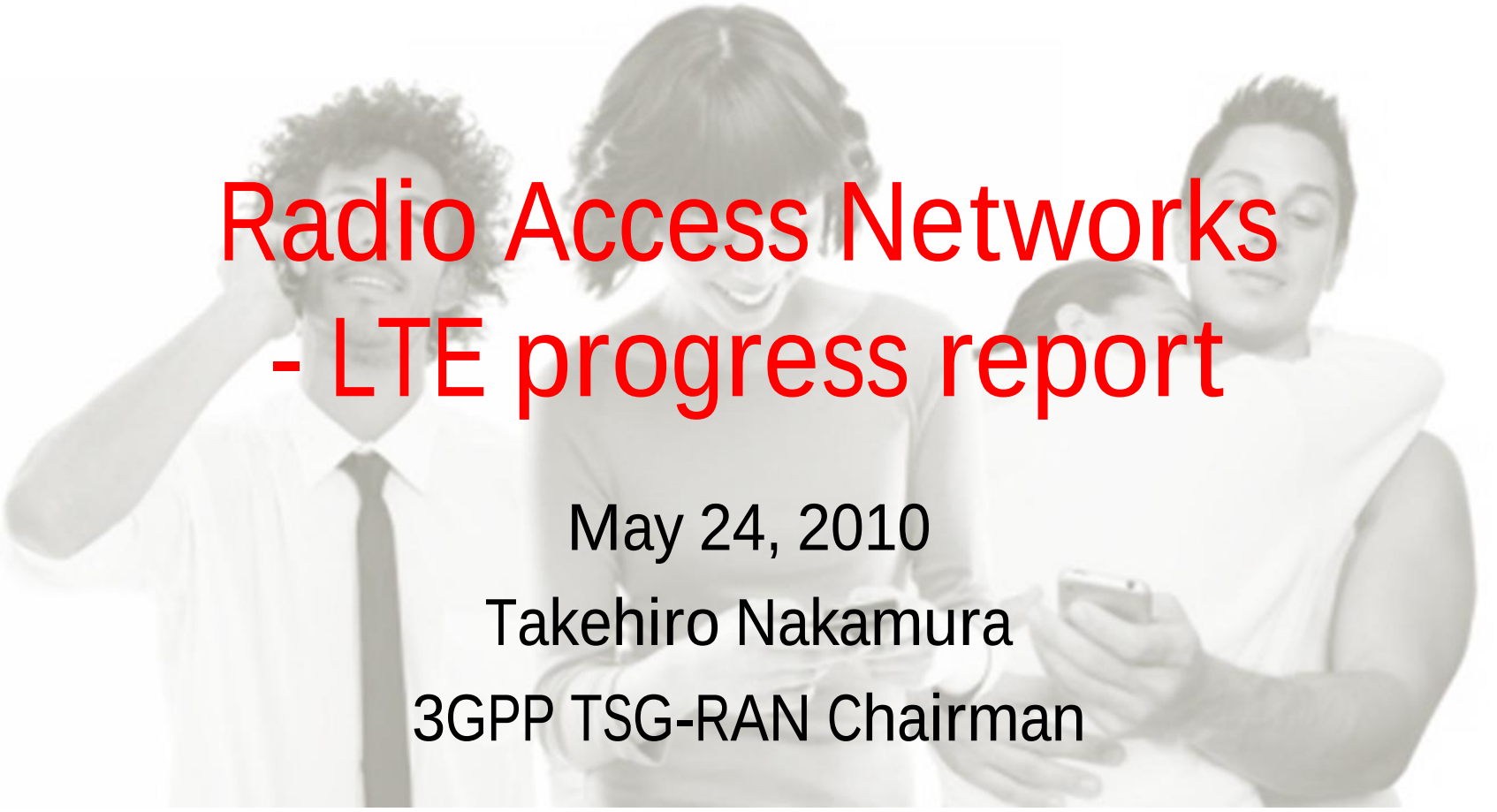

Radio Access Networks - LTE progress report

May 24, 2010

Takehiro Nakamura

3GPP TSG-RAN Chairman

THE Mobile Broadband Standard

Contents

- 3GPP TSG-RAN standardisation activities
- LTE Release 8 overviews
- LTE Release 9 overviews
- LTE Release 10 (LTE-Advanced)
  - Motivation
  - Standardization of ITU-R IMT-Advanced and 3GPP LTE-Advanced
  - Key requirements
  - Key features
  - Performance evaluations
- LTE Release 11

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3GPP TSG-RAN
Standardisation Activities

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3GPP Structure

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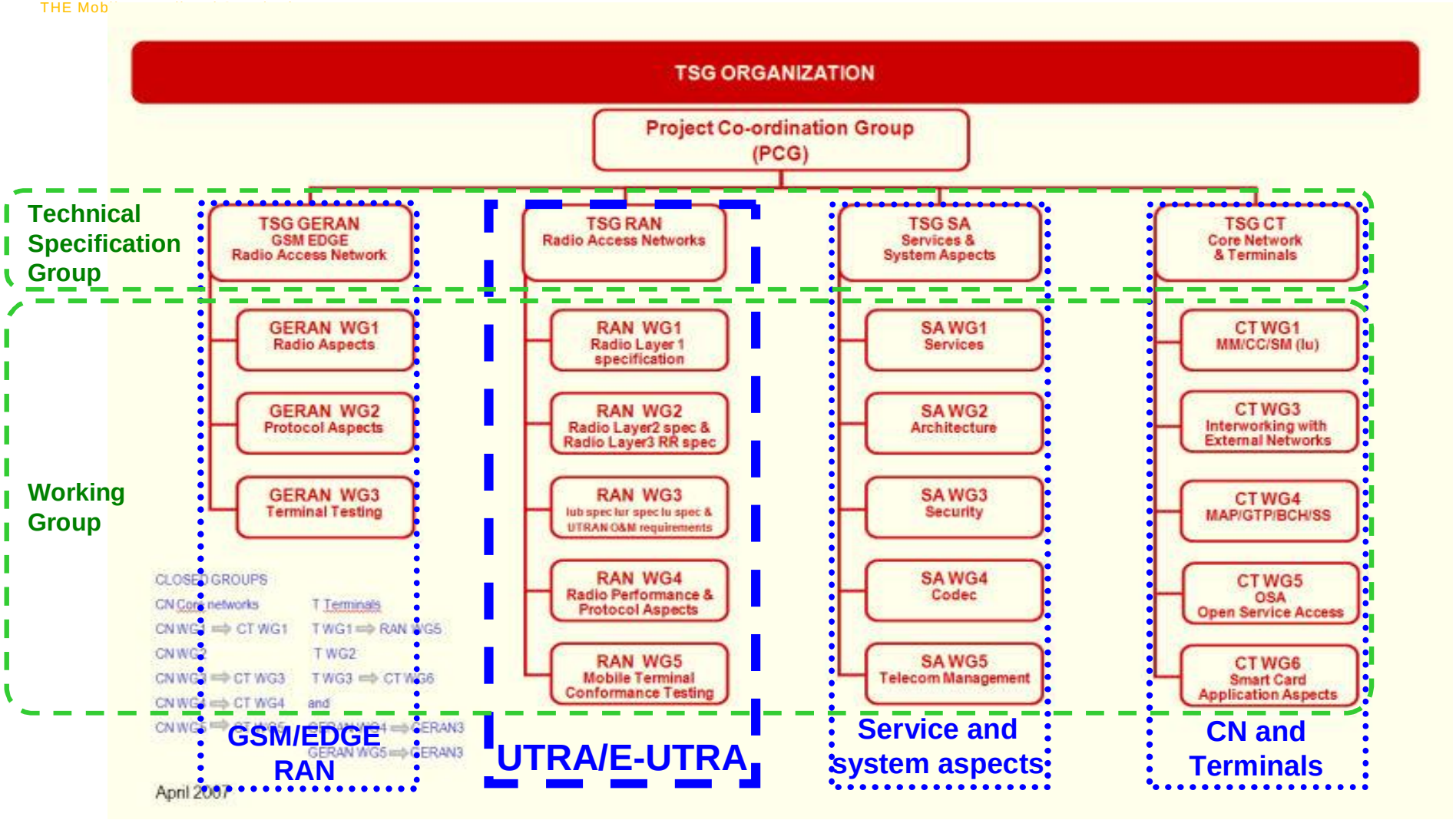

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Releases of 3GPP Specifications

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1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013

Release 99 **W-CDMA**

Release 4 **1.28Mcps TDD**

Release 5 **HSDPA**

Release 6 **HSUPA, MBMS**

Release 7 **HSPA+ (MIMO, HOM etc.)**

ITU-R M.1457
IMT-2000 Recommendation

Release 8 **LTE**

Release 9 **Minor LTE enhancements**

ITU-R M.[IMT.RSPEC]
IMT-Advanced Recommendation

Approved at ITU-R WP5D meeting in Oct. 2010 as a IMT-Advanced technology

Release 10 **LTE-Advanced**

Release 11

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Technology Evolution path in 3GPP Standards

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Release 99	Release 4	Release 5	Release 6	Release 7	Release 8	Release 9	Release 10
25 series							
WCDMA		HSDPA	HSUPA	HSPA+			
			36 series		LTE		LTE-A

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LTE Release 8

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Motivation of LTE Release 8

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- 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

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LTE Release 8 Key Features

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- 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

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LTE-Release 8 User Equipment Categories

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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

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LTE Release 9

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Rel-9 LTE features

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- Small enhancements from LTE Release 8 mainly for higher layer
  - HeNB (Home eNode B)
    - HeNB Access Mode
      - Rel-8: Closed Access Mode
      - Rel-9: Open and Hybrid Mode
    - HeNB Mobility between HeNB and macro
      - Rel-8: Out-bound HO
      - Rel-9: in-bound and inter-CSG HO
  - SON (self-organizing networks)
    - Rel-8: Self configuration, Basic self-optimization
    - Rel-9: RACH optimization, etc
  - MBMS
    - Rel-8: Radio physical layer specs
    - Rel-9: Radio higher layer and NW interface specs
  - LCS (Location Services)
    - Rel-8: U-Plane solutions
    - Rel-9: C-Plane solutions, e.g. OTDOA

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LTE Release 10 and Beyond (LTE-Advanced)

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Motivation of LTE-Advanced

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- IMT-Advanced standardisation process in ITU-R
- Additional IMT spectrum band identified in WRC07
- Further evolution of LTE Release 8 and 9 to meet:
  - Requirements for IMT-Advanced of ITU-R
  - Future operator and end-user requirements

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Standardization of ITU-R IMT-Advanced and 3GPP LTE-Advanced

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ITU

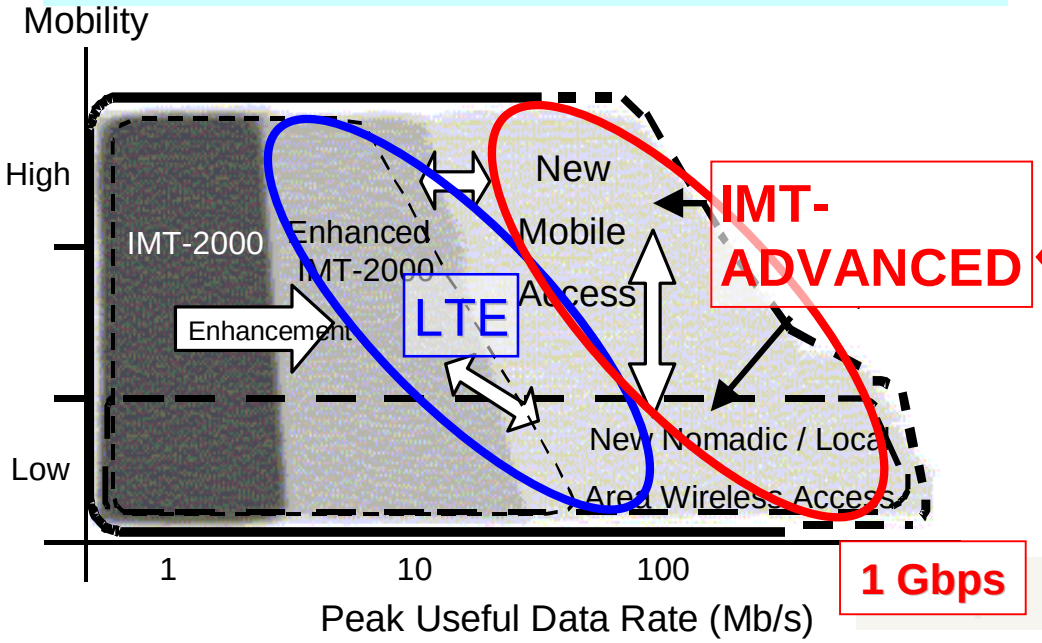
Standardization activities for beyond IMT-2000 from the beginning of 2000's

→ ***IMT-Advanced***

ITU-R Recommendation M.1645

Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000

- Van Diagram -



Propose

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LTE Release 8

LTE ADVANCED

LTE Release 10 and beyond (LTE-Advanced)

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Time Plan of ITU-R IMT-Advanced and 3GPP LTE-Advanced

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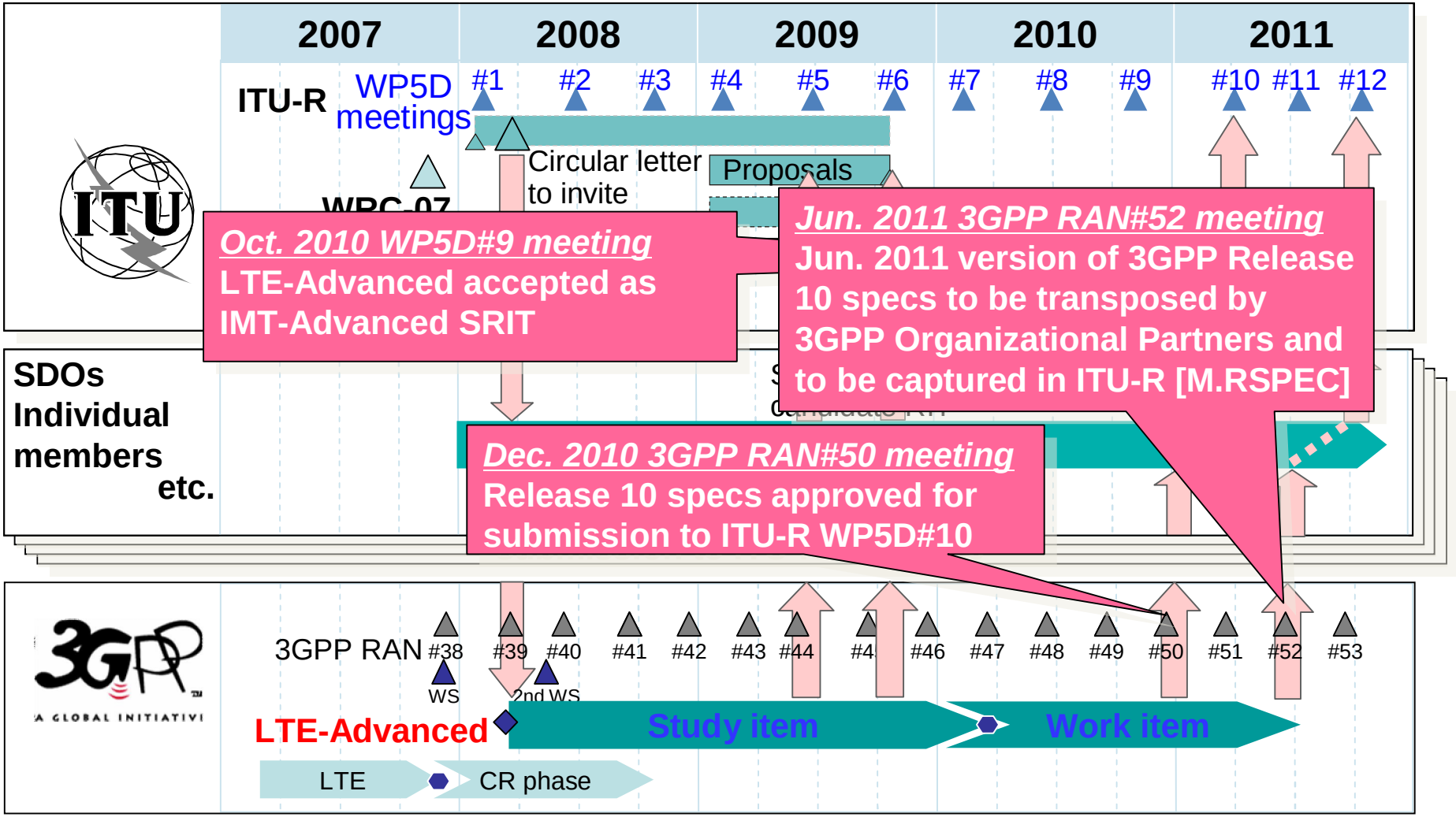

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LTE-Advanced Proposal for ITU-R IMT-Advanced

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IMT-Advanced

International Telecommunication Union

IMT

"LTE-Advanced"
Set of RIT(SRIT)

FDD RIT | TDD RIT

WirelessMan-Advanced RIT

3GPP members FDD&TDD

Japan FDD&TDD

China TDD

"LTE Release 10 & beyond(LTE-Advanced)"

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LTE Advanced

FDD mode

TDD mode

LTE Release 10

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Key Requirements for LTE-Advanced

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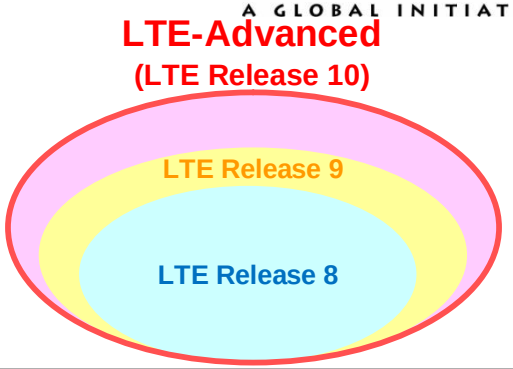
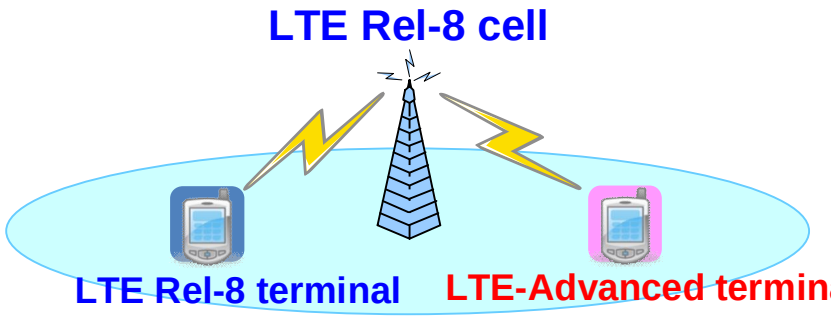
- **LTE-Advanced shall be deployed as an evolution of LTE Release 8 and on new bands.**
- **LTE-Advanced shall be backwards compatible with LTE Release 8**

➔ **Smooth and flexible system migration from Rel-8 LTE to LTE-Advanced**

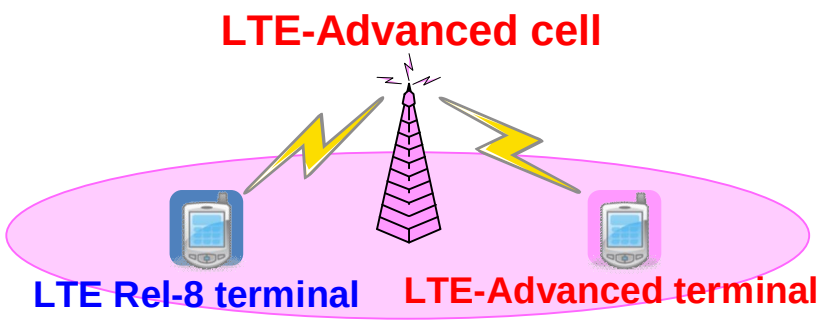


LTE-Advanced contains all features of LTE Rel-8&9 and additional features for further evolution

LTE-Advanced evolved from LTE Rel-8



An LTE-Advanced terminal can work in an LTE Rel-8 cell



An LTE Rel-8 terminal can work in an LTE-Advanced cell

LTE-Advanced backward compatibility with LTE Rel-8

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Target performance of LTE-Advanced

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		Rel. 8 LTE	LTE-Advanced	IMT-Advanced
Peak data rate	DL	300 Mbps	1 Gbps	1 Gbps(*)
	UL	75 Mbps	500 Mbps	
Peak spectrum efficiency [bps/Hz]	DL	15	30	15
	UL	3.75	15	6.75

		Antenna configuration	Rel. 8 LTE*1	LTE-Advanced*2	IMT-Advanced*3
Average spectrum efficiency [bps/Hz/cell]	DL	2-by-2	1.69	2.4	–
		4-by-2	1.87	2.6	2.2
		4-by-4	2.67	3.7	–
	UL	1-by-2	0.74	1.2	–
		2-by-4	–	2.0	1.4
Cell edge user throughput [bps/Hz/cell/user]	DL	2-by-2	0.05	0.07	–
		4-by-2	0.06	0.09	0.06
		4-by-4	0.08	0.12	–
	UL	1-by-2	0.024	0.04	–
		2-by-4	–	0.07	0.03

x 1.4-1.7

*1 See TR25.912(Case 1 scenario) *2 See TR36.913(Case 1 scenario)
*3 See ITU-R M.2135(Base Coverage Urban scenario)

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Key Features in LTE Release 10

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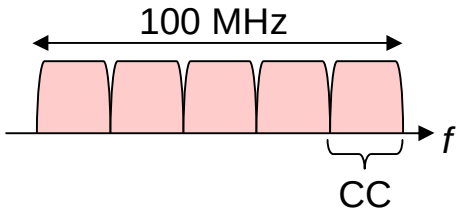
Support of Wider Bandwidth(Carrier Aggregation)

- Use of multiple component carriers(CC) to extend bandwidth up to 100 MHz
- Common physical layer parameters between component carrier and LTE Rel-8 carrier

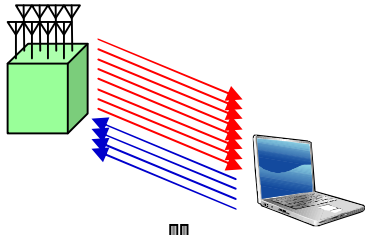
➔ Improvement of peak data rate, backward compatibility with LTE Rel-8



Advanced MIMO techniques

- Extension to up to 8-layer transmission in downlink
- Introduction of single-user MIMO up to 4-layer transmission in uplink
- Enhancements of multi-user MIMO

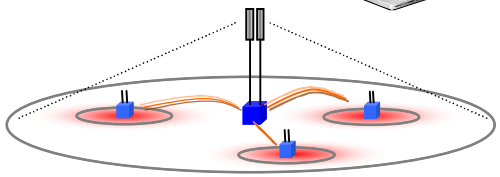
➔ Improvement of peak data rate and capacity



Heterogeneous network and eICIC(enhanced Inter-Cell Interference Coordination)

- Interference coordination for overlaid deployment of cells with different Tx power

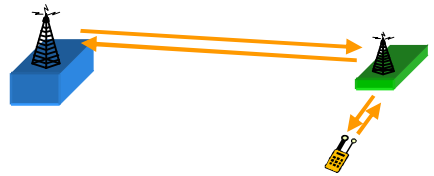
➔ Improvement of cell-edge throughput and coverage



Relay

- Type 1 relay supports radio backhaul and creates a separate cell and appear as Rel. 8 LTE eNB to Rel. 8 LTE UEs

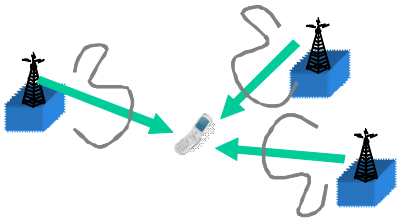
➔ Improvement of coverage and flexibility of service area extension



Coordinated Multi-Point transmission and reception (CoMP)

- Support of multi-cell transmission and reception

➔ Improvement of cell-edge throughput and coverage



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Other New Features in LTE Release 10

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- Minimisation of drive tests (MDT)
  - UE logging and reporting of measurements linked to location information
  - To assist operators in detecting coverage holes and understanding coverage footprint
- LTE self-organising network (SON) enhancements
  - Radio link failure reporting enhancements
  - To optimise handover parameters
- Machine type communication (MTC)
  - Differentiated access control for core network protection from overload
- MBMS counting
  - Counting of UEs interested in particular service to optimise MBMS transmission
- HeNB mobility (network architecture) enhancements
  - Direct interface support for optimised handover between HeNBs

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3GPP LTE-Advanced Self-Evaluation

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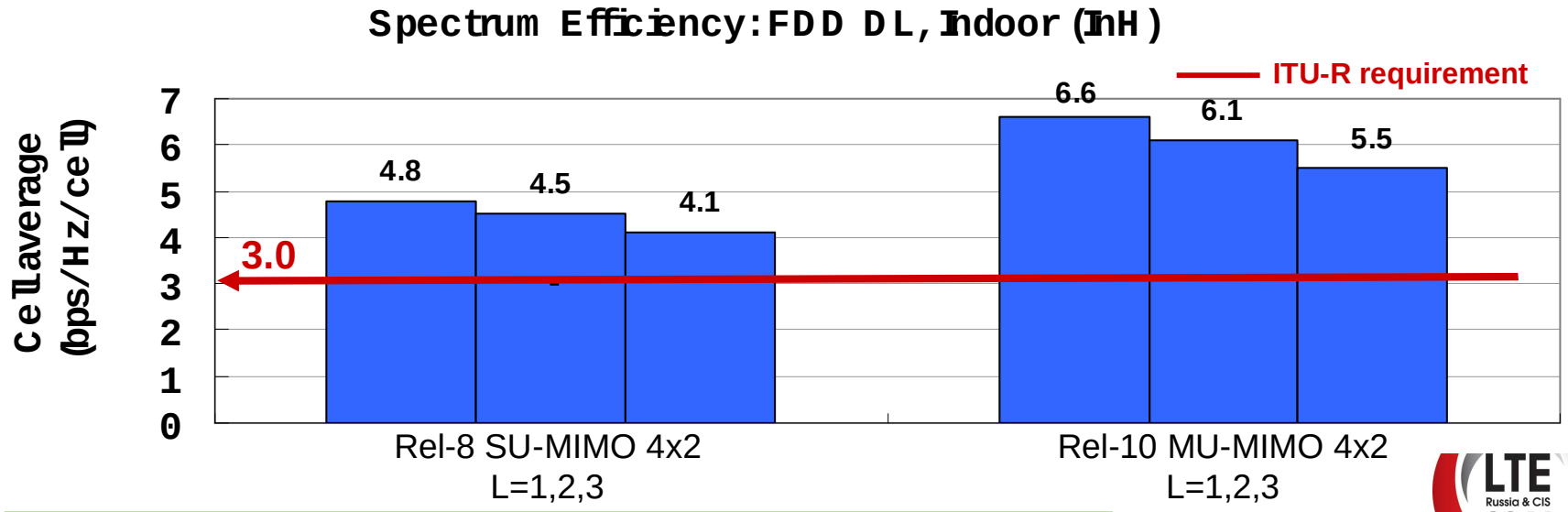
- The self-evaluation results shows:
  - For LTE Release 10, FDD RIT and TDD RIT Component meets the minimum requirements of all 4 required test environments, individually.
  - Baseline configuration exceeding ITU-R requirements with minimum extension
    - LTE release 8 fulfills the requirements in most cases (no extensions needed)
    - Extensions to Multi-user MIMO from Release 8 fulfills the requirements in some scenarios (Urban Macro/Micro DL)



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Release 11

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Release 11 Work Items

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- Further enhancements of LTE-Advanced started in Release 11
- So many WIs on new spectrum band and new spectrum band combinations for carrier aggregation

  - Network-Based Positioning Support for LTE
  - Service continuity in connected mode and location information for MBMS for LTE
  - Further Enhanced Non CA-based ICIC for LTE
  - LTE Carrier Aggregation Enhancements
  - LTE RAN Enhancements for Diverse Data Applications
  - Carrier based HetNet ICIC for LTE
  - LTE-Advanced Carrier Aggregation of Band 3 and Band 7
  - LTE Advanced Carrier Aggregation of Band 4 and Band 17
  - LTE Advanced Carrier Aggregation of Band 4 and Band 13
  - LTE Advanced Carrier Aggregation of Band 4 and Band 12
  - LTE Advanced Carrier Aggregation of Band 5 and Band 12
  - LTE Advanced Carrier Aggregation of Band 20 and Band 7
  - LTE Advanced Carrier Aggregation Band 2 and Band 17
  - LTE Advanced Carrier Aggregation Band 4 and Band 5
  - LTE Advanced Carrier Aggregation Band 5 and Band 17
  - New Band LTE Downlink FDD 716-728MHz
  - LTE E850 - Lower Band for Region 2 (non-US)

  } New spectrum and new spectrum band combinations

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Conclusions

- LTE Release 8
  - Specification completed and stable
  - Commercially deployed and committed to deploy by many operators all over the world
- LTE Release 9
  - Small enhancements of LTE Release 8
  - Specification completed and stable
- LTE Release 10
  - Stage 3 frozen and to be stabilized
  - Accepted as a technology of IMT-Advanced by ITU-R WP5D
  - Materials and specifications submitted to ITU-R WP5D for ITU-R recommendation M.[IMT.RSPEC]
- LTE Release 11
  - Started with many Work Items and Study Items for further enhancements of LTE Release 10

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Thank You

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