



# Proposal for Candidate Radio Interface Technologies for IMT-Advanced Based on LTE Release 10 and Beyond (LTE-Advanced)

Takehiro Nakamura  
3GPP TSG-RAN Chairman

# Introduction








- 📶 In response to the ITU-R Circular Letter 5/LCCE/2 which invites proposals for candidate radio interface technologies for the terrestrial component of IMT-Advanced, the Third Generation Partnership Project (3GPP) is providing *a complete submission of **LTE Release 10 & beyond (LTE-Advanced)*** under Step 3 of the IMT-Advanced process in Document IMT-ADV/2(Rev.1)
- 📶 This submission of the 3GPP candidate SRIT (which includes an FDD RIT component and a TDD RIT component) is based on the currently approved work within 3GPP and follows the ITU-R IMT-Advanced submission format and guidelines.
- 📶 The *3GPP Proponent* <sup>[1]</sup> has provided all required information within each of required major components either directly or by endorsement of this contribution made by 3GPP individual members on behalf of 3GPP:
- 📶 The submission of LTE-Advanced as a candidate for IMT-Advanced was acknowledged by ITU-R WP5D as a “complete” submission
- 📶 Following slides show overview of this submission together with relevant information

[1] The *3GPP Proponent* of the 3GPP submission is collectively the 3GPP Organizational Partners (OPs). The Organizational Partners of 3GPP are ARIB, ATIS, CCSA, ETSI, TTA and TTC (<http://www.3gpp.org/partners>)

# Contents



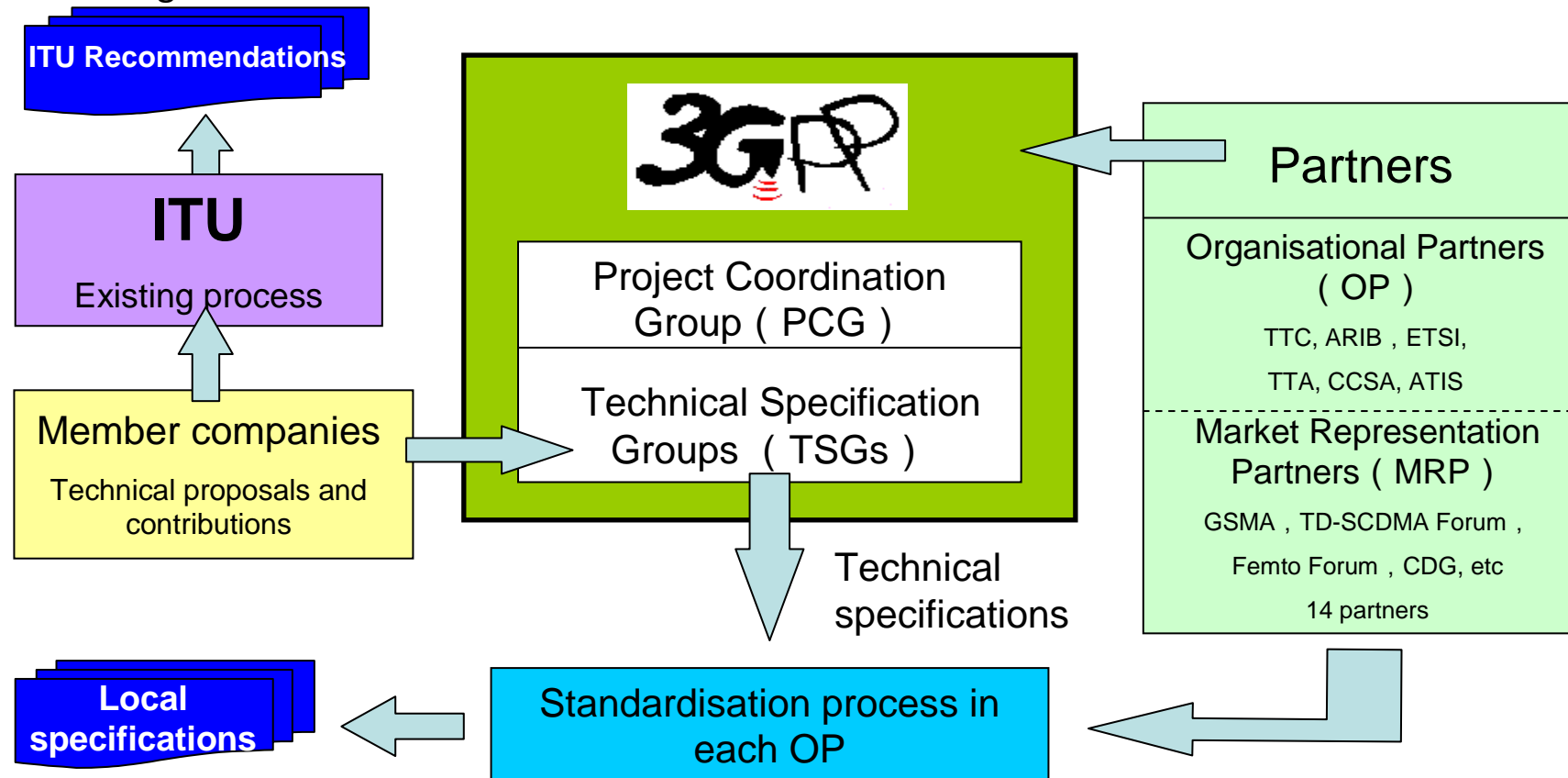
-  3GPP standardisation activities
-  LTE Release 8
-  LTE-Release 10 and beyond (LTE-Advanced)
-  Self-evaluation
-  ITU-R submission documents



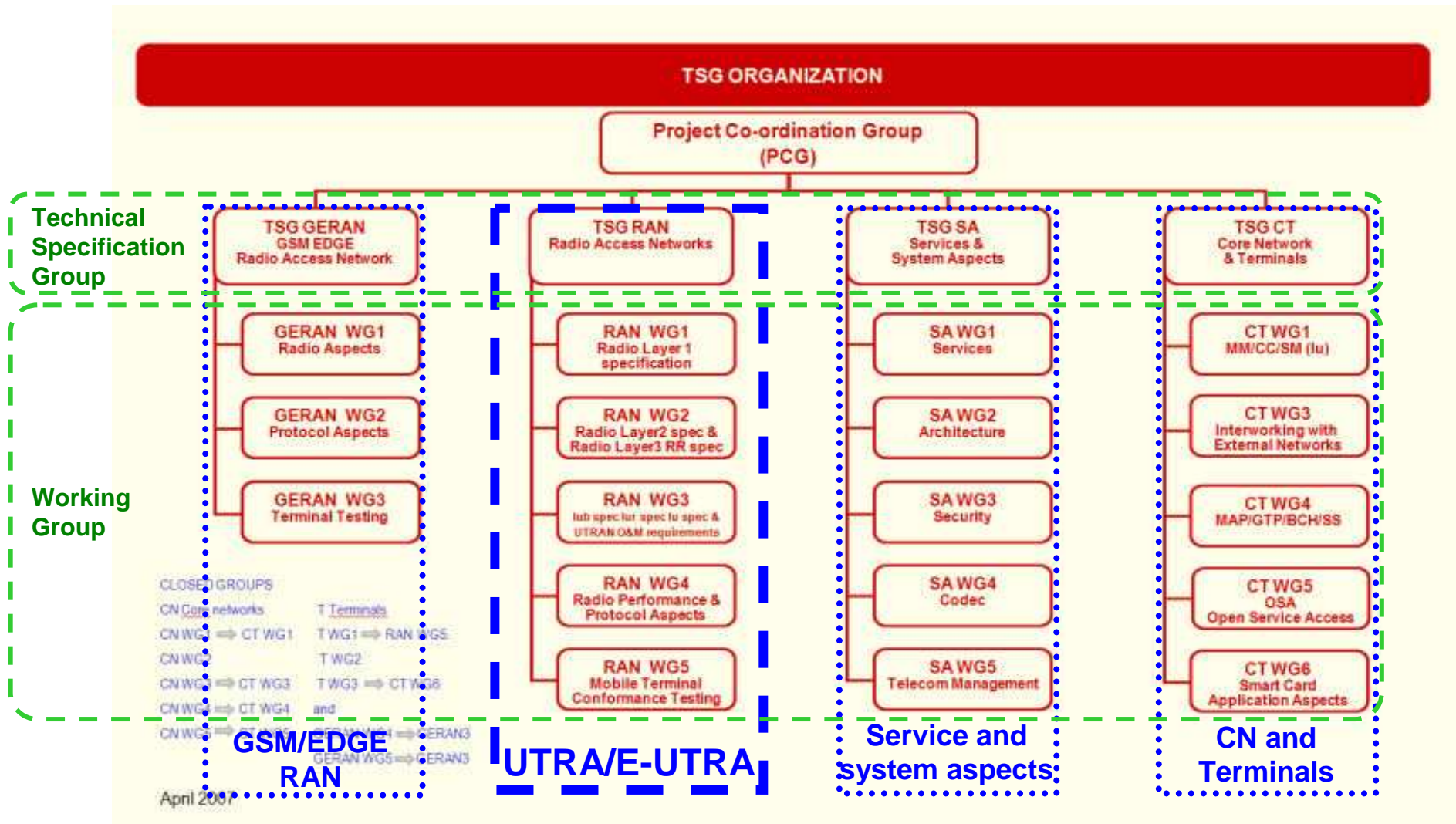
# 3GPP Standardisation Activities

# 3GPP Standardisation Process

- 3GPP develops technical specifications on 3G **and beyond** mobile communication systems
- 3GPP Organisational Partners standardize local specifications based on the specifications developed by 3GPP
- The standardisation process in each OP is only a form of transposition and that no technical changes are introduced



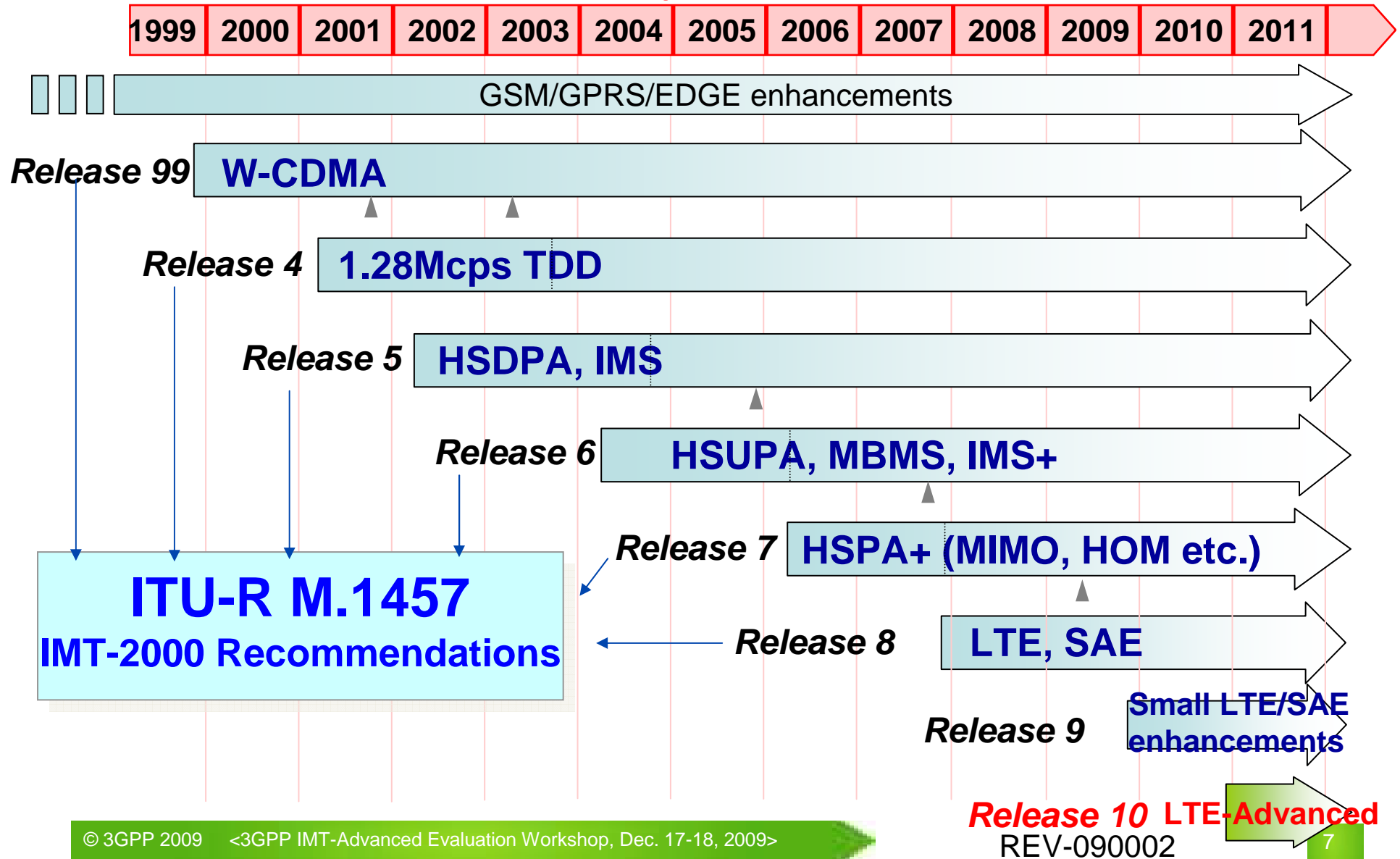
# 3GPP Structure





A GLOBAL INITIATIVE

# Release of 3GPP specifications





# LTE Release 8



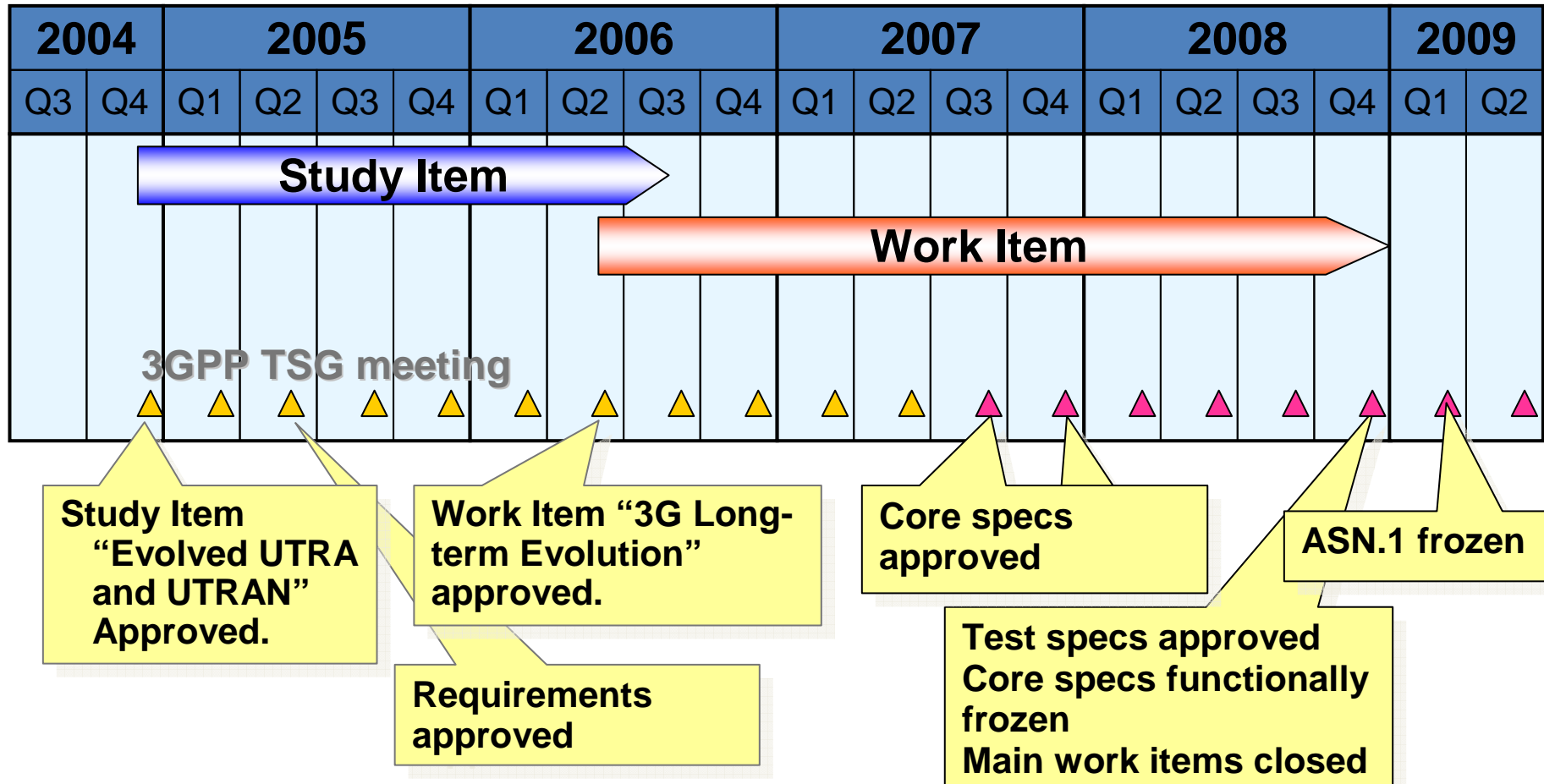


# Motivation of LTE Release 8






- 📶 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
- 📶 Inter-working with other systems, e.g. cdma2000
- 📶 FDD and TDD within a single radio access technology
- 📶 Efficient Multicast/Broadcast
  - Single frequency network by OFDM
- 📶 Support of Self-Organising Network (SON) operation

# LTE Release 8 Major Parameters



<b>Access Scheme</b>	<b>UL</b>	<b>DFTS-OFDM</b>
	<b>DL</b>	<b>OFDMA</b>
<b>Bandwidth</b>		<b>1.4, 3, 5, 10, 15, 20MHz</b>
<b>Minimum TTI</b>		<b>1msec</b>
<b>Sub-carrier spacing</b>		<b>15kHz</b>
<b>Cyclic prefix length</b>	<b>Short</b>	<b>4.7<math>\mu</math>sec</b>
	<b>Long</b>	<b>16.7<math>\mu</math>sec</b>
<b>Modulation</b>		<b>QPSK, 16QAM, 64QAM</b>
<b>Spatial multiplexing</b>		<b>Single layer for UL per UE Up to 4 layers for DL per UE MU-MIMO supported for UL and DL</b>

# LTE Release 10 and Beyond (LTE-Advanced)



# Overview of LTE-Advanced



## Motivation of LTE-Advanced

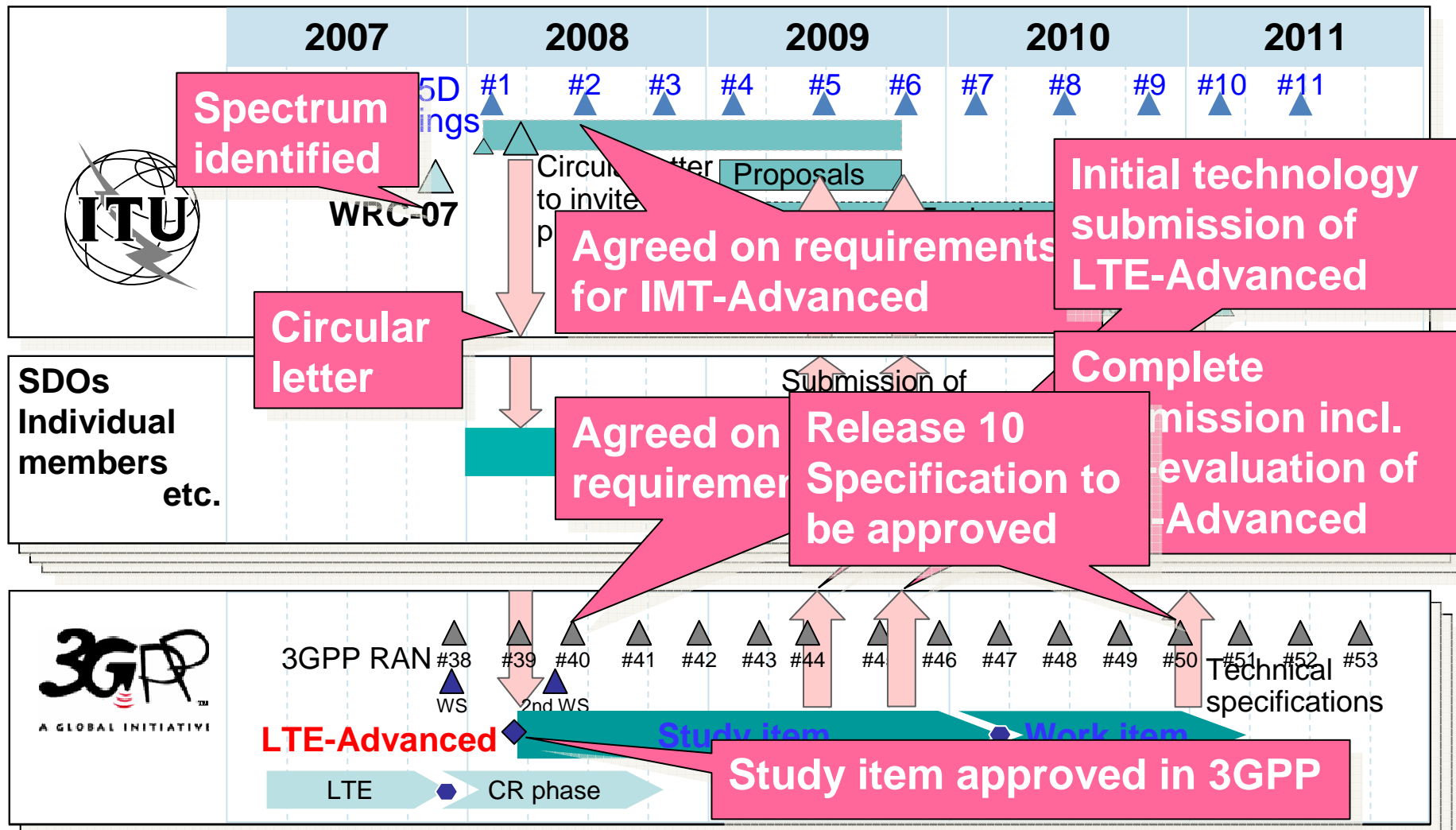
- IMT-Advanced standardisation process in ITU-R
- Additional IMT spectrum band identified in WRC07
- Further evolution of LTE Release 8 and 9 to meet:
  - Requirements for IMT-Advanced of ITU-R
  - Future operator and end-user requirements

## 3GPP status

- Feasibility study is ongoing under study item, “Further advancements for E-UTRA(LTE-Advanced)”
- Requirements and targets for LTE-Advanced were agreed and possible technologies to meet the requirements and the targets were identified
- Self-evaluations were conducted and confirmed that LTE-Advanced meet the all requirements of IMT-Advanced
- All necessary documents to be submitted to ITU-R WP 5D#6 as the complete submission were approved in 3GPP
- In 3GPP TSG-RAN#46 meeting in December 2009, some work items, based on the study results of the study item, were agreed to develop specifications for LTE-Advanced

## Proposal of LTE-Advanced is an SRIT including FDD RIT and TDD RIT

# Standardisation Schedule For IMT/LTE-Advanced

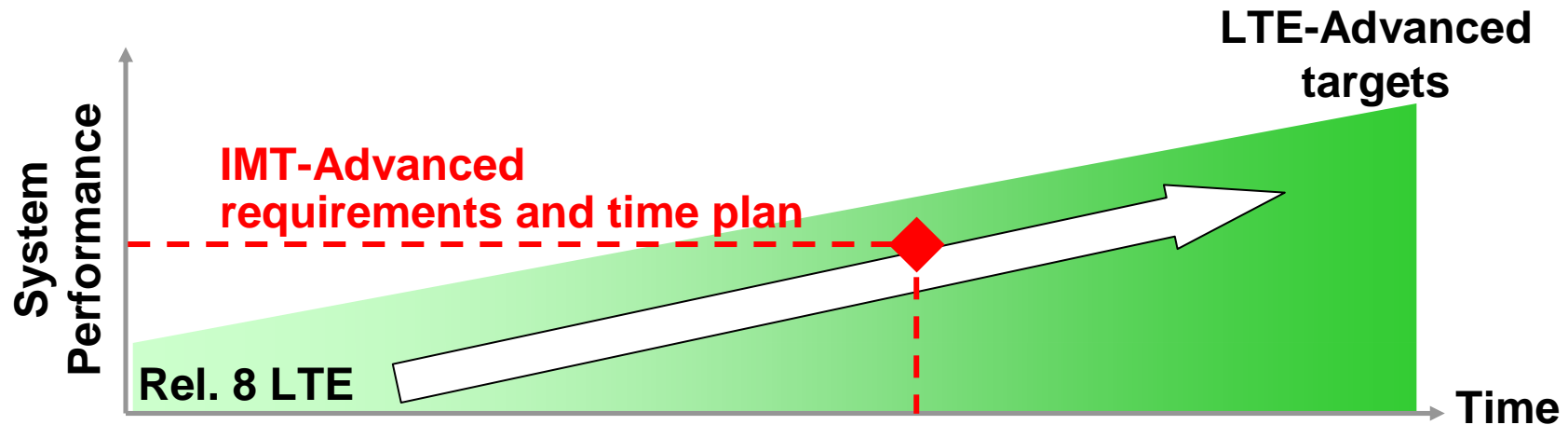




# General Requirements for LTE-Advanced



- 📶 LTE-Advanced is an evolution of LTE
- 📶 LTE-Advanced shall meet or exceed IMT-Advanced requirements within the ITU-R time plan
- 📶 Extended LTE-Advanced targets are adopted



# System Performance Requirements



## Peak data rate

- 1 Gbps data rate will be achieved by 4-by-4 MIMO and transmission bandwidth wider than approximately 70 MHz

## Peak spectrum efficiency

- DL: Rel. 8 LTE satisfies IMT-Advanced requirement
- UL: Need to double from Release 8 to satisfy IMT-Advanced requirement

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

\*“100 Mbps for high mobility and 1 Gbps for low mobility” is one of the key features as written in Circular Letter (CL)

# System Performance Requirements (Cont'd)



## Capacity and cell-edge user throughput

- Target for LTE-Advanced was set considering gain of 1.4 to 1.6 from Release 8 LTE performance

		Ant. Config.	Rel. 8 LTE*1	LTE-Advanced*2	IMT-Advanced*3
Capacity [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

\*1 See TR25.912(Case 1 scenario)

\*2 See TR36.913(Case 1 scenario)

\*3 See ITU-R M.2135(Base Coverage Urban scenario)

# Other Important Requirements

## Spectrum flexibility

- Actual available spectra are different according to each region or country
- In 3GPP, various deployment scenarios for spectrum allocation are being taken into consideration in feasibility study

### Total 12 scenarios are identified with highest priority

	Tx BWs	No. of Component Carriers (CCs)	Bands	Duplex
1	UL: 40 MHz DL: 80 MHz	UL: Contiguous 2x20 MHz CCs DL: Contiguous 4x20 MHz CCs	3.5 GHz band	FDD
2	100 MHz	Contiguous 5x20 MHz CCs	Band 40 (2.3 GHz)	TDD
3	100 MHz	Contiguous 5x20 MHz CCs	3.5 GHz band	TDD
4	UL: 40 MHz DL: 80 MHz	UL: Non-contiguous 20 + 20 MHz CCs DL: Non-contiguous 2x20 + 2x20 MHz CCs	3.5 GHz band	FDD
5	UL: 10 MHz DL: 10 MHz	UL/DL: Non-contiguous 5 MHz + 5 MHz CCs	Band 8 (900 MHz)	FDD
6	80 MHz	Non-contiguous 2x20 + 2x20 MHz CCs	Band 38 (2.6 GHz)	TDD
⋮	⋮	⋮	⋮	⋮

- Support for flexible deployment scenarios including downlink/uplink asymmetric bandwidth allocation for FDD and non-contiguous spectrum allocation

## Other Important Requirements (Cont'd)



- 📶 LTE-Advanced will be deployed as an evolution of LTE Release 8 and on new bands.
- 📶 LTE-Advanced shall be backwards compatible with LTE Release 8 in the sense that
  - a LTE Release 8 terminal can work in an LTE-Advanced NW,
  - an LTE-Advanced terminal can work in an LTE Release 8 NW
- 📶 Increased deployment of indoor eNB and HNB in LTE-Advanced.

# Technical Outline to Achieve LTE-Advanced Requirements



- 📶 Support wider bandwidth
  - Carrier aggregation to achieve wider bandwidth
  - Support of spectrum aggregation
  - ➔ Peak data rate, spectrum flexibility
- 📶 Advanced MIMO techniques
  - Extension to up to 8-layer transmission in downlink
  - Introduction of single-user MIMO up to 4-layer transmission in uplink
  - ➔ Peak data rate, capacity, cell-edge user throughput
- 📶 Coordinated multipoint transmission and reception (CoMP)
  - CoMP transmission in downlink
  - CoMP reception in uplink
  - ➔ Cell-edge user throughput, coverage, deployment flexibility
- 📶 Further reduction of delay
  - AS/NAS parallel processing for reduction of C-Plane delay
- 📶 Relaying
  - Type 1 relays create a separate cell and appear as Rel. 8 LTE eNB to Rel. 8 LTE UEs
  - ➔ Coverage, cost effective deployment

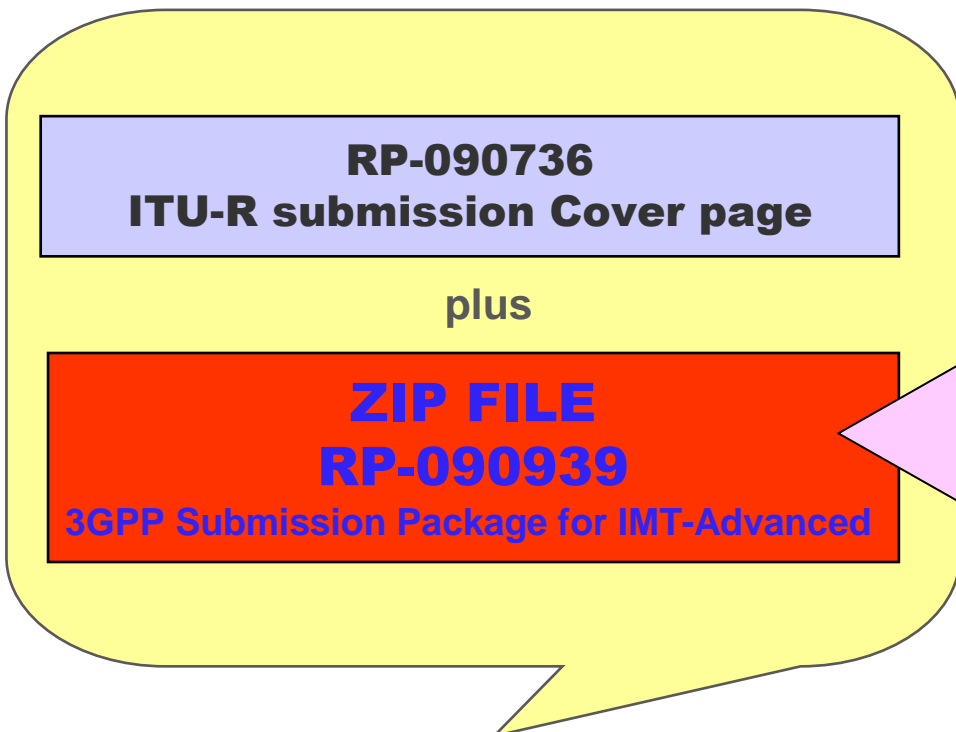
\* See appendix 1 in this slide set for further information on LTE-Advanced technologies

# ITU-R Submission Documents



- 📶 The 3GPP submission to the ITU-R includes the following templates organized as an FDD Radio Interface Technology component (FDD RIT) and as a TDD Radio Interface Technology component (TDD RIT). Together the FDD RIT and the TDD RIT comprise a Set of Radio Interface Technologies (SRIT).
- 📶 The 3GPP developed FDD RIT and TDD RIT templates include characteristics and link budget templates and compliance templates for services, spectrum, and technical performance.
- 📶 3GPP provides additional supporting information in document 3GPP TR 36.912 v9.0.0; Feasibility study for Further Advancements for EUTRA(LTE-Advanced) (Release 9).
- 📶 Templates are found in Annex C of Technical Report TR 36.912.

# Structure of ITU-R Submission Documents from 3GPP



**RP-090743**  
**TR36.912 v9.0.0 Main Body**  
Additional supporting information on LTE-Advanced  
Detailed self-evaluation results in section 16  
Following documents are captured in Annex A and C

**RP-090744**  
**Annex A3: Self-evaluation results**  
Detailed simulation results provided from 18 companies

**RP-090745**  
**Annex C1: Characteristics template**  
Update version of ITU-R Document 5D/496-E  
Relevant 3GPP specifications listed at the end of this document  
Templates for FDD RIT and TDD RIT contained separately

**RP-090746**  
**Annex C2: Link budget template**  
Two Link budget template files for LOS and NLOS  
Each file includes link budget templates for five radio environments specified in ITU-R M.2135  
Templates for FDD RIT and TDD RIT contained separately

**RP-090747**  
**Annex C3: Compliance template**  
This template shows LTE-Advanced fulfills all requirements of IMT-Advanced in ITU-R  
Templates for FDD RIT and TDD RIT contained separately

## Overall ITU-R Submission ITU-R 5D/564-E

Contributed by individual members of 3GPP



# Contact Person for Questions Related to 3GPP ITU-R Submission



 Takehiro Nakamura

NTT DOCOMO, Inc

3GPP TSG-RAN Chairman

Email: [nakamura@nttdocomo.co.jp](mailto:nakamura@nttdocomo.co.jp)