3GPP BASED TV SERVICE LAYER

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ABSTRACT

Video consumption on mobile devices is getting more and more popular. Among others, a significant amount of traffic is TV centric, but generally delivered Over-The-Top. 3GPP is addressing needs to migrate TV services to 3GPP-based distribution systems by enhancing LTE Broadcast, developing new codec and service extensions and providing solutions to fulfil TV centric requirements. This document presents the latest developments in 3GPP standards from an operator's, end device and network manufacturer's point of view.

INTRODUCTION

The Third Generation Partnership (3GPP) project since its creation in December 1998 has a long history in enabling mobile communication and had included enablers for media streaming and distribution in its very early roadmap. Whereas initially the quality of video streaming media was limited on phones, with the advance of smartphones and tablets as well as high-speed and 4G mobile broadband networks, 3GPP-based devices have become the prime medium for accessing media services, and the quality is getting on par with the media consumed for example on stationary TV Sets.

In addition, more and more conventional linear and new on-demand type TV services are made available on mobile devices, such as operator's TV bouquet or Over-The-Top (OTT) unicast services. Whereas this trend is showing the demand, it is expected to result in delivery cost issues as the demand grows, as forecast. Scalability is required and therefore, 3GPP has started an initiative to explicitly address TV Services, by promoting existing functionalities and providing enhancements, wherever necessary. For this purpose, the 3GPP service requirements in TS 22.101 (1) have been extended just recently (please refer to clause 32) to address TV Enhancements. TV service support is referred as a feature whereby 3GPP networks can provide unicast and broadcast transport, referred to as "TV transport services", to support distribution of TV programs. Each type of TV service has different requirements in order to meet regulatory obligations and public service and commercial broadcaster's requirements regarding content distribution. Requirements are optional to implement depending on the type of TV transport services a mobile network operator (MNO) chooses to offer.

In addition, there is a growing interest from Over-the-top (OTT) TV/video service providers to be able to reach their customers regardless of location, and available access technology, particularly when the consumers have cellular access but not access to a broadcast TV signal (if that signal exists at all). Based on these considerations, this paper reviews the existing architectural options, the available enablers as well as potential enhancements to run and enable TV services on top of 3GPP access networks.

3GPP ARCHITECTURE FOR TV SERVICES

3GPP provides a set of enablers that permit the distribution of streaming user services on top of 3GPP bearers. A key benefit of 3GPP systems compared to other media distribution systems is the availability of unicast and broadcast bearers that both can be used for media distribution. Figure 1 provides an MBMS (Multimedia Broadcast and Multicast Service) centric service architecture that may be considered to run TV services on top of 3GPP bearers taking into account broadcast and unicast bearers.

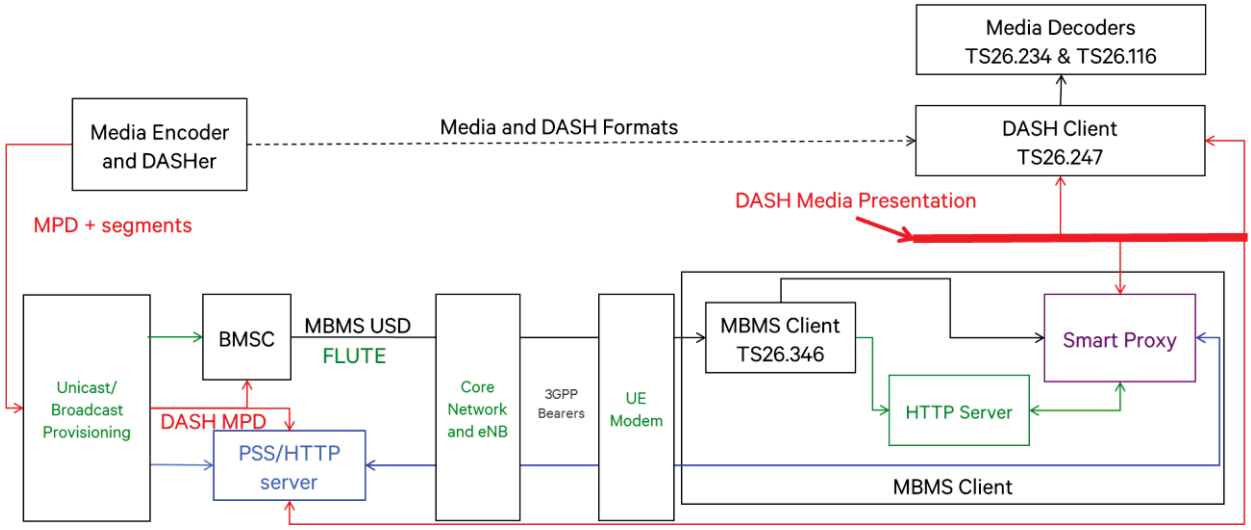

Figure 1 A possible 3GPP Service Architecture for TV Service

The cellular 3GPP radio architecture provides significant potentials to distribute TV Services. A key enabler is obviously the mobile broadband access through HSPA, LTE, LTE advanced and other advances in the mobile radio communication including upcoming 5G. We will not address these details in this paper. However, briefly pointing to the broadcast capabilities of 3GPP bearers, for example in (2) it is shown that the radio layer of LTE Broadcasting can be used for TV distribution. Existing High Power High Tower (HPHT) broadcast technology typically operate in Multi Frequency Network (MFN) mode with a frequency reuse of at least 4 and a spectrum efficiency of up to 4 bps/Hz inside each cell, typically resulting an overall spectrum efficiency of approx. 1bps/Hz. eMBMS (evolved MBMS, i.e. MBMS over LTE), in a multi-cell deployment, uses a single-frequency network (SFN) configuration, establishing a so called MBSFN. MBSFN permit a spectrum efficiency of up to 2bps/Hz over the entire coverage area (3). What was in the past a drawback at cell edges (with inter-cell interferences) becomes an advantage with increased power reception. Different analysis papers conclude that a cellular Low Power Low Tower radio architecture has the potential for being used for TV distribution, in particular to include reception on mobile devices as well as to achieve indoor penetration. And to re-iterate that with new service types, the availability of an inherently built in unicast connection provides additional incentives to use a cellular architecture for TV service distribution.

While different architecture may be considered for running TV services on top of 3GPP networks, including OTT architectures or external service layers, Figure 1 shows that 3GPP and in particular also eMBMS provides a relevant set of tools to operate TV services. The components involved are

- the MBMS user services, including protocol and codecs as defined in TS 26.346 (5). MBMS permits service announcement and discovery based on the User Service Description (USD) as well as delivery protocols for media real-time and non real-time distribution of objects, primarily the FiLe delivery over Unidirectional Transport (FLUTE) protocol. However, MBMS User services also include unicast options for associated delivery procedures and unicast fall-back,
- the 3GP-DASH formats, which enable encapsulation and efficient distribution over PSS unicast and MBMS broadcast as defined in TS 26.247 (8) together with the set of codecs defined in TS 26.346, TS 26.234 (4) and specifically TS 26.116 (7, for TV video profiles).
- The 3GPP Presentation Layer as defined in TS 26.403 (9) based on HTML-5.

More details on the specific enablers, potential gaps and enhancement opportunities are provided in the remainder of this paper.

EXISTING ENABLERS FOR TV SERVICES

MBMS User Services

MBMS User Services as defined in TS 26.346 specify distribution of download and streaming services in a consistent manner end-to-end over unicast and broadcast bearers. Figure 2 provides the MBMS service architecture. A key benefit of eMBMS/LTE Broadcast is the reuse of the LTE physical layer to a large extent. The service layer including the Broadcast Multicast Switching Centre (BM-SC) enables to integrated 3rd party content, possibly aggregated in application into the MBMS user services.

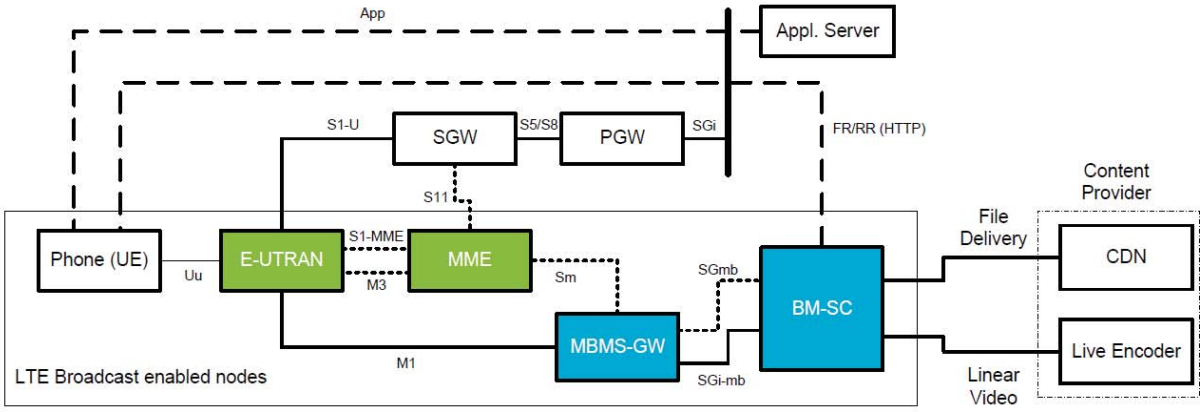

Figure 2 MBMS Service Architecture

LTE-based MBMS User Services were introduced already in Release-9 of 3GPP and includes functionalities like consumption, reception and quality of experience reporting, repair procedures and Forward Error Correction. The MBMS User Service has been enhanced recently to add relevant functionalities that are of matter and interest for potentially operating a TV service within 3GPP. Primary focus for media distribution was the use of DASH formats in order to simplify convergence with unicast deployments and enable MBMS being used as a transport optimization rather than a fully vertical service. Note that the ATSC3.0 architecture (10) re-uses a significant amount of concepts as defined in 3GPP primarily for reasons of convergence of unicast and broadcast, as well as stationary

and mobile TV services. 3GPP services have been enhanced in Release-12 and Release-13 and the key aspects potentially relevant for TV services are summarized in the following:

- Profiles: MBMS was introduced with generic purpose application in mind and therefore provides well-justified flexibility. However, due to the significant interest in TV-like services, MBMS Profiles that subset the technology for DASH-based streaming over MBMS and non-real time media delivery have been defined.
- Unicast fallback: a set of features are provided that permit to offer the same service over MBMS broadcast as well as unicast and permits the UE to seamlessly switch across the delivery methods. This is primarily defined for unicast coverage extensions, but may also be used for hybrid service offerings.
- MBMS Operation On-Demand (MOOD): allows the service to be dynamically migrated from unicast to broadcast and/or vice versa based on consumption reporting in specific service areas,. This enables scalability and efficient usage of the radio resources and ensures consistently good quality especially while demand for a particular service is growing unexpectedly.
- Generic Application Services: In order to simplify the integration of 3rd party object-based media services such as HTML-5 presentations or object-based streaming such as DASH or others, the ability is provided to offer a service for which all resources are managed by the operator as part of an MBMS User Services and the resources are distributed as either unicast or broadcast, or both.

DASH

In 2011, 3GPP developed Dynamic Adaptive Streaming over HTTP (DASH) jointly with MPEG in order to address a single format for segmented adaptive bitrate streaming. TS 26.247 defines the 3GPP profile for DASH. With recent advances in MPEG, DVB-DASH (11) and the DASH-IF (11) in order to address TV centric OTT services, Release-13 was a good opportunity to harmonize the profiles in order to provide a consistent segment format for TV-based distribution. They key extensions to 3GP-DASH were the following:

- Profile Alignment: A distribution profile is defined that enables DVB-DASH and DASH-IF based DASH content to be also distributed and consumed by 3GPP networks and devices.
- Consistent and Robust Live Service: In order to address typical use cases for consistent live service distribution including random access, consistent end-to-end latency, robustness and seamless switching, several tools were collected in a profile to address the needs for consistent TV distribution.
- Ad Insertion: Enablers to support server and client-based add splicing, including targeted ad insertion, where added to TS 26.247 in alignment with DASH-IF and DVB.
- Encoding and Deployment Guidelines for DASH over MBMS: In TS 26.346 a set of best practices are collected in an annex in order to marry the DASH unicast formats with MBMS broadcast delivery. The guidelines solve some typically perceived ambiguities and shows the natural combination of DASH with broadcast and hybrid services.

HTML-5

Interactive and rich presentation services are both key for future TV services. Based on the experience of OTT providers as well as public broadcasters, using for example HbbTV, 3GPP aligned its presentation format in TS 26.307 (9) with the most ubiquitous presentation layer, namely HTML-5. The profile is a set of HTML-5 markup, style, graphics and scripting options. In addition, a set of APIs are mandated or recommended, specifically Forms, Canvas, XHR, Media Source Extension (MSE) with ISO BMFF Byte Stream format, Geolocation, Encrypted Media Extensions (EME), Web sockets, server-sent events and WebCrypto. In addition, playback of DASH Media Presentations through the video tag are recommended to be supported.

The support of these functions on 3GPP UEs will enable content authors with a set of enablers to create innovative media services and may be consumed in a browser-based environment.

TV Video Profiles

During the recently finalized Release-13, 3GPP completed work on a set of video profiles that allow service providers to be able to rely on a well-defined set of video formats and a consistent quality of experience for TV-centric services over 3GPP networks. The commonly used video formats in the Broadcast industry were identified and adapted for TV and VoD distribution over 3GPP systems - inspired by the desire to minimize interoperability issues and to maximize harmony between 3GPP and the Broadcast world. Figure 2 provides the basic motivation and scope of the work. Findings and conclusions on video formats are documented in the Technical Report TR 26.949 (6).

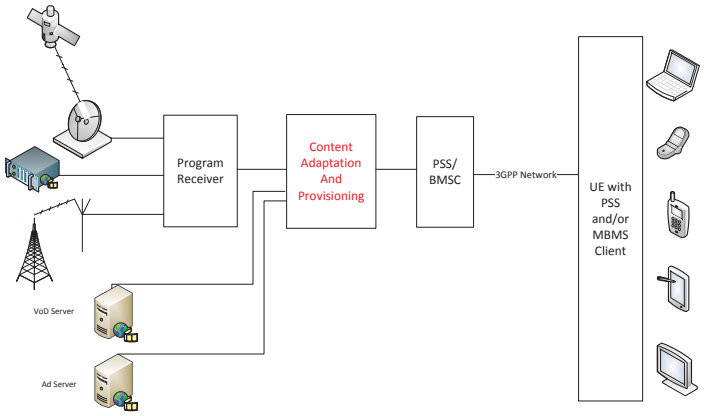

Figure 2 Scope of 3GPP TV Video Profiles

Based on these findings, a set of 5 operating points, ranging from 720p HD to Ultra HD (4K 2160p), are defined: (i) 720p HD AVC up to 30fps, (ii) 1080p Full HD AVC up to 60fps (iii) 720p HD HEVC up to 30fps, (iv) 1080p Full HD HEVC up to 60fps, and (v) Ultra HD HEVC up to 60fps. All of these requirements on video formats are documented in a new specification TS 26.116 “Television (TV) over 3GPP services; Video profiles” (7). This specification also defines a limited set of sub-resolutions for 3GPP-DASH adaptive streaming delivery and a mapping of the operating points to DASH delivery. While serving the primary purpose to target the 3GPP user services, these operation points can be referenced by external bodies and even Over-the-Top (OTT) providers offering similar types of services.

The updated user service specifications amending the 3GPP TV video profiles are the unicast PSS specification TS 26.234 and the MBMS protocol and codecs specification TS 26.346. With these updates, 3GPP Video is ready for Prime-Time TV.

In a world where it is the desire of the content provider to provide a realistic and possibly controllable quality to different end-devices that are connected through a 3GPP network,

the definition of such a limited set of operation points provides confidence on the quality of experience offered by 3GPP services when used for TV-like distribution. These are particularly useful for second screen applications as well as hybrid broadcast broadband services. Traditional broadcasters and service providers are keen to provide a unified service offering to mobile devices without requiring adapting content encoding to a multitude of different device capabilities.

ONGOING WORK ADDRESSING ADDITIONAL USE CASES AND REQUIREMENTS

TV Enhancements

Anticipating the needs as introduced in the introduction, 3GPP launched a work to collect use cases and service requirements in order to address 3GPP enhancements for TV video Service in Release-14. Based on the study results in TR 22.816 (13), service requirements related to TV services were agreed and documented in for TS 22.101 (1), clause 32. The use cases and requirements encourage work in different areas, primarily on the radio access network (RAN), the 3GPP architecture and the 3GPP user service layer.

The primary work in RAN focuses on eMBMS enhancements in order to support or larger inter-site distances (e.g. 15km or larger), support for standalone carrier with 100% capacity dedicated to MBSFN transmission, reception from one or more eMBMS cells that may be non-collocated and asynchronous with one or more cells that are simultaneously used for unicast and TV transport service without being authenticated. The work in the service architecture is dedicated to QoS guarantees across large geographical areas, decoupling of content, MBMS service and MBMS transport functions, broadcast-only and hybrid broadcast/unicast services, network-based service exposure and additional enhancements.

On user service layer, the work primarily addresses objectives in order to permit replication of legacy services (such as linear TV services) as well the enabling new TV services including on-demand and hybrid services. Also enabling existing A/V experiences as well as new experiences is key for future-proof enablers. Among others, the following aspects are considered: (i) Service Announcement and Discovery, (ii) Generic Service Layer functionalities such as consumption and QoE reporting, robustness, etc. (iii) TV service codecs and formats, (iv) Multi-service offerings (service and component multiplexing, channel change, etc.) (v) TV Service Metadata, including Program rating and parental control, (vi) Accessibility, (vii) DRM, Conditional Access and Security Aspects (viii) Targeted and flexible ad insertion, (ix) Interactive services and rich presentation formats, and (x) Requirements relating to regional and regulatory aspects (e.g. blackouts, Emergency Alert System (EAS)).

It is expected that the existing enablers up to Release-13 cover a significant amount of the service requirements, such as e.g. on the video formats and the DASH formats, and only a smaller subset needs to be defined to fulfil broadcast TV requirements.

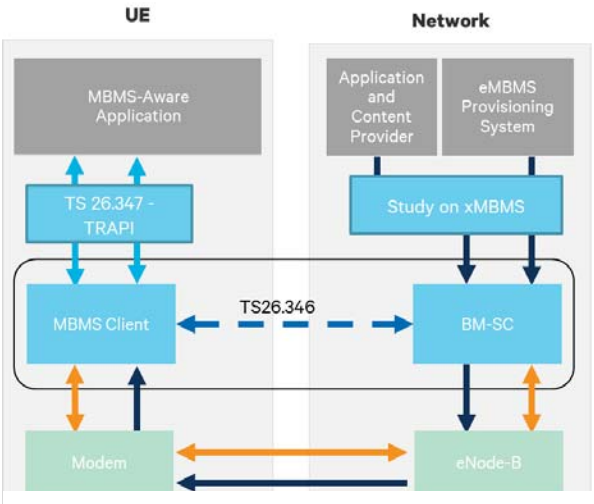

Figure 3 MBMS APIs

MBMS APIs and Transport Protocol

As another relevant enabler and as part of the MBMS Transport Protocol and API (TRAPI) work item, 3GPP is progressing work to provide application-friendly methods and interfaces to access 3GPP MBMS User services. TS 26.347 (14) is primarily targeted for developers of web and user applications and attempts to abstract complex MBMS procedures in simple methods and interfaces. MBMS Client vendors can implement this API and URL to simplify the integration of their applications with MBMS User Services. According to Figure 3, this specification defines an API to MBMS User Services and a URL to access resources available as part of an MBMS User Service. Note that the MBMS client and the MBMS-aware application may be on the same device, or, if the MBMS receiver is deployed on a gateway, it may also be on a separate device.

As a complementary work to the device APIs, 3GPP also initiated work to support provisioning of services and service capability exposure also on the network side under the acronym extended MBMS (xMBMS).

Additional Enablers and Studies: Improved QoE Reporting and Virtual Reality

In addition to the core MBMS work items, 3GPP also addresses work and studies in different other areas to support media streaming deployments, among others:

- Improved QoE Reporting: As a significant amount of video traffic is not provided as a walled-garden operator service, but the operator is highly interested in understanding the performance of video streaming services on its network, Quality-of-Experience (QoE) reporting for such scenarios is studied such as to be provided to both service providers and operators. QoE metrics are also improved to enable evaluation of the video quality experienced by the user.
- Virtual Reality: The immersive multimedia experience has been an exploration topic for several years. With the recent progress made in rendering devices, such as Head mounted displays (HMD), a significant quality of experience can be offered. 3GPP conducts a study to collect relevant use cases for Virtual Reality in order to later potentially define media formats and network capabilities required for providing a true immersive experience.

CONCLUSIONS

In a world where the way to watch TV contents has dramatically changed, 3GPP has focused over the past few years on the efficient delivery of TV services while adapting to the new consumption model paradigms. The definition of technical enablers suiting to more and more frequent on-demand requests (unicast) as well as the large coverage of popular events (broadcast) was the challenge to take and eMBMS, DASH and the TV profiles are the first answers. The demand for video services has never been so high and will continue to grow. TV channels and content providers are looking for ways to reach out to millions of user's devices in the most efficient way. Broadcasters, Operators and Service Providers can leverage their networks and the 3GPP standards to offer such broadcast and unicast media distribution solution.

And with 5G on the horizon, it is clear from (15): "While personalization of communication will lead to a reducing demand for legacy broadcast as deployed today, e.g. linear TV, the

fully mobile and connected society will nonetheless need efficient distribution of information from one source to many destinations."

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