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# Collaboration of Cellular and Broadcast Networks for Media Transmission: A Technical Survey

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**ABSTRACT**

Cellular networks and broadcast networks provide a better media transmission by considering high data rate and flexibility. The Cellular network provides various services using unicast or multicast model. In this survey, Cloud radio access network(C-RAN), which is a cooperative structure of both cellular and broadcasting network has been proposed. To allow smooth communication between broadcasters and users, Dedicated Return Channel(DRC) of a broadcasting network is used. Discusses two more approaches, namely, 3GPP (3rd Generation Partnership Project) and ATSC 3.0 (Advanced Television Systems Committee) and presents a cooperative structure of DVB-T2 (Digital Video Broadcasting-2nd generation Terrestrial) and LTE (Long Term Evolution).

***Keywords: Broadcasting network, C-RAN,Cellular network, DRC, Hybrid network***

## I.INTRODUCTION

Broadcasting refers to the process of transmission of packets to all recipients concurrently and is highly efficient by limiting cost for a larger population [1]. The Main goal of future media transmission includes high flexibility services and high efficiency transmission.  LTE is often used to refer to wireless broadband technologies. LTE-advanced is a standard for 4G broadband technology developed by 3GPP, which provides simple and low-cost deployment in LTE infrastructure [2].  To provide a better video experience for users, collaboration of broadcast and broadband network services, hybrid broadcast broadband TV (HBBTV) is developed. Services delivered by HbbTV consists of Teletext, catch-up services, video-on-demand, EPG, interactive advertising, personalization, voting, games, social networking, and other multimedia applications. Additionally, eMBB(enhanced Mobile Broadband) application is a common hardware and software architecture which are meant for data flow applications such as Software Defined Radios(SDR), image processing [2]. The Broadcasting model provides more efficiency in the delivery of data to a large number of subscribers at high quality.Return Channel consists of information from users to the service providers. Broadband networks can be used as return channel. Techniques in both MAC and physical layer areconsidered and tested to provide higher communicationreliability and system throughput. DRC is used for providinginteractive data transmission through unique broadcasting network [1]. A cellular network or mobile network is a communication network where the last link is wireless.

Collaborative structure of the broadcasting network and cellular network based on C-RAN has been proposed. C-RAN (Cloud-RAN), also known as Centralized RAN is a centralized cloud-computing based architecture for radio access networks that supports 2G,3G,4G and future wireless media communication [4]. C-RAN is the basis for 5G wireless communication. The main advantages pertaining to C-RAN includes reducing deployment and operating costs of radio access network, optimization of resource utilization and improvement of system throughput.

### 1.1. CHALLENGES AND MOTIVATIONS

In C-RAN, Front haul requires high bandwidth capability with low delay. Optical fiber is very expensive. Virtualization technique involves distributed processing and resource sharing between multiple BBUs. To support sharing among users, BBUs in the same pool needs to cooperate together and security issues regarding user privacy and trusted parties [4]. Challenges faced by LTE includes interoperability, traffic management and security [7].

Main motivation for using C-RAN: Low Latency is provided by C-RAN by time taken to reach destination and includes performance metrics such as propagation delay and transmission delay. C-RAN also provides faster deployment as total number of components at each cell site is lowered and makes installation simple, cost-effective as C-RAN lowers the cost and high-power consumption and adaptable to temporal non-uniform traffic [5]. LTE-A is used to provide increased data throughput, communication efficiency and reliability of the data transmission.

## II.STRUCTURE OF THE SYSTEM

To handle user's demands, enhanced Mobile Broadband(eMBB) aims at providing services that require higher bandwidth [6]. C-RAN is also known as Green RAN. The main purpose of C-RAN is Virtualization and Centralization. C-RAN is a form of distributed base station system architecture. C-RAN includes 3 layers namely, Remote Radio Heads(RRH), Front Haul and Baseband unit (BBU) pool. In RRH, the base station is separated into radio unit and a signal processing unit. The function of BBU unit is to provide scalability, cost reduction.

Converged BBU unit consists of a pair of virtual broadcasting cluster for cellular network and broadcasting network. Software-defined networking(SDN) based scheduler is used to allocate resources to each of the networks. Broadcasting tower enables the use of radio over fiber (RoF) technology for both the networks to reduce the analog/digital conversion process and to provide services without any interference. To provide high transmission capacity, Optical Fiber Communication is considered to be the ideal fronthaul. Bidirectional transmission is provided by broadcasting distribution network, which acts as link between BBUs and RRHs. For future media transmissions, a simple and efficient strategy of combination of Cellular network and Broadcast network is used [6].

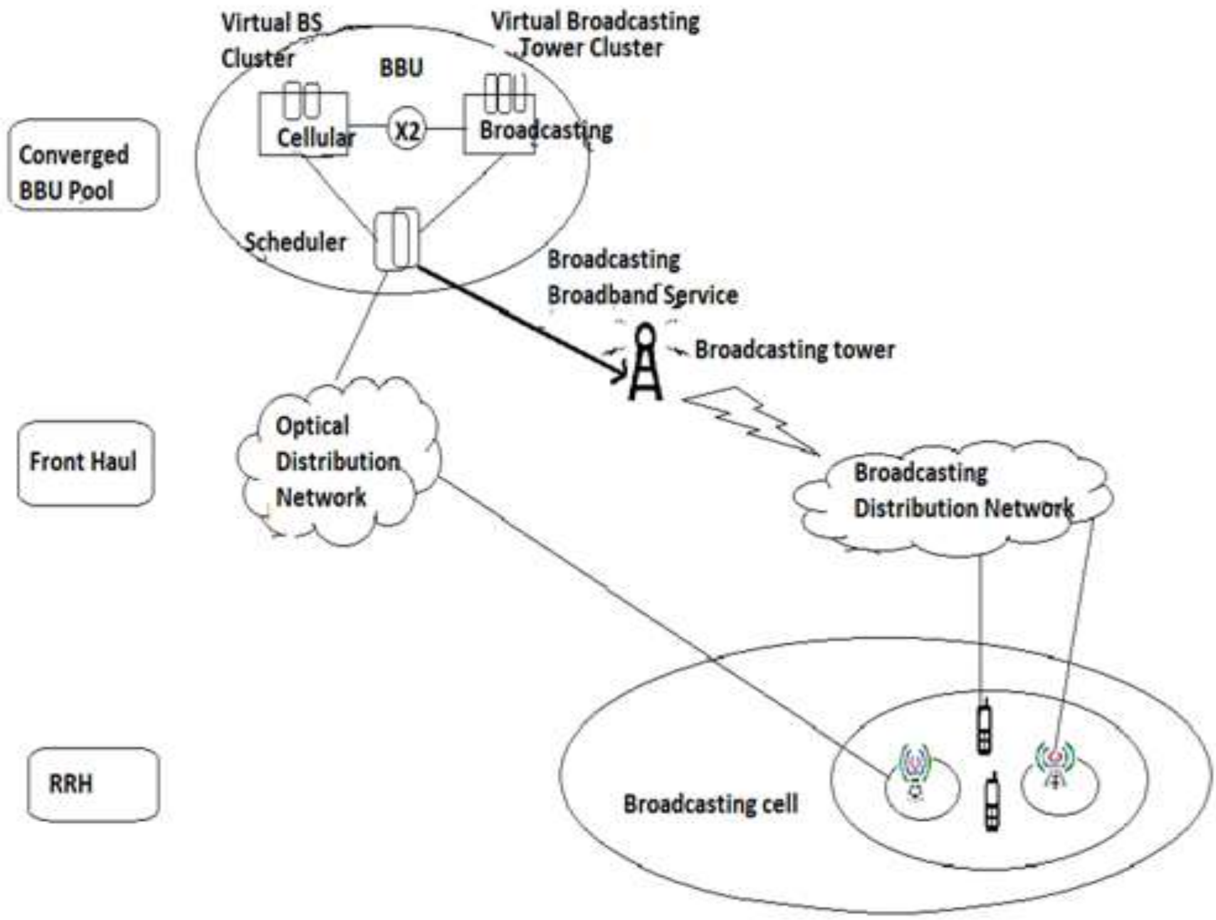


**Fig 1: C-RAN Structure**

## III. ASSOCIATION OF BROADCASTING NETWORK AND 5G NETWORK

5G wireless network provides increase in data rate, Quality of Service(QoS) and connectivity. Aim of 5G is to provide vehicular communications and Healthcare applications.

Extended customer premise equipment(E-CPE) is used to achieve a unified access to both of the networks without modifying the mobile terminals. Both the networks can be connected in parallel using E-CPE. At one point, it is connected to broadcast network to receive linear broadcast content and at the other point, it is connected to cellular network to receive data applications. Bidirectional communication is provided by cellular channel and broadcasting dedicated return channel [6]. Fig 2 represents collaboration of broadcasting and cellular network.

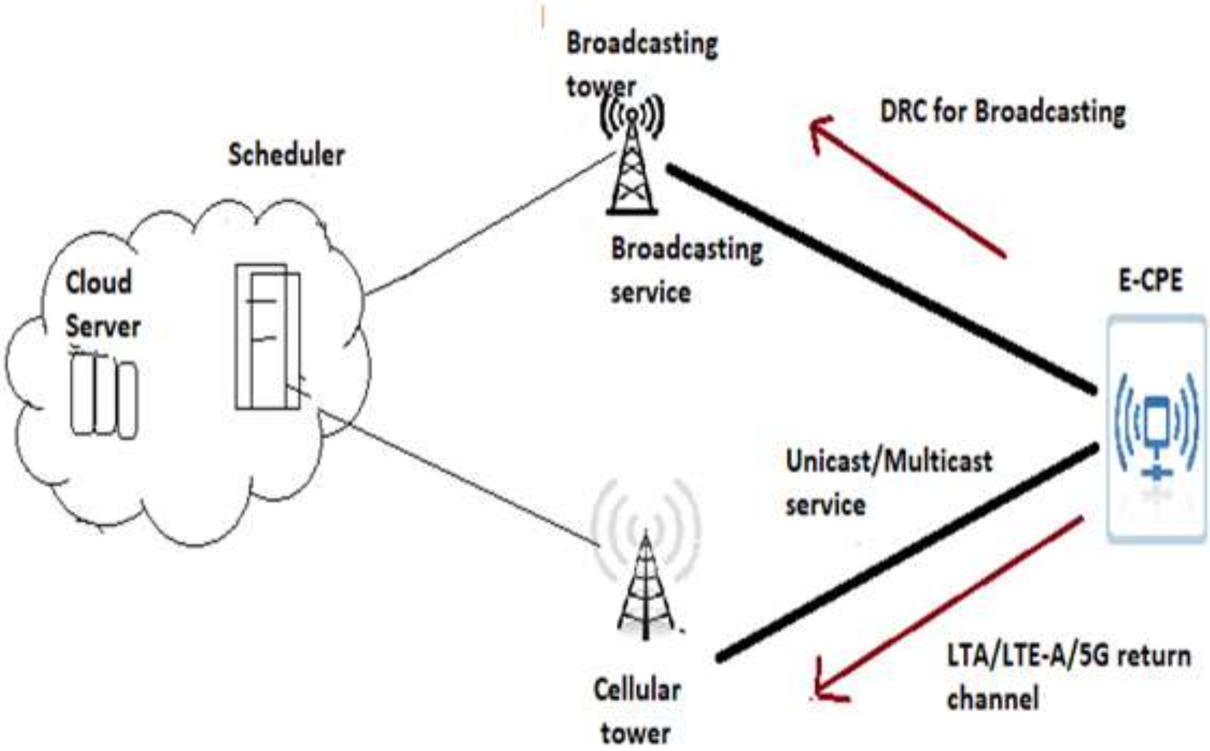


**Figure 2: Collaboration of Broadcasting and Cellular network**

## IV.TECHNICAL APPROACHES FOR 5G AND ATSC COORDINATION

ATSC 3.0 also known as Next-Gen TV uses physical layer which provides increased bandwidth efficiency and compression performance [3]. Fig 3 shows the collaborative frame structure of LTE and ATSC 3.0.By using hybrid modulators, LTE Broadcast signal is in-band with DVB-T2 signal. LTE signals are rendered into FEF (Future Extension Frames), which is used to identify frame types with frequency division multiplexing(FDM) mode. Length of DVB-T2 and LTE part is an integer multiple of 10ms., that is the length of single frame of LTE radio. FEFs allow the cooperative transmission of a classical broadcast stream and of an arbitrary signal with LTE-A+ [14]. Figure 4 represents the cooperative frame structure of LTE-A+ and ATSC 3.0.

Baseband sampling rates (BSR) is used to make sure that frame boundaries of several networks are always aligned corresponding to their sample clocks has to be derived from a common factor. BSR is calculated as follows:

$$fs = 0.384\text{MHz} *(16 + N') \quad \text{---------1}$$

LTE-A+ has a sampling rate of 0.384*(16+4) =7.68M which is well suited with ATSC 3.0 system(1). In ATSC 3.0, period of a frame can be specified as time and signal aligned. In time-aligned mode, total frame length is an integer multiple of 5ms and for implementing hybrid network, an extra synchronization buffer is not needed, as the sampling clock is assigned at each frame boundary. In signal-aligned mode, frame length is an

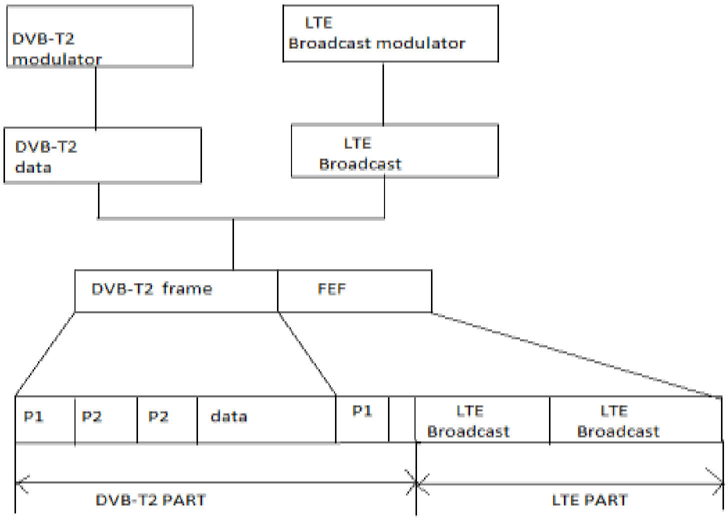


**Figure 3: Collaborative frame structure LTE and ATSC 3.0**

In ATSC 3.0, period of a frame can be specified as time and signal aligned. In time-aligned mode, total frame length is an integer multiple of 5ms and for implementing hybrid network, an extra synchronization buffer is not needed, as the sampling clock is assigned at each frame boundary. In signal-aligned mode, frame length is aninteger multiple of (1/384) ms [7]. Hybrid modulation can be provided at BBU pool, using C-RAN structure, which reduces the expenses [5].

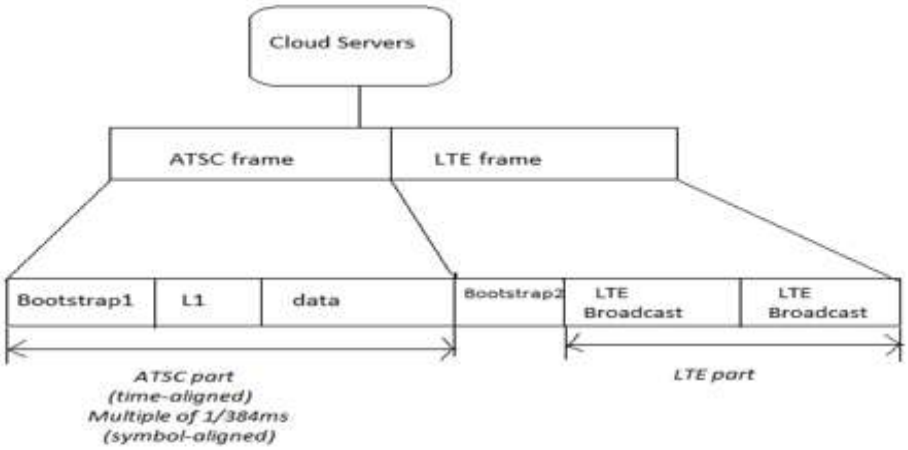


**Figure 4: Frame structure of collaboration of LTE-A+ and ATSC**

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## V. DRC FOR BROADCASTING NETWORK

Techniques in both physical and MAC layer are considered to achieve higher communication reliability and system throughput. For bi-directional communication, there must be a downlink channel from transmitter to all the consumers. The downlink channel is mainly used for data transfer and signaling of random access [1]. Solutions have been proposed, namely, independent downlink channel and cooperative downlink channel. The first approach is to collaborate with the downlink broadcast that makes use of Physical Layer Pipe(PLP) as the logical channel, whereas the return channel operates on another frequency different from the downlink broadcast. The second approach is to outline an independent bidirectional system in Time Division Duplex(TDD) mode. For downlink signaling and unicast/multicast data transfer, pseudo-periodical PLP is used.

Fig 5 shows a graphical representation of mapping of PLP-R and unicast downlink data. To understand about pseudo-periodical PLP, Real-time Physical Layer Pipe(PLP-R) is defined. The parameters considered in PLP-R is same as PLP in ATSC downlink system limited with payload and reservation strategy and is reserved frame by frame. At the very beginning of PLP, timestamps are inserted in downlink part of PLP-R, using which users can achieve synchronization based on timestamps [4]. In real-time data transfer, to reduce the resource occupation in downlink broadcast system, small amount of resource is reserved. Synchronization is achieved by DRC system using timestamp inserted in PLP-R and fetching the synchronization information from the broadcast demodulator. Another way is to use opportunistic PLP that is, at the gateway of downlink scheduler, all signaling and data for return channel is inserted.interactive services. Three alternative periods are proposed to provide more flexibility to broadcast users by expanding the limitation on the period of the downlink PLP-R [1].The period of downlink PLP-R increases with the average access delay.

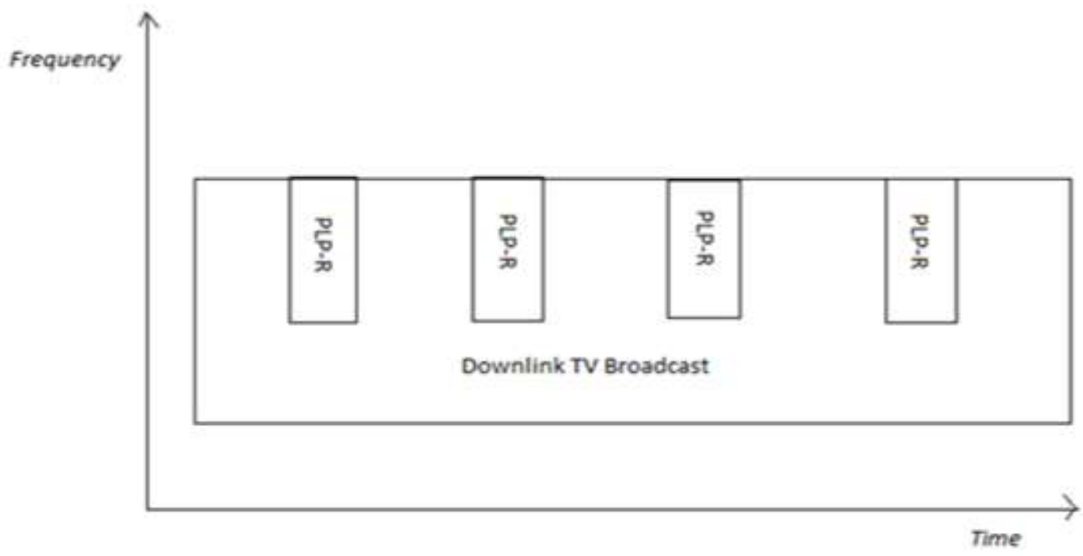


**Figure 5: Graphical representation of mapping PLP-R and unicast downlink data**

## VI.CONCLUSION

Future media transmission aims at providing users with a well-supplied set of media services in highly-efficient and highly flexible manner. Advantages of both cellular and broadcasting networks to fulfil the target at a lower expense. In this survey, an overview of cooperative radio access network architecture named C-RAN has been proposed. For providing very high data rates, the next generation 5G wireless communication is used.

C-RAN structure is designed to make development and implementation of new generation systems (LTE, 5G) much cheaper, faster and more flexible, mainly on centralized signal processing and network maintenance. By using cloud servers, particular deployment expenses can be reduced. By multiple sampling rates ATSC 3.0 networks, convergence can be enabled, which permits combination of broadcast and cellular transmissions in the same frequency band using a time multiplexing. Data Return Channel (DRC) which is used to support interaction between broadcasters and users, improves robustness of hybrid networks. Transmission parameters can be adjusted adaptively by broadcasters, return channel provides interactive services. Three alternative periods are proposed to provide more flexibility to broadcast users by expanding the limitation on the period of the downlink PLP-R [1].

The period of downlink PLP-R increases with the average access delay.

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