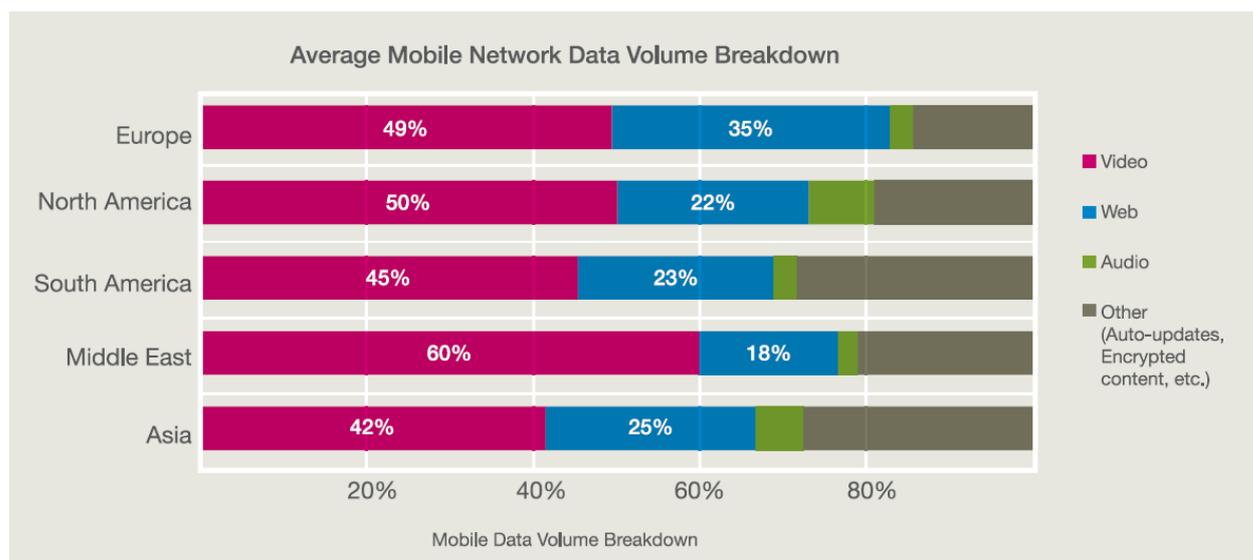


White Paper - LTE Video Is Set to Take Off

Video traffic is growing rapidly

Mobile video is becoming one of the most popular and widely adopted services. This is mainly due to the advent of large-screen smart phones, mobile-connected tablets, LTE-based high speed mobile network deployment, and more readily available video contents. There are now more people intending to buy tablets rather than desktop PCs for home computing. Since mobile video content has higher bit rates than other mobile content types, it contributes to much of the mobile traffic growth.

Up to 60% of all data traffic is now video traffic in some regions of the world, as reported by mobile video optimization specialist Bytemobile, shown in Figure 1. Other sources project that video will account for 71% of data traffic by 2016.



Source: Bytemobile, 2012

Figure 1 - Average Mobile Network Data Volume Breakdown

There are two types of mobile video services: consumer-oriented mobile video services and business-oriented mobile video services. Consumer-oriented mobile video focuses on entertainment and social networking, and the applications are mobile TV, video on demand (VoD), push video, video sharing, video messaging, mobile advertising, social networking, etc. Business-oriented mobile video services emphasize enhanced communications and collaboration, such as interactive voice and video response (IVVR), conversational video, video conferencing, etc.

LTE supports video services better

LTE offers high performance, and compares favorably with fixed broadband (FBB). It has the additional advantage of providing mobility. This has a significant impact on user experience and satisfaction. User behavior is changing with the availability of LTE. Users can now watch live video outdoor with mobile devices by using LTE, and continue to watch the video when they are at home. Operators already providing IPTV and OTT video services on their FBB network will be able to leverage their existing IPTV platform to deliver high-quality video content to their LTE subscribers through unicast and broadcast services.

High performance

LTE is capable of providing a true broadband user experience with average downlink speeds exceeding 10 Mbps in a typical outdoor environment with macro cell coverage. In an indoor environment or hotspot areas with small cell coverage, users can expect to reach even higher speeds.

LTE's initial data packet connection is typically 50 ms, and then between 12-15 ms roundtrip latency afterwards. The low latency of LTE, combined with its high average bit rates, makes it an ideal platform for demanding services such as video, gaming, and VoIP.

The real-life performance measurements of LTE and 3G in the USA are summarized in Table 2. The latency and service bit rates in LTE are persistently better than those in 3G.

	Overall Results							
	Reception		Latency		Download		Upload	
	AT&T	Verizon	AT&T	Verizon	AT&T	Verizon	AT&T	Verizon
4G LTE								
Average	3 bars	3 bars	102ms	107ms	16.5 Mb/s	15.2 Mb/s	9.5 Mb/s	5.3 Mb/s
3G								
Average	4 bars	4 bars	139ms	165ms	2.6 Mb/s	0.8 Mb/s	0.6 Mb/s	0.8 Mb/s

Note: Latency measurements include host processing time.

Source: PadGadget, March 2012

Table 2 - Real-life Performance of LTE and 3G

High spectral efficiency and wide bandwidth

LTE has high spectral efficiency due to the use of OFDMA and MIMO technologies, as shown in Figure 3. LTE also has the advantage of supporting up to 20 MHz of bandwidth per carrier. With carrier aggregation in LTE-Advanced utilizing multiple carriers, up to 100 MHz of bandwidth can be realized in the near future. High spectral efficiency and wide bandwidth make LTE more economical and especially suitable for delivering multiple video streams over the air interface.

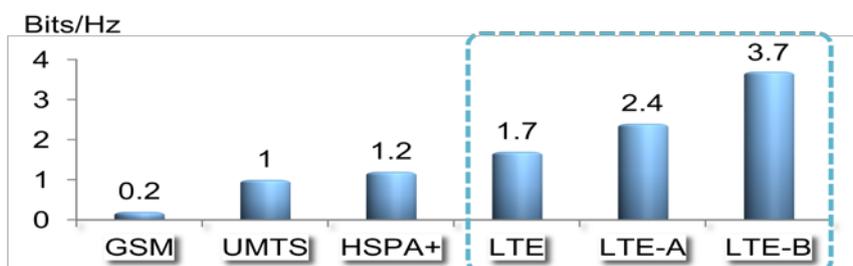


Figure 3 – Spectral Efficiency

LTE unicast and broadcast services

Existing LTE networks support video services by using unicast bearer service. With the addition of a few new network elements, as shown in Figure 4, an LTE network can also provide broadcast bearer service for the delivery of high quality video and contents. Broadcast service optimizes the air interface bandwidth usage by delivering the same content to a large number of users within the broadcast area. This translates into less cost per bit per user for the operators. Broadcast service in LTE has been defined in 3GPP since Release 9 as Evolved Multimedia Broadcast/Multicast Service (eMBMS), which allows flexible partitioning of bandwidth between broadcast services and unicast services at the LTE air interface.

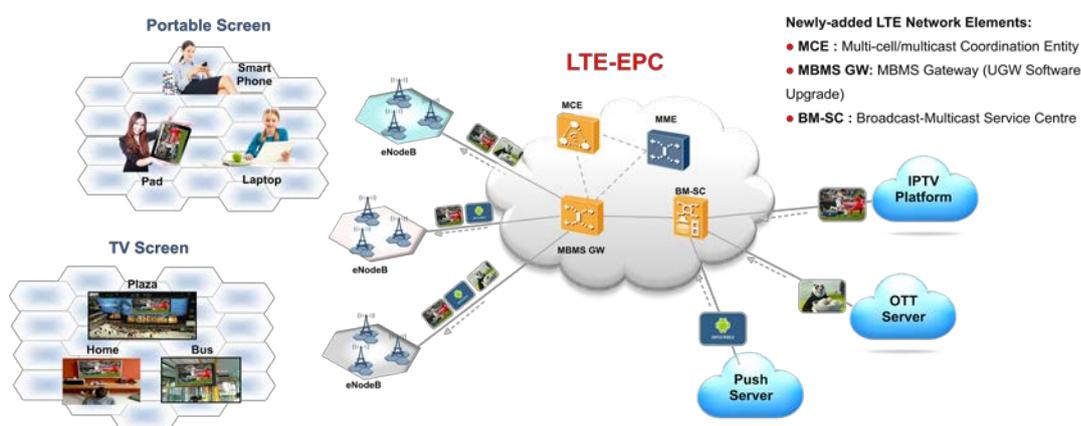


Figure 4 – eMBMS Architecture

This bandwidth partitioning is done in time division multiplexing (TDM) mode at the LTE air interface sub-frame level. As defined in the standards, up to 60% of LTE air interface bandwidth can be assigned for broadcast service in LTE-FDD, and up to 50% in LTE-TDD.

The bandwidth partitioning mix between unicast and broadcast needs not to be fixed at all time. Rather, it can be changed according to network traffic conditions and time-of-day, as determined by the operator. An example of bandwidth partitioning according to time-of-day is shown in Figure 5. Between mid-night and 6:00 am when most people are sleeping and the network is idling, broadcast services can be used most effectively to push video from the IPTV platform to the user equipment (UE).

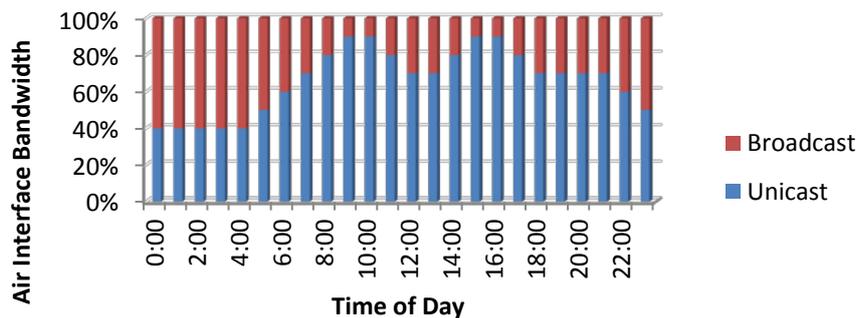


Figure 5 – Example of LTE Air Bandwidth Partitioning

LTE broadcast has one unique feature that differs from unicast in that the modulation and coding scheme (MCS) of a video streaming session at the air interface is usually set by the base station at optimal values so that a UE located at the cell edge, where the received signal is at the lowest, can still receive and decode the video at the correct service bit rate. This means that all UEs within the same cell broadcast area will receive the broadcast signal at the same service bit rate, independent of their distances from the base station. User experience is therefore consistent. In contrast, the bit rate of a video stream session delivered by unicast service may be affected by the traffic condition of the network at the time and the location of the UE (usually the closer to the base station, the higher is the bit rate). User experience may therefore vary, especially if the UE is moving.

Multicast/Broadcast Single Frequency Network (MBSFN)

MBSFN in LTE video improves the receive signal strength of a UE at the cell edge. All cells within a MBSFN area are phase synchronized and broadcast the same content. The UE at the cell edge receives identical signals from the serving cell and adjacent cells, each with different signal strength. Since these signals are phase synchronized and have the same content, they can be combined additively by the UE to increase the overall receive signal strength, as illustrated in Figure 6.

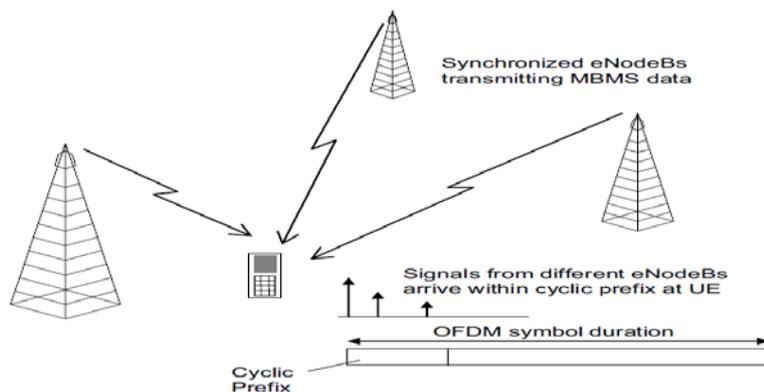


Figure 6 – MBSFN Signal Reception

Enhanced QoS support

LTE offers the promise of policy-based, fixed-mobile convergence for real-time applications such as VoIP, push-to-talk dispatch, messaging enhanced with video clips and even two-way video telephony.

Unlike 3G, LTE changes to a policy-based QoS mechanism to better support both real-time and non real-time video applications. LTE treats any service data flow (SDF) as belonging to one of nine QoS classes identified by QoS Class Identifier (QCI), as shown in Figure 7.

QCI	Resource Type	Priority	Packet Delay Budget	Packet Error Loss Rate	Example of Services	
1	GBR	2	100 ms	10 ⁻²	Conversational Voice	
2		4	150 ms	10 ⁻³	Conversational Video (Live Streaming)	
3		5	300 ms	10 ⁻⁶	Non-Conversational Video (Buffered Streaming)	
4		3	50 ms	10 ⁻³	Real Time Gaming	
5	Non-GBR	1	100 ms	10 ⁻⁶	IMS Signaling	
6		7	100 ms	10 ⁻³	Voice, Video (Live Streaming), Interactive Gaming	
7		6	8	300 ms	10 ⁻⁶	Video (Buffered Streaming) TCP-based(e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
8						
9						

Figure 7 – LTE QoS Classes

Policy control in LTE is the mechanism that allows operators control access to their network and services. Policy control depends on rules formulated from the technical details of an SDF. The appropriate policy rules can jointly control, the user's services, the sense of what a user is willing to pay for a service, and the capabilities of an access network into one functioning unit. Policy control is a part of Policy and Charging Control (PCC) in LTE which allows for the possibility of charging a user for his experience and not just for the number of bits delivered to his UE.

Huawei's vision on LTE video

Differentiated services avoid being a "bit pipe", create additional revenue

LTE video offers many new business opportunities to the operators. The operators can

introduce services such as live TV, push VoD, push advertisement, video sharing, video messaging, video downloading, e-education, and e-health. These services can bring in additional revenue beyond just bit delivery.

LTE broadcast and unicast services synergize each other

LTE broadcast service is suitable for delivering common content to a large user population. Whereas LTE unicast service is suitable for delivering personalized content to individual users. The operators can exploit these advantages in creating new innovative services.

As an example in mobile TV, most subscribers only watch a few popular TV channels, as shown in Figure 8. Operators can use LTE broadcast service for popular channels, and LTE unicast service for “long-tail” (less watched) channels. The LTE air interface bandwidth saved by using broadcast service for popular channels can be utilized to relief network congestion during busy hours, and for new unicast services to generate additional revenue for the operator.

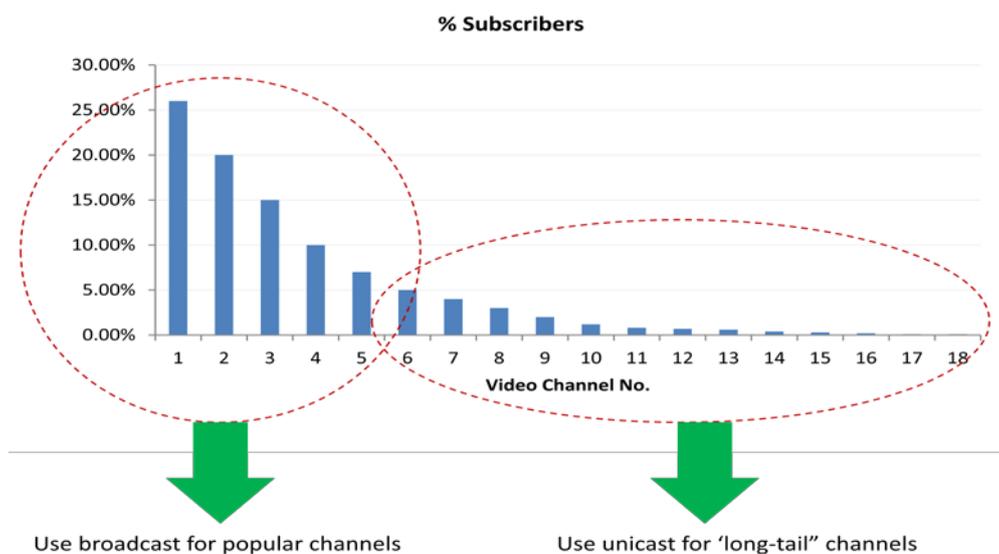


Figure 8 – Example Use of LTE Broadcast and Unicast Services for Mobile TV

Another example is in push content service. Operators can use LTE broadcast service to push the content catalog or electronic program guide to all users. Individual users can then select and order their own favorite content through unicast service. After authentication, payment (for pre-paid users) and authorization, the personalized content can then be delivered to individual users by unicast service.

IP video and LTE Video synergize to support multi-screen

Fixed-mobile convergence is beginning to occur. Video contents will be made available as cloud services. By using both IP video and LTE video services, the operators can deliver

video content to the subscribers wherever they go, with any screen: TV, desktop PC, laptop, tablet or smartphone.

H.265 accelerates LTE video service development

Compared to H.264, H.265 coding scheme for video can reduce the bit rate by as much as 50% while maintaining the same video quality. H.265 can therefore effectively double the number of video streams within a given air interface “bit pipe”, allowing the operators to offer more video services at reduced cost.

Brighter tomorrow for LTE video

The rapid development in LTE video will allow subscribers to enjoy video contents seamlessly with multiple screens anywhere at any time. It will enable the users to share their feelings through social networking services, and search for information in video format more readily.

Acronyms

BM-SC	Broadcast/Multicast Service Center
eMBMS	Evolved Multimedia Broadcast/Multicast Service
EPC	Evolved Packet Core
FBB	fixed broadband
FDD	frequency-division duplexing
GBR	guaranteed bit rate
GSM	Global System for Mobile
HSPA	High-Speed Packet Access
IP	Internet Protocol
IPTV	IP television
IVVR	interactive voice and video response
LTE	Long Term Evolution
LTE-A	LTE Advanced
LTE-B	LTE Beyond
MBMS GW	MBMS Gateway
MBSFN	Multicast/Broadcast Single Frequency Network
MCE	Multi-cell/Multicast Coordination Entity
MIMO	multiple input and multiple output
MME	Mobility Management Entity
OFDM	orthogonal frequency division multiplexing
OFDMA	orthogonal frequency division multiple access
PCC	Policy and Charging Control
QCI	QoS Class Identifier



QoS	quality of service
SDF	service data flow
TDD	time-division duplexing
TDM	time-division multiplexing
UE	user equipment
UMTS	Universal Mobile Telecommunications System
VoD	video on demand