

Update of E-UTRA and IMT-Advanced Requirements

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Status in ITU-R and 3GPP on IMT-Advanced

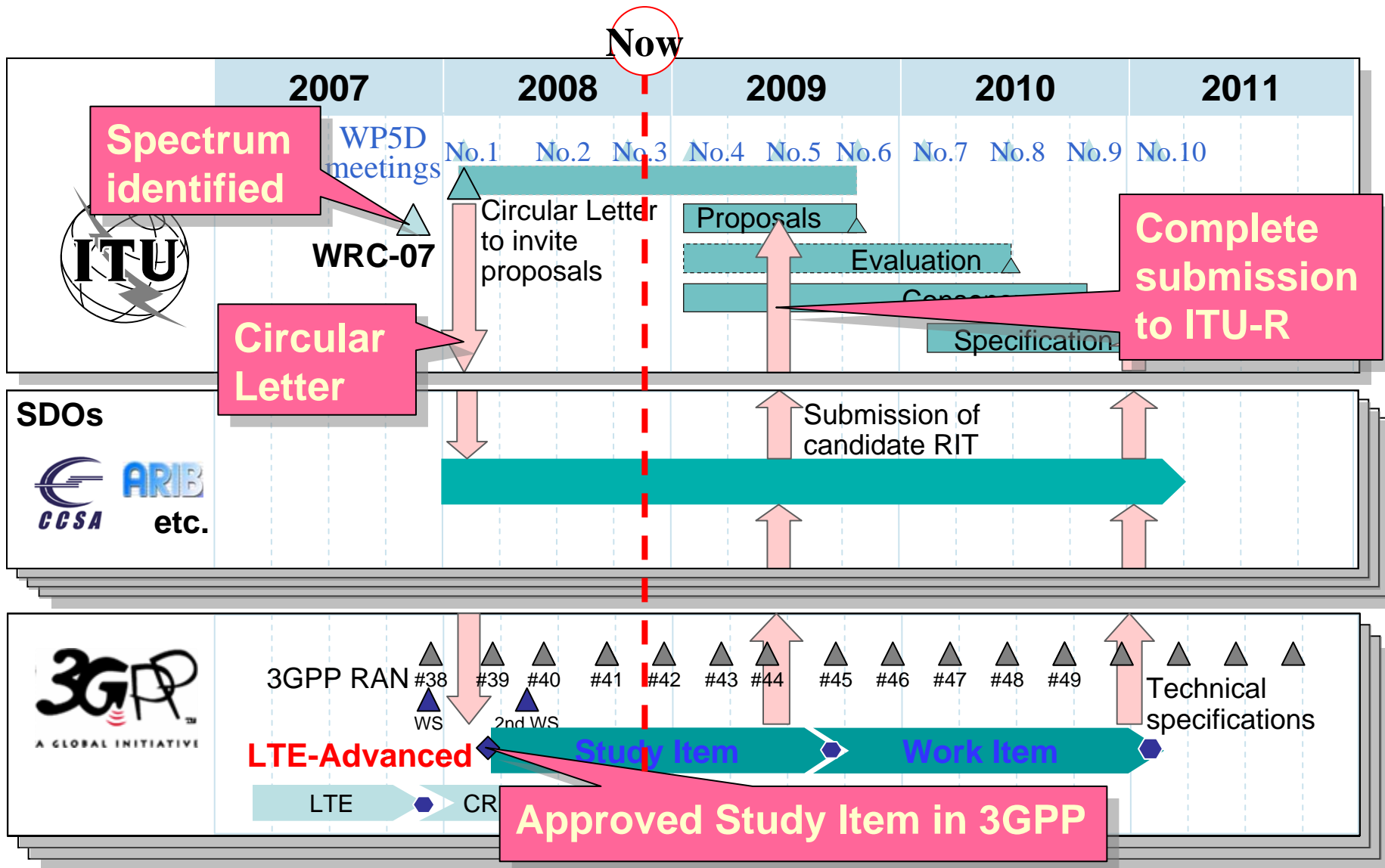
● ITU-R

- ▶ Three reports, which include requirements of IMT-Advanced and the basis for evaluation criteria, were approved in ITU-R Study Group 5 meeting in November 2008
 - ▶ IMT.TECH: Requirement of IMT-Advanced
 - ▶ IMT.EVAL: Evaluation guideline for IMT-Advanced
 - ▶ IMT.REST: Requirements, evaluation criteria and submission template for IMT-Advanced

● 3GPP

- ▶ Study Item, “LTE-Advanced” was approved in March 2008
- ▶ Requirements of the LTE-Advanced captured in 3GPP TR 36.913 were approved in June 2008
- ▶ Simulation assumption considering alignment with ITU-R evaluation criteria were agreed
- ▶ Outcome of the LTE-Advanced will be submitted to ITU-R as a candidate of IMT-Advanced in 2009

Schedule for IMT-Advanced

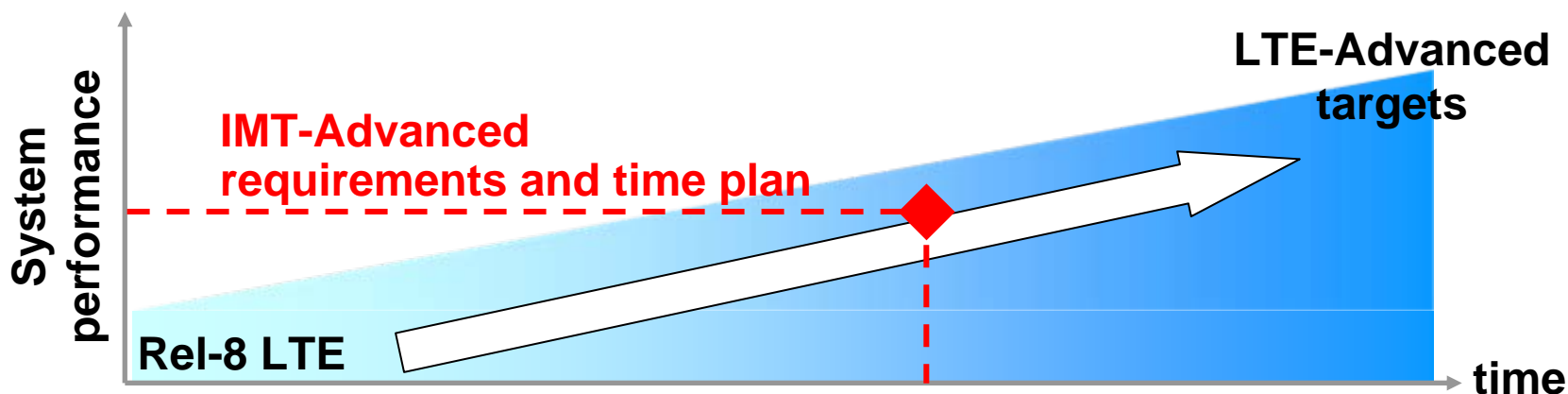


IMT/LTE-Advanced requirements/targets

- General Requirements
 - Relationship with Release 8 LTE and ITU-R IMT-Advanced
- Capability-related Requirements
 - Peak data rate
 - Latency
- System Performance Requirements
 - Peak spectrum efficiency
 - Average spectrum efficiency (Capacity)
 - Cell edge user throughput
 - Mobility
- Deployment-related Requirements
- Spectrum deployment
- Cost related requirements

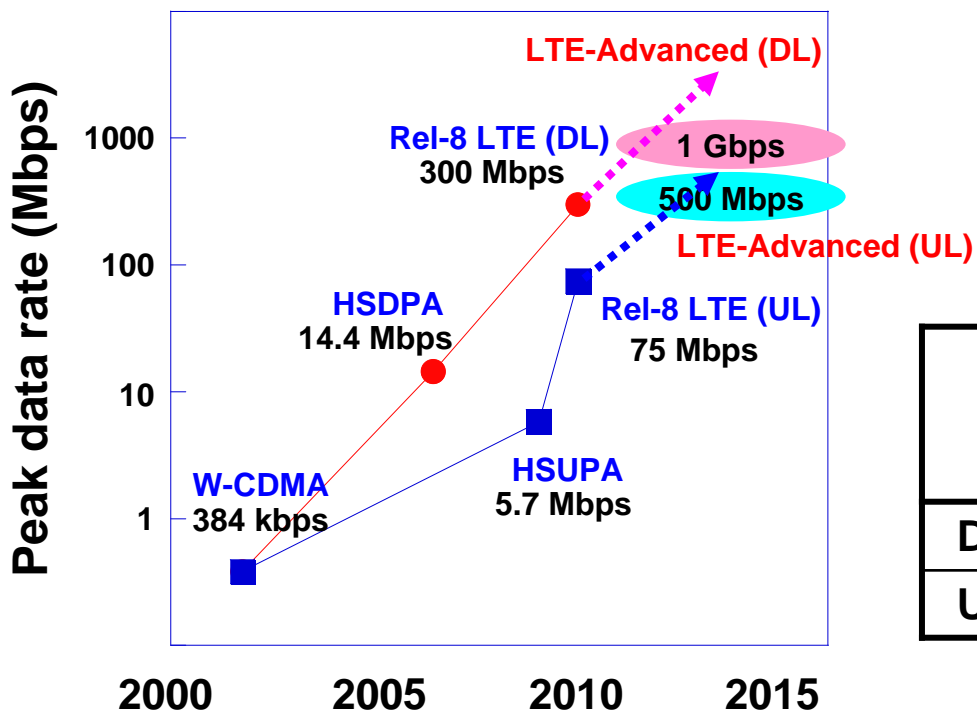
General requirements

- LTE-Advanced is an evolution of LTE
- All relevant requirements of LTE are valid also for LTE-Advanced
- LTE-Advanced shall meet or exceed IMT-Advanced requirements within the ITU-R time plan
- Targets of LTE-Advanced are adopted as long term targets



Peak data rate

- This requirement is defined as the highest theoretical data rate which system can support
- The target in ITU-R M.1645 of 1 Gbps can be an appropriate target for LTE-Advanced considering future traffic demand and expected technology evolution



	Rel-8 LTE evaluation results	LTE-Advanced target
DL	300 Mbps	1 Gbps
UL	75 Mbps	500 Mbps

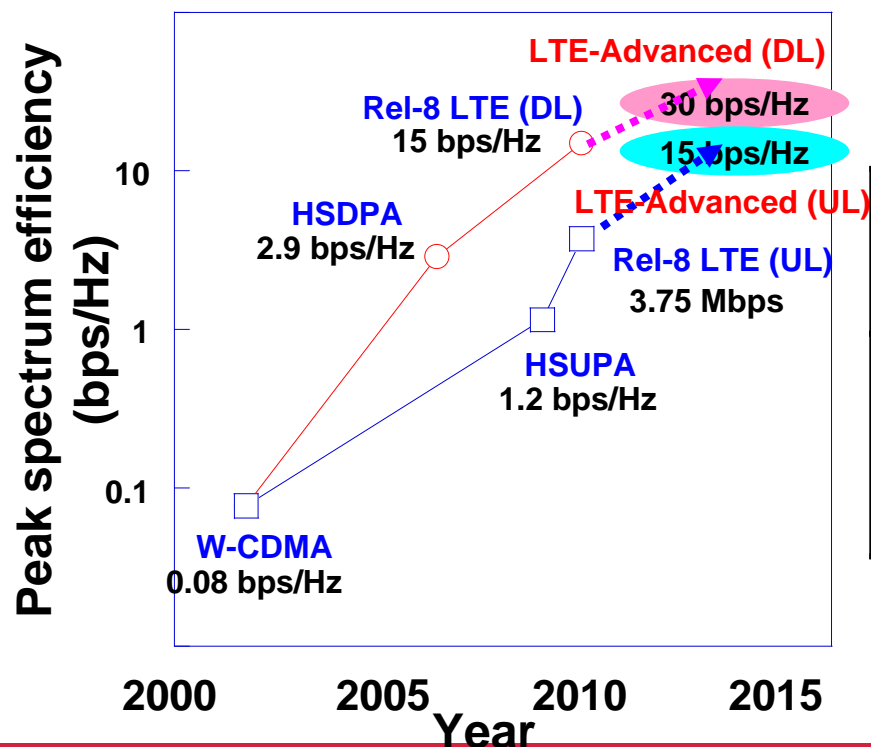
Latency

- C-Plane latency
 - This requirement is defined as the transition time from idle mode to connected mode
 - Further improvement from LTE are targeted in LTE-Advanced
- U-Plane latency
 - This requirement is defined as the one-way transit time in RAN for a packet being available at the IP layer
 - Further improvement from LTE are targeted in LTE-Advanced

	Rel-8 LTE Evaluation results	LTE-Advanced target	IMT-Advanced requirements
C-Plane latency	< 100 ms	Less than 50 msec	100 msec
U-Plane latency	5 msec	Better than LTE	10 msec

Peak spectrum efficiency

- This requirement is defined as the highest theoretical data rate normalized by spectrum bandwidth
- This requirement is essential in case of limited spectrum bandwidth
- Maximum antenna configurations, i.e. the maximum number of streams, are assumed to achieve the requirement



	Rel-8 LTE evaluation results	LTE-Advanced targets	IMT-Advanced requirements
DL	15 bps/Hz (4 streams)	30 bps/Hz (8 streams)	15 bps/Hz (4 streams)
UL	3.75 bps/Hz (1 stream)	15 bps/Hz (4 streams)	6.75 bps/Hz (2 streams)

Average spectrum efficiency

- This requirement is defined as the aggregate throughput of all users normalized by bandwidth and divided by the number of cells
- Requirements for four radio environments are specified in ITU-R and to be specified in 3GPP
 - Indoor, Microcellular, Base coverage urban and high speed
- This requirement is essential for operators in terms of capacity and cost per bit



Targets/requirements for the radio environment of Case 1^(*) /Base coverage urban^(**)

	Antenna configurations	LTE (Rel-8) [bps/Hz/cell] ^(*)	LTE-Advanced [bps/Hz/cell] ^(*)	Improvement from LTE		IMT-Advanced ^(**)
DL	2x2	1.69	2.4	42%		–
	4x2	1.87	2.6	39%	App. 10%	2.2
	4x4	2.67	3.7	39%	App. 50%	–
UL	1x2	0.74	1.2	62%		–
	2x4	–	2.0	–	App. 70%	1.4

^(*) Based on radio environment of “Case 1”

Inter-cell distance: 500 m, carrier frequency: 2 GHz, bandwidth: 10 MHz, DL Tx power: 46 dBm, penetration loss: 20 dB: mobility speed: 3 km/h (see 3GPP TR 25.814)

^(**) Based on radio environment of “Base coverage urban”

Similar model to 3GPP “Case 1” (see ITU-R IMT.EVAL)

Cell edge user throughput

- This requirement is defined as 5 % point of CDF of average user throughput normalized by bandwidth assuming 10 user in a cell
- Requirements for four radio environments are specified in ITU-R and to be specified in 3GPP
 - Indoor, Microcellular, Base coverage urban and high speed
- This requirement is essential for operators in terms of better user experience and coverage



Targets/requirements for the radio environment of Case 1^(*) /Base coverage urban^(**)

	Antenna configurations	LTE (Rel-8) [bps/Hz/cell] ^(*)	LTE-Advanced [bps/Hz/cell] ^(*)	Improvement from LTE		IMT-Advanced ^(**)
DL	2x2	0.05	0.07	40%		–
	4x2	0.06	0.09	50%		0.06
	4x4	0.08	0.12	50%		–
UL	1x2	0.024	0.04	67%		–
	2x4	–	0.07	–		0.03

^(*) Based on radio environment of “Case 1”

Inter-cell distance: 500 m, carrier frequency: 2 GHz, bandwidth: 10 MHz, DL Tx power: 46 dBm, penetration loss: 20 dB: mobility speed: 3 km/h (see 3GPP TR 25.814)

^(**) Based on radio environment of “Base coverage urban”

Similar model to 3GPP “Case 1” (see ITU-R IMT.EVAL)

Mobility

- 3GPP LTE-Advanced requirements
 - The system shall support mobility across the cellular network for various mobile speeds up to 350km/h (or perhaps even up to 500km/h depending on the frequency band).
 - System performance shall be enhanced for 0 to 10km/h

- ITU-R IMT-Advanced requirements
 - Traffic channel link data rates in four radio environments are specified as requirements of mobility assuming mobile speed. Antenna configurations of DL 4x2 and UL 2x4 are assumed

	Bits/s/Hz	Speed (km/h)
Indoor	1.0	10
Microcellular	0.75	30
Base coverage urban	0.55	120
High speed	0.25	350

Deployment related requirements

- 3GPP LTE-Advanced requirements
 - LTE-Advanced will be deployed as **an evolution of Release 8 LTE** and on new bands
 - LTE-Advanced shall be **backwards compatible with Release 8 LTE**. However, non-backward compatible element might be considered if significant gain or benefit can be achieved
 - It should be expected to have **increased deployment of indoor eNB and Home eNB** in LTE
 - In addition to the deployment scenario in Release 8 LTE, the system shall be considered in **indoor scenario**
 - Interworking with legacy RATs
 - Support of handovers with legacy RATs and network sharing are required
 - The same inter-RAT interworking capabilities with at least same performance as in Release 8 LTE shall be supported.

- ITU-R IMT-Advanced requirements
 - Inter-system handovers between the candidate IMT-Advanced system and at least one IMT system shall be supported.

Spectrum deployment

- 3GPP LTE-Advanced requirements
 - LTE-Advanced shall operate in spectrum allocations of **different sizes including wider spectrum allocations than those of Release 8 LTE** to achieve higher performance and the target peak data rate, e.g. **up to 100 MHz**
 - Main focus for wider bandwidth solution than 20MHz should be on **consecutive spectrum**, but **aggregation of the spectrum** for LTE-Advanced should be supported considering **reasonable UE complexity**
 - FDD and TDD should be supported for existing paired and unpaired band, respectively
 - For new identified band, **duplex mode** should be studied
 - LTE-Advanced is required to cope with following scenarios:
 - LTE-Advanced shall be possible to **operate standalone**
 - Operation of Release 8 LTE and LTE-Advanced **in the same spectrum**
- ITU-R IMT-Advanced requirements
 - IMT-Advanced system is able to utilize at least one band identified for IMT
 - **Scalable bandwidth** is the ability of the candidate RIT to operate with different bandwidth allocations. This bandwidth may be supported by **single or multiple RF carriers**.
 - The RIT shall support a scalable bandwidth **up to and including 40 MHz**
 - Proponents are encouraged to consider extensions to support operation in **wider bandwidths (e.g. up to 100 MHz)** and the research targets expressed in Recommendation ITU-R M.1645.

Cost related requirements

- 3GPP LTE-Advanced requirements
 - LTE-Advanced should allow **backhaul using LTE spectrum**
 - Further enhancements of **SON(Self-Organized Network) and self configuration** shall be an essential element
 - eNode B implementation cost efficiency and flexibility for multi-vendor deployments should be considered, such as **RF requirements in specific scenarios** or base station modularity aspects with e.g. **remote radio units and open interfaces**
- ITU-R IMT-Advanced key feature
 - One of the key features of IMT-Advanced is a high degree of commonality of functionality worldwide while retaining the flexibility to support a wide range of services and applications **in a cost efficient manner**

Overviews of IMT/LTE-Advanced requirements

		ITU-R IMT-Advanced Minimum requirements		3GPP LTE-Advanced Requirements and targets		3GPP Release 8 LTE Evaluation results (TR 25.912)			
Average spectrum efficiency (bit/s/Hz/cell)	Indoor	3 (4x2)	2.25 (2x4)	TBD	TBD	N/A	N/A		
	Microcellular	2.6 (4x2)	1.8 (2x4)	TBD	TBD	N/A	N/A		
	Base coverage urban	2.2 (4x2)	1.4 (2x4)	2.6 (4x2)	2.0 (2x4)	1.87 (4x2)	0.74 (1x2)		
	High speed	1.1 (4x2)	0.7 (2x4)	TBD	TBD	N/A	N/A		
Peak spectrum efficiency (bit/s/Hz)		15 (4x4)	6.75 (2x4)	30 (8x8)	15 (4x4)	15 (4x4)	3.75 (1Tx)		
Spectrum bandwidth		40 MHz		Wider than LTE, e.g. 100MHz		1.4-20 MHz			
Cell-edge user spectrum efficiency (bit/s/Hz)	Indoor	0.1 (4x2)	0.07 (2x4)	TBD	TBD	N/A	N/A		
	Microcellular	0.075 (4x2)	0.05 (2x4)	TBD	TBD	N/A	N/A		
	Base coverage urban	0.06 (4x2)	0.03 (2x4)	0.09 (4x2)	0.07 (2x4)	0.06 (4x2)	0.024 (1x2)		
	High speed	0.04 (4x2)	0.015 (2x4)	TBD	TBD	N/A	N/A		
Latency	C-plane, U-plane		< 100 msec, 10 msec		< 50 msec, Better than LTE		91 msec, 5 msec		
Mobility (bit/s/Hz/cell)	Indoor@10 km/h		1.0 (UL 2x4)		No worse than LTE		N/A	N/A	
	Microcellular@30 km/h		0.75 (UL 2x4)				N/A	N/A	
	Base coverage urban@120 km/h		0.55 (UL 2x4)				N/A	N/A	
	High speed@350 km/h		0.25 (UL 2x4)				N/A	N/A	
HO interruption time	Intra-frequency		27.5 msec		No worse than LTE		18.5 msec (DL), 25 msec (UL)		
	Inter-frequency	Within a spectrum band		40 msec			N/A		
		Between spectrum bands		60 msec					
VoIP capacity (Active users/cell/MHz)	Indoor		50		Better than LTE		N/A		
	Microcellular		40				N/A		
	Base coverage urban		40				44		
	High speed		30				N/A		

Conclusions

- In ITU-R SG5 meeting in November 2009, the three reports capturing the requirements and evaluation criteria for IMT-Advanced were approved
- 3GPP has started the study of LTE-Advanced since March 2008 to improve Release 8 LTE performance furthermore and to submit the study results to ITU-R as a candidate of IMT-Advanced
- 3GPP has general requirements that:
 - LTE-Advanced is an evolution of LTE
 - LTE-Advanced shall meet or exceed IMT-Advanced requirements within the ITU-R time plan
 - Targets of LTE-Advanced are adopted as long term targets
- Considering these general requirements, 3GPP approved LTE-Advanced requirements in June 2008
- Based on these requirements and evaluation conditions, aggressive discussion is on going and will be continued in 3GPP. Outcome of the study will be submitted from 3GPP to ITU-R in 2009 as a candidate of RIT for IMT-Advanced
- Evaluation conditions of LTE-Advanced considering alignment with those of IMT-Advanced were agreed in 3GPP so that evaluation results in 3GPP can be used for evaluation process in ITU-R