

Qualcomm Research

San Diego

LTE eMBMS Technology Overview

November 2012

LTE Evolved Multimedia Broadcast Multicast Service (eMBMS)

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Efficient Broadcast Delivery to a Large Number of Users
Capacity offload from unicast transmission for common content

Reuse Existing LTE Spectrum for Broadcast
Same LTE carrier resource is flexibly allocated between unicast and broadcast

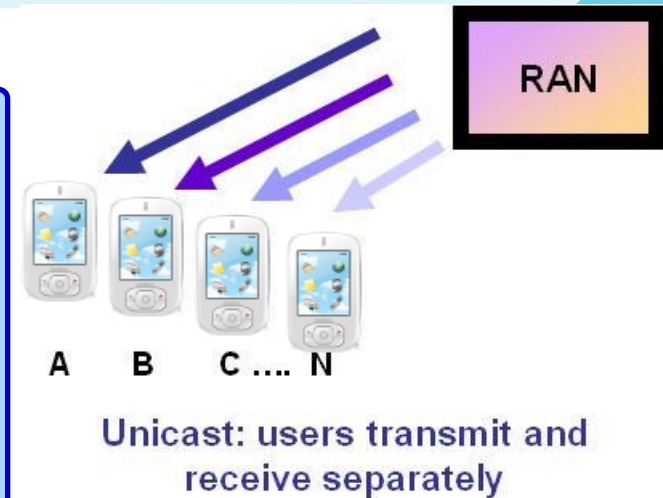
Enable Superior Performance of High Throughput and Excellent Coverage
OFDM signals enhance the gain from single frequency network transmission

Cost Effective Upgrade of LTE Networks and Devices
Leverage LTE ecosystem for mass market adoption

eMBMS Efficiently Delivers Rich Media to Mass Users

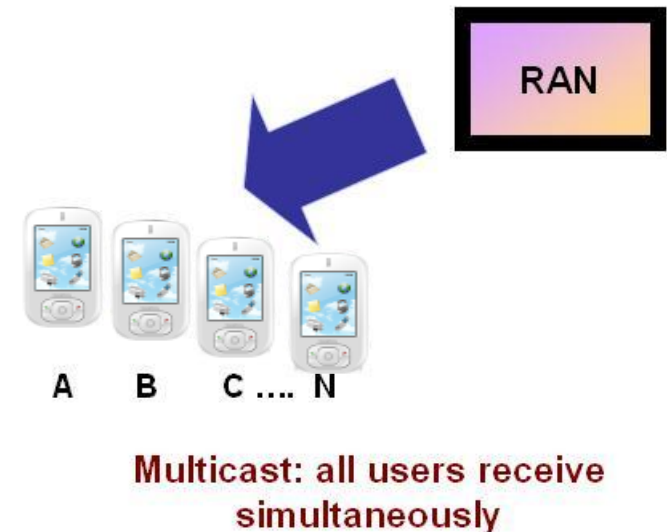
Unicast

- One to one transmission
- Each user sends and receives data individually
- Apps: VOD, E-mail, web-browsing, VT, MMS, Media downloads



Broadcast/Multicast

- One to many transmission
- More efficiency and lower cost for common content
- Apps: Live Video/Audio streaming, push media, e-publication, application download, OS updates



Existing LTE Carriers Can be Flexibly Allocated Between Unicast and Broadcast

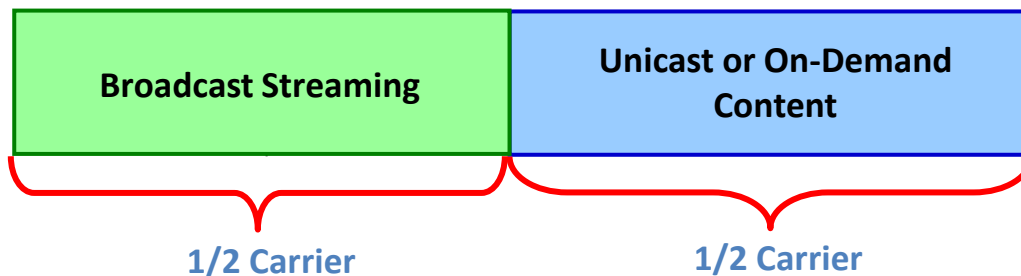


Example of LTE network resource TDM allocation

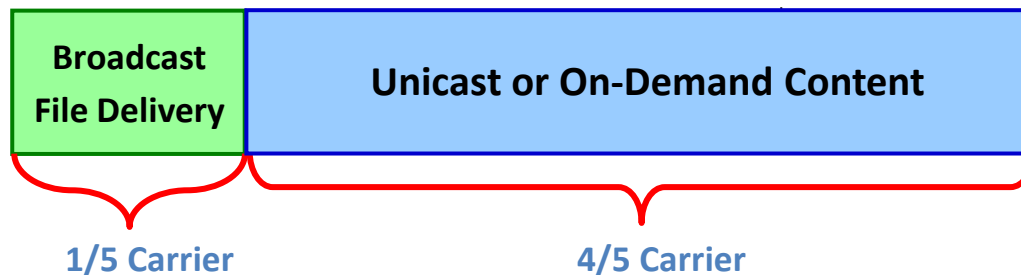
Regular Hours



Game Time or Special Events



Night



LTE resources reserved for eMBMS only when needed
No impact on LTE unicast capacity at other times

LTE Resource is Allocated to eMBMS Only in the Target Service Areas

- Venue-specific broadcast

- Sports / arena only
- Rich media: multiple cameras, replays, statistics



- Region-specific broadcast

- Home team games
- Local events/news



- Nation-wide broadcast

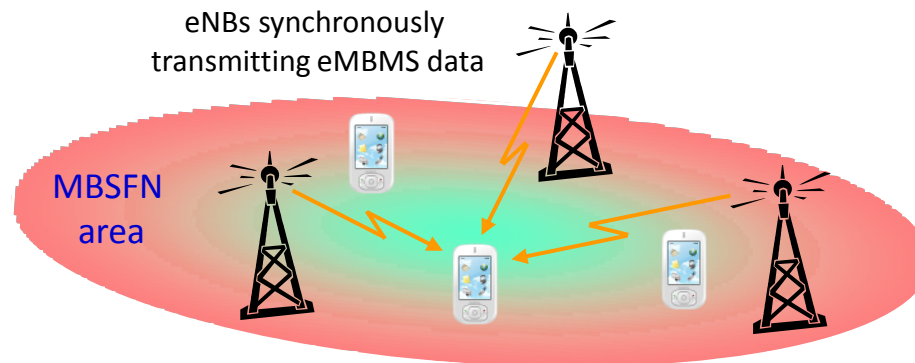
- World Cup and Super Bowl
- Breaking news



eMBMS allows operators to control the service area to match audience

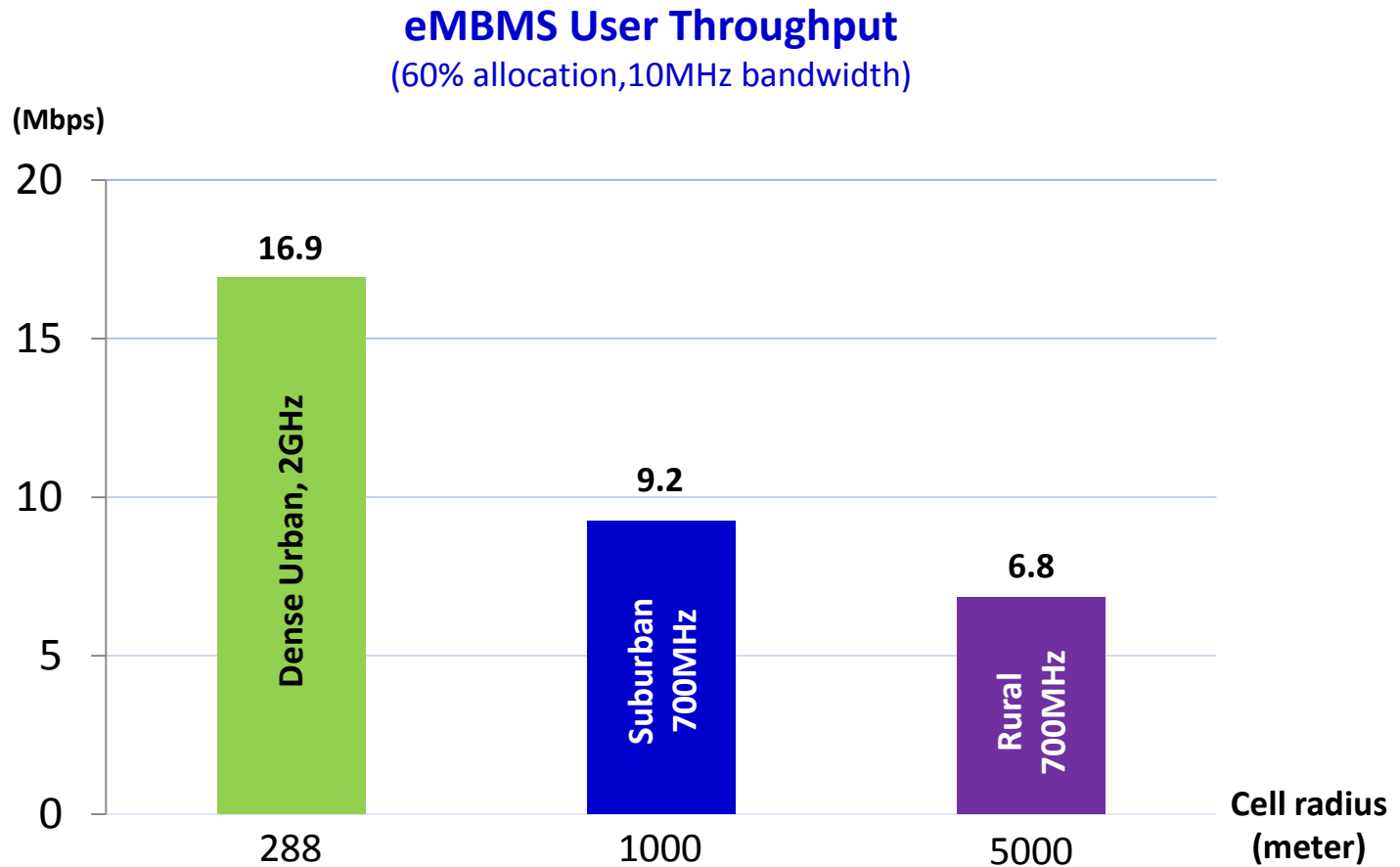
eMBMS Leverages LTE Single Frequency Network Transmission

- **Efficient mechanism to deliver common content over LTE networks**
 - Reuse LTE network infrastructure and wideband OFDM signal design
 - Up to 60% of subframes can be allocated to eMBMS traffic
- **OFDM signals enhance the gain from single frequency network transmission**
 - Synchronous LTE network allows broadcast over a Single Frequency Network (MBSFN)
 - Same signal transmitted synchronously by multiple eNBs within an MBSFN area
 - Efficient signal combining at UE receivers to achieve high operating SNR



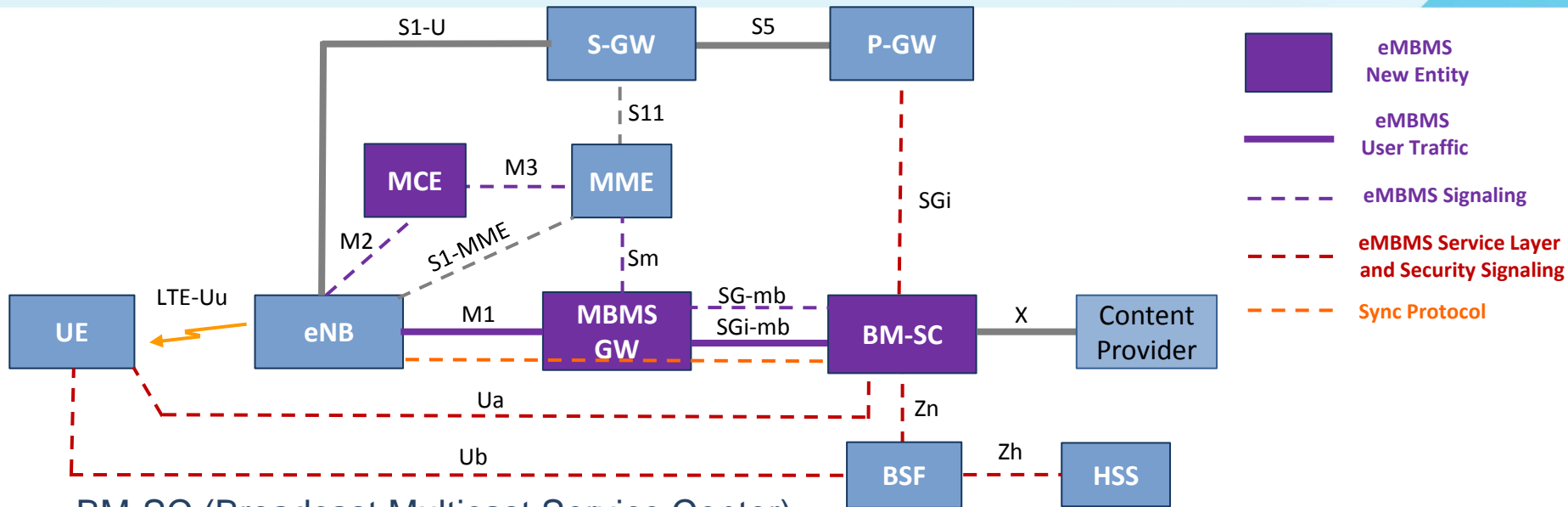
eMBMS Provides Excellent Broadcast Performance

- eMBMS potentially delivers highest rate in dense urban deployment



Results are for center site out of a 57-cell MBSFN area, using the criteria of 95% coverage and <1% BLER. TU6 channel model. eNBs use two transmit antennas with downtilt, see appendix for more details.

eMBMS System Reuses LTE eUTRAN Elements

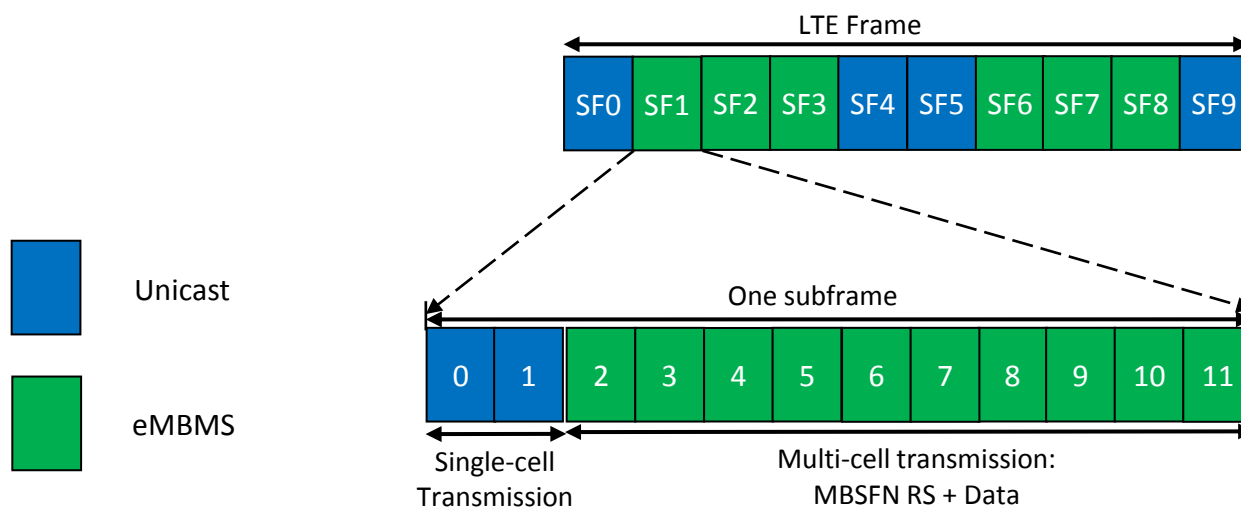


- **BM-SC (Broadcast Multicast Service Center)**
 - Provides membership, session and transmission, proxy and transport, service announcement, security, and content synchronization
- **MBMS GW (eMBMS Gateway)**
 - Distribute MBMS user plane data to eNBs using IP Multicast
 - Perform MBMS Session Control Signaling towards the E-UTRAN via MME
- **MCE (Multi-cell/multicast Coordination Entity)**
 - The MCE can be a separate entity or as part of eNB
 - Provides admission control
 - Allocation of the time/frequency radio resource for eMBMS
 - Deciding the radio configuration, e.g., Modulation and Coding Scheme (MCS)

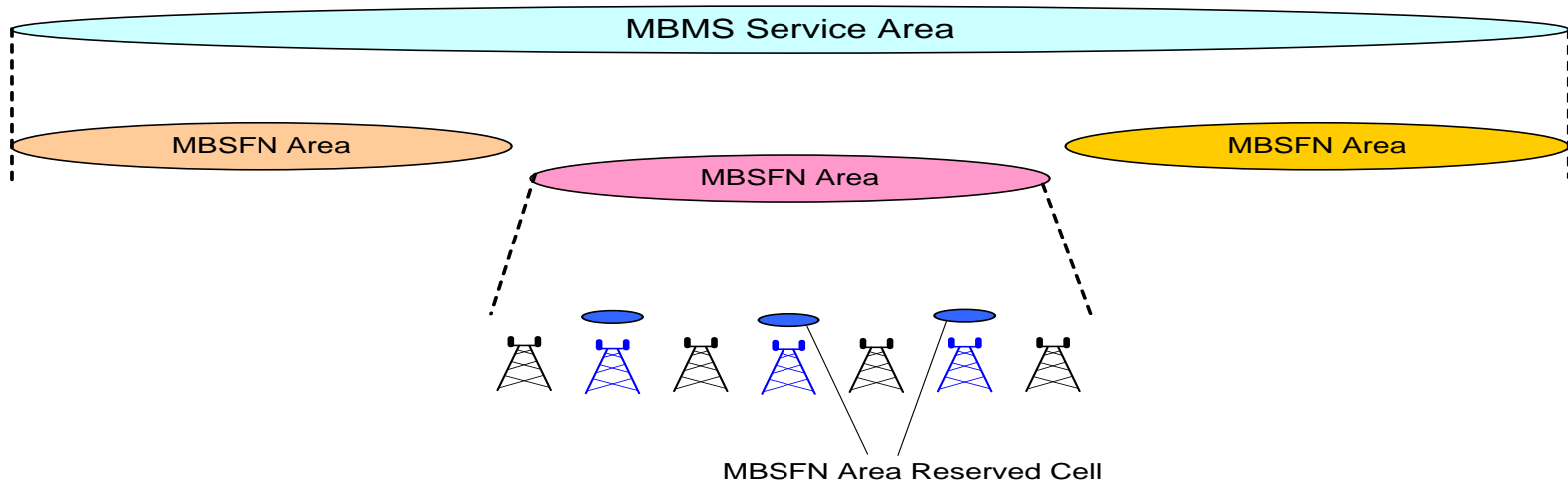
BSF: Bootstrapping Server Function
 HSS: Home Subscriber Server
 MME: Mobility Management Entity
 P-GW: Packet Data Network Gateway
 SGW: Serving Gateway
 eNB: E-UTRAN Node B
 UE: User Equipment

eMBMS Channel Structure is Compatible With LTE

- eMBMS and unicast transmissions are mixed by TDM in one common LTE carrier
 - FDD subframes 1/2/3/6/7/8 can be configured as MBSFN subframes
 - First 1 or 2 symbols are used for unicast common signal and control channels
 - Transmission gap lies in between unicast and MBSFN symbols if CP lengths are different
 - MBSFN is not transmitted in subframes 0/4/5/9 (FDD) or 0/1/2/5/6 (TDD)
 - Needed for unicast services and control channels/signals



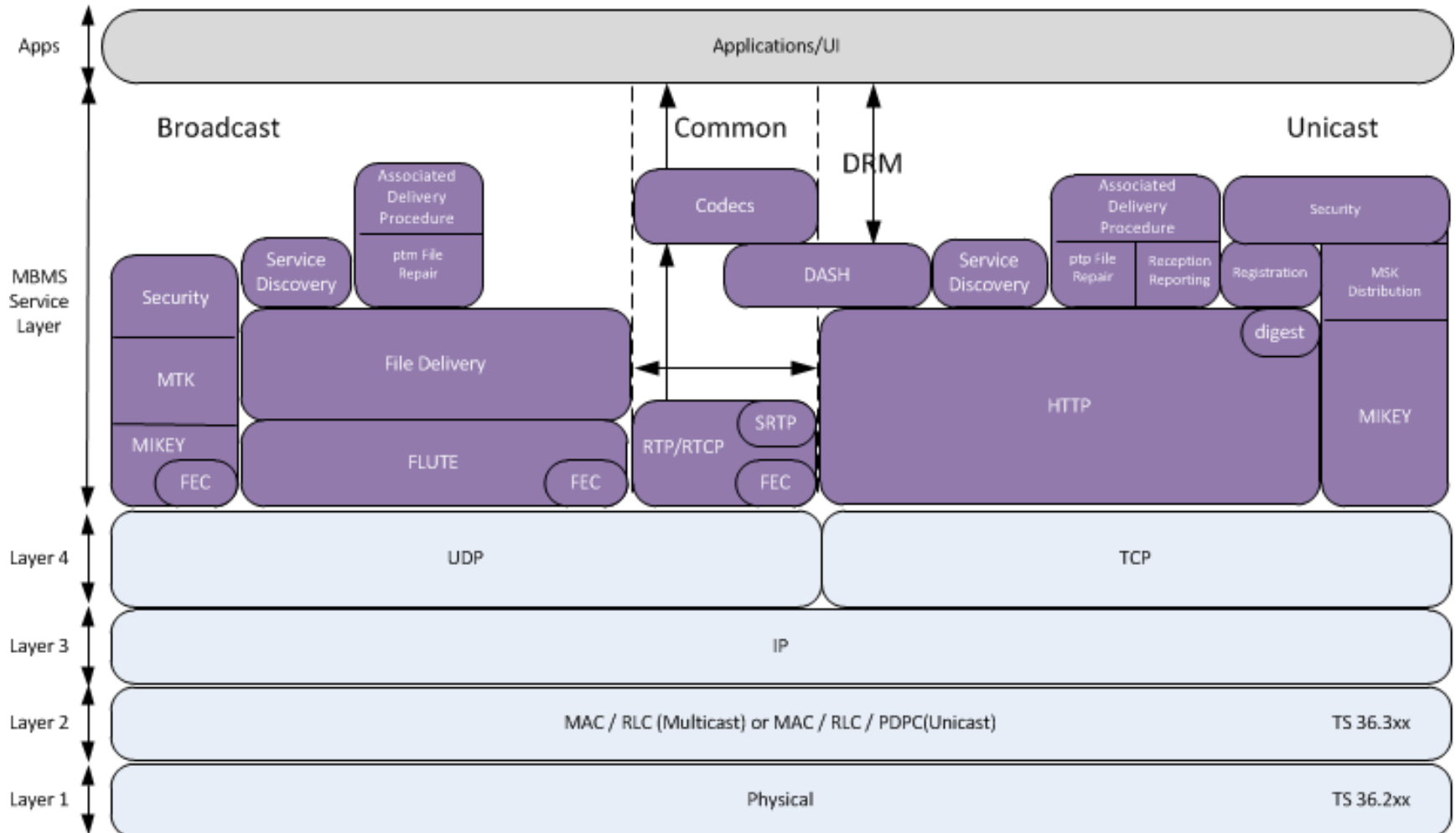
MBSFN Area Defines eMBMS Broadcast Service



- MBSFN Area is an area of eNBs from which the same eMBMS content can be synchronously transmitted
 - Overlap between MBSFN areas is supported
 - One eNB can belong to up to 8 MBSFN areas

eMBMS Devices Reuse LTE Protocols

- Broadcast services are mainly used for content delivery while unicast services are used for eMBMS control



3GPP allows both HTTP streaming (DASH) or RTP

DASH Enables High Quality Streaming Service Over Any Access Network to Any Device

- DASH (Dynamic Adaptive Streaming over HTTP) offers a standardized adaptive streaming solution for mobile
 - Standardized in MPEG and in 3GPP
 - Unified end-to-end system for fixed and mobile devices
 - Client controlled playback selects optimal bit rate based on dynamically changing conditions known only at the client
 - Reuse widely deployed HTTP servers and content delivery networks (CDNs) for scalability
 - Mitigate firewalls via standard HTTP get requests
- DASH formatted content can be streamed over eMBMS
 - DASH allows seamless transitions between unicast and broadcast based on coverage and popularity of content

March
2010

3GPP
Published
Adaptive
HTTP
Streaming
(AHS)
TS26.234

May 2011

3GPP
Published
3GP DASH

July
2011

MPEG
submitted a
draft
standard for
MPEG-DASH

November
2011

MPEG-DASH
Ballot
Approved

March
2012

Published
MPEG-DASH
Became
Available

eMBMS Standards Status

- eMBMS baseline was defined in Rel-9
 - Physical layer defined
 - Upper layers specifications defined are stable enough for implementation
 - Most of service layer and security adopted from the existing MBMS spec
 - Basic support for adaptive HTTP streaming via broadcast
 - A few bugs have been identified and fixed recently due to real implementation, for example:
 - Allow multiband/Multi-frequencies eMBMS service discovery in idle state
- Rel-10 provides additional features
 - “Counting” of eMBMS interested UEs if the network is expected to enable/disable MBSFN
 - Allocation and Retention Priority (ARP) enables priority between eMBMS sessions
 - Allows unicast reception in MBSFN subframes
 - Support for Dynamic Adaptive Streaming over HTTP (DASH) over broadcast
- A large number of companies currently participating in 3GPP on eMBMS



eMBMS Standard Continues to Evolve (1)

- Agreed eMBMS Enhancements in Rel-11
 - Support of service continuity
 - Service continuity with MBMS provided via more than one frequency layers
 - Service continuity with respect to mobility within the same MBSFN area
 - Information provided to UE and feedback to network on service continuity, for example:
 - Both MBMS cells and non-MBMS cells provide MBMS service area IDs (SAI) of the current frequencies and of neighbour frequencies in system information
 - The UE sends MBMS interest indications to the network
 - Service Layer Enhancements
 - Reception reporting aggregation and reception reporting from specific UEs
 - Content schedule information included in User Service Description(USD) to save the UE battery life
 - Pre-FEC repair Quality of Experience(QoE) metrics report to allow operator to optimize FEC configuration of FLUTE
 - Unicast File Repair with HTTP Byte Range Request
 - Location filtering to allow UE to selectively receive a service

eMBMS Standard Continues to Evolve (2)

- Examples of future eMBMS enhancements targeted for R12 and beyond
 - Broadcast and unicast switching based on demand
 - Counting enhancements to improve accuracy and utility
 - Longer cyclic prefix (33.3 usec) in mixed carrier to increase system capacity (SNR)
 - eMBMS multi layer transmission (MIMO) to increase system capacity
 - Dedicated eMBMS carrier design
 - MBSFN PHY measurements report such as RSRP/RSRQ/RSSI
 - MTC group support using eMBMS
 - Emergency alert using eMBMS to send rich multimedia data such as the map of affected area

eMBMS Summary

- eMBMS provides an efficient and low-cost solution to deliver common multimedia content
 - Reaches a high scalable number of subscribers for mass audience events
 - Effective capacity offloading from unicast
- Flexible carrier sharing between LTE unicast and broadcast
 - Reuse LTE resource for eMBMS when and where needed
- eMBMS leverages LTE deployment and ecosystem for mass market adoption
 - Cost-effective upgrade to LTE network and devices
- Simulation demonstrated up to 17Mbps eMBMS throughput with 10MHz LTE carrier
 - OFDM signal enhances the gain from single frequency network transmission



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