3GPP
LTE Radio Access Network

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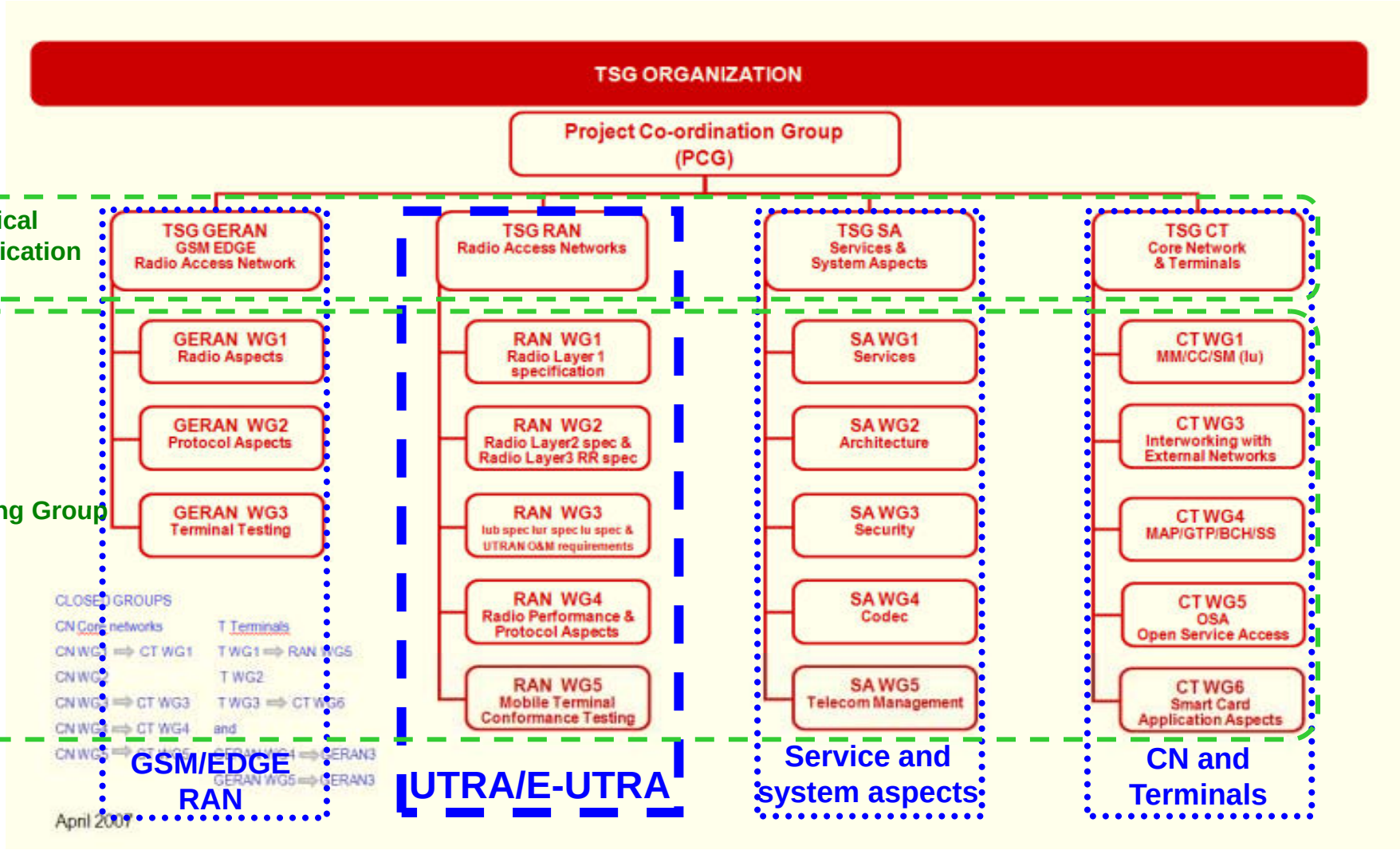
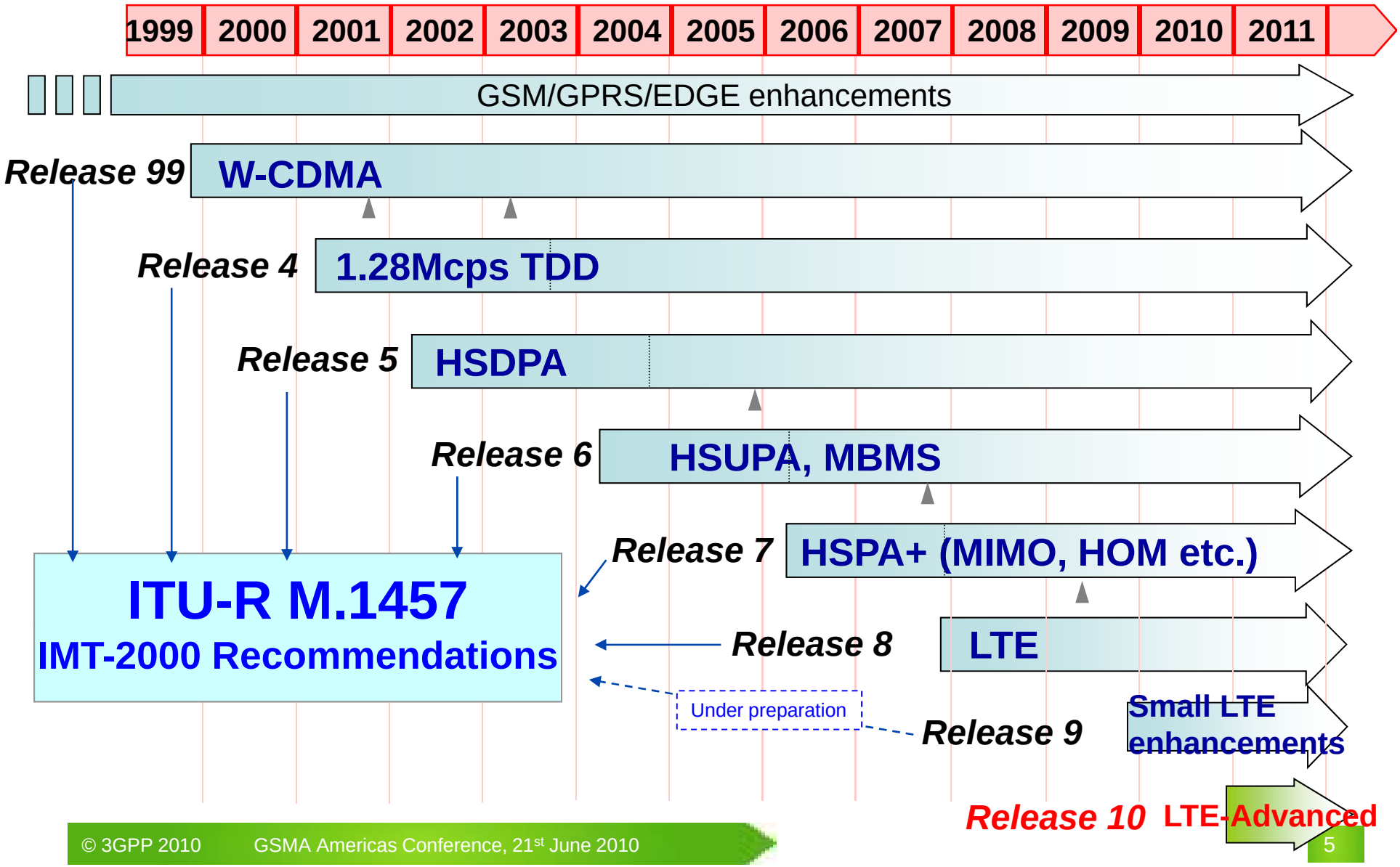
3GPP TSG-RAN
Standardization Activities

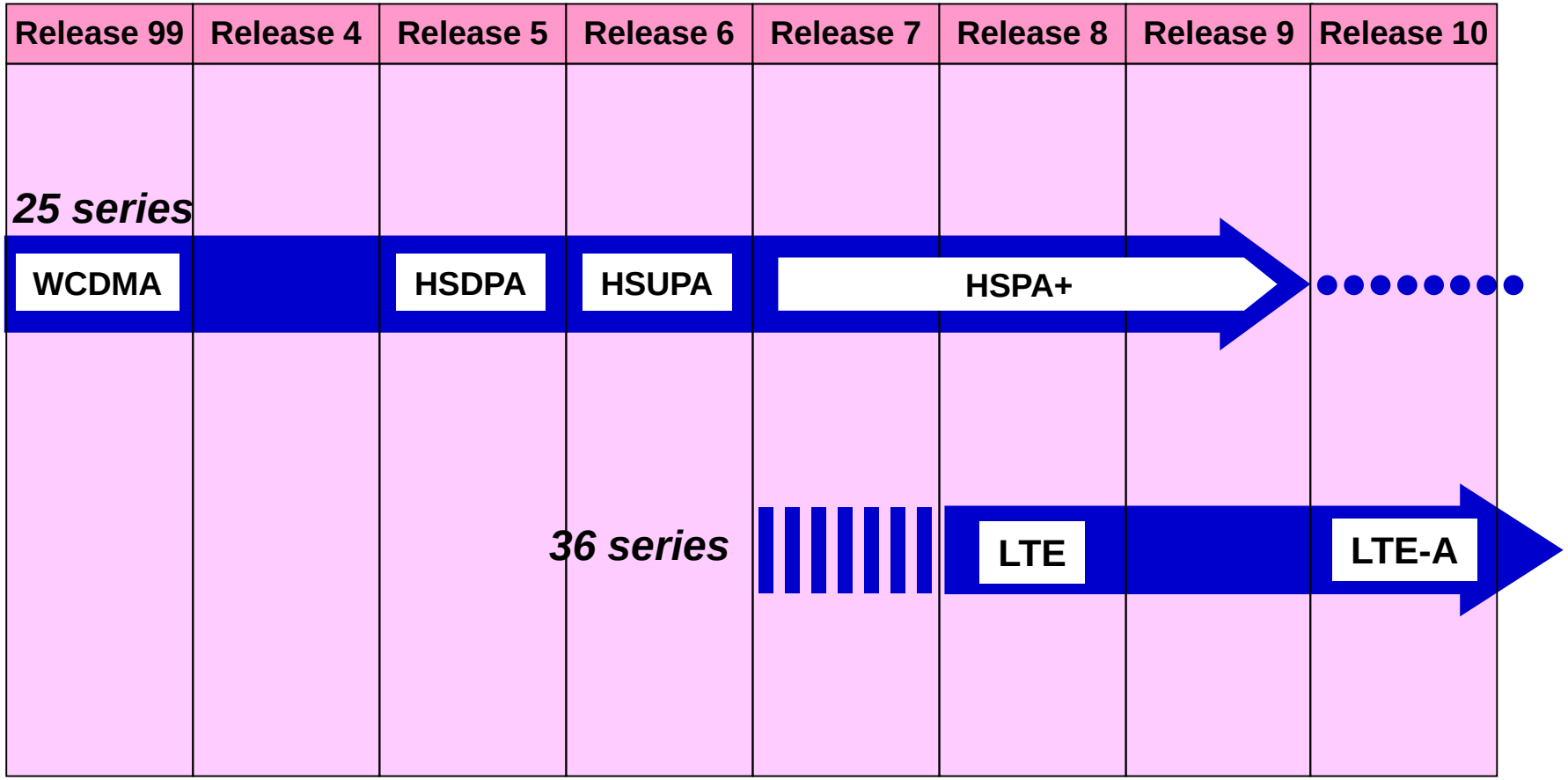
3GPP Structure



Release of 3GPP RAN specifications



Technology Evolution path of 3GPP TSG-RAN Standards

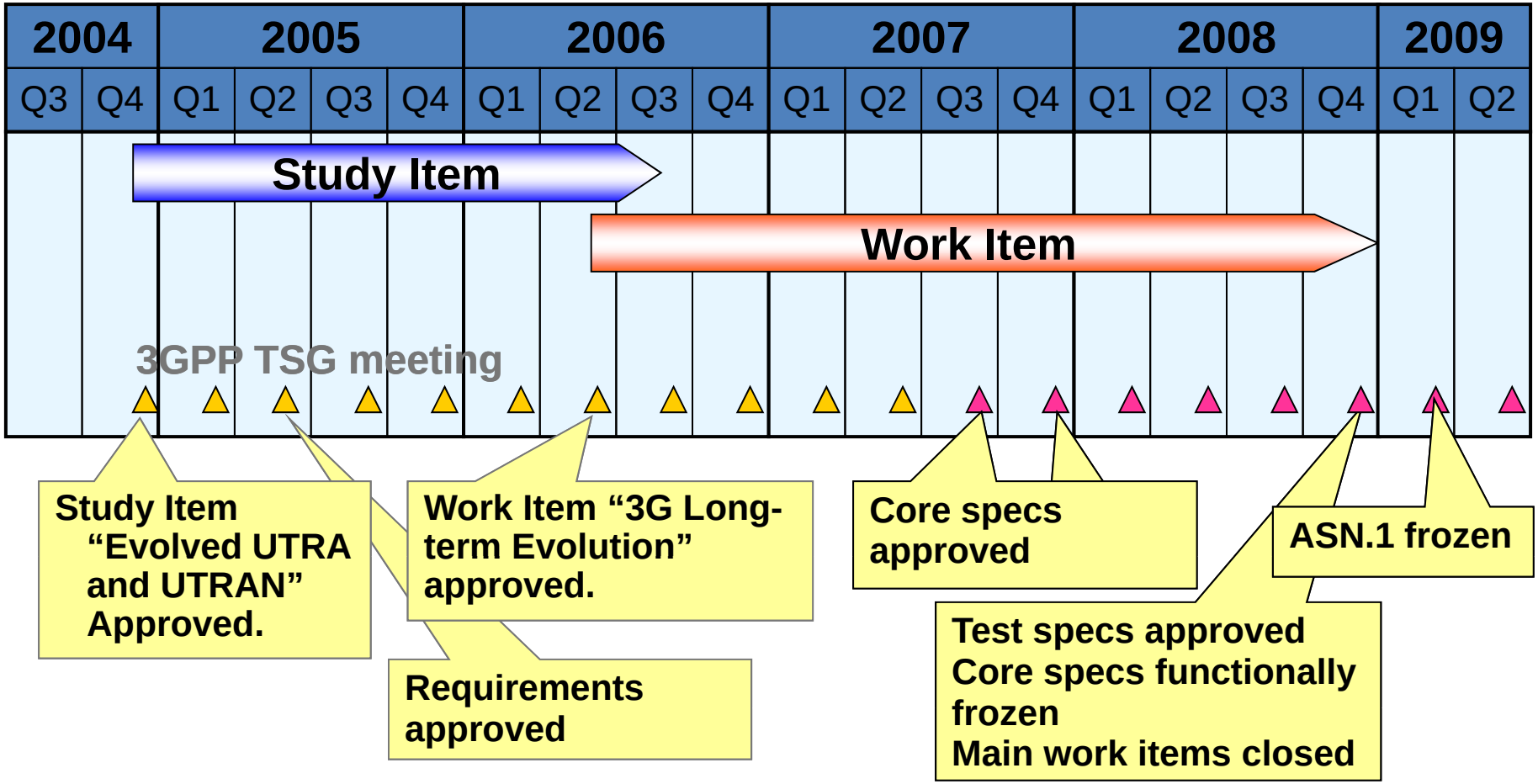


LTE Technical Overviews

Motivation of LTE Release 8

- Need to ensure the continuity of competitiveness of the 3G system for the future
- User demand for higher data rates and quality of services
- PS optimised system
- Continued demand for cost reduction (CAPEX and OPEX)
- Low complexity
- Avoid unnecessary fragmentation of technologies for paired and unpaired band operation

LTE Release 8 Standardisation History



LTE Release 8 Key Features

- High spectral efficiency
  - OFDM in Downlink
    - Robust against multipath interference
    - High affinity to advanced techniques
      - Frequency domain channel-dependent scheduling
      - MIMO
  - DFTS-OFDM("Single-Carrier FDMA") in Uplink
    - Low PAPR
    - User orthogonality in frequency domain
  - Multi-antenna application
- Very low latency
  - Short setup time & Short transfer delay
  - Short HO latency and interruption time
    - Short TTI
    - RRC procedure
    - Simple RRC states
- Support of variable bandwidth
  - 1.4, 3, 5, 10, 15 and 20 MHz

LTE Release 8 Key Features (Cont'd)

- Simple protocol architecture
  - Shared channel based
  - PS mode only with VoIP capability
- Simple Architecture
  - eNodeB as the only E-UTRAN node
  - Smaller number of RAN interfaces
    - eNodeB ↔ MME/SAE-Gateway (S1)
    - eNodeB ↔ eNodeB (X2)
- Compatibility and inter-working with earlier 3GPP Releases including CSFB
- Inter-working with other systems, e.g. cdma2000
- FDD and TDD within a single radio access technology
- Self-Organising Network (SON) operation
- CSG/HeNB
- PWS/ETWS (Earthquake Tsunami Warning System)

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**	**4.7μsec**
	Long	**16.7μsec**
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 Enhancements

- Release 9
  - Small enhancements from LTE Release 8
    - HeNB (Home eNode B) enhancements
    - SON (self-organizing networks) enhancements
    - E-MBMS (Evolved-Multimedia Broadcast Multicast Service)
    - LCS (Location Services)
    - PWS/CMAS (Commercial Mobile Alert System)
  - Specification frozen in March 2010
- Release 10 (LTE-Advanced)
  - Further evolution of LTE Release 8 and 9 to meet:
    - Requirements for IMT-Advanced of ITU-R
    - Future operator and end-user requirements
  - As a candidate of IMT-Advanced in ITU-R, 3GPP proposed LTE Release 10 & beyond (LTE-Advanced)
  - Self-evaluation results show LTE-Advanced meet the all requirements of ITU-R and 3GPP
  - Specifications of LTE-Advanced will be approved in December 2010 and submit to ITU-R WP 5D in March 2011
  - Technologies to be included in Release 10
    - Spectrum/carrier aggregation for wider bandwidth based on component carrier(CC) concept
    - Advanced MIMO techniques up to 8-layers for DL and 4-layers for UL
    - Heterogeneous network
    - Relaying

Further enhancements defined in LTE Release 9, 10 and beyond can be deployed in a backwards compatible manner to LTE Release 8!

LTE Performance

Rel. 8 LTE Performance Verification Results in 3GPP

Spectrum efficiency (bps/Hz/cell)

Downlink:

(Requirement: 3 - 4 fold from Rel. 6 HSDPA)

Cell Distance	500 m		1732 m	
HSPA 1x2	0.53	-	0.52	-
LTE 2x2 MIMO	1.69	x 3.2	1.56	x 3.0
LTE 4x2 MIMO	1.87	x 3.5	1.85	x 3.6
LTE 4x4 MIMO	2.67	x 5.0	2.41	x 4.6

Uplink:

(Requirement: 2 - 3 fold from Rel. 6 HSUPA)

Cell Distance	500 m		1732 m	
HSPA 2 Rx div	0.33	-	0.32	-
LTE 2 Rx div	0.74	x 2.2	0.68	x 2.2
LTE 4 Rx div	1.10	x 3.3	1.04	x 3.3

Voice capacity (users/5 MHz)

Cell Distance	Downlink	Uplink
500 m	317	241
1732 m	289	123

U-plane latency (one-way transmission delay in RAN)

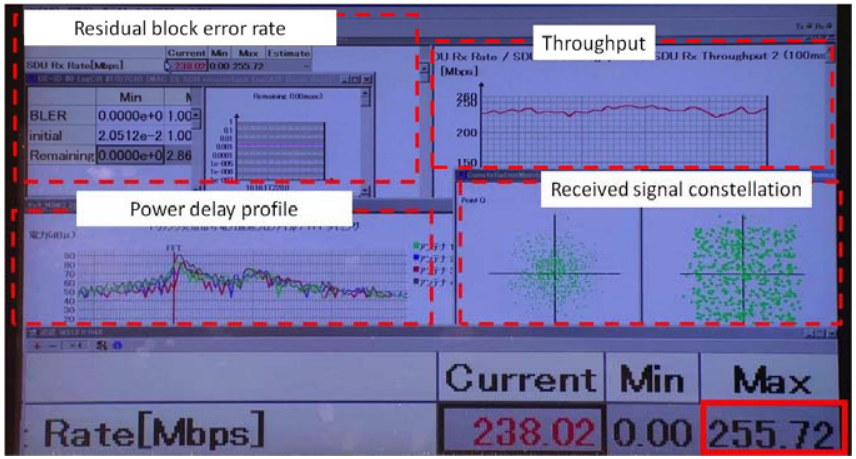
(Requirement: 5-msec one-way delay in RAN)

Function	Value (0% HARQ)	Value (30% HARQ)
Total one-way delay	3.5 ms	5 ms

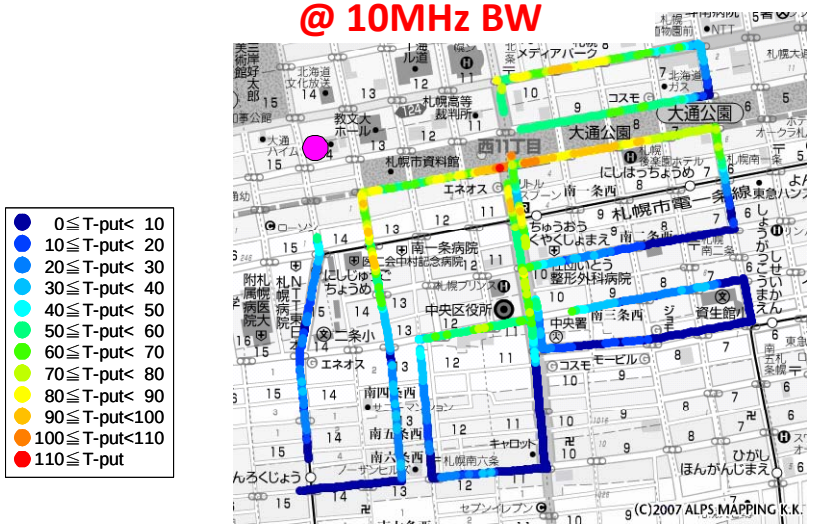
Source: 3GPP TR25.912

NTT DOCOMO Field Experiment

Downlink Peak Throughput in the Field Trial



Throughput distribution @ 10MHz BW

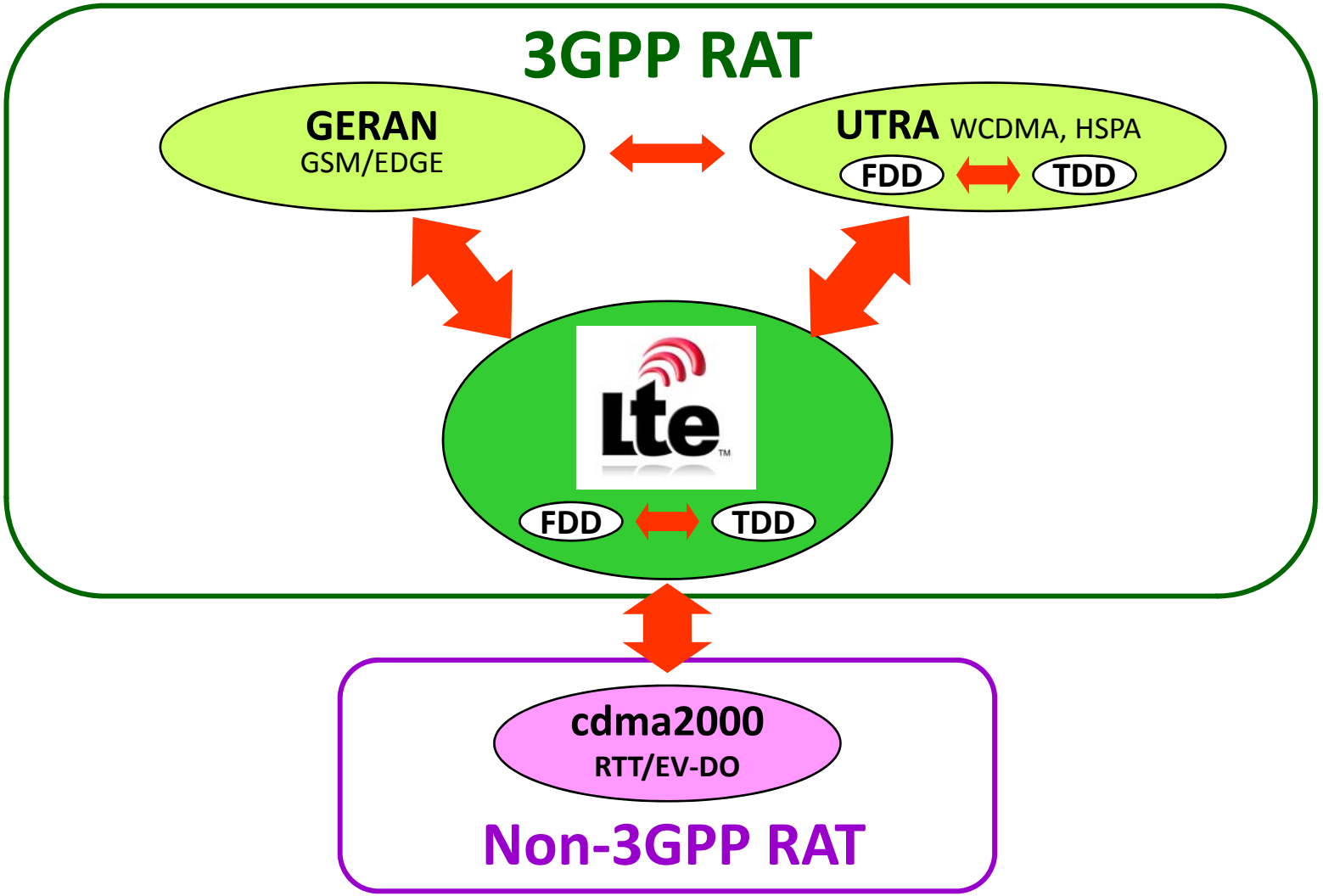


Handover trial in Yokosuka

Bidirectional HD Video and Gaming

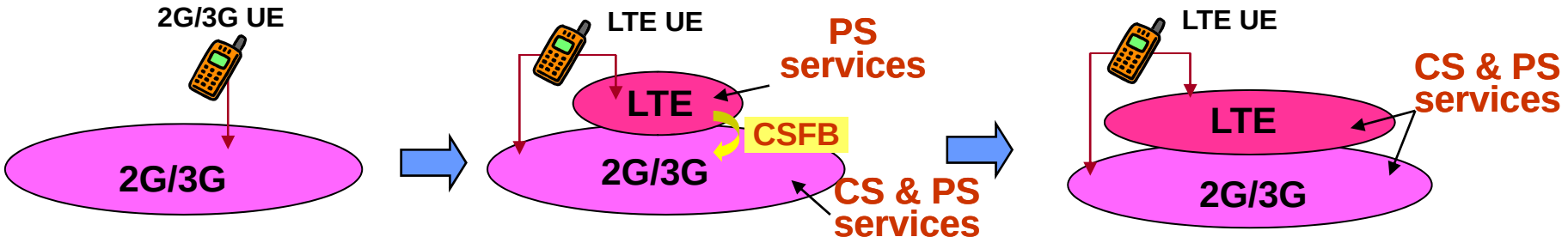
LTE Deployment Scenarios

Supported Inter-working between Radio Access Technologies



Possible LTE Deployment Scenarios

- **Initial stage of LTE**
  - Overlaid with 2G(e.g.GERAN) and/or 3G(e.g. UTRA, cdma2000) deployment area
  - 2G, 3G and LTE multi-mode terminal
  - Focus on packet switched (PS) services
    - Circuit switched (CS) services can be provided in 2G/3G cells using CS Fallback(CSFB)
- **As LTE terminals become wide spread**
  - Expand LTE deployment area
  - CS services will be provided in LTE in PS domain based on IMS



Challenges for LTE Deployment

Possible Challenges and activities for LTE Deployment

- Many test cases for interfaces, Radio, X2 and S1
  - ← Less problem compared with WCDMA introduction
    - Simple protocol and architecture
    - Support of PS domain only, i.e. No support of CS domain
  - ← Aggressive industry activities for smooth introduction of LTE
    - Aggressive inter-operability test activities between multi-vendors in e.g. LSTI
    - Reduction of test cases for initial terminal in e.g. NGMN
- Many options/configurations
  - ← Less problem compared with WCDMA introduction but still exist
    - Support of Feature Group Indicator
      - Mandatory UE features, which is not matured for testing, can be informed to RAN
- Support of multiple-RATs and inter-working between RATs
  - Overlaid deployment scenarios of multiple RATs expected
  - ← Prioritization of supporting RAT and interworking functions
- Spectrum band to be supported in the terminal
  - Variety of spectrum band specified in 3GPP specs following regional requirements
  - ← Activities for operator's prioritization of supporting spectrum band in each region, e.g. NGMN
- Voice strategies
  - ← Thanks to GSMA activities, CSFB was identified as the intermediate solution toward VoLTE and common IMS profile was identified for VoLTE

LTE Operating band in 3GPP latest spec

(extract from 36.101 v9.3.0)

E-UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit			Downlink (DL) operating band BS transmit UE receive			Duplex Mode
	F_{UL_low}	–	F_{UL_high}	F_{DL_low}	–	F_{DL_high}	
1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD
2	1850 MHz	–	1910 MHz	1930 MHz	–	1990 MHz	FDD
3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz	FDD
4	1710 MHz	–	1755 MHz	2110 MHz	–	2155 MHz	FDD
5	824 MHz	–	849 MHz	869 MHz	–	894MHz	FDD
6[1]	830 MHz	–	840 MHz	875 MHz	–	885 MHz	FDD
7	2500 MHz	–	2570 MHz	2620 MHz	–	2690 MHz	FDD
8	880 MHz	–	915 MHz	925 MHz	–	960 MHz	FDD
9	1749.9 MHz	–	1784.9 MHz	1844.9 MHz	–	1879.9 MHz	FDD
10	1710 MHz	–	1770 MHz	2110 MHz	–	2170 MHz	FDD
11	1427.9 MHz	–	1447.9 MHz	1475.9 MHz	–	1495.9 MHz	FDD
12	698 MHz	–	716 MHz	728 MHz	–	746 MHz	FDD
13	777 MHz	–	787 MHz	746 MHz	–	756 MHz	FDD
14	788 MHz	–	798 MHz	758 MHz	–	768 MHz	FDD
15	Reserved			Reserved			FDD
16	Reserved			Reserved			FDD
17	704 MHz	–	716 MHz	734 MHz	–	746 MHz	FDD
18	815 MHz	–	830 MHz	860 MHz	–	875 MHz	FDD
19	830 MHz	–	845 MHz	875 MHz	–	890 MHz	FDD
20	832 MHz	–	862 MHz	791 MHz	–	821 MHz	FDD
21	1447.9 MHz	–	1462.9 MHz	1495.9 MHz	–	1510.9 MHz	FDD
…							
33	1900 MHz	–	1920 MHz	1900 MHz	–	1920 MHz	TDD
34	2010 MHz	–	2025 MHz	2010 MHz	–	2025 MHz	TDD
35	1850 MHz	–	1910 MHz	1850 MHz	–	1910 MHz	TDD
36	1930 MHz	–	1990 MHz	1930 MHz	–	1990 MHz	TDD
37	1910 MHz	–	1930 MHz	1910 MHz	–	1930 MHz	TDD
38	2570 MHz	–	2620 MHz	2570 MHz	–	2620 MHz	TDD
39	1880 MHz	–	1920 MHz	1880 MHz	–	1920 MHz	TDD
40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD

Note 1: Band 6 is not applicable


Thank you!