

Technical Report EBU - Part II

5G FOR THE DISTRIBUTION OF AUDIOVISUAL MEDIA CONTENT AND SERVICES

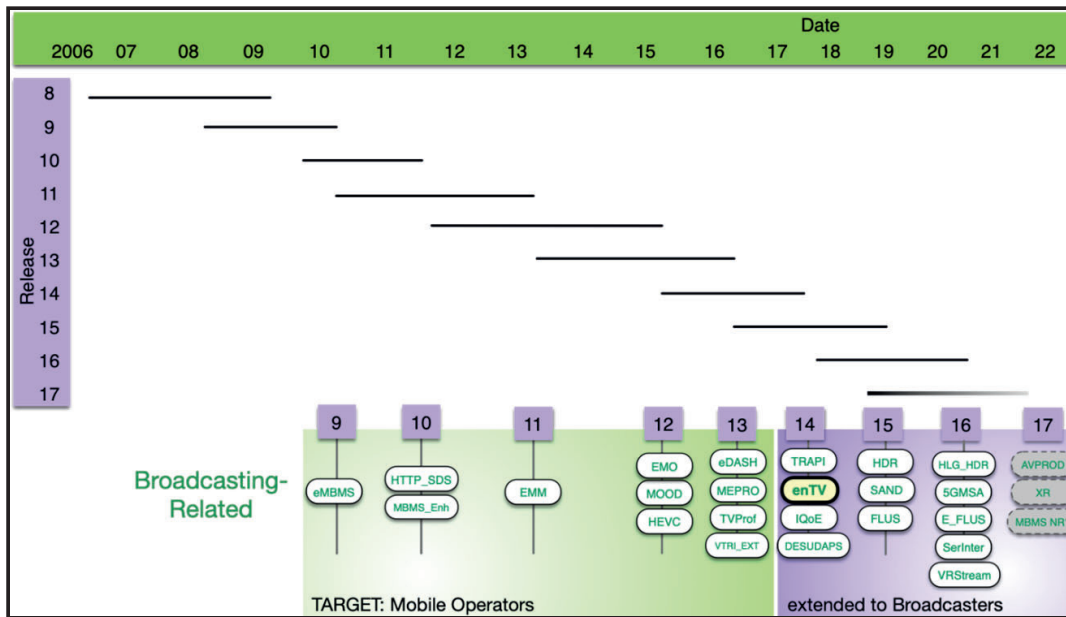


Figure 5: 3GPP timeline of work items related to media

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3. Status of 5G Standardization and Deployments

3GPP is standardizing functionality to improve the distribution of AV media over 5G networks to mobile devices, and potentially conventional TV sets equipped with 5G receivers. The standardisation activity related to AV media distribution can be broken down into two main areas:

-- 5G Broadcast, which refers to “LTE based 5G Terrestrial Broadcast”, as defined by 3GPP in LTE Release 16, which do not necessarily require operation by a mobile network operator.

-- 5G Mobile Broadband, which refers to developments in 3GPP based on the new radio access (New Radio - NR) and core (5G Core - 5GC) technologies from Release 15, which are operated and deployed in mobile networks.

• **Figure 5** shows the schedule of work while the following sections elaborate further on the intentions, functionalities, and capabilities of various aspects of the standardization activities that are relevant to the distribution of AV media.

It is worth noting that the inclusion of a feature in 3GPP specifications is a necessary step but it does not guarantee that this feature will inevitably be implemented in 5G networks and devices. The scope and timing of market deployment of a particular functionality are largely driven by the existing or expected market demand. This depends on many factors, some of which may be difficult to predict. Therefore, it is not possible to identify a reliable timeline for the availability of various standardized 5G features.

3.1 5G Broadcast

The standardization process for dedicated 5G Broadcast has now largely been completed. It started in Rel 14 under the EnTV work item based on 4G LTE networks. This first phase of the standard was completed in summer 2017, appearing in 3GPP TR 22.816 [4]. Rel 16 further enhanced the physical layer of the specification to close three main gaps that were identified in the Rel 14 [5]. Rel 16, which is named LTE based 5G Terrestrial Broadcast [6] is expected to be complete during 2020.

The overall aim of dedicated 5G Broadcast is to provide broadcasters with the means of delivering linear TV services to mobile and portable devices, as well as conventional TV sets, with a single chipset in accordance with their requirements. The broadcast requirements are substantially based on the conventional distribution of linear TV content outlined in § 2.4.

The main features of 5G terrestrial broadcast which collectively aim to fulfil these requirements are set out below. The first six features are related to radio access enhancements while the final four are related to the system layer.

- Longer Range: 200 μ s cyclic prefix (CP) for single frequency networks with inter site distances in the order of 15km (Rel 14)
- Greater Broadcast Capacity: dedicated broadcast networks with 100% eMBMS carrier allocation (Rel 14)
- Greater Efficiency: sub frames have reduced overhead in dedicated broadcast transmissions (Rel 14)
- Greater mobility: 100 μ s CP with 2.5 kHz carrier spacing for reception at speeds up to 250 km/h (Rel 16)
- Support for HPHT Networks: 300 μ s CP for single frequency networks with inter site distances in the order of 100 km (Rel 16)
- Receive Only Mode (ROM): Delivery of free to air content to devices without SIM cards or service subscription (Rel 14)
- Transport Only Mode: TV programmes can be delivered in native format without transcoding (Rel 14)
- Standardised xMB Interface: AV media can be delivered over LTE with a unified framework and standard interfaces between content providers and network operators (Rel 14)
- Shared Broadcast: multiple operators can serve users on a common broadcast carrier (Rel 14)

Physical layer time interleaving was studied in Release 16, and found to be beneficial for dedicated broadcast, but not included in the final specification.

The main use case for LTE based 5G Broadcast requires specific hardware implementation additional to regular unicast hardware in the user device, the RAN and the core.

3.2 5G Mobile Broadband

5G technology boasts multiple capabilities for a wide range of communications, including enhanced Mobile Broadband (eMBB), massive Machine Type Communications (mMTC) and Ultra Reliable Low Latency Communications (URLLC). It also includes multicast and broadcast capabilities suitable for certain applications. Corresponding network architectures are designed to address that wide range of applications with shared infrastructure in Radio Access, Transport and Core Network.

The first releases of 5G address radio access, core network and service aspects. 5G New Radio (NR) [7] is the access technology defined for the 5G System [8] and is designed to push the boundaries of mobile communications to enhancements in terms of data rates, latency, reliability, and connectivity.

The key 5G radio aspects in Rel 15 include:

- Native forward compatibility mechanisms
- New channel coding: LDPC for data channel, Polar coding for control channel
- Native support for Low Latency and Ultra Reliability
- Flexible and modular RAN architecture: split fronthaul, split control and user plane
- Native end to end support for Network Slicing
- Improved Efficiency: 5G MIMO, 5G Power and location improvements, Device Capabilities improvements
- New Features: URLLC, V2X (D2D), Enhanced Positioning, Industrial IoT, 5G Satellite, new spectral ranges

Rel 15 lays the foundation for the definition of new 5G Core Technologies, including:

- Orchestration and Virtualization (NFV) – de couple logical function from hardware
- Slicing – logical end 2 end networks tailored to customer needs
- Multi Access Edge Computing (MEC) – resources where they are needed (especially for URLLC)
- API Exposure – 3rd party access to 5G services
- Service Based Architecture (SBA) – stateless, open, flexible
- Harmonized Protocols & Access Agnostic – generic solutions with integrated support for fixed networking, 5G satellite access, ...
- New Media (Virtual Reality, Extended Reality, ...)
- Specific ‘vertical industry support’: Broadcasting, Mission Critical Communications, Vehicle to Everything, Industrial Automation, Future Railway Mobile Communication System, etc.

The details for several of the functions are deferred to later releases, but the basic principles of the architecture are defined in Rel 15.

Besides the development of RAN and Core architectures, a key concept in 5G is network slicing [9]. It entails the establishment of independent sub networks for specific services and users based on a physical 5G network infrastructure. The sub network consists of base stations, transmission functions and core network functions. The underlying technological principles are to be found in software defined networking (SDN) and multi tier cloud architectures for all network functions. Network slicing allows for perfect isolation of all data and operation of individual sub networks. Each individual sub network can have its own specific characteristics regarding 5G network parameters such as maximum throughput, end to end latency and data traffic density.

In content distribution, network slices can be envisaged to provide channels to broadcasters tailored to their requirements in terms of performance, reliability and content integrity.

Based on the flexibility of using network resources by applying Network Slicing, Service Level Agreements (SLA's) can be arranged between network and service/content providers. One example, in conjunction with the purposes in question is to guarantee a certain coverage in time and geographical extent for a given throughput.

3.2.1 5G Multicast / Broadcast

Rel 17 will add support for multicast and broadcast in the 5G System, i.e. based on 5G Core and 5G New Radio (NR). The scope of the work [10] is to provide RAN support for public safety and mission critical, V2X applications, transparent IPv4/IPv6 multicast delivery, IPTV, software delivery over wireless, group communications and IoT applications. An SA2 Study Item will investigate supporting 5G multicast / broadcast in the core architecture (see TR 23.757 [11]).

The RAN work focuses on the dynamic use of multicast / broadcast in small scale (primarily single cell) deployments with minimum RAN changes. In practical terms this means there is no support for large scale SFNs or ROM devices, as currently enabled for LTE based 5G Broadcast. However, developments under this work item should not prevent a future evolution to include similar features. The main use case for LTE based 5G Broadcast requires specific HW implementation additional to regular unicast HW.

Rel 17 multicast / broadcast aims for use cases where multicast / broadcast or unicast could dynamically be selected by the MNO, depending on which mode is most spectrally efficient in a particular situation. The WID (Work Item Description) states that implementation impact should be limited, and UE complexity minimized (e.g. avoiding device hardware impact). If this is achieved, NR multicast / broadcast functionalities may later be implemented via SW upgrades. These enhancements may benefit the distribution of media content over mobile networks and may play a role for the distribution of IPTV services over Fixed Wireless Access (FWA) [12].

3.2.2 5G Media Streaming Architecture

The 5G Media Streaming Architecture in 3GPP [13] is developing an architecture to enable collaboration scenarios between a third party content and service provider and an MNO, for potentially mutual benefits. 5G Media Streaming enables an external provider to access a subset of functions in the 5GMS system to generate complex workflows, but at the same time retain control of some aspects in its own domain.

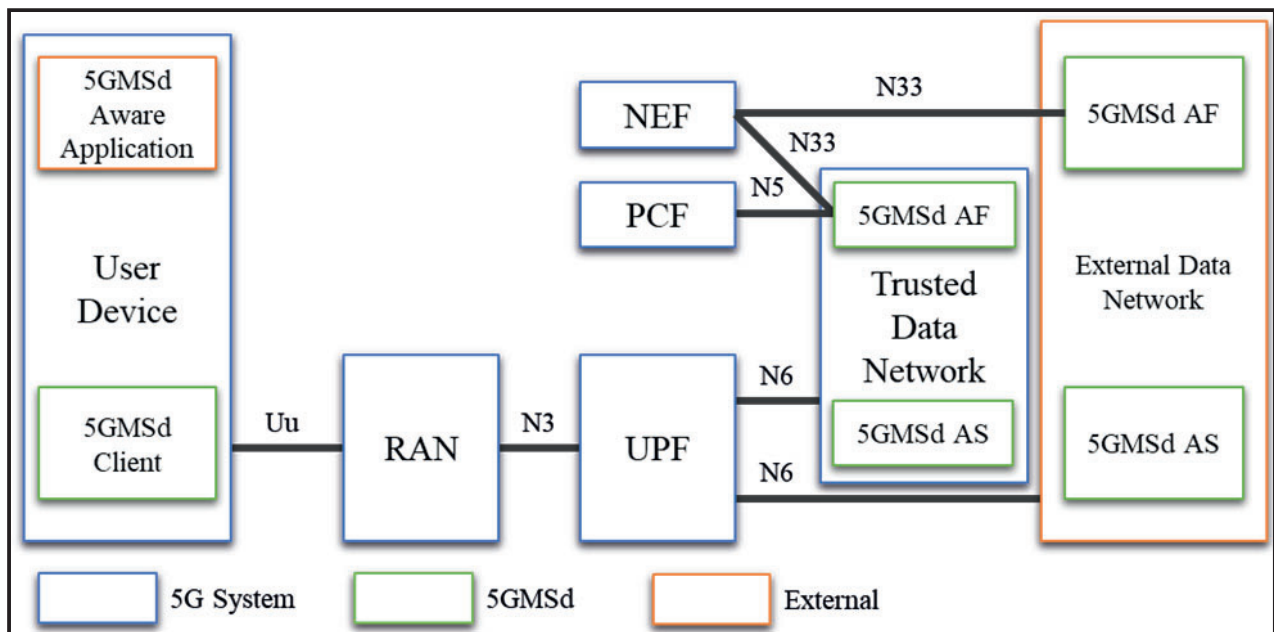


Figure 6: Basic scheme of the 5G Media Downlink Streaming architecture.

Example of collaboration scenarios that motivate the design of such functionalities are:

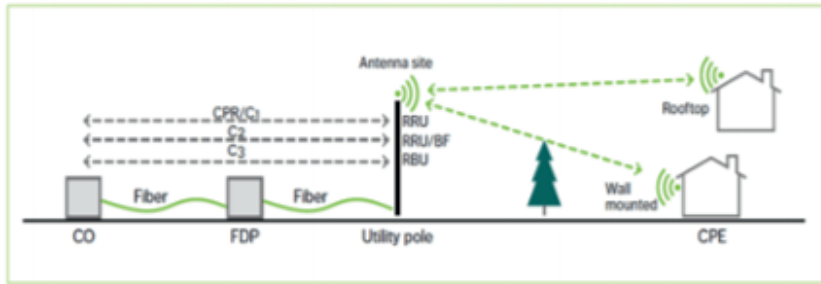
- MNO CDN: the MNO acts as a CDN for the third party provider. The third party provider uses well defined interfaces to upload streaming content to the MNO and also uses a subset of the 3GPP defined 5GMS functions (e.g., Content delivery protocol, Network Assistance, Session Management, Metrics collection) for optimized delivery. Codecs, DRM, Manifest format, etc. are all under control of the third party provider.
- Linear Service: The third party provider pushes a live service into the network. The MNO transcodes that content, if necessary, into 5GMS compatible formats and the 5G Aware application use the 5GMS 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.

3.2.2.1 Multicast in 5G Media Streaming Architecture

Multicast / broadcast architecture has the potential to play an important role in 5G media streaming. A new study in TR 26.802 [14] will evaluate the impact of multicast / broadcast features to 5GMSA. The goal of this study item is to identify and evaluate potential enhancements to the 5G Media Streaming Architecture to provide multicast broadcast media streaming services including scenarios for multicast ingestion or multicast distribution.

3.2.3 Hybrid DASH/HLS over eMBMS

To reach all devices, media streams must be provided in both HLS and the DASH format in parallel. Beyond the enhancements related to LTE based 5G Terrestrial Broadcast targeting dedicated deployments, a new Rel 16 work item [15] aims at enabling the delivery of Hybrid DASH/HLS over eMBMS. Thus, Rel 16 will enable the delivery of CMAF (Common Media Application Format) fragmented formats over eMBMS to reach all devices with one format.



| Capability | 5G Target |
|----------------------------|-----------|
| Peak Data Rate | 20 Gbit/s |
| User Experienced Data Rate | 1 Gbit/s |
| Latency | 1 ms |

Figure 7: Basic FWA concept and key performance indicators

3.2.4 Fixed Wireless Access

Fixed Wireless Access (FWA) [12] is a means of providing ‘last mile’ internet connections to homes and business without the need for fixed lines such as twisted pairs and fibre cables. 3GPP 4G/5G standards are well suited for FWA leveraging the 3GPP ecosystem.

FWA is primarily targeting stationary receiving devices, usually with line of sight visibility of the transmitter / base station. Furthermore, FWA modems may be connected to a fixed, external antenna in order to achieve the line of sight path to the transmitter and, particularly in higher frequency ranges, avoid signal attenuations due to building penetration loss, in order to establish a reliable link.

With 5G FWA, massive use of beamforming, new/more spectrum and high frequency spectrum (e.g. mm Wave) allow for many UEs to be connected simultaneously to the same base station (i.e. using the same spectrum simultaneously thanks to the beamforming) and with data rates comparable to many fixed line internet connections in use today.

In line with other types of broadband connections a 5G FWA connection is typically terminated at the FWA modem, which is connected to an indoor Wi Fi network providing the indoor coverage. Any type of fixed, portable or handheld device (TV set, tablet, smartphone etc.) may then access content in the home via Wi Fi.

Figure 7 depicts the basics of the FWA concept and key performance indicators [16].

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