

Evolution to LTE - an overview

April 2010

Global mobile Suppliers Association (GSA)

www.gsacom.com

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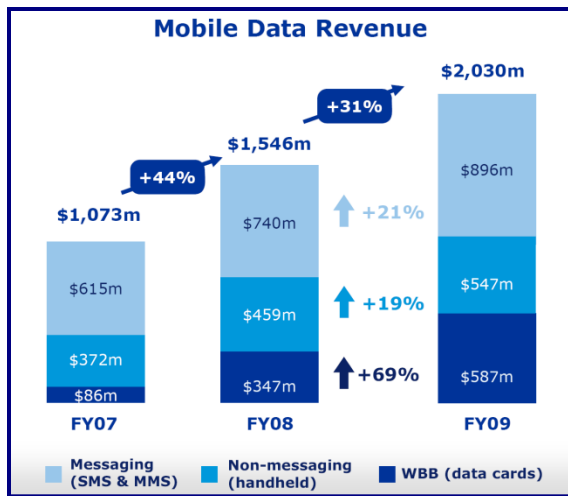
Mobile broadband growth has taken off



Most operators have a mobile broadband offer
Traffic, subscriptions and revenue growth are strong in all markets

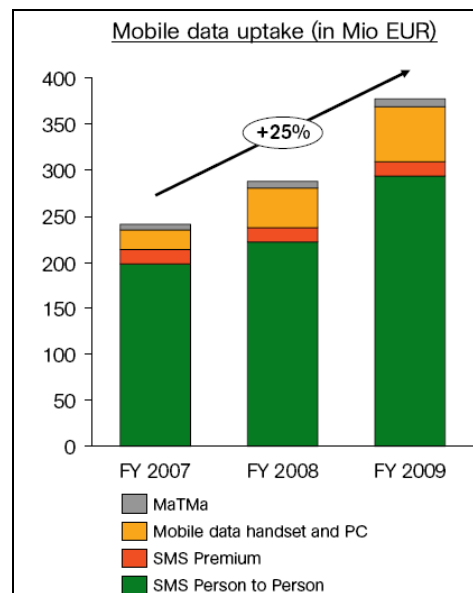
Examples:

Telstra

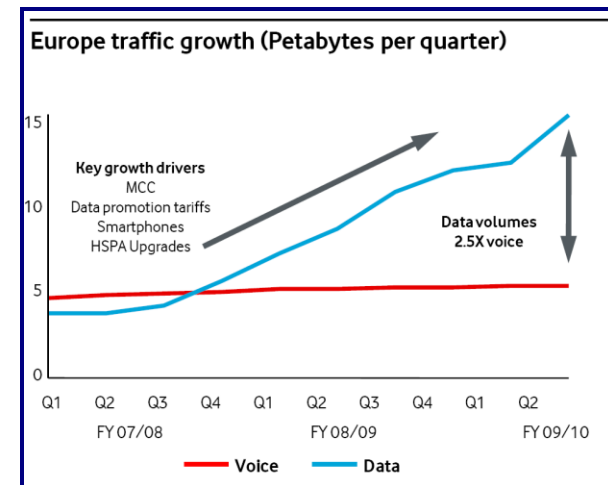


➤ Mobile data revenue up 31% FY09

Mobistar



Vodafone



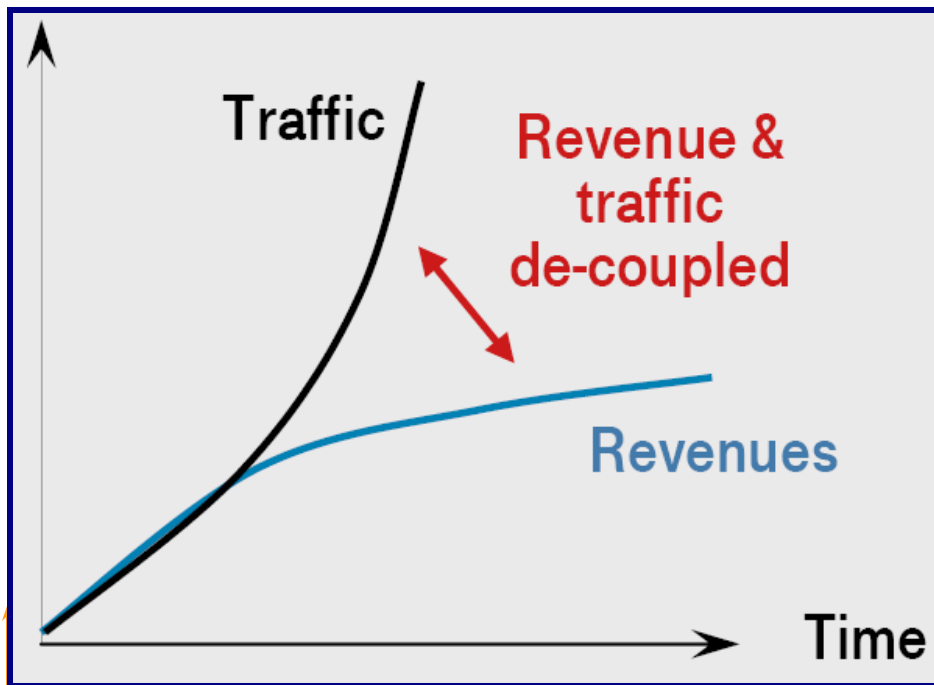
➤ Data traffic has risen 300% in the past two years

Challenge: supporting more subscribers, providing more capacity, lower cost of delivery/byte, improve the user experience

Source: GSA - Mobile Broadband Growth Reports from Operators Worldwide April 2010

The industry direction is to LTE

LTE is needed to accommodate huge traffic growth



Traffic rising/revenue falling

40x – 100x traffic increase

may need to be supported
across several frequency bands

Mobile broadband is gaining momentum from widespread 3.5G deployments, flat rate data tariffs, and availability of internet friendly mobiles

Drivers for LTE



LTE is being driven by pervasive convenience of mobile communications and increased penetration combined with improved performance and the falling costs of wireless devices & services.

➤ **Broadband connectivity** – access to more info and more entertainment

➤ Voice ARPU being driven down by **low cost** VoIP services

➤ **More mobile** in work/personal life

➤ Capture **maximum ARPU**

➤ Invention of **new technologies** and business models

➤ Mobile phones allowing **anytime anywhere accessibility**

➤ **Strong growth** in smartphone segment

➤ Mobile data has become a **reality**

➤ **Innovative data** services

➤ **High demand** for bandwidth, **better quality** and services tuned to own personal profile

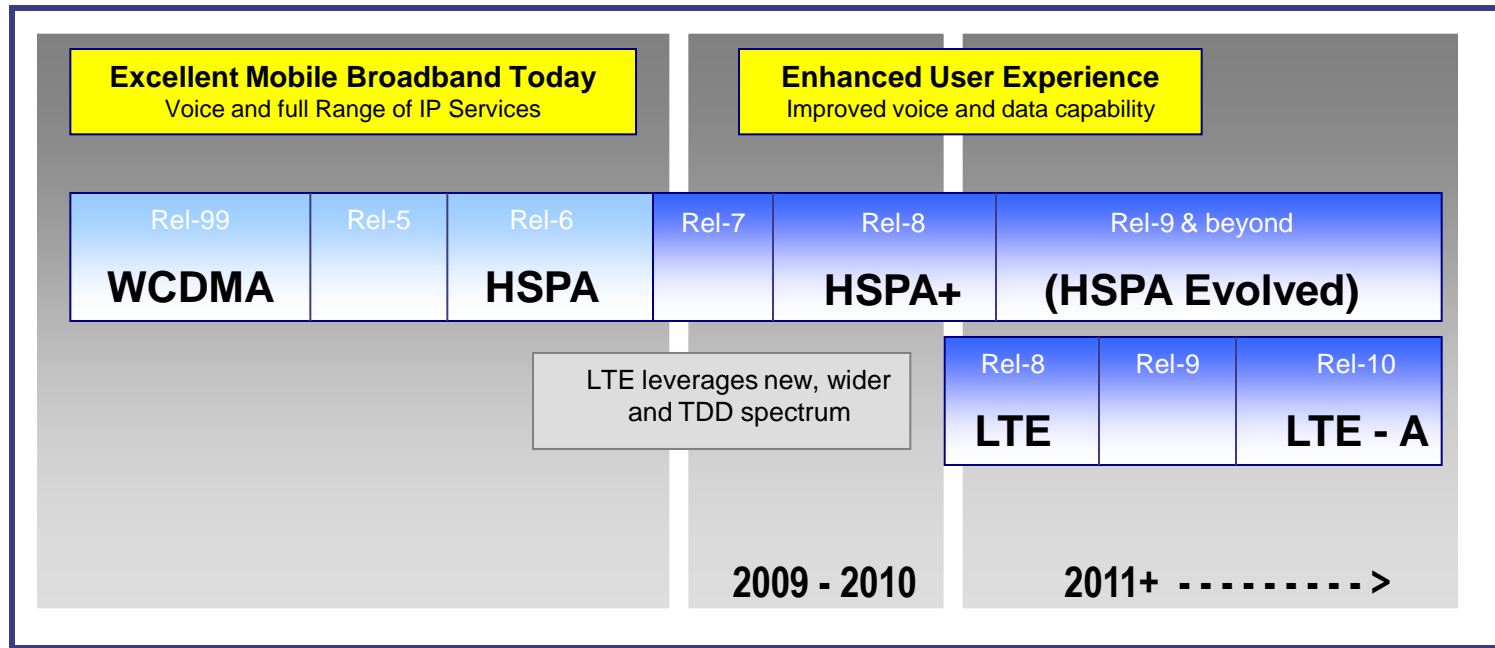
LTE - Long Term Evolution



'The Internet of things'

- LTE is the **next generation network** beyond 3G for mobile broadband, standardized by 3GPP
- LTE networks will provide the **capacity to support demand** for connectivity from a new generation of consumer devices tailored to those new mobile applications
- LTE is the **next step in the user experience** which will enhance more demanding applications
- LTE is essential to take **mobile broadband to the mass market**
- LTE will **support new services** and features which require higher levels of capability and performance
- LTE will support **mixed data, voice, video** and **messaging** traffic
- LTE **supports a full IP-based network** and harmonization with other radio access technologies

The Roadmap for LTE



Targets for LTE



- Instantaneous downlink peak data rate of at least 100 Mb/s within 20 MHz allocation (5bps/Hz)
- Instantaneous uplink peak data rate of 50 Mb/s (2.5bps/Hz within a 20 MHz uplink allocation)
- Downlink: average user throughput per MHz, 3 to 4 times Release 6 HSDPA
- Uplink: average user throughput per MHz, 2-3 times Release 6 enhanced Uplink
- E-UTRAN optimised for low mobile speed: 0-15 km/h. Higher mobile speed between 15-120 km/h should be supported with high performance. Mobility shall be maintained at speeds 120km/h-350km/h (or even up to 500 km/h depending on the frequency band)
- Spectrum flexibility: scalable to operate in 1.4, 2.5, 5, 10, 15 and 20Mhz allocations: Uplink and downlink, paired and unpaired
- Co-existence with GERAN/3G on adjacent channels: with other operators on adjacent channels: overlapping or adjacent spectrum at country borders: handover with UTRAN and GERAN

Operator benefits using LTE (1)



LTE is the natural evolution for GSM and HSPA network operators

Lower cost per bit, higher capacity, greater flexibility and **true global appeal**

Re-use of several existing network assets

Greater **economies of scale**

Deliver new, improved services and applications

With LTE, an operator can achieve a **sustainable competitive advantage**

LTE operators gain economic benefits to strengthen its market position

LTE also brings a much **improved Business Proposition** compared to the legacy technologies

Operator benefits using LTE (2)



Lower cost

IP-based flat network architecture; Low OPEX
High degree of self configuration/optimization
High re-use of assets including sites

Complements 3G/HSPA

Addresses high capacity requirements
Seamless service continuity/multimode devices
Next generation solution for 3GPP and 3GPP2

Improved performance

Higher capacity, peak and user data rates
Higher bandwidth
“Always on”; enhanced user experience

Highly reliable

Extreme efficiency, Innovation and intelligence
which supports a proposition of personalized and
quality experience to its customers

Spectrum flexibility

Can use **new** or **re-farmed** spectrum, FDD and
TDD. Variable channel bandwidth

Strong industry support globally

Eco-system will build on the success and volumes
established for HSPA

Business opportunities



- LTE provides **2 to 5 times greater spectral efficiency** than most advanced 3G networks, **reducing the cost per bit** and allowing **better economics** for operators and end users.
- It is **affordable mass market wireless broadband** services - boosting Operator profitability.
- **Faster downloads**, video sharing, true Mobile TV with more channels and **better quality**.
- Increased peak data rates, with the potential for **100 Mbps peak downstream** and **50 Mbps peak upstream**, **reduced latency**, **scalable bandwidth** capacity, and **backwards compatibility** with existing GSM and WCDMA-HSPA and HSPA+ systems.
- Future developments could yield peak throughput of the order of 300 Mbps

LTE employs a new modulation technique on the radio interface - OFDM (Orthogonal Frequency Division Multiplex), together with MIMO (Multiple Input Multiple Output) antenna technology

OFDM splits the information into multiple narrowband subcarriers, allowing each of them to carry a portion of the information at a lower bit rate, making OFDM a very robust modulation, particularly in multipath scenarios, like urban areas

MIMO technology creates several spatial paths on the air interface between the network and subscriber, so these paths can carry the same or different streams of information, which allows an increase in either the coverage (due to higher Signal to Noise Ratio (SNR) at the receiver) or user data throughput

LTE Release 8 Major Parameters

Access Scheme	UL	DFTS-OFDM
	DL	OFDMA
Bandwidth	1.4, 3.5, 10,15, 20MHz	
Minimum TTI	1msec	
Sub-carrier spacing	15kHz	
Cyclic prefix length	Short	4.7usec
	Long	16.7usec
Modulation	QPSK, 16QAM, 64QAM	
Spatial multiplexing	Single layer for UL per UE Up to 4 layers for DL per UE MU-MIMO supported for UL and DL	

LTE-Release 8 User Equipment Categories

Category		1	2	3	4	5
Peak rate Mbps	DL	10	50	100	150	300
	UL	5	25	50	50	75
Capability for physical functionalities						
RF bandwidth	20MHz					
Modulation	DL	QPSK, 16QAM, 64QAM				
	UL	QPSK, 16QAM				QPSK, 16QAM, 64QAM
Multi-antenna						
2 Rx diversity	Assumed in performance requirements.					
2x2 MIMO	Not supported	Mandatory				
4x4 MIMO	Not supported				Mandatory	



LTE is specified in 36 series technical specifications

The LTE Release 8 specifications can be found on www.3gpp.org

™ ETSI has registered "LTE" as a trademark for the benefit of the 3GPP Partners

Evolution of the 3GPP Core Network - SAE

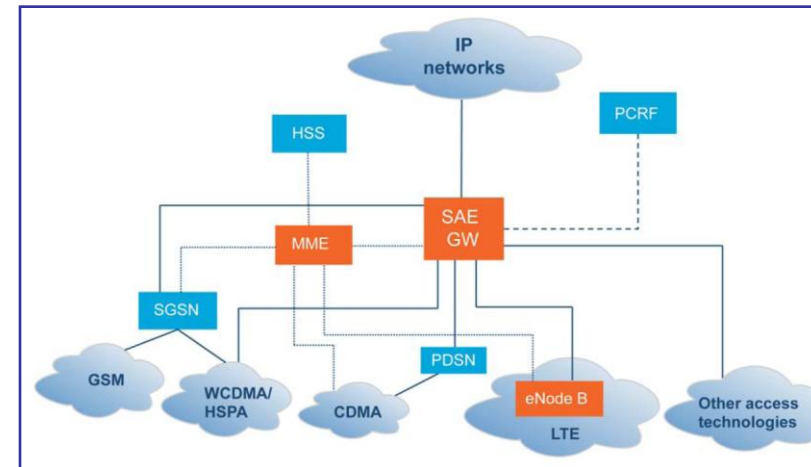
The 3GPP core network has also undergone System Architecture Evolution (SAE) in the same timeframe as LTE, optimizing it for packet mode and, in particular, for the IP-Multimedia Subsystem (IMS), which supports all access technologies, including fixed wire-line access.

This allows:

- Improvements in latency, capacity, throughput
- Simplification of the core network, and optimization for IP traffic and services, and expected growth
- Simplified support & handover to non-3GPP access technologies

The result is the evolved packet system (EPS) that consists of the core network part, the evolved packet core (EPC) and the radio network evolution part, the evolved UTRAN (E-UTRAN), i.e. LTE. The EPS is also standardized within 3GPP Release 8 (March 2009) and is the baseline for implementations.

The architecture is based on an evolution of the existing GSM/WCDMA core network, with simplified operations and smooth, cost-efficient deployment



Source: Ericsson

There are two nodes in the SAE architecture user plane; the LTE base station (eNodeB) and the SAE Gateway. This flat architecture reduces the number of involved nodes in connections. LTE base stations are connected to the core network over the S1 interface

Is LTE ready?

- Standards are complete (Release 8 – March 2009)

- LTE has **global acceptance** by leading operators worldwide
 - 64 network commitments provides the proof
 - the number of operators committed to LTE more than doubled in the year to April 2010

- On December 15th 2009, **TeliaSonera launched** the world's first commercial LTE services, in Sweden and Norway

- **Spectrum is available** to support initial system deployments

- Several **trials** and **commercial deployments** are on-going throughout the world

- LTE performance consistently **meets or exceeds expectations**:
“*while still in its infancy, commercial LTE networks in Stockholm and Oslo already outperform many fixed broadband connections*” – Signals Research Group, LLC statement in GSA's *Evolution to LTE report* (page 7)

Who is committed?

64 LTE network commitments worldwide



- 64 LTE network commitments in 31 countries
- Up to 22 LTE networks in service by end 2010
- 39 or more LTE networks in service by end 2012



Source of data: GSA Information Paper "Evolution to LTE" – April 7, 2010

Who is committed?

64 LTE network commitments – anticipated launch dates

Country	Operator	Expected launch
Norway	TeliaSonera	Launched 2009
Sweden	TeliaSonera	Launched 2009
Armenia	Vivacell-MTS	2010
Canada	Telus	2010
Canada	Bell Canada	2010
China	China Telecom	2010
China	China Mobile	2010
Finland	TeliaSonera	2010
Japan	NTT DoCoMo	2010
Japan	Emobile	2010
South Korea	SK Telecom	2010
South Korea	KT	2010
Sweden	TeleNor Sweden	2010
Sweden	Tele2 Sweden	2010
USA	CenturyTel	2010
USA	MetroPCS	2010
USA	Vizon Wireless	2010
UAE	Etisalat	2010
Canada	Rogers Wireless	2010-11
Germany	Vodafone	2010-11
USA	Cox Comms	2010-11
South Africa	Vodacom	2010-11
Germany	T-Mobile	2011
Ireland	Hutchison 3	2011
Japan	Softbank Mobile	2011
Jordan	Zain	2011
Portugal	TMN	2011
South Korea	LG Telecom	2011
USA	AT&T Mobility	2011
USA	Aircell	2011

Austria	T-Mobile	2011-12
Austria	Mobilkom Austria	2011-12
Austria	Hutchison 3	2011-12
Austria	Orange	2011-12
France	Orange	2011-12
New Zealand	Telecom NZ	2011-12
Japan	KDDI	2012
Taiwan	Chunghwa Telecom	2012
Uzbekistan	MTS	2012
Australia	Telstra	To be confirmed
Bahrain	Zain	To be confirmed
Brazil	Vivo	To be confirmed
Estonia	EMI	To be confirmed
Finland	DNA	To be confirmed
Finland	Elisa	To be confirmed
France	SFR	To be confirmed
Hong Kong	SmartOne-Vodafone	To be confirmed
Hong Kong	PCCW	To be confirmed
Hong Kong	CSL Limited	To be confirmed
Hong Kong	Hutchison 3	To be confirmed
Hong Kong	China Mobile	To be confirmed
Italy	Telecom Italia	To be confirmed
Netherlands	KPN	To be confirmed
Norway	TeleNor	To be confirmed
Philippines	Piltel	To be confirmed
Russia	Svyazinvest	To be confirmed
Saudi Arabia	Zain	To be confirmed
Saudi Arabia	STC	To be confirmed
Singapore	M1	To be confirmed
Singapore	SingTel	To be confirmed
Singapore	Starhub	To be confirmed
South Africa	Cell C	To be confirmed
USA	T-Mobile USA	To be confirmed
USA	Commnet Wireless	To be confirmed

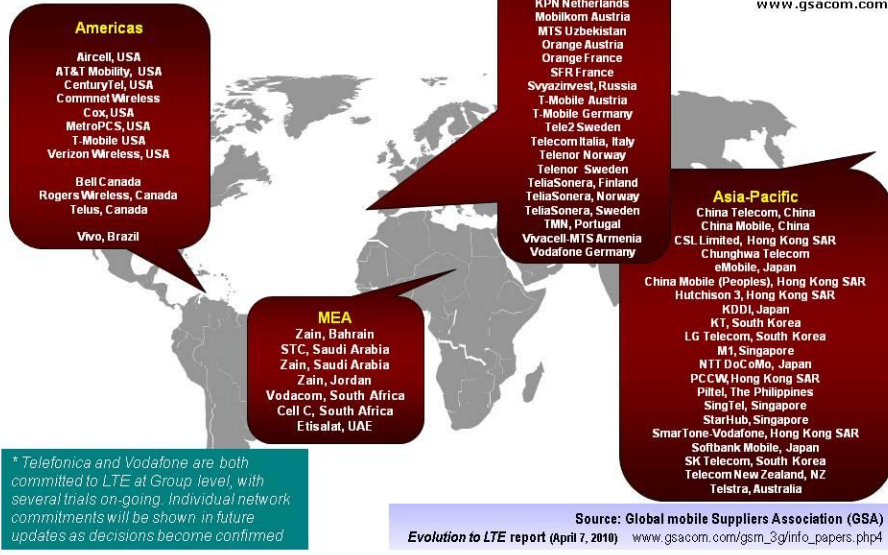
Source of data: GSA Information Paper "Evolution to LTE" – April 7, 2010

Global LTE Commitments



Global LTE Commitments

64 LTE network operator commitments, 31 countries



64 LTE network commitments in 31 countries

Up to 22 LTE commercial network launches expected by end 2010
(39 or more LTE networks expected to be in service by end 2012)



These and more charts and maps are available at
www.gsacom.com/news/statistics.php4

Some of the LTE operator announcements

- there are many more!



- **Verizon Wireless** is deploying LTE in 700 MHz band. Trial networks in Boston and Seattle, are now in the final phase. Verizon Wireless plans LTE launches in 25-30 cities by end 2010 and nationwide by 2013
- **Bouygues Telecom** has selected an infrastructure partner for Europe's first LTE trial in the 1800 MHz band
- **Saudi Telecom Company (STC)** is deploying LTE and has announced its infrastructure partner
- **Telstra** has announced plans to trial LTE from May 2010. Testing will comprise not only urban but also rural evaluations of LTE in addition to extensive laboratory trials
- LTE is expected to be launched in **China** in 2010
- **Etisalat UAE** is testing LTE and targeting service launch during 2010
- **Pannon** (Hungary) has selected an infrastructure partner to build a commercial LTE trial network. **Magyar Telekom** (T-Mobile) is also trialing LTE
- **M1** in Singapore has successfully completed a 100 Mbps data call on its LTE trial network
- **Telefonica** is trialing LTE on its mobile networks in Argentina, Brazil, Czech Republic, Germany, Spain and the UK
- **SingTel** is undertaking LTE trials in Australia, Indonesia, the Philippines and Singapore
- **Zain Jordan** is planning to trial LTE this year ahead of commercial launch in 2011

All the announcements are available in GSA's Evolution to LTE report

Source of data: GSA Information Paper "Evolution to LTE" – April 7, 2010

LTE network and technology trials – some examples



Country	Operator
Argentina	Telefonica
Australia	Optus
Belgium	Telenet
Brazil	Telefonica
Chile	Entel PCS
Chile	Movistar
Czech Republic	O2 (Telefonica)
France	Bouygues Telecom
Germany	O2 (Telefonica)
Hungary	Pannon
Hungary	Magyar Telekom (T-Mobile Hungary)
Indonesia	Telkomsel
Kazakhstan	Vimpelcom
Russia	MTS
Russia	Vimpelcom
Russia	Tele2 Russia
Russia	Megafon
Singapore	SingTel
Slovak Republic	O2 (Telefonica)
Spain	Telefonica
The Philippines	Globe Telecom
The Philippines	Smart
UK	O2 (Telefonica)
Ukraine	MTS-Ukraine

The table lists 24 operator cases where a trial has been announced but a clear commitment from the operator confirming post-trial commercial rollout is not yet given

GSA believes many of these trials will lead to further commitments to deploy commercial LTE systems being announced, in addition to the 64 network commitments already declared

Source of data: GSA Information Paper "Evolution to LTE" – April 7, 2010

LTE eco-system

- more platforms and user devices announced



Mobile phones, computer and consumer electronic devices including notebooks, netbooks, ultra-mobile PC's, gaming devices, cameras, and PMPs will incorporate embedded LTE connectivity.

Supplier	Model name	Form factor
4M Wireless	PS100 UE protocol stack	Software
Altair Semi	FourGee™ 3100/6200	Chipset
Altair Semi	FourGee™ 6150 for TDD	Chipset
Beceem	BCS500 LTE FDD/TDD and WiMAX	Chipset
Continuous Computing, picoChip, Cavium Networks	LTE femtocell reference design	Chipset reference design
Huawei	E398 LTE/GSM/HSPA 2.6 GHz, 900 MHz	USB modem
Icera	Dual mode HSPA/LTE soft modem	Chipset
Infineon	SMARTi™ LU LTE / 3G / 2G multimode RF Transceiver	Chipset
LG	LD100	USB modem
LG	M13 test device CDMA EV-DO/LTE dual mode band 13	USB modem
LG	LTE handset modem chip	Chipset
Nokia	RD-3 multi mode	USB modem
Qualcomm	MDM9200 (WCDMA-HSPA, HSPA+ and LTE)	Chipset

Qualcomm	MDM9600 (CDMA2000 1X, EV-DO Rev. B, SV-DO, SV-LTE, WCDMA-HSPA, HSPA+ and LTE)	Chipset
Qualcomm	MSM8960 (CDMA2000 1X, EV-DO Rev. B, WCDMA-HSPA, HSPA+ and LTE)	Chipset
Samsung	GT-B3710 (2.6 GHz)	USB modem
Samsung	LTE, 3G and 2G compatible	USB modem
Samsung	N150 10 inch with Kalmia LTE chipset	Netbook
Samsung	SCH-r900 multi-mode CDMA-LTE handset	Handset
Sequans	SQN3010 TD-LTE being prepared for sampling	Chipset
ST-Ericsson	M700 LTE quad band	Chipset
ST-Ericsson	M710 multi mode LTE quad band	Chipset
Toshiba	T130 13.3 inch: choice of 4 Intel LTE ULV processors	Notebook
ZTE	AL600 LTE/UMTS/EV-DO	USB modem
ZTE	AL620 LTE/UMTS/EDGE	USB modem
ZyXEL	ZLR-2070S	Router

Source of data: GSA Information Paper "Evolution to LTE" – April 7, 2010

LTE: industry forecasts



- **Research and Markets:** by 2015, 380 million subscribers In the US, the EU-5 (France, Germany, Italy, Spain and UK), Scandinavia, China, Japan and South Korea will have access to mobile data through LTE networks
- **Strategy Analytics:** the global LTE handset market will reach 150 million sales units by 2013.
- **ABI Research:** by 2013 operators will spend over \$8.6 billion on LTE base stations infrastructure.

Voice over LTE

LTE is likely to be deployed with a focus on data services connectivity for PCs, netbooks, etc

- Voice service will be introduced as a second step
- The One Voice initiative – announced on November 4, 2009, aims for industry agreement on a harmonized way to implement voice and SMS over LTE, based on existing standards.
 - The GSMA VoLTE (Voice over LTE) initiative was formally announced at the Mobile World Congress on 15th February 2010. In establishing the VoLTE initiative, GSMA has adopted the work of the One Voice Initiative as the basis of the work to lead the global mobile industry towards a standard way of delivering voice and messaging services for Long-Term Evolution (LTE). Using IP Multimedia Subsystem specifications developed by 3GPP as its basis, GSMA have expanded upon the original scope of One Voice work to address the entire end-to-end voice and SMS ecosystem by also focussing on Roaming and Interconnect interfaces, in addition the interface between customer and network.

For more information see

Evolution to LTE: GSA Information Paper
www.gsacom.com/gsm_3g/info_papers.php4

Spectrum for LTE deployments

- An operator may introduce **LTE in 'new' bands** where it is easier to deploy 10 MHz or 20 MHz carriers
 - e.g. **2.6 GHz band** (IMT Extension band) or **Digital Dividend spectrum 700, 800 MHz**
 - Or in **re-farmed** existing mobile bands e.g. 850, 900, 1700, 1800, 1900, 2100 MHz

- Eventually **LTE may be deployed in all of these bands – and others later**

- 2.6 GHz (for capacity) and 700/800 MHz (wider coverage, improved in-building) is a good combination

- LTE offers a **choice of carrier bandwidths**: 1.4 MHz to 20 MHz
 - the widest bandwidth will be needed for the highest speeds
 - for example, the TeliaSonera networks in Oslo and Stockholm each utilize a 20 MHz carrier

700 MHz is a key band for LTE



- 700 MHz LTE deployments include Verizon Wireless, AT&T Mobility, several regional players
 - 700 MHz spectrum availability will extend throughout Americas. This could be earliest in Chile where LTE trials are planned by Entel PCS, Claro and Movistar. Subtel (regulator) expected to soon launch a spectrum auction (2.6 GHz, 700 MHz)
- The Indian government has formed a task group to develop a national band plan at 700 MHz
- Consultations on future use of 700 MHz have commenced in New Zealand

Verizon Wireless

LTE commercial launch in 25-30 markets scheduled by end 2010
Nationwide by end 2013



2.6 GHz is a key band for LTE in Europe and Asia



- Telenor and Netcom have been granted licences and 2.6 GHz spectrum and will build LTE networks in Norway
- TeliaSonera announced LTE commercial service launch in Oslo on December 15, 2009



- Teliasonera, Elisa and DNA have been granted licences for 2.6 GHz spectrum and will build LTE networks in Finland



- TeliaSonera Sweden is deploying LTE using nationwide 2x20 MHz 2.6 GHz spectrum and announced commercial service launch in Stockholm on December 15, 2009



- In Hong Kong, 2x15 MHz blocks of 2.6 GHz FDD spectrum have been auctioned, and won by China Mobile, Genius Brand and CSL Limited

Several auctions of 2.6 GHz spectrum are scheduled or planned throughout European markets during 2010-2011 which is key spectrum for LTE

Source of data: GSA Information Paper "Evolution to LTE" – April 7, 2010

LTE deployment – Sweden example

Using new and re-farmed spectrum



2.6 GHz spectrum has been auctioned

900 MHz can be used for 3G

“ The present licences in the 900 MHz band will be renewed and it will be possible for the operators to phase in new technology for mobile broadband while at the same time continuing to offer GSM mobile telephony. The entire frequency space available in the 900 MHz band will be assigned, which will enable entry of the new stakeholder through PTS approving the transfer of frequencies to the operator Hi3G”

Press release, PTS, 13/03/09



Tele2 Sweden and Telenor Sweden are to build a nationwide LTE network through a new JV, “Net4 Mobility”

Operators will share spectrum in the 900 MHz and 2.6 GHz bands

Shared GSM network also planned to extend reach by 30 – 50%

800 MHz is a key band for LTE

- *Digital Dividend spectrum*
- *Excellent for rural coverage and in building coverage*



- The transition from analog to digital terrestrial television will release large amounts of spectrum potentially for mobile broadband deployments – the so-called Digital Dividend
- In 2005 the European Commission identified the release of the digital dividend in Europe as a spectrum policy priority. The Commission later called for efforts to be made at the World Radiocommunication Conference (WRC-07) to give mobile services the same status as broadcasting services
- WRC 07 identified the 790-862 MHz band for mobile service in Europe, the Middle East and Africa
- Some countries have now confirmed the availability of the 790-862 MHz band (subject to allocation processes i.e. auction), including Denmark, Finland, France, Germany, Sweden and Switzerland
 - Germany plans to auction a package of spectrum including 3 x 20 MHz DD spectrum in April 2010
 - Other governments in Europe are expected to follow in 2010 and later
- Many operators will deploy LTE in this band



Other frequency bands for LTE

LTE FDD

LTE FDD will most likely in future be deployed in existing cellular bands too, including:

- 850 MHz
- 900 MHz
- AWS (1700/2100 MHz)
- 1800 MHz
- 1900 MHz
- 2100 MHz

Future possibilities:

- 450 – 470 MHz
- 3.6 GHz

TD-LTE

Early TDD Spectrum for LTE (TTD-LTE)

- IMT Extension Center Gap 2570–2620 MHz
- 2.3 TDD i.e. 2300 – 2400 MHz

Future TDD possibility

- 3.6 GHz

The LTE market will include TDD as well as FDD systems

Li Yizhong, Minister of Industry and Information Technology, stated recently that TD-SCDMA subscribers in China are expected to reach 80 million by 2011. China Mobile aims to cover 238 cities by end 2009. According to MII, China Mobile had 6.86 million TD-SCDMA subscribers by end February 2010

LTE TDD (TD-LTE) is positioned as the next evolution in TD-SCDMA family and a natural progression

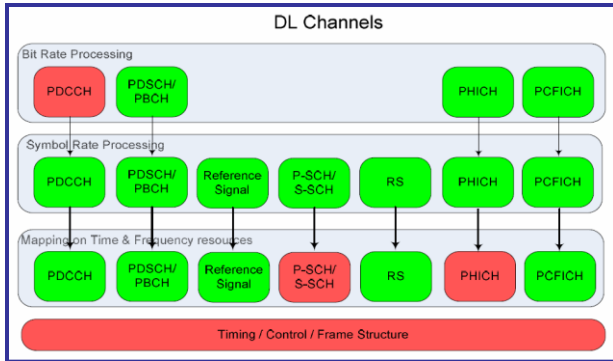
- From 3GPP standards perspective: significant commonalities with FDD
- From vendor perspective: increasing use of software defined radio techniques
- From operator perspective: spectrum availability, flexible base stations
- TD-LTE is a real complement to LTE FDD
- TD-LTE will be able to exploit global economies of scale similar to LTE FDD
- TD-LTE: the perfect choice for providing high speed mobile broadband access in unpaired spectrum
- Both TD-LTE and LTE FDD have a clear and smooth evolution path towards LTE-Advanced

TD-LTE trials on-going now

- An LTE TDD demonstration network is being readied for the Shanghai 2010 World Expo, which opens on May 1.

TD-LTE

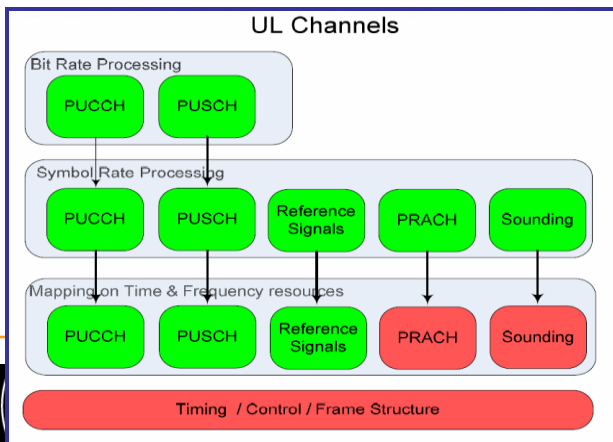
- comparison of FDD and TDD modes



FDD v TDD DL PHY differences

In the DL, the PDCCH contains a number of extra bits specific to TDD

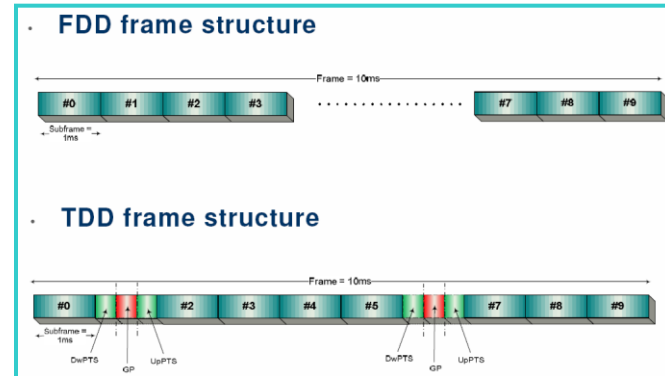
The P-SCH, S-SCH and PHICH also differ from FDD. Other channels are unchanged



FDD v TDD UL PHY differences

TDD operation affects the timing, control and frame structure.

For the UL channels, the key changes are the PRACH channel and sounding.



DwPTS: sent from eNodeB as part of synchronisation
GP: empty guard band
UpPTS: sent from UE as part of synchronisation

TD-LTE

- more information

GSA

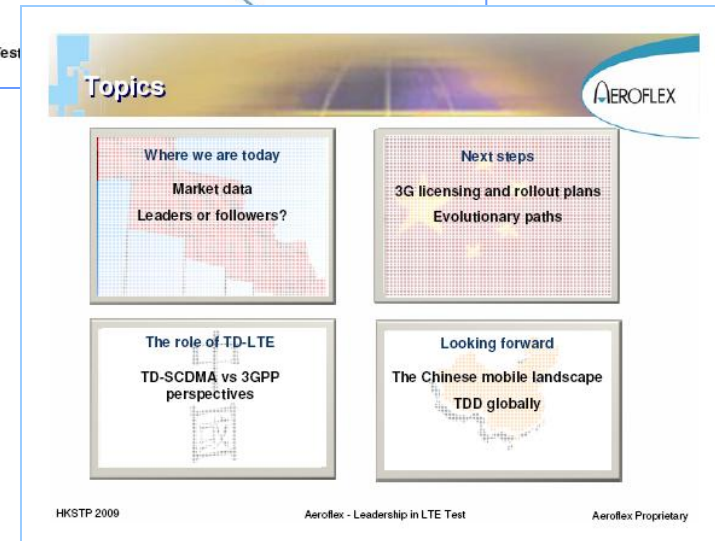
Recommended download – www.gsacom.com

From TD-SCDMA to TD-LTE (Presentation by Aeroflex Asia at 4G Wireless Broadband Evolution seminar)

- Where we are today
- Next steps
- The role of TD-LTE
- Looking forward

Presentation by Stephen Hire, Director of Marketing, Aeroflex Asia at the 4G Wireless Broadband Evolution seminar - Hong Kong, September 7, 2009 - jointly organized by GSA and Hong Kong Science and Technology Parks (www.hkstp.org)

Aeroflex (www.aeroflex.com) is a member organization of the Global mobile Suppliers Association (GSA)



LTE-Advanced



3GPP made a formal submission to the ITU, meeting the deadline of October 7, 2009, proposing that LTE Release 10 & beyond (LTE-Advanced) be evaluated as a candidate for IMT-Advanced.

The submission was made jointly in the name of the 3GPP Organizational Partners: ARIB, ATIS, CCSA, ETSI, TTA and TTC.

GSA is a Market Representation Partner in 3GPP

3GPP plans to complete its work on LTE-Advanced specifications by 2010/2011



Smooth transition from 3G to 4G

LTE-Advanced will be the main feature of 3GPP Release 10

LTE-Advanced formally submitted on Oct 7, 2009 to the ITU for evaluation as a candidate for IMT-Advanced

Improved spectrum efficiency

Support for wider bandwidth: Up to 100 MHz

Downlink transmission scheme
• Improvements to LTE by using 8x8 MIMO
• Data rates 100 Mbps high mobility, 1 Gbps low mobility

Uplink transmission scheme
• Improvements to LTE; data rates up to 500 Mbps

Reduced latency

Relay functionality
• Improving cell edge coverage
• More efficient coverage in rural areas

Backward compatibility and interworking with LTE and other 3GPP legacy systems

Further information:

Beyond Mobile Broadband: What Is LTE-Advanced & What Will It Offer to Your Network

- a presentation of the key drivers and steps towards 4G with 3GPP LTE-Advanced, timelines for standardization activities, key features and benefits

www.gsacom.com/gsm_3g/info_papers.php4

LTE: a single global standard



- **LTE is on track**, attracting global industry support.
 - The first LTE systems launched in 2009

- LTE is the **natural migration choice** for GSM/HSPA operators. LTE is also the **next generation mobile broadband system** of choice of leading CDMA operators, who will be in the forefront of service introduction

- As a result of collaboration between 3GPP, 3GPP2 and IEEE there is a **roadmap for CDMA operators to evolve to LTE**

- Successful handovers between CDMA and LTE networks have been demonstrated and announced

- The LTE TDD mode (TD-LTE) is a real complement to LTE FDD and is the perfect choice for providing high speed mobile broadband access through unpaired radio spectrum.
 - LTE TDD provides a future-proof evolutionary path for TD-SCDMA

- With LTE we have **one single global standard**, securing and driving even higher economies of scale and importantly, simplifying roaming



Evolution to LTE

GSA Information Paper

GSA
Global mobile Suppliers Association
April 7, 2010
INFORMATION PAPER
GSM/3G MARKET/TECHNOLOGY UPDATE

Evolution to LTE: GSA Information Paper
www.gsacom.com/gsm_3g/info_papers.php4

Evolution to LTE

3GPP Long Term Evolution (LTE), targets capacity and data rate speed, data throughput enhancements and low latency, to support new services, and features requiring higher levels of capability and performance. Business users and consumers today browse the Internet or send and receive e-mails using HSPA-enabled notebooks, or with HSPA modems and dongles, and send/receive video or music on 3G/HSPA phones. **LTE is the next step in the user experience, which will enhance more demanding applications such as interactive TV, mobile video blogging, advanced games and professional services.** Downlink and uplink data rates are significantly higher, supported by the necessary network architecture and technology enhancements. LTE reduces the cost per Gigabyte delivered, essential for addressing the mass market. The new system supports a full IP-based network, and harmonization with other radio access technologies.



LTE is needed to accommodate huge traffic growth

LTE standardization is complete and approved by 3GPP within Release 8, and is the basis for initial LTE deployments worldwide. The LTE standard supports both FDD and TDD modes with the same specification and hardware components.

LTE is on track, attracting global industry support. With the HSPA mobile broadband ecosystem in

place LTE is the natural migration choice for GSM/HSPA network operators. As a result of collaboration between 3GPP, 3GPP2 and IEEE, there is a roadmap for CDMA operators to evolve to LTE. It is clear that LTE is the next generation mobile broadband system of choice also for many CDMA operators, particularly leading players. Successful handovers between CDMA and LTE networks were demonstrated and announced in August 2009, showing how activities such as video downloading and web surfing were maintained as the user moved between LTE & CDMA coverage areas. The LTE TDD mode provides a future-proof evolutionary path for TD-SCDMA, another 3GPP standard. An LTE TDD demonstration network is being readied for the Shanghai 2010 World Expo, which opens on May 1. As a result we have with LTE one single global standard, which in turn will secure and drive even higher economies of scale and also simplify roaming.

64 LTE network commitments worldwide

On December 15, 2009 TeliaSonera launched the world's first LTE services in Sweden and Norway

- GSA confirms in this report (April 7, 2010)
- 64 LTE network commitments in 31 countries
 - Up to 22 LTE networks in service by end 2010
 - 39 or more LTE networks in service by end 2012

GSA believes that over time LTE will be the choice for many more operators and be introduced according to business needs. Several more operators are testing/trialing LTE and further announcements are expected. Infrastructure solutions now shipping offer an easy upgrade path to LTE.

A total of 88 operators in 43 countries have committed to deploy LTE systems or are engaged in trials or other planning activities.

Availability of new spectrum, particularly in the 2.6 GHz and Digital Dividend bands (700, 800 MHz), is a crucial factor for LTE deployments in many countries, as are the regulatory conditions, and will directly determine deployment and launch dates in those markets.

Higher data throughputs including for new applications, which LTE delivers. LTE brings the opportunity for additional spectrum in Digital Dividend (700, 800 MHz) and 2.6 GHz bands, initially giving comparable throughput capacity and performance, and will continue to improve and also benefit from larger bandwidth deployments (up to 20 MHz).

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The Growing LTE eco-system

Mobile phones, computer and consumer electronic devices including notebooks, netbooks, UMPCs, gaming devices, cameras, and PMPs will have embedded LTE connectivity. A huge growth in M2M applications enabled by LTE is forecast. Since the LTE standard supports hand-over and roaming to existing mobile networks, most devices will ensure ubiquitous mobile broadband coverage from day one. Examples of LTE devices and platforms include:

Supplier	Model name	Form factor
4M Wireless	PS100 UE protocol stack	Software
Altair Sem	FourGee™ 3100/200	Chipset
Altair Sem	FourGee™ 3150 for TDD	Chipset
Becom	BS3500 LTE FDD/TDD and WIMAX	Chipset
Continous Computing, proChip, Cavium Networks	LTE femtocell reference design	Chipset reference design
Huawei	E396 LTE/GSM/HSPA 2.6 GHz, 900 MHz	USB modem
Icera	Dual mode HSPA/LTE soft modem	Chipset
Infinion	SMART™ LU LTE / 3G / 2G multiband RF Transceiver	Chipset
LG	LD100	USB modem
LG	M13 test device CDMA EV-DO/LTE dual mode band 13	USB modem
LG	LTE handset modem chip	Chipset
Nokia	RD-3 multi mode	USB modem
Qualcomm	MDM9200 (WCDMA-HSPA, HSPA+ and LTE)	Chipset
Qualcomm	MDM9600 (CDMA2000 1X, EV-DO Rev. B, SV-DO, SV-LTE, WCDMA-HSPA, HSPA+ and LTE)	Chipset
Qualcomm	MSM9600 (CDMA2000 1X, EV-DO Rev. B, WCDMA-HSPA, HSPA+ and LTE)	Chipset
Samsung	GT-B3710 (2.6 GHz)	USB modem
Samsung	LTE_3G and 2G compatible	USB modem
Samsung	N150 10 inch with Kalima LTE chipset	Netbook
Samsung	SCH-F900 multi-mode CDMA/LTE handset	Handset
Sequans	SGN3010 TD-LTE being prepared for sampling	Chipset
ST-Ericsson	M70	Chipset
ST-Ericsson	LTE quad band	Chipset
ST-Ericsson	M710 multi mode LTE quad band	Chipset
Toshiba	T130 13.3 inch choice of 4 Intel LTE ULV processors	Notebook
ZTE	AL620 LTE/UMTS/EV-DO	USB modem
ZTE	AL620 LTE/UMTS/EDGE	USB modem
ZyXEL	ZLR-2070S	Router

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Mobile Broadband Update

GSA calculates that there are over 2.25 billion GSM, WCDMA and HSPA subs in commercial HSPA-enabled networks globally

Commercial WCDMA networks	325	HSPA subscriptions (Dec 09)	217 m
Countries WCDMA launched in	135	HSDPA networks 3.6 Mbps or higher	> 79%
WCDMA subs (incl. HSPA) Dec 09	453 m	HSDPA networks 7.2 Mbps or higher	> 53%
WCDMA 3G network market share	> 73%	HSDPA devices launched	2,137
Commercial EDGE networks	487	Commercial HSPA networks	98
Countries EDGE launched in	190	Networks with HSUPA launched	> 31%
GPRS networks evolved to EDGE	> 80%	HSUPA devices launched	493
HSPA networks with EDGE	> 66%	HSPA devices with EDGE support	> 80%
HSPA network commitments	364	HSPA+ network commitments	80
Commercial HSPA networks	315	Countries with HSPA+ network commitments	41
Countries HSPA launched in	133	21 Mbps HSPA+ networks launched	36
Live WCDMA networks with HSPA	97%	28 Mbps HSPA+ networks launched	5
		LTE network commitments	64
		Countries with LTE network commitments	31

Source: GSA surveys and reports - up to April 7, 2010
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