ENHANCED TV SERVICES OVER 3GPP MBMS

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ABSTRACT

Efficient distribution of free-to-air and pay TV services to mobile receivers as well as stationary terrestrial TV receivers, with the integration of roof-top antenna reception and existing TV receivers is a major accomplishment in the latest Release of 3GPP to enable economically viable mobile and terrestrial TV services. During the just completed 3GPP Release 14, the specifications related to MBMS have gone through a very significant set of enhancements. Large scale changes to architecture concepts, major enhancements to the radio layer as well as upgrades on the service layer enable the distribution of TV Services. The new architecture enables reuse of functionalities defined up to Rel-13, but also permits TV Broadcast providers to build on their existing TV broadcast service infrastructure. This paper introduces the key concepts defined in 3GPP Rel-14 and provides some outlook for Broadcast services in 5G.

1 INTRODUCTION

The provision of TV services on mobile devices had been attempted throughout several decades with more and less success. Today, TV services are available on mobile devices, primarily through mobile unicast and Over-the-top (OTT) services, typically in HD quality, comparable to existing TV service offerings – with fully integrated user interactivity and personalization. At the same time, terrestrial TV service delivery to stationary TV sets has also undergone enhancements not only in quality (High Definition (HD), Ultra High Definition (UHD), High Dynamic Range (HDR), etc.), but also reception, with for example, the availability of of unicast delivery, Given that the previous approach to defining mobile modes in dedicated broadcast systems was not successful, primarily due to the lack of broadcast receivers in mobile devices, 3GPP has undertaken a different approach in its latest Release 14 by providing a set of enablers which permit the distribution of TV services using mobile centric receiver technologies also for stationary TV sets. In particular, the latest defined 3GPP enablers support (i) Mobile and fixed television reception in a common spectrum allocation, (ii) free-to-air services, (iii) quality levels comparable to broadcast television, and (iv) operation in accordance with EU decisions on 470-790 MHz spectrum. The efficient distribution of free-to-air and pay TV services as well as integration

of roof-top antenna reception with existing TV receivers represent major accomplishments in the latest Release of 3GPP MBMS specifications.

In the Rel-14 version of the 3GPP specifications, eMBMS (evolved Multimedia Broadcast Multicast Service) features quite a significant set of enhancements. Large scale changes to architecture concepts, major enhancements to the radio layer as well as upgrades in the service layer enable the distribution of TV Services. The new architecture enables reuse of functionalities defined up to Rel-13 [1][2], but also permits TV Broadcast providers to build on their existing TV broadcast service infrastructure. This paper introduces the key concepts defined in Rel-14 and provides some outlook for Broadcast services in 5G. 3GPP provides specification in Releases, typically every 12 to 18 months. Whereas Rel-13 was completed end of 2015, and Rel-14 was completed mid of 2017, Rel-15 is currently ongoing and is the first release targeting 5G with expected completion date mid of 2018.

2 ARCHITECTURE AND SERVICE LAYER ENHANCEMENTS

2.1 Architecture

3GPP up to Rel-13 [1] provides a significant number of enablers and functionalities to distribute real-time and non-real-time content from the MNOs Broadcast-Multicast Service Center (BM-SC) to a MBMS capable User Equipment (UE). Whereas up to Rel-13, the primary focus was on enhancing the distribution functionalities from the BM-SC to the MBMS client, in Rel-14 the architecture was upgraded to include an interface from the content provider to the BM-SC (the xMB interface), as well as an interface from the MBMS client to the Content Receiver application (MBMS-API) (see Figure 1). In all cases, 3GPP permits the inclusion of unicast distribution of the services, for example by using MBMS-operation-on-Demand (MooD) or unicast fallback (defined in TS 26.346 [4] since Rel-12). Furthermore, following typical mobile application and OTT service approaches, the content provider may establish a direct connection outside MBMS/broadcast distribution, e.g. for service configuration and updates.

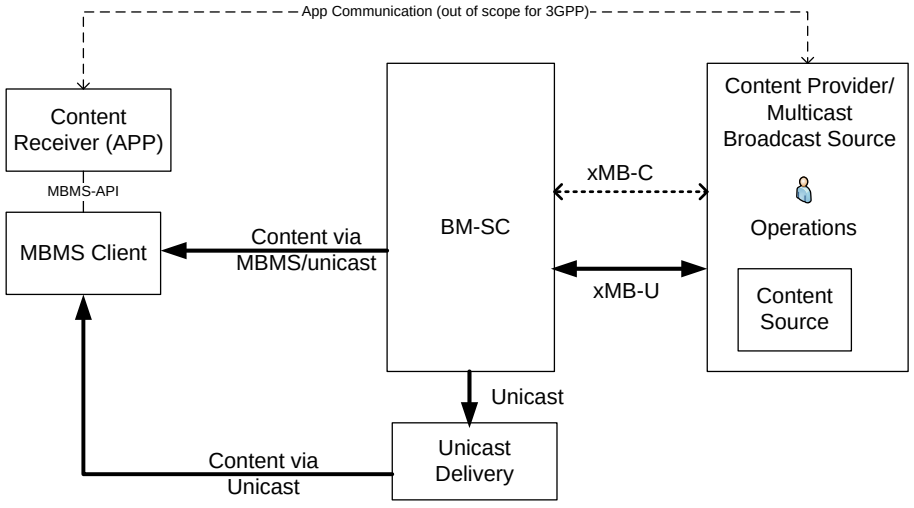

Figure 1 Simplified Architecture for TV Services over 3GPP MBMS

2.2 Content Provider and MBMS User Services

3GPP up to Rel-13 [1] provided three primary services, namely RTP- and DASH-based real-time streaming services, as well as file-based Non-Real-Time (NRT) data services, for example via carousel or schedule-based distribution. In existing real-time services, the content formats are required to follow the 3GPP PSS/DASH specifications [3][4][6][7]. With Rel-14, this restriction is relaxed by the addition of a “transport-only mode” which permits the distribution of externally-defined content formats. According to Figure 2, a content provider may use one or more service types to generate a rich TV service offering, for example access by a web or native application on mobile devices or smart TVs. The services are established through the xMB control plane interface (xMB-C) and provided to the BM-SC through the xMB user plane interface (xMB-U). The application can query for services and may use appropriate receiving entities to consume the services. For distribution from BM-SC to MBMS client, one of three different delivery methods may be used: streaming-delivery method (for RTP services), download delivery methods (for data services and DASH-over-MBMS) or the transparent delivery method for transport-only services. Content services may be mapped to MBMS user services and exposed to the application through the control part of the MBMS-API (MBMS-API-C), involving the MBMS client for service discovery and establishment. Alternatively, the services may also be announced and established by external means, for example by announcing the Temporary Mobile Group Identifier (TMGI) and IP information for accessing the Content Provider service without MBMS client involvement.

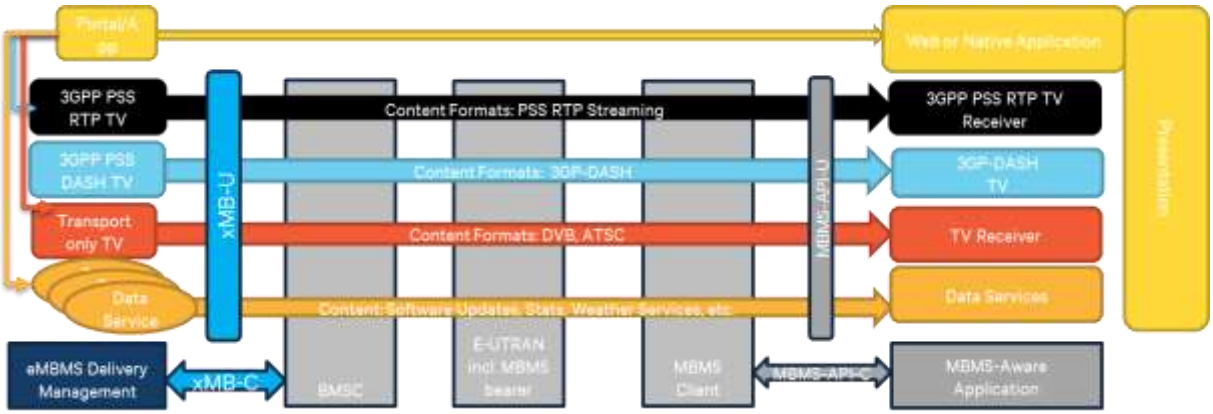

Figure 2 Service Architecture

2.3 Standardized Content Provider Interface

In order to simplify the access to MBMS system functionalities, a standard interface is defined and referred to as the extended MBMS interface (xMB) in order to establish connectivity between a content provider and the BM-SC. The xMB interface provides the capability for the content provider to (i) authenticate and authorize itself to the BM-SC(s), (ii) create, modify and terminate a service, (iii) create, modify and terminate a session, (iv) query information and (v) deliver content to the BM-SC. The xMB interface also provides the capability for the BM-SC to (i) authenticate and authorize a content provider, (ii) notify the content provider of the status of an MBMS user service usage, and (iii) retrieve content from the content provider. Only authorized content providers are allowed to input media

content across xMB-U. The xMB interface permits four different session types: Streaming, file, application (including DASH streaming) and transport mode. The stage-2 procedures are defined in TS 26.346 [4] and the detailed stage-3 procedures based on a RESTful design including JSON schema are defined in TS 29.116 [5].

2.4 Transport-only Mode

The use of the MBMS network as a common delivery platform for different content types and services will be an important factor in achieving broad success of the 3GPP broadcast delivery platform. Based on this observation a content pass-through mode was defined in Rel-14 that enables the distribution of IP packet streams and UDP Application Data Unit (ADU) flows over MBMS bearers. This for example enables TV broadcasters to deliver service content via MBMS in their native format without transcoding, such as MPEG-2 TS. Furthermore, such a mode permits the re-use of existing TV receivers, for example existing MPEG-2 TS receivers.

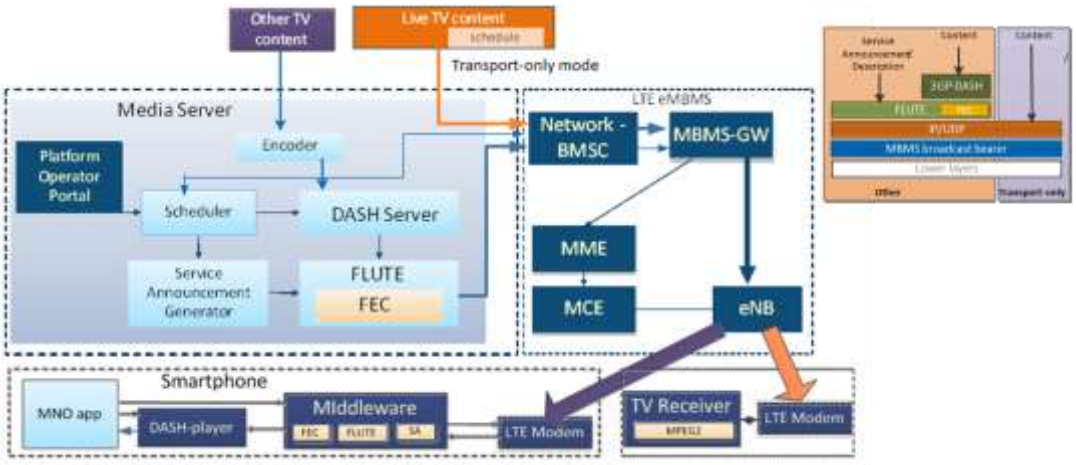

Figure 3 Transport-only mode

The transport-only mode is enabled by the use of the transparent delivery method which permits the distribution of any IP-based data flow through MBMS bearer services. However, the BM-SC may add additional functionalities such as the creation of MBMS User Services with their associated service layer features, such as service announcement, file repair, QoE/reception reporting and consumption reporting. The delivery protocol is extensible to enable new functionalities in future releases, such as QoS using FEC. For details refer to TS 26.346 [4].

2.5 Receive-only Mode

One of the major extensions of the 3GPP specification is the addition of the receive-only mode. This mode enables devices without the (U)SIM card or 3GPP subscription to access a subset of 3GPP MBMS services. Receive-only mode is particularly relevant to expanding the reach of MBMS into traditional TV receivers and to enable Free-to-Air content broadcast over MBMS. Obviously, services configured for this mode may also be received by regular mobile devices as enhanced and rich service offerings, possibly combined with

independent unicast. The same may be enabled for stationary TV sets, for example by integrating a broadband connection to enable interactive services feeding of live TV broadcast. The receive-only mode provides the opportunity for more cost-effective data plans for mobile TV (bundled plans). Receive-only services are broadcast on the reserved range of TMGI. The reserved range uses the well-known PLMN ID 901-56, assigned by ITU-T for Receive Only Mode. The reserved range is sub-divided based on the type of service.

2.6 MBMS Service APIs and URL

MBMS Application Programming Interfaces (MBMS-APIs) were introduced primarily for developers of web and user applications with the objective of abstracting complex MBMS procedures by the use of simple methods and interfaces. MBMS client vendors can implement the service APIs to simplify the integration of MBMS-aware applications with MBMS User Services. In this scenario, service content can be accessed by the application through well-defined APIs: The application communicates with the MBMS client to discover and access services for rendering by existing media players. The APIs support the distribution of existing TV services (e.g. DVB), and also provides new capabilities to support dynamic broadcast/unicast handoff, consumption reporting, etc. The APIs may be implemented within a device or as a local network interface, i.e. in the latter, the MBMS service terminates in a gateway device such as a WiFi Access Point which acts as a media server to applications residing in multiple client devices. A detailed example on the usage of the APIs is provided in section 4.

In addition, TS 26.347 now also defines a URL form for MBMS User services. The URL form is designed to refer to a single resource, just like HTTP (or FTP), and hence can be used in the myriad places that resources are referred to by URLs. Indeed the 'threads' of the world-wide web are the URL pointers that link resources together.

Using MBMS URLs in the formats that reference resources by URLs enables services using those formats to use MBMS delivery of resources. Many of those services also use 'fallback lists', where the origin format (for example, the <video> element in HTML) embeds a series of alternatives, giving, for each, a URL pointer and some information (MIME type, codecs used, and so on) about the resource at that location. Platforms not supporting the resource type, or URL type, of an alternative would skip past it, moving down the fallback list. This could, for example, enable a content distributor to offer high bitrate, high quality, content via MBMS, and a lower-quality, lower bitrate fallback over HTTP, in a backwards-compatible way.

3 RADIO ENHANCEMENTS

Beyond service layer enhancements, Rel-14 also provides upgrades on the radio. As a brief summary, the following extensions are provided:

- Assuming Single Frequency Network (SFN) operation and cellular network planning, support of larger inter-site distance: Larger cyclic prefix (CP) (**200 µs**) designed to cover 15km Inter-Site-Distance (ISD), Target spectral efficiency of **2 bps/Hz** with rooftop antennas, and introduction of an intermediate numerology with **33 µs** CP. Note that CP is also known as guard interval in the broadcast community.

- Dedicated or mixed MBMS carrier: Mixed unicast/broadcast from same carrier, up to 100% MBMS allocation, and a self-contained system information and sync signals for dedicated carriers
- Different types of devices: Enhanced support for rooftop reception, handheld devices and car-mounted antenna, as well as multiple numerologies (15kHz, 7.5kHz and 1.25kHz) designed for different deployment/mobility scenarios
- New subframe type: New type of MBSFN subframe without unicast control region to reduce overhead in MBMS transmissions with respect to previous releases
- Shared MBMS Broadcast: Operators can aggregate their MBMS networks into a shared MBMS content distribution platform. This avoids broadcasting the same content at the same time over different networks and therefore improves coverage and bandwidth efficiency.

4 EXAMPLE SERVICE OFFERING

Figure 4 provides an example architecture and Figure 5 an example call flow when offering a free-to-air DVB-IPTV service according to TS 102 034 over MBMS. The Content Provider configures content delivery to the BMSC through xMB-C by establishing a TV transport service. An existing DVB-IPTV server provides MPEG-2 TS-over-IP data streams that are delivered from the server to the BM-SC through the xMB-U interface. The BM-SC announces the service through its Service Announcement Channel (SACH) mechanism on a dedicated and reserved download delivery session using the receive-only service announcement profile as defined in TS 26.346. This service announcement user service is also delivered over MBMS broadcast bearers on TMGIs in the reserved range as described previously for receive-only mode services.

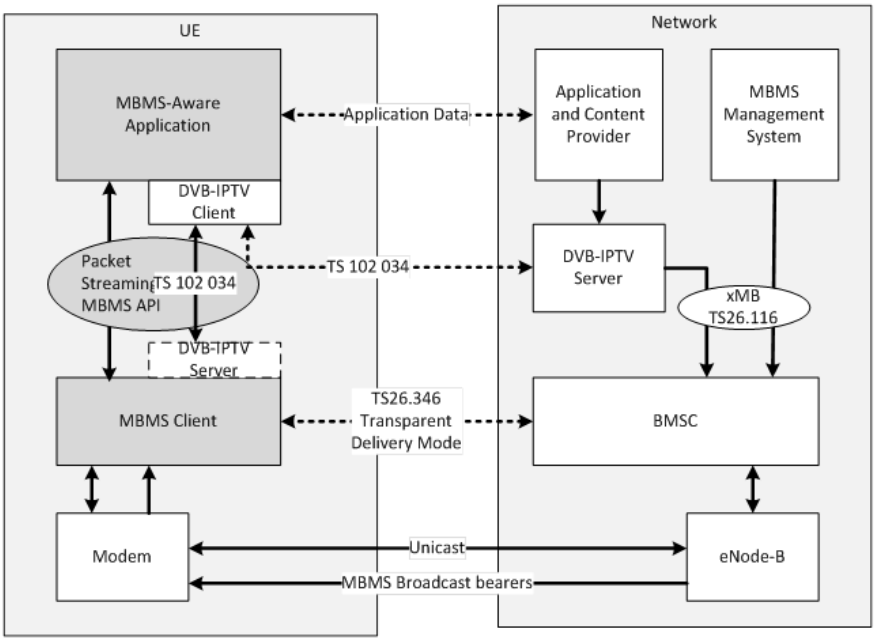

Figure 4 Example Service Offering: DVB-IPTV MPEG-2 TS over 3GPP MBMS

The MBMS-Aware Application (MAA) queries the MBMS client to provide a list of transparent receive only services. Based on the list of available service, the MAA calls the startPacketService() API to initiate the service. The MBMS client provides the received transport-only service acting as a DVB-IPTV Server to a TV centric DVB-IPTV client. The MAA can control the service consumption through control APIs, for example to stop the service and possibly switch to a different one. The DVB-IPTV client (media client) is agnostic and unaware of the underlying MBMS delivery.

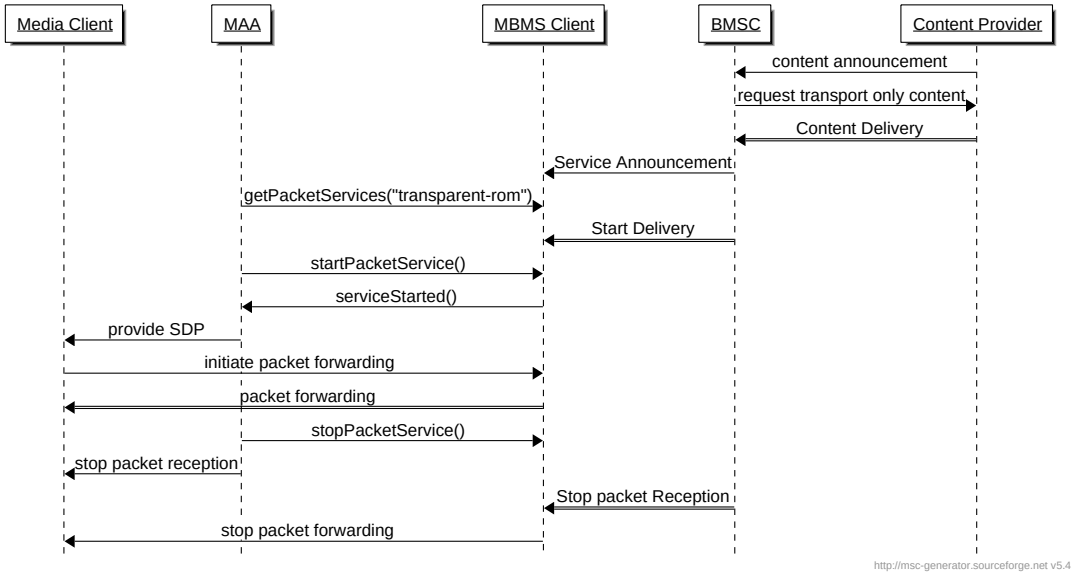

Figure 5 Example call flow for a service offering

5 OUTLOOK ON 5G

3GPP Rel-14 specifications represent a major advancement in broadcast services carriage over cellular networks. However, with the advent of 5G, starting with Rel-15, some questions arise on how 5G will address broadcast services. A set of principles and requirements are established according to the presentation of the 3GPP RAN chairman [9]:

- 5G will support existing Multicast/Broadcast (M/B) services, but there is no plan to re-invent the wheel, i.e., only to facilitate a smooth evolution. Currently this is foreseen to be addressed in 5G phase-3.
- Data rate up to 300 Mbps (e.g. video streams such as 4k UHD) with 15 broadcast channels of 20 Mbps each simultaneously over the same carrier. Round-trip delay in the magnitude of 10-12 ms running an 8k 3D video streaming of 250 Mbps for uplink and downlink
- Dynamic area adjustment depending on, for example, user density and specific service requirements.
- Static and dynamic resource allocation between M/B and unicast up to 100% of DL resources to allow large cells (up to 100 km radius), with local, regional and national broadcast areas.
- Two tracks for MBMS in upcoming Releases:

- Radio-centric optimization of mixed unicast/multicast content delivery: such optimizations will eventually be added to 5G radio by the 3GPP community
- Standalone cellular broadcasting system: based on the latest version coming from 3GPP Release-14 – enTV, with a gap analysis to evaluate what is missing. This effort is expected to be supported by the broadcast community.

On the service layer, it is expected that the existing functionalities are extended to support greater unicast delivery capabilities, additional means to measure and report service usage, and enhanced media experience for the end-user. As the architecture is now in place, service features can be gradually added which make use of the bi-directional network. This may for example include upgrade of media profiles to support UHD-1 phase 2, accessibility and subtitles, advanced Ad Insertion, reporting on consumption and QoE, a DRM framework to support heterogenous DRM systems, better app and browser integration, more APIs, CDN integration and new experiences such as Virtual Reality.

6 CONCLUSIONS

3GPP MBMS has undergone a significant amount of system-level and architectural upgrades in order to support the carriage of TV services. These new enablers will allow MNOs to fully support TV broadcasters in the delivery of a wide variety of TV services to a broad range of device types, and may shape the future of TV distribution. 3GPP has all the architectural elements in place to enable new service capabilities and user experiences in the future by leveraging the dynamic and agile mobile broadband systems and technologies as key components of the next generation content delivery industry.

7 REFERENCES

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