

Worldwide Mobile Broadband Market Trend

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ROHDE & SCHWARZ

Outline

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- I The Mobile Broadband Market**
 - I Mobile broadband drivers
 - I Technology Trends
 - I The LTE Eco-System
- I The LTE eco system from a T&M perspective**
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 - I Infrastructure Providers
 - I Mobile Device / Chip Set Industry
- I Outlook into LTE-Advanced**
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Rohde & Schwarz at a Glance

- | Independent, autonomous company
- | For more than 75 years, the specialist in T&M and wireless communications
- | Represented in over 70 countries, with subsidiaries in 60 countries
- | Turnover of EUR 1.2 billion (FY 08/09)
- | Export share > 80 %
- | 7400 employees worldwide
- | Active business fields are test and measurement, secure communications, radiomonitoring / radiolocation, broadcasting and services.



Rohde & Schwarz around the world

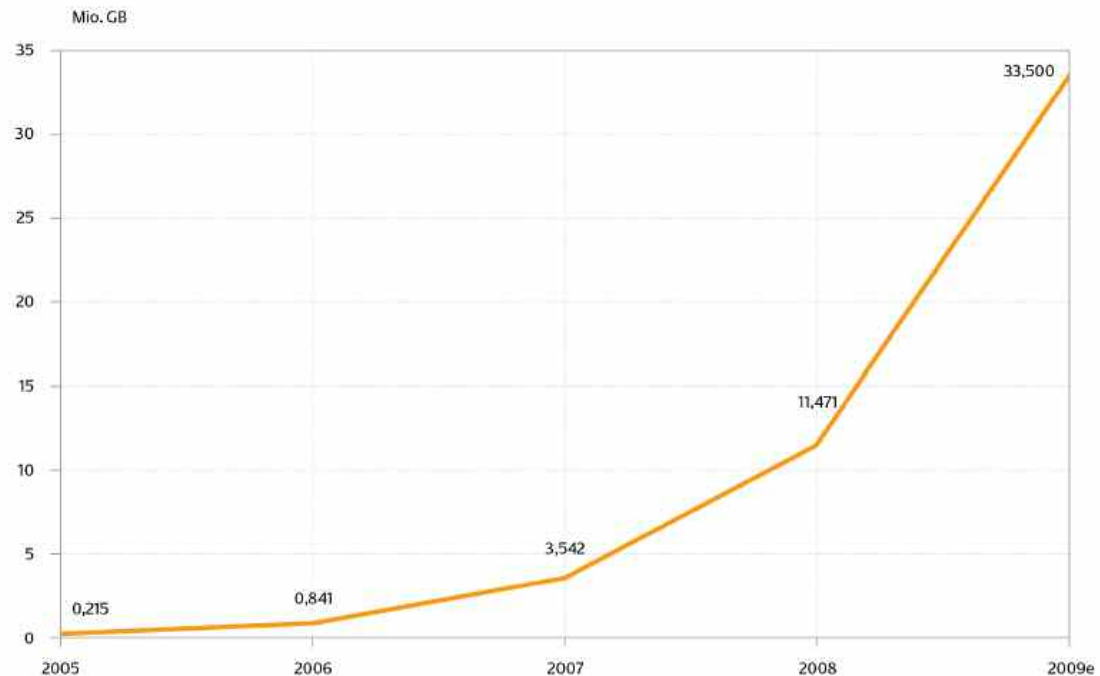


Mobile Broadband Market

Real mobile broadband is happening now

**Q2/2010:
530 million mobile
broadband
subscriptions
(WCDMA, HSPA)****

**71% of the
German internet
users own an
internet capable
mobile user
device*****



German mobile data increase 2005-2009*

Sources:

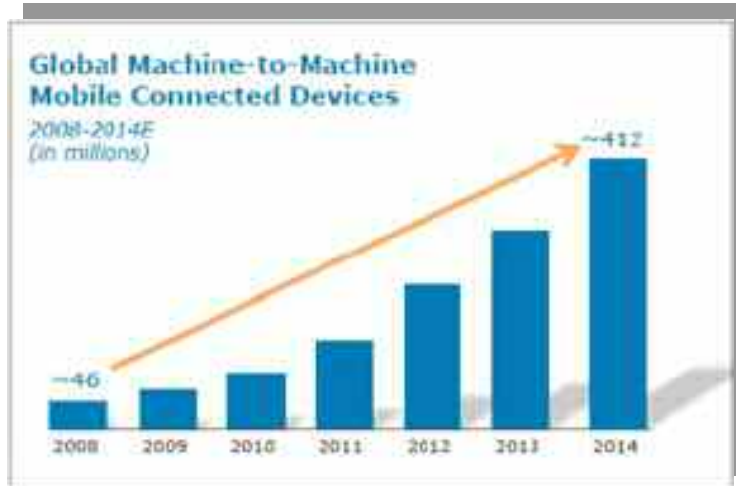
*Bundesnetzagentur

**GSA (Global mobile Supplier Association)

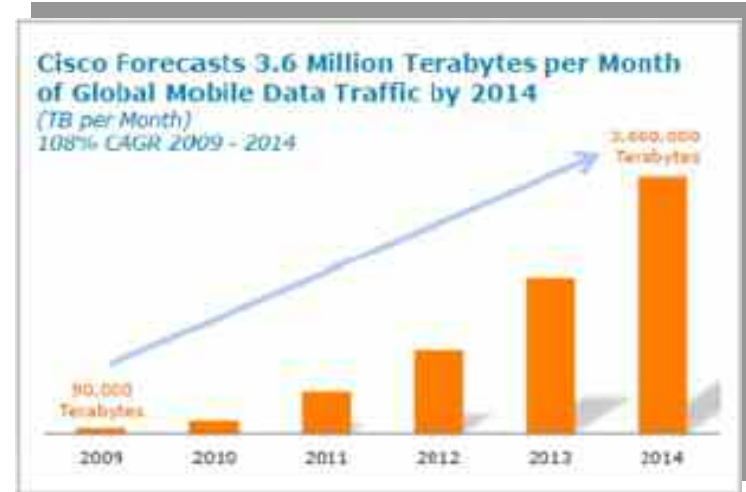
***Accenture Mobile Web Watch

Mobile Broadband Market

Drivers for mobile broadband



Source: Juniper Research, Jan. 2010



Source: Cisco, VNI Mobile, 2010



Smartphone

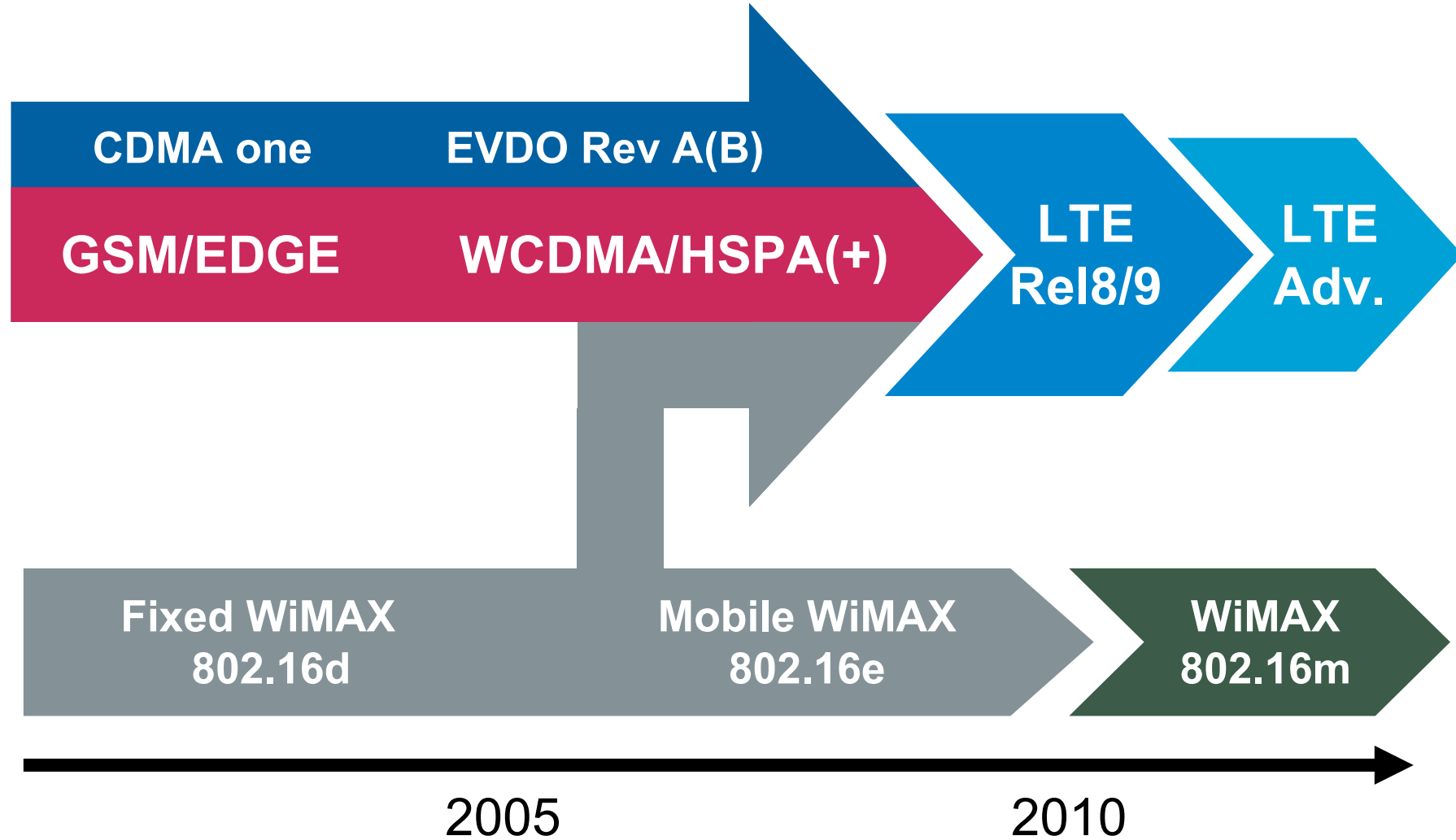


Voice centric device

Sony CEO H. Stringer set forth the goal of having 90 percent of Sony's CE devices network-enabled

Technology Evolution Path

Main Trends



Technology Evolution Path

WiMAX operator/manufacturer broaden scope to (TD-)LTE

US WiMAX service provider Clearwire announced plans to trial LTE technology this year, August 2010

clearw^{ire}



Yota chooses LTE over WiMAX for new market rollouts, May 2010

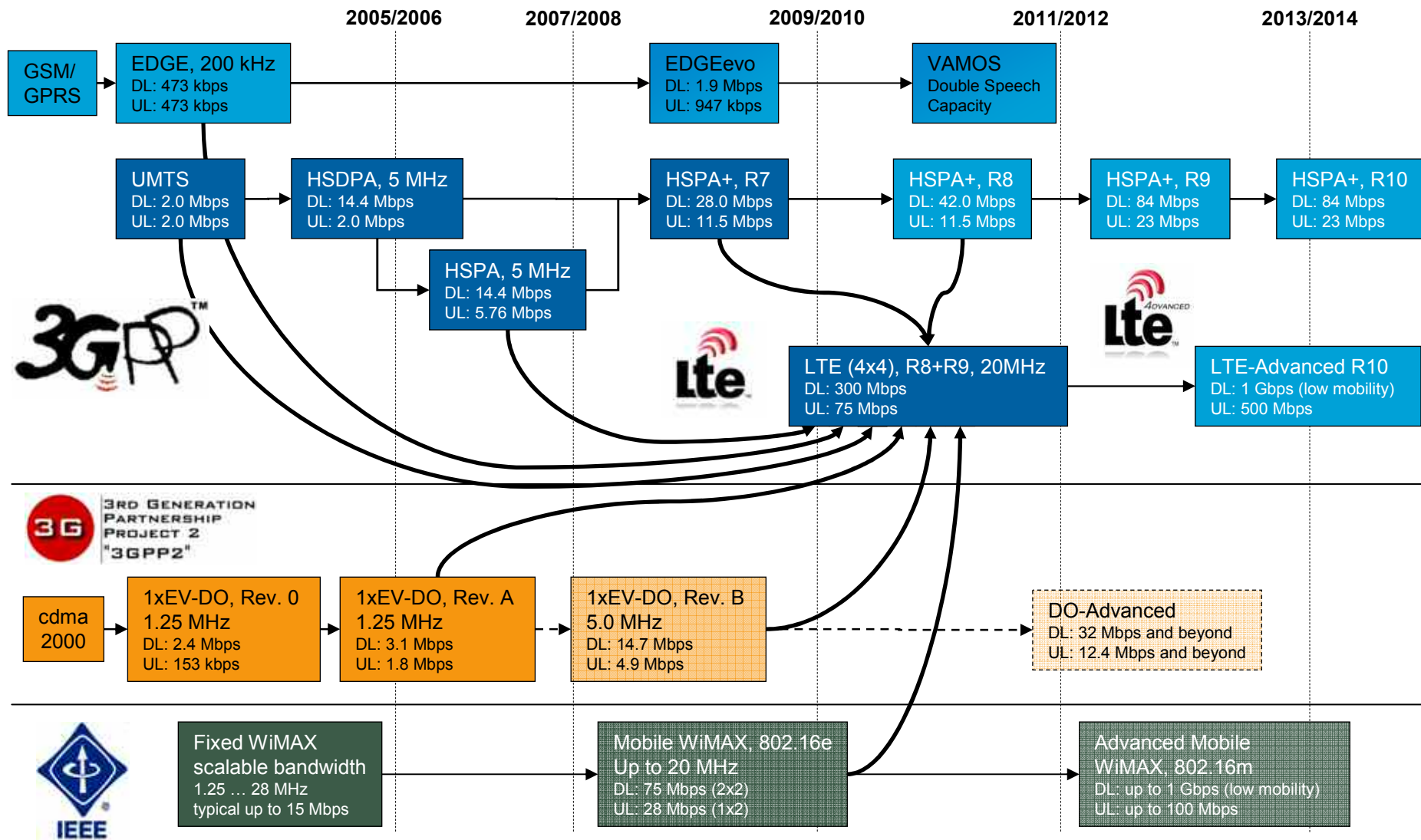


Beceem Ends 4G Debate with integrated 4G LTE/WiMAX Chip, February 2010



Sequans' LTE solutions feature high performance category 3 throughput, TDD and FDD for global compatibility, August 2010

Technology evolution path



A strong platform for LTE deployment

Mobile Broadband Market

CSA calculates that the subscriptions in countries

GSA

www.gsa.com

302 commercial C2K 1xRTT networks in 120 countries,

Commercial WCDMA networks	357	HSDPA networks 3.6 Mbps or higher	81.5%
Countries WCDMA launched in	148	HSDPA networks 7.2 Mbps or higher	58%
WCDMA 3G network market share	> 75%	HSDPA devices launched	2,579
WCDMA subs (incl. HSPA) Q2 10	530m	Commercial HSUPA networks	118
Commercial EDGE networks	531	Networks with HSUPA launched	> 33%
Countries EDGE launched in	198	HSUPA devices launched	724
GPRS networks evolved to EDGE	> 80%	HSPA devices with EDGE support	> 63%
HSPA networks with EDGE	> 70%	HSPA+ network commitments	116
HSPA network commitments	401	HSPA+ network commitment countries	54
Commercial HSPA networks	353	HSPA+ networks launched	63
Countries HSPA launched in	147	LTE network commitments	101
		LTE network commitment countries	41
		Additional pre-commitment network trials	31

Mobile Suppliers Association (GSA)

115 commercial 1xEV-DO Rel. 0 networks in 62 countries,
100 commercial 1xEV-DO Rev. A networks in 49 countries

Source GSA and CDG, July 2010

Strong rising LTE commitments

A global operator community is ready to start

- I Up to 22 LTE networks in service by end 2010
- I Up to 50 LTE networks in service by end 2012



Source of data: GSA Information Paper “Evolution to LTE” – June 7, 2010 Slide

TeliaSonera

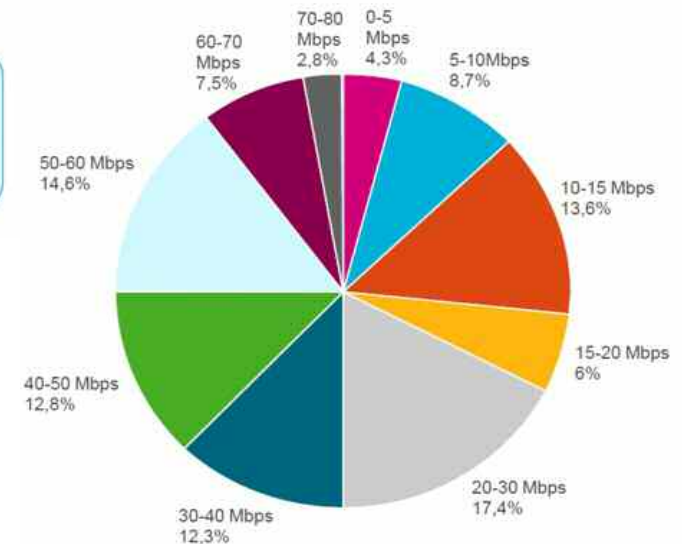
LTE is commercially available

I LTE commercial launch on Dec 14, 2009

- I Two city networks in Stockholm and Oslo
- I Gothenburg added in August 2010
- I Population coverage at launch: 400,000
- I Initially modems/USB dongles for 4G only
- I Limited number of modems to start with

Oslo live measurement

Oslo DL Throughput pedestrian, LTE 20 MHz performance and Category 3 modems



Source: Signals Research Group, LLC

4G Roll out 2009 and 2010

Helsingborg	Karlstad
Örebro	Växjö
Jönköping	Sundsvall
Norrköping	Luleå
Umeå	Visby
Eskilstuna	Ski areas
Gävle	Airports
Södertälje	Karlstad
Borås	Växjö



Germany – Digital Dividend

LTE 800 - Broadband Access in rural areas

I Deutsche Telekom starts nation wide LTE-Deployment

- I Around 500 LTE-Sites on Band 20 planned until end 2010
- I No mobility in the beginning
- I Further Band 7 deployment will start in 2011



I Vodafone Germany to deploy LTE network

- I Nation wide LTE coverage by 2013 starting with Band 20
- I Plans to have 1,500 base stations upgraded by the end of 2011 in rural areas without access to broadband services.



LTE - front runners pushing the wireless industry

- I **Verizon** providing coverage to about 100 million people by the end of 2010. 2013 Verizon Wireless expects to have same coverage with LTE as they do have now with their 3G network based on 1xEV-DO Rev. A



- I **NTT DOCOMO** is verifying its new commercial LTE network in the Tokyo area, prior to the full-scale launch of a commercial extra-high-speed LTE service in December



- I **China Mobile** TD-LTE trials currently running, challenging timescales established for prototype, dual-mode and multimode devices



The LTE eco-system is building up LTE FDD and TD-LTE

- I **Several LTE platforms have been announced by device and chipset manufacturers and were demonstrated to carriers and at trade shows,**
 - I 1st commercial LTE handsets are data cards, majority LTE-only, limited to one frequency band/bandwidth,
 - I Next wave is going to be dual-mode or even triple, supporting several frequency bands,
- I **Various field trials are ongoing, using selected infrastructure provider and device manufacturer,**



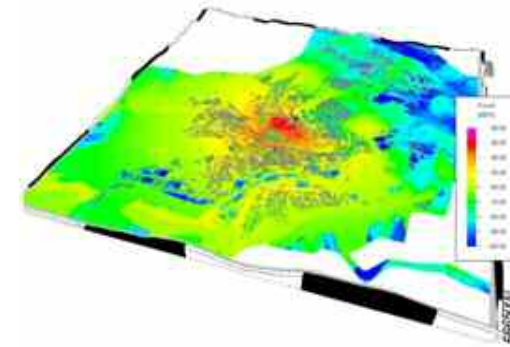
Supplier	Model name	Form factor
4M Wireless	PS100 UE protocol stack	Software
Altair Semi	FourGee™ 3100/6200	Chipset
Altair Semi	FourGee™ 6150 for TDD	Chipset
Beceem	BCS500 LTE FDD/TDD and WiMAX	Chipset
Continuous Computing, picoChip, Cavium Networks	LTE femtocell reference design	Chipset reference design
Huawei	E398 LTE/GSM/HSPA 2.6 GHz, 900 MHz	USB modem
Icera	Dual mode HSPA/LTE soft modem	Chipset
Innofidei	LTE TDD	Chipset, USB dongle
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
MediaTek	LTE mobile terminal platform licensing arrangement with NTT DoCoMo	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
Runcom	Chipset	Chipset
Samsung	GT-B3710 (2.6 GHz)	USB modem
Samsung	GT-B3730 (LTE/2G/3G)	USB modem
Samsung	N150 10 inch with Kalmia	USB modem
Samsung		
Sequans		
ST-Ericsson		
ST-Ericsson		
Toshiba		
Wavesat		
ZTE		
ZTE		
ZyXEL		

20 chip set / terminal manufacturers reported platforms into GSA

The LTE eco system from a T&M perspective

Main areas of involvement

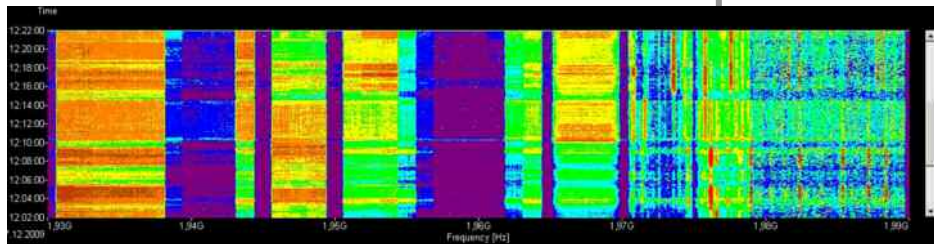
- I **Network operators preparing and launching LTE services request easy to use test equipment to assess performance in the lab and in the field.**
- I **Infrastructure providers need to verify their equipment during development and production ensuring time to market and consequently require efficient test strategies.**
- I **Mobile device / Chip set industry at the edge of starting volume production while at the same time continuously enhancing functionality, e.g. multiple RAT support, demanding most efficient T&M support.**



Test Challenges for Network Operators

Testlabs

- Trial Management
- Terminal verification
- Vendor Selection
- Performance testing
- Quality Assurance



Deployment

- Antenna system
- Site acceptance
- Spectrum clearance



Operations

- Optimization
- Spectrum Management
- Field Maintenance
- Trouble shooting
- Interference hunting



Test Challenges for Infrastructure Providers

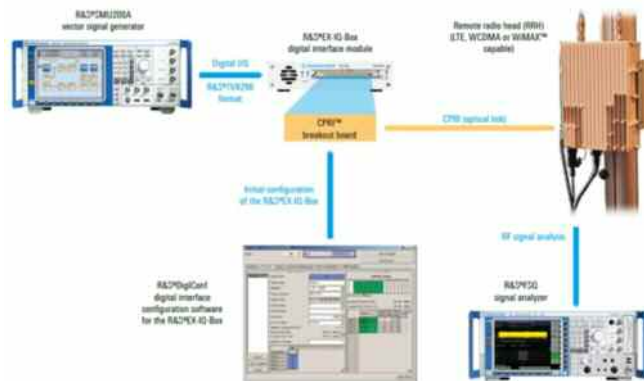
Development

Production

Deployment

Services

- MIMO / Beamforming
- RF characteristic verification
- Digital Interface (CPRI) testing



- Throughput performance verification under real life propagation conditions
- eNodeB scheduling algorithm verification
- KPI measurements (throughput, peak data rates, handover performance ..)



Test Challenges for the Mobile Device / Chip Set Industry

Current main activities/trends

I RF and Protocol verification

- I Achieving highest E2E data rates in the lab
- I Inter RAT handover (LTE/C2K and LTE/WCDMA and LTE/GSM)
 - Taking into account the variety of different frequency bands
- I Preparation for GCF certification to start end 2010
 - “GCF, the Global Certification Forum, is on schedule to release an LTE device certification scheme before the end of 2010 – in time for a wave of commercial LTE network launches expected towards the end of the year.”



I LTE network operator test plans

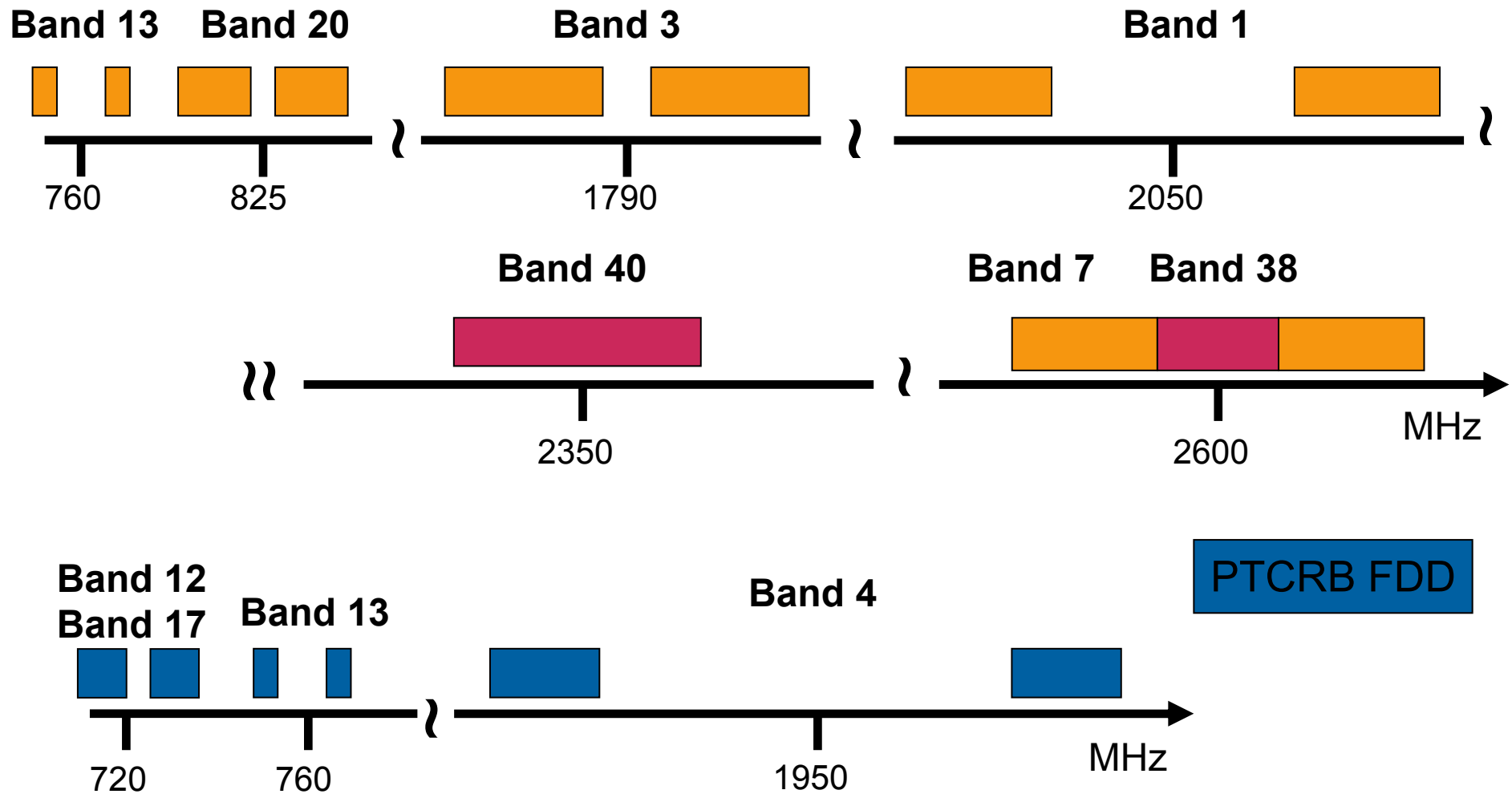
- I Developing/Verifying specific operator requirements



Priority Frequency Bands

present a diverse landscape

GCF FDD
GCF TDD



LTE/LTE-A Frequency Bands (FDD/TDD)

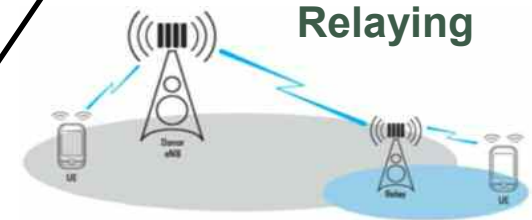
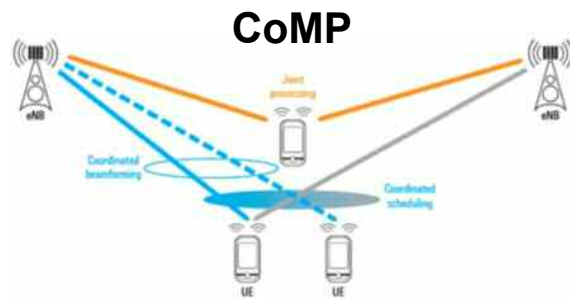
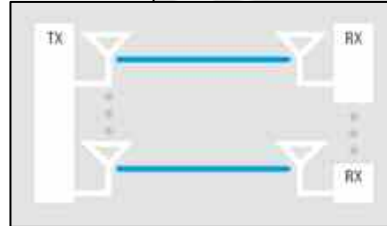
E-UTRA Operating Band	Uplink (UL) operating band		Downlink (DL) operating band	
	F_{UL_low}	F_{UL_high} [MHz]	F_{DL_low}	F_{DL_high} [MHz]
1	1920	– 1980	2110	– 2170
2	1850	– 1910	1930	– 1990
3	1710	– 1785	1805	– 1880
4	1710	– 1755	2110	– 2155
5	824	– 849	869	– 894
6	830	– 840	875	– 885
7	2500	– 2570	2620	– 2690
8	880	– 915	925	– 960
9	1749.9	– 1784.9	1844.9	– 1879.9
10	1710	– 1770	2110	– 2170
11	1427.9	– 1452.9	1475.9	– 1500.9
12	698	– 716	728	– 746
13	777	– 787	746	– 756
14	788	– 798	758	– 768
17	704	– 716	734	– 746
18	815	– 830	860	– 875
19	830	– 845	875	– 890
20	832	– 862	791	– 821
21	1447.9	– 1462.9	1495.9	– 1510.9
22	3410	– 3500	3510	– 3600

E-UTRA Operating Band	Uplink (UL) operating band		Downlink (DL) operating band	
	F_{UL_low}	F_{UL_high} [MHz]	F_{DL_low}	F_{DL_high} [MHz]
33	1900	– 1920	1900	– 1920
34	2010	– 2025	2010	– 2025
35	1850	– 1910	1850	– 1910
36	1930	– 1990	1930	– 1990
37	1910	– 1930	1910	– 1930
38	2570	– 2620	2570	– 2620
39	1880	– 1920	1880	– 1920
40	2300	– 2400	2300	– 2400

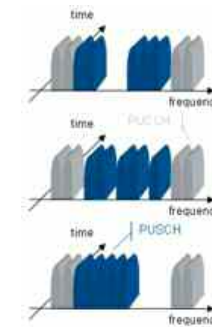
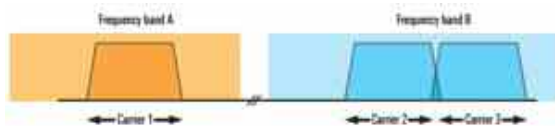
LTE-Advanced

Feature overview

MIMO (DL) 8x8
MIMO (UL) 4x4



Carrier Aggregation



Enhanced SC-FDMA

LTE / LTE-Advanced

The innovation platform for the next decade

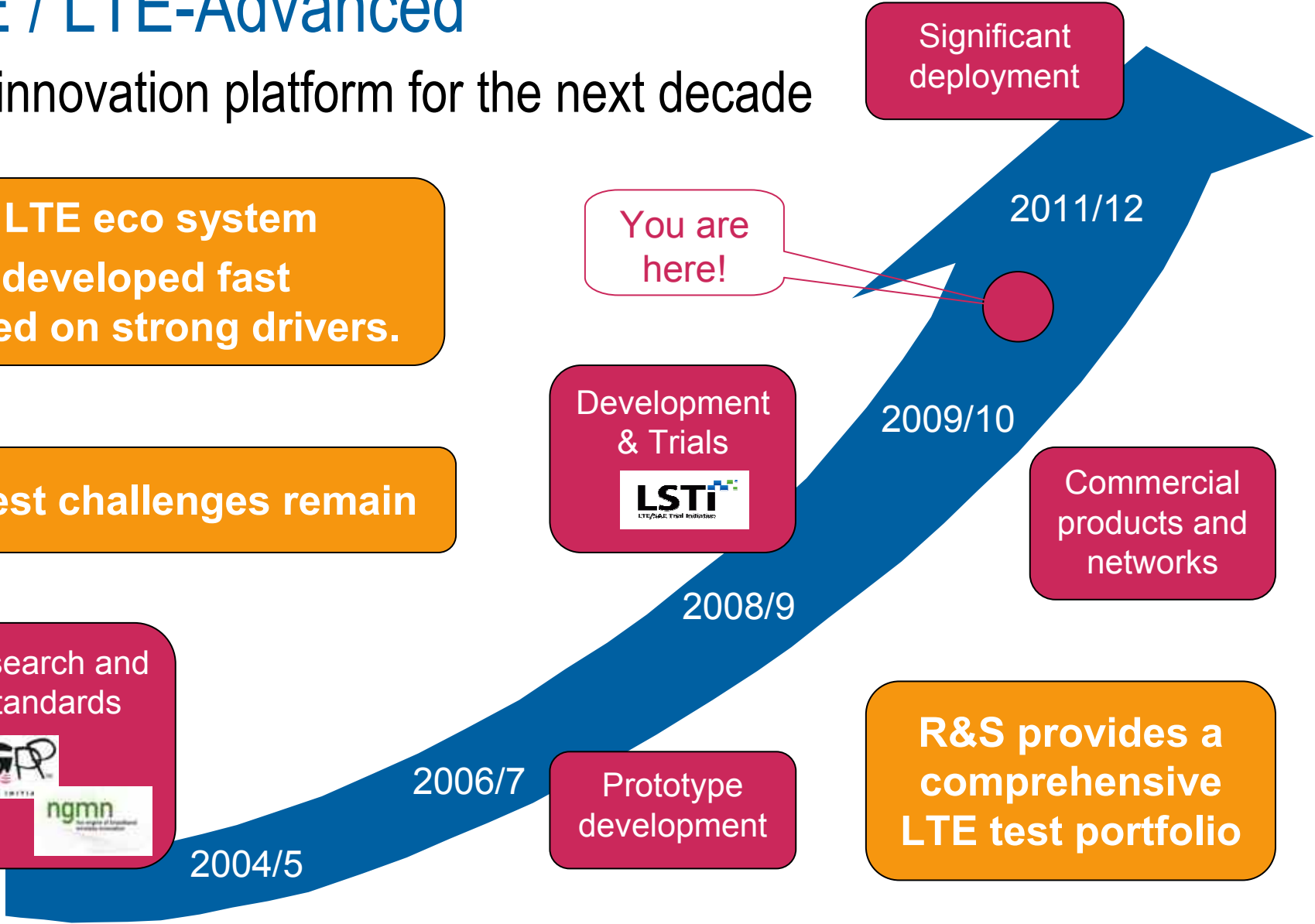
The LTE eco system has developed fast based on strong drivers.

Test challenges remain

Research and Standards



3GPP
A GLOBAL PARTNER
ngmn
The network of standards
and innovation





**Thank you
for your attention!**

