A Survey on Multicast Broadcast Services in 5G and Beyond

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***Abstract*—Increased usage of video consumption along with a host of new services such as software download over wireless networks, group communications, and Internet of Things (IoT) applications have created a need for support of Multicast Broadcast Services (MBS) in wireless networks. While the Third Generation Partnership Project (3GPP) is defining its own mechanism for MBS support in Fifth Generation (5G) system, supplementing the native 5G MBS support with non-3GPP Broadcast Networks may bring additional advantages. A unique characteristic of the 3GPP 5G System (5GS) architecture is the existence of a converged core, capable of supporting diverse access technologies, 3GPP and non-3GPP access technologies in a uniform manner. The 5GS also supports multiple integration points for non-3GPP access networks. These may be utilized for its integration with non-3GPP broadcast networks such as non-3GPP satellite access networks and digital terrestrial broadcast networks enabling it to harness them for multicast broadcast service delivery. In this article, we review the upcoming 3GPP 5G MBS standards along with some of its limitations. We also present state of the art standardization initiatives towards convergence of non-3GPP broadcast networks with the 5GS including our proposals submitted to standards organizations.**

***Index Terms*—Multicast/broadcast services, Non-3GPP broadcast networks, 3GPP 5G MBS network, Satellite access network, Digital terrestrial broadcast networks.**

I. Introduction

According to Qualcomm Fifth Generation (5G) Broadcast report, video continues to be the major driver of mobile data traffic; approximately 80% of overall mobile data is estimated to be video traffic by 2022 and around 800 million users are expected to be engaged in live streams on social media daily [1]. Similarly, in the latest mobility report published by Ericsson, massive Internet of Things (IoT) is estimated to comprise 51% of the overall 5.5 billion cellular IoT connections and the total IoT connections may exceed 30 billion by the year 2027 [2]. It appears that a large fraction of these video and IoT communication needs can be efficiently supported via multicast/broadcast services. In addition to these use cases, cellular broadcast deployment is capable of supporting many other use cases such as group communication, vehicle to vehicle communication, or public safety and disaster relief communications in a more efficient manner.

Support for multicast/broadcast services in cellular networks spans across multiple generations. The Third Generation (3G) cellular systems introduced Multimedia Broadcast Multicast Services (MBMS) which evolved to eMBMS in Long Term Evolution (LTE) systems and Multicast Broadcast Services (MBS) support in the 5G System (5GS) [3] [4]. Unfortunately, the cellular multicast/broadcast services have not found widespread usage till now. However, the situation is expected to change with the deployment of the 5GS.

In addition to cellular broadcast, various standalone digital broadcasting systems (or Digital Terrestrial Technologies (DTT)) like Digital Video Broadcasting (DVB) and Advanced Television Systems Committee (ATSC) provide delivery platforms for broadcast services. Unlike the cellular broadcast services, these technologies have seen widespread deployment, e.g., ATSC 3.0 system is deployed in South Korea and the US among other countries and DVB-T2 has presence in 144 countries with over 1 billion DVB-T2 receivers deployed worldwide [5]. In addition to DTT networks, there is a significant traction towards usage of satellite access networks (Non-Terrestrial Networks (NTN)) for multicast broadcast services. NTNs are particularly suitable for this purpose due to their large coverage area. Many new NTNs such as SpaceX Starlink and Amazon's Kuiper are being deployed globally and can be used for MBS.

An important characteristic of Third Generation Partnership Project (3GPP) defined 5GS architecture is the existence of a converged core capable of simultaneously supporting 3GPP and non-3GPP access technologies. The 5GS architecture also provides the ability to support multiple integration points for non-3GPP networks, which can be leveraged for convergence of the non-3GPP broadcast networks and the 5GS. The convergence of non-3GPP broadcast networks like DTT and NTN with the 5GS can bring many benefits such as large coverage area support, high spectral efficiency (4K-quadrature amplitude modulation in ATSC 3.0) and improved mobility support. In addition, support for multi frequency and single frequency networks in DTT provides the advantages of spectrum sharing. The usage of DTT may also enable improved resource utilization across non-3GPP broadcast networks and 3GPP Next Generation Radio Access Network (NG-RAN) further reducing the load on the cellular spectrum. In such a converged network, users can also be moved across the 5G NG-RAN and the non-3GPP broadcast networks dynamically for improved efficiency and user experience.

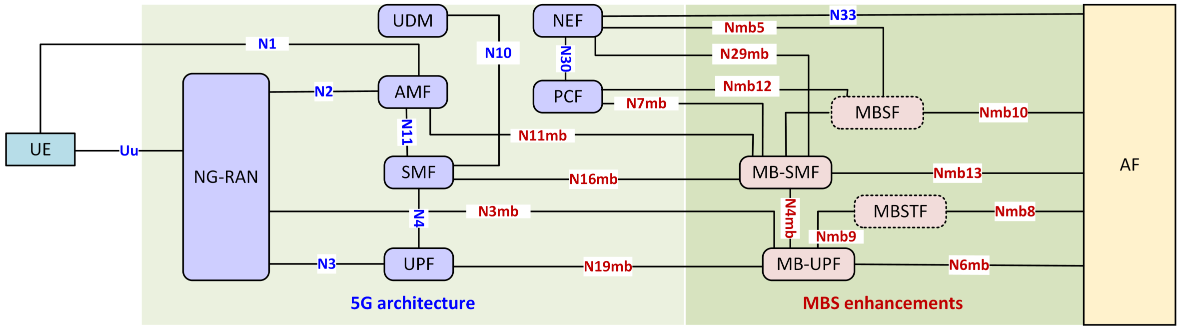

Fig. 1. 5G architecture with MBS enhancements [4]. AMF: Access and Mobility Management Function, AF: Application Function, MB-SMF: Multicast/Broadcast Session Management Function, MBSF: Multicast/Broadcast Service Function, MBSTF: Multicast/Broadcast Session Transport Function, MB-UPF: Multicast/Broadcast User Plane Function., NEF: Network Exposure Function, NG-RAN: Next generation Radio Access Network, PCF: Policy Control Function, UDM: User Data Management, and UE: User Equipment.

This paper provides an overview of the existing and ongoing standardization efforts in 3GPP and Telecommunications Standards Development Society India (TSDSI) for MBS support in 5GS. We present core and Radio Access Network (RAN) level enhancements as included in the 5GS architecture to support MBS. Standardization initiatives towards 'convergence of NTN and DTT access and the 5GS' are also detailed including our proposals for convergence. We have proposed multiple approaches for integrating NTN and DTT networks with 5GS detailed in Sections IV-B, V-A, and V-B. We also highlight some of the limitations of the existing architecture of the 5GS with respect to support for MBS.

II. 5G MBS Architecture

MBS support in 5G architecture has been detailed in 3GPP technical specification TS 23.247 [4]. Figure 1 provides an overview of the major components in the 5GS architecture [6] along with the new functions introduced to support multicast broadcast services. Access and Mobility Management Function (AMF) primarily provides control plane interface towards the NG-RAN to serve the User Equipments (UEs). Session Management Function (SMF) establishes the data path between the UEs and the User Plane Function (UPF) to facilitate UE data transfer. Unified Data Management (UDM) facilitates centralized user data management and Policy Control Function (PCF) uses the policy related information to configure policy rules in the 5G network. Network Exposure Function (NEF) allows external Application Functions (AFs) to interact with the 5G core network functions. Listed below are the new functions for supporting MBS enhancements:

1) Multicast/Broadcast Session Management Function (MB-SMF): MB-SMF primarily supports MBS session management related functionalities along with controlling Quality of Service (QoS) parameters of those sessions. MB-SMF configures the Multicast/Broadcast-UPF (MB-UPF) to apply multicast and broadcast data transport rules based on the policies received from PCF. MB-SMF also interacts with the NG-RAN (via AMF) to establish data transmission resources (in the case of multicast) or to control data transport (in the case of broadcast) for 5GC shared MBS traffic delivery method. It interacts with SMF to modify the existing Protocol Data Unit (PDU) sessions associated with a multicast session and controls multicast data transport using 5GC individual MBS traffic delivery method.

2) Multicast/Broadcast User Plane Function (MB-UPF): MB-UPF is primarily responsible for the delivery of multicast and broadcast data to NG-RAN nodes using 5GC shared/individual MBS traffic delivery methods. MB-UPF interacts with Multicast/Broadcast Service Transport Function (MBSTF)/AF to receive multicast and broadcast data to be delivered to the UEs. It also ensures QoS enforcement based on the policies configured by the MB-SMF.

3) Multicast/Broadcast Service Function (MBSF): MBSF provides service level functionality to support multicast broadcast services and it also facilitates inter working with LTE's MBMS. It interacts with AF and MB-SMF for MBS session related operations along with selecting a serving MB-SMF for a particular MBS Session. MBSF also controls MBSTF and determines the destination Internet Protocol (IP) multicast address for MBS sessions.

4) Multicast/Broadcast Service Transport Function (MBSTF): MBSTF acts as the media anchor for MBS data traffic along with sourcing of IP multicast address if required. It configures generic packet transport functionalities like framing and forward error correction.

A. Delivery methods

Following are the two delivery methods defined in 5G MBS architecture:

5GC Shared MBS traffic delivery method (Figure 2): This delivery method is applicable to both multicast and broadcast sessions where a single copy of data packet is delivered to the NG-RAN, which then delivers the data packets to all the UEs in that particular session. Between NG-RAN and UE, MBS data packets can be delivered over the radio using two possible methods.

- Point-To-Point (PTP) delivery method: In this method separate copy of data packets are delivered to individual UEs by NG-RAN.
- Point-To-Multipoint (PTM) delivery method: In this method, NG-RAN delivers single copy of data packets to multiple UEs.

5GC Individual MBS traffic delivery method (Figure 3): This delivery method is applicable only for multicast sessions where MB-UPF receives a single copy of data packet. MB-UPF handles the replication of those data packets and those are delivered to individual UEs via their dedicated PDU sessions. So, for each UE, a PDU session is required to be associated with the multicast session.

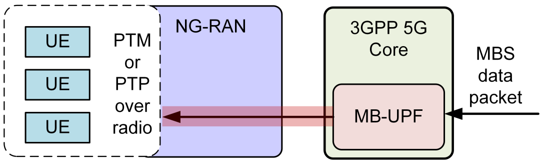

Fig. 2. 5GC Shared MBS traffic delivery method. 3GPP: Third Generation Partnership Project, 5G: Fifth Generation, MB-UPF: Multicast/Broadcast User Plane Function, MBS: Multicast Broadcast Services, NG-RAN: Next Generation Radio Access Network, PTM: Point-to-multipoint, PTP: Point-to-point, UE: User Equipment

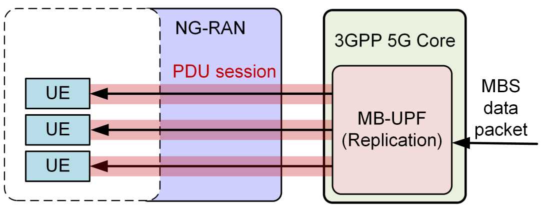

Fig. 3. Individual MBS traffic delivery method. 3GPP: Third Generation Partnership Project, 5G: Fifth Generation, MB-UPF: Multicast/Broadcast User Plane Function, MBS: Multicast Broadcast Services, NG-RAN: Next Generation Radio Access Network, PDU: Protocol Data Unit, UE: User Equipment

B. Radio aspects of MBS delivery

In 5G MBS New Radio (NR), broadcasting is applicable to all the available UEs irrespective of their connected state, and acknowledged delivery mode is not applied for the same. However, multicasting can be only made possible for UEs which are in Radio Resource Control (RRC)-active state. Besides, broadcasting of MBS session identifier is required to activate the MBS session. Sublayers for 5G MBS NR are shown in Fig. 4 referred from [7]. Service Data Adaptation Protocol (SDAP) layer does mapping of incoming QoS flows into MBS Radio Bearers (MRBs) which can be multicast or broadcast MRBs based on the QoS policies. Protocol Data Convergence Protocol (PDCP) layer performs reordering of the packets and further link these packets to Radio Link Layer (RLC) entities. RLC layer segments these packets into small

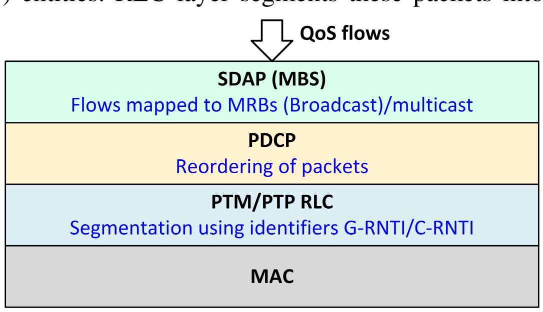

Fig. 4. Sublayers for 5G MBS NR [7]. MBS: Multicast/Broadcast Services, SDAP: Service Data Adaptation Protocol, MRB: MBS Radio Bearers, PDCP: Protocol Data Convergence Protocol, RLC: Radio Link Layer, G-RNTI: Group Radio Network Temporary Identifier, C-RNTI: Cell Radio Network Temporary Identifier, QoS: Quality of Service, PTM: Point-to-multipoint and PTP: Point-to-point.

sub-packets. There are two types of RLCs, PTM RLC or PTP RLC. PTM RLC is used to send same packet to multiple users with the use of Group Radio Network Temporary Identifier (G-RNTI). PTP RLC uses Cell Radio Network Temporary Identifier (C-RNTI) and supports acknowledged mode of delivery. Further multiplexing/demultiplexing is performed at the Medium Access Control (MAC) layer.

C. Key advantages of 5G MBS over LTE eMBMS

A key difference between the MBS support in 5GS and eMBMS support in LTE is that 5GS (the core as well as NG-RAN) has awareness of all UEs accessing a particular multicast service while such awareness is not available within the LTE system (core/RAN). This is possible in 5GS since UEs join a multicast service (session) by informing the 5G core through Non-Access Stratum (NAS) signaling. This UE awareness in 5GS allows NG-RAN to allocate a multicast group specific Radio Network Temporary Identifier (RNTI) to deliver data to UEs belonging to a particular multicast group, which is not possible in 4G eMBMS.

Dynamic switching between PTM and PTP modes at RAN level in 5G MBS NR has added an extra advantage of serving acknowledged delivery mode for multicast services based on QoS requirement for those particular flows. This facility is not available in LTE eMBMS. Besides, 5G MBS has included dedicated functional support in the architecture to serve MBS deliveries which is not the case in LTE eMBMS architecture. These supported aspects in 5G MBS architecture are advantageous in terms of guaranteeing reliability and latency.

D. Standardization initiatives and limitations of 5G MBS Architecture

3GPP specifications for multicast/broadcast enhancements in cellular networks are listed in Table I. 3GPP initiated multicast/broadcast service integration by defining group communication system enablers for LTE in TS 23.468 [3]. Various options and solutions with respect to architectural changes and procedures for MBS enhancements in 5GS were discussed and presented in 3GPP TR 23.757. The MBS architecture presented in Fig. 1 is specified in 3GPP TS 23.247 [4].

TABLE I
CURRENT SPECIFICATIONS TO SUPPORT MULTICAST/BROADCAST SERVICES

Technical Specifications / Report	Title
3GPP TS 23.247 V17.1.0 (2021-12) [4]	Architectural enhancements for 5G multicast-broadcast services; Stage 2 (Release 17)
3GPP TS 26.502 V1.0.0 (2021-12) [8]	5G multicast–broadcast services; User Service architecture (Release 17)
3GPP TS 23.468 V16.0.0 (2020-07) [3]	Group Communication System Enablers for LTE (GCSE-LTE); Stage 2 (Release 16)
3GPP TR 23.757 V17.0.0 (2021-03) [9]	Study on architectural enhancements for 5G multicast-broadcast services (Release 17)
ETSI TS 103 720 V1.1.1 (2020-12) [10]	5G Broadcast System for linear TV and radio services; LTE-based 5G terrestrial broadcast system

Recently, specifications on architectural enhancements for 5G MBS started including the aspects of UE-AF application level details and service announcements mechanisms. Inspite of specifications supporting multicast/broadcast enhancements in LTE and 5G architectures, there are certain limitations that need to be addressed to serve upcoming usage requirements. Improving resource efficiency for MBS reception is required along with group event management reporting for MBS sessions. It is also necessary to expose MBS sessions related statistics. To overcome some of these limitations, few work items are initiated and are open for contributions in 3GPP (listed in Table II).

TABLE II
APPROVED WORK ITEMS IN 3GPP TO SUPPORT MBS ENHANCEMENTS

Work Item	Objective
RP-212714* Evolution for broadcast and multicast services	Support of multicast reception by UEs in RRC-inactive state and its impact on mobility scenarios
SP-211609** Architectural enhancements for 5G multicast-broadcast services Phase-2	Support for on demand MBS session triggered by AF and efficient resource utilization by choosing multicast or unicast delivery method
SP-211603** Generic group management, exposure and communication enhancements	To enhance NEF exposure framework to enable capability exposure for provisioning of traffic characteristics and monitoring of performance characteristics applicable to each UE of a given group

*Referred from Tdocs of 3GPP RAN-94e meeting (Available online at https://www.3gpp.org/DynaReport/TDocExMtg–RP-94-e–60214.htm)
**Referred from Tdocs of TSG SA Meeting SP-94e (Available online at https://www.3gpp.org/DynaReport/TDocExMtg–SP-94-e–60223.htm)

III. CONVERGENCE OF 5G MBS AND DEDICATED BROADCAST NETWORKS

3GPP has indeed moved towards a converged core with interworking support for non-3GPP access technologies like Wi-Fi and wireline access. To facilitate this convergence, all 3GPP and non-3GPP access technologies use a common Access Network (AN) and Core Network (CN) interfaces defined in 3GPP specifications. Using these well defined interfaces opens up possibilities for integrating other access technologies like satellite and dedicated broadcast networks into the 3GPP umbrella. Convergence of such technologies in 5G can provide many benefits and few are listed below:

- Provide new opportunities for collaboration in terms of resource sharing between cellular and broadcast networks which can result in improved resource utilization.
- Enhance broadcast capabilities and extend reach to more users to serve more diverse set of MBS services with associated QoS requirements.
- Enhance flexibility in cellular networks to choose delivery method based on resource availability.
- Provide extended coverage and mobility support with flexibility in deployment.
- Reliable and assured MBS delivery through various delivery networks.

However, integration of different delivery networks has many challenges. To list a few, need for static and dynamic resource allocation methods and strategies, standardized interfaces and protocol stacks for different delivery methods, support from various operators like cellular network operators, broadcasters and content providers. Solution for this convergence has to benefit both the operators as well as the users, and it should also be feasible to implement. There are two major broadcast technologies, NTN and DTT that are being considered for integration with 5G. In this context, we discuss various in-progress efforts to converge these broadcast technologies with 5G in subsequent sections.

IV. CONVERGENCE OF SATELLITE ACCESS IN 5G

Advancements in satellite access technology specifically towards reducing latency by deploying Low Earth Orbit (LEO) satellites have drawn lot of interest in the 3GPP community. There are two approaches for converging satellite access in 5G, they are discussed in the following sections.

A. Integration of satellite access based 5G-NR

To integrate satellite access as an additional radio access technology, 5G-NR can be supported over satellite access as shown in Fig. 5.

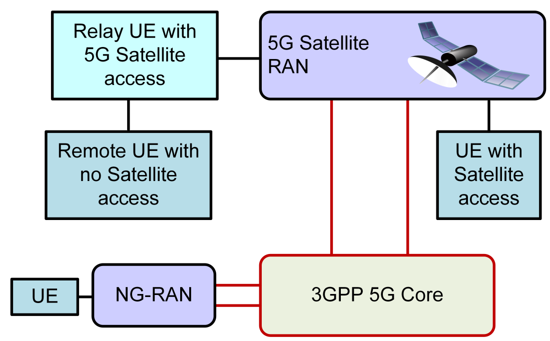

Fig. 5. Integration of satellite access based 5G-NR. NG-RAN: Next Generation Radio Access Network, RAN: Radio Access Network, and UE: User Equipment

TABLE III
STANDARDIZATION INITIATIVES

Technical Specifications/Report	Title
3GPP TR 22.822 V16.0.0 [11]	Study on using Satellite Access in 5G; Stage 1 (Release 16)
3GPP TR 38.811 V15.1.0 (2019-06) [12]	Study on New Radio (NR) to support non-terrestrial networks (Release 15)
3GPP TS 22.261 V18.4.0 (2021-09) [13]	Service requirements for the 5G system; Stage 1 (Release 18)

NG-RAN design can get impacted to support satellite access though the impact is limited. Minor adaptations in few physical/higher layer aspects, for example, advanced antenna configuration to manage satellite spectrum ranges shall be required [12], [14]. Impact of high latency (on the feeder and service links) needs to be addressed especially in the control plane procedures with adaptation in timer values. Besides that, architectural enhancements are also required to make the system compatible for communication with high altitude platforms. Relay UEs can be deployed to provide service continuity in the case of moving platforms. Whereas UE with satellite access should be able to access satellite RAN and NR both. Standardization efforts towards this has been initiated in 3GPP, existing technical specifications and reports are listed in Table III and open work items for further contributions are also listed in Table IV.

TABLE IV
APPROVED WORK ITEMS ON SATELLITE ACCESS IN 3GPP

Work Item	Objective
RP-212713* NTN (Non-Terrestrial Networks) evolution	Enhancements for NG-RAN based NTN with implicit compatibility to support HAPS (high altitude platform station) and ATG (air to ground) scenario
RP-212729* New WID on IoT NTN enhancements	Architectural enhancements to support discontinuous coverage for mobility enhancement
SP-211602** Support of satellite backhauling in 5GS	Architecture enhancements for support of UPF deployed on GEO satellite with gNB on the ground
SP-211616** 5GC enhancement for satellite access Phase 2	Architectural enhancements considering prediction, awareness and notification of UE wake-up time, power saving optimizations.

*Referred from Tdocs of 3GPP RAN-94e meeting (Available online at https://www.3gpp.org/DynaReport/TDocExMtg–RP-94-e–60214.htm)
**Referred from Tdocs of TSG SA Meeting SP-94e (Available online at https://www.3gpp.org/DynaReport/TDocExMtg–SP-94-e–60223.htm)

B. Integration of non-3GPP satellite access using a new interworking function

Usage of non-3GPP satellite access for MBS in 5GS is very promising as there are many different types of non-3GPP satellite access, both legacy and new like OneWeb, Telesat, Space, Starlink, and Amazon's Kuiper, etc., can be used for this purpose. With 5GS' availability of MBS delivery framework (3GPP TS 23.247 [4]), it is easy to integrate non-3GPP satellite access as non-3GPP access with 5G core with limited changes expected in existing interfaces (N2/N3) using an interworking function as shown in Fig.6.

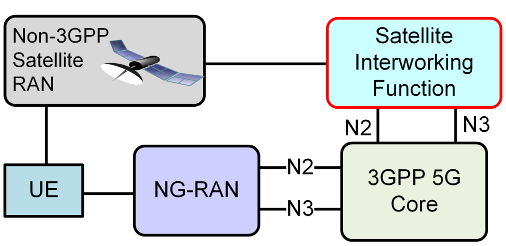

Fig. 6. Integration of non-3GPP satellite access using a new interworking function. NG-RAN: Next Generation Radio Access Network, and UE: User Equipment

We have proposed this approach to initiate standardization as a new work item in 3GPP meeting as presented in Table V. By deploying interworking function, there is no impact on functions like AF, MBSF and MBSTF and this solution is aligned with 5GS architectural principles. It can provide unified MBS session management across 3GPP NG-RAN and non-3GPP satellite network, and 5G core can manage data flow through both non-3GPP satellite network and 5G NG-RAN. It can reuse the inbuilt unicast–multicast switching mechanism of 5G core. This solution can result in improved resource utilization across non-3GPP satellite network and 3GPP 5G NG-RAN. However, synchronization across two access networks in case of user mobility is an important requirement, which may need to be addressed.

TABLE V
NEW WORK ITEM SUBMITTED TO 3GPP*

Work Item	Objective
S1-220068	New WID on Usage of Non-3GPP NTN for Multicast Broadcast Services in 5GS

*Referred from Tdocs of 3GPP SA1-97e Meeting (Available online at https://www.3gpp.org/DynaReport/TDocExMtg–S1-97-e–60256.htm).

V. CONVERGENCE OF DTT IN 5G

Though 3GPP standard TS 22.261 [13] identifies a set of technologies (such as satellite access) to be used for MBS within 5GS, non-3GPP DTT has not been identified currently as a technology for MBS delivery within 5GS. We propose two different approaches towards integration of DTT based networks for MBS in 5GS as detailed in the following subsections.

A. Integration of non-3GPP broadcast network using a new interworking function

Access of non-3GPP broadcast network can be made available in 5GS using new interworking function for non-3GPP broadcast technologies (as shown in Fig. 7). As detailed in Section IV-B, this method has little impact on the existing interfaces and architecture. In addition, non-3GPP broadcast networks can be used for multicast/broadcast transmission and there can be easy switching between non-3GPP broadcast network and 3GPP 5G NG-RAN.

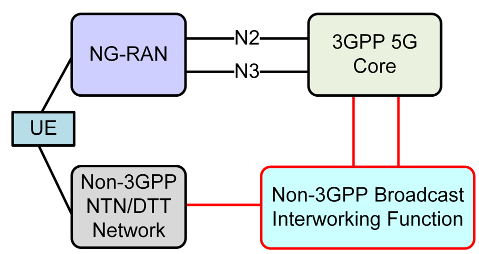

Fig. 7. Integration of non-3GPP broadcast network using a new interworking function. UE: User Equipment, NTN: Non-Terrestrial Network, DTT: Digital Terrestrial Technologies, and NG-RAN: Next Generation Radio Access Network.

TABLE VI
NEW WORK ITEM SUBMITTED TO 3GPP

Work Item	Objective
S2-220069	New WID on the usage of Non-3GPP Digital Terrestrial Broadcast Networks for Multicast Broadcast Services in 5GS

*Referred from Tdocs of 3GPP SA1-97e Meeting (Available online at https://www.3gpp.org/DynaReport/TDocExMtg–S1-97-e–60256.htm)

Selection of appropriate 3GPP or non-3GPP access technology for a service can result in optimization and resource efficiency. It enhances service continuity to a user outside 3GPP

NR coverage as DTT based broadcast networks can have large coverage support and high spectral efficiency due to higher order modulation scheme support. We have proposed usage of non-3GPP DTT for MBS in 5GS through an interworking function. It has been submitted as a new work item to 3GPP (detailed in Table VI).

B. Integration of non-3GPP broadcast network with 5GS via application function

We have also proposed integration of non-3GPP DTT with 5GS via an AF. This enhancement in the architecture for integration of 3GPP 5GS and non-3GPP Broadcast Networks (N3BN) has been proposed for consideration in TSDSI as detailed in Table VII. The approach is to include a customized AF called Multicast Broadcast Offload System (MBOS) which can serve as a mediator between the 5G network, N3BN and the content provider as shown in Fig. 8. MBOS can facilitate efficient usage of network resources based on session/load related information made available to it by the 3GPP network or the UEs.

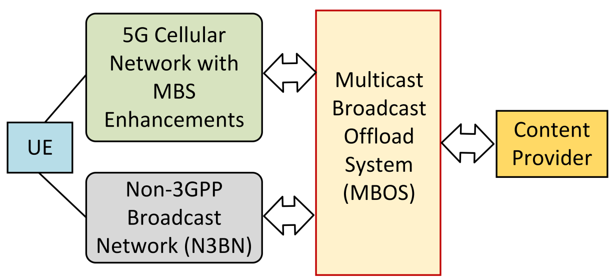

Fig. 8. MBOS for load sharing between 5G and non-3GPP broadcast networks. UE: User Equipment.

TABLE VII
NEW ITEM SUBMITTED TO TSDSI

Work Item	Objective
TSDSI-SGN-NIP226-V1.0.0	Baseline Requirements and High-Level Architecture for NIP226 (5G Extensions for Broadcast Offload)

*Referred from TSDSI New Item Proposal list (Available online at - https://tsdsi.in/new-item-proposals/)

MBOS can decide to switch an ongoing 5G unicast/multicast/broadcast session to the N3BN or vice versa. Unicast sessions of one or more UEs accessing the same content can be switched to a multicast session on the N3BN, similarly when the N3BN becomes unreachable due to UE mobility, the session can be switched back to unicast delivery mode on the 5G network. Multicast sessions and broadcast sessions can also be switched between the two delivery networks. The switching decision can either be based on pre-configured policies or data collected (for the purposes of analytics) from the 5G network/UEs. MBOS interacts with the content provider and acts as a media anchor for delivery via the 5G network or N3BN. Through a signalling PDU session between the UEs and the MBOS, the MBOS can collect information about the ongoing sessions to make switching decisions. By learning the QoS requirements of the delivery network, it can be set for the particular sessions through MBOS. This proposal does not require any new interface and functionality in 5GS.

VI. CONCLUSION

Soaring demands for video traffic, software delivery over radio and other use cases have fuelled the need for multicast/broadcast service support in the 5G system. To support these requirements and reduce congestion in cellular networks, the MBS support is being included in 5GS. We review ongoing work and efforts towards standardization of the MBS in 5GS. We also review standardization initiatives towards convergence of non-3GPP DTT, non-3GPP NTN and 3GPP-NTN (NR-based satellite access) with 5GS. NR-based satellite access may require small adaptations in the NR design aspects whereas integration of non-3GPP satellite access through an interworking function requires no changes in the NG-RAN or 5G Core architecture. The mechanism of interworking functions for integration of non-3GPP access with 5GS is quite flexible and enables integration of many non-3GPP access technologies such as DTT broadcast networks. AF driven method for convergence of non-3GPP networks with 5GS has also proposed which does not require any changes in the existing 5G architecture. The converged architecture of 5GS with MBS support via native NG-RAN as well non-3GPP broadcast networks provides immense flexibility towards delivery of data to users. The architecture can be exploited to support varied schemes and algorithms to improve resource utilization and network performance. This review also highlights open 'work items' towards integration of non-3GPP access technologies with 3GPP 5GS.

ACKNOWLEDGMENT

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REFERENCES

[1] Qualcomm, "Pioneering 5G Broadcast - Building on Multiple Generations of Cellular Broadcast Technology Leadership," *Report*, May, 2021.
[2] Ericsson, "Ericsson Mobility Report," *Report*, Nov, 2021.
[3] 3GPP TS 23.468, "Group Communication System Enablers for LTE; Stage 2 (Release 16) ," *Technical Specification*, 2020.
[4] 3GPP TS 23.247, "Architectural enhancements for 5G multicast-broadcast services; Stage 2 (V17.1.0 (2021-12)," *Technical Specification*, 2021.
[5] DVB Project Office, "Comparing ATSC 3.0 with DVB-T2," *White paper*, August, 2010.
[6] 3GPP TS 23.501, "System architecture for the 5G System (5GS); Stage 2 (V17.1.1 (2021-06)," *Technical Specification*, 2021.
[7] Shrivastava, V. Kumar, B. Sangkyu, and B. Youngkyo, "5G Evolution for Multicast and Broadcast Services in 3GPP Release 17," *TechRxiv. Preprint.*, 2021.
[8] 3GPP TS 26.502, "5G Multicast–Broadcast Services; User Service architecture; V2.0.0 (2022-02)," *Technical Specification*, 2022.
[9] 3GPP TR 23.757, "Study on architectural enhancements for 5G multicast-broadcast services; V17.0.0 (2021-03)," *Technical Specification*, 2021.
[10] ETSI TS 103 720, "5G Broadcast System for linear TV and radio services; LTE-based 5G terrestrial broadcast system (2020-12)," *Technical Specification*, 2020.
[11] 3GPP TR 22.822, "Study on using Satellite Access in 5G; Stage 1 V16.0.0 (2018-06)," *Technical Report*, 2018.
[12] 3GPP TR 38.811, "Study on New Radio (NR) to support non-terrestrial networks V15.4.0 (2020-09)," *Technical Report*, 2020.
[13] 3GPP TS 22.261, "Service requirements for the 5G system; Stage 1 V18.4.0 (2021-09)," *Technical Report*, 2021.
[14] X. Lin, S. Rommer, S. Euler, E. A. Yavuz, and R. S. Karlsson, "5G from Space: An Overview of 3GPP Non-Terrestrial Networks," *IEEE Communications Standards Magazine*, vol. 5, no. 4, pp. 147–153, 2021.