26.114 clause 5.2.1.

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ITT4RT Phase2 on track

- A more enhanced real-time 360-degree video delivery framework by including the following aspects
  - Viewport margins; Viewport sharing and following
  - QoE metrics around motion to high quality delay and other relevant metrics reporting functionality
  - Overlays using scene description
  - Evaluation of RTP-based signaling of SEI message information as an alternative to bitstream signaling.
  - Immersive speech/audio support based on multi-mono EVS.

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Thank you

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