Evolution to LTE

3GPP is developing the evolution of mobile communications systems beyond GSM/EDGE and WCDMA-HSPA systems. "3G Mobile System Long Term Evolution (LTE)", targets capacity and data rate speed and throughput enhancements and reduced latency to support new services and features requiring higher levels of capability and performance.

Business users and consumers can today browse the Internet or send and receive e-mails using HSPA-enabled notebooks, or using HSPA modems, including USB dongles, as well as send and receive video or music using their 3G/HSPA phones. LTE is the next step in user experience and it will further enhance more demanding applications such as interactive TV, mobile video blogging, advanced games or professional services. Data rates will be significantly higher for both the downlink and uplink paths, supported by the necessary network architecture and technology enhancements.

LTE reduces the cost per Gigabyte delivered, which is essential for addressing the mass market. The new system includes support of a full IP-based network and harmonization with other radio access technologies.

LTE targets a smooth evolution from current 3GPP and 3GPP2 systems, and is a major step towards IMT-Advanced (often referred to as 4G). LTE includes many features originally considered for a future 4G system.

3GPP has announced approval of the functional freeze of LTE Terrestrial Radio Access Network technology specifications for inclusion in Release 8. Specifications for LTE and the associated system architecture (SAE - see below) are almost completed, and sufficiently stable for commercial implementation. LTE supports both FDD and TDD modes with the same specification and hardware components. The **NGMN Alliance** has approved LTE/SAE as its first NGMN compliant technology.

LTE can be deployed in existing 2G and 3G system spectrum, as well as utilize new spectrum such as 2.6 GHz currently being auctioned in many parts of the world, and the 700 MHz band which was auctioned as part of the Digital Dividend, beginning in the United States of America. There is strong interest in the opportunities arising as part of the Digital Dividend for additional UHF spectrum, including 790-862 MHz band in Region 1 (Europe, Africa and Middle East), 698-806 MHz in Region 2 (Americas) and in Asia, which would enable LTE to be globally deployed efficiently over large geographical areas, and improve in-building coverage.

LTE is on track, attracting global industry support. With the HSPA mobile broadband eco-system in place, LTE is the natural migration choice for GSM/HSPA network operators. LTE is also the next generation mobile broadband system of choice of many CDMA operators, particularly the leading players. Infrastructure vendors are now shipping LTE-compatible solutions - including to customers in Europe, Asia and North America.

GSA's research confirms **31** network operators have committed to LTE deployments, as detailed later in this paper. The first LTE systems are expected to enter service in 2010, possibly earlier.

ABI Research forecasts by 2013 operators will spend over $8.6 billion on LTE base stations infrastructure. For operators that have already deployed 3G networks, LTE will be a key CAPEX driver over the next five years."

LTE: High-level requirements

- Reduced cost per bit
- Increased service provisioning – more services at lower cost with better user experience
- Flexibility of use of existing/new frequency bands
- Simplified architecture, open interfaces
- Allow for reasonable terminal power consumption

LTE utilizes a new radio air interface technology known as Orthogonal Frequency Division Multiple Access (OFDMA) to provide several key benefits, including significantly increased peak data rates, increased cell edge performance, reduced latency, scalable bandwidth, co-existence with GSM/EDGE/UMTS systems, & reduced CAPEX/OPEX.

Basic drivers for LTE

- Demand for higher data rates
- New spectrum allocations (e.g. 2.6 GHz)
- Greater flexibility in frequency allocations
- Continued cost reduction; future competitiveness

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LTE Objectives

- Significantly increased peak data rates
- Increased cell edge bit rates
- Improved spectrum efficiency; scaleable bandwidth
- Improved latency
- Reduced CAPEX and OPEX
- Acceptable system/terminal complexity, cost, power consumption
- Compatibility with earlier releases & other systems
- Optimized for *low*, but supporting *high* mobile speed

Targets include:

- Instantaneous downlink peak data rate of at least 100 Mb/s within 20 MHz allocation (5 bps/Hz)
- Instantaneous uplink peak data rate of 50 Mb/s (2.5 bps/Hz within a 20MHz uplink spectrum 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 optimized for low mobile speed: 0-15 km/h. Higher mobile speed between 15-120 km/h should be supported with high performance
- Mobility across the cellular network shall be maintained at speeds 120 km/h-350 km/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 20 MHz 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 & GERAN

LTE radio network products will incorporate several features that simplify building and management of next-generation networks. Plug-and-play, self-configuration and self-optimization simplify and reduce network rollout and management cost. LTE will be deployed alongside simplified, IP-based core and transport networks that are easier to build, maintain and introduce services on.

System Architecture Evolution (SAE)

In the same time frame as LTE development, 3GPP's core network has been undergoing System Architecture Evolution (SAE), optimizing it for packet mode and, in particular, for the IP-Multimedia Subsystem (IMS) which supports all access technologies, even including fixed wire-line access. Aims include:

- 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

31 LTE network commitments and deployments

Verizon Wireless, Vodafone, and **China Mobile** have conducted joint trial activities of LTE in both FDD and TDD modes. **Verizon** acquired almost half of the spectrum in the 2008 US 700 MHz auction and will use this band to launch LTE. The company has announced 2 infrastructure vendors for the initial deployment phase. According to press reports, 2 trial LTE markets will be launched by end 2009, and up to 35 commercial LTE markets by end 2010. **China Mobile** is building out its TD-SCDMA network so that cell sites and other elements may be re-used for the LTE network

AT&T Mobility was the 2nd largest winner of spectrum in the 700 MHz auction, and plans to deploy LTE using this, plus spectrum acquired in the 2006 advanced wireless services (AWS) auction, and 700 MHz spectrum acquired from Aloha Partners. AT&T Mobility has a contiguous band of 20 MHz for LTE across 82% of the population in the top 100 markets. The company plans commercial LTE in key markets by mid-2011.

NTT DoCoMo plans to commercially launch LTE in 2010, and has demonstrated data rates of 250 Mbps downlink, 50 Mbps uplink in field tests & public events.

KDDI is deploying LTE as an overlay to its CDMA mobile network

Telstra confirmed LTE is on its roadmap

Telecom New Zealand is committed to LTE

Telecom Italia plans to deploy LTE

China Telecom plans to migrate to LTE

TeliaSonera Mobile Networks AB Sweden plans to roll out LTE using nationwide 2 x 20 MHz spectrum acquired in the 2.6 GHz auction. The company announced an infrastructure contract for an LTE system in Stockholm for commercial launch in 2010.

TeliaSonera Norway (which owns NetCom) announced at the same time the award of an LTE infrastructure

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contract with a different supplier for an LTE system in Oslo, also for commercial launch in 2010

Tele2 Sweden and **Telenor Sweden** announced on April 14, 2009 a joint venture to build a LTE network. The JV includes spectrum sharing in the 900MHz and 2.6 GHz bands. Roll-out will start this year with the intent of launching LTE services by end 2010, or when modems are available. In 2013, the operators expect 99% of the Swedish population to have access to mobile broadband at speeds up to 80 Mbps in rural areas and up to 150 Mbps in urban areas.

SK Telecom and **KTF** both plan to deploy LTE

France Telecom/Orange is engaged in LTE studies and trials, with deployment anticipated from 2011

T-Mobile anticipates deploying LTE from 2011, with trials starting later this year. In 2008 T-Mobile claimed the world's first operator-led LTE handover

US regional carrier **CenturyTel** has announced plans to deploy LTE in 700 MHz spectrum from 2010. **MetroPCS,** another US regional carrier, plans to deploy LTE in 2H 2010. US cable operator **Cox** has indicated plans to deploy LTE in 700 MHz spectrum from 2011. **Aircell** will deploy LTE to boost capacity of its in-flight network, with commercial launch expected in 2011

Bell Canada and **Telus** confirmed they will co-operate on deploying a national HSPA network, with later upgrades to LTE. The HSPA network will be available by 2010 and overlay the CDMA networks of both companies, as well as the Telus iDEN network. **Rogers Wireless** is currently conducting LTE trials

SmarTone-Vodafone has confirmed plans to deploy LTE re-using its GSM (900/1800) spectrum, having withdrawn from the BWA 2.5-2.7 GHz spectrum auction in Hong Kong. 2x15 MHz blocks of new paired FDD spectrum were won each by China Mobile (Peoples Phone), Genius Brand (a Hutchison Telecom/PCCW joint venture), and Hong Kong CSL.

Hong Kong CSL has confirmed plans to deploy LTE in this new 2.6 GHz spectrum. **PCCW** has also committed to LTE deployment in the new spectrum. No bids were received for 100 MHz of unpaired (TDD) spectrum in the 2.3 GHz and 2.5 – 2.6 GHz bands

Piltel is reported to have approached NTC, the Philippines regulator, applying for the remaining 3G license, which it plans to use for LTE

Ireland's government awarded a contract in December 2008 to **Hutchison 3 Ireland** to roll out broadband under the National Broadband Scheme, which will supply broadband to the remaining 10% of Ireland's population and 33% of its land surface not currently having access to any broadband service. 3 Ireland is deploying HSPA, to be followed by HSPA+, and plans to start deploying LTE in 2011.

Telefonica Spain recently conducted LTE field tests at its Madrid Demonstrations Center, showing download speeds over 140 Mbps.

Country	*Operator*	*Anticipated LTE service launch*
USA	Verizon	2010
USA	MetroPCS	2010
USA	CenturyTel	2010
Sweden	TeliaSonera	2010
Sweden	Tele2 Sweden	2010
Sweden	Telenor Sweden	2010
Norway	TeliaSonera	2010
Japan	NTT DoCoMo	2010
Japan	KDDI	2010
Canada	Telus	2010
Canada	Bell Canada	2010
Canada	Rogers Wireless	2010-11
USA	Aircell	2011
USA	Cox	2011
USA	AT&T Mobility	2011
Ireland	Hutchison 3	2011
Germany	T-Mobile	2011
China	China Mobile	2011
Spain	Telefonica O2	2011
China	China Telecom	2011-12
France	Orange	2011-12
New Zealand	Telecom NZ	2011-12
South Korea	SK Telecom	Not known
South Korea	KTF	Not known
Philippines	Piltel	Not known
Italy	Telecom Italia	Not known
Hong Kong	SmarTone-Vodafone	Not known
Hong Kong	HK CSL Ltd	Not known
Hong Kong	PCCW	Not known
Australia	Telstra	Not known
Various	Vodafone	Not known

LTE operator commitments – April 15, 2009
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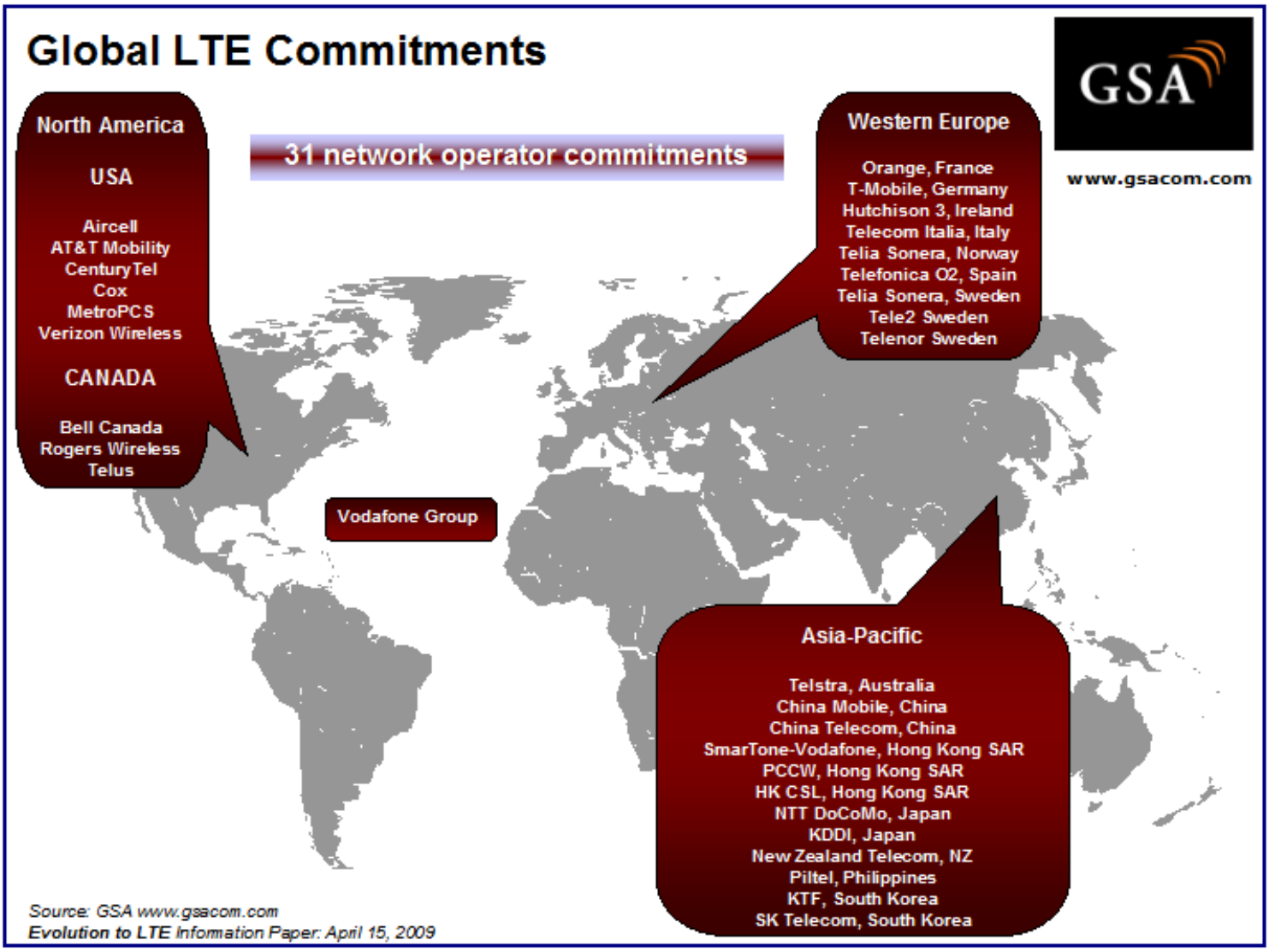

Global LTE commitments world map
Download at www.gsacom.com

LTE Devices

Mobile phones, computer and consumer electronic devices including notebooks, netbooks, ultra-mobile PCs, gaming devices, cameras, and PMPs will incorporate embedded LTE connectivity. LTE and multi-mode ICs and devices are scheduled to become available in 2009. Examples of LTE platforms already announced confirm the developing LTE eco-system:

- **Ericsson** M700 LTE-capable platform for commercial release in 2009. Products based on the M700 platform are expected in 2010
- **Qualcomm** MDM 9200 and MDM 9600 LTE device chipsets, scheduled to sample in Q2 2009
- **Infineon** has sampled its LTE RF transceiver, the SMARTi™ LU
- **LG** has developed a handset LTE modem chip, and forecasts the first LTE mobile phones will likely reach the market in 2010
- **Samsung** is collaborating with semiconductor manufacturer Sandbridge Technologies
- **ST-NXP Wireless** launched the Nexperia PNX6910 cellular system solution for LTE

Several test equipment manufacturers have announced and launched LTE test systems

Strategy Analytics forecasts the global LTE handset market will increase from 70 million sales units in 2012 to 150 million by 2013.

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IPR Framework for LTE/SAE

On April 14, 2008 Alcatel-Lucent, Ericsson, NEC, NextWave Wireless, Nokia, Nokia Siemens Networks and Sony Ericsson announced a mutual commitment to a framework for establishing predictable and more transparent maximum aggregate costs for licensing intellectual property rights (IPR) that relate to LTE/SAE standards. The framework is based on the principle of fair, reasonable and non-discriminatory (FRAND) licensing terms for essential patents.

It means that the companies agree, subject to reciprocity, to reasonable, maximum aggregate royalty rates based on the value added by the technology in the end product, and to flexible licensing arrangements according to the licensors' proportional share of all standard essential IPR for the relevant product category.

The companies agree a reasonable *maximum aggregate royalty level* for LTE essential IPR in handsets is a single-digit percentage of the sales price, while for notebooks with embedded LTE, a single-digit dollar amount is considered the maximum level.

LTE/SAE Trial Initiative (www.lstiforum.org)

Vendors and operators have joined forces under the *LTE/SAE Trial Initiative* to demonstrate the potential of LTE/SAE through joint tests, including radio performance, interoperability, field tests and full customer trials.

Results feed into technology developments and standardization, help define/validate network launch plans, and also help to validate the emerging LTE ecosystem, including devices and applications.

A Proof of Concept activity has consolidated measurements from leading equipment vendors to show that the industry's targets for performance are achievable. In addition to peak rates and minimum latency, results also reveal the 'real world' performance that operators will be able to offer to end users.

Results are available in a presentation www.lstiforum.org/file/news/Latest_LSTI_Results_Feb09_v1.pdf

Further evolution of LTE: *IMT-Advanced*

3GPP is elaborating a Technical Report "*Requirements for further advancements for E-UTRA (LTE-Advanced)*" for further evolution of LTE, for consideration within the ITU call for "IMT-Advanced" technologies.

See www.3gpp.org/FTP/Specs/html-info/36913.htm

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

LTE conferences – upcoming events

GSA is participating in or endorsing selected LTE conferences during 2009, including:

- LTE World Summit, Berlin, May 18-20
- LTE Russia and CIS Forum, Moscow, May 26-27
- LTE in Russia 2009, Moscow, June 16-17

More information about these and other events can be found on the GSA website Events page **www.gsacom.com/events/index.php4**

Discounts are available for GSA member companies

GSA represents leading GSM/3G/WCDMA-HSPA and LTE suppliers worldwide, covering close to 100% of mobile market share. GSA delivers authoritative facts, market intelligence, objective analysis and information. 56,704 professionals from 198 countries used the GSA website in 2008. Interaction and enhanced information-sharing with fixed and mobile operators is facilitated by seminars and relationship events, including the GSA Mobile Broadband Forum, and via the Operators Zone for immediate global reach. GSA advises governments, regulators and policy-makers on optimum conditions for market development. Briefings are given to media and analysts. GSA is a 3GPP Market Representation Partner and co-operates with key organisations worldwide.

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