# 5G MEDIA STREAMING ARCHITECTURE

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## ABSTRACT

The existing 3GPP Packet Switched Streaming (PSS) architecture which was developed for 3G and 4G and evolved to carry streaming content with DASH (Dynamic and Adaptive Streaming over HTTP) is now seen as too limited for 5G. 3GPP has therefore started developing a new media streaming architecture, considering the latest advances in the media industry and the features offered by the 5G system. Recognizing that nowadays most media and video content delivered to the user is provided by several online service providers, the new 3GPP 5G Media Service Architecture (5GMSA) focuses on different collaboration and deployment models between mobile network operators and media service providers. These collaboration and deployment models also cater for traditional broadcasters, which increasingly see the need for high quality contributions via mobile network, e.g. to cover unplanned or transient events. The new architecture supports unicast downlink media distribution and uplink streaming.

## 1 INTRODUCTION AND MOTIVATION

The existing 3GPP (Third Generation Partnership Project) Packet Switched Streaming (PSS) architecture, described in TS 26.233 [1] and TS 26.234 [2], was developed for 3G and 4G and was tailored for Mobile Network Operator (MNO) managed streaming services of the like of Mobile TV. Its architecture is vertical with a strong integration of its components like codecs, DRM (Digital Rights Management), transport protocols, analytics and device functionalities. PSS assumes that the services are under control of the MNO. With the explosion of online video services on Mobile Broadband Access, the PSS architecture has been evolved to support more efficient codecs and delivery protocols i.e. DASH (Dynamic and Adaptive Streaming over HTTP) with HEVC (High Efficiency Video Coding) video coding aligned with the industry, together with network assistance functions and analytics support. Despite these enhancements, the PSS architecture is still not fit for purpose to integrate current online video services.

The 5G System offers many features e.g. Mobile Broadband connectivity with high bitrates and low latency, network slicing, distributed and mobile edge compute, that have the potential to augment the quality and efficiency of Audio/Video streaming services and to enable newly emerging services beyond traditional 2D video of TV and online services like 360VR, 6DoF (6 Degrees of Freedom) VR, Augmented Reality and Mixed Reality applications. The combination of 5G system features with state-of-the-art and emerging media services promises new technical and commercial opportunities.

For the above reasons, the PSS architecture is being replaced by the 5G Media Streaming Architecture (5GMSA). 5GMSA intends to offer a simpler and more modular design enabling services with different degrees of cooperation between Third-Party content and service providers, broadcasters and MNOs. The focus of 3GPP's 5GMSA is leveraging the 5G concept of network exposure via APIs, in order to provide external service providers an easy way to interact with the 5G network and device functionalities and use the capabilities offered by 5G to delivered superior media services. The initial version of new architecture supports unicast downlink media distribution and uplink streaming, broadcast and multicast is expected to be integrated in the future.

The present article describes the 5G Media Streaming Architecture developed by 3GPP SA WG4 in Rel-16. This architecture will then serve as basis for Technical Specification of APIs (Application Programming Interface) and device and network functionality requirements within Rel-16 which is scheduled to be published end of year 2019.

## 2 5G ARCHITECTURE OVERVIEW

The 5G architecture builds upon a modular design and the separation between control plane and user plane, in order to allow scalability and flexible deployments, which is being accelerated by the increased penetration of network function virtualisation and software defined networking. Additionally, interactions among network functions in the 5G architecture is based on a service-based model and interaction between 5G network functions and external third-parties is made possible through the concept of *capability exposure*.

Figure 1 depicts the 5G architecture, with the control plane being pictured at the top (above the N1/N2/N4 interfaces) and the data plane at the bottom. The data plane consists of UE (user equipment), RAN (Radio Access Network), UPF (User plane function, essentially a network switch or router) and the DN (Data Network, i.e. the Internet). The control plane consists of several network functions needed to support a mobile connection for a UE. The most relevant network functions are the AMF (Access and Mobility Management Function, which enables the setup and teardown of a UE mobile connection), the PCF (Policy Control Function, which provides policy rules for UEs and services), the SMF (Session management function, which configures traffic routing for a particular UE session and select the UPFs that the session shall use), the NEF (Network Exposure function, which is used to expose some network capabilities to external parties) and the AF (Application

Function, which influences traffic routing and policy management for a specific application).

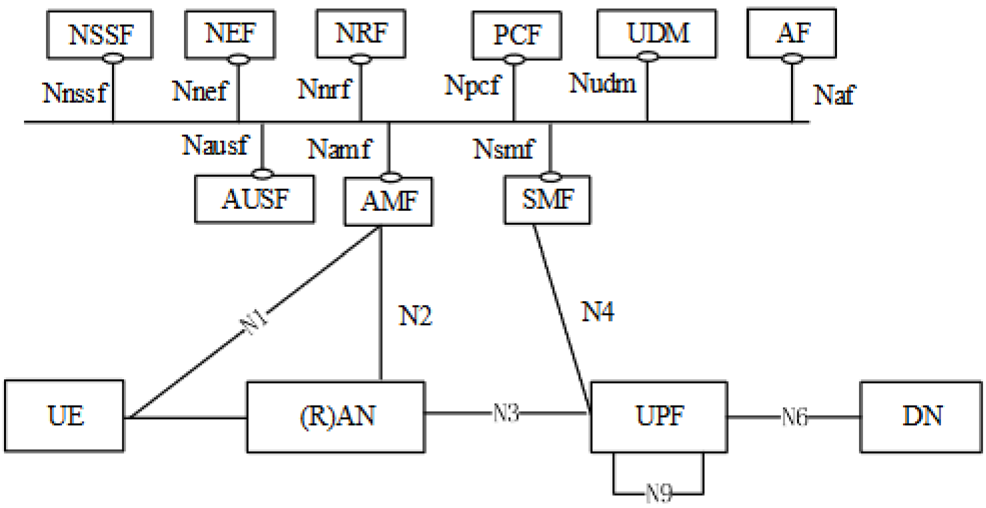


Figure 1 5G architecture

Application flows (i.e. user plane traffic) are terminated on the network side by Application Servers, which can include Application Function (AF) capabilities. Application Servers can interact with other Network Functions such as the NEF or the PCF in order to leverage exposed services such as QoS or specific charging policies. The 5G Media Streaming Architecture distinguishes Media AF and Media AS functions. The former are used for media control, the latter for media content traffic. Both traffic types are user plane traffic from 5G core network perspective.

## 3 DOWNLINK STREAMING ARCHITECTURE

To enable MNOs as well as third parties and online media content providers to offer high quality downlink streaming services to mobile users, the 5G media downlink streaming architecture devised by 3GPP introduces the so called *trusted media functions*. Trusted media functions are deployed both in the network and on the UE, and interface with external media application servers and media functions (e.g. belonging to a third party or online media content provider) via APIs, that guarantee access control and authorization, as well as differentiation among collaboration models between the operator and the media content providers. Trusted media functions located in the mobile network include AFs as well as ASs. Beyond executing control actions on behalf of the UE or external media application servers (e.g. performing network assistance in the delivery of the media content), media AFs also control and configure the usage of the ASs deployed in the mobile network itself, e.g. selecting the closest AS to a specific user. Envisioned trusted media functions located in the network include: Adaptive Bit Rate (ABR) Encoder, Encryption and Encapsulator, Streaming Manifest Generator and Segment Packager, Origin Server, CDN Server (possibly located at the edge), DRM Server, Metrics Server; Service Director,; Content Guide

Server, Replacement content server for example for advertisements; Manifest modification server, Session Management Server as well as content enrichment functions (e.g. object detection, content filtering, etc).

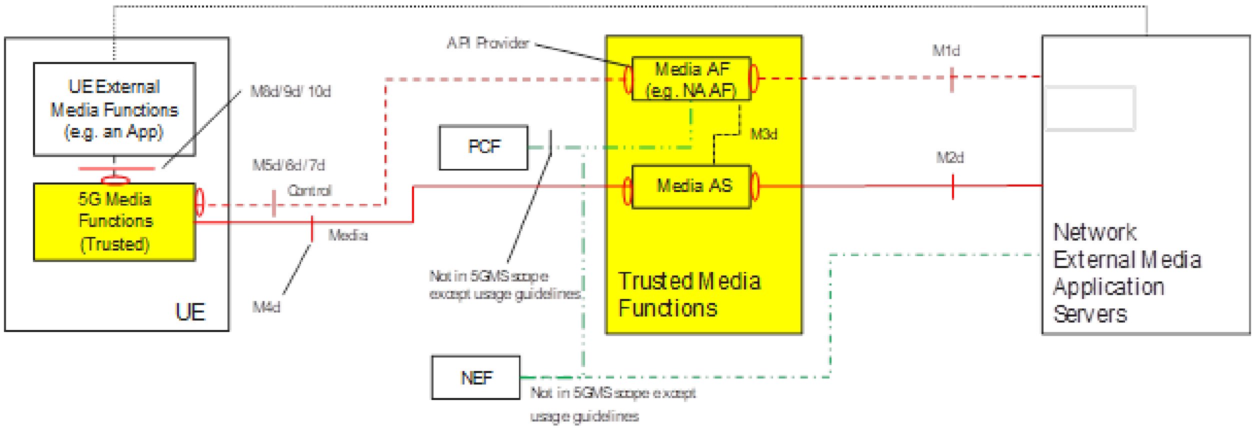


Figure 2 5G media downlink streaming architecture

Figure 2 shows a high-level view of the 5G media downlink streaming architecture, with the trusted functions highlighted in yellow. Following the 5G approach of separating control plane from user plane, the 5G media downlink streaming architecture defines «media con-trol interfaces» M5d/6d/7d between the UE and the AFs in the 5G network, in order to carry signalling parameters and media configuration information. Conversely, the *media user interface* M4d between the UE and the AS's is used to carry the media content itself. A similar separation is carried out in the exposure of AFs' and ASs' APIs towards external media application servers (interfaces M1d and M2d respectively).

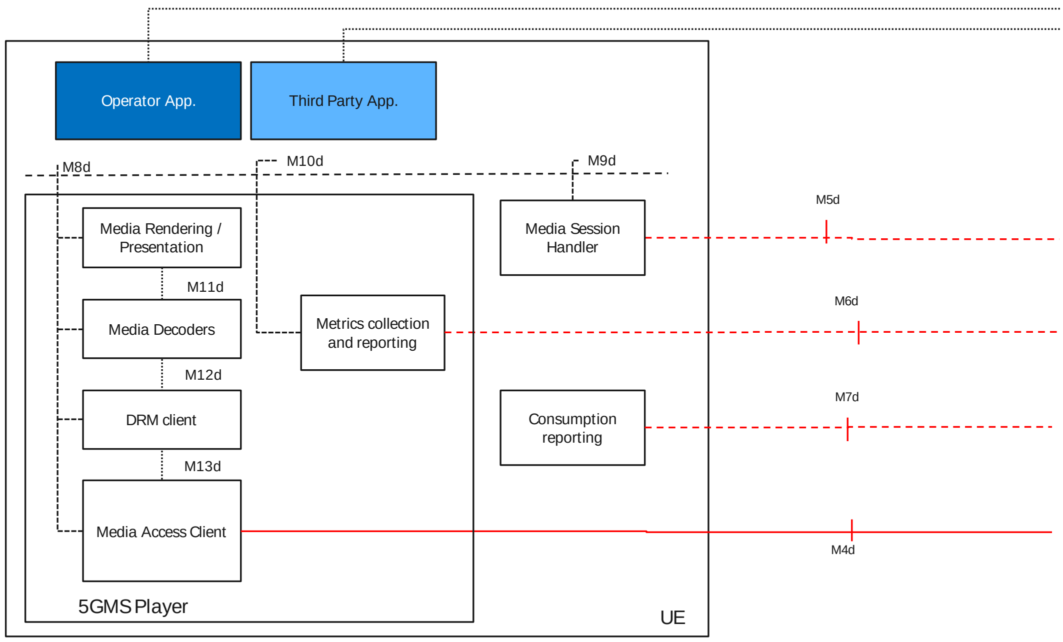


Figure 3 5G Media Streaming UE

Figure 3 shows a close-up view of the UE, with the trusted media functions located below the horizontal dashed line. The Operator App and the Third-party App, located above the horizontal dashed line, will use APIs M8d/9d/10d to access the UE media trusted functions. Several UE media trusted functions may communicate to the AF(s) located in the mobile network in order to use 5G capabilities to improve the delivery of the service. Specifically, the Media Session Handler may receive help in the establishment of the session. Consumption reporting may provide information on the currently consumed media, on the UE capabilities and on the environment of the media session which in turn may be used by the AF for potential transport optimization within the mobile network. The Media Access client receives the media data from the AS, which can be either located within the mobile network (among the trusted media functions) or outside of it (external media application server).

Metrics collection and reporting may provide information related to the user experience. For this purpose, streaming sessions can be monitored on the client side, and metrics related to the session quality reported back to the service or network provider. The metrics cover typical streaming issues, e.g. bitrate adaptations, length of initial buffering, and any occurrences of rebufferings. Metrics collection can be configured in two different ways; either via metadata included during content delivery, or via specific 5G control-plane messages. In both cases the configuration controls what metrics to measure, how often the collected metrics shall be reported, and what node to report back to. Metrics collection can also be restricted to certain geographical areas. For many overall performance monitoring use-cases it might be enough to report all the collected metrics after the session has finished, but if needed metrics can be reported more often, potentially down to every five to ten seconds. Especially for long sessions, e.g. a complete two-hour movie, getting reports also during the session might be useful to detect and potentially address any quality issues.

## 4 UPLINK STREAMING ARCHITECTURE

The amount of uplink video traffic is increasing, stimulated by consumer and industry needs. Consumers are sharing more and more video into social media platforms. Industry partners, such as professional media production companies, start using cellular networks as uplink from professional cameras and other devices.

3GPP introduces a new set of functions on the UE and on the network side, called Trusted Uplink (UL) Media Functions, which are specified by 3GPP and controlled by a mobile network operator. A 3$^{rd}$ Party provider may use some or all provided functions in order to build e2e application services.

Figure 4 depicts the high-level functional architecture for the media functions. Any media function can use network services, which are exposed by an MNO using exposure APIs. Trusted UL Media Functions may directly interact with network functions like a PCF. Other external UL media functions may always connect via a NEF. The Trusted UL Media Functions contains UL Media AFs (for control interactions) and UL Media ASs. The Role of the AFs is to offer services towards the trusted UL media functions on the UE and also to external application server. The UL Media AS receives media content via the M4u API and can then forward the content to External application server. Depending on the configuration using the M1u API, the UL Media AS may do additional processing.

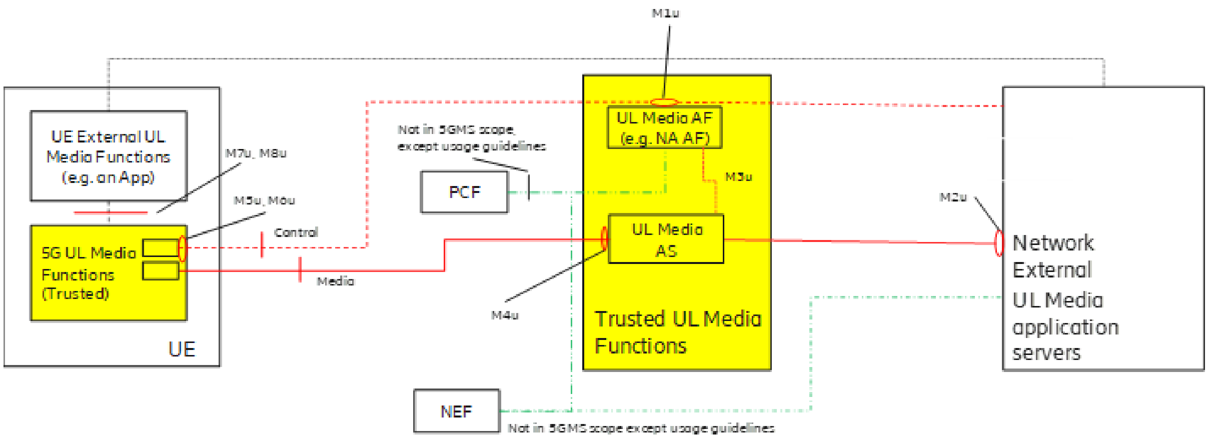


Figure 4 5G Uplink Media Streaming Architecture

Figure 5 depicts the UE model for Uplink Media Streaming. Applications (App) may access the trusted UL media functions using APIs (M7u and M8U). One set of APIs is more media-plane oriented and used to influence the media capturing, encoding and upstreaming process. The Media Upstream Client is responsible for streaming the media content to the UL Media AS. The other set of APIs are more control and session related.

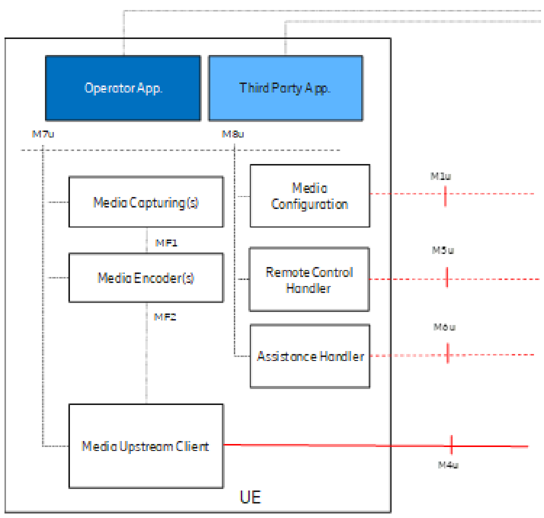


Figure 5 UE model for 5G UL Media Streaming

The Media Configuration function is used to configure (via the UL Media AF), the UL Media AS, which acts as sink for the uplink streaming. The configuration procedure can include media processing and media forwarding from the UL Media AS to other function as well as session specific QoS or charging configuration. The Remote Control Handler offer Remote Control capabilities to authorized UL Media AFs. This allows remote controlling of e.g. drone mounted cameras. Remote control is also widely used within professional media production cases. The Assistance Handler is used for any sort of network assistance. Applications may use only a subset of the functions or all functions, depending on the application needs.

## 5 COLLABORATION SCENARIOS

A key objective of 5G Media Streaming is the ability to enable collaboration scenarios between a third-party content and service provider and an MNO, for potentially mutual benefits. Figure 6 provides a decomposition of the UE and the 5G network. 5G Media Streaming enables that an external provider can access a subset of functions in the 5GMS system to generated complex workflows, but at the same time leave certain control within its own domain.

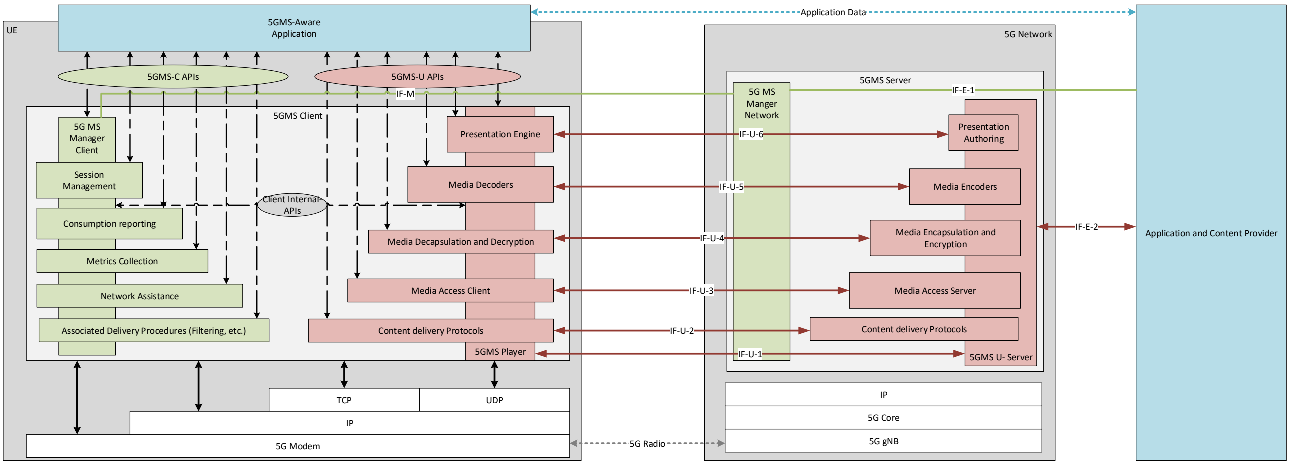


Figure 6 Detailed function decomposition for 5G Media Downlink Streaming.

TS26.501 [3] documents some example collaboration scenarios that motivate the design of such APIs. A few examples are provided as follows:

- MNO CDN: the MNO acts as a CDN for the third-party provider. The third-party provider uses well-defined interfaces to upload streaming content to the MNO and also uses a subset of the 3GPP defined 5GMS functions (e.g., Content delivery protocol, Network Assistance, Session Management, Metrics collection) for optimized delivery. Codecs, DRM, Manifest format, etc. are all under control of the third-party provider.
- Live Broadcast: The third-party provider pushes a live service into the network in a proprietary format. The MNO transcodes that content into 5GMS compatible formats and the 5G Aware application use the 5G MS Player for playback of the content. Codecs, DRM, Manifest format, etc. are all under control of the MNO. The MNO also ensures timely delivery of the service.
- Media Processing: The third-party provider uploads the content in a defined format as done for an origin server, but the MNO adds additional functionalities, for example it provides targeted and regional ad insertion, it does automatic captioning of the content by using network internal AI functions.

The above scenarios are surely not comprehensive. The opportunities come from the fact that the individual functions in 5GMS can be accessed and combined flexibly, and in particular that the new 5G functionalities can be accessed by third-party providers. 3GPP will not define new end-to-end services but do everything to make the beauty of 5G accessible to the rich content media industry for improved and new user experiences. For more progress, stay tuned.

## 6 WHAT'S NEXT AND WHAT ELSE?

The 5G Media streaming Architecture Technical Specification TS 26.501 [3] serves as the basis for normative APIs and device and network capabilities. This normative work item is called “5G Media Streaming stage 3”. The stage 3 work is scheduled to complete by end of year 2019 as part of 3GPP Rel-16 – a.k.a. 5G Phase 2.

The stage 3 work consists of the creation and updates of 3GPP specifications to come up with a modular but consistent set of specifications enabling deployment of multimedia streaming services in TS 26.511 “5G Media Streaming (5GMS); Profiles, Codecs and Formats” [4]. This specification will document all requirements relating to 5G UEs (User Equipment), 5G Media AS(s) and content providers capabilities relating to coding, encapsulation and packetization of media content. It will leverage the following specifications:

- TS 26.116: “Television (TV) over 3GPP services; Video profiles”. [6]
- TS 26.117 “5G Media Streaming (5GMS); Speech and Audio Profiles” [7]
- TS 26.118 “3GPP Virtual reality profiles for streaming applications” [8]
- TS 26.307 “Presentation layer for 3GPP services” [9]
- TS 26.512 “5G Media Streaming (5GMS); Protocols” [5]

This specification will document all requirements relating to 5G UEs (User Equipment), 5G Media AS(s), 5G Media AFs and content providers capabilities relating to protocols such as content ingest and distribution interface, uplink streaming, use of slicing, setup of QoS, network media processing, quality metrics collection and reporting, network assistance, consumption reporting etc. It will leverage the following specifications:

- TS 26.247 Transparent end-to-end Packet-switched Streaming Service (PSS); Progressive Download and Dynamic Adaptive Streaming over HTTP (3GP-DASH) [10]
- TS 26.238 Uplink streaming [11]

Rel-17 may then use and possibly extend this architecture to enable further advanced Media services like e.g. Immersive and Extended Reality applications [12].

## 7 CONCLUSIONS

The 5G Media Streaming Architecture intends to offer a simpler and modular component integration model enabling services with different degrees of cooperation between Third-Party content and service providers, broadcasters and Mobile Network operators.

With such commitment, 3GPP enables the Media and Broadcast industry high-quality and value-added services and content to be efficiently delivered over 5G networks in cooperation with Mobile Network operators.

Standardization is an ongoing process and always a team effort to support the industry. Interested parties are always welcome to join.

## 8 REFERENCES


[1] 3GPP TS 26.233 "Transparent end-to-end Packet-switched Streaming service (PSS); General description"
[2] 3GPP TS 26.234 "Transparent end-to-end Packet-switched Streaming Service (PSS); Protocols and codecs"
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[4] TS 26.511 "5G Media Streaming (5GMS); Profiles, Codecs and Formats"
[5] TS 26.512 "5G Media Streaming (5GMS); Protocols"
[6] TS 26.116: "Television (TV) over 3GPP services; Video profiles".
[7] TS 26.117 "5G Media Streaming (5GMS); Speech and Audio Profiles"
[8] TS 26.118 "3GPP Virtual reality profiles for streaming applications"
[9] TS 26.307 "Presentation layer for 3GPP services"
[10] TS 26.247 Transparent end-to-end Packet-switched Streaming Service (PSS); Progressive Download and Dynamic Adaptive Streaming over HTTP (3GP-DASH)
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