LTE and UMTS Terminology and Concepts

By Chris Reece, Subject Matter Expert - 8/2009

UMTS and LTE networks are surprisingly similar in many respects, but the terms, labels and acronyms they use are very different. How can a UMTS operator make sense of this new jargon?

Introduction

A colleague of mine (Don Hanley) put together a comparison of 1xEV-DO and LTE. I committed many months ago to put together a similar comparison for UMTS/HSPA+ and LTE. I have finally done so. Don's comparison can be found at http://www.lteuniversity.com/blogs/donhanley/archive/2009/02/10/lte-and-1x-1xev-do-terminology-and-concepts.aspx. It will not take a very close examination to see that I have taken Don's paper and simply modified it for UMTS. Props to Don for laying the groundwork for this comparison.

UMTS/HSPA+ and LTE were both created by the 3GPP standards body. Therefore, there are a number of terms that are similar, but there are also a number of terms that are quite different. Both UMTS and LTE are designed to offer high-speed packet data services to mobile subscribers, and since they are both a product of 3GPP, they have taken similar approaches to solving some of the challenges they both face. An engineer familiar with UMTS and HSPA+ will have an easier time in understanding LTE simply by learning the meaning of key LTE terms and associating them with their UMTS counterparts.

For the sake of this paper, the terms UMTS, HSPA, and HSPA+ will be used interchangeable and synonymously. Technically, there are differences between UMTS, HSPA, and HSPA+, but most operators are deploying the latest solutions. Therefore, their networks support all of these technologies.

The following sections take the LTE concepts, grouped into related categories, and provide a brief explanation of each, along with the corresponding UMTS equivalent. In some cases, there is a one-to-one match between LTE and UMTS; in others, there simply is no equivalent concept. In most cases, however, there is generally something within UMTS that performs a function similar to its LTE counterpart, under a different name or in a different location. We will identify the similarities and differences of LTE-EPS and UMTS networks in various categories, including Air Interface, Access and Core Networks, Identities and Operations.

Air Interface

Not surprisingly, the greatest differences between LTE and UMTS lie in the air interface. UMTS is a Wideband CDMA-based system, using fixed 5 MHz channels, while LTE is a scalable

OFDMA system, capable of using anywhere between 1.4 MHz and 20 MHz, divided into 15 kHz subcarriers. UMTS devices are assigned timeslots for downlink traffic, but can transmit at any time on the uplink (the hallmark of a CDMA system); LTE terminals must be explicitly allocated uplink and downlink non-overlapping resources to send and receive traffic. The Physical Layer descriptions of these two technologies are as different as night and day.

Nonetheless, they must both be capable of supporting multiple users simultaneously, of allowing new users to access the network, of tracking the terminal's location, and of redirecting traffic as the user moves. Key LTE terms relating to the air interface and their UMTS equivalents are listed here.

LTE Term	Meaning and Usage	UMTS Equivalent
OFDMA	Orthogonal Frequency Division Multiple Access, physical layer of LTE Downlink	WCDMA
SC-FDMA	Single Carrier Frequency Division Multiple Access, physical layer of LTE Uplink	WCDMA
Subcarrier	A single 15 kHz radio channel	Radio channel
Symbol	A single 66.67 µs time period	Chip (0.26 µs)
Resource Element	The smallest unit of radio resources, one subcarrier for one symbol	n/a
Resource Block	The smallest block of resources that can be allocated, 12 subcarriers for 7 symbols (84 resource elements)	n/a
Slot	7 consecutive symbols	Slot
Subframe	2 consecutive timeslots	n/a
Frame	10 consecutive subframes, the basic transmission interval	Frame
Synchronization Signal	Periodic signal for synchronizing with and identifying cells	Primary and Secondary Sync Channels (P-SCH & S-SCH)
Reference Signal	Periodic signal for transmission quality measurements	Common Pilot Channel (CPICH)
PBCH	Physical Broadcast Channel	Broadcast Control Channel (BCCH)
PDSCH	Physical Downlink Shared Channel	High Speed – Physical Downlink Shared Channels (HS-PDSCHs) [for HSPA+] or Dedicated Physical Data Channel (DPDCH) [for a R99 channel]
PDCCH	Physical Downlink Control Channel	High Speed – Shared Control Channel (HS-

		SCCH) [for HSPA+] or Dedicated Physical Control Channel (DPCCH) [for a R99 channel]
PCFICH	Physical Control Format Indicator Channel	NA
PHICH	Physical Hybrid ARQ Indication Channel	E-DCH HARQ Indication Channel (E-HICH) [for HSPA+] or NA [for a R99 channel]
PRACH	Physical Random Access Channel	Physical Random Access Channel (PRACH)
PUSCH	Physical Uplink Shared Channel	E-DCH Dedicated Physical Data Channel (E-DPDCH) [for HSPA+] or Dedicated Physical Data Channel (DPCCH) [for a R99 channel]
PUCCH	Physical Uplink Control Channel	E-DCH Dedicated Physical Control Channel (E-DPCCH) [for HSPA+] or Dedicated Physical Control Channel (DPCCH) [for a R99 channel]

Access Network

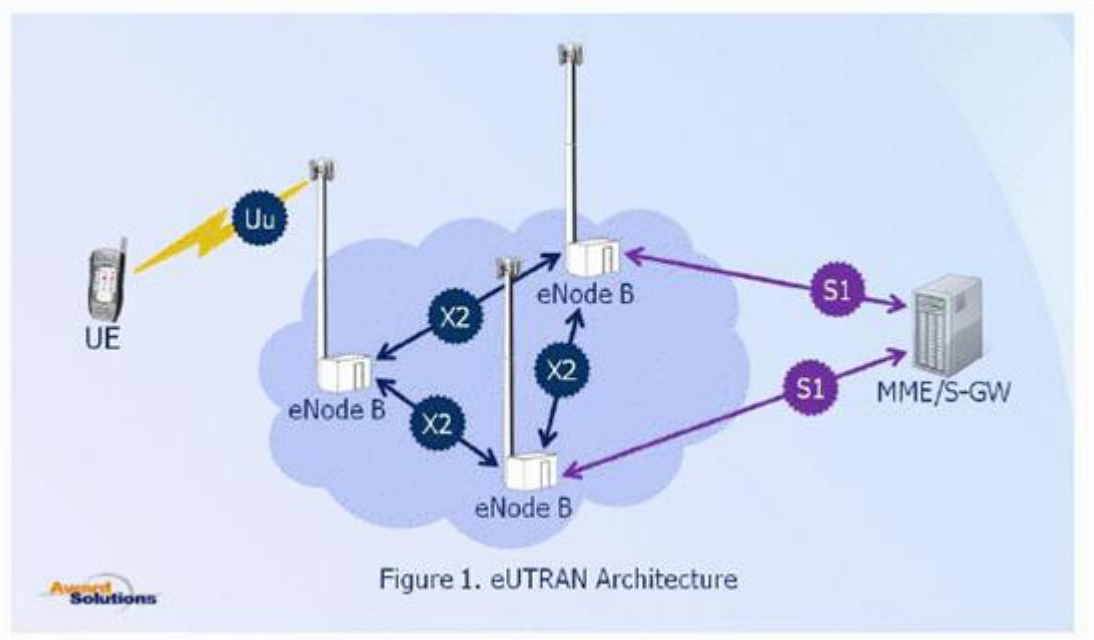


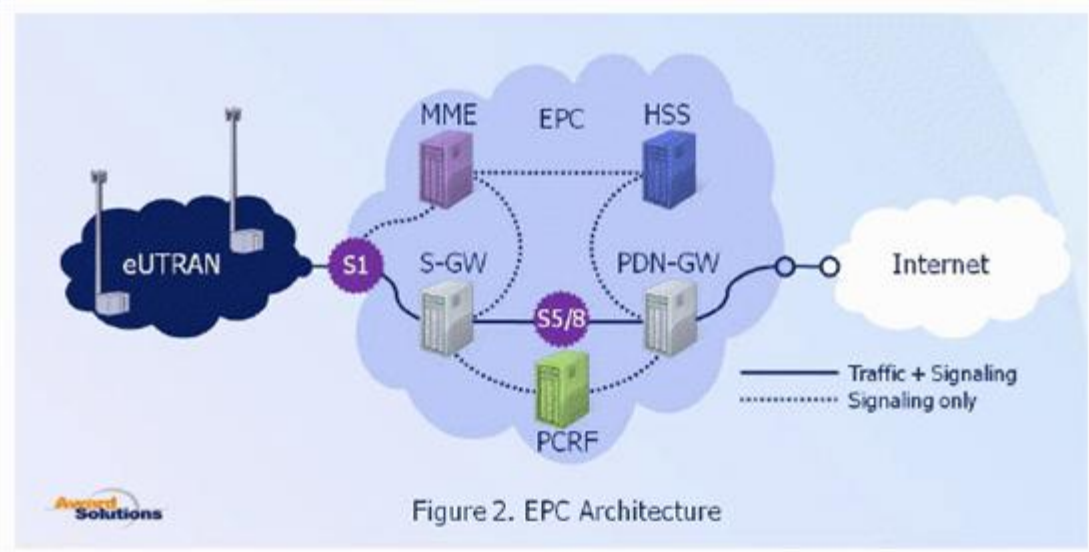
Figure 1 illustrates an LTE eUTRAN, the radio access network. The eUTRAN has a flat architecture with no centralized controller; instead each eNodeB manages its own radio resources and collaborates with other eNodeB's over the X2 interface. The eNodeB's connect to the core network over the S1 interface to allow users to register with the network and send and receive traffic.

Key LTE terms relating to the access network and their UMTS equivalents are listed here:

LTE Term	Meaning and Usage	UMTS Equivalent
eUTRAN	Evolved Universal Terrestrial Radio Access Network	UTRAN
eNode B	Evolved Node B	Node B
Physical Layer Cell ID	Unique cell identifier	Scrambling Code
UE	User Equipment	UE
X2	eNode B <-> eNode B interface	Iub and Iur
S1	eNode B <-> core network interface	Iu
LTE-Uu	LTE air interface	Uu
Attach	A configured signaling path between the UE and the eNode B	Attach
Radio Bearer	A configured and assigned radio resource	Radio Bearer

Core Network

The LTE and UMTS core networks are more similar than they are different; Figure 2 shows a view of the LTE Evolved Packet Core (EPC). Both are based on IP protocols and support seamless access to packet-based services; both make use of GTP to redirect traffic as the user moves through the network.



Key LTE terms associated with the core network, and their 1xEV-DO equivalents, are listed here:

LTE Term	Meaning and Usage	UMTS Equivalent
EPC	Evolved Packet Core	Packet Switched Core Network (PS-CN)
MME	Mobility Management Entity	Serving GPRS Support Node (SGSN)
S-GW	Serving Gateway	Serving GPRS Support Node (SGSN)
P-GW	Packet Data Network Gateway	Gateway GPRS Support Node (GGSN)
HSS	Home Subscriber System	Home Location Register (HLR)
PCRF	Policy Charging Rule Function	PCRF
GTP	GPRS Tunneling Protocol	GTP
S1 Bearer	A configured traffic path between the eNode B and the S-GW	Iu Bearer
S5/S8 Bearer	A configured traffic path between the S-GW and the PDN-GW	Gn/Gp Bearer

EPS Bearer Service	A configured end-to-end traffic path between the UE and the PDN-GW (Radio Bearer + S1 Bearer + S5/S8 Bearer)	PDP Context

Operational Terms and Identifiers

When a mobile device arrives in the network, it must be recognized, configured and assigned resources, and its services must be maintained as it moves from cell to cell. Various terms associated with LTE operational functions, and their UMTS equivalents, are listed here:

LTE Term	Meaning and Usage	UMTS Equivalent
UE	User Equipment (the mobile device)	UE
IMSI	International Mobile Subscriber Identity [Mobile Country Code (MCC), Mobile Network Code (MNC) and Mobile Identification Number (MIN)]	IMSI
IMEI	International Mobile Equipment Identity	IMEI
Downlink (DL)	Transmissions from the network to the mobile	Downlink (DL)
Uplink (UL)	Transmissions from the mobile to the network	Uplink (UL)
Ciphering	Over-the-air privacy	Ciphering
Attach	Initial registration process	Attach
MIB, SIB	Master Information Block and System Information Block	MIB, SIB
DCI	Downlink Control Information	High Speed – Shared Control Channel (HS-SCCH)
UCI	Uplink Control Information	E-DCH – Absolute Grant Channel (E-AGCH) and E-DCH – Relative Grant Channel (E-RGCH)
C-RNTI	Cell Radio Network Temporary Identifier	High Speed – RNTI (H-RNTI)
CQI	Channel Quality Indicator	CQI
HARQ	Hybrid ARQ	HARQ
Handover	Redirection of traffic from one base station to another	Handover
Measurement Control events A1, A2, A3, A4, A5, B1, B2	Thresholds for cell selection and handover	Measurement Control e1a, e1b, e1c, e1d, e1j

Conclusion

A simple description in a table does not convey the full complexity of a concept; a detailed understanding of LTE's technologies, architectures and interfaces is needed to fully appreciate both the similarities and the differences between LTE and UMTS/HSPA+. Nevertheless, the fact that LTE and UMTS concepts can be laid out side-by-side in this way should help to reassure UMTS operators that the step from 3G to 4G is not as big a leap as they may have thought.

Award Solutions, Inc. provides exceptional training and consulting in advanced wireless and Internet technologies. Our proven experience enables us to offer a complete suite of services: cutting edge technology training, customized training solutions, and advanced technology consulting.

Our products and services provide our clients with innovative, flexible, and cost-effective solutions that help rapidly boost their workforce productivity and competence to more quickly meet their market demands. Award Solutions will be happy to customize our course content to meet any specific needs.

The level of technical depth in our training courses gives students a unique benefit that they can apply immediately. We offer a range of courses appropriate for audiences needing a high-level overview, as well as engineers looking for in-depth details.

Award Solutions continues to provide successful training and network performance solutions as well as professional consulting services for many telecommunications and Internet equipment manufacturers, service providers and enterprises, just as we have since 1997.

Please visit our website at www.awardsolutions.com for our full line of services and latest curriculums.

If you have any questions, concerns or comments regarding this document, please write to us at: friends@awardsolutions.com