

# 3GPP LTE Standardization Status Update and Latest Trends

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**ROHDE & SCHWARZ**

# Outline

- I **Rohde & Schwarz at a Glance**
- I **Status of LTE deployments**
- I **Current LTE challenges**
- I **LTE Release 9 and LTE-Advanced**
- I **Conclusion**



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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 1.3 billion (FY 09/10)
- | Export share approx. 90 %
- | 7400 employees worldwide
- | Active business fields are test and measurement, secure communications, radio monitoring / radiolocation, broadcasting and services.



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# A strong platform for LTE deployment

WCDMA/HSPA and 1xRTT/EV-DO as basis for LTE

Mobile Broadband		GSA	
Commercial WCDMA networks	383	HSPA+ networks 3.5 Mbps or higher	31.3%
Countries WCDMA launched in	158	HSPA+ networks 7.2 Mbps or higher	60%
WCDMA 3G network (market share)	76.9%	HSPA+ devices launched	2,822
WCDMA subs (incl. HSPA) Q4 10	832 m	HSPA+ devices launched	92
	531	Networks with HSPA+ launched	1,35%
	186	HSPA+ devices launched	845
	>70%	HSPA+ network commitments	148
HSPA network commitments	478	HSPA+ network commitment countries	67
Commercial HSPA networks	380	HSPA+ networks launched	103
Countries HSPA launched in	155	LTE network commitments	128
Top WCDMA network	42%	LTE network commitment countries	52
	25	Additional pre-commitment network trials	52
	526	LTE networks launched	17
		Dual-mode HSPA-LTE devices	27

**309 commercial C2K 1xRTT networks in 121 countries.**

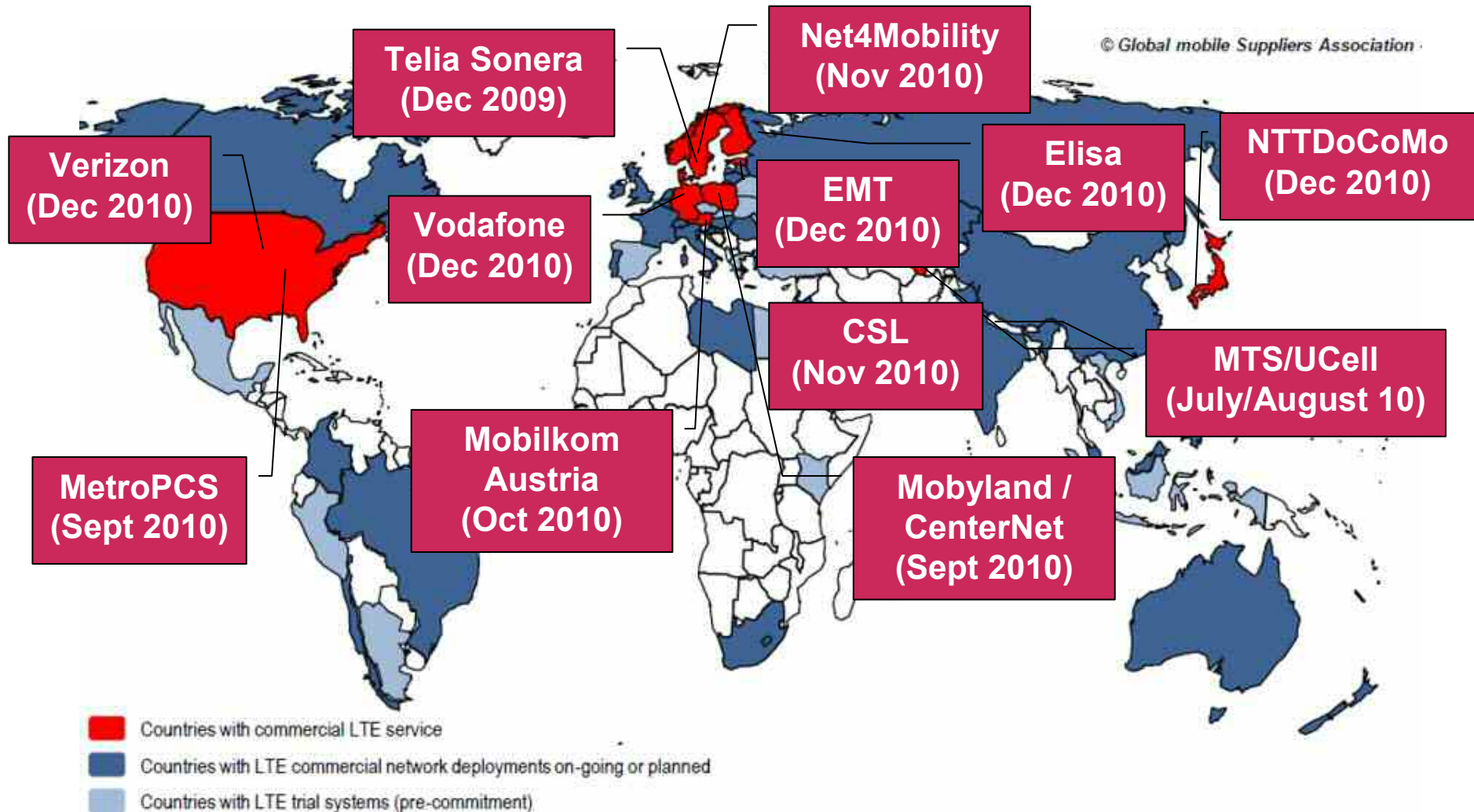
**564 mio. 1xRTT subscribers, 149 mio. 1xEV-DO subscription.**

**120 commercial 1xEV-DO Rel. 0 networks in 66 countries, 120 commercial 1xEV-DO Rev. A networks in 56 countries, 3 commercial 1xEV-DO Rev. B Networks.**

Source GSA and CDG, February 2011

# Commercial LTE Networks

17 commercial LTE systems are launched by end 2010



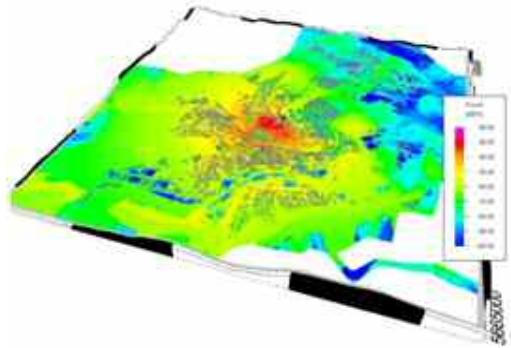
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# The LTE eco system from a T&M perspective

## Main areas of involvement



**Network operators preparing and launching LTE services install easy to use test equipment to assess performance in the lab and in the field.**

**Infrastructure providers need to verify their equipment during development, production and in the field ensuring time to market.**

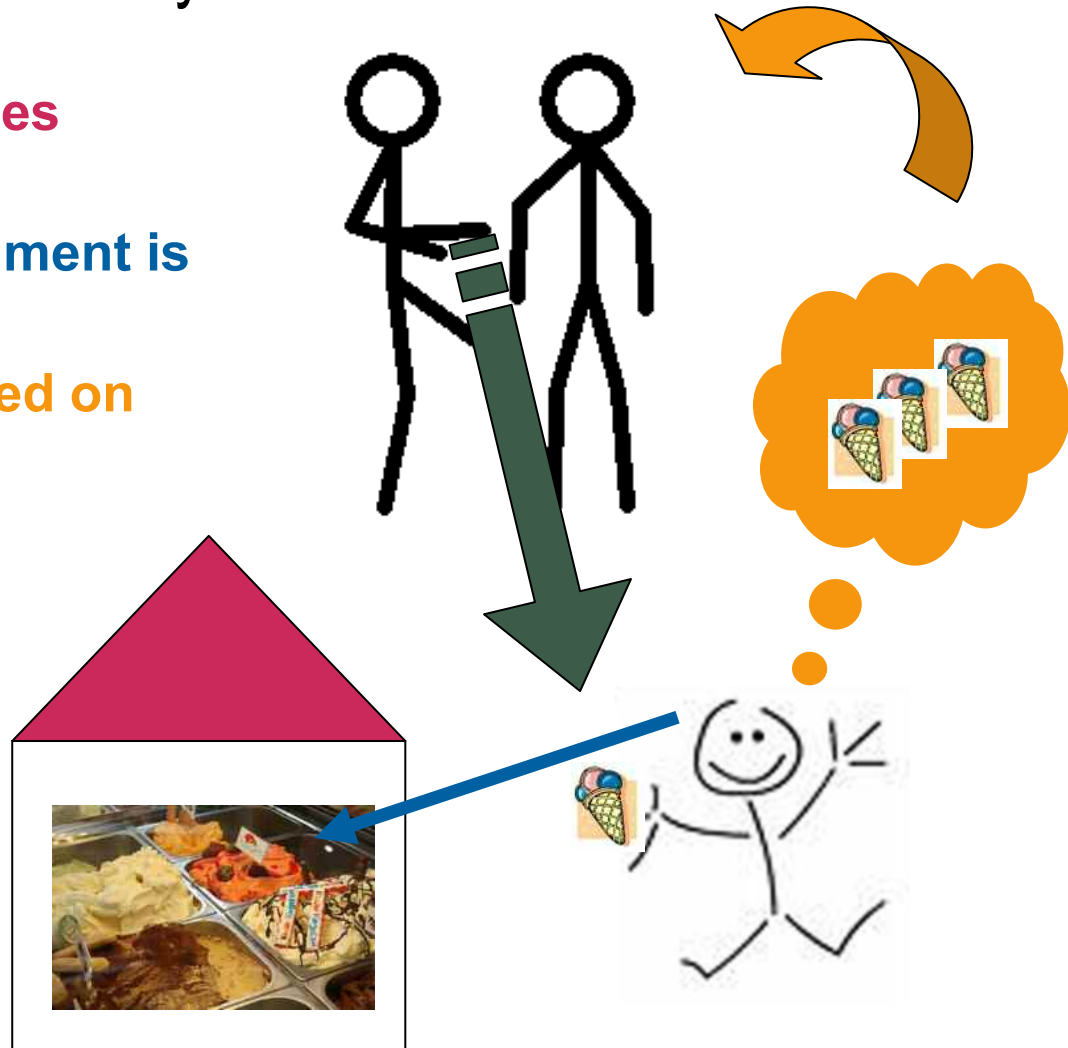


**Mobile device / Chip set industry starting volume production while at the same time continuously enhancing functionality, e.g. multiple RAT handover.**

# Accessing LTE performance in the field

Resource allocation in our daily life

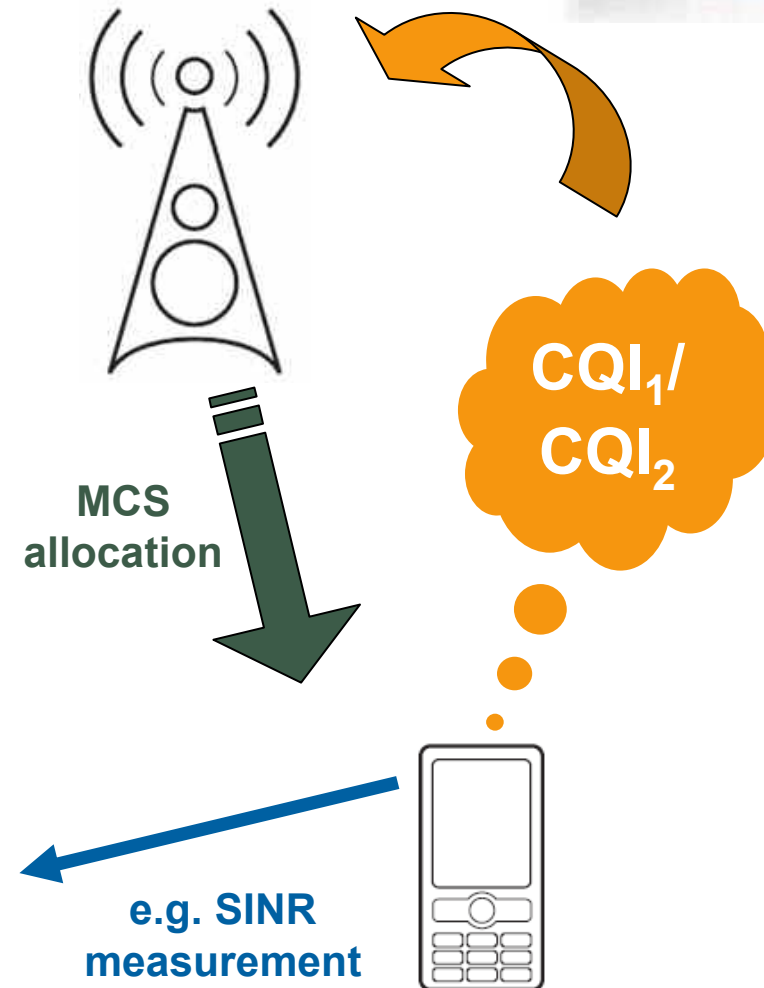
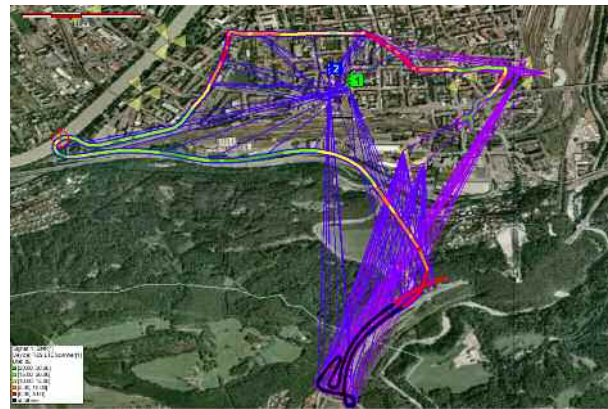
- I **Environment determines what is possible**
- I **Measuring the environment is important**
- I **Resource request based on what is possible**
- I **Resource allocation**
- I **LTE resource allocation is fairly similar!**



# Accessing LTE performance in the field

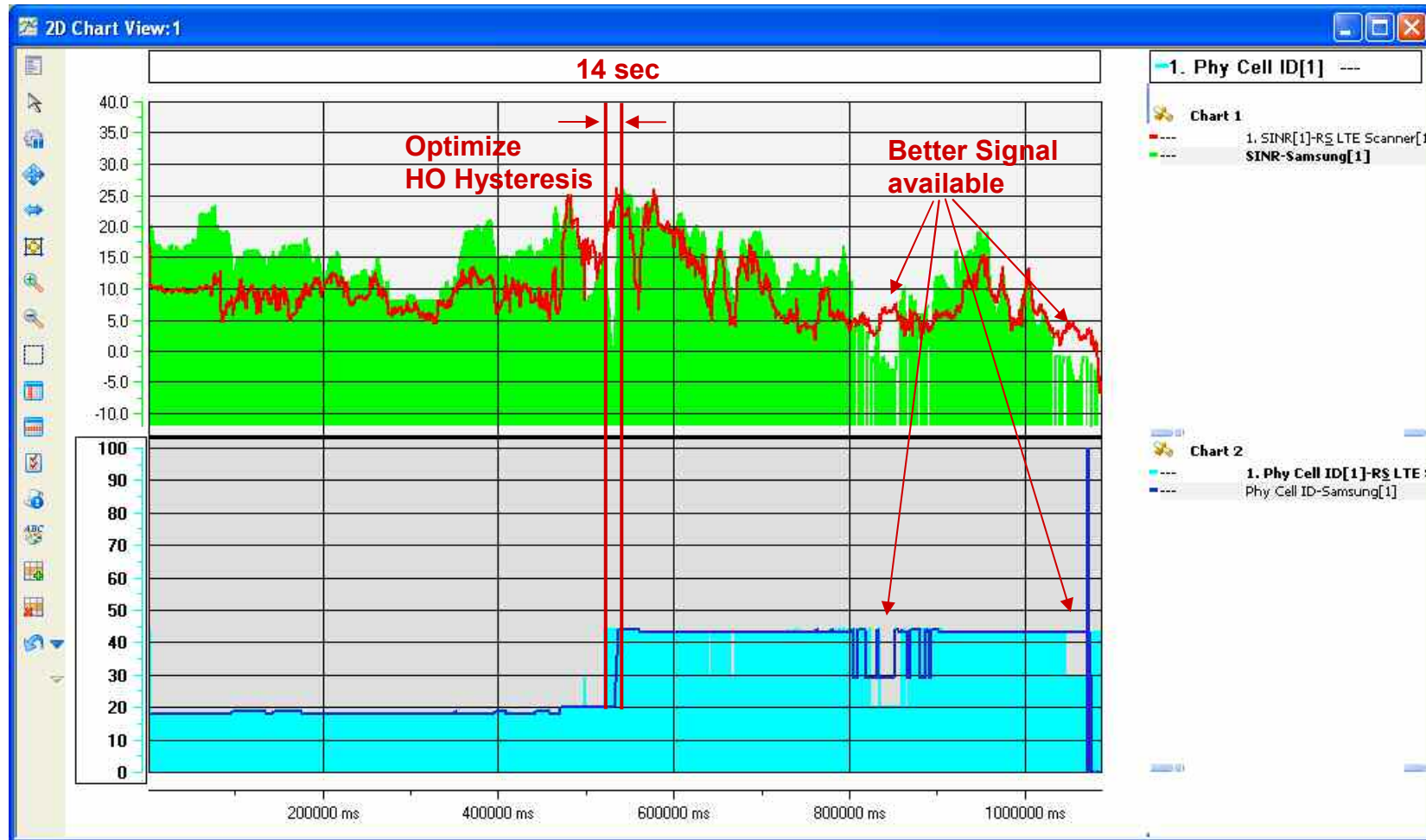
## Resource allocation in LTE

- I **Environment determines what is possible**
- I **Measuring the environment is important**
- I **Resource request based on what is possible**
- I **Resource allocation**



# Real life measurement example

## Handover Optimization



# Test Challenges for Infrastructure Providers

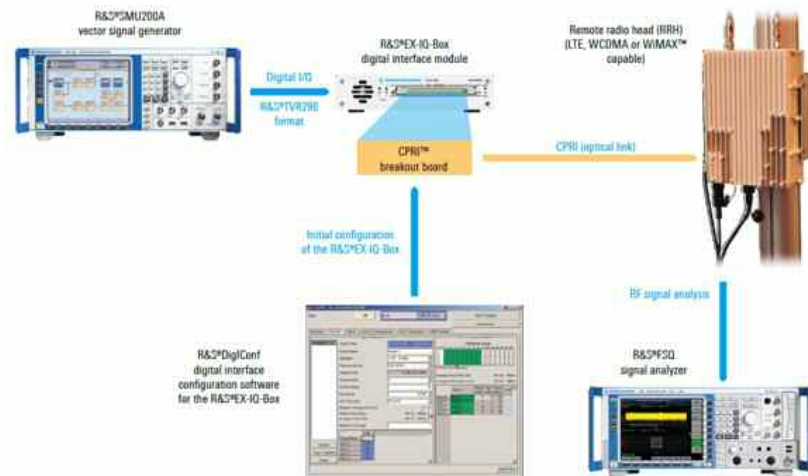
## Development

## Production

## Deployment

## Services

- MIMO / Beamforming
- RF characteristic verification
- Digital Interface (CPRI) testing
- UL timing adjustment
- HARQ process evaluation



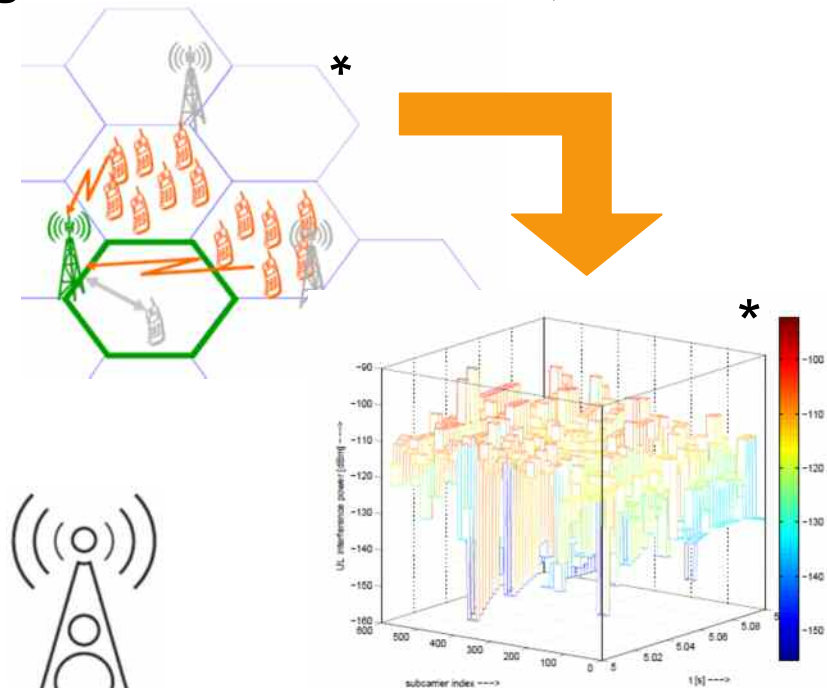
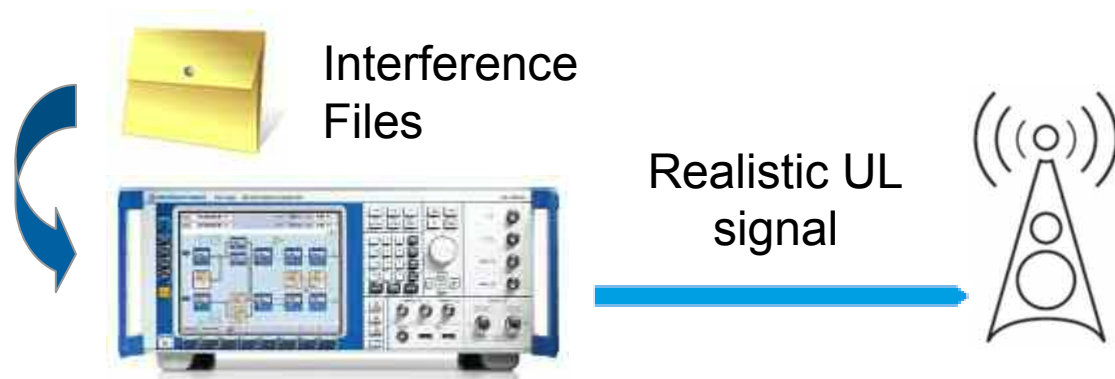
- Throughput performance verification under real life propagation conditions
- eNodeB scheduling algorithm verification
- KPI measurements (throughput, peak data rates, handover performance ..)



# Test Challenges for Infrastructure Providers

## Realistic eNodeB Receiver Testing in the Lab

- I eNodeB minimum performance is verified according to 3GPP specifications, i.e. TS 36.104/36.141 using fixed reference channels, multiple fading scenarios and noise, however...
- I Real life interference does not look like AWGN
- I It strongly depends on UE positions and varies over time



\* Source pictures:  

# 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 GCF certification
  - “16 December 2010: The Global Certification Forum (GCF) has extended its mobile device certification scheme to encompass LTE. From today, the GCF Certification process can be applied to LTE devices designed to operate in either the 700 MHz band or the 800 MHz European Digital Dividend band.”
- I Voice support

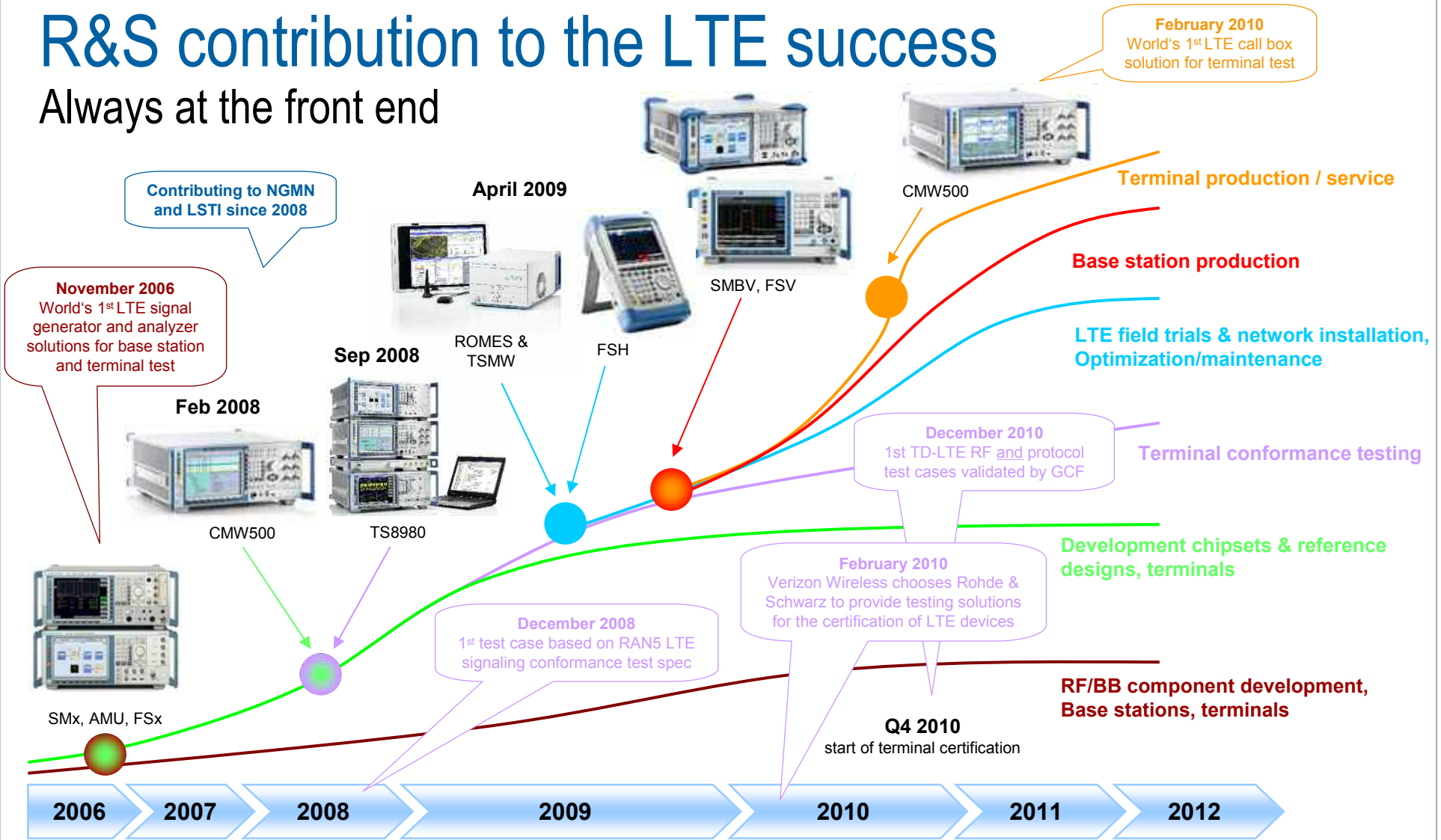
### I LTE network operator test plans

- I Developing/Verifying specific operator requirements



# R&S contribution to the LTE success

Always at the front end

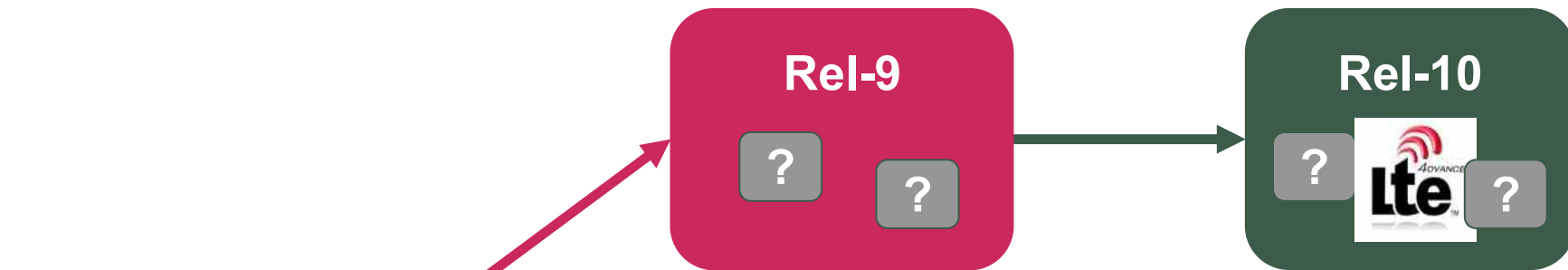


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# The LTE evolution path



## I Mainly the following 3GPP Release 9 features related to the air interface,

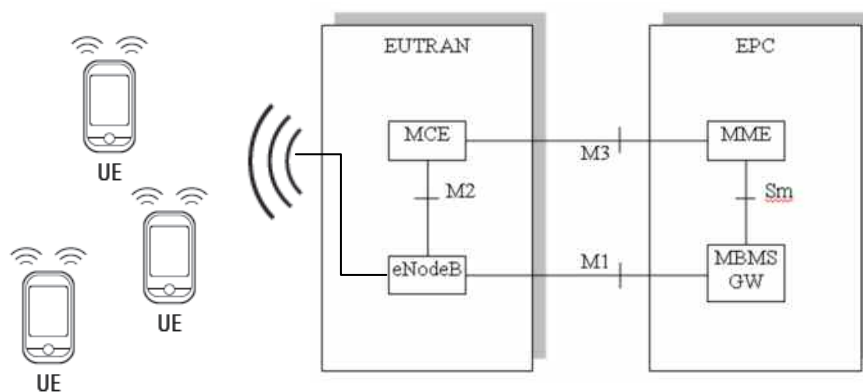
- I Multimedia Broadcast Multicast Services (MBMS) for LTE,
- I LTE MIMO: dual-layer beamforming,
- I LTE positioning
- I PWS (Public Warning System)
- I RF requirements for multi-carrier and multi-RAT base stations,
- I Home eNodeB specification (femto-cell),
- I Self-Organizing Networks (SON).

# LTE Release 9

## Enhanced Multimedia Broadcast Multicast Services

- MBMS is not new, it has been first specified in WCDMA with 3GPP Release 6,
  - Optimized transmission of broadcast / point-to-multipoint services,
  - MBSFN – Multimedia Broadcast multicast service Single Frequency Network is set up

- Impact on PHY layer, already available with 3GPP Release 8, higher layer and architectural aspects now with 3GPP Release 9,
  - Add. subcarrier spacing  $\Delta f = 7.5$  kHz,
  - Cyclic prefix = 33.3  $\mu$ s
  - 3 OFDM symbols per slot,
  - MBSFN subframes are divided into a MBSFN and non-MBSFN region,
  - Physical Multicast Channel (PMCH) carries MBMS user and control data,
  - Modified reference signal structure compared to common PDSCH transmissions.



# LTE Release 9

## Dual-layer beamforming

- I **3GPP Rel-8 – Transmission Mode 7 = beamforming with no UE feedback, using UE-specific reference signal pattern,**
  - I Estimate the position of the UE (Direction of Arrival, DoA),
  - I Pre-code digital baseband to direct beam at direction of arrival,
  - I **BUT** single-layer beamforming, only one codeword (TB),
  
- I **3GPP Rel-9 – Transmission Mode 8 = beamforming with or without UE feedback, using UE-specific reference signal pattern, but dual-layer,**
  - I Mandatory for TDD, optional for FDD,
  - I 2 (new) reference signal pattern for two new antenna ports 7 and 8,
  - I New DCI format 2B to schedule transmission mode 8,
  - I Performance test in 3GPP TS 36.521 Part 1 (Rel-9) are adopted to support testing of transmission mode 8.

# LTE Release 9

## LTE positioning / PWS

### **I The standard positioning methods supported for E-UTRAN access are:**

- I** network-assisted GNSS (Global Navigation Satellite System) methods
- I** downlink positioning (OTDOA – Observed Time Difference Of Arrival)
- I** enhanced cell ID method

### **I PWS extends the Warning System support of the E-UTRA/E-UTRAN beyond that introduced in the Release 8 ETWS (Earthquake and Tsunami Warning System) by providing**

- I** multiple parallel warnings, repeated warnings (2 seconds up to 24 hours), replacing/cancelling of warnings



# LTE Release 9

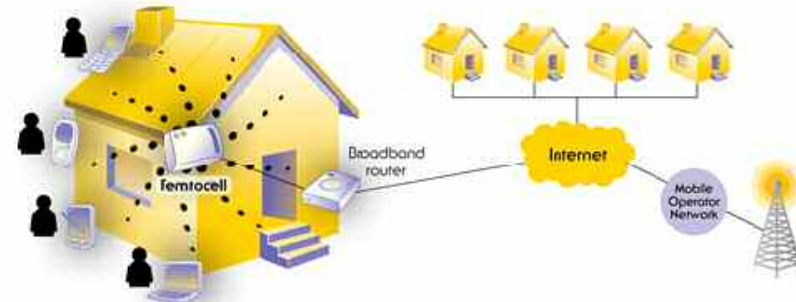
## Multi-carrier + multi-RAT base stations / home eNodeB (femto)

WCDMA/  
HSPA+



GSM/  
EDGE

LTE



- I Multi-carrier and Multi-Standard Radio (MSR) base stations,
- I New specification (3GPP TS 37.104) to clarify which RF requirements have to be supported by these base stations,
  - I Category 1 – E-UTRA FDD and UTRA FDD,
  - I Category 2 – E-UTRA FDD, UTRA FDD, GSM/EDGE,
  - I Category 3 – E-UTRA TDD, UTRA-TDD,

- I Specification of different base station classes (wide area, local area, home BS), basically providing RF requirements for FDD and TDD,
  - I Transmitter: e.g. BS output power, unwanted emissions, frequency error
  - I Receiver: e.g. sensitivity, dynamic range, blocking

# LTE Release 9

## 3GPP RAN#50 – Completion Level Overview



Feature		Core Specs (RAN1-4)	UE Tests (RAN5) Conformance Aspects
Rel 9	MBMS for LTE	100%	0%
	Dual-layer Beamforming	100%	5%
	LTE Positioning	100%	60%
	Multi Carrier Multi RAT Base Station	100%	-
	Home eNodeB	100%	30%
	SON	100%	-

- I Main area of implementation activity at the moment
- I Some interest existing

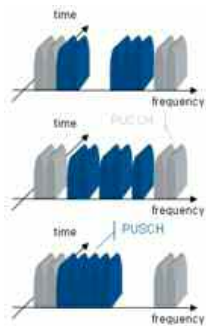
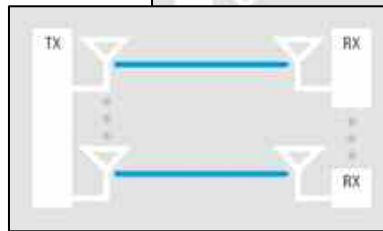
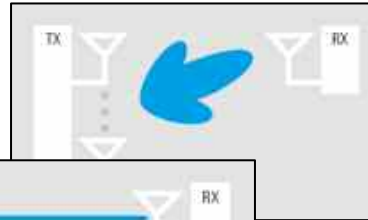


# LTE-Advanced

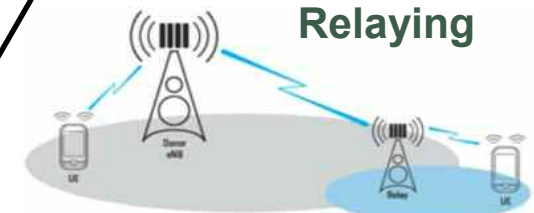
## Feature overview

MIMO (DL) 8x8

MIMO (UL) 4x4



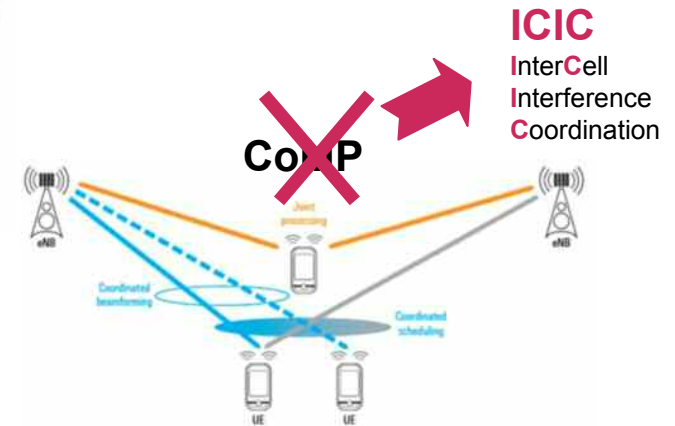
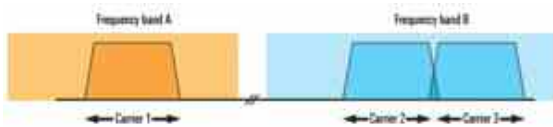
Enhanced  
SC-FDMA



Relaying



Carrier Aggregation



ICIC  
InterCell  
Interference  
Coordination

# LTE-Advanced

## 3GPP RAN#50 – Completion Level Overview



Feature		Core Part (RAN1-4)	Perf. Part (RAN4)	UE Tests (RAN5) Conformance Aspects
Rel 10	Carrier Aggregation for LTE	85%	20%	
	Enhanced Downlink Multiple Antenna Transmission for LTE	95%	10%	
	UL multiple antenna transmission for LTE	85%	25%	
	Relays for LTE	65%	5%	
	Enhanced ICIC for non-CA based deployments of heterogeneous networks for LTE	75%	20%	
	SON enhancements	80%	-	
	Further enhancements for MBMS	80%	-	

- I Feature prioritization in the market is ongoing
- I As in WCDMA/HSPA carrier aggregation is helping in divers operator spectrum allocations, however also places challenges to the terminal implementation

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# Conclusion

**Rapid deployment of commercial LTE systems!**

**Challenges like verifying LTE performance in the field, multi RAT / multi frequency band support and voice support require efficient test solutions.**

**First improvements in LTE Release 9 are already on various roadmaps and will be introduced soon.**

**R&S provides a comprehensive LTE test portfolio!**



**Thank you  
for your attention!**

