

# 5G-MAG Reference Tools

## Making specifications fit into products

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On behalf of the coordinators and contributors!



OSMART WORKSHOP #3 – December 2024

# Media + Connectivity



# Current Areas of Work and Topics

[5g-mag.com/topics](https://5g-mag.com/topics)

5G  
MAC



Media over IP &  
Connected Production



Content  
Distribution & Delivery



eXtended Reality  
& Immersive Media





### Non-Public Networks

Standalone network deployments,  
venues, public network integrated NPNs



### 3GPP Media Delivery Systems

Uplink contribution, network assistance,  
real-time communications



### Time Sensitive Communications

Time synchronization, PTP distribution



### Network Capability Exposure & APIs

Discoverability and use of network  
features and capabilities



### Non-Terrestrial Networks

Uplink media delivery, NPN backhaul



# Content Distribution & Delivery

Technology and Enablers



## 3GPP Media Delivery Systems

Content hosting, network assistance, consumption reporting, QoE metrics,...



## MBMS & 5G Broadcast

Delivery of TV, radio and emergency alerts over broadcast networks



## 5G Multicast Broadcast Services

Scalability of content in 5G networks



## Network Capability Exposure & APIs

Discoverability and use of network features and capabilities



## Non-Terrestrial Networks

Content distribution, reliable multicast, GEO/MEO/LEO orbits



## XR Media Integration in 5G

Split rendering, IVAS, 3D media messages, XR architecture



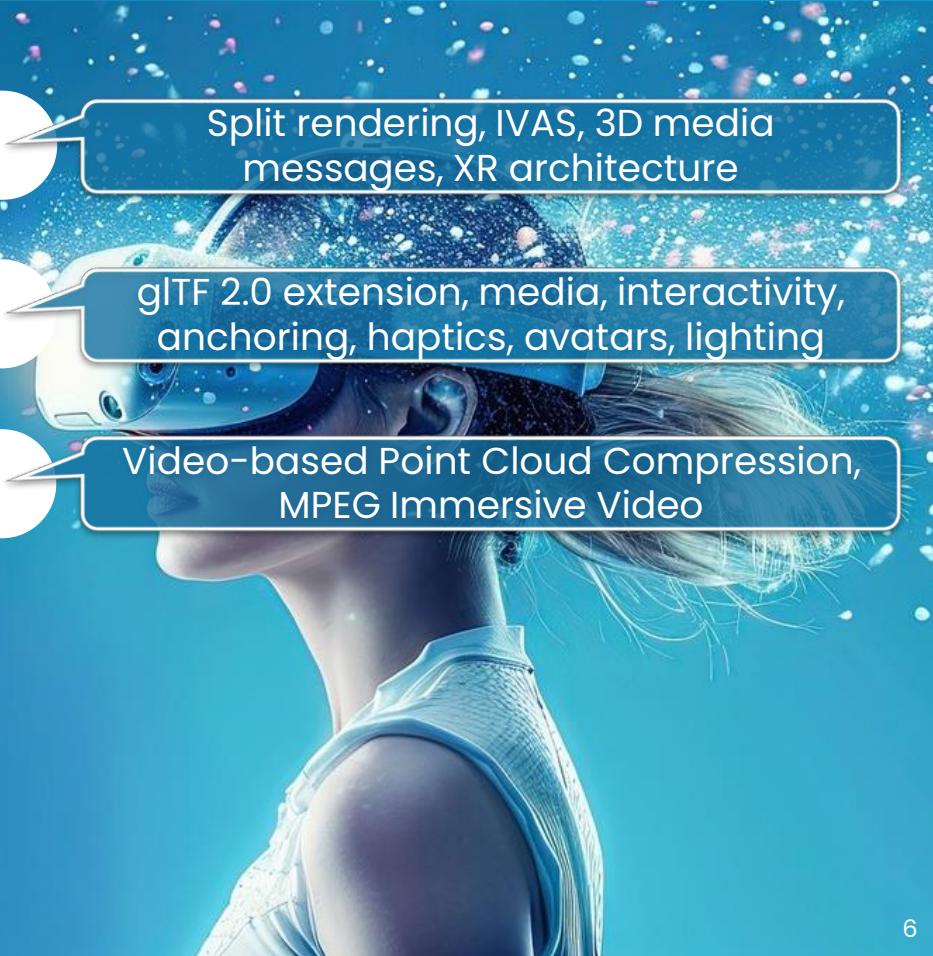
## MPEG-I Scene Description

glTF 2.0 extension, media, interactivity, anchoring, haptics, avatars, lighting



## Volumetric Video (v3C)

Video-based Point Cloud Compression, MPEG Immersive Video



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## Making specifications fit into products

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[developer.5g-mag.com](http://developer.5g-mag.com)

# Reference Implementations

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Open Developer Community  
Media + Connectivity + Software



Open community of  
developers



Feedback to SDOs  
Validation and Verification



Permissive software  
license model

Reference Implementations





**Open Developer Community  
Media + Connectivity + Software**

## Join the community and participate

**Development community sponsored by 5G-MAG members**

**Open to 5G-MAG members and non-members**

[5g-mag.github.io/](https://5g-mag.github.io/)  
[/Getting-Started](https://5g-mag.github.io/Getting-Started)



Discussions at the  
5G-MAG Forum



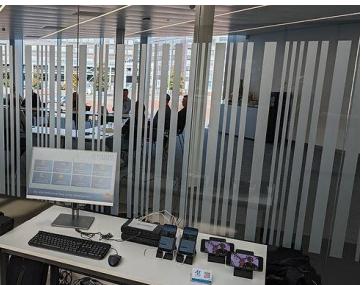
Mailing List with  
Releases & News



**Public Calls**  
Last Friday of the month  
13:00 – 14:30 CEST

# Promoting Technologies and Solutions

[5g-mag.com/trials](https://5g-mag.com/trials)



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**Using the Blender glTF exporter with the XR Unity Player**  
by Nils Duval Motion Spell

**DEVELOPER XCHANGE**  
[developer.5g-mag.com](https://developer.5g-mag.com)

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**Consumption Reporting, Network Assistance & Dynamic Policies**  
by David Waring BBC R&D and Daniel Silhavy Fraunhofer FOKUS

**DEVELOPER XCHANGE**  
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我们一起用5G  
让紧急通讯第一时间找到你

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**中国国际供应链促进博览会**  
CHINA INTERNATIONAL SUPPLY CHAIN EXPO  
2023.11.28 - 12.02  
China International Exhibition Center (Shunyi Venue), Beijing  
Connecting the World for a Shared Future

**5G-MAG Reference Tools in action at...**  
China International Supply Chain Expo  
28th November to 2nd December 2023 – Beijing (China)



# 5G MAG REFERENCE TOOLS < / >

Streaming, content delivery and collaboration with 5G networks



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# Streaming, content delivery and collaboration with 5G networks

Reference Tools



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## 5G Media Streaming Architecture

AS, AF, Clients, Provisioning APIs, Network Assistance, Dynamic QoS, QoE metrics collection and reporting, consumption reporting, application provider UI



## 5G Core Network Components

Integration with 5G Core components (BSF, PCF) via service consumer libraries



## UE Data Collection, Reporting & Event Exposure

Generic Data Collection AF and instantiation in the 5GMS AF



## 3GPP RAN and Core Platforms

Open-source 5GC, NG-RAN, EPC, E-UTRAN used for demonstrators



Reference Implementations



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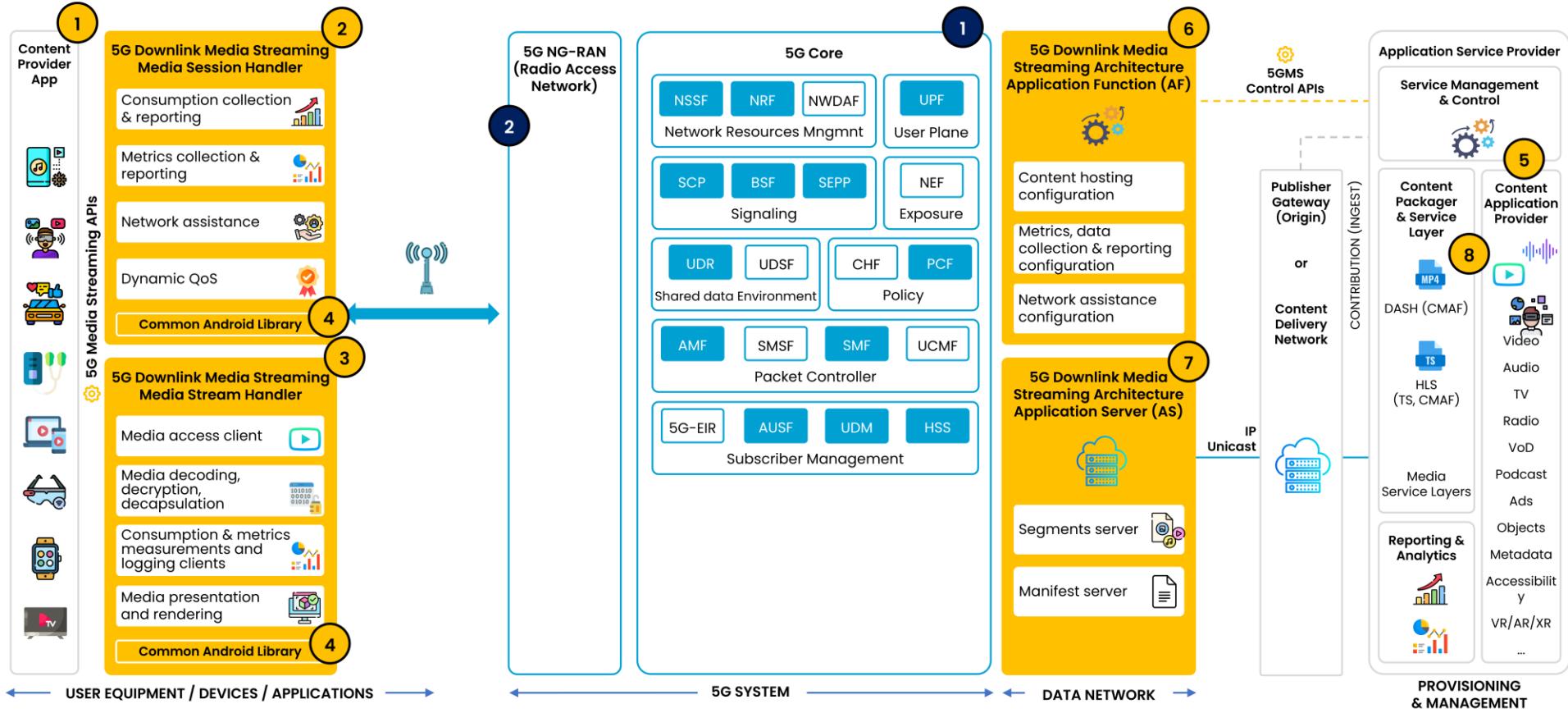


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## 5G Media Streaming Architecture





# What is being implemented?

## Network Assistance

- Enables the 5GMS client to interrogate or manipulate the network QoS for an ongoing media streaming session
- Bit rate Recommendation:** 5GMS Client requests an estimate from a network-side component of the 5GMS System of the bit rate that can currently be offered
- Delivery Boost:** The 5GMS Client speculatively requests a temporary boost to the bit rate of a media streaming session from a network-side component of the 5GMS System

## Dynamic Policies

- Enables the 5GMS Client in the UE to manipulate the network traffic handling policies for an ongoing media streaming session.
- Allows a separate handling of data flows within the same PDU session

## QoE Metrics Reporting

- Allows the Quality of Experience of media streaming sessions to be logged by the 5GMS System and exposed for analysis.

### Example:

```
<QoeMetric>
    <BufferLevel>
        <BufferLevelEntry
level="29992" t="1688980890949" />
    </BufferLevel>
</QoeMetric>
```

## Consumption Reporting

- Measurement and logging of content consumption-related information
- Example:

```
{
    "mediaPlayerEntry": "https://dash.akamaized.net/envivio/EnvivioDash3/manifest.mpd",
    "reportingClientId": "ab960db0-9282-4626-8d45-188c51db0fad",
    "consumptionReportingUnits": [
        {
            "mediaConsumed": "v4_258",
            "serverEndpointAddress": {
                "ipv4Addr": "192.168.2.4",
                "portNumber": 80
            },
            "startTime": "2023-10-24T13:55:26Z",
            "duration": 180
        }
    ]
}
```

# Key Highlights

- **Reference implementations** of **5G Media Streaming Architecture** specifications:
  - Web portal for Application Providers + Analytics (QoE) portal
  - Application Server (wrapping OpenResty)
  - Application Function (based on the Open5GS framework)
  - Android client application incorporating Media Player (wrapping ExoPlayer)
  - Media Session Handler as Android background service
- Supporting local deployment while we work on:
  - Cloud deployment (Akamai/Linode with AS/AF and Application Provider)
- **We need:**
  - Integration with live services
  - Interoperability with media players
  - Abstraction between 5GMS / OTT app
  - Get ready for advanced media delivery functionalities (next slide)

# Key Highlights

## ■ Advanced Media Delivery

- Common Client Metadata
- Common Server-and Network-Assisted Streaming
- Multi-CDN and Multi-Access Media Delivery
- Modem Usage Optimized Media Streaming:
- DRM and Conditional Access
- In-session Unicast Repair for MBS Object Distribution
- MBS User Service and Delivery Protocols for eMBMS
- Selected MBMS Functionalities not supported in MBS
- DASH/HLS Interoperability
- Further harmonization of RTC and Streaming for Advanced Media Delivery
- Improved QoS support
- Impacts and opportunities of QUIC for segmented content delivery

Enhancing our  
**CONTENT  
DELIVERY  
PLATFORM**  
 through open specifications

**Workshop: Advanced Media Delivery**  
 with 3GPP SA4: 2nd May 2024 @ 15:30 CEST

CMCD  
 CMSD  
 Multi-CDN  
 Energy Optimization  
 DRM  
 Unicast Repair  
 Delivery Protocols  
 DASH/HLS  
 RTC and Streaming  
 QoS Support





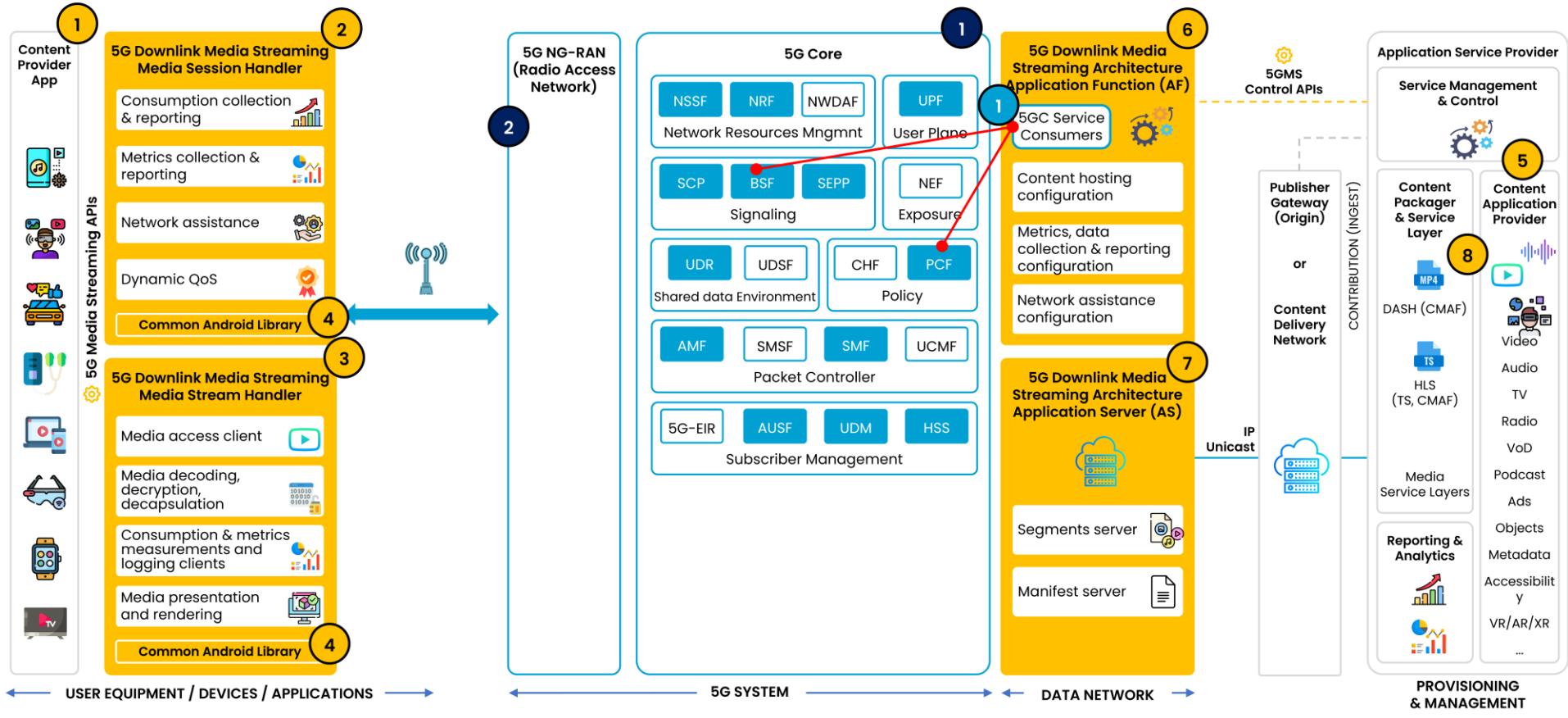
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## 5G Core Network Components

B B C





# Key Highlights

- The 5G-MAG Reference Tools provide an end-to-end reference implementation of 5GMS functions and APIs alongside reusable service consumer libraries to invoke service operations on:
  - Binding Support Function (BSF).
  - Policy & Charging Function (PCF).
- 5GMS Application Function (AF) needs to communicate with the 5G Core in order to manipulate network Quality of Service (QoS) for ongoing media streaming sessions
- **We need:**
  - Integration with commercial/advanced **5G Core implementations for testing reference implementations** of 3GPP specifications, in particular for "5G Media Streaming"
  - Main requirements: **5G Core** supporting Binding Support Function (**BSF**), Policy & Charging Function (**PCF**) and Network Repository Function (**NRF**)

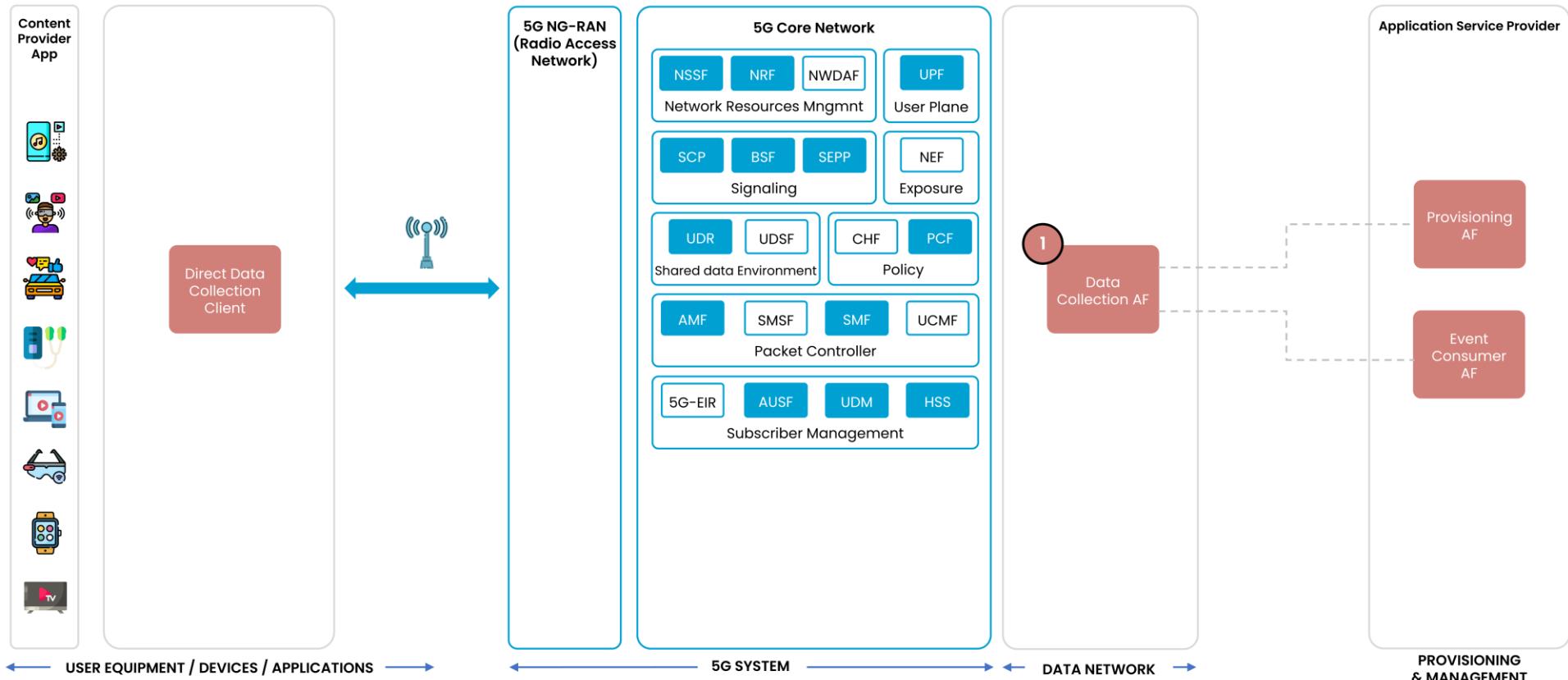


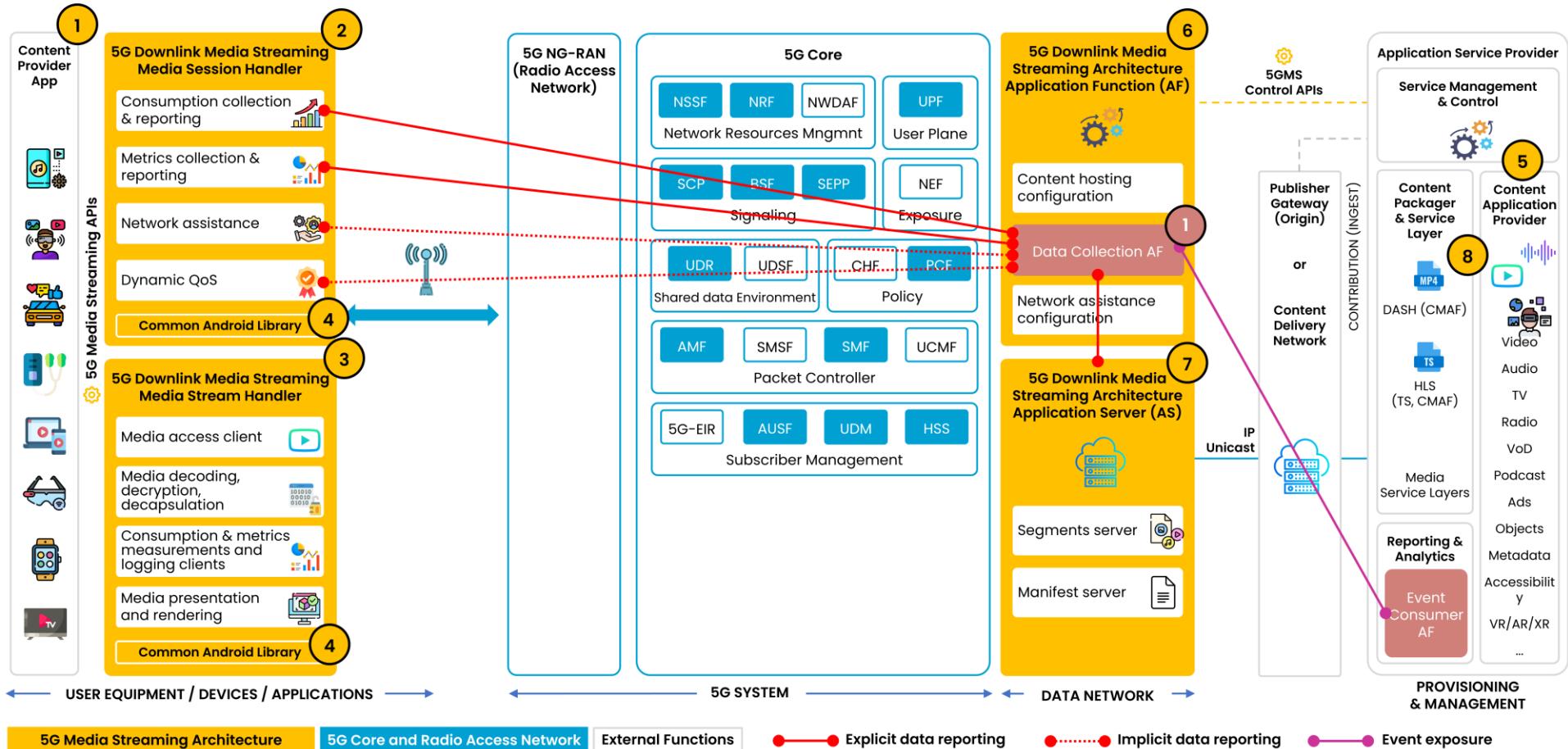
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## UE Data Collection, Reporting & Event Exposure







# Key Highlights

- Release candidate of standalone UE data reporting and event exposure
- Data Collection and Reporting AF receives UE data reporting from data collection clients
- Collection of UE data from Application Server logs and event exposure to consumers:
  1. Consumption reporting by the Media Session Handler to the 5GMS AF.
  2. QoE metrics reporting by the Media Session Handler to the 5GMS AF.
  3. Dynamic Policy invocations by the Media Session Handler logged by the 5GMS AF.
  4. Network Assistance invocations by the Media Session Handler logged by the 5GMS AF.
  5. 5GMS access logged by the 5GMS AS when the Content Hosting feature is provisioned.
- **We need:**
  - At the moment... Testing



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## 3GPP RAN and Core Platforms

# What is being implemented?

- Some **5G-MAG Reference Tools Projects** make use of software developed by several Open-Source initiatives. In particular:

srsRAN Project ([www.srsran.com/](http://www.srsran.com/)), in its two variants:

- [srsran/srsRAN Project: Open source O-RAN 5G CU/DU solution from Software Radio Systems \(SRS\)](#), used primarily as the **NG-RAN** to build 5G-MAG Reference Tools demonstrators and PoCs (e.g. **5GMS**) and as the basis for the development of NG-RAN related components for **MBS**
- [srsran/srsRAN 4G: Open source SDR 4G software suite from Software Radio Systems \(SRS\)](#), used primarily as the basis for the LTE-based 5G Broadcast components, emergency alerts over 5G Broadcast and the development of UE functionalities for MBS

Open5GS Project ([www.open5gs.org](http://www.open5gs.org)), used primarily as the **5GC** to build 5G-MAG Reference Tools demonstrators and PoCs (e.g. **5GMS**) and as the basis for the development of 5GC related components for **MBS**

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## Broadcast and multicast systems



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## MBMS & LTE-based 5G Broadcast

End-to-end system including transmitters, middleware and client app



## Multimedia delivery protocols

Including support of FLUTE and ROUTE for content delivery over multicast



## DVB-I over 5G Systems

Initial implementation supporting DVB-I over LTE-based 5G Broadcast



## Emergency Alerts over 5G Broadcast

Initial implementation of emergency alerts based on CMAS



## 5G Multicast Broadcast Services

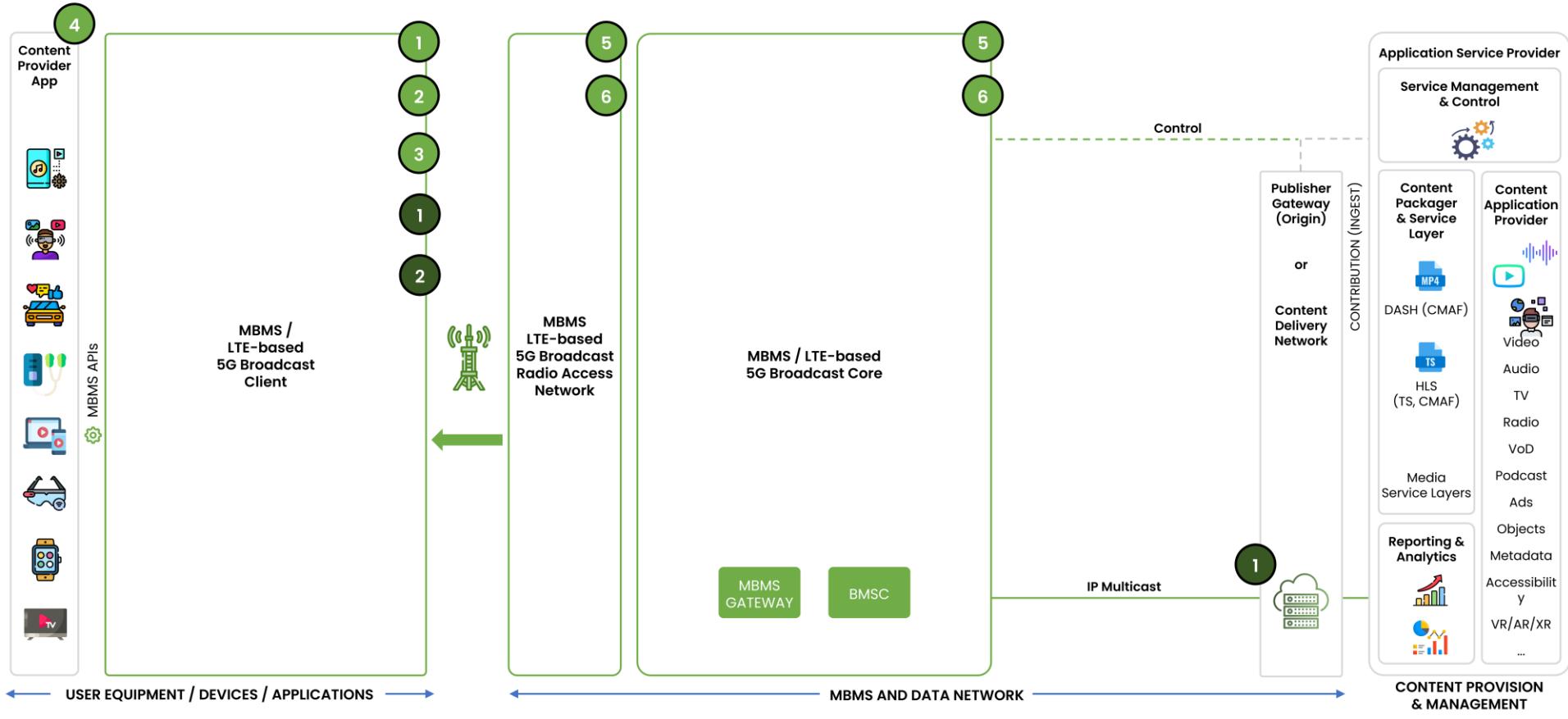
Initial implementation of MBS 5G Core components



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## MBMS & LTE-based 5G Broadcast



# Key Highlights

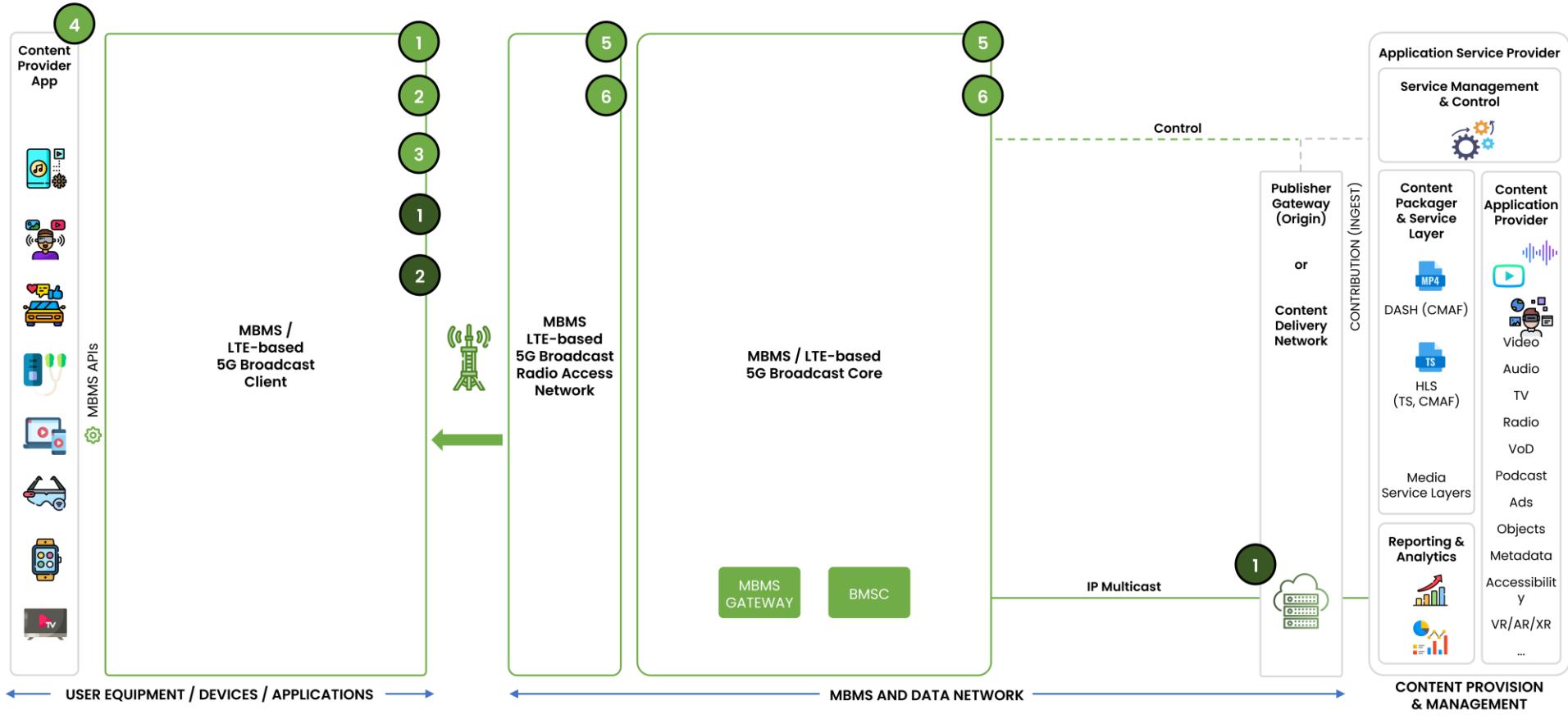
- **Reference implementations** of **LTE-based 5G Broadcast** specifications:
  - Transmitter with a subset of features for 100% broadcast allocation
  - SDR receiver with a subset of features for 100% broadcast transmitters
  - Transmitter with a subset of features for legacy MBMS modems (pre Rel-14)
  - Android application including:
    - Media player
    - Caching of DASH/HLS segments for seamless switching between content over unicast and multicast
    - Decapsulation of FLUTE
    - Call to Android Group Communication Service for interactions with the MBMS modem
- **We need:**
  - Offload of app functionalities into more modular processes
  - Better integration with DASH/HLS
  - Discuss correct approach for content steering both server side and players
  - Integration/Interop with third party core networks, in progress for NAKOLOS



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## Multimedia Content Delivery Protocols



# Key Highlights

- Reference implementations of **FLUTE** and **ROUTE**
- **We need:**
  - Better integration of protocols transparently on top of the MBMS stack (e.g. ROUTE)
  - Exploration of low-latency delivery using LL-DASH/CMAF and ROUTE

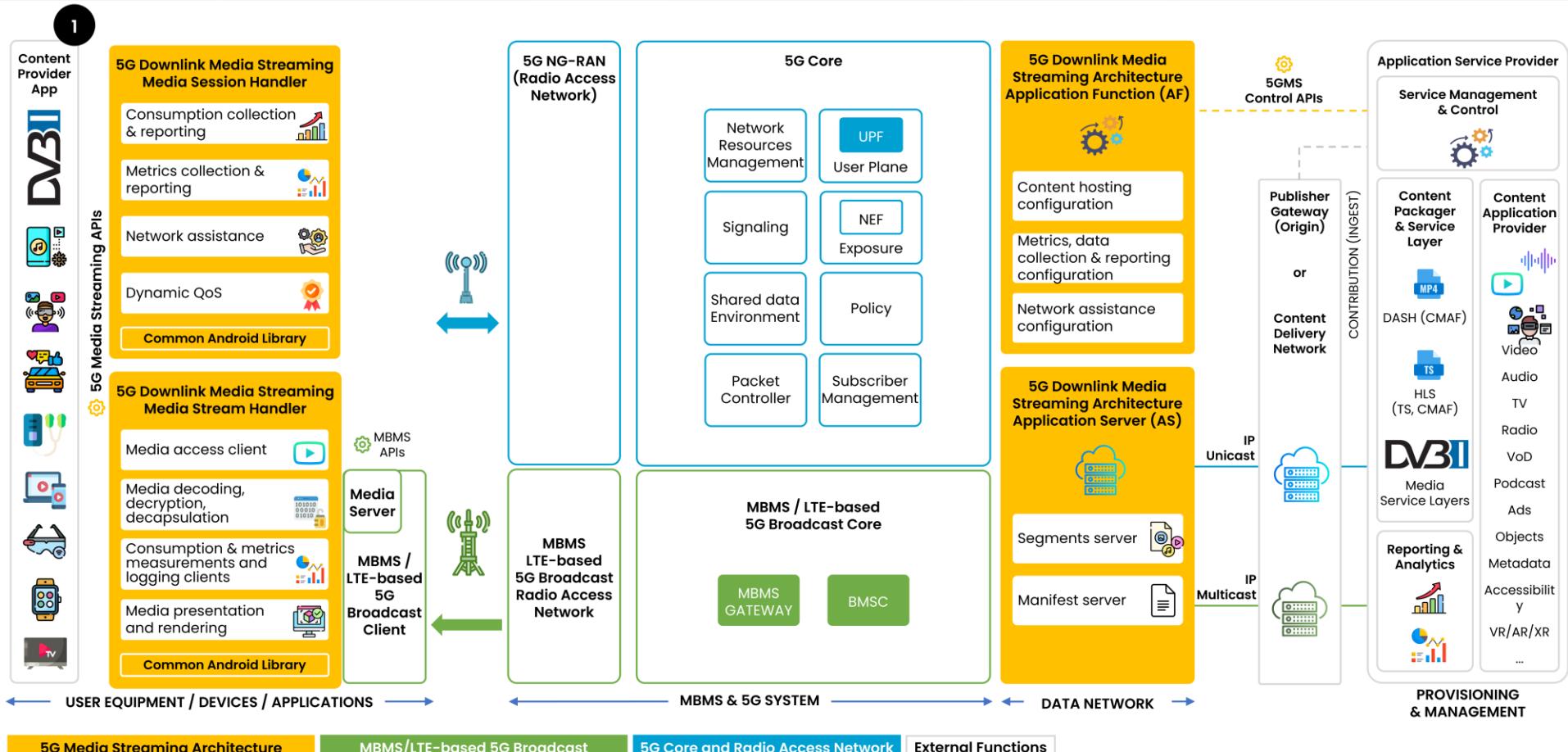


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## DVB-I Services over 5G Systems





# Key Highlights

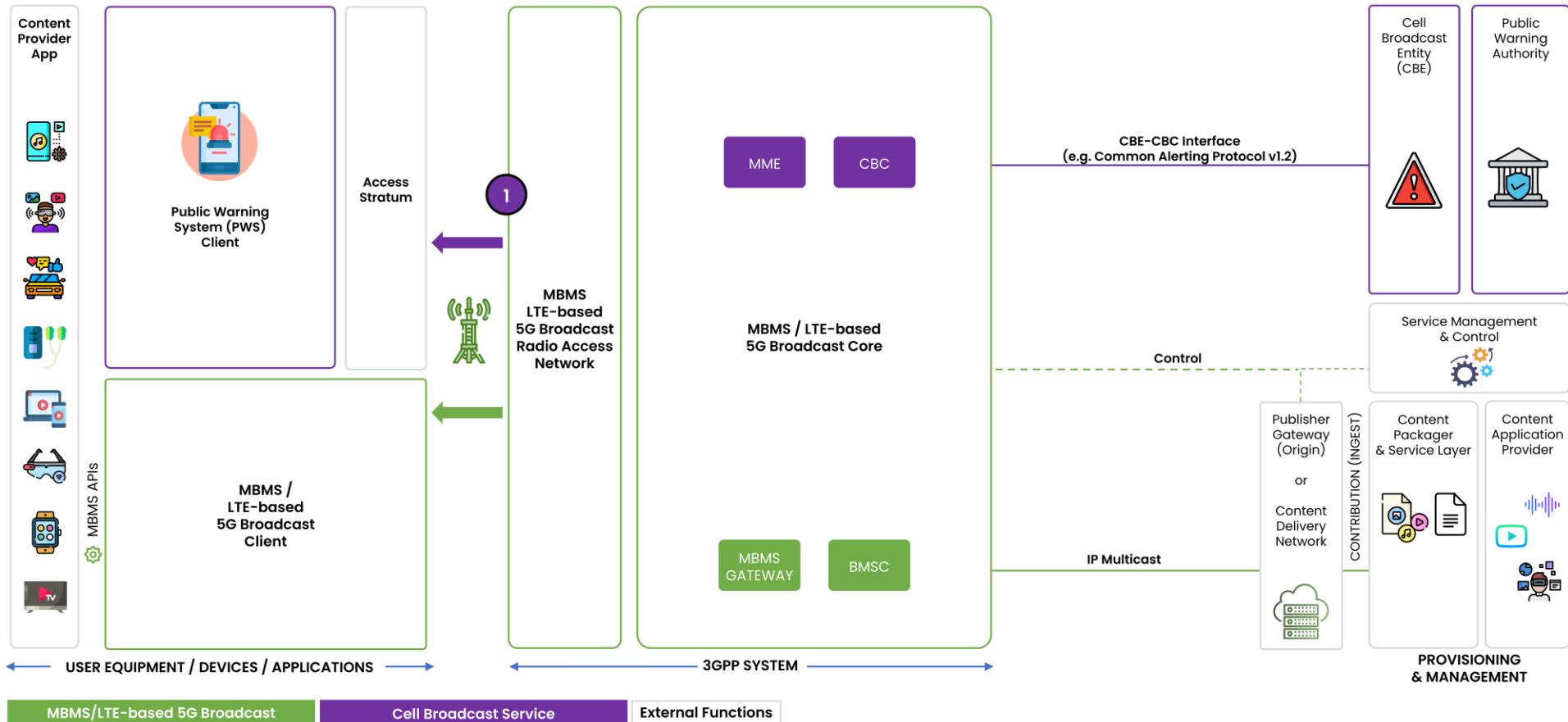
- **Reference implementations of DVB-I Player with initial support for delivery over 5G Broadcast**
  - Basic broadcast distribution of DVB-DASH content
- **We need:**
  - Standard-compliant implementation of DVB-I Player consuming content from MBMS client
    - But we need to solve the previous step of splitting the Android app functions
  - Extension for 5G Media Streaming Architecture



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## Emergency Alerts over 5G Broadcast



# Key Highlights

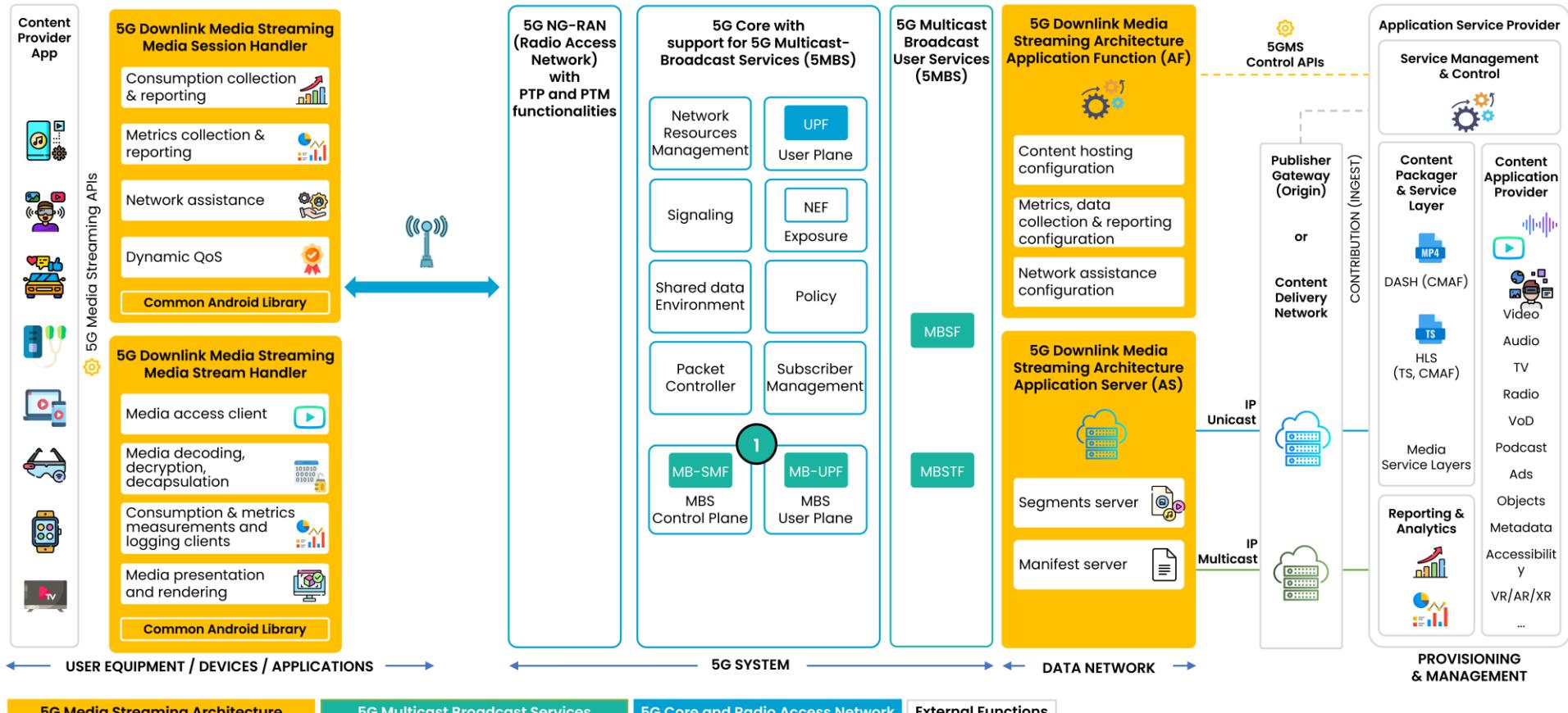
- Reference implementations of delivery of CMAS alert messages over a 5G Broadcast transmitter
- We need:
  - Potential integration of URLs in the alert message to invoke MBMS client components and redirect to media services



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## 5G Multicast–Broadcast Services



# Key Highlights

- **Reference implementations of 5G Multicast Broadcast Services**
  - Initial support of 5G Core MBS components (MB-UPF, MB-SMF)
- **We need:**
  - At the moment... testing

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Immersive Media experiences  
and eXtended Reality



Just a teaser today...

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### XR Media Integration in 5G with MPEG-I Scene Description

Initial implementation of MPEG-I Scene Description extensions for glTF2.0 assets



### V3C Immersive Platform

V3C volumetric video decoding platform supporting V-PCC, MIV and V3C carriage

# Reference Implementations

developer.5g-mag.com



- Two projects under **Immersive Media**



**XR Media Integration in 5G**

Qualcomm

interdigital.



**V3C Immersive Platform**

interdigital.

**PHILIPS**

- **MPEG-I series of standards**

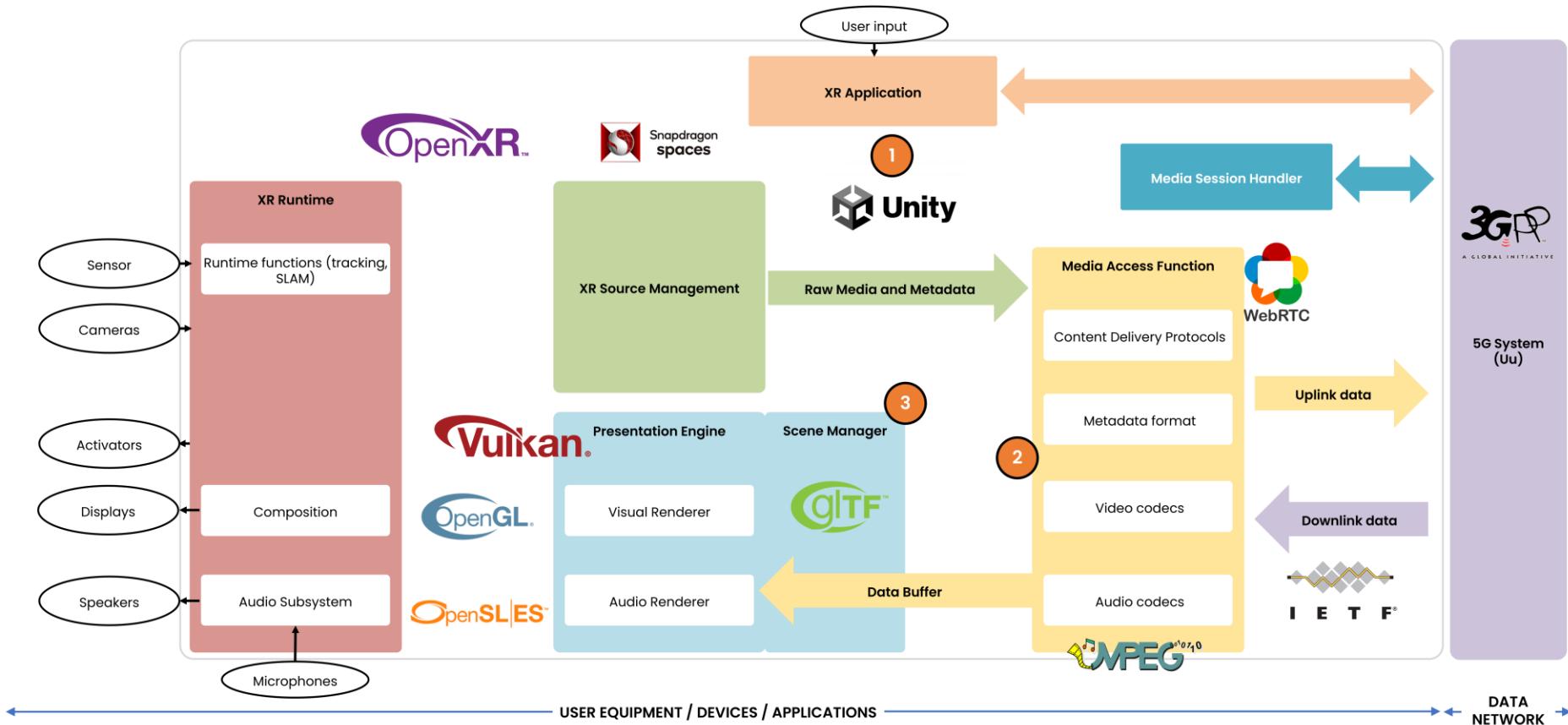
- ISO/IEC 23090-5, V3C and V-PCC
- ISO/IEC 23090-12, MPEG Immersive Video (MIV)
- ISO/IEC 23090-10, Carriage of V3C
- ISO/IEC 23090-14, Scene Description



- **3GPP Specifications in the scope of eXtended Reality**

- <https://5g-mag.github.io/Standards/pages/xr.html>
- Use Cases, Scenarios, Requirements, Devices – RTC, Split Rendering,...
- Media capabilities and services
- Codecs (IVAS) – Testing methodologies and performance requirements,...

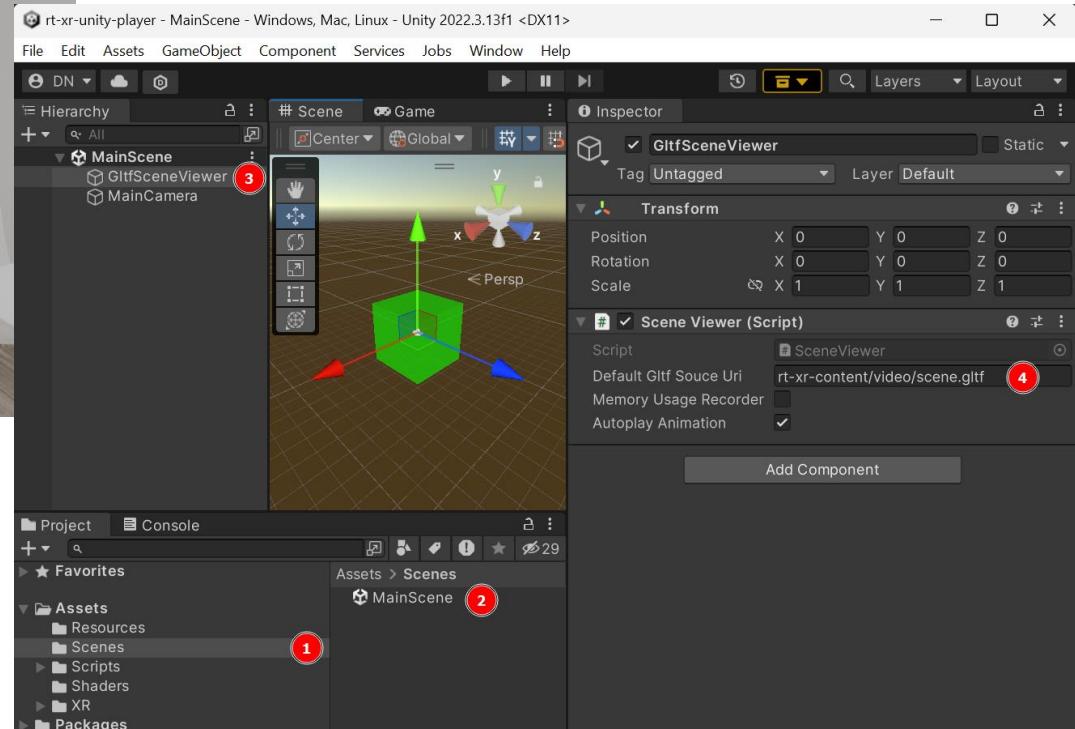






# XR Media Integration in 5G

## GitHub Repositories and Projects



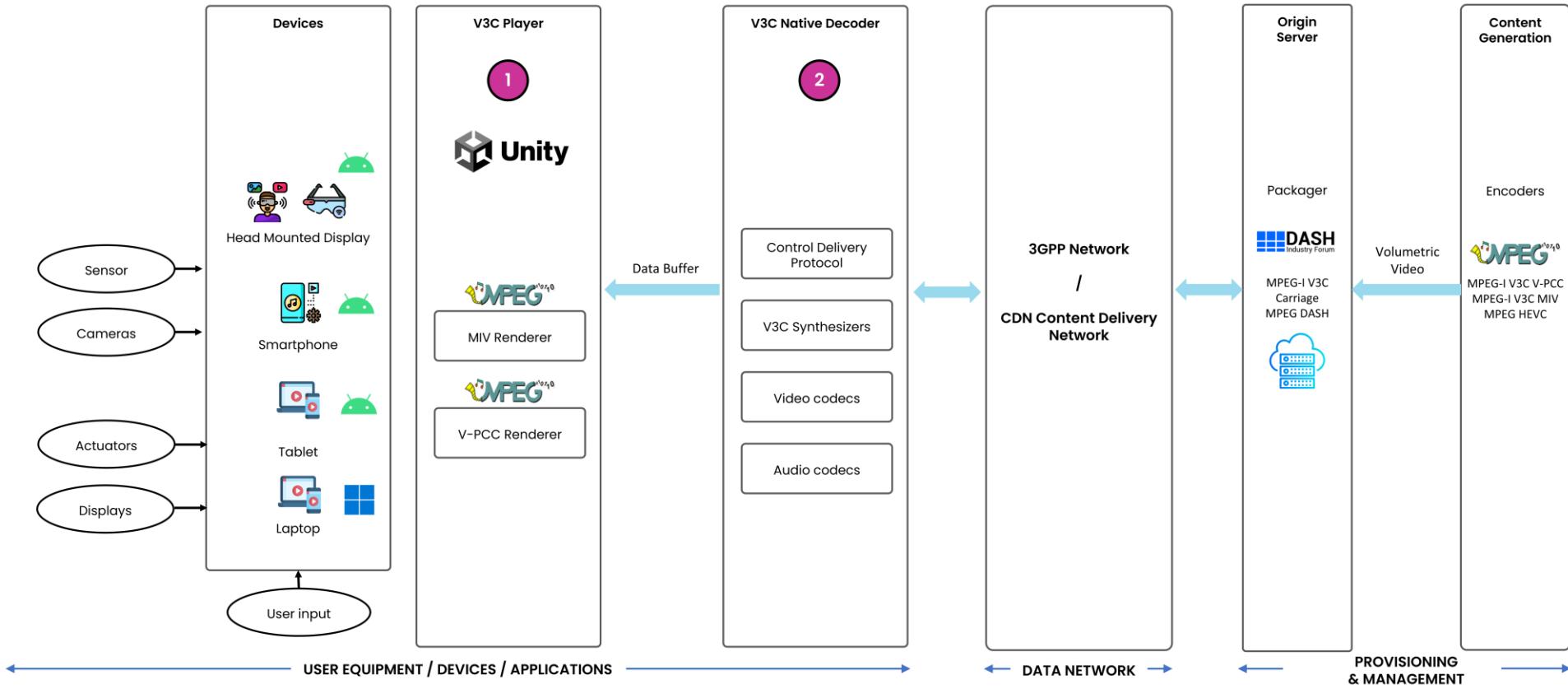


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## V3C Immersive Platform







- A V3C simple player (Unity application) is available to visualize volumetric video contents and dynamically interact with them
- V3C test contents are provided for V-PCC, MIV MVD and MIV MPI



### V-PCC test content - Soccer Red

- Point cloud frames quantized to 1024-sized cube
- 60 4K cameras hemispheric rig
- 32 frames at 25 FPS
- Dynamic point cloud object
- **Encoded with V-PCC test model R24.0**
- Profile HEVC Main10 V-PCC Basic Rec0
- **XD Productions Content**



### MIV MVD test content - DanceB

- Acquired using 6 physical cameras
- Estimation of depth maps, object label maps, and background view.
- 128 frames at 15 FPS
- Geometry, Texture and Transparency atlases
- **Encoded with MIV test model v19.1**
- HEVC Main10 MIV Extended Level 2.5
- **Philips content**



### MIV MPI test content - Mannequin

- CGI content recorded in Unity
- 15 FHD virtual cameras in Unity
- 32 frames at 25 FPS
- Texture and Transparency atlases
- **Encoded with MIV test model v19.1**
- Profile MIV Extended MPI
- **InterDigital content**



## AI/ML Evaluation Framework

Implementation of the AI/ML evaluation framework defined in 3GPP SA4 TR26.927



Reference Implementations

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