On Enhanced Multimedia Broadcast Multicast Service for 4G

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Abstract: The enhanced multimedia broadcast multicast service (eMBMS) was originally introduced in long term evolution (LTE) release 9 and has been improved in releases 10 and 11. The goal of eMBMS is to improve the coverage of high data rates and cell-edge throughput of broadcast services. In this paper we analyze this service that in spite of not being widely deployed has received increased importance due to the availability of new smart phones and tablet devices creating conditions to become eMBMS more attractive. The performance results indicate that the use of soft frequency reuse in single frequency network is essential for improving eMBMS throughput and coverage.

Index Terms : 3GPP LTE, eMBMS, Soft Frequency Reuse, SFN

1. Introduction

4G networks are gaining momentum, mobile data traffic is growing exponentially with new multimedia applications on smart mobile devices putting more stringent demands on the quality of service. In addition to supporting efficiently the signaling and traffic from interactive video and gaming applications 4G networks also need to handle the signaling and traffic from a multitude of machine-type communication devices.

Heterogeneous networks comprising macrocells and low-power nodes are gaining importance. Macrocells are essential for provision of wide-area coverage and support of high-mobility, addition of small cells is the mechanism for providing exponential capacity growth to match demand. These and others features are among the key requirements that have driven the development of LTE Release 11 [1,2].

Features such as enhanced multimedia broadcast multicast service (eMBMS) [3], machine type communications, in-device coexistence and energy saving are among the new features introduced in Release 11. This article presents system level simulations for eMBMS transmissions considering the scenarios defined by 3GPP. On section 2 eMBMS is introduced, on section 3 is provided a description of the soft frequency reuse used in system level simulations. Numerical results and conclusions are presented on section 4.

2. Introduction to eMBMS

The evolved multimedia broadcast and multicast service (eMBMS) television service was specified at the physical layer in Release 8 but was not functionally complete until Release 9. The features in Release 9 provide a basic MBMS service carried over an MBMS single frequency network (MBSFN). One limitation of Release 9 definition was the lack of a feedback mechanism from the UEs that would inform the network if sufficient UEs were present in the target area to justify turning on the MBSFN locally. In Release 11, further MBMS enhancements for service continuity were specified including support on multiple frequencies, reception during radio resource control (RRC) idle and RRC connected states, and support to take user equipment (UE) positioning into account for further optimization of the received service.

eMBMS is performed either in single cell or multi-cell mode. In single cell transmissions, eMBMS traffic is mapped to the downlink shared channel (DL-SCH). In multi-cell mode, transmissions from cells are carefully synchronized to form a MBSFN [4,5,6].

MBSFN is an elegant application of OFDM for cellular broadcast. The principle of operation is quite simple. Identical transmissions are broadcast from closely coordinated cells simultaneously on a common frequency [6]. Signals from adjacent cells arrive at the receiver and are dealt with in the same manner as multipath delayed signals. In this manner, UE can combine the energy from multiple transmitters with no additional receiver complexity.

If the UE is at a cell boundary, the relative delay between the two signals is quite small. However, if the UE is close to one base station and relatively distant from a second base station, the amount of delay between the two signals can be quite large. For this reason, MBSFN transmissions might be supported using 7.5 kHz sub-carrier spacing (instead of 15 kHz) and a longer CP [4]. MBSFN networks also use a common reference signal from all transmitters within the network to facilitate channel estimation. As a consequence of the MBSFN transmission scheme, UE can roam between cells with no handover procedure required. Signals from various cells will vary in strength and in relative delay, but in aggregate the received signal is still dealt with in the same manner as a conventional single channel OFDM transmission.

Figure 1 illustrates MBSFN transmission scheme B) including also an illustration of the Single Cell Point-to-Multipoint transmission A), the other scenario to be evaluated later in this paper.

eMBMS brings improved performance thanks to higher and more flexible LTE bit rates, MBSFN operation and carrier configuration flexibility. Release 11 also brings improvements in the areas of the service layer with a video codec for higher resolutions and frame rates and forward error correction (FEC) including procedures to ensure MBMS reception in a multifrequency LTE network. It creates new revenue opportunities by enabling

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