5G-MAG Reference Tools: Bringing 5G Media to Life

Dr. Jordi J. Giménez
gimenez@5g-mag.com

FOSDEM'24

February 2024

WHO WE ARE

International non-for-profit cross-industry association

Global Internet, 5G-based access & APIs for media applications and services

Global Internet, 5G-based access & APIs for media applications and services

5G MAG REFERENCE < TOOLS />

Community of Developers

Open community sponsored by 5G-MAG

Reference Implementations

for validation, testing, experimentation

BBC

Bitstem

Dolby

Fraunhofer FOKUS

IDTOLU 5G E2E INNOVATION

interdigital.

MOTION SPELL

ors group

Qualcomm

resillion

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

5G-MAG Reference Tools Development Programme

WHAT WE DO

5G MAG REFERENCE TOOLS

5G Downlink Media Streaming (5GMSd)

5G Core Network components

Multimedia delivery protocols

MBMS & LTE-based 5G Broadcast

Emergency Alerts over 5G Broadcast

5G Multicast Broadcast Services

XR Media integration in 5G

AI/ML Evaluation Framework

5G-MAG Reference Tools under development

Some examples under development

WORK IN PROGRESS

5G Media Streaming network components developed so far:

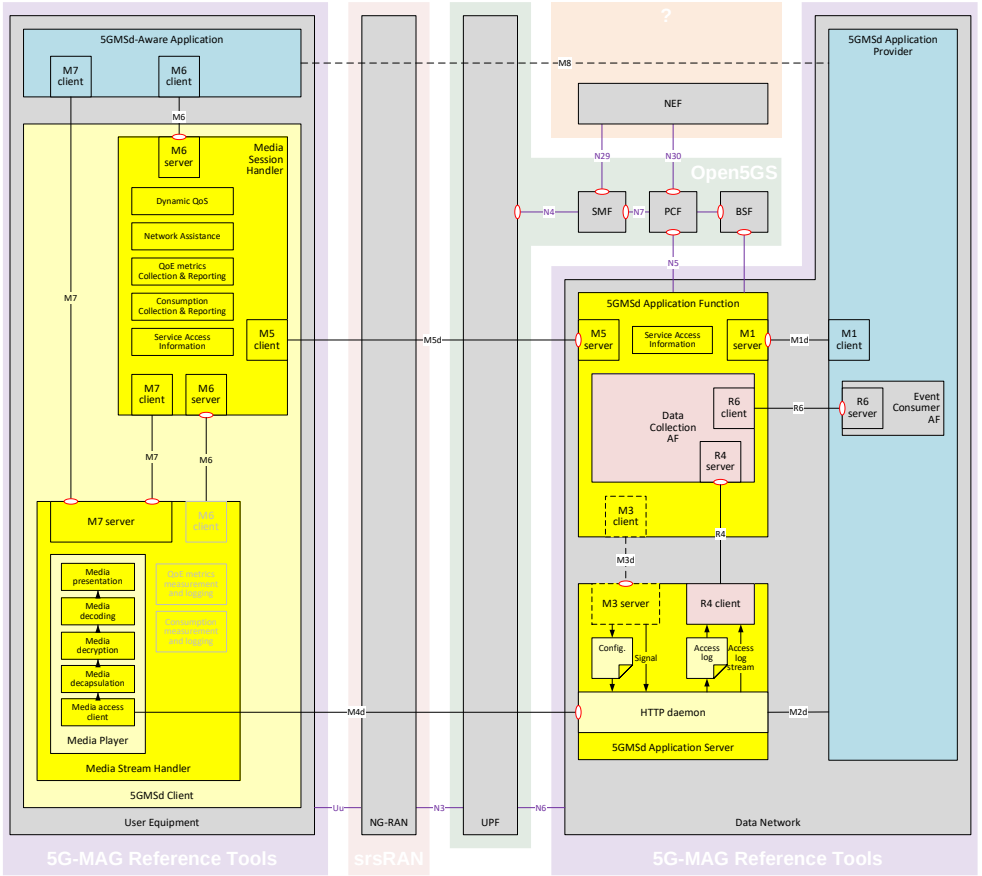
- 5GMS Application Server
  - Wrapping OpenResty (Nginx)
- 5GMS Application Function
  - Built in the Open5GS framework.

5G Media Streaming Client components developed so far on Android:

- 5GMS-enabled Media Player
  - Wrapping ExoPlayer.
- Media Session Handler
  - Background service.
- 5GMS-Aware Application
  - App, optionally incorporating the Media Player component.

5G-MAG Reference Tools – 5G Media Streaming (downlink) functional map

<Richard.Bradbury@bbc.co.uk> [2.March.2023]



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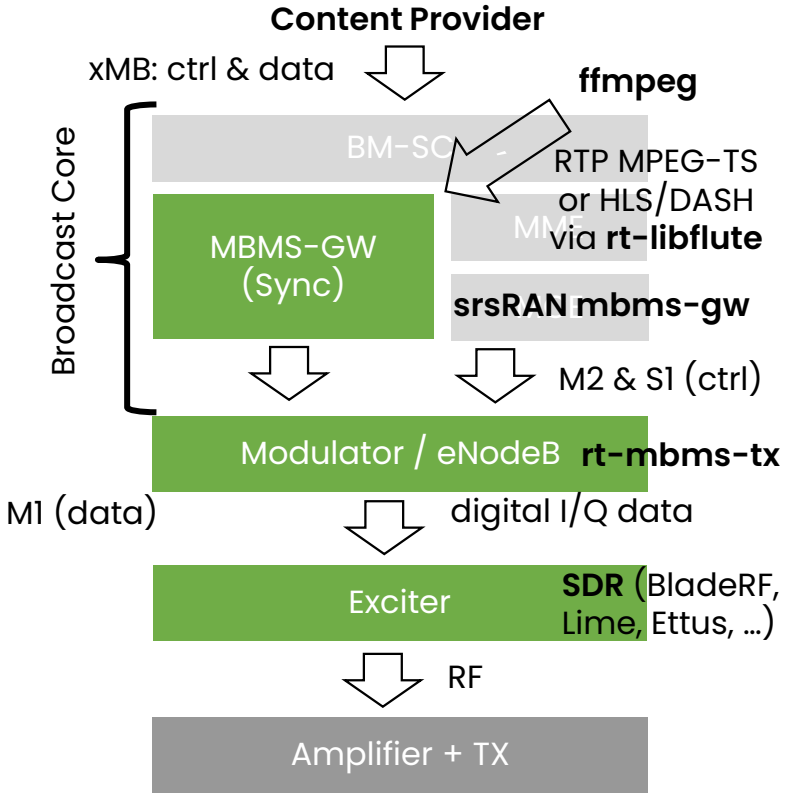
Some examples under development

WORK IN PROGRESS

Stationary reception
rt-wui / VLC / dash.js / …
rt-mbms-mw
(with rt-libflute)
rt-mbms-modem
(using srsRAN) SDR

Qualcomm QRD or CRD
rt-mbms-mw-android
QC MBMS MW
Baseband (HW)
with QC SW to enable ROM



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Some examples under development

WORK IN PROGRESS

5G MAG REFERENCE TOOLS

XR & Immersive Media

3GPP Baseline Architecture for AR/MR (XR Baseline Client)

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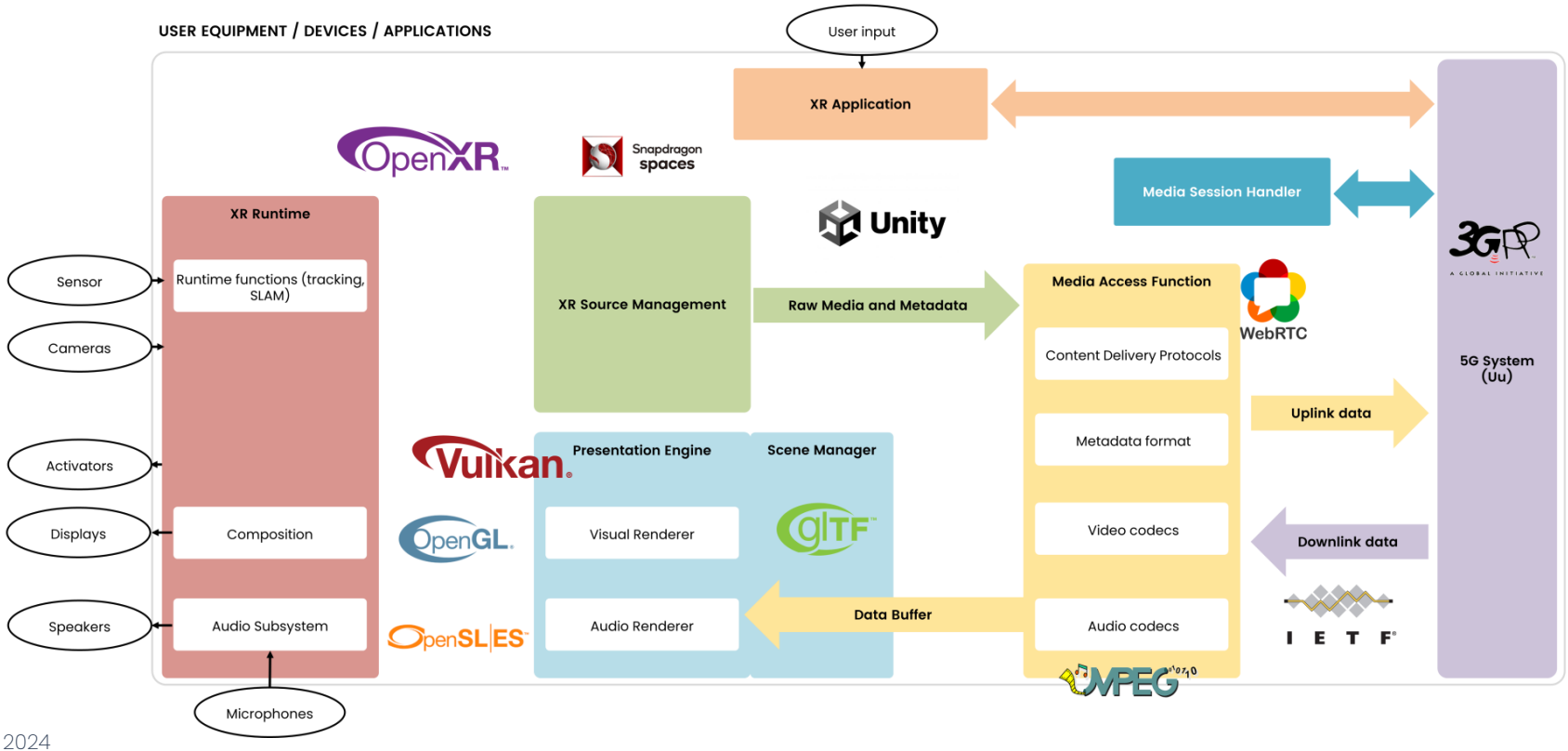

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5G-MAG Reference Tools @ IBCShow 2023

BRINGING 5G MEDIA STREAMING TO LIFE

5G-MAG DEMO POWERED BY 5G-MAG REFERENCE TOOLS

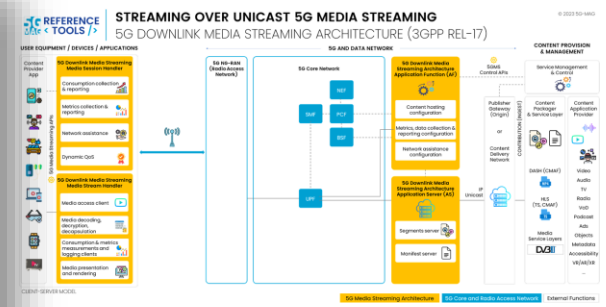
VISIT US AT BOOTH 10.D21 (EBU)

DEMO SETUP BY BBC R&D

CONTRIBUTIONS FROM: Fraunhofer FOKUS, Qualcomm, Dolby and BBC R&D

STREAMING OVER UNICAST 5G MEDIA STREAMING

5G DOWNLINK MEDIA STREAMING ARCHITECTURE (3GPP REL-17)



5G Media Streaming (5GMS) is a set of technical specifications defined in 3GPP with the aim to achieve better media streaming Quality of Experience by effective collaboration between content providers and mobile networks. Key features under development include:

- Content Hosting
  - CDN deployed inside/outside the mobile network.
- Dynamic network QoS policy
  - Automatically tracking representation switching during a streaming session.
- Quality of Experience metrics reporting
  - Supporting non-real-time performance auditing.
- Network Assistance
  - Throughput estimation (bit rate recommendation).
  - Temporary delivery boost.
- Consumption reporting
  - Including exposure of CDN access logs.

The demo is using some of the 5G-MAG Reference Tools available in our GitHub. In particular the following:

- 5GMS Application Function
- 5GMS Application Server
- 5GMS Media Session Handler
- 5GMS Media Stream Handler
- 5GMS Application
- 5GMS Common Android Library
- 5GC Service Consumers

Note that this demo is partially supported by third-party components (srsRAN gNodeB and Open5GS 5GCore)

Get more details and join the Developer Community

developer.5g-mag.com

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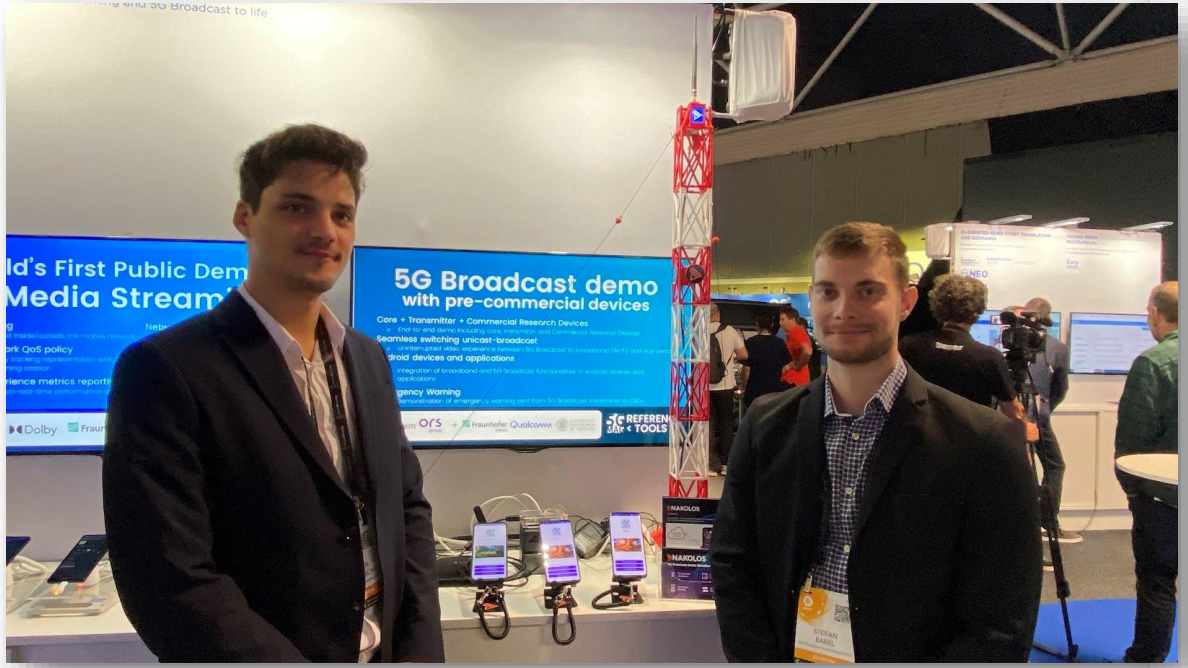
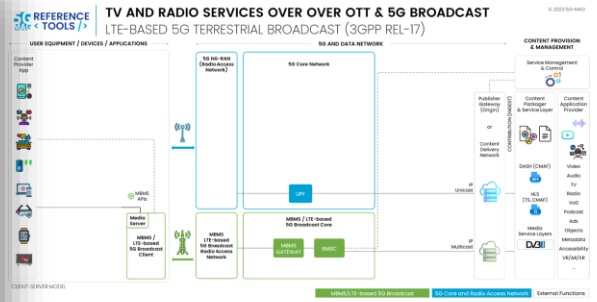


BRINGING 5G BROADCAST TO LIFE

5G-MAG DEMO POWERED BY 5G-MAG REFERENCE TOOLS

VISIT US AT BOOTH 10.D21 (EBU) DEMO SETUP BY ORS Group and Bitstem

CONTRIBUTIONS FROM Fraunhofer FOKUS, Qualcomm, iTEAM-UPV, ORS Group and Bitstem

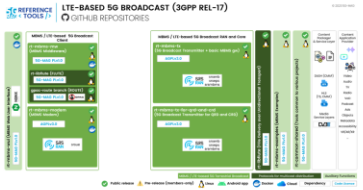


LTE-based 5G Broadcast is a set of technical specifications defined in 3GPP to address requirements for broadcasting to mainstream mobile devices. This demonstrator presents the 5G-MAG Reference Tools for 5G Broadcast running on commercial research devices (CRDs). Key features under development include:

- End-to-end demo of 5G Broadcast including 5G Broadcast core, transmitter and CRDs for reception
- Seamless switching between 5G Broadcast and broadband: uninterrupted video experience if the distribution path changes from 5G Broadcast to broadband (Wi-Fi) and vice-versa
- Integration of broadband and 5G Broadcast functionalities in Android devices and applications
- Demonstration of emergency warning sent from 5G Broadcast transmitter to CRDs.

The demo is using some of the 5G-MAG Reference Tools available in our GitHub. In particular the following:

- 5G Broadcast Transmitter for CRD
- MBMS Middleware for Android
- MBMS Middleware
- MBMS Modem
- FLUTE



Note that this demo is partially supported by third-party components (Nakolos 5G Broadcast core and Bitstem 5G Broadcast transmitter) which are not open-source but free to use for 5G-MAG members for tests and demos.

Get more details and join the Developer Community

developer.5g-mag.com

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HOW TO PARTICIPATE

Contribute

GitHub

- All development is happening on Github
- Dedicated **project boards** for each new feature: https://github.com/orgs/5G-MAG/projects
- **Getting started guide** for each topic, e.g., 5G Downlink Media Streaming: https://github.com/5G-MAG/Getting-Started/wiki
- All information at https://github.com/5G-MAG

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github.com/5G-MAG

*We accept code under the license terms contributors feel comfortable with (check each of the 30+ repos)

Participate

slack

tinyurl.com/join5gmagslack

Discussions around development of features and resolving issues. Dedicated channels for each project

Calls

5g-mag.com/community

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

Internal Calls
- Fridays - every other week
- 13:00 – 14:30 CEST

Groups

tinyurl.com/join5gmaggroup

Announcements of upcoming meetings, new release candidates and new releases

5g-mag.com/community

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It's...

5G MEDIA PRODUCTION

It’s...

UPLINK VIDEO

It’s...

STREAMING

It’s…

5G BROADCAST

It's...

MULTICAST

It’s...

BEYOND 2D

It's...

XR

It's...

THANK YOU!
developer.5g-mag.com

In more details...

5G-MAG Reference Tools

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5G MAG REFERENCE TOOLS

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Implementing...
5G Media Streaming Architecture

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BBC Dolby Fraunhofer FOKUS Qualcomm

STREAMING OVER UNICAST 5G MEDIA STREAMING

5G DOWNLINK MEDIA STREAMING ARCHITECTURE (3GPP REL-17)

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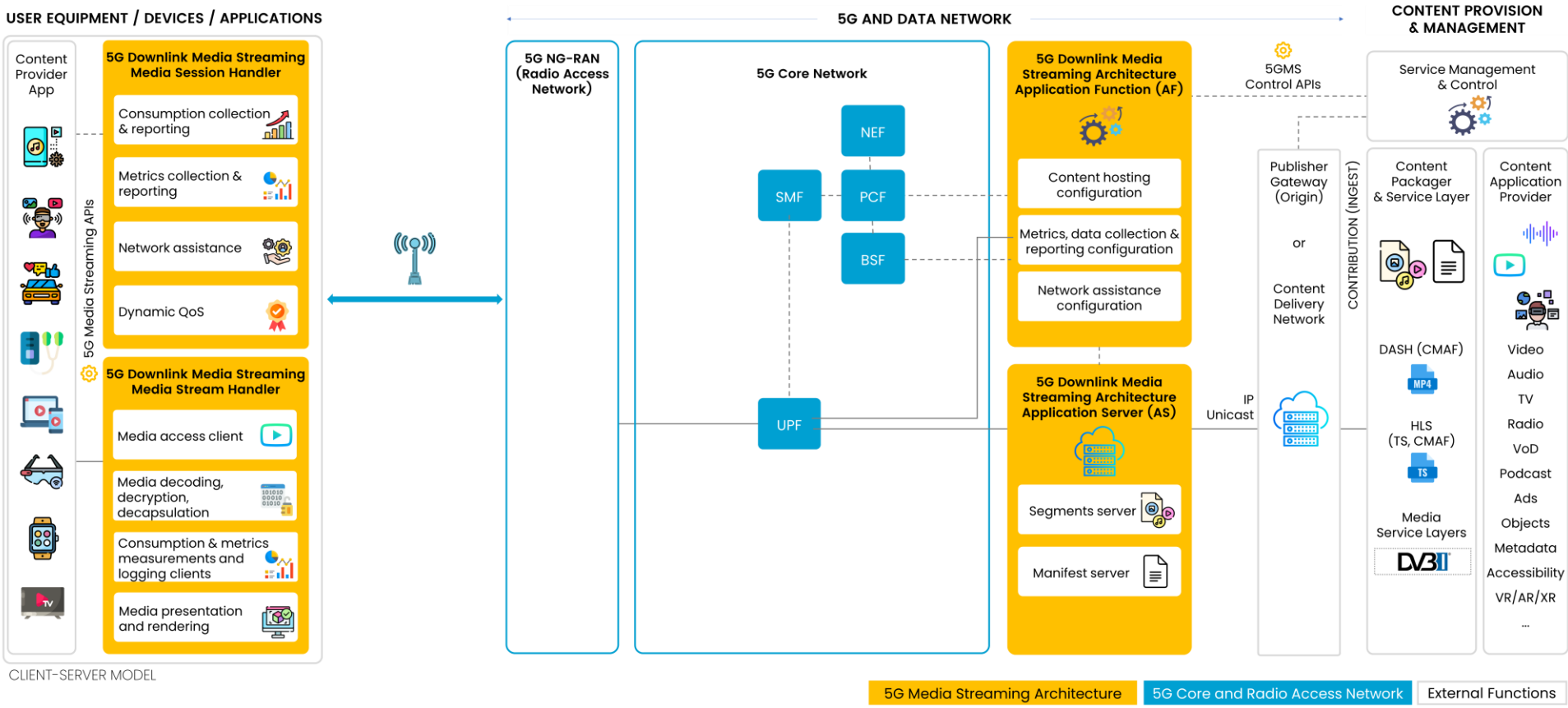

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Available Resources

- GitHub Repositories:
  - 5GMSd Application Function (rt-5gms-application-function)
  - 5GMSd Application Server (rt-5gms-application-server)
  - 5GMSd Media Session Handler (rt-5gms-media-session-handler)
  - 5GMS Examples (rt-5gms-examples)
  - 5GMS Common Android Library (rt-5gms-common-android-library)
  - 5GMS Media Stream Handler (rt-5gms-media-stream-handler)
  - 5GMS-Aware Applications (rt-5gms-application)

- Find in our GitHub the following resources:

  https://github.com/5G-MAG/Getting-Started/wiki/5G-Downlink-Media-Streaming

  Specifications and architecture

  On-going projects

  Using the tools

  Related repositories

GitHub

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Under development

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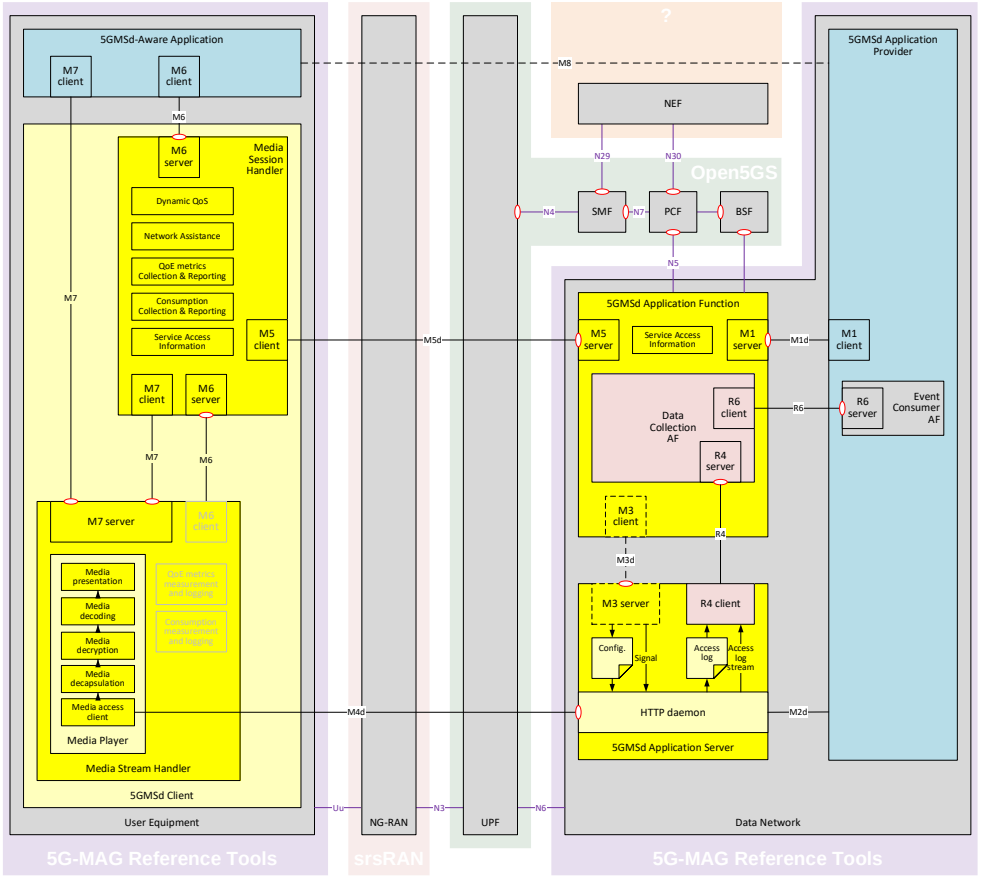
<Richard.Bradbury@bbc.co.uk> [2.March.2023]



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Under development: 5GMS Features (Update: January'24)

5G Media Streaming feature	5GMS Application Function		5GMS Client
	Provisioning (M1)	Usage (M5)	
Content hosting	Pull-based ☑	Done ☑	Done ☑
QoE metrics reporting	Pending release ☑	Pending release ☑	Pending release ☑
Consumption reporting	Done ☑	Done ☑	Done ☑
Network Assistance			
Delivery boost	*Not applicable*	Done ☑	**To do**
Throughput estimation	*Not applicable*	**To do**	**To do**
Dynamic Policies	Done ☑	Done ☑	**To do**

Not implemented and welcome…

- 5GC with support for PCF
- 5GC with support for NEF

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5G DOWNLINK MEDIA STREAMING ARCHITECTURE (3GPP REL-17)

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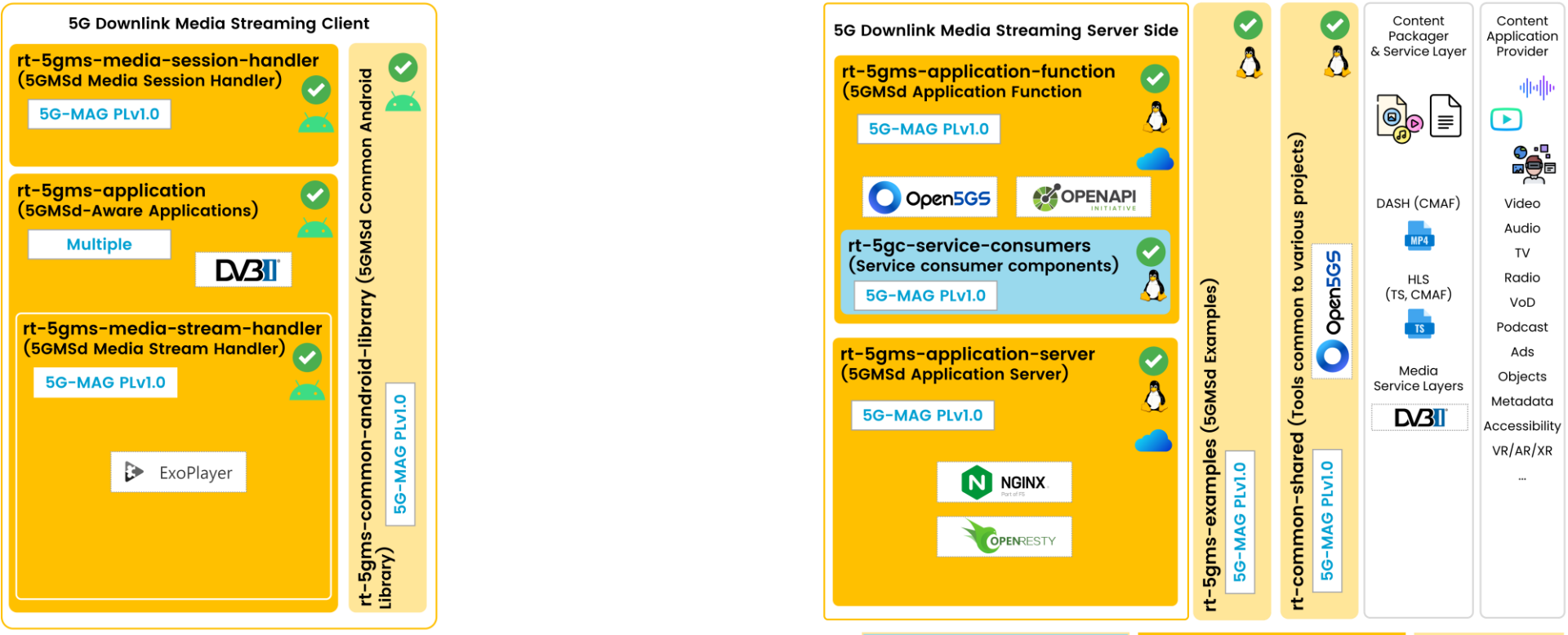

5G Core Network Auxiliary Functions | 5G Media Streaming Architecture | Auxiliary Functions

Public release | Pre-release (members-only) | Linux | Android | Docker | Cloud | Dependency | Code Licence

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Release Highlights

5GMSd Application Function (rt-5gms-application-function/releases)

- Release v1.4.0 - 5GMS Application Function
  - Adds Consumption Reporting, Network Assistance, Dynamic Policies
  - Enhancements: ACME certificate management, Improved validation on API communications, Uplift all interfaces to comply with 3GPP TS 26.512 V17.7.0.
- From previous releases…
  - Implementation of the interfaces at reference point M1 for: Provisioning Session (TS 26.512 clauses 4.3.2 & 7.2), Content Protocols Discovery (TS 26.512 clauses 4.3.4 & 7.5), Server Certificates (TS 26.512 clauses 4.3.6 & 7.3), Content Hosting Configuration (TS 26.512 clauses 4.3.3 & 7.6)
  - 5GMS Application Function M3 API

5GMSd Application Server (rt-5gms-application-server/releases)

- Release v1.2.2 - 5GMS Application Server
  - Adds Consumption Reporting
  - Feature: TS 26.512 v17.7.0 uplift
- From previous releases…
  - Add Certificate handling for HTTPS distribution
  - Add M3 interface

5GMSd Media Session Handler (rt-5gms-media-session-handler/releases)

- Release v1.1.0 - 5GMS Media Session Handler
  - 5GMS Consumption reporting: Add support to Media Session Handler
  - Dispatch information about locationReporting and accessReporting to the Media Stream
- From previous releases…
  - Adds a MediaSessionHandlerMessengerService to establish a bidirectional messenger endpoint with the Media Stream Handler.

5GMSd Media Stream Handler (rt-5gms-media-stream-handler/releases)

- Release v1.1.0 - 5GMS Media Stream Handler
  - Initial support for 5GMS Consumption reporting
  - Add support for location reporting
- From previous releases…
  - Adds an ExoPlayerAdapter that implements the M7 interface.

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Release Highlights

5GMSd Application (rt-5gms-application/releases)

- Release v1.1.0 - 5GMS Application
  - Request access to ACCESS_FINE_LOCATION to support location property when doing consumption reports
  - Request permission for getting GPSI for Consumption Reporting
- From previous releases…
  - Visualize the selected bitrate and the selected Representation as an overlay on top of the video
  - Move to Media3 for Exoplayer dependency
  - Adds a user interface to select between different M8 data/endpoints and to select the target stream to be played.
  - Allows for adding new M8 endpoints either via a local .json file or via a server endpoint.
  - Adds a network interface to fetch M8 information
  - Exo-DVB-I Player: The Exo DVB-I Player uses the Android ExoPlayer and the DVB-I Reference Client functionality to provide the capabilities to select and play back media content.

5GMS Common Android Library (rt-5gms-common-android-library/releases)

- Release v1.1.0 - 5GMS Common Android Library
  - 5GMS Consumption reporting: Add support in common Android library
  - Multiple changes related to Consumption Reporting that add required model classes and new Util functions
  - Add new events to be dispatched to enable location reporting
  - Add logic to derive either domain name or the IP address from a request URL

5GMS Examples (rt-5gms-examples/releases)

- Release v1.0.0 - 5GMS Examples
  - Adds a simple express.js server to mock functionality of the Application Function. The first route m8.js is used to return information about the available services and the available base URL to the Application Function. The 5GMSd Aware Application uses this route as M8 interface. The second route service-access-information.js provides the corresponding ServiceAccessInformation to the data that is returned via M8.

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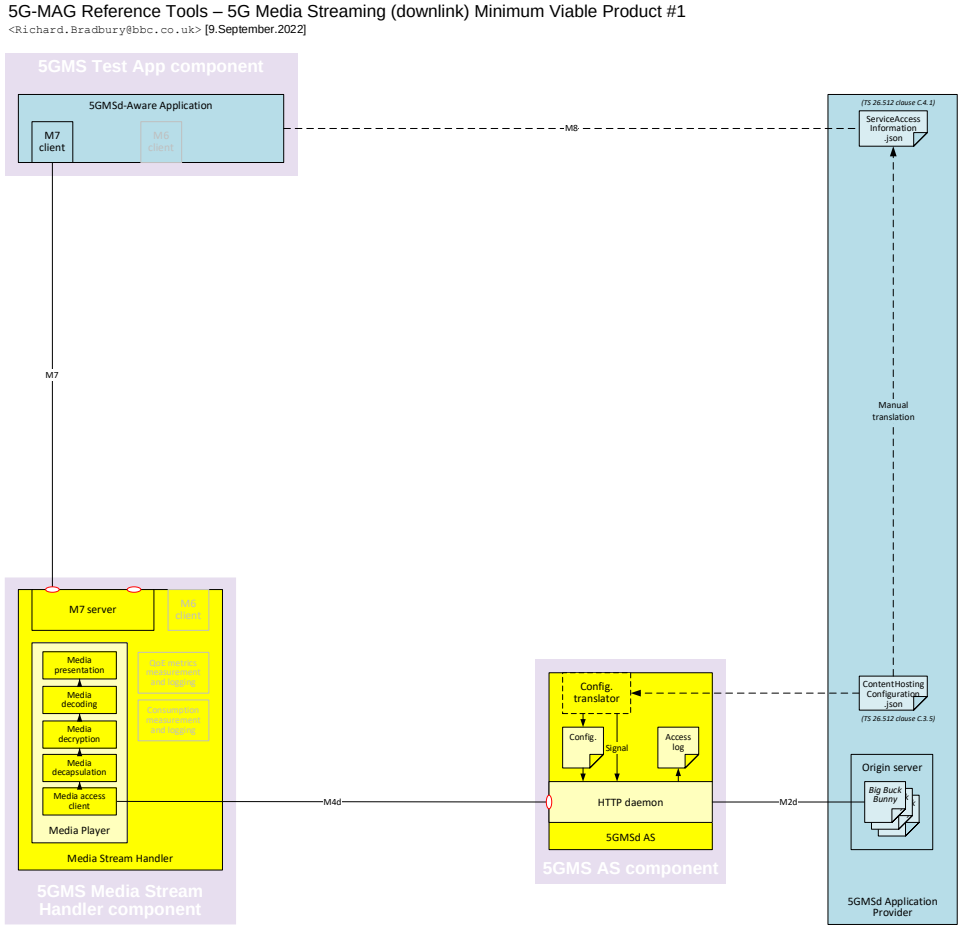
Projects:

5GMS Application Server for MVP#1

WORK IN PROGRESS

- Started with a single static Content Hosting Configuration file (JSON) following the syntax defined in TS 26.512 clause C.3.5.
  - Exposes a virtual host at reference point M4d.
- Changes to HTTP redirect handling by the 5GMS AS have been made recently.



Kanban board

5GMS:
Basic media stream handling (MVP#1)

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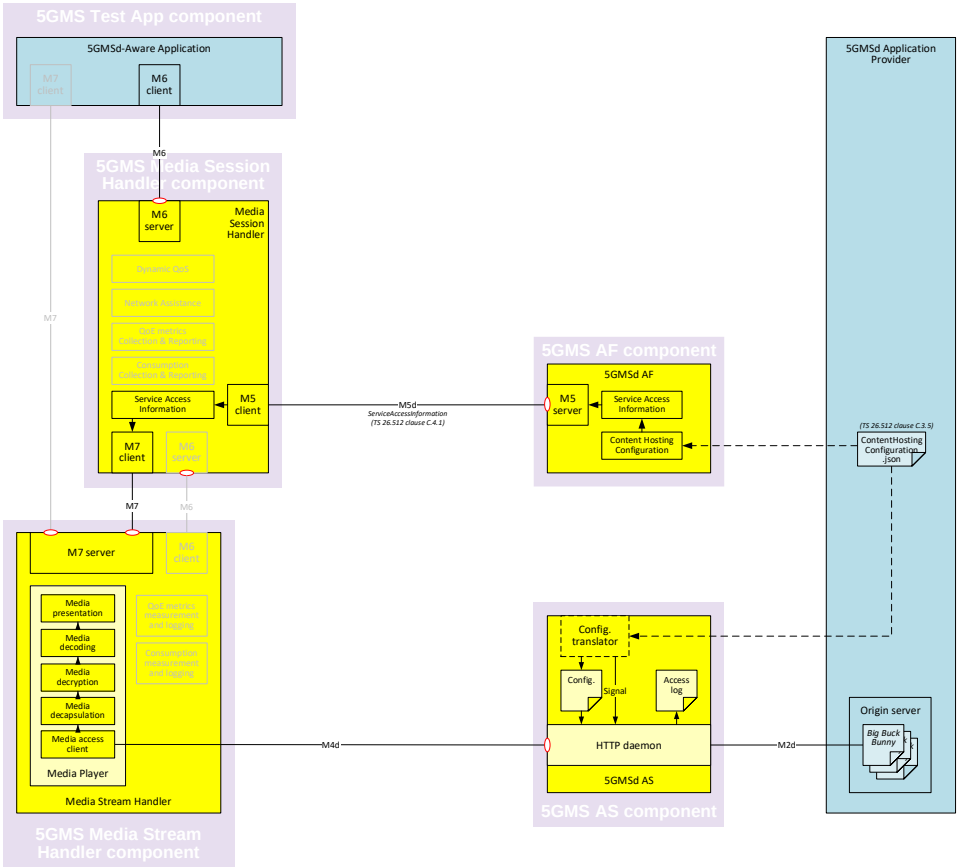
5GMS Application Function for MVP#2

- Started with a single static Content Hosting Configuration file (JSON) following the syntax defined in TS 26.512 clause C.3.5.
  - Exposes corresponding **Service Access Information** at M5d.
- No further development work planned on Application Function under MVP#2.

5G-MAG Reference Tools – 5G Media Streaming (downlink) Minimum Viable Product #2

<Richard.Bradbury@bbc.co.uk> [23.August.2022]



Kanban board

5GMS:
Media session handling (MVP#2)

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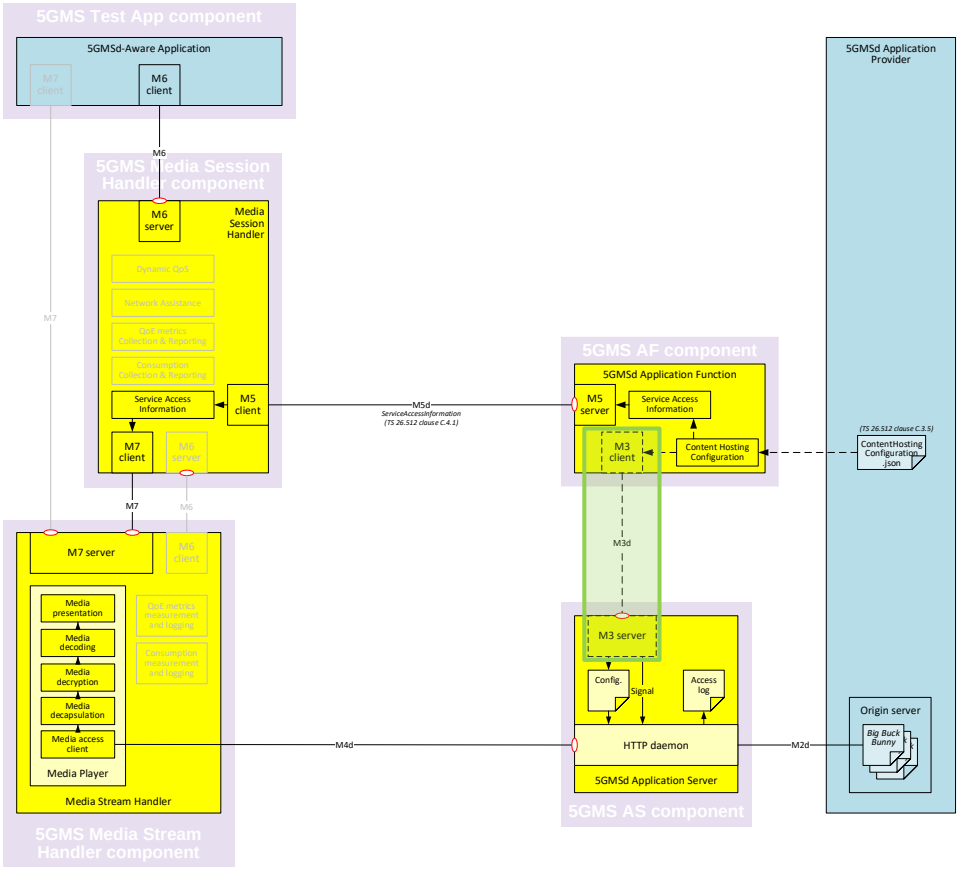
Projects:

5GMS: M3 link

- AS now configured by the AF and no longer accepts a static Content Hosting Configuration.
  - Model: AS maintains a flat list of server certificates and a flat list of Content Hosting Configurations.
- Initial implementation checked in to AS and AF repositories, including uplift of M3d API to track changes in M1d API as TS 26.512 V17.3.0.
- No further work planned until Content Publishing Configuration for uplink media streaming is agreed (Release 18).

5G-MAG Reference Tools – 5G Media Streaming (downlink) M3 link

<Richard.Bradbury@bbc.co.uk> [5.October.2022]



5GMS:
M3 link (AF to AS RESTful OpenAPI)

Kanban board

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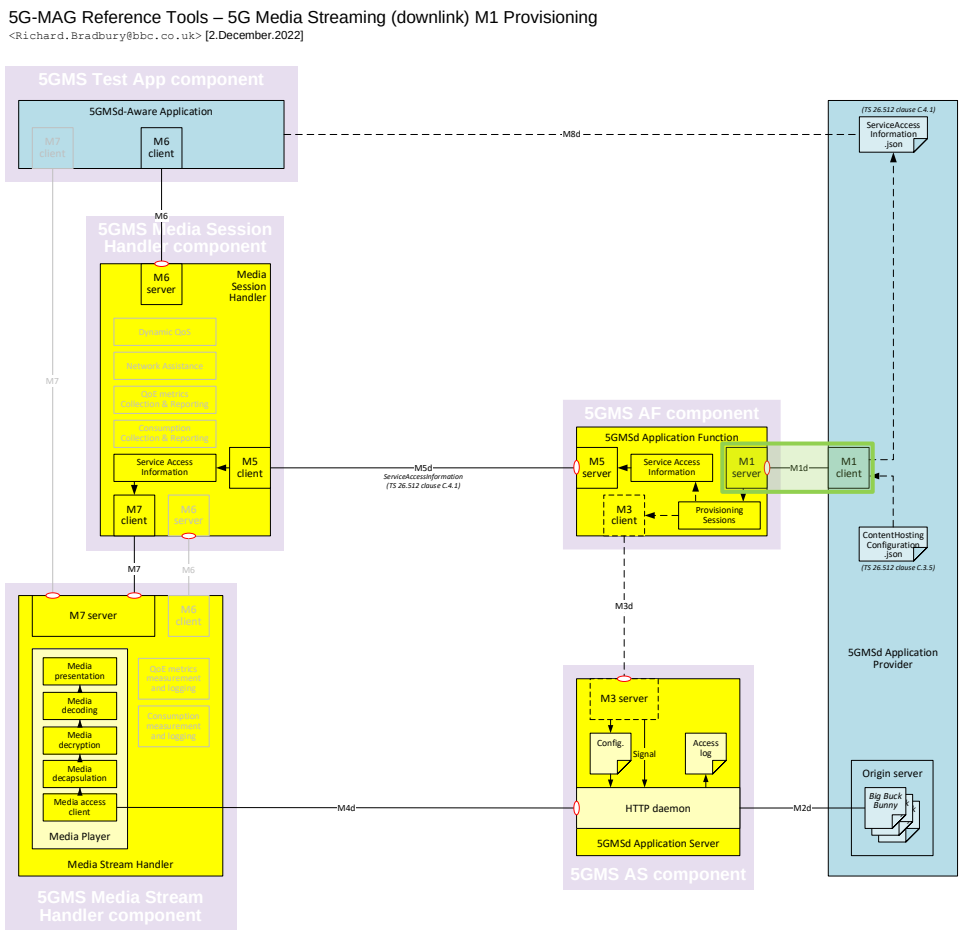
Projects:

5GMS: M1 provisioning

- Application Function now configured via the M1d API and longer accepts a static Content Hosting Configuration.
- Implemented first three APIs at M1d:
  - Provisioning Sessions API.
  - Server Certificates Provisioning API.
  - Content Hosting Provisioning API.
- Uplift to comply with TS 26.512 V17.3.0.
- (Fraunhofer FOKUS currently implementing the Metrics Provisioning API.)
- Next planned development by BBC:
  - Policy Templates Provisioning API.

5GMS:
M1d Provisioning

Kanban board



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Projects:

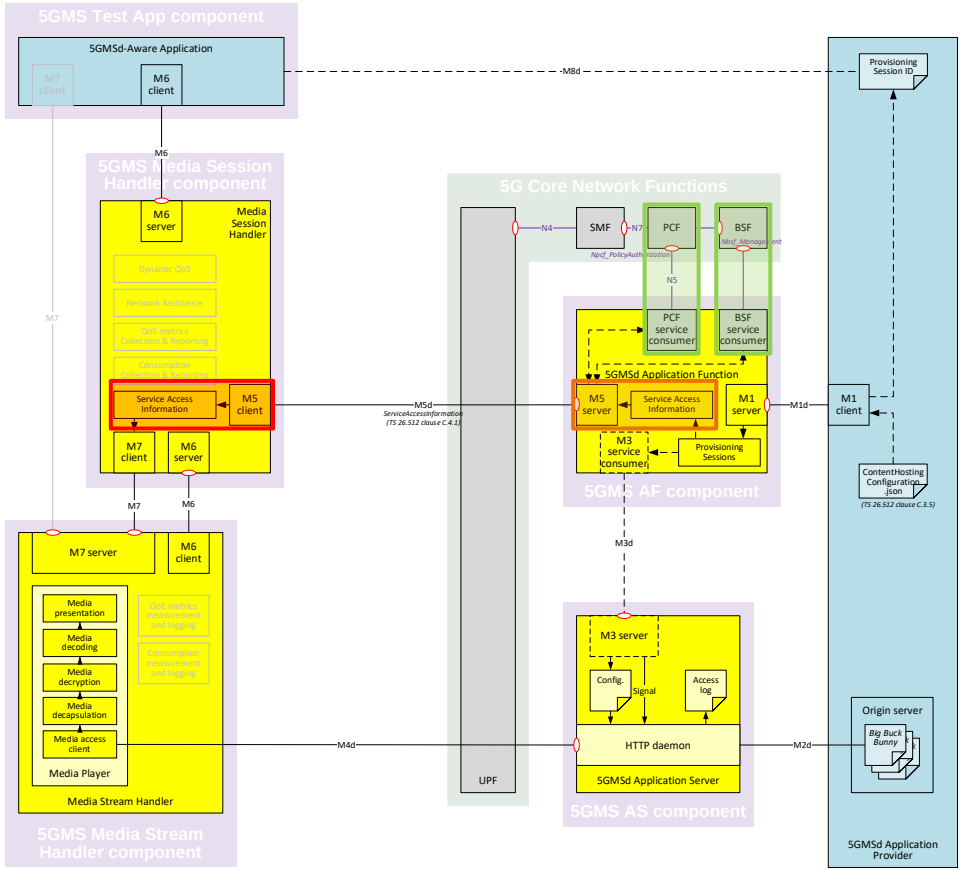
5GMS: Network Assistance

WORK IN PROGRESS

- Aiming to support both delivery boost and throughput estimation (bit rate recomm.).
- Developed new service consumer libraries for communicating with the Binding Support Function (BSF) and Policy & Charging Function (PCF).
- Integration into 5GMS AF underway:
  - (No M1 provisioning: static configuration only ☺.)
  - Additional Service Access Information at M5 for use by the Media Session Handler.
  - Implement M5 Network Assistance API.
  - (Uplift of 5GMS AF to recently published TS 26.512 V17.5.0 already complete.)
- Additional development of the Media Session Handler needed to invoke M5 APIs.

5G-MAG Reference Tools – 5G Media Streaming (downlink) PCF Integration

<Richard.Bradbury@bbc.co.uk> [6.July.2023]



Kanban board

5GMS:
Network Assistance and Dynamic Policies features

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Projects:

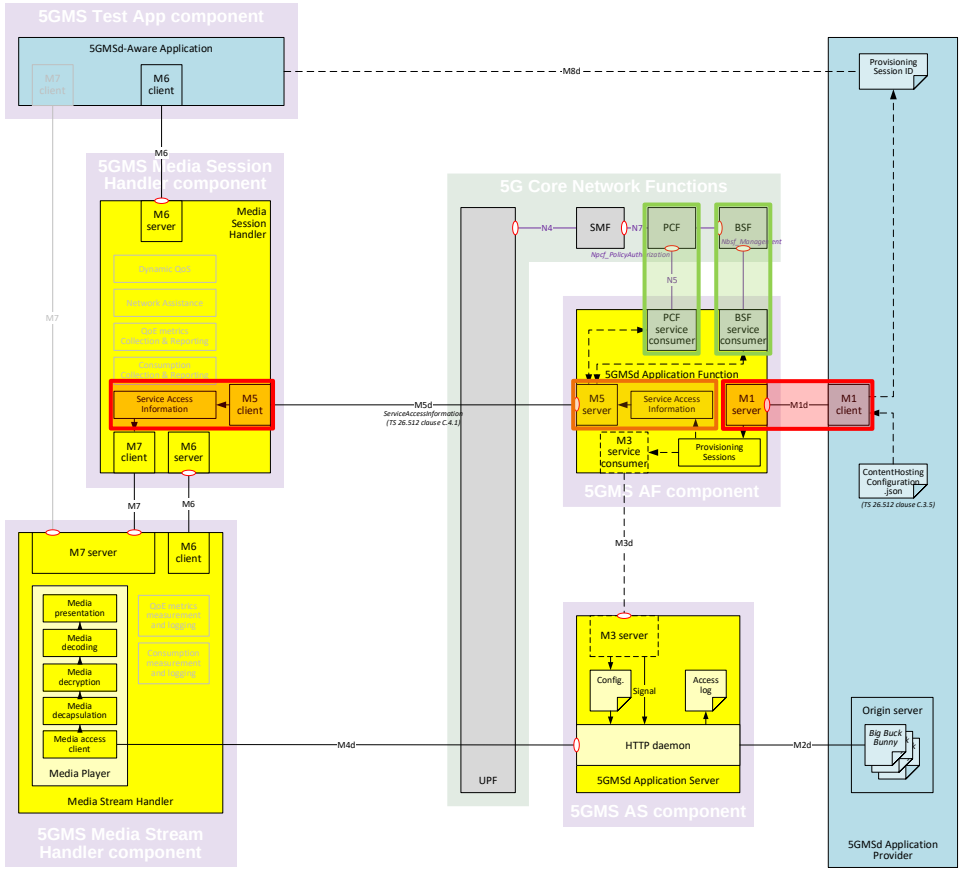
5GMS: Dynamic Policies

WORK IN PROGRESS

- Reuse service consumer libraries for communicating with the BSF and PCF.
- Development work in the 5GMS AF:
  - Implement M1 Policy Templates API.
  - Additional Service Access Information at M5 to support the Media Session Handler.
  - Implement M5 Dynamic Policies API.
- Corresponding changes to the Media Session Handler needed to invoke these at M5.

5G-MAG Reference Tools – 5G Media Streaming (downlink) PCF Integration

<Richard.Bradbury@bbc.co.uk> [6.July.2023]



5GMS: Network Assistance and Dynamic Policies features

Kanban board

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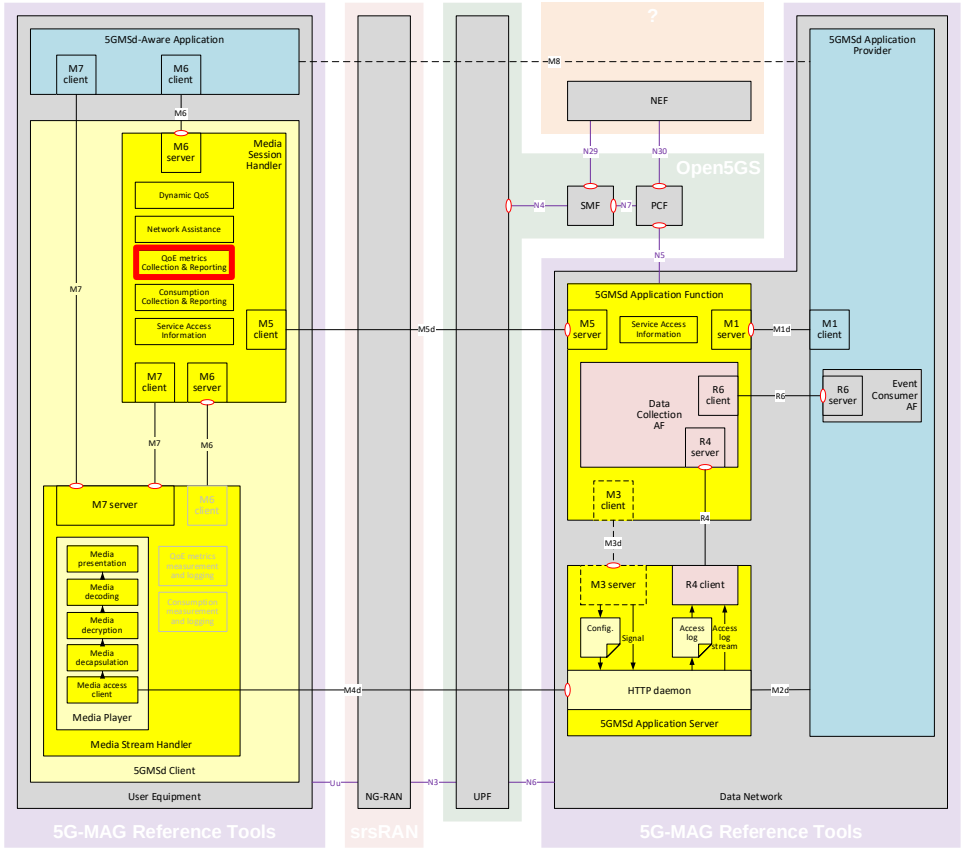
Projects:

5GMS: QoE Metrics Collection & Reporting

WORK IN PROGRESS

- Metrics Measurement and Logging Client:
  - Performs the measurement and logging of QoE metrics in accordance with the Metrics Reporting Configuration part of provisioning data, supplied by the 5GMSd Application Provider to the 5GMSd AF, and forwarded by the 5GMSd AF to the Media Player via the Media Session Handler.
- Initial implementation of QoS metrics and consumption collection and reporting
- Aim to support multiple metric schemes. In particular:
  - For downlink media streaming, TS 26.247 clauses 10.6.1 and 10.6.2 specify the required MIME content type and metrics report format for the 3GPP urn:3GPP:ns:PSS:DASH:QM10 metrics reporting scheme



Kanban board

5GMS:
QoE metrics collection and reporting feature

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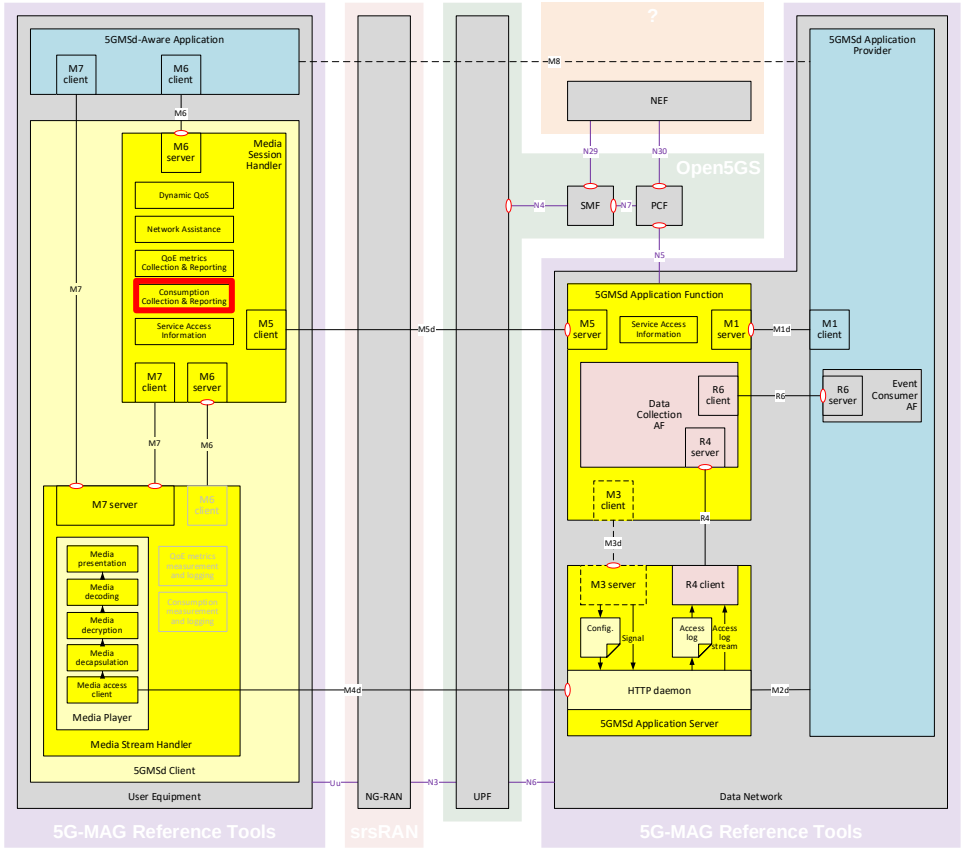
Projects:

5GMS: Consumption Collection & Reporting

WORK IN PROGRESS

- Consumption Measurement & Logging Client:
  - Performs the measurement and logging of content consumption-related information in accordance with the Consumption Reporting Configuration part of provisioning data, supplied by the 5GMSd Application Provider to the 5GMSd AF, and forwarded by the 5GMSd AF to the Media Player via the Media Session Handler.
- Initial implementation of **QoS metrics and consumption collection and reporting**
- Aim to support **multiple metric schemes**. In particular:
  - For downlink media streaming, TS 26.247 clauses 10.6.1 and 10.6.2 specify the required MIME content type and metrics report format for the 3GPP urn:3GPP:ns:PSS:DASH:QM10 metrics reporting scheme



Kanban board

5GMS:
Consumption collection and reporting feature

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5G MAG REFERENCE < TOOLS />

Implementing...
5G Core Network components

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Available Resources

- GitHub Repositories:
  - 5G Core Service Consumers (rt-5gc-service-consumers)
  - UE Data Collection Application Function (rt-5gc-data-collection-application-function)

- Find in our GitHub the following resources:
  https://github.com/5G-MAG/Getting-Started/wiki/5G-Core-Network
  - Specifications and architecture
  - On-going projects
  - Using the tools
  - Related repositories

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5G DOWNLINK MEDIA STREAMING ARCHITECTURE (3GPP REL-17)

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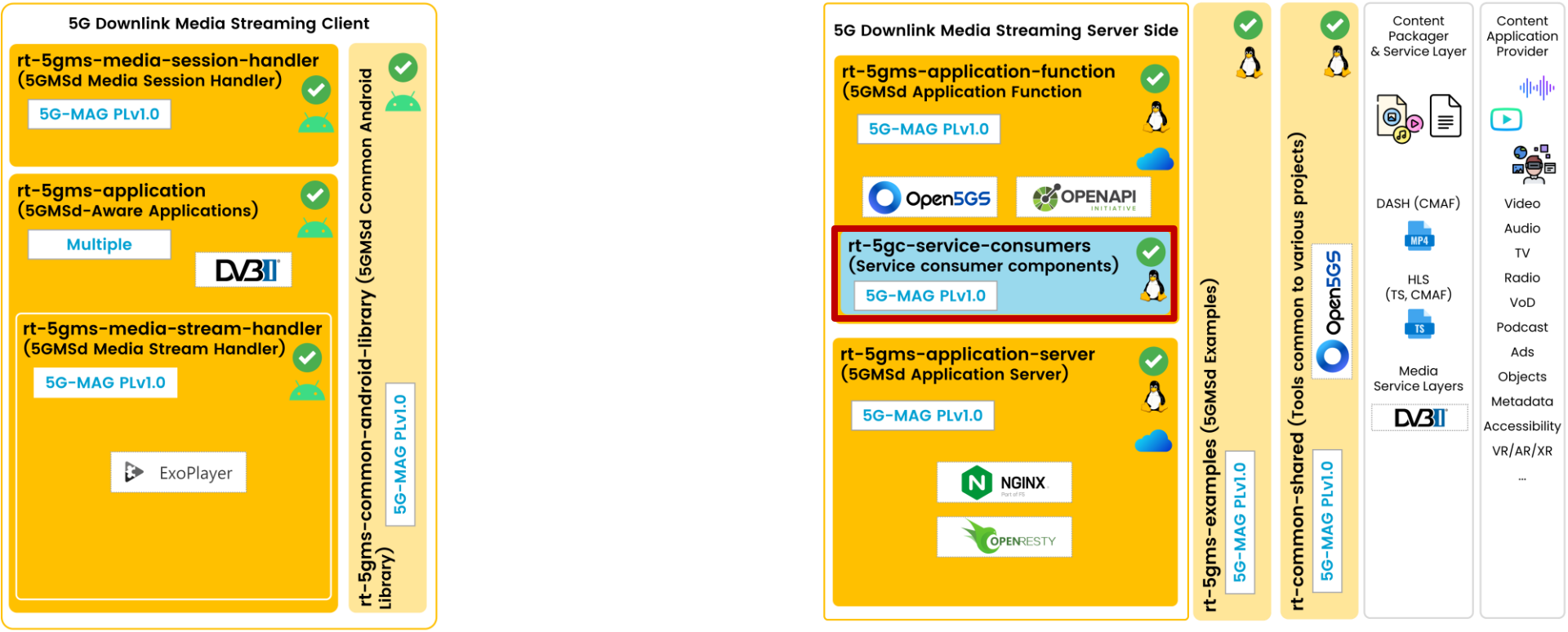

5G Core Network Auxiliary Functions | 5G Media Streaming Architecture | Auxiliary Functions

Public release | Pre-release (members-only) | Linux | Android | Docker | Cloud | Dependency | Code Licence

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Release Highlights

5GC Service Consumers (rt-5gc-service-consumers/releases)

- Release v1.0.0 - 5GC Service Consumers
  - This is the first release of the 5G Core Service Consumer libraries and tools. These are based upon the Open5GS 5G Core and can be used as an independent set of tools for testing or controlling 5G Core APIs or as libraries for adding API handling into your own Open5GS based AF implementations.
  - Initial commit of the Service Consumer libraries and tools
  - Service Consumer Libraries: Various bug fixes and improvements

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STREAMING OVER UNICAST 5G MEDIA STREAMING

5G DOWNLINK MEDIA STREAMING ARCHITECTURE (3GPP REL-17)

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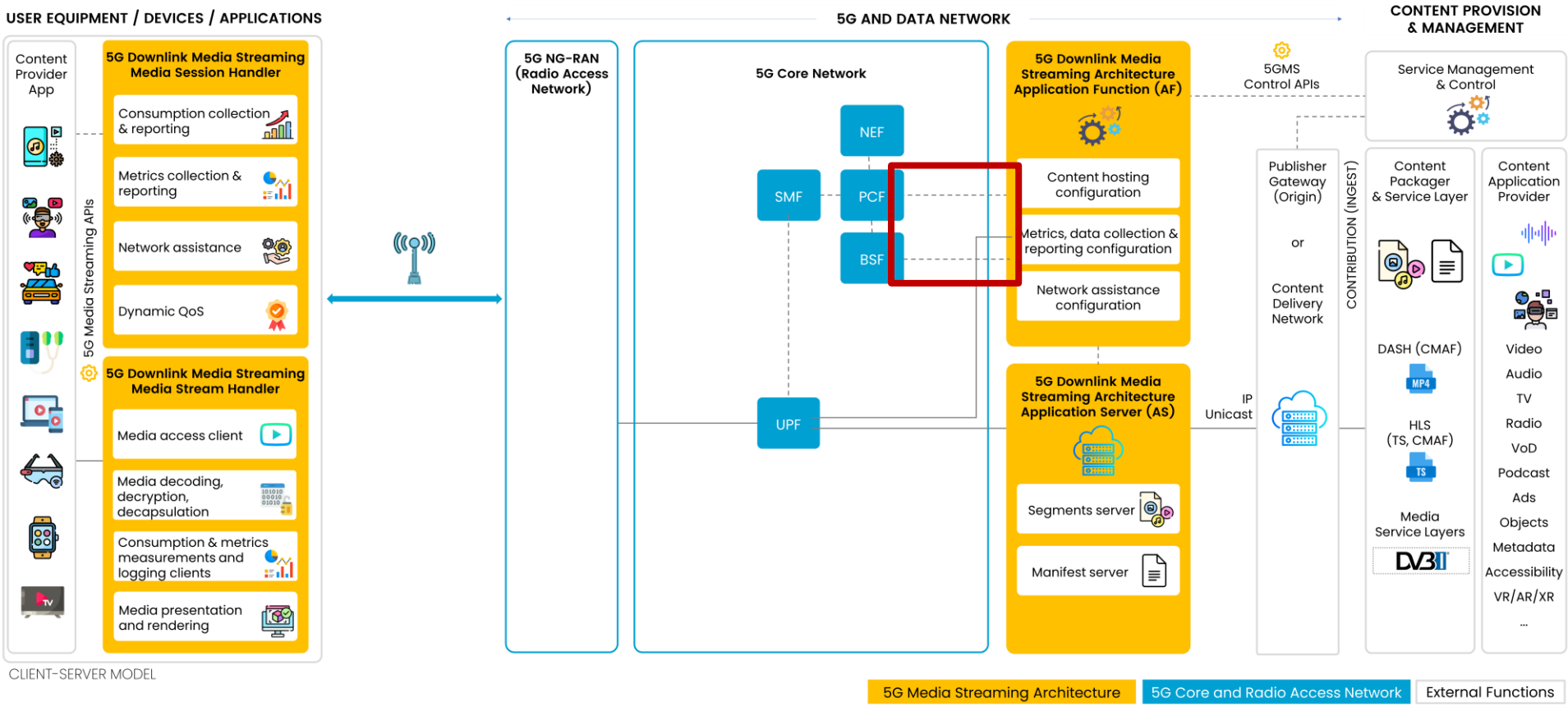

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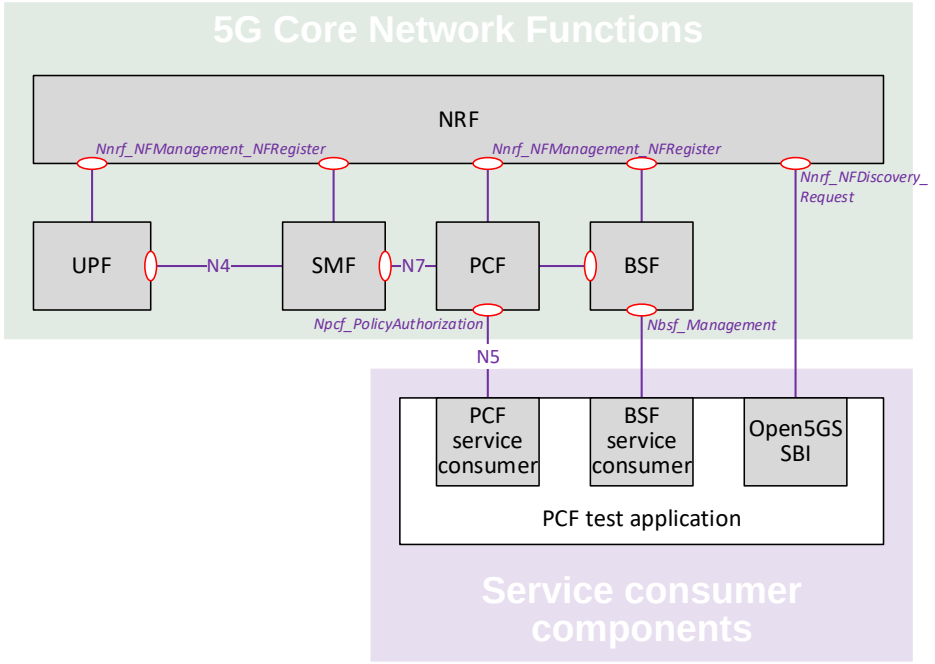
5GC: Service consumer libraries & test app

- The 5GMS AF needs to communicate with the 5G Core in order to manipulate network Quality of Service (**QoS**) for ongoing media streaming sessions.
- Solution: *reusable* service consumer libraries to invoke service operations on:
  - Binding Support Function (**BSF**).
  - Policy & Charging Function (**PCF**).
- Could also be exploited by future functions (MBSF, MBSTF, etc.)
- Also developing a command line PCF test application.
  - To test libraries against another 5G Core.



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5GMS:
Network Assistance and Dynamic Policies features

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STREAMING OVER UNICAST 5G MEDIA STREAMING

5G DOWNLINK MEDIA STREAMING ARCHITECTURE (3GPP REL-17)

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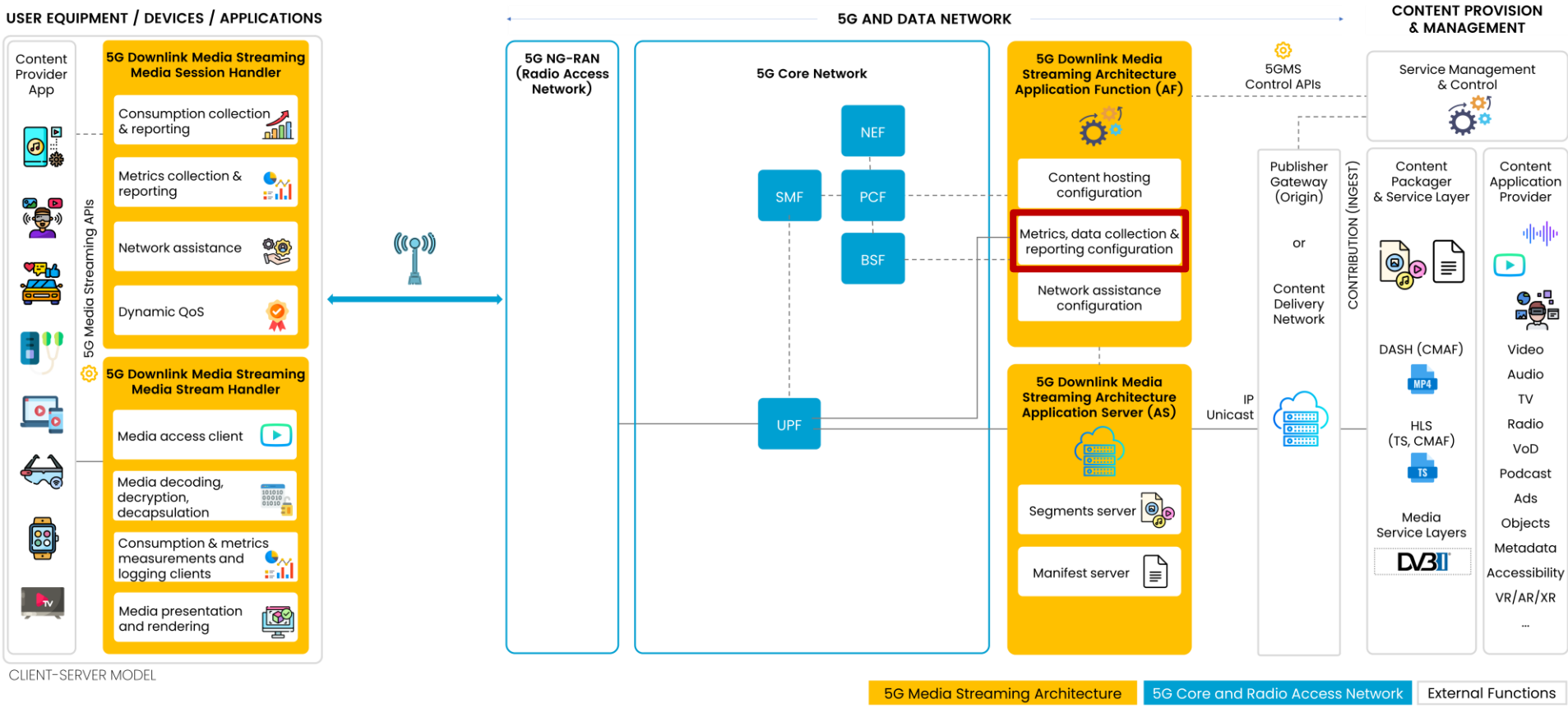

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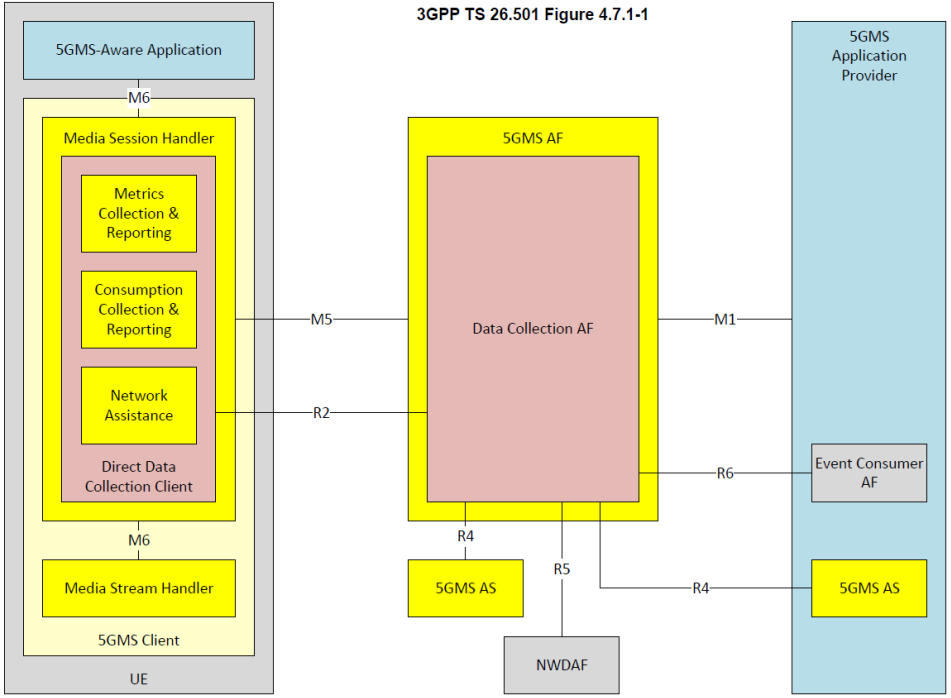
5GC: Data Collection, Reporting & Event Exposure

WORK IN PROGRESS

- Exposure of UE Data to other Network Functions in the 5G System (e.g. NWDAF, third-party AFs,...).
- Implementation of a standalone Data Collection AF able to receive generic data reports from the UE and expose them as events to event consumers.
- Implementation in a shared library able to be integrated into the 5GMS AF.
- The project complements the client-side collection and reporting for QoE metrics and consumption.



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5GMS:
UE data collection, reporting and event exposure

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Implementing...
Multimedia content delivery protocols

developer.5g-mag.com

Bitstem Fraunhofer FOKUS ors group Qualcomm

Available Resources

- GitHub Repositories:
  - FLUTE Library for LTE-based 5G Broadcast / MBMS (rt-libflute)
  - ROUTE integrated within MBMS Middleware (rt-mbms-mw/tree/route-gpac)

- Find in our GitHub the following resources:
  https://github.com/5G-MAG/Getting-Started/wiki/Multimedia-content-delivery
  - Specifications and architecture
  - On-going projects
  - Using the tools
  - Related repositories

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LTE-BASED 5G BROADCAST (3GPP REL-17)

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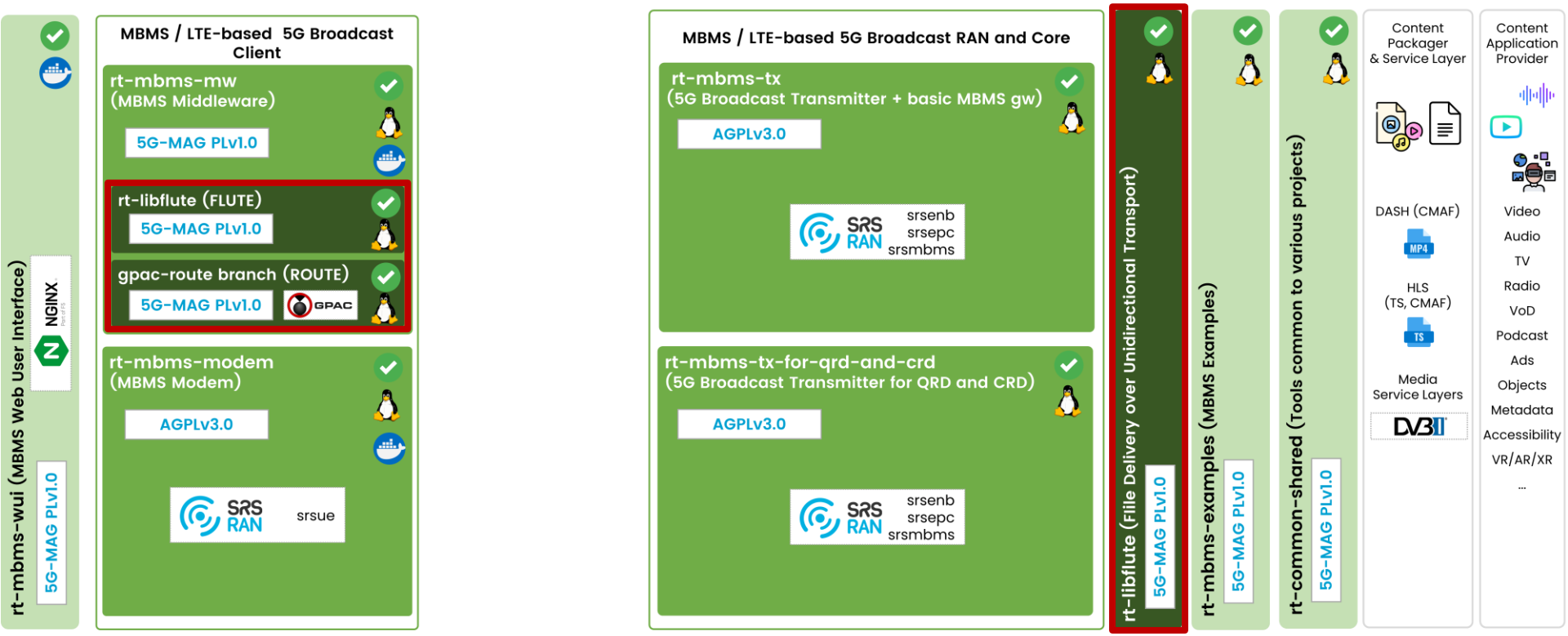

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Support for FLUTE

- Implementation of FLUTE (File Delivery over Unidirectional Transport) library
  - IETF RFC 6726
  - With FEC Rapor10 support

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MBMS:
Support for FLUTE

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Support for ROUTE

WORK IN PROGRESS

- Implementation of ROUTE (Real-time Transport Object delivery over Unidirectional Transport) library to extract a DASH/HLS live filesystem from a ROUTE/IP session
- What it implements at the server side:
  - ROUTE over multicast IP (UDP);
  - Partial segments can be dispatched. Needed for low latency
  - 3 flavours: generic ROUTE (RFC), ATSC3, DVB MABR - updates according https://www.ietf.org/rfc/rfc9223.html
  - Not implemented: EXT_NOP/EXT_TIME, and optionally EXT_AUTH if used; Congestion; FEC (RAPTORQ as in RFC 6330)
- What it implements at the client side:
  - 3 flavours: generic (RFC), ATSC3, ATSC3 Korean, DVB MABR - updates https://www.ietf.org/rfc/rfc9223.html
  - ROUTE over multicast IP (UDP);
  - Skip repeated files;
  - Low latency;
  - Partially implemented: File repair simple option:
    - MPEG-2 TS: all lost ranges are adjusted to 188-bytes boundaries, and transformed into NULL TS packets.
    - ISOBMFF: all top-level boxes scanned, incomplete boxes are transformed in free boxes, except mdat.
  - Not implemented: Reorder (with timeout); Choose service ID to bootstrap on for ATSC 3.0 mode; FLUTE (as documented in in RFC 3926 and TS 26.346); Congestion; FEC (RAPTORQ as in RFC 6330)

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MBMS:
Support for ROUTE

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Implementing...

MBMS & LTE-based 5G Broadcast

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TV AND RADIO SERVICES OVER 5G BROADCAST

LTE-BASED 5G TERRESTRIAL BROADCAST (3GPP REL-17)

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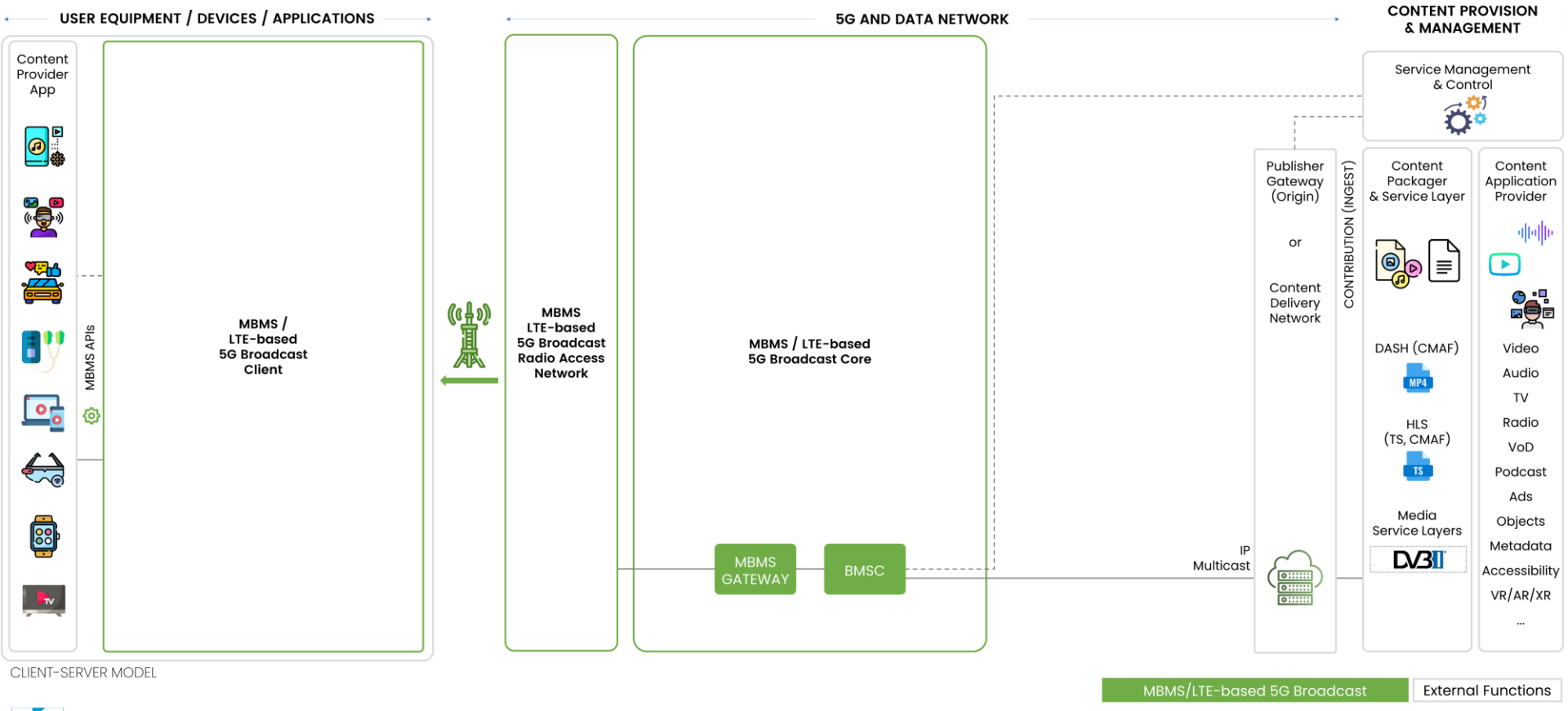

TV AND RADIO SERVICES OVER OVER OTT & 5G BROADCAST

LTE-BASED 5G TERRESTRIAL BROADCAST (3GPP REL-17)

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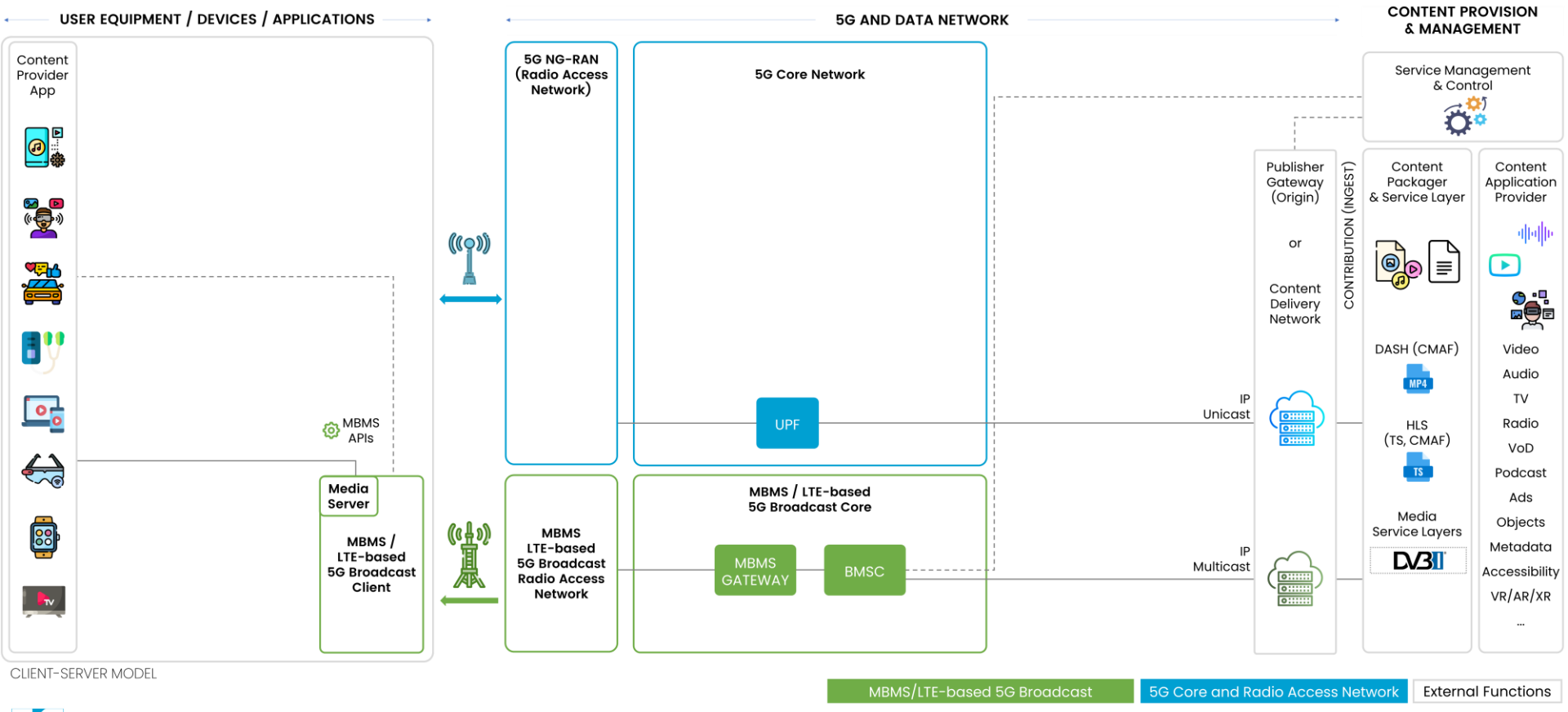

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HYBRID UNICAST MEDIA STREAMING & 5G BROADCAST

5G DOWNLINK MEDIA STREAMING OVER MBMS (3GPP REL-17)

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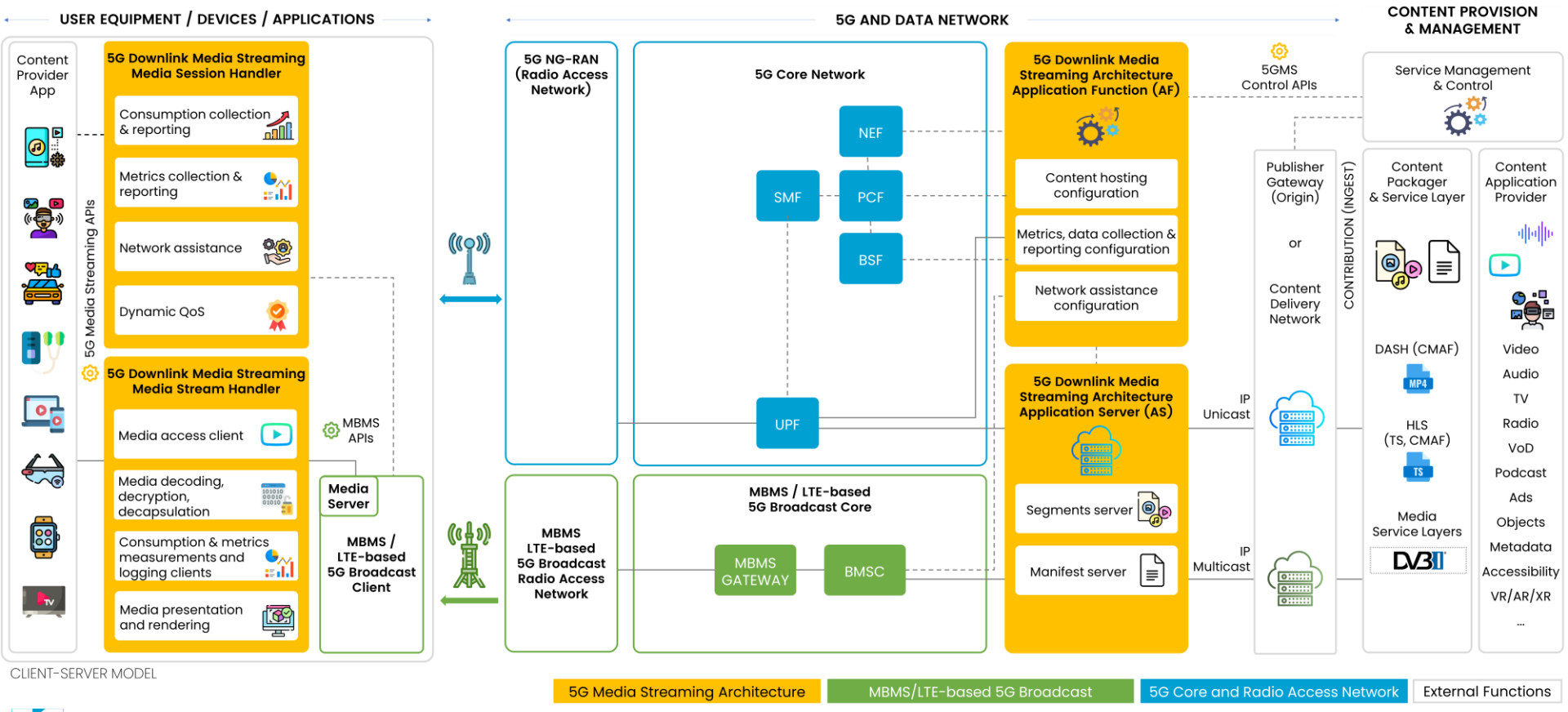

CLIENT-SERVER MODEL

5G Media Streaming Architecture | MBMS/LTE-based 5G Broadcast | 5G Core and Radio Access Network | External Functions

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Available Resources

- GitHub Repositories:
  - 5G Broadcast Transmitter (rt-mbms-tx)
  - Transmitter for QRDs and CRDs (rt-mbms-tx-for-qrc-crd)
  - MBMS Middleware (rt-mbms-mw)
  - MBMS Modem (rt-mbms-modem)
  - Web User Interface for Modem, MW & Application (rt-wui)
  - MBMS Examples (rt-mbms-examples)

- Find in our GitHub the following resources:
  https://github.com/5G-MAG/Getting-Started/wiki/MBMS-&-LTE-based-5G-Broadcast
  - Specifications and architecture
  - On-going projects
  - Using the tools
  - Related repositories

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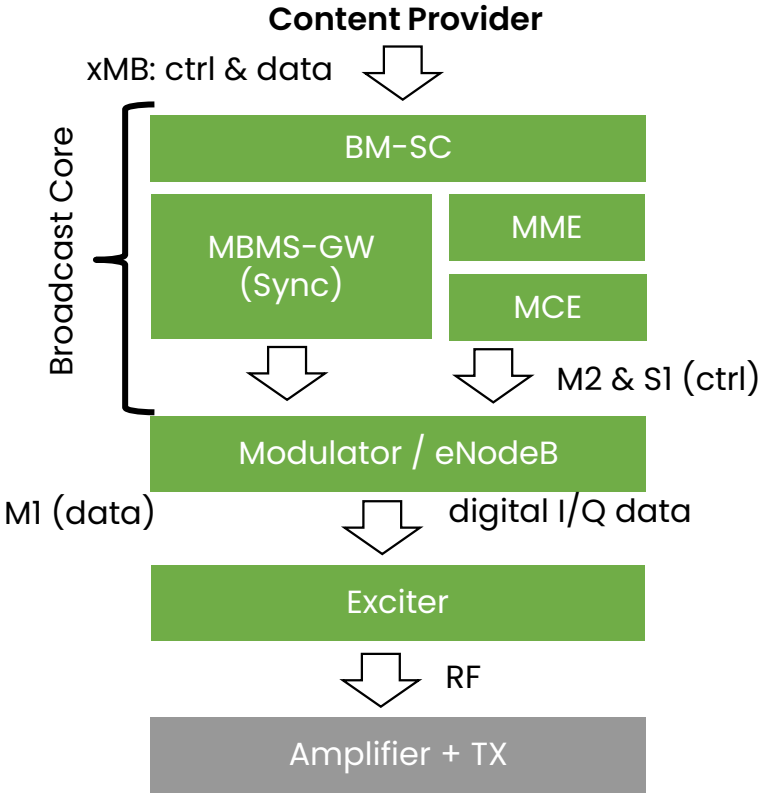
Under development

Stationary reception
Application
Middleware
Modem (HW)

Reception on mobile
Application
Middleware (Android)
Baseband (HW)



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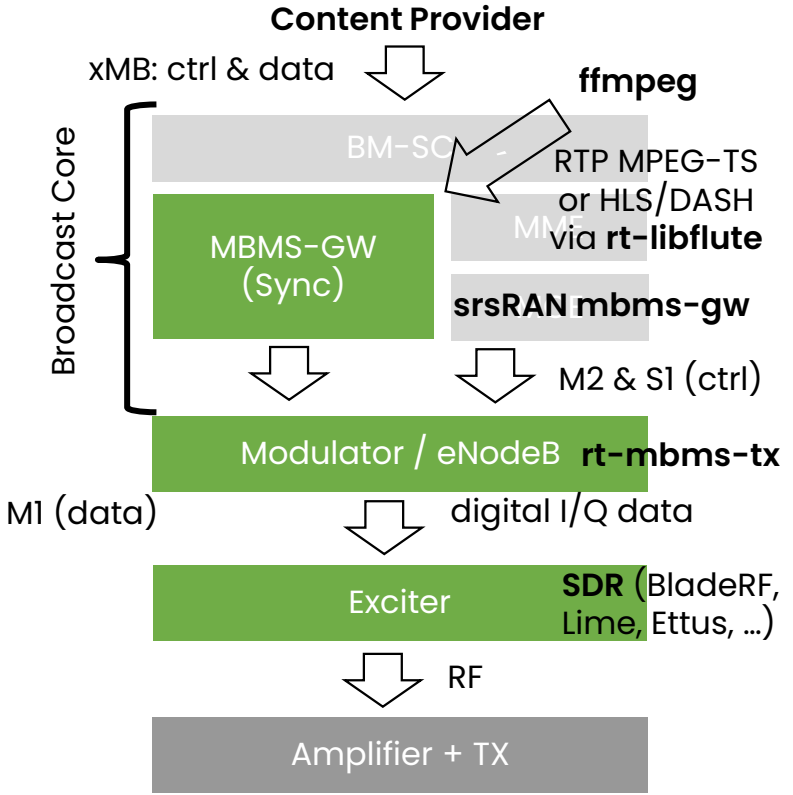
Under development

Stationary reception
rt-wui / VLC / dash.js / …
rt-mbms-mw
(with rt-libflute)
rt-mbms-modem
(using srsRAN) SDR

Qualcomm QRD or CRD
rt-mbms-mw-android
QC MBMS MW
Baseband (HW)
with QC SW to enable ROM



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LTE-BASED 5G BROADCAST (3GPP REL-17)

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rt-mbms-wui (MBMS Web User Interface)

NGINX

5G-MAG PLv1.0

MBMS / LTE-based 5G Broadcast Client

rt-mbms-mw
(MBMS Middleware)

5G-MAG PLv1.0

rt-libflute (FLUTE)

5G-MAG PLv1.0

gpac-route branch (ROUTE)

5G-MAG PLv1.0

GPAC

rt-mbms-modem
(MBMS Modem)

AGPLv3.0

SRS RAN srsue

MBMS / LTE-based 5G Broadcast RAN and Core

rt-mbms-tx
(5G Broadcast Transmitter + basic MBMS gw)

AGPLv3.0

SRS RAN srsenb srsepc srsmbms

rt-mbms-tx-for-qrd-and-crd
(5G Broadcast Transmitter for QRD and CRD)

AGPLv3.0

SRS RAN srsenb srsepc srsmbms

rt-libflute (File Delivery over Unidirectional Transport)

5G-MAG PLv1.0

rt-mbms-examples (MBMS Examples)

5G-MAG PLv1.0

rt-common-shared (Tools common to various projects)

5G-MAG PLv1.0

Content Packager & Service Layer

DASH (CMAF)

MP4

HLS (TS, CMAF)

TS

Media Service Layers

DVB

Content Application Provider

Video
Audio
TV
Radio
VoD
Podcast
Ads
Objects
Metadata
Accessibility
VR/AR/XR
...

MBMS / LTE-based 5G Terrestrial Broadcast | Protocols for multicast distribution | Auxiliary Functions

Public release | Pre-release (members-only) | Linux | Android | Docker | Cloud | Dependency | Code Licence

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Release Highlights

LTE-based 5G Broadcast Transmitter (rt-mbms-tx/releases)

- Release v1.0.0 – LTE-based 5G Broadcast Transmitter
  - This is the first release of the LTE-based 5G Broadcast Transmitter. This implementation is based on the existing MBMS implementation in srsRAN_4G eNodeB, modified to include a feature set of 3GPP Rel-17 LTE-based 5G Terrestrial Broadcast. It also includes a basic MBMS gateway which creates a virtual network interface sgi_mb which receives IP multimedia traffic.

MBMS Modem (rt-mbms-modem/releases)

- Release v1.2.1 – MBMS Modem
  - Enables automatic gain control configuration for the SDR reader via the configuration file
- From previous releases…
  - Rebase to srsRAN. Important: This links to the fembms branch of srsRAN: https://github.com/5G-MAG/srsRAN/branches
  - Support for MIMO / dual RX streams from BladeRF

MBMS Middleware (rt-mbms-mw/releases)

- Release v0.10.0 - MBMS Middleware
  - Add support for seamless switching between broadcast and unicast delivery for HLS streams
  - Add support for three different service announcement formats as document
  - Add support for seamless switching demo via flute-ffmpeg watchfolder approach

Web User Interface (rt-wui/releases)

- Release v0.1.0 – Web User Interface
  - Add support for seamless switching between broadcast and unicast streams for HLS content
  - Update to dash.js 4.4.0
- From previous releases…
  - Provide DASH manifest url directly to application.js if available
  - Provide HLS manifest url directly to application.js if available

MBMS Examples (rt-mbms-examples/releases)

- Release v0.2 – MBMS Examples
  - Add support for seamless switching using the flute ffmpeg watchfolder approach
- From previous releases…
  - Adds an example implementation to demonstrate rt-mbms-mw usage without the rt-mbms-modem part.

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Under development: What is missing?

Implemented so far…

- End-to-end support for LTE-based 5G Terrestrial Broadcast
  - Standalone 5G Broadcast transmitter and basic MBMS gateway (Release 14)
  - Standalone 5G Broadcast transmitter for QRDs and CRDs (Rel 9 with Receive-Only Mode capabilities)
  - MBMS Modem/Receiver (Release 17)
  - MBMS Middleware
  - Web User Interface for PHY layer and signaling parameters with integrated player
- Implementation of FLUTE and ROUTE libraries for the MBMS Modem
- Support of DASH, HLS and RTP playback over 5G Broadcast
- Support for seamless switching (only HLS) between unicast and broadcast

Not implemented and welcome…

- Uplift of 5G Broadcast transmitter to Release 18
- Seamless switching and Android middleware support for DASH
- Further development of MBMS gateway
- Development of BM-SC with xMB interface

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5G Broadcast SDR-based Modem

- Software-defined radio (SDR)-based modem with support of:
  - Receive-only mode services within a mixed carrier (support of Rel-14 ROM)
  - Receive-only mode services in a dedicated carrier (support of Rel-14, Rel-16 and Rel-17 features)
- Dedicated 5G Broadcast SDR modem implements the following Rel-16 features:
  - Increased CAS robustness
    - PBCH repetition
    - Semi-static CFI in MIB
    - New PDCCH format 4: 16 CCEs / 144 REGs
  - New subcarrier spacings 0.37 kHz, 1.25 kHz and 2.5 kHz
- Dedicated 5G Broadcast SDR modem implements the following Rel-17 features:
  - Support for 6/7/8 MHz MBSFN subframes
- Other improvements:
  - Merged features from all branches (dual-rx, mixed mode, …) into development
  - Took care of warnings: Now builds clean again with GCC 11.4 at -Wall -Wextra -Wpedantic -Werror
  - Brought srsRAN_4G up to latest main branch revision from SRS
  - Improved MIB decoding for dedicated cells, was getting confused by MBSFN symbols
  - Speed up startup/synchronisation: SDR is only retuned if parameters have changed
  - Fixed PDSCH resource allocation for 1.4MHz / 6 PRBs

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MBMS:
MBMS Modem - Rel 17 Support

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5G Broadcast Transmitters

- Work on two versions of transmitters oriented to:
  - Receive-only mode services within a mixed carrier (support of Rel-14 ROM for CRD/QRDs)
  - Receive-only mode services in a dedicated carrier (support of Rel-14, Rel-16 and Rel-17 features)

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MBMS:
5G Broadcast Transmitters

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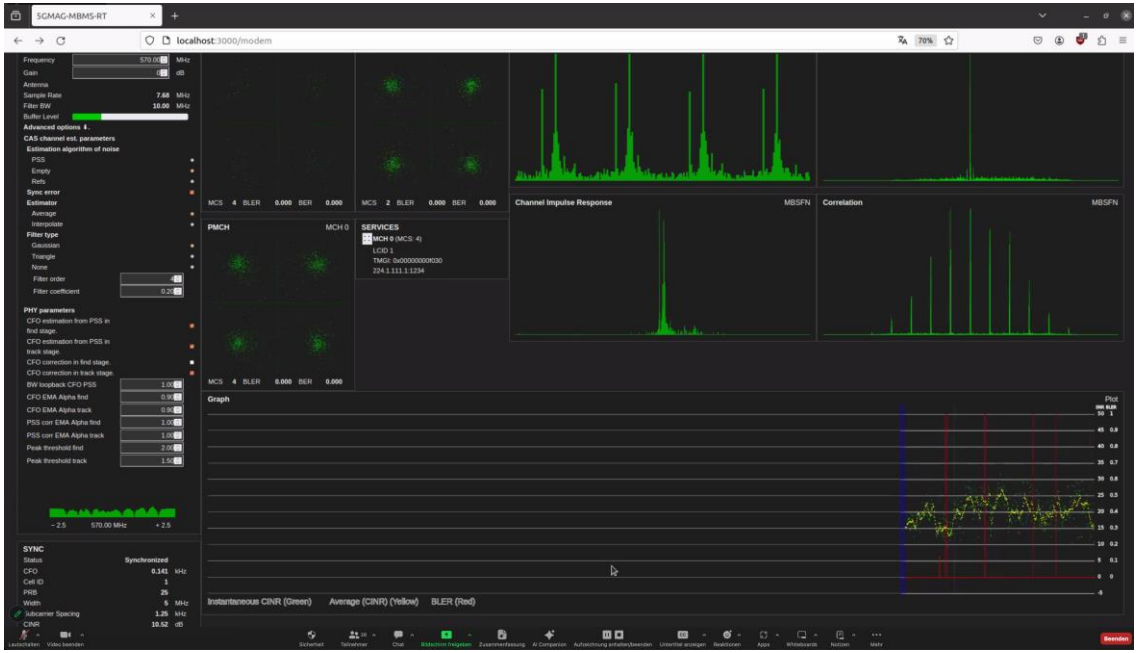
Web User Interface

WORK IN PROGRESS

Web User Interface (rt-mbms-wui)

- Interfaces via RESTful API to rt-mbms-modem and rt-mbms-mw
- Useful for checking basic reception parameters
- Middleware file list and service announcement
- Contains HLS and DASH players

- New features added for visualization of advanced parameters



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MBMS:
Web User Interface

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5G Broadcast & Hybrid Unicast-Broadcast

- Seamless switching between broadcast and OTT/unicast content delivery
- Enables flexible usage of bandwidth
  - Broadcast on demand: services can be dynamically provisioned when the demand is there, otherwise viewers are on OTT / using CDN download
  - Off-peak times are freed for e.g. content prepositioning / data services
  - Any mix is possible, e.g.
    - 24/7 radio channels with robust coding and SCS 2.5kHz for high mobility
    - 4 TV channels at 1080p / 3 Mbps during the day, but only one at UHD / 12 Mbps for a sports game in the evening
- Mobility scenarios between MBSFN areas: can carry same MBMS service

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MBMS:
Seamless switching between broadcast & unicast

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Implementing...
Emergency Alerts over 5G Broadcast

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EMERGENCY ALERTS OVER 5G BROADCAST

LTE-BASED 5G BROADCAST EXTENDED WITH PUBLIC WARNING SYSTEMS

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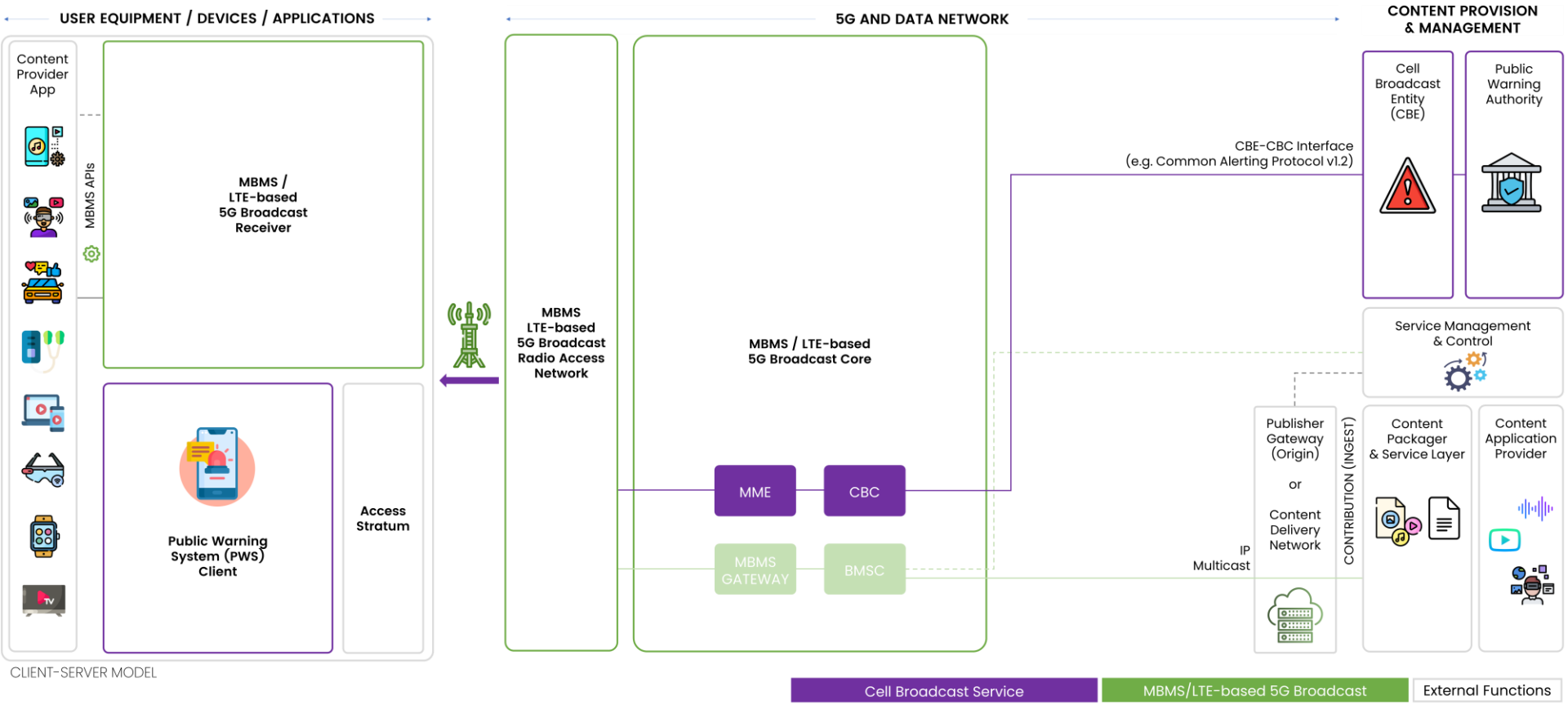

Available Resources

- GitHub Repositories:
  - 5G Broadcast Transmitter (rt-mbms-tx)
  - Transmitter for QRDs and CRDs (rt-mbms-tx-for-qrc-crd)
  - MBMS Middleware (rt-mbms-mw)
  - MBMS Modem (rt-mbms-modem)
  - Web User Interface for Modem, MW & Application (rt-wui)
  - MBMS Examples (rt-mbms-examples)

- Find in our GitHub the following resources:
  https://github.com/5G-MAG/Getting-Started/wiki/Emergency-Alerts-5G-Broadcast
  - Specifications and architecture
  - On-going projects
  - Using the tools
  - Related repositories

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Under development: What is missing?

Under development…

- Initial support of SIB12 delivery over eNodeB

Not implemented and welcome…

- Development of MME with interface to CBC
- Development of CBC and interface to MME
- Development of CBE generating CAPv1.2 to CBC
- Mapping of CAPv1.2 to SIB12

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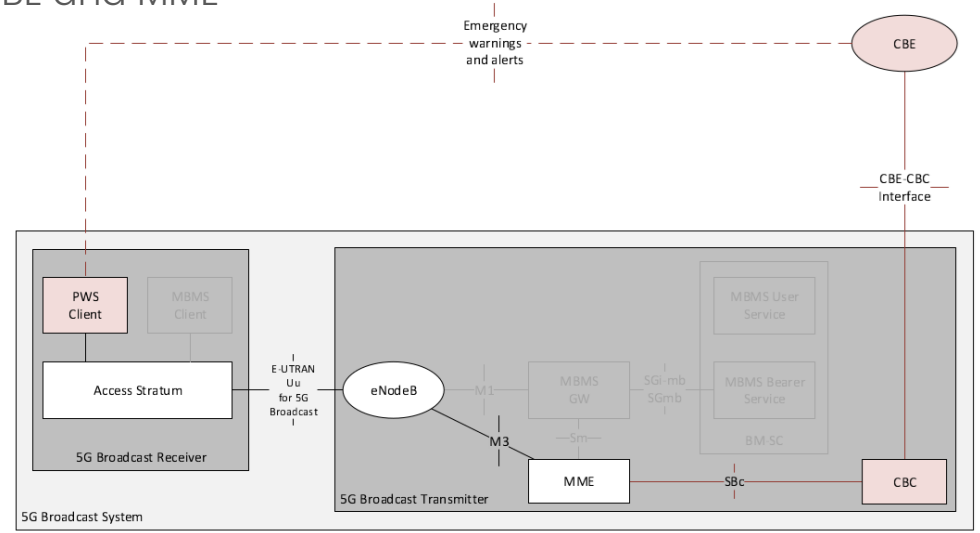
Emergency Alerts over 5G Broadcast

WORK IN PROGRESS

- Implementation of Cell Broadcast Service functions
  - Cell Broadcast Entity (CBE)
  - Cell Broadcast Center (CBC)
- Implementation of interface CBE-CBC with Common Alerting Protocol v1.2 (CAP v1.2)
- Implementation of interface SBc between CBE and MME



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[MBMS: Public Warning System]

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Implementing...
5G Multicast-Broadcast Services (MBS)

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STREAMING OVER 5G MULTICAST-BROADCAST SERVICES

5G MULTICAST-BROADCAST USER SERVICES (3GPP REL-17)

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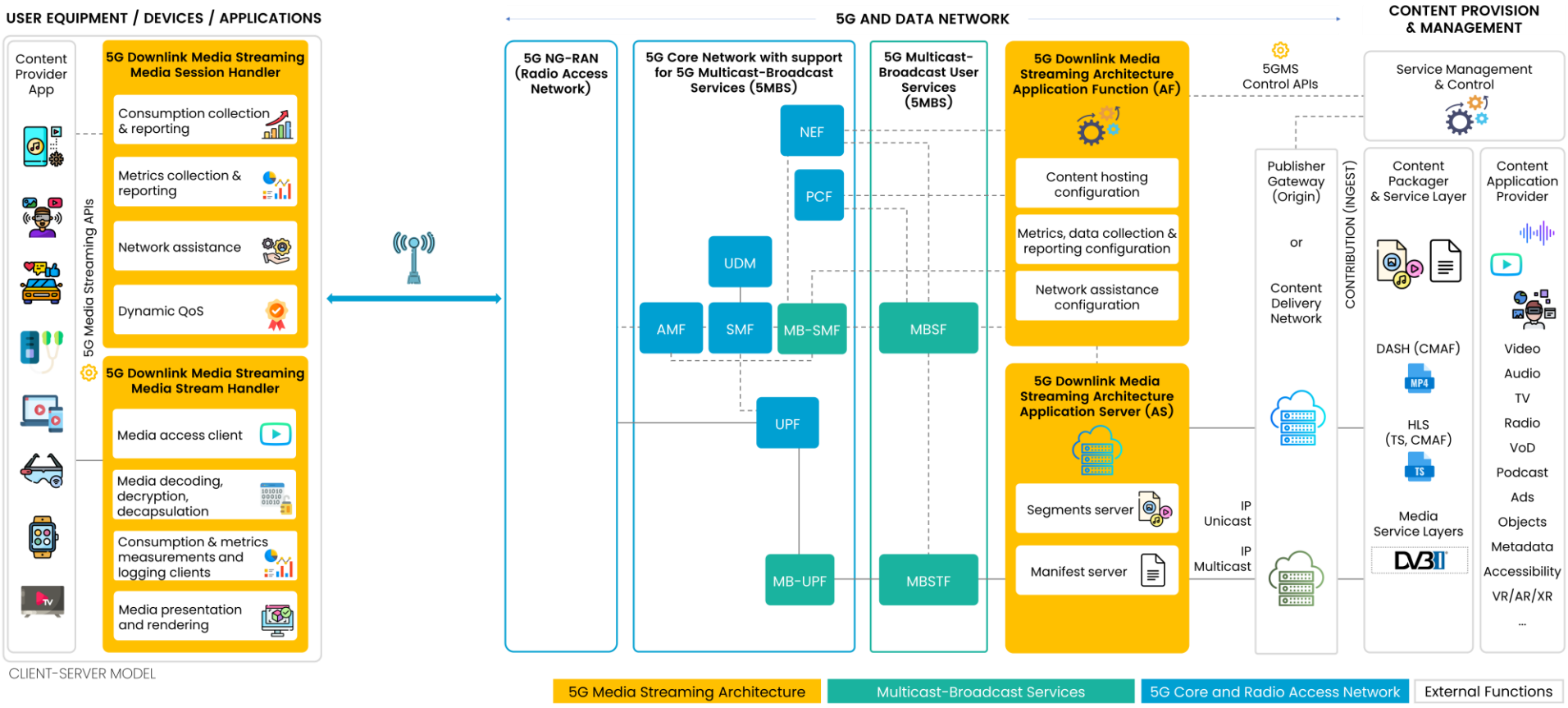

Available Resources

- GitHub Repositories:
  - Under development

- Find in our GitHub the following resources:
  https://github.com/5G-MAG/Getting-Started/wiki/5G-Multicast-Broadcast-Services
  - Specifications and architecture
  - On-going projects
  - Using the tools
  - Related repositories

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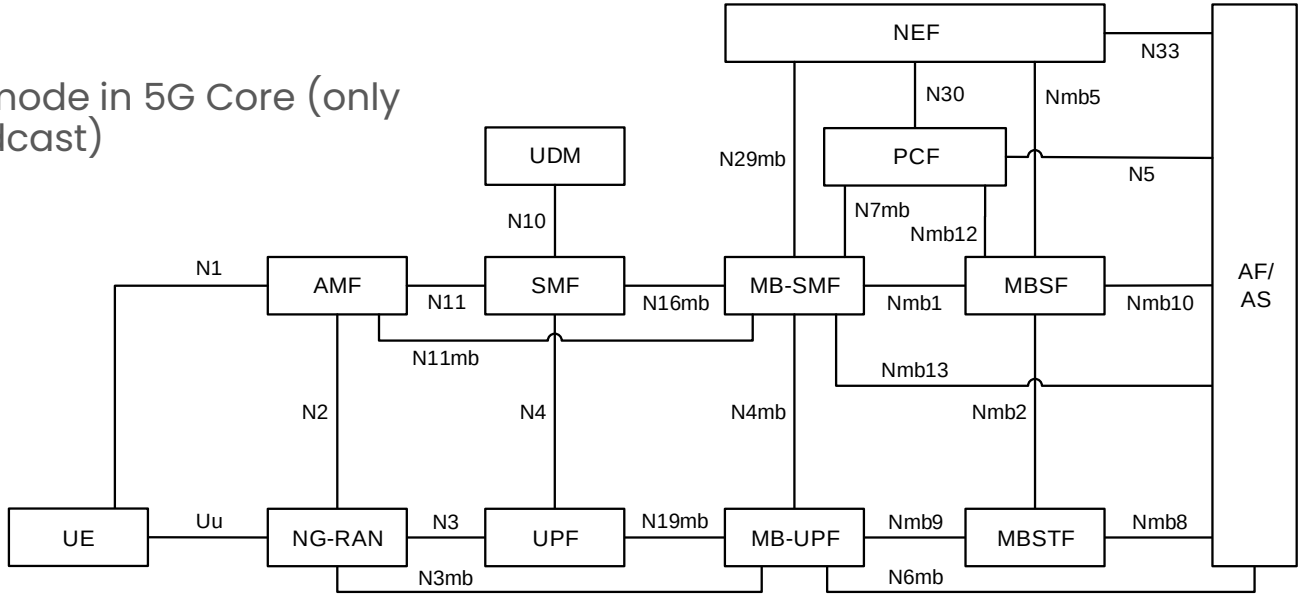
Under development: 5MBS Masterplan

- Start with Broadcast mode in RAN and 5G Core
  - MVP#0: only user plane – MB-UPF
  - MVP#0.1: user plane and control plane* – MB-UPF, MB-SMF* and AMF*

Why? Less complexity (MBS session management, implementation)

- Continue with Multicast mode in 5G Core (only shared subset with Broadcast)



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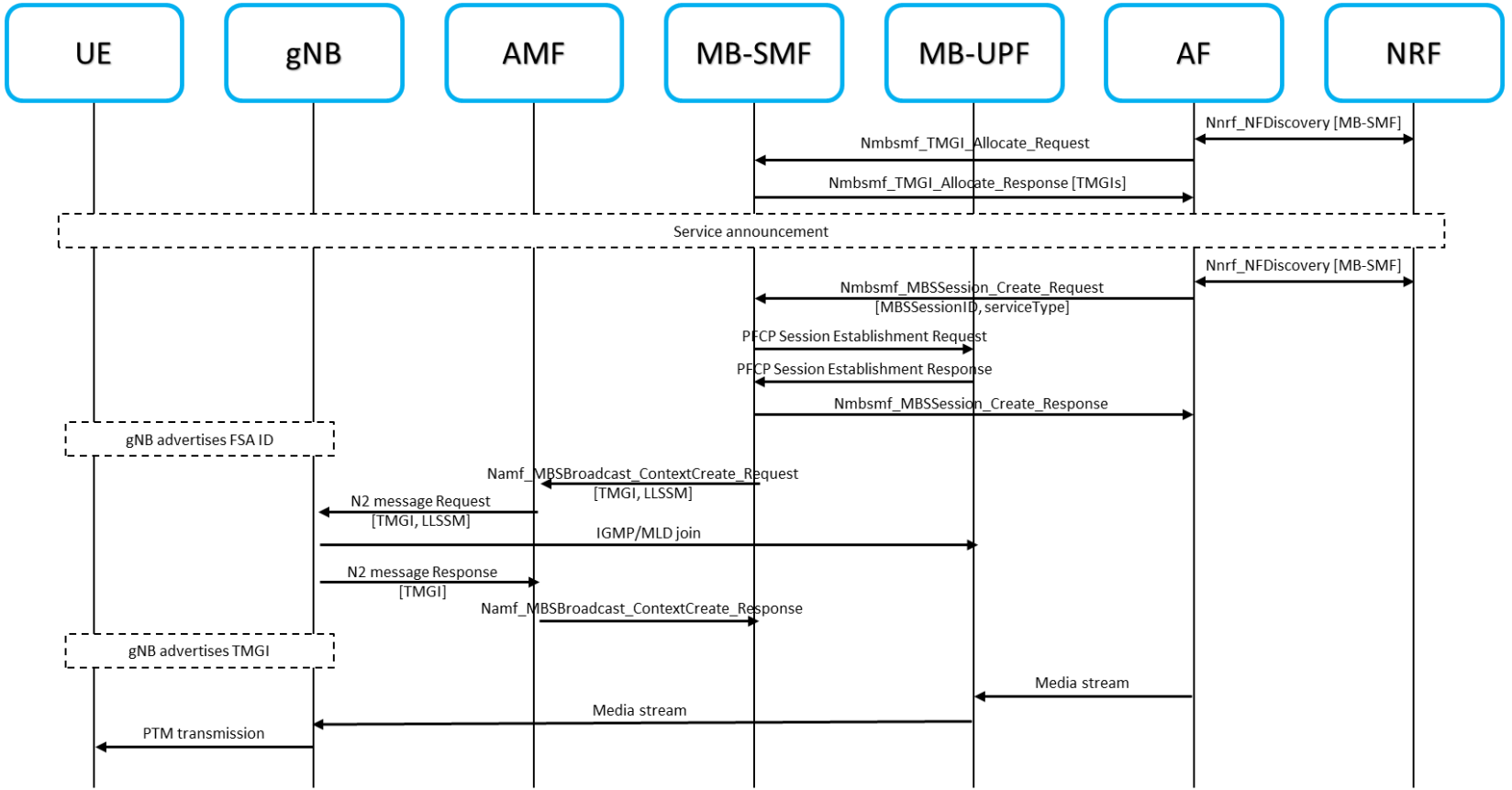
Under development: Progress



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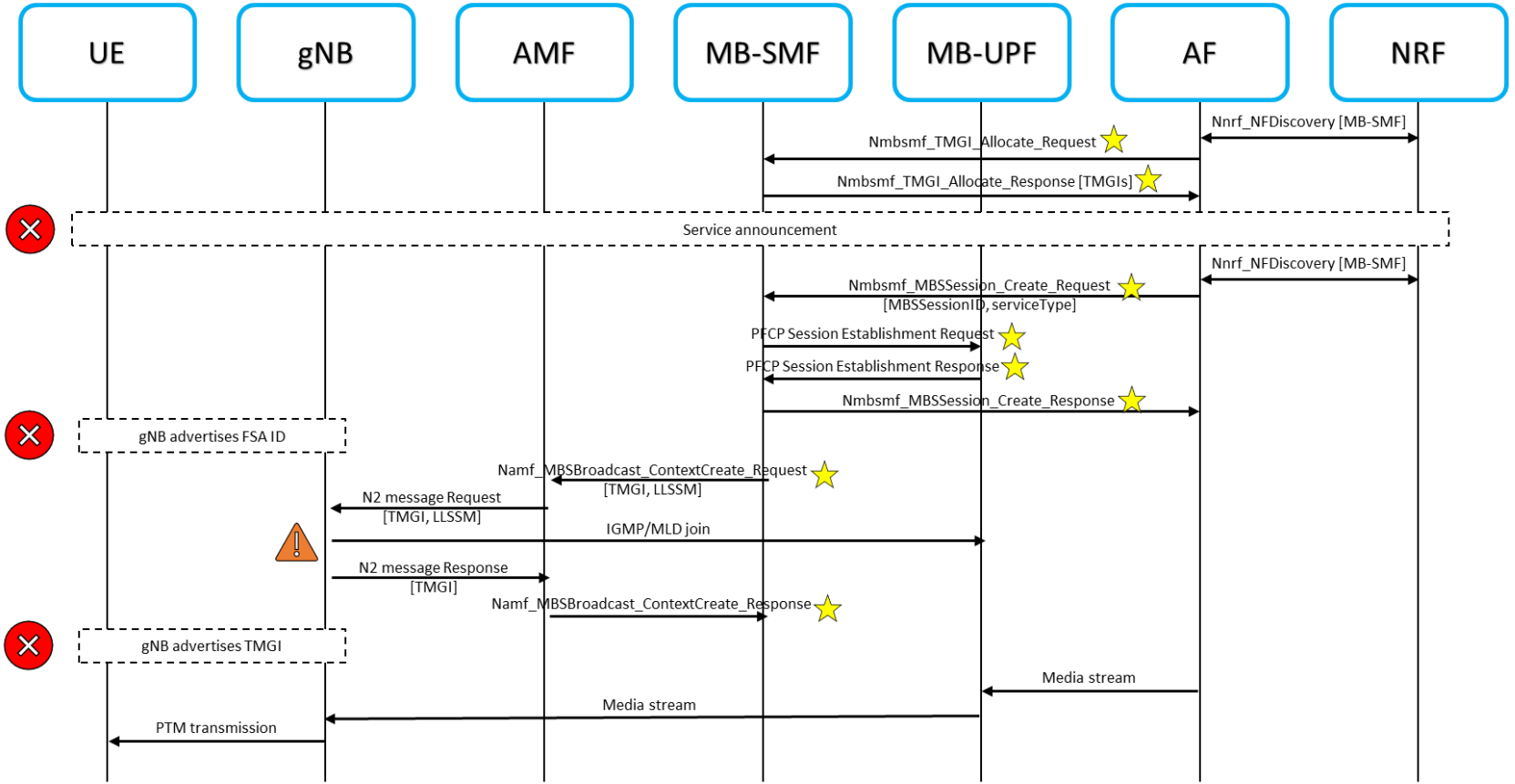
Under development: Progress



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Under development: What is missing?

Under development…

- Initial support of MB-UPF in 5GC

Not implemented and welcome…

- Support for MBS in gNodeB
- MBS User Services
- Linux-based Modem with MBS support

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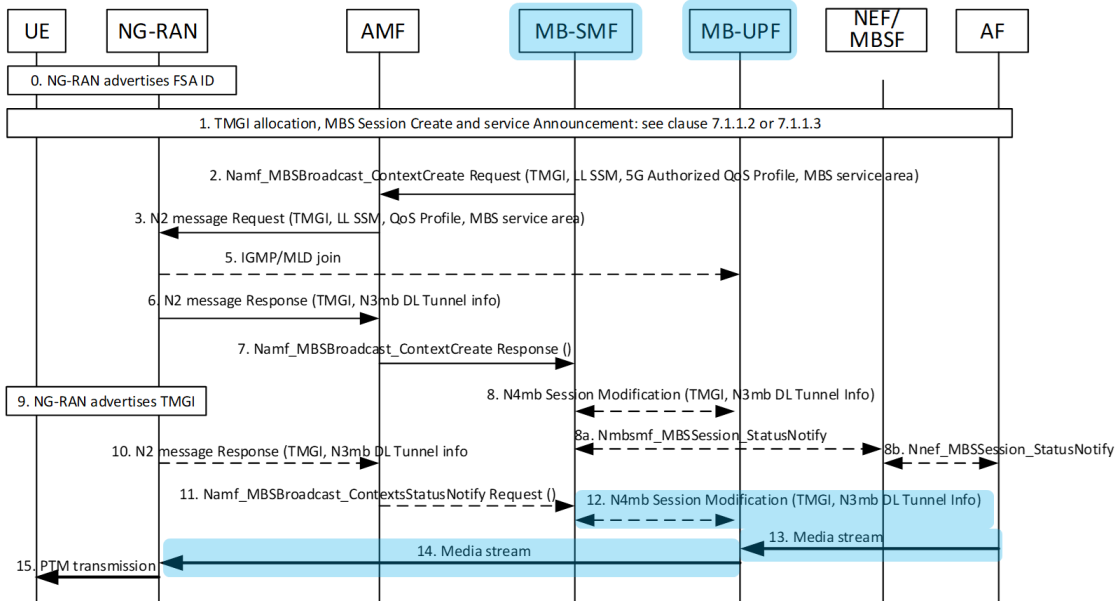
5G Core functions for MBS

WORK IN PROGRESS

- Initial implementation of **MB-UPF and basic multicast capabilities in the 5G Core**
- Start with Broadcast mode in RAN and 5G Core
  - MVP#0: only user plane – MB-UPF
  - MVP#0.1: user plane and control plane* – MB-UPF, MB-SMF* and AMF*

Why? Less complexity (MBS session management, implementation)

- Continue with Multicast mode in 5G Core (only shared subset with Broadcast)



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5MBS:
5G Core functions (MB-UPF)

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Implementing...
XR Media integration in 5G

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Qualcomm

XR & Immersive Media

3GPP Baseline Architecture for AR/MR (XR Baseline Client)

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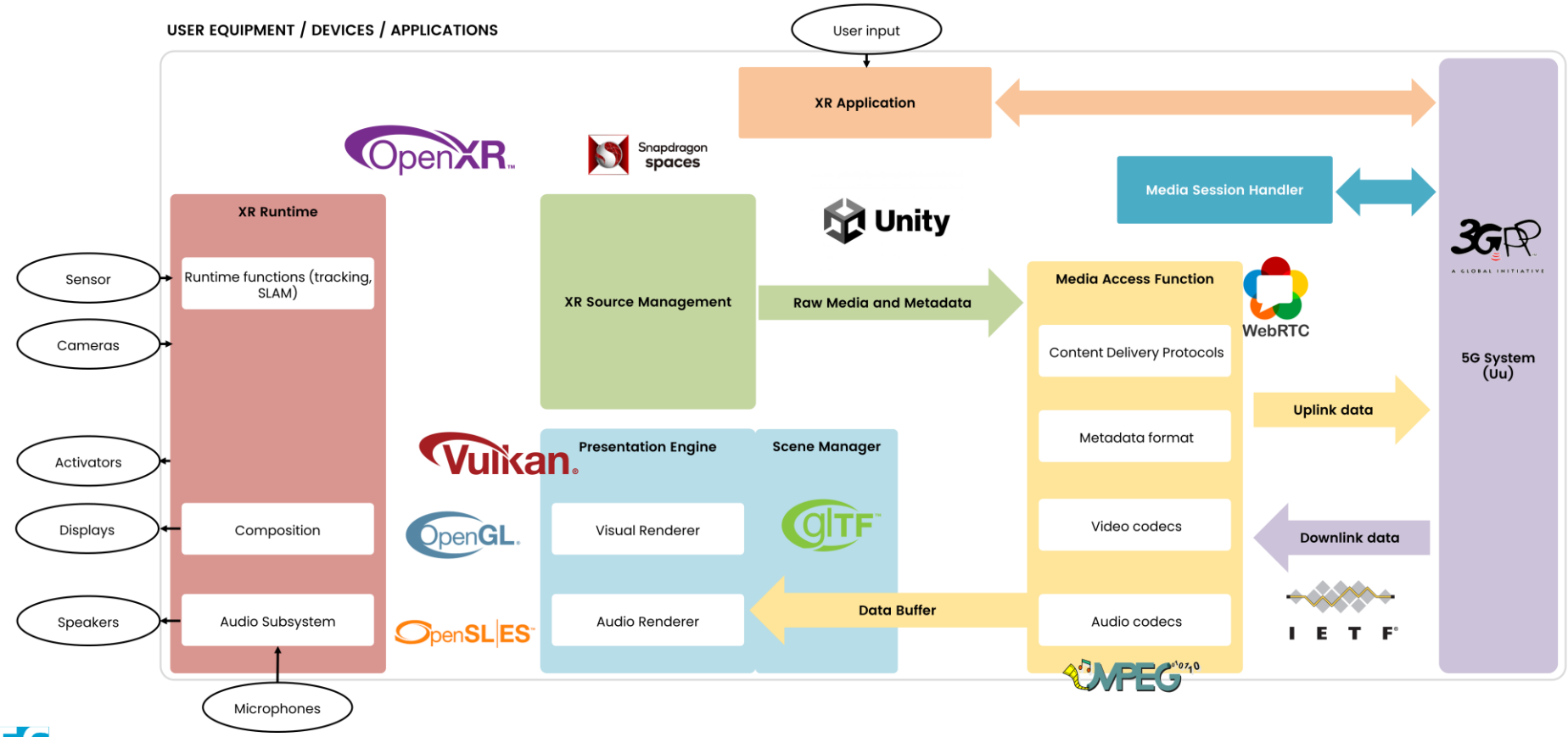

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Available Resources

- At the moment these GitHub Repositories are private:
  - XR Unity Player (rt-xr-unity-player)
  - XR Blender Exporter (rt-xr-blender-exporter)
  - Efficient glTF 3D import / export package for Unity (rt-xr-glTFast)
  - XR Content (rt-xr-content)
  - XR MAF Plugin (rt-xr-maf-plugin)
  - XR MAF Native (rt-xr-maf-native)

- Find in our GitHub the following resources:
  https://github.com/5G-MAG/Getting-Started/wiki/XR-Media-integration-in-5G
  - Specifications and architecture
  - On-going projects
  - Using the tools
  - Related repositories

These repositories are currently under development and testing

- Early access for testing can be requested using the form available at
- www.5g-mag.com/early-access

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Under development: XR Media Integration in 5G

Content Playback

- Unity and Unreal Engine 5 are widely used for the creation of 3D experiences
- An open-source XR Player based on Unity Plugins is available (an XR Web Player is expected too)
- Player is able to load at runtime a 3D scene and render it to create an immersive expériences
- Open-source will help developers to get started with standardized technologies and their integration into 5G-MAG

Content Creation

- Blender is an open-source and widely used 3D authoring tool with native support for glTF
- Extended Blender for authoring Metaverse 3D scenes
- Open-source project to close the loop on content creation/consumption
- Project in has recently been released through 5G-MAG
- Enables developers to create content and ship players that can consume it

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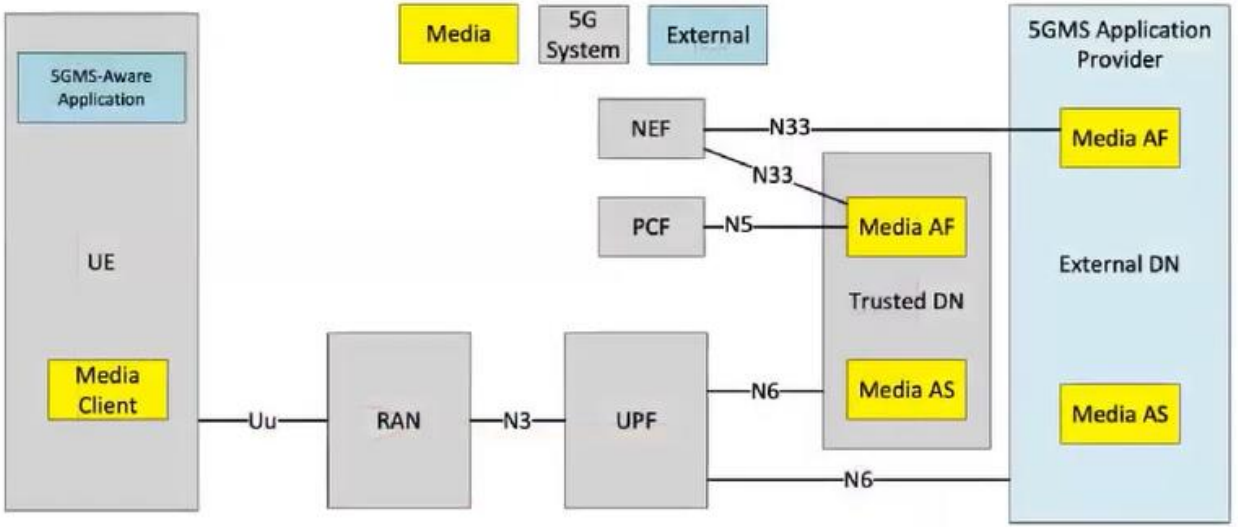
Under development: XR Media Integration in 5G

- Next steps into integration with 5G
  - Enable QoS suppoted asset component streaming and download
  - Support both DASH and WebRTC
  - Interface with MSH to request QoS for multiple streams
  - Contributions are solicited



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XR repos with ISO/IEC 23090-14 functionalities

- All issues related to the release of version 1.0.0 of the XR repositories dealing with functionalities defined in ISO/IEC 23090-14

- More information soon, please check: www.5g-mag.com/tutorials

- Background information is available here:
  - Slides: https://www.khronos.org/developers/linkto/gltf-2.0-extensions-in-mpeg-and-3gpp-real-time-exchange-formats-for-3d-experiences
  - Video: https://www.khronos.org/developers/linkto/gltf-2.0-extensions-in-mpeg-and-3gpp-real-time-exchange-formats-for-3d-experiences-vid
  - White paper: https://mpeg.org/wp-content/uploads/mpeg_meetings/140_Mainz/w22138.zip

Kanban board

XR: Repositories with ISO/IEC 23090-14:2023 functionalities - Release 1.0.0

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Implementing...
AI/ML Evaluation Framework

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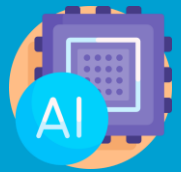
Qualcomm interdigital



Available Resources

- At the moment these GitHub Repositories are private:
  - Evaluation Framework for AI/ML (rt-ai-ml-evaluation-framework)

- Find in our GitHub the following resources:
  https://github.com/5G-MAG/Getting-Started/wiki/AI-ML-Evaluation-Framework
  - Specifications and architecture
  - On-going projects
  - Using the tools
  - Related repositories

These repositories are currently under development and testing

- Early access for testing can be requested using the form available at
- www.5g-mag.com/early-access

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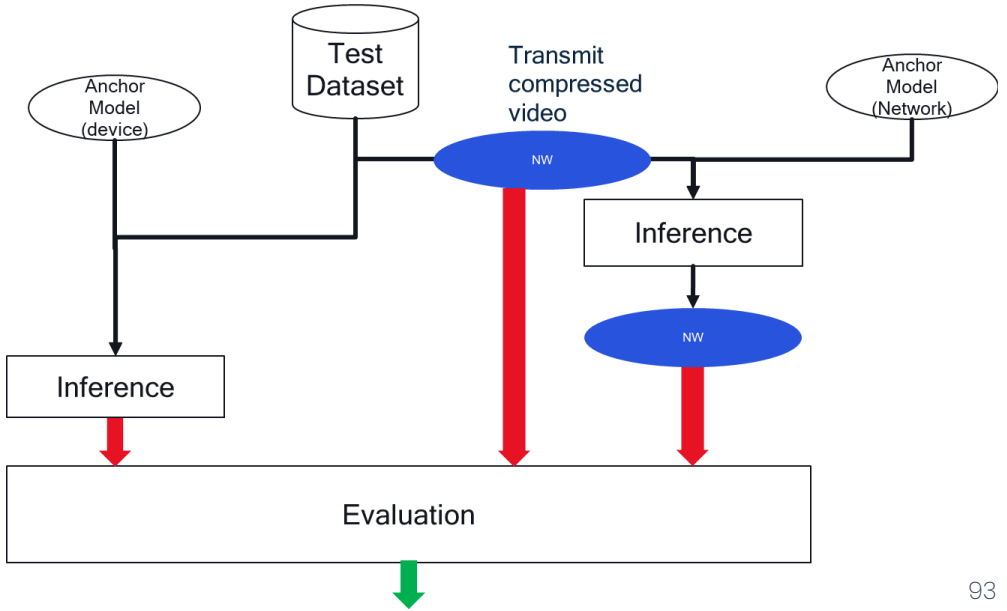
AI/ML Evaluation Framework

- This project is the implementation of the AI/ML evaluation framework as defined in 3GPP SA4 TR 26.847.
- The purpose is to establish an evaluation framework and use it for the evaluation of scenarios collected for the 3GPP FS_AI4Media study. This includes the collection of scenarios based on the use cases identified, and defining a scenario template for the description of scenarios for the evaluation.
- The evaluation framework documents common testbed architectures and anchors, metrics (e.g. AI/ML task metrics, feasibility/performance metrics), and specific details (such as test configuration and constraints) for each scenario evaluation.



Kanban board

AI/ML:
Evaluation Framework

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Extras for 5G-MAG members

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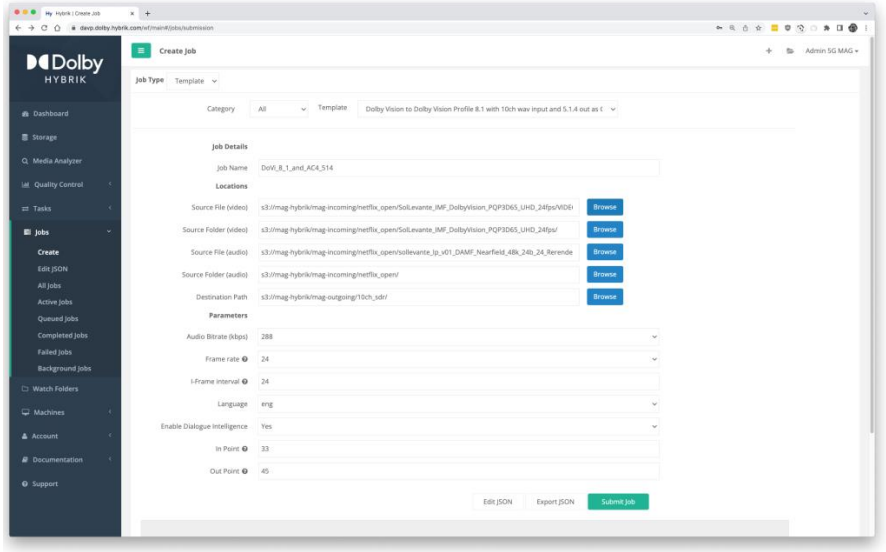
Encoding service from Dolby Laboratories

THANK YOU

- Currently 10 encoding recipes available, reach out if you're looking for something else
- Free cloud-based encoding service for experimentation in scope of 5G-MAG Reference Tools
- Leveraging Dolby's professional infrastructure (Hybrik)
- Best effort and limited support for contributors (no SLA)

- **Free demo and testing licenses are made available by Dolby Laboratories to 5G-MAG members.**
- Please contact Kurt Krauss at Kurt.Krauss@dolby.com



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5G Broadcast Modulator from Bitstem

THANK YOU

Bitstem

- Supports FeMBMS (3GPP Release 14 up to 18) and eMBMS (Release 9/12 mixed mode for Android prototype handsets CRD/QRD)
- Channel bandwidths 3, 5, 6, 7, 8 and 10 MHz
- Subcarrier spacings (Δf) of 0.37, 1.25, 2.5, 7.5 and 15 kHz
- Supports ETWS/cell broadcast warning message distribution via SIB12
- RESTful API for configuration, control and status to allow for integration into an existing web interface or configuration system
- Data and control inputs through standardised M1, S1 and M2 interfaces, compatible with 3GPP-compliant 5G Broadcast cores
- Output of modulated I/Q data via Ethernet
- Supports demos and trials through direct ingress of traffic and local configuration, and can output I/Q data via USB directly to BladeRF SDRs
- **Free demo and testing licenses are made available by Bitstem to 5G-MAG members.**
  - Please contact Klaus Kühnhammer at klaus@bitstem.com

5GM turns your OFDM transmitter into a 5G Broadcast transmitter.

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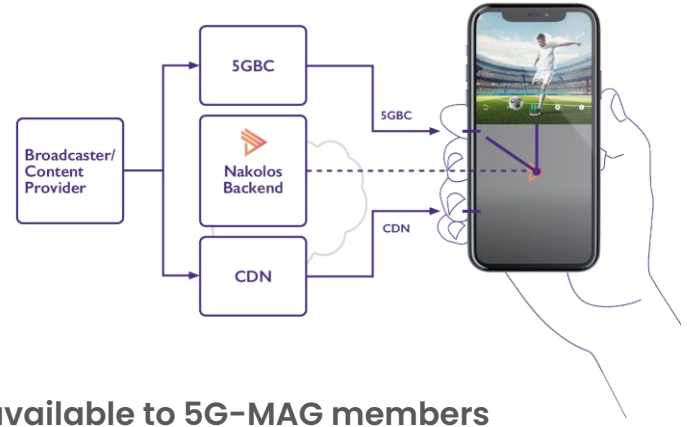
Nakolos: 5G Broadcast meets Broadband

THANK YOU

- Nakolos, a joint-project by ORS Group and Bitstem GmbH develops products and solutions for content providers and broadcast network operators to utilize the combination of 5G Broadcast and Broadband.
- 5G Broadcast Core
  - FeMBMS, LTE-based terrestrial broadcast (3GPP Releases 14, 16, 17), eMBMS (Release 9/12 mixed mode for Android prototype handsets CRD/QRD)
  - Operable in 5G BC standalone or connected mode for broadcast-broadband solutions
  - Runs on-premise or in the cloud
  - Interoperability with different transmitter vendors and emergency warning systems by supporting 3GPP interfaces: xMB, M1, M2, M3, CAP
  - High availability through redundancy on-premise or in the cloud
- 5G Broadcast middleware
  - Standalone app for use-case tests
  - Easy integrable into existing apps for commercial use
- Hybrid connect
  - Broadband load monitoring
  - Dynamic provisioning of 5G Broadcast cores
  - Reports and insights



- **Free demo and testing licenses for the 5G Broadcast core are made available to 5G-MAG members**
  - Please contact Johann Mika at johann.mika@ors.at (More info at www.nakolos.com)

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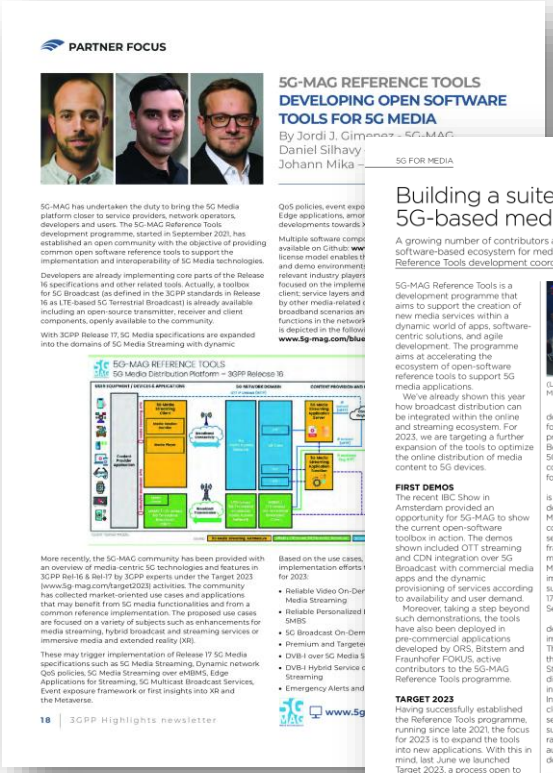
5G-MAG Reference Tools in use

developer.5g-mag.com

Conferences and Publications


PARTNER FOCUS

5G-MAG REFERENCE TOOLS
DEVELOPING OPEN SOFTWARE TOOLS FOR 5G MEDIA

By Jordi J. Giménez - 5G-MAG
Daniel Silhavy
Johann Mika –

5G-MAG has undertaken the duty to bring the 5G Media platform closer to service providers, network operators, developers and users. The 5G-MAG Reference Tools development programme, started in September 2021, has established an open community with the objective of providing common open software reference tools to support the implementation and interoperability of 5G Media technologies.

Developers are already implementing core parts of the Release 16 specifications and other related tools. Actually, a toolbox for 5G Broadcast (as defined in the 3GPP standards in Release 16 as LTE-based 5G Terrestrial Broadcast) is already available including an open-source transmitter, receiver and client components, openly available to the community.

With 3GPP Release 17, 5G Media specifications are expanded into the domains of 5G Media Streaming with dynamic

QoS policies, event expo
Edge applications, amor
developments towards

Multiple software compo
available on Github: www
license model enables t
and demo environment
relevant industry player
focused on the impleme
client; service layers and
by other media-related
broadband scenarios an
functions in the network
is depicted in the follow
www.5g-mag.com/blue

5G-MAG REFERENCE TOOLS
5G Media Distribution Platform – 3GPP Release 16

More recently, the 5G-MAG community has been provided with an overview of media-centric 5G technologies and features in 3GPP Rel-16 & Rel-17 by 3GPP experts under the Target 2023 (www.5g-mag.com/target2023) activities. The community has collected market-oriented use cases and applications that may benefit from 5G media functionalities and from a common reference implementation. The proposed use cases are focused on a variety of subjects such as enhancements for media streaming, hybrid broadcast and streaming services or immersive media and extended reality (XR).

These may trigger implementation of Release 17 5G Media specifications such as 5G Media Streaming, Dynamic network QoS policies, 5G Media Streaming over eMBMS, Edge Applications for Streaming, 5G Multicast Broadcast Services, Event exposure framework or first insights into XR and the Metaverse.

Based on the use cases,
implementation efforts
for 2023:

- Reliable Video On-Der
  Media Streaming
- Reliable Personalized
  5MBS
- 5G Broadcast On-Dem
- Premium and Targete
- DVB-I over 5G Media S
- DVB-I Hybrid Service
  Streaming
- Emergency Alerts and

www.5g

18 | 3GPP Highlights newsletter

5G FOR MEDIA

Building a suite of open-source tools for 5G-based media services

A growing number of contributors are collaborating to accelerate t
software-based ecosystem for media applications. **Daniel Silhavy**
Reference Tools development coordinator, describes the work and

5G-MAG Reference Tools is a development programme that aims to support the creation of new media services within a dynamic world of apps, software-centric solutions, and agile development. The programme aims at accelerating the ecosystem of open-software reference tools to support 5G media applications.

We've already shown this year how broadcast distribution can be integrated within the online and streaming ecosystem. For 2023, we are targeting a further expansion of the tools to optimize the online distribution of media content to 5G devices.

FIRST DEMOS

The recent IBC Show in Amsterdam provided an opportunity for 5G-MAG to show the current open-software toolbox in action. The demos shown included OTT streaming and CDN integration over 5G Broadcast with commercial media apps and the dynamic provisioning of services according to availability and user demand.

Moreover, taking a step beyond such demonstrations, the tools have also been deployed in pre-commercial applications developed by ORS, Bitstem and Fraunhofer FOKUS, active contributors to the 5G-MAG Reference Tools programme.

TARGET 2023

Having successfully established the Reference Tools programme, running since late 2021, the focus for 2023 is to expand the tools into new applications. With this in mind, last June we launched Target 2023, a process open to the media and telecom industries, to on-board use cases. It has been instrumental in drawing the picture of what 5G-MAG

(L to R): Jordi Giménez (5G-MAG), Daniel
Mika (ORS Group) and Antonio Arcidiacc

developers may be able to deliver for 2023, with the roadmap presented at IBC2022. Below is an outline of what 5G-MAG Reference Tools contributors are currently focusing on.

BBC Research & Development is contributing to the development of baseline 5G Media Streaming features such as content hosting and media session handling, providing a framework for contributors to add more advanced functionality. Meanwhile, it is working to implement multicast-broadcast support based on 3GPP Release 17 Multicast and Broadcast Services (MBS).

Dolby is contributing with the development of a reference implementation of a DVB-I player. The implementation focuses on the support of 5G Media Streaming as an entry point to different delivery mechanisms, including unicast and broadcast. In addition, Dolby provides a free cloud-based content creation service to contributing members, supporting HDR (high dynamic range) and NGA (next generation audio) for experimentation and demonstration purposes.

5G-MAG Reference Tools is a softw
open to the community. Learn mor
developer.5g-mag.com; and check
at github.com/5G-MAG.

14 tech-/ | tech.ebu.ch | December 2022

PARTNER FOCUS

DRIVING SPECIFICATIONS THROUGH 5G-MAG'S OPEN-SOURCE REFERENCE TOOLS

By 5G-MAG

3GPP has progressed and completed the enablers for media services on 3GPP-based systems. However, a reference and conformance programme to validate and prototype the 3GPP specifications and catalyze the adoption was lacking.

As the 3GPP Market Representation Partner serving the media industry vertical, the 5G Media Action Group (5G-MAG) has undertaken the task to fill this gap by co-ordinating the creation of a set of open-source reference implementations of relevant 3GPP technical specifications, which are available freely at www.5g-mag.com/reference-tools.

Transforming open standards into services and applications

5G REFERENCE TOOLS
Open Software Toolbox for Connected Media Applications

3GPP specifications for multimedia applications

3GPP started developing functionalities for multimedia services and applications as part of the Rel-16 and Rel-17 specifications. These include enablers for 5G Media Streaming and extensions such as edge processing, analytics and event exposure, improvements to LTE-based 5G Broadcast and hybrid services, 5G Multicast Broadcast Services (MBS); eXtended Reality (XR) and Augmented Reality (AR) experiences. In parallel to this work, 5G-MAG is developing reference software - the 5G-MAG Reference Tools.

To this date, the following components and functionalities are available in our repositories (www.5g-mag.com/repositories):

- End-to-end MBMS and **LTE-based 5G Broadcast** system with a set of Rel-17 features supported in a standalone transmitter, modem and middleware.
- A reference implementation of the **FLUTE** protocol for multicast file transfer.
- Network-side support for downlink 5G Media Streaming (5GMSd) with:
  - A reference **5GMSd Application Function** supporting northbound provisioning operations (at reference point M1d) and southbound network operations (at reference point M5) to UEs via the User Plane.

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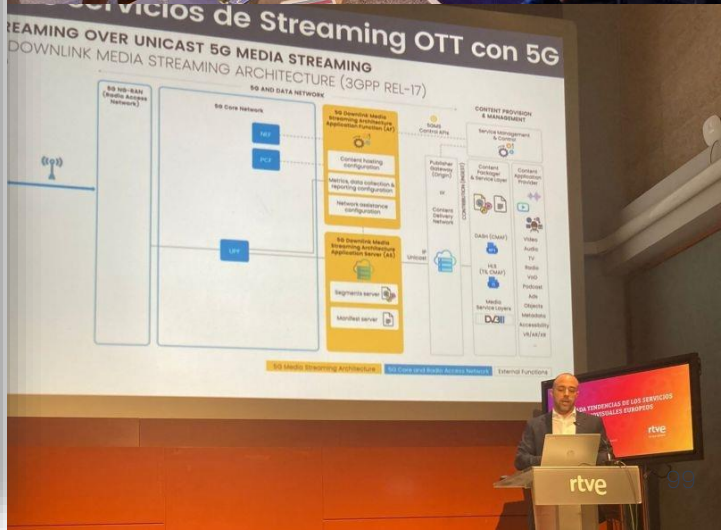

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Demos @ IBCShow 22

5G-MAG

Nakolos (ORS/Bitstem)

Fraunhofer FOKUS

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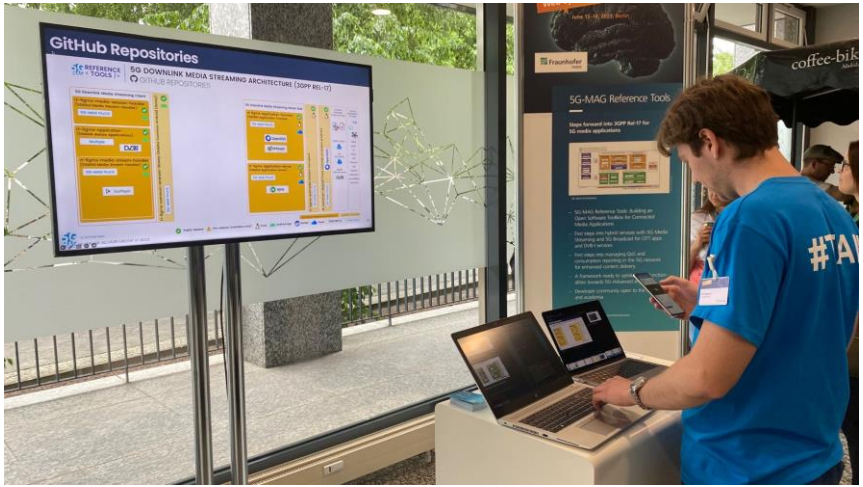
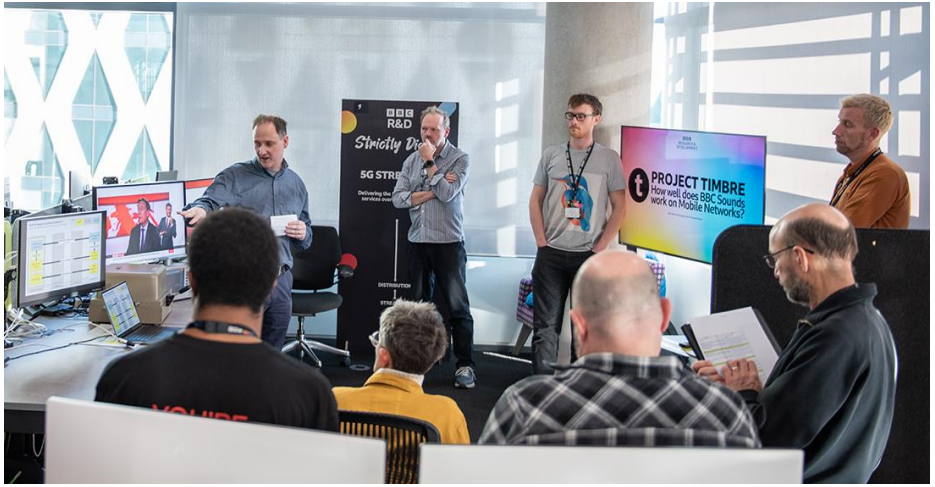
5G-MAG Reference Tools Demos 2023





FOKUS Media Web Symposium 2023

BBC R&D Open Day 2023

IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB) 2023

www.5g-mag.com/events

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5G-MAG Reference Tools @ IBCShow 2023

BRINGING 5G MEDIA STREAMING TO LIFE

5G-MAG DEMO POWERED BY 5G-MAG REFERENCE TOOLS

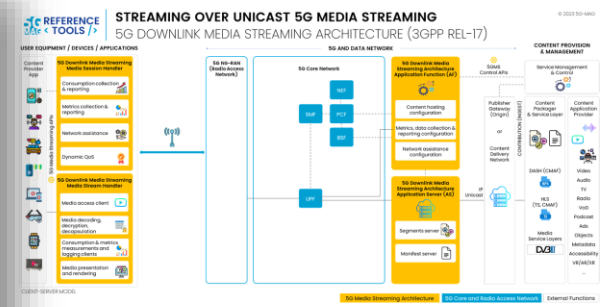
VISIT US AT BOOTH 10.D21 (EBU)

DEMO SETUP BY BBC R&D

CONTRIBUTIONS FROM: Fraunhofer FOKUS, Qualcomm, Dolby and BBC R&D

STREAMING OVER UNICAST 5G MEDIA STREAMING

5G DOWNLINK MEDIA STREAMING ARCHITECTURE (3GPP REL-17)



5G Media Streaming (5GMS) is a set of technical specifications defined in 3GPP with the aim to achieve better media streaming Quality of Experience by effective collaboration between content providers and mobile networks. Key features under development include:

- Content Hosting
  - CDN deployed inside/outside the mobile network.
- Dynamic network QoS policy
  - Automatically tracking representation switching during a streaming session.
- Quality of Experience metrics reporting
  - Supporting non-real-time performance auditing.
- Network Assistance
  - Throughput estimation (bit rate recommendation).
  - Temporary delivery boost.
- Consumption reporting
  - Including exposure of CDN access logs.

The demo is using some of the 5G-MAG Reference Tools available in our GitHub. In particular the following:

- 5GMS Application Function
- 5GMS Application Server
- 5GMS Media Session Handler
- 5GMS Media Stream Handler
- 5GMS Application
- 5GMS Common Android Library
- 5GC Service Consumers

Note that this demo is partially supported by third-party components (srsRAN gNodeB and Open5GS 5GCore)

Get more details and join the Developer Community

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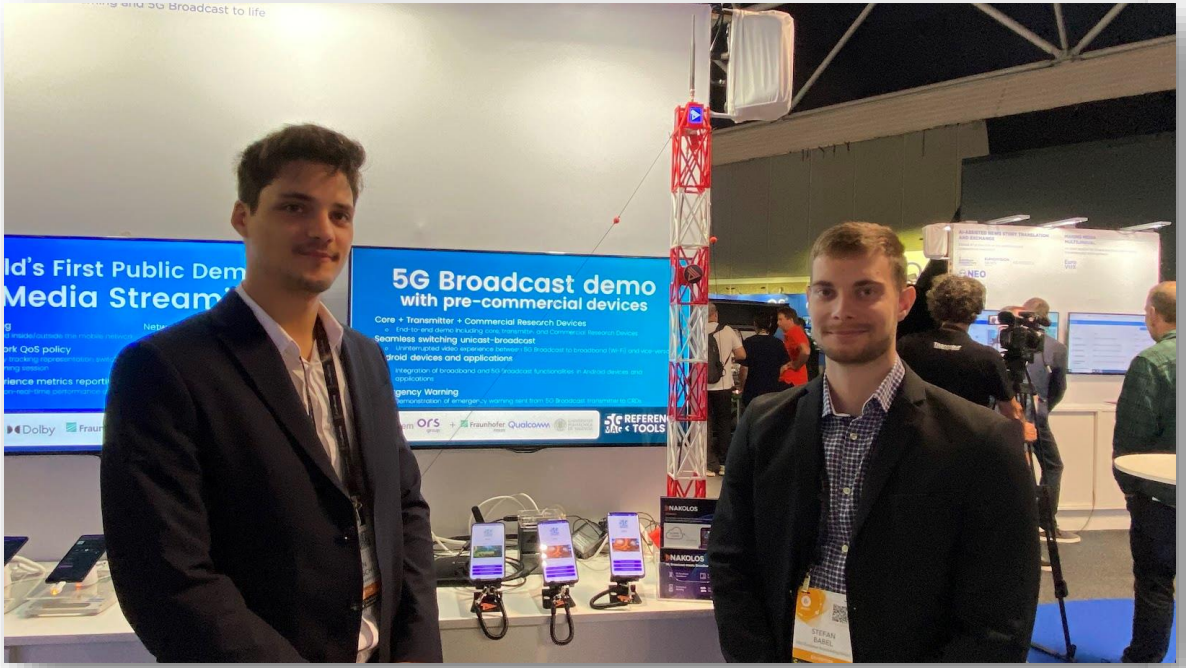
5G-MAG Reference Tools @ IBCShow 2023



BRINGING 5G BROADCAST TO LIFE

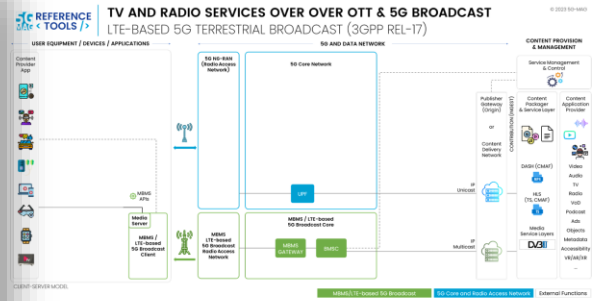
5G-MAG DEMO POWERED BY 5G-MAG REFERENCE TOOLS

VISIT US AT BOOTH **10.D21 (EBU)** DEMO SETUP BY **ORS Group** and **Bitstem**

CONTRIBUTIONS FROM **Fraunhofer FOKUS, Qualcomm, iTEAM-UPV, ORS Group** and **Bitstem**

TV AND RADIO SERVICES OVER OVER OTT & 5G BROADCAST

LTE-BASED 5G TERRESTRIAL BROADCAST (3GPP REL-17)

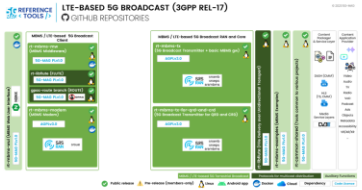


LTE-based 5G Broadcast is a set of technical specifications defined in 3GPP to address requirements for broadcasting to mainstream mobile devices. This demonstrator presents the 5G-MAG Reference Tools for 5G Broadcast running on commercial research devices (CRDs). Key features under development include:

- End-to-end demo of 5G Broadcast including 5G Broadcast core, transmitter and CRDs for reception
- Seamless switching between 5G Broadcast and broadband: uninterrupted video experience if the distribution path changes from 5G Broadcast to broadband (Wi-Fi) and vice-versa
- Integration of broadband and 5G Broadcast functionalities in Android devices and applications
- Demonstration of emergency warning sent from 5G Broadcast transmitter to CRDs.

The demo is using some of the 5G-MAG Reference Tools available in our GitHub. In particular the following:

- 5G Broadcast Transmitter for CRD
- MBMS Middleware for Android
- MBMS Middleware
- MBMS Modem
- FLUTE



Note that this demo is partially supported by third-party components (Nakolos 5G Broadcast core and Bitstem 5G Broadcast transmitter) which are not open-source but free to use for 5G-MAG members for tests and demos.

Get more details and join the Developer Community

developer.5g-mag.com

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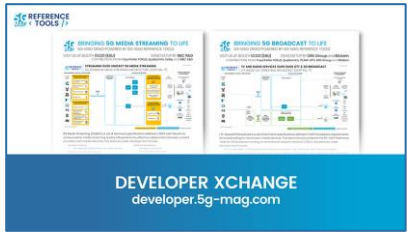
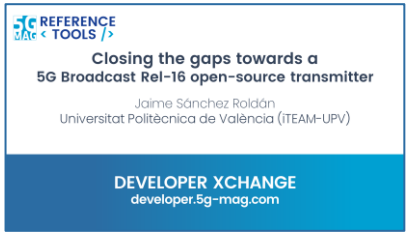
DEVELOPER XCHANGES & WORKSHOPS

DEVELOPER XCHANGES

Developers present their implementations and progress with the 5G-MAG Reference Tools. Take a look at https://www.5g-mag.com/tutorials





5G-MAG PARTICIPATES IN OSMART WORKSHOPS

The OSMART (Open-Source Media Application Reference Tools) workshop is a regular exchange involving the development of open-source software for media applications with a series of status updates and roadmaps on relevant projects from relevant organizations. Find more information: https://www.5g-mag.com/osmart and join the community at https://github.com/osmart-community/

OSMART
OPEN-SOURCE MEDIA APPLICATION REFERENCE TOOLS

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Stay tuned!

Daniel Silhavy
5G-MAG Reference Tools Development Coordinator
daniel.silhavy@fokus.fraunhofer.com

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MEDIA ACTION GROUP

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