eMBMS: LTE multimedia broadcast/multicast services

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Two Papers to present ...

1. Evolved multimedia broadcast/multicast service (eMBMS) in LTE-advanced.
2. Understanding the super-sized traffic of the super bowl.
First Paper ..
Introduction

- Tremendous growth in data traffic “video, over mobile broadband networks”.
  - Increasing number of users.
  - Improved content availability.
  - Smartphones with higher media capabilities.
  - Deployments of higher-capacity and -capability access and core networks.

- A broadcast mode should complement unicast delivery of content.
What is MBMS?! 

- The multimedia broadcast/multicast service (MBMS) standard defined by the Third Generation Partnership Project (3GPP).
- **MBMS** is a point-to-multipoint service in which data are transmitted from a single source entity to multiple recipients.
- introduced as Release 6 (Rel-6).
- updated in 3GPP Rel-9 to include Long Term Evolution (LTE) called evolved MBMS (eMBMS) with improved performance.
- 3GPP Rel-11 improvements in the service layer with e.g. a video codec for HR and frame rates and FEC, and the radio network.
eMBMS creates new revenue opportunities by enabling delivery of premium video content to many users with SQoS in defined areas, and by enabling pushed content services via user equipment (UE) caching.

What does SQoS stand for?

Secure Quality Of Service
Use Cases for Broadcast

• Three methods of pushing media from content servers to end-user devices: **unicast, broadcast, and multicast**.

• **The unicast case** today on mobile broadband access like high-speed packet access (HSPA) and LTE - media is transported on a dedicated radio and core network link.
  ✓ efficient to cover Real-time Voice and video communication, Web, email or social media, on-demand video streaming.

• **The broadcast case** today on terrestrial television - a single unidirectional link shared by several users in one radio cell.
  ✓ many users located in the same areas consume the same content at the same time, pushing contents without interaction with the user.

• **The multicast case** allows us to know which users have activated or joined a particular service and charge them.

• In eMBMS, multicast is only used for the transport of data within the network.
Use Cases for Broadcast

- MBMS over UMTS terrestrial radio access network (UTRAN) was standardized, the industry was focused on **The Mobile TV Use Case**.
- Digital video broadcasting for handheld (DVB-H) networks deployed in several countries, and MBMS for mobile broadband operators to offer the same services over the UTRAN access.

- Not a big success.
  - ✓ Mobile users utilize their devices for killing time, prefer on-demand video. **Sol:** Broadcast should also be used in a general case to give an efficient on-demand experience.
  - ✓ Limited video quality by achievable BW over MBMS UTRAN
    **Sol:** In Rel-7, MBMS over SFN transmission (MBSFN) allows increasing the capacity by a factor up to 3 or 4.
    **Limitation:** not possible to use the same frequency for MBMS and non-MBMS transmissions.
Use Cases and Services
Audiovisual Streaming over eMBMS

- Video streaming moved from RTP based streaming to HTTP.
- 3GPP standardized an Adaptive HTTP Streaming (AHS) protocol in Rel-9 which then introduced into eMBMS.
- AHS adopted by MPEG (baseline of MPEG-DASH).
- Rel-10 version of DASH (3GPDASH) a compatible profile of MPEG-DASH.
Both 3GP-DASH and MPEG-DASH content can be streamed over eMBMS.
The client cannot request particular representations, manifest contains only one representation of audio and video.
eMBMS Enhancement to Unicast Apps

- Smartphone applications today can run in non interactive mode to retrieve content, notifications, or software updates over unicast access.

- This use case can be performed more efficiently for a large end-user device population by broadcasting content rather than relying on unicast.
eMBMS Enhancement to Unicast Apps

• Prior to any MBMS sessions, the content/software is announced to all targeted end-user devices via unicast.

Figure 2. eMBMS UE caching use case
End-User Device and Network Service Layer Interaction

• The eMBMS service layer architecture involves the same entities as for video streaming services e.g. end users, servers, CDN.

• No direct connection from the end user to a video streaming servers or content/software servers on unicast IP connections.

• A new entity (called BM-SC) is needed to control broadcast sessions of the MBMS gateway (MBMS-GW) and map incoming server traffic.
Download Over eMBMS

- File Delivery over Unidirectional Transport (FLUTE) protocol was introduced for delivery of files or file segments.

- FLUTE is carried over UDP and IP multicast toward end-user devices.

- The files to be delivered in a session are listed in a file delivery table (FDT).

- Each file has a filename and location, a content type, identification, expiry information, and a hash to be able to differentiate file versions.

- FEC and encryption can be used.

- Files can be of very different sizes segmented into source blocks.
File Repair

• Radio layer can provide an arbitrarily high level of QoS, cannot guarantee error free reception.

• **File repair**: allow end-user devices to retrieve missing parts of a file after their broadcast session is over.

• The device will connect over unicast to fetch more file segments in order to be able to construct the whole file. (a unicast procedure)
Application Layer FEC

• Application layer FEC (AL-FEC) specified to allow end-user devices to improve the probability of reception of data.
• The receiver can use the received source and encoding symbols to retrieve missing source symbols lost during transmission.
• FEC can be decoded using software implementations.
• FEC can be used for file segment streaming, and file delivery.
eMBMS QoS

- High bit rates (500 kb/s to 1 Mb/s) for real-time services in using LTE for eMBMS.
- 3GPP Rel-11 video (720p HDTV, H.264) and audio (full band) codecs.

- Quality of experience (QoE) metrics and reception reporting defined for evaluating the quality experienced by a particular user.
• The LTE network is a radio cellular network.
• **Radio Resources**: The allocated frequency spectrum for each LTE cell or the portion in time or frequency.

• **An LTE base station** is physical equipment transmitting the signals of one or more cells.
• To transmit the data of MBMS services to mobile terminals, LTE base stations use the same antennas and frequencies to transmit to each LTE mobile terminal.
• For each MBMS session, the associated data are broadcast in each LTE cell of the area determined by the BMSC.
Coverage and Efficiency : SFN Transmission

**Goal:** Reducing the amount of radio resources for the transmission in the case of transmissions to a single mobile terminal.

**limitation:** Signal loss due to a larger distance and interference, thus largely increase the amount of radio resources required for each service.

**Solution:** “single frequency network” having neighbor cells transmitting exactly the same signal in a fully synchronized manner.

- The radio signals from different cells are interfering constructively and the received signal level is increased.
- much less radio resources to broadcast a flow of data.
- Saving radio resources.
- provide better service to other users or provide service to more users.
- Reduce the cost for the network
- Surpass UMTS.
SFN Transmission and Non-SFN

✓ To allow coexistence of SFN transmissions for MBMS and non-SFN transmissions for other services, the LTE network must reserve a pattern of time intervals “fixed over a few hours” for SFN transmissions.

✓ Up to 60 percent of an LTE frequency carrier may be dedicated to MBMS transmissions.

✓ In the case of 5 MHz (like UMTS), with an inter-site distance of 500 m, it is possible to transmit 9 Mb/s of MBMS data (e.g., up to 140 channels of 64 kb/s or up to 35 channels of 256 kb/s), and there is no restriction on the channel size.

✓ Using a 20 MHz LTE frequency carrier for eMBMS, simultaneous transmission of about five HDTV channels is possible, parallel to unicast services.
SFN across LTE Base Stations
MBMS Service Reception

✓ An LTE terminal receiving MBMS services from an MBSFN area reads all the periodic control messages.

✓ Determine in which time intervals the desired services are transmitted and turn off its receiver in the other time intervals in order to reduce its battery consumption.

✓ To allow quickly finding any desired services, the control messages are repeated a pre-determined number of times. The LTE cell notifies LTE terminals, in the same way as incoming unicast data, when there is a change in control information so that the UE can read MBMS control messages less frequently.

✓ For LTE multi-frequency network, the network can indicate in the MBMS service description the frequencies or the cell groups selected by the BMSC to provide the service.
How to Deploy eMBMS Services?!

✓ Device chipsets need hardware support for eMBMS modem.

✓ Network protocols and application software need to be upgraded.

✓ A BM-SC needs to be introduced in the network along with the required interfaces to content servers and the service guide application servers.

✓ LTE base stations must be tightly synchronized in wide areas.

✓ For the expected coverage areas of MBMS services, sets of existing LTE cells should be selected to create MBSFN areas, ensuring proper coverage, and MCEs should be deployed to control the designed MBSFN areas.
Introduction

- Cellular Data traffic has been growing rapidly.
- Over 80% growth in total volume year over year with the advent of smartphones and others.

- **Challenge:** tens of thousands of users congestion managing the traffic demands at special events where several gates at a given time.
- **Example:** The annual Super Bowl football game in the United States.
Introduction

• 2013 Super bowl have a large number of users accessing a LTE cellular network deployed using a Distributed Antenna System(DAS) which provides 4G LTE, and combined with a stadium-wide deployment of WiFi hotspots (700 access points).

• 80% carried data more than the previous year, with about 388 GBytes transferred.

• During a long unprecedented power outage, users ’consumed approximately 10 GB more data than they did during any other hour’ of the game.
Traffic Volumes

Result: with high-speed LTE there is significant traffic demand despite extensive deployment of in-stadium WiFi.
Evolved Node B (eNodeB) Volumes

**Result:** usage changes significantly from one part of the stadium to another as the event progresses.

**Solution:** shifting radio resources, as demand shifts from one eNodeB to another at the venue.
Video Consumption

**Result:** video consumption, despite having only a small number of users, consumes a large share of the capacity.

**Solution:** understanding the role of providing a fair share of resources to meet the utility of all the users across the application spectrum, is important.
Result: with the shift in application mix, uplink traffic is much more prominent (almost matching downlink).

Solution: an approach to tradeoff delay tolerance for mitigating congestion.
Proposed Approach

• an approach to tradeoff delay tolerance for mitigating congestion.
• Exploit cellular multicast (eMBMS), a straight-forward implementation isn’t enough.

✓ **Reason:** Since there is, on average, only one viewer of the live content per cell. The peak usage (measured over 1 minute time scales) was about 6 simultaneous viewers across all the cell sites provisioned at the stadium.

• **Proposed approach principle:** use end-system storage as a cache of popular content that is pre-placed through multicast can indeed help achieve the expected benefits of multicast.
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Thanks for being awake !!
Questions??!