

LTE – What's next

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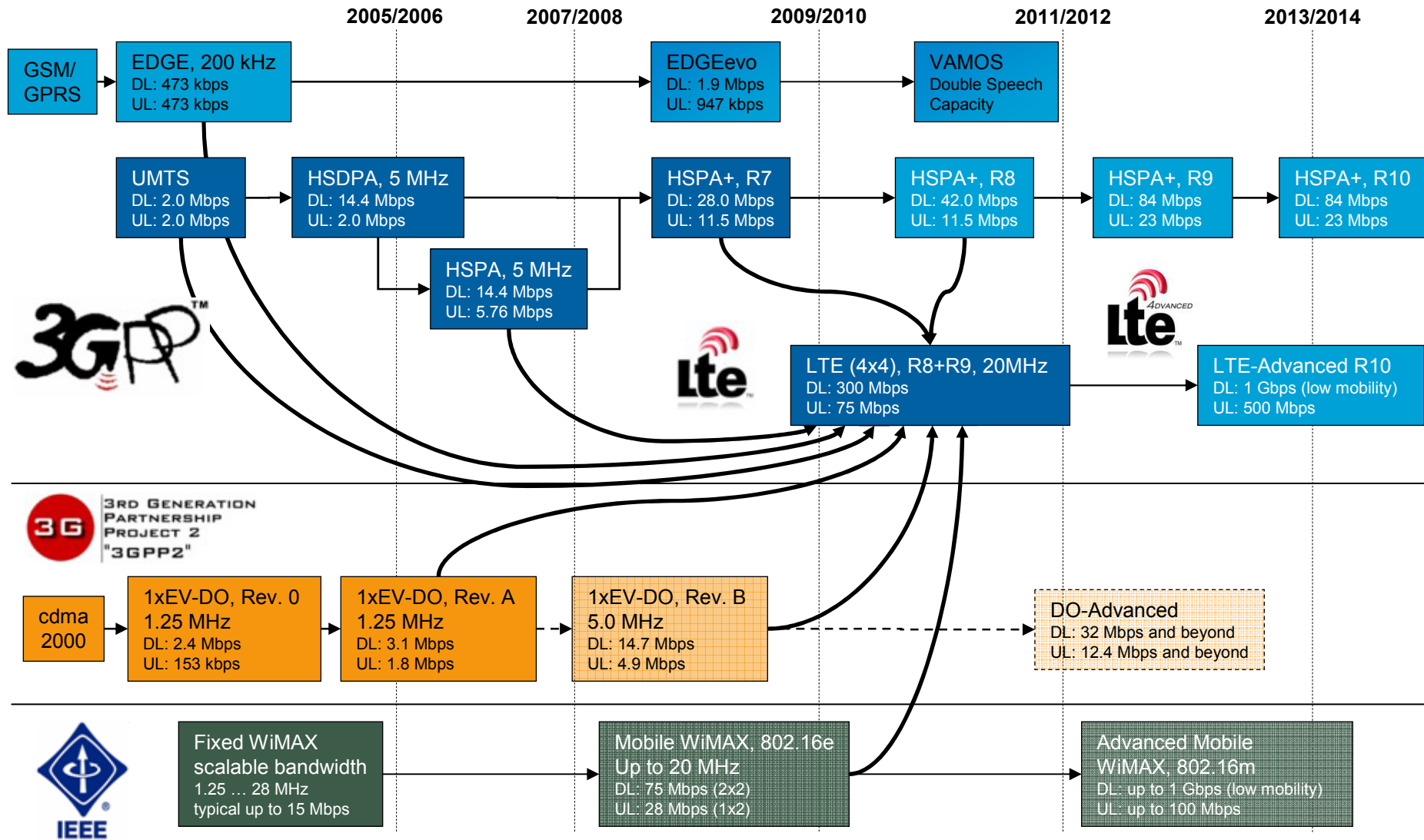
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ROHDE & SCHWARZ

Technology Evolution Path



A strong platform for LTE deployment

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

Commercial EDGE networks	531	HSDPA devices launched	3,071
Countries EDGE launched in	196	HSPA+ devices launched	144
HSPA networks with EDGE	> 72%	HSUPA devices launched	1,069
Commercial WCDMA networks	400	HSPA+ network commitments	173
WCDMA subs (incl. HSPA) Q4 10	632 m	HSPA+ network commitment countries	77
HSPA network commitments	429	HSPA+ networks launched	123
Commercial HSPA networks	398	Commercial HSPA networks with HSPA+	30%
Countries HSPA launched in	160	Countries with commercial HSPA+ networks	65
Live WCDMA networks with HSPA	99.5%	LTE network commitments	154
HSPA subs (Q4 10)	342 m	LTE network commitment countries	60
HSPA networks min. 7.2 Mbps DL	68%	Additional pre-commitment network trials	54
Networks with HSUPA launched	39%	LTE networks launched	20
UMTS900 networks launched	32	LTE user devices announced	98
UMTS900-HSPA devices	618	Dual-mode HSPA-LTE devices	53

Source GSA and CDG, May 2011

A strong platform for LTE deployment

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

561 mio. 1xRTT & 1xEV-DO Rev0 & 1xEV-DO RevA subscribers (Q3/10)

365 commercial C2K 1xRTT & 1xEV-DO networks in 125 countries/territories.

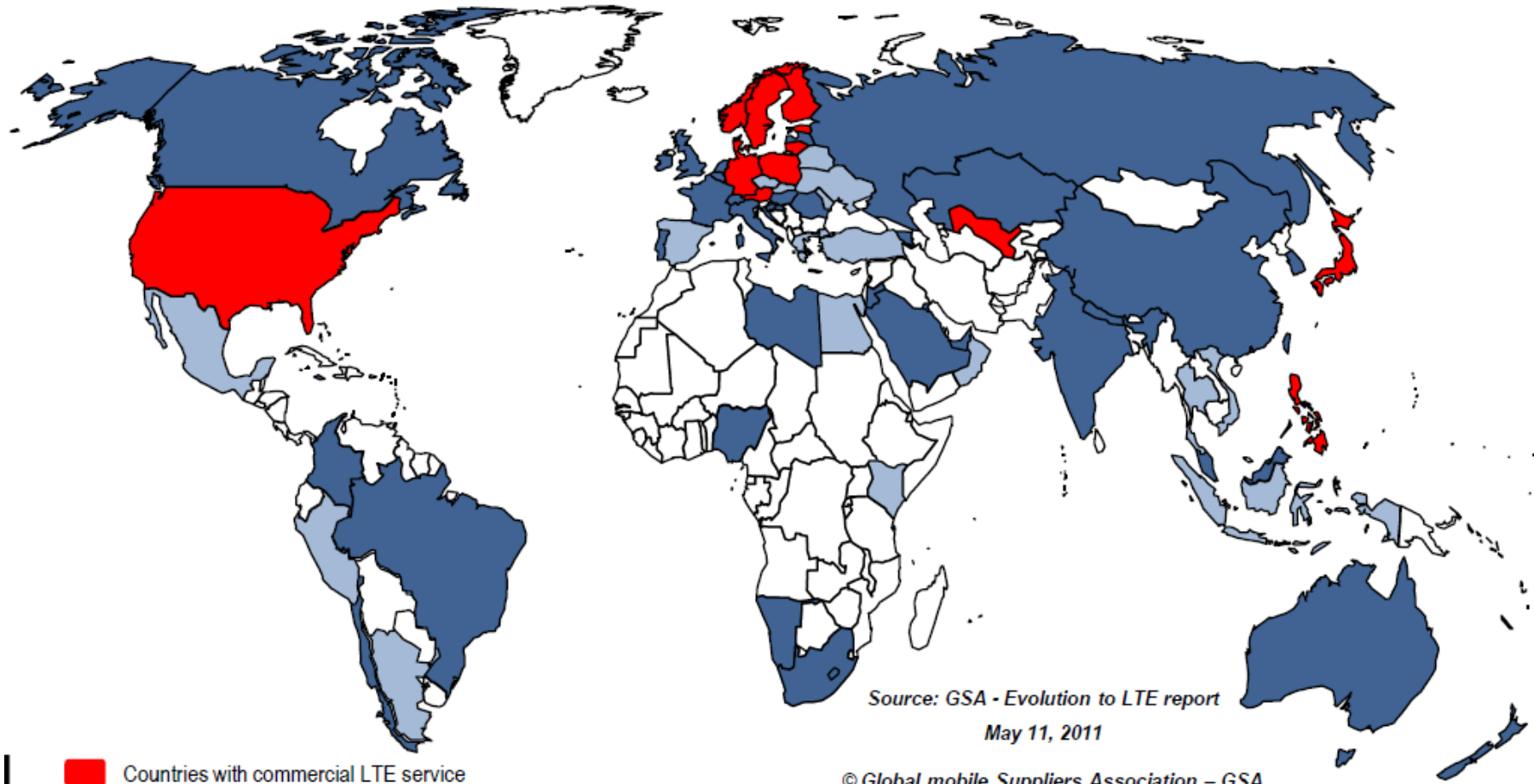
HSPA networks with EV-DO Rev. A	531	HSPA networks launched	144
Commercial WCDMA networks	196	HSPA devices launched	1,069
WCDMA subs (incl. HSPA) Q4 10	> 72%	HSPA+ network commitments	173
HSPA network commitments	400	HSPA+ network commitment countries	77
Commercial HSPA networks	632 m	HSPA+ networks launched	123
Countries HSPA launched	429	3 commercial 1xEV-DO Rev. B networks in 3 countries	30%
Networks with HSUPA launched	398	LTE network commitments	65
UMTS900 networks launched	160	LTE network commitment countries	154
UMTS900-HSPA devices	5%	Additional pre-commitment network trials	60
	2 m	LTE networks launched	54
	8%	LTE user devices announced	20
	39%	Dual-mode HSPA-LTE devices	98
	32		53
	618		




120 commercial 1xEV-DO Rel. 0 networks in 67 countries, 122 commercial 1xEV-DO Rev. A networks in 57 countries,

Source GSA and CDG, May 2011

Introduction

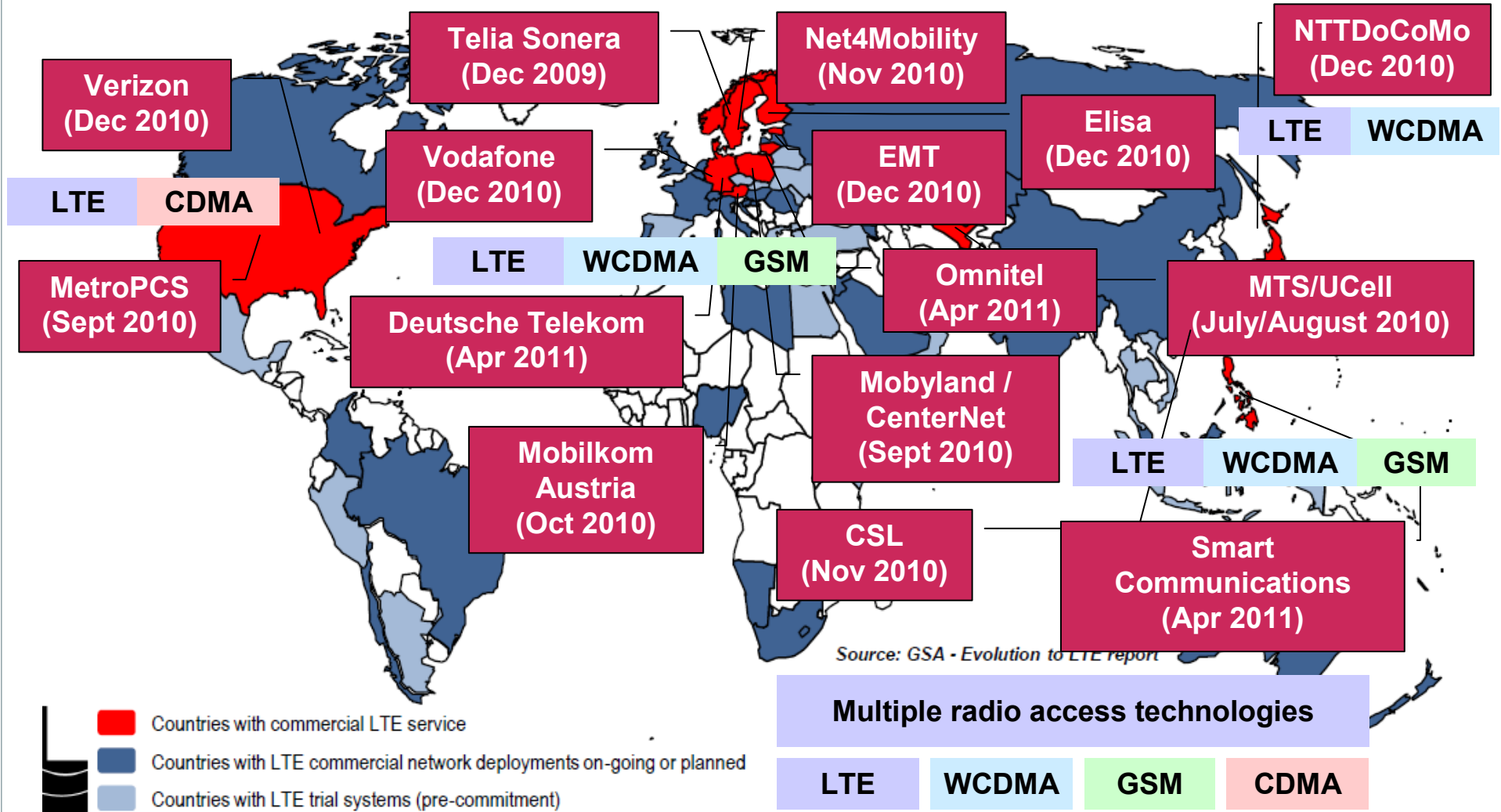
20 commercial LTE networks launched by end Q1/2011



-  Countries with commercial LTE service
-  Countries with LTE commercial network deployments on-going or planned
-  Countries with LTE trial systems (pre-commitment)

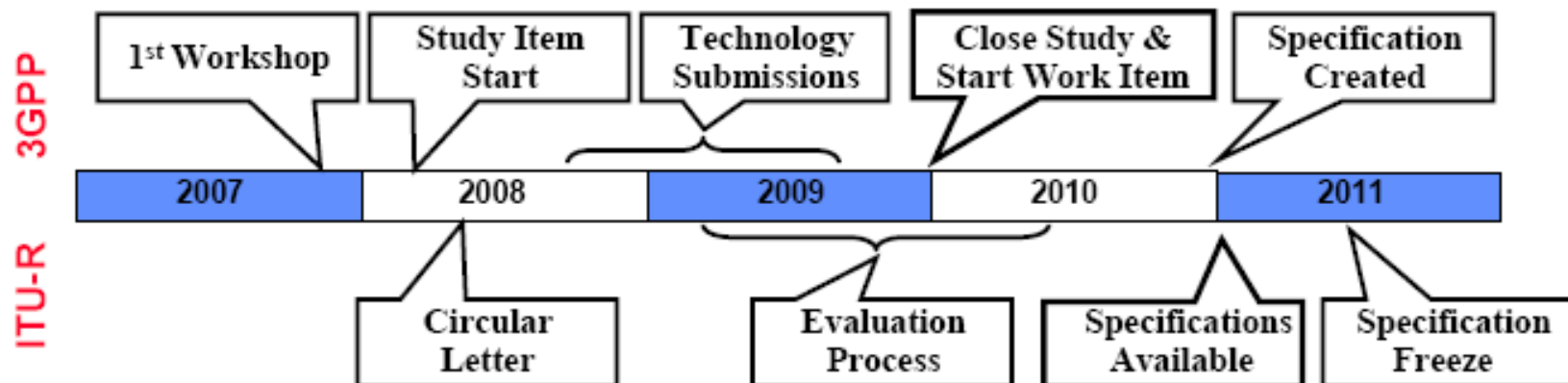
Introduction

20 commercial LTE networks launched by end Q1/2011

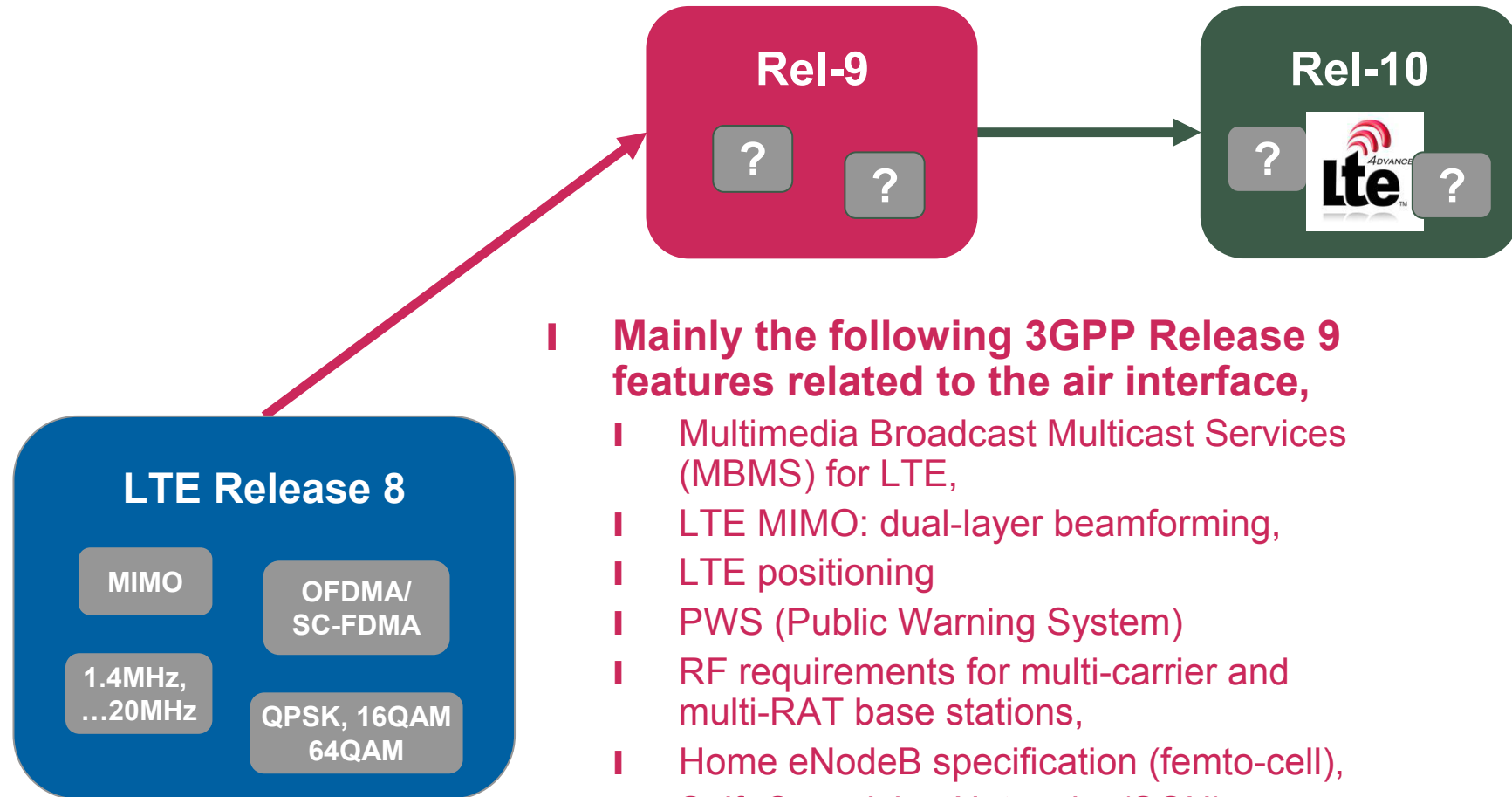


3GPP Release 10 and ITU Schedule

- I **The ITU has coined the term IMT-Advanced to identify mobile systems whose capabilities go beyond those of IMT 2000.**
 - I Enhanced peak data rates to support advanced services and applications, 100 Mbit/s for high and 1 Gbit/s for low mobility were established as targets for research,
- I **A major reason for aligning LTE-Advanced with the call for IMT-Advanced is that IMT conformant systems will be candidates for future new spectrum bands.**



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

3GPP RAN#51 – Completion Level Overview



Feature		Core Specs (RAN1-4)	UE Tests (RAN5) Conformance Aspects
Rel 9	MBMS for LTE	100%	5%
	Dual-layer Beamforming	100%	70%
	LTE Positioning	100%	50%
	Multi Carrier Multi RAT Base Station	100%	-
	Home eNodeB	100%	20%
	SON	100%	-

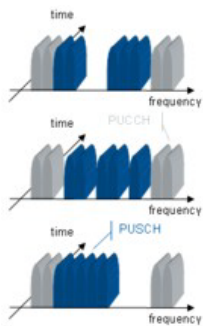
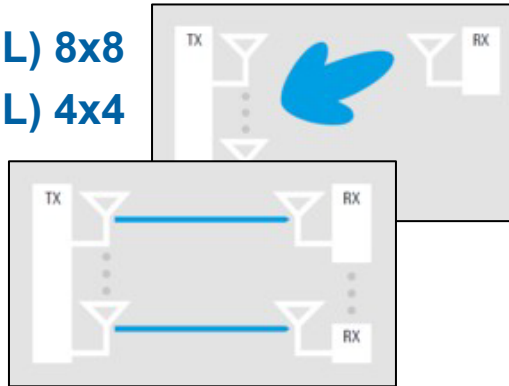
- I Main area of implementation activity at the moment
- I Some interest existing



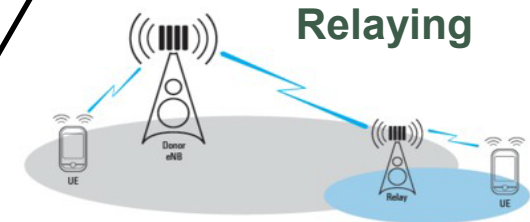
LTE-Advanced

Feature overview

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



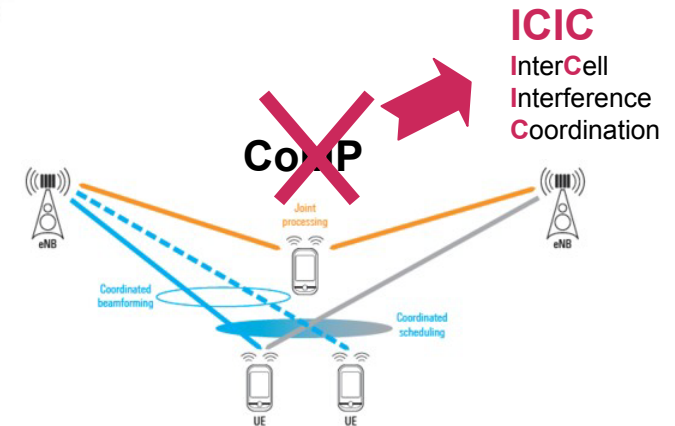
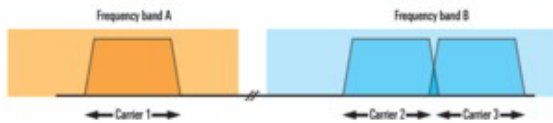
Enhanced
SC-FDMA



Relaying



Carrier Aggregation

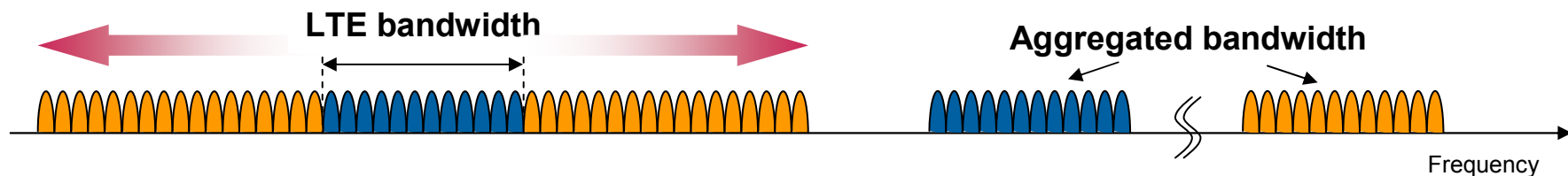


ICIC
InterCell
Interference
Coordination

LTE-Advanced

Carrier Aggregation

- I Two or more component carriers are aggregated in LTE-Advanced in order to support wider bandwidths of up to 100 MHz,
 - Support for contiguous and non-contiguous component carriers,



- Each component carrier limited to a maximum of 100 RB (20 MHz) using the 3GPP Release 8 numerology (means at maximum 5 carriers, each 20 MHz),
 - The following carrier aggregation scenarios shall be considered when appraising the feasibility of the RF scenarios and parameters:
 - Intra- and Inter-band with contiguous and non-contiguous component carrier operation,
- I Challenges for a “100-MHz terminal”,
 - Commercially available RF filter for 100 MHz bandwidth,
 - Commercially available ADC in terms of sampling rates and quantization rates,
 - Channel decoding and soft buffer size,

LTE-Advanced

Carrier Aggregation – Specification Work

- I Due to time constraints within 3GPP standardization (RAN4 being the responsible working group) the following scenarios will be worked on first,
- I Intra band is prioritized over inter band,
- I Additional scenarios may be added at a later stage (release independent).

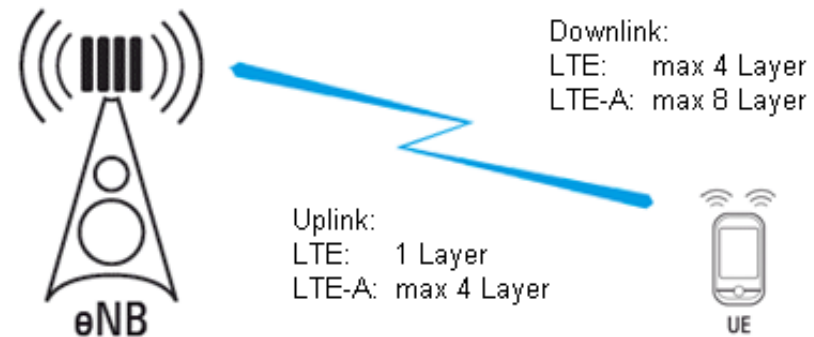
Intra band CA operating bands				
E-UTRA CA Band	E-UTRA Band	Uplink (UL) operating band	Downlink (DL) operating band	Duplex Mode
CA_1	1	1920 – 1980 MHz	2110 – 2170 MHz	FDD
CA_40	40	2300 – 2400 MHz	2300 – 2400 MHz	TDD

Inter band CA operating bands				
E-UTRA CA Band	E-UTRA Band	Uplink (UL) operating band	Downlink (DL) operating band	Duplex Mode
CA_1-5	1	1920 – 1980 MHz	2110 – 2170 MHz	FDD
	5	824 – 849 MHz	869 – 894 MHz	

LTE-Advanced

Enhanced MIMO Schemes

- I Up to 8x8 MIMO in downlink
- I Up to 4x4 MIMO in uplink



- I In addition the downlink reference signal structure has been enhanced compared with LTE Release 8 by
 - I reference signals targeting PDSCH demodulation
 - UE specific, i.e. an extension to multiple layers of the concept of Release 8 UE-specific reference signals used for beamforming
 - I reference signals targeting channel state information (CSI) estimation for CQI/PMI/RI/etc reporting when needed
 - cell specific, sparse in the frequency and time domain and punctured into the data region of normal subframes

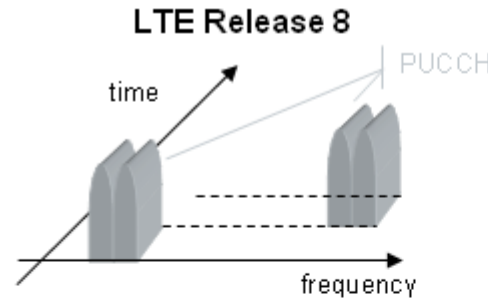
**4Tx in UL postponed
to Release 11**

LTE-Advanced

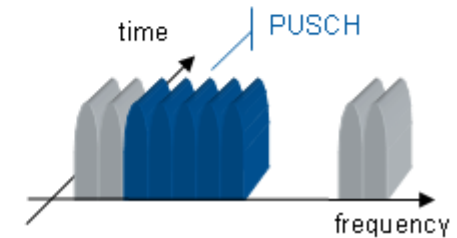
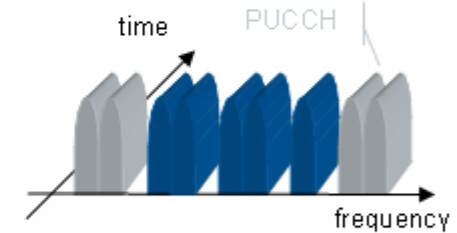
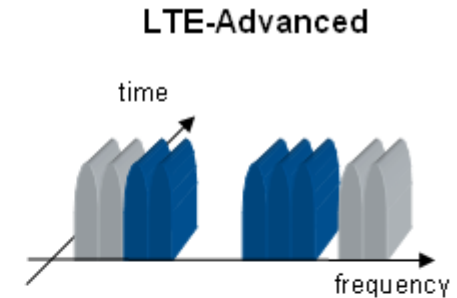
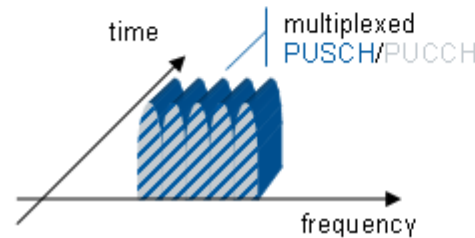
Enhanced uplink SC-FDMA



- I The uplink transmission scheme remains SC-FDMA.
- I The transmission of the physical uplink shared channel (PUSCH) uses DFT precoding.
- I Two enhancements:
 - I Control-data decoupling
 - I Non-contiguous data transmission



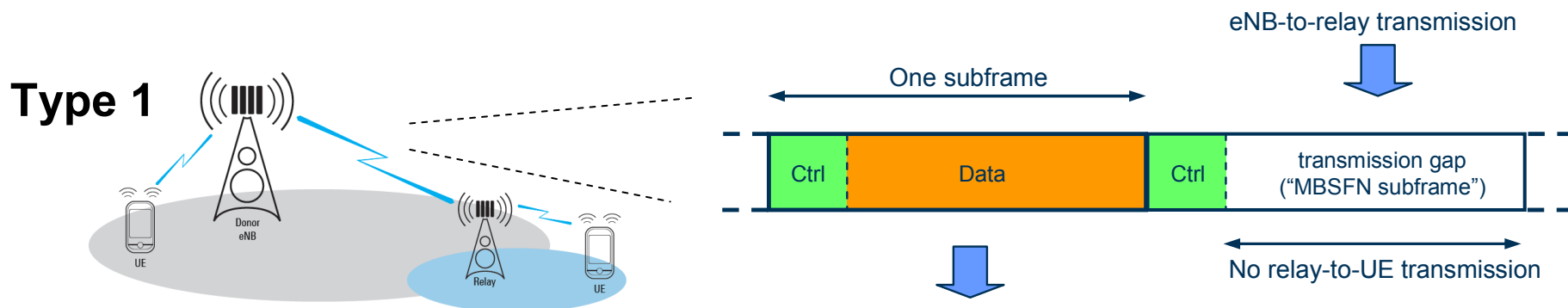
Either PUCCH only at both edges of UL channel bandwidth or PUCCH multiplexed into PUSCH.



LTE-Advanced

Relaying

- I **LTE-Advanced extends LTE Release 8 with support for relaying in order to enhance coverage and capacity**
- I **Relay Node (RN) Type 1**
 - I terminates layer 2 and 3 protocols at the air interface
 - I Creates new cell with own identity
- I **3 realizations of Type 1 RNs**
 - I Outband (Type 1a)
 - I Inband with and without resource partitioning

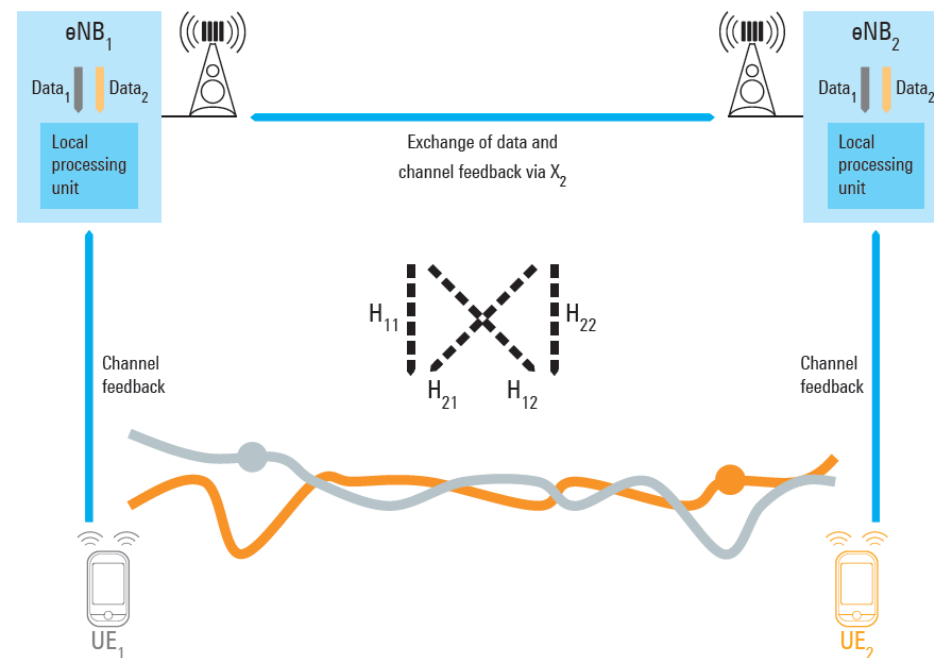


LTE-Advanced

CoMP – Distributed Cooperation Approach

Not in Release 10

- I In this two eNodeB example the goal is to crosswise eliminate the interference between the two cells
- I Modifications required on top of LTE Release 8
 - I Clock synchronization between eNodeBs
 - I Synchronous data exchange
 - I Cell specific pilots
 - I Channel feedback / Channel state information
 - I Precoded Pilots



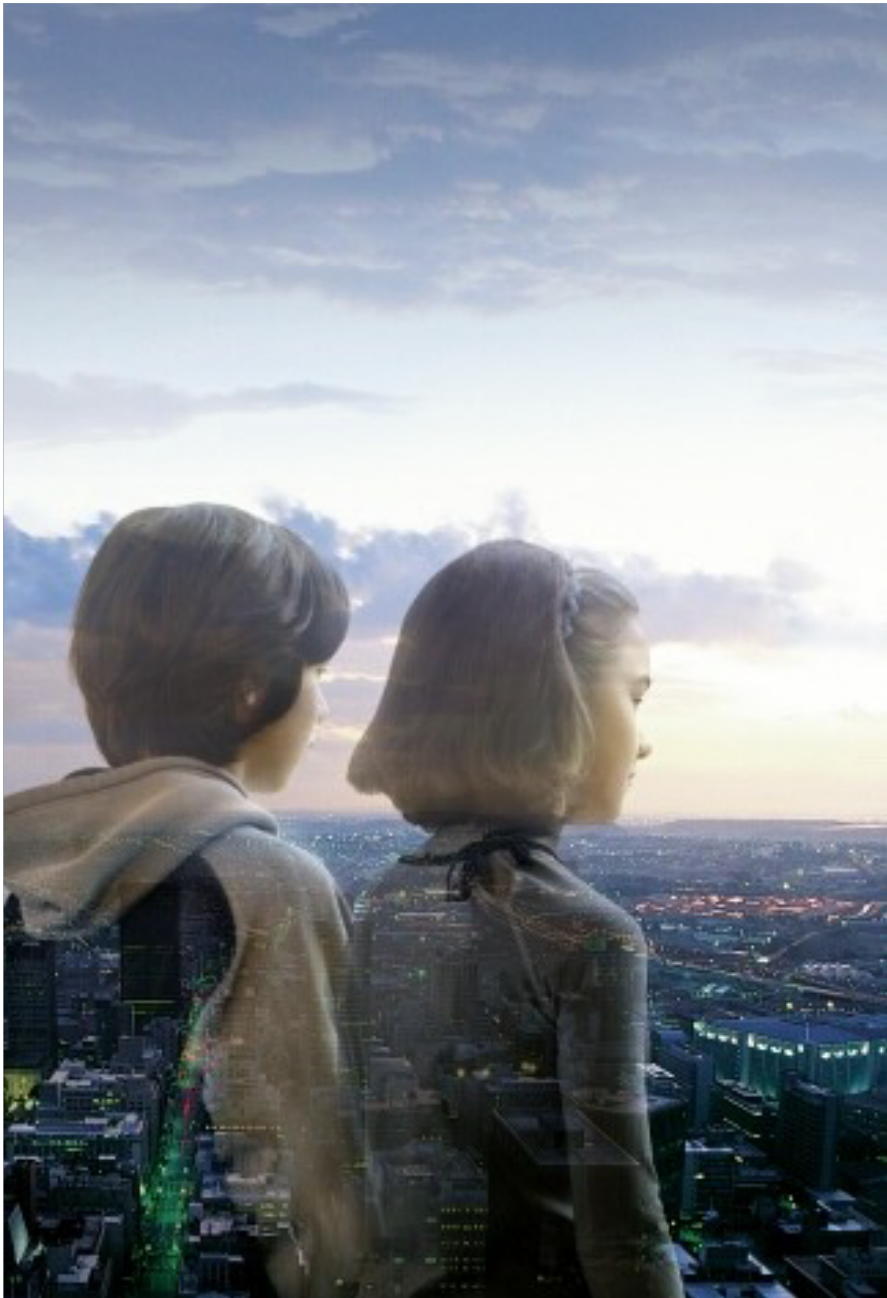
LTE-Advanced

3GPP RAN#51 – Completion Level Overview



Feature		Core Part (RAN1-4)	Perf. Part (RAN4)	UE Tests (RAN5) Conformance Aspects
Rel 10	Carrier Aggregation for LTE	90%	30%	
	Enhanced Downlink Multiple Antenna Transmission for LTE	100%	30%	
	UL multiple antenna transmission for LTE (4Tx postponed to Rel11)	95%	35%	
	Relays for LTE	83%	25%	
	Enhanced ICIC for non-CA based deployments of heterogeneous networks for LTE	95%	40%	
	Multi-standard radio BS RF requirements for non-contiguous spectrum deployments	90%	15%	
	SON enhancements	85%	-	
	Further enhancements for eMBMS	100%	-	





**Thank you
for your attention!**



Read more...

1MA-169 Application Note

LTE-Advanced Technology Introduction Application Note

Although the commercialization of LTE technology began in end 2008, the technology is still being enhanced in order to meet ITU-Advanced requirements. This application note summarizes these necessary improvements, which are known as LTE-Advanced.



LTE-Advanced
Main Catalog
03.2010 1M1192_16

1MA-166 Application Note

LTE-Advanced Signal Generation and -Analysis Application Note

Products:

- | R&S®SMU200A
- | R&S®SMBV100A
- | R&S®AMU200A
- | R&S®FSQ
- | R&S®FSG
- | R&S®FSV

This Application Note describes LTE-Advanced signal generation with spectrum aggregation in numerous configurations using one or more Vector Signal Generators R&S®SMU200A or R&S®SMBV100A. Various examples illustrate how to analyze these signals using the Vector Signal Analyzer R&S®FSQ, R&S®FSG or R&S®FSV.



Application Note
Rohde & Schwarz 02/2010 1M1166_06

Country	Operator	Expected launch
Norway	TeliaSonera	Launched 15.12.09
Sweden	TeliaSonera	Launched 15.12.09
Uzbekistan	MTS	Launched 28.07.10
Uzbekistan	Ucell	Launched 09.08.10
Poland	Mobyland and CenterNet	Launched 07.09.10
USA	MetroPCS	Launched 21.09.10
Austria	A1 Telekom Austria	Launched 05.11.10
Sweden	TeleNor Sweden	Launched 15.11.10
Sweden	Tele2 Sweden	Launched 15.11.10
Hong Kong	CSL Limited	Launched 25.11.10
Finland	TeliaSonera	Launched 30.11.10
Germany	Vodafone	Launched 01.12.10
USA	Verizon Wireless	Launched 05.12.10
Finland	Elisa	Launched 08.12.10
Denmark	TeliaSonera	Launched 09.12.10
Estonia	EMT	Launched 17.12.10
Japan	NTT DoCoMo	Launched 24.12.10
Germany	Deutsche Telekom	Launched 05.04.11
Philippines	Smart Communications	Launched 16.04.11
Lithuania	Omnitel	Launched 28.04.11
Armenia	Vivacell-MTS	2011
Australia	Telstra	2011
Australia	VHA	2011
Austria	T-Mobile	2011
Austria	Hutchison 3	2011
Canada	Telus	2011
Canada	Bell Canada	2011
Canada	Rogers Wireless	2011
Canada	Shaw Communications	2011
Colombia	UME EFM	2011
Denmark	3 Denmark	2011
Denmark	TDC	2011
Denmark	TeleNor	2011
Finland	DNA	2011
Germany	O2 (Telefonica)	2011
Hong Kong	PCGW	2011
Hungary	Magyar Telekom (T Mobile)	2011
India	Qualcomm India LTE Venture	2011
India	Reliance (LTE TDD)	2011
Ireland	Hutchison 3	2011
Japan	Emobile	2011
Japan	Softbank Mobile	2011
Jordan	Zain	2011
Poland	Aero2 (LTE TDD)	2011
Portugal	TMN	2011
Portugal	Vodafone Portugal	2011
Russia	Rostelecom	2011
Russia	Yota	2011
Saudi Arabia	Etisalat (Mobily)	2011
South Africa	Vodacom	2011
South Korea	LG Uplus	2011
South Korea	KT	2011
South Korea	SK Telecom	2011
Sweden	3	2011
Switzerland	Orange	2011
Switzerland	Swisscom	2011
UAE	Du	2011
UAE	Etisalat	2011
USA	Cox Comms	2011
USA	CenturyTel	2011
USA	AT&T Mobility	2011
USA	Aircell	2011
USA	BayRCS	2011
USA	Cellular South	2011
USA	Lightsquared	2011
USA	Mosaic Telecom	2011
USA	Leap Wireless	2011
USA	US Cellular	2011
Austria	Orange	2011-12
Andorra	Andorra Telecom	2012
Australia	Vivid Wireless (LTE TDD)	2012
China	China Mobile (LTE TDD)	2012
China	China Telecom	2012
Croatia	VIPNet	2012
France	Orange	2012
Japan	KDDI	2012

Malaysia	P1 Networks (LTE TDD)	2012
Nepal	Ncell	2012
Philippines	Globe	2012
Taiwan	Chunghwa Telecom	2012
Uruguay	Antel	2012
Malaysia	DiGi	2013
Monaco	Monaco Telecom	2013
Armenia	Armentel	To be confirmed
Armenia	Orange Armenia	To be confirmed
Australia	Optus	To be confirmed
Australia	EnergyAustralia	To be confirmed
Bahrain	Zain	To be confirmed
Belgium	Belgacom (Proximus)	To be confirmed
Brazil	Vivo	To be confirmed
Canada	MTS Allstream	To be confirmed
Canada	Sasktel	To be confirmed
Chile	Entel PCS	To be confirmed
Chile	Movistar	To be confirmed
Croatia	Hrvatski Telekom	To be confirmed
Estonia	Elisa	To be confirmed
Estonia	Tele2	To be confirmed
France	SFR	To be confirmed
Germany	E Plus	To be confirmed
Hong Kong	SmartOne-Vodafone	To be confirmed
Hong Kong	Hutchison 3	To be confirmed
Hong Kong	China Mobile	To be confirmed
Hungary	Telenor Magyarorszag	To be confirmed
India	Bharti Airtel (LTE TDD)	To be confirmed
India	Tikona Digital (LTE TDD)	To be confirmed
Italy	Telecom Italia	To be confirmed
Italy	Wind	To be confirmed
Jamaica	Claro	To be confirmed
Jersey	Clear Mobitel	To be confirmed
Kazakhstan	Kcell	To be confirmed
Kuwait	Zain	To be confirmed
Latvia	Bite	To be confirmed
Latvia	Tele2	To be confirmed
Latvia	LMT	To be confirmed
Libya	Al Madar	To be confirmed
Lithuania	Tele2	To be confirmed
Luxembourg	Orange	To be confirmed
Malaysia	Asiaspace	To be confirmed
Malaysia	U Mobile	To be confirmed
Namibia	Leo (Cell One)	To be confirmed
Netherlands	KPN	To be confirmed
Netherlands	Vodafone	To be confirmed
Netherlands	T Mobile	To be confirmed
Netherlands	Ziggo 4	To be confirmed
Netherlands	Tele2	To be confirmed
New Zealand	Telecom NZ	To be confirmed
New Zealand	Vodafone NZ	To be confirmed
Nigeria	Globacom	To be confirmed
Norway	Telenor	To be confirmed
Philippines	Piltel	To be confirmed
Poland	ERA	To be confirmed
Qatar	Otel	To be confirmed
Romania	Vodafone	To be confirmed
Russia	Svyazinvest	To be confirmed
Saudi Arabia	Zain	To be confirmed
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Singapore	M1	To be confirmed
Singapore	SingTel	To be confirmed
Singapore	StarHub	To be confirmed
South Africa	Cell C	To be confirmed
South Africa	MTN	To be confirmed
Sri Lanka	Dialog	To be confirmed
Sri Lanka	Mobitel	To be confirmed
Taiwan	Global Mobile (LTE TDD)	To be confirmed
Tunisia	Tunisiana	To be confirmed
UK	Vodafone	To be confirmed
UK	O2	To be confirmed
USA	Agri-Valley Broadband	To be confirmed
USA	Cellcom	To be confirmed
USA	T-Mobile USA	To be confirmed
USA	Comnet Wireless	To be confirmed
USA	NetAmerica Alliance	To be confirmed
USA	Texas Energy Network	To be confirmed
USA	Public Service Wireless	To be confirmed

154 LTE network commitments in 60 countries



www.gsacom.com

Country	Operator
Abkhaz	Aquafon
Argentina	Telefonica
Argentina	Personal
Belarus	BeST (Life)
Belarus	MTS
Belgium	Mobistar
Belgium	Telenet
Belgium	KPN Base
Bolivia	Entel Movil
Brazil	Oi
Brazil	Telefonica
Canada	Wind Mobile
Czech Republic	O2 (Telefonica)
France	Bouygues Telecom
Egypt	Vodafone
Egypt	Mobinil
Egypt	Etisalat Misr
Greece	Cosmote
Indonesia	Telkomsel
Indonesia	XL Axiata
Indonesia	Indosat
Latvia	Triatel
Lithuania	Bite
Kazakhstan	Vimpelcom
Kenya	Safaricom
Malaysia	Maxis
Malaysia	Celcom
Mexico	Telcel
Mexico	Telefonica
Moldova	Orange Moldova
Oman	Omantel
Paru	Telefonica
Poland	Poikomtel
Portugal	Optimus
Puerto Rico	Claro
Qatar	Vodafone Qatar
Russia	MTS
Russia	Vimpelcom
Russia	Tele2 Russia
Russia	MegaFon
Russia	OAO Voentelecom
Slovak Republic	O2 (Telefonica)
Slovak Republic	Orange
Spain	Telefonica
Spain	Vodafone
Thailand	DPC/AIS
Turkey	Turkcell
UK	Clear Mobitel
UK	Argva
Ukraine	MTS-Ukraine
USA	Clearwire
Vietnam	FPT Telecom
Vietnam	VDC (VNPT)
Vietnam	Viettel

54 pre-commitment trials

GSA Evolution to LTE report: May 11, 2011

