

IMT-Advanced Standardization Status and Future in ITU-R WP5D

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International Telecommunication Union

- ❖ UN specialized AGENCY, for information and communication technology issues
- ❖ The global focal point for governments and private sector in developing networks and services
- ❖ A forward-looking, dynamic organization (Dr. Toure)
- ❖ **Mission : bringing the benefits of ICT to all the world's inhabitants**

Plenipotentiary Conference

Council

Radiocommunication Sector

World Radiocommunication Conference (WRC)

Radiocommunication Assembly (RA)

Radio Regulations Board (RRB)

Advisory group

Study group

Radiocommunication Bureau (BR)

Telecommunication Standardization Sector

World Telecommunication Standardization Assembly (WTSA)

Advisory group

Study group

Telecommunication Standardization Bureau (TSB)

Telecommunication Development Sector

World Telecommunication Development Conference (WTDC)

Advisory group

Study group

Telecommunication Development Bureau (BDT)

Secretary- General

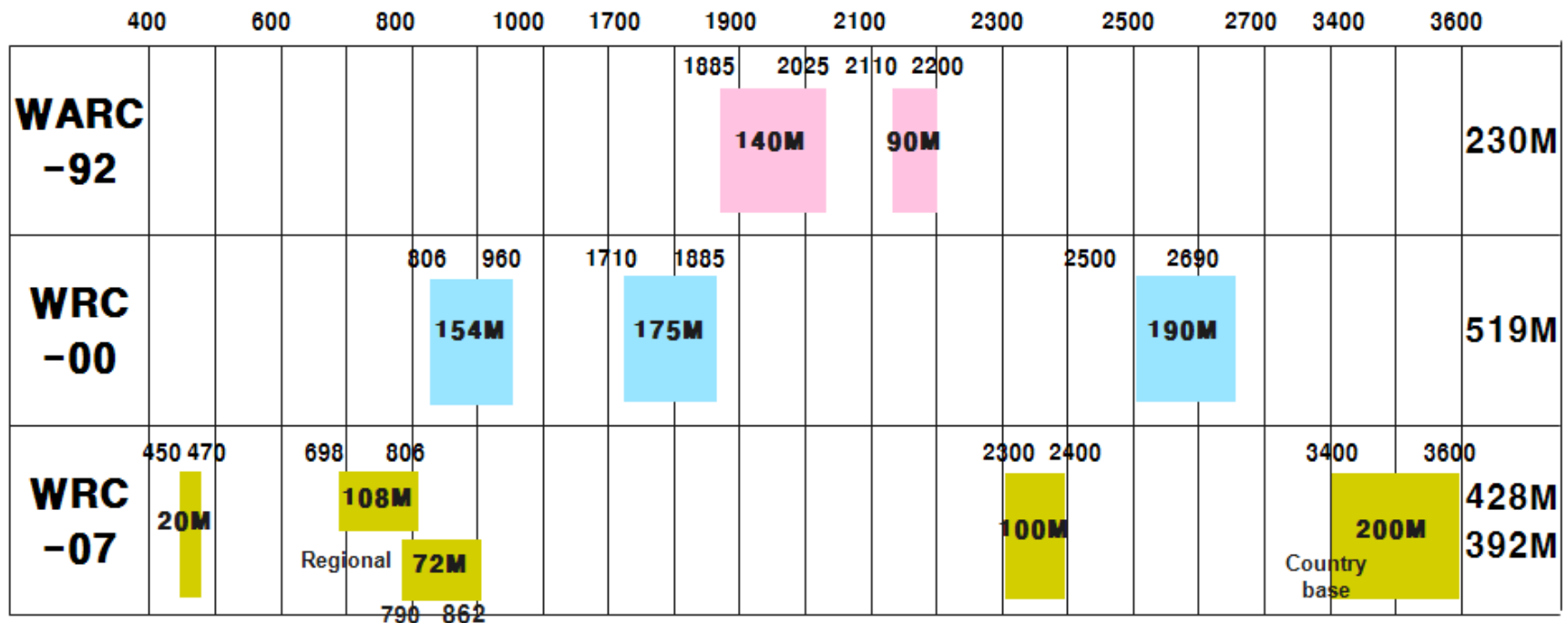
Deputy Secretary- General

World Radiocommunication Conference

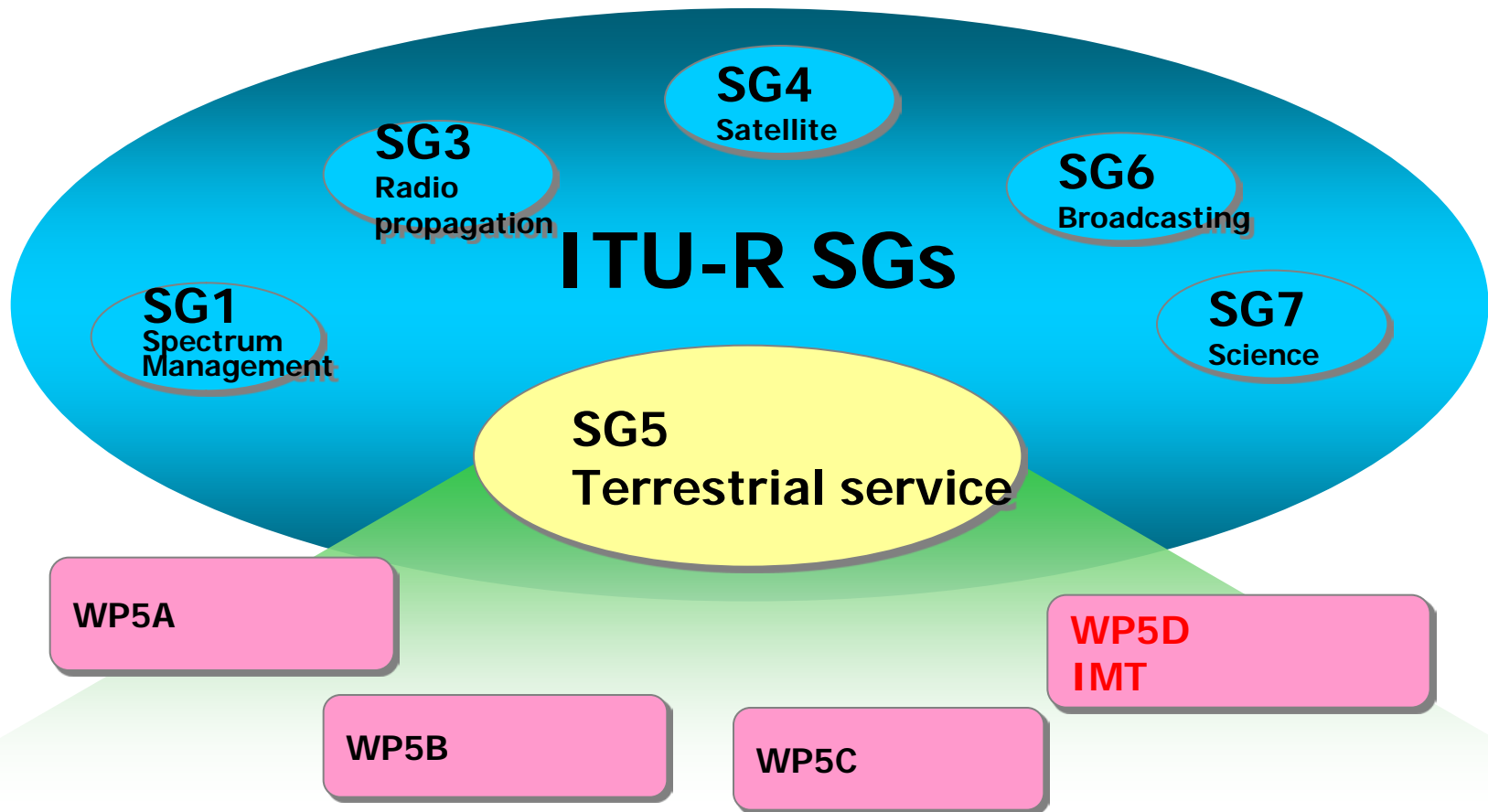
- World Radiocommunication Conferences (WRC) revise **Radio Regulations** (RR) (international use of frequency spectrum)
 - ◆ held every three-four years along with a Radiocommunication Assembly (RA)
 - ◆ Supported by two conference preparatory meetings
 - **RA-12: Jan. 16-Jan. 20, 2012, Geneva, Swiss**
 - **WRC-12: Jan. 23-Feb. 17, 2012, Geneva, Swiss**

Spectrum identification for IMT at WRC

- No distinction of IMT-2000 & IMT-Advanced in the use of frequency



ITU-R Study Groups - 1



ITU-R Study Groups - 2

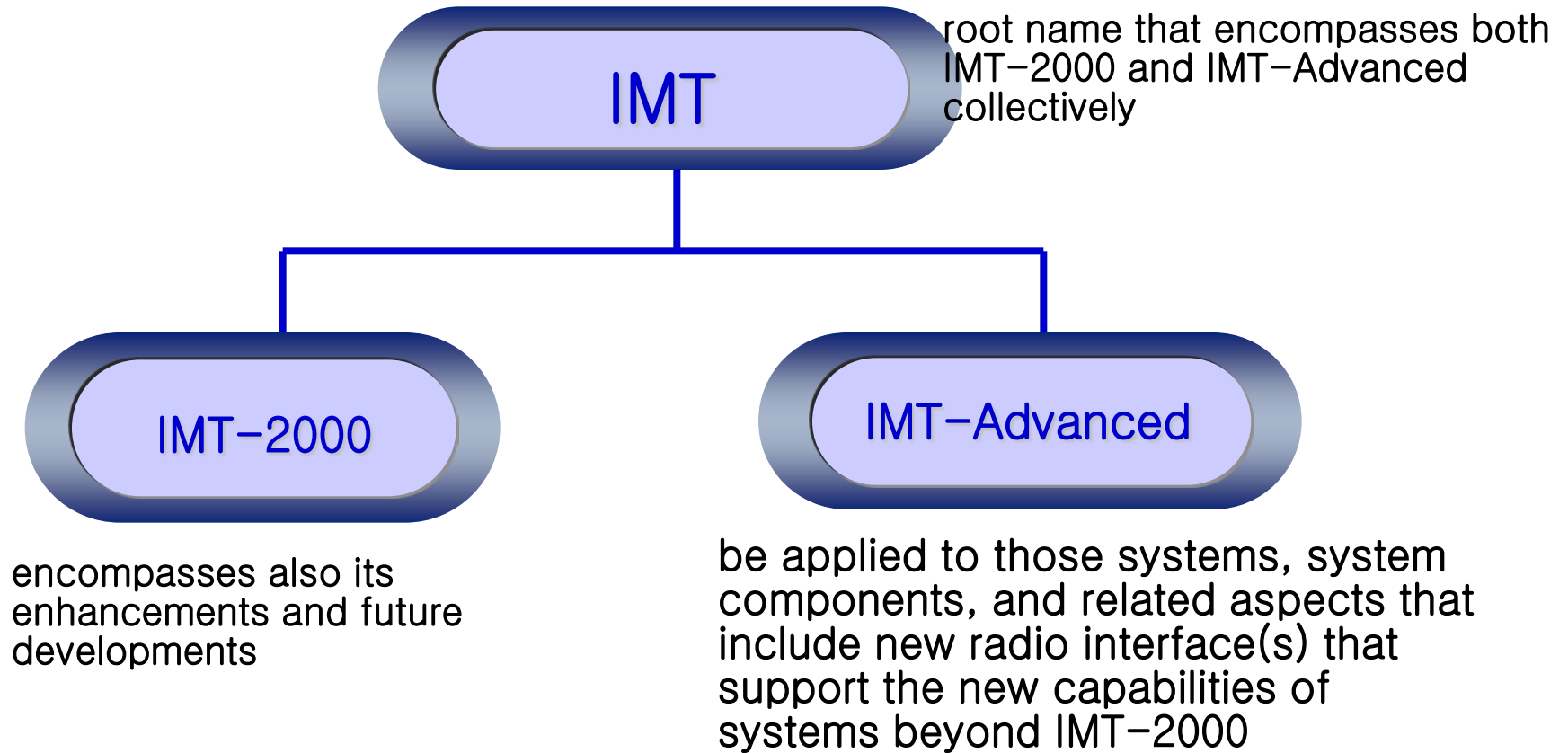
SG1 Spectrum Management	SG3 Radio propagation	SG4 Satellite Service	SG5 Terrestrial Services	SG6 Broadcasting service	SG7 Science services
WP1A Spectrum engineering techniques	WP3J Propagation fundamentals	WP4A orbit/spectrum utilization for FSS and BSS	WP5A Land Mobile (except IMT), Amateur	WP6A Terrestrial Broadcasting delivery	WP7A Time signals and frequency standard emissions
WP1B Spectrum management methodologies and economic strategies	WP3K Point-to-area propagation	WP4B FSS, BSS, MSS System and IP- based Application, SNG	WP5B Maritime, Aeronautical, radio determination service	WP6B BS assembly and access	WP7B Space radio communication applications
WP1C Spectrum monitoring	WP3L Ionospheric propagation and radio noise	WP4C orbit/spectrum utilization for MSS and RDSS	WP5C Fixed HF systems	WP6C Programme Production and quality assessment	WP7C Remote sensing systems
	WP3L Point-to-point and Earth-space propagation		WP5D IMT		WP7D Radio astronomy

ITU-R WP5D

- Under ITU-R SG5(terrestrial service)
 - ✂ **TG8/1** from 1985 ⇒ **WP8F** from 2000 ⇒ **WP5D** from 2008
- IMT-2000 and IMT-Advanced standardization and its update
- Channel arrangements and frequency sharing etc.

- Chairman and vice-chairmen
 - chairman: Stephen Blust (U.S.A)
 - vice-chairmen: Kyujin Wee (Korea), Hakan Ohlsen (Sweden)

IMT Naming (ITU-R Resolution 56)



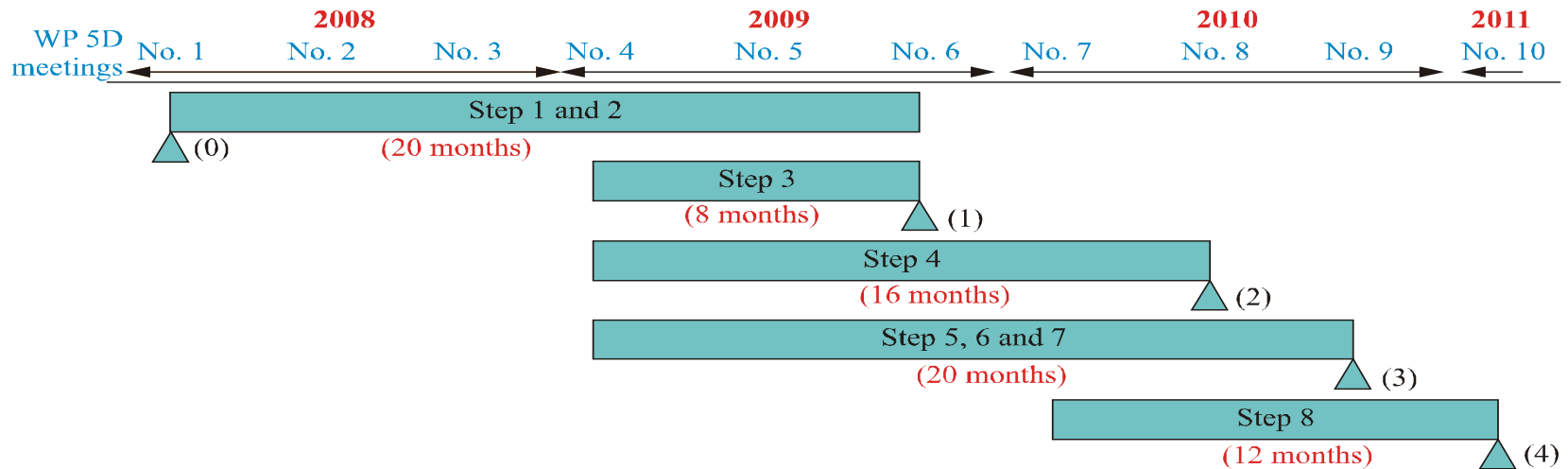
Importance in the standardization of IMT

- Internationally harmonized use of spectrum
- Global and international standardization rather than national and regional standardization
 - ◆ Cooperation with 3GPP, 3GPP2, IEEE
- Facilitation of worldwide market growth
- New business and role player through operators, manufacturers of communications and broadcasting services

IMT-Advanced standardization Process

- Development of Minimum Requirement
 - ◆ Spectrum, Technical and Service Aspect
- Submission
- Evaluation
- Consensus Building
- Radio Interface Specification(s)
- Approval of ITU

IMT-Advanced standardization schedule



Steps in radio interface development process:

Step 1: Issuance of the circular letter

Step 2: Development of candidate RITs and SRITs

Step 3: Reception of the RIT and SRIT submissions and acknowledgement of receipt

Step 4: Evaluation of candidate RITs and SRITs by evaluation groups

Step 5: Review and coordination of outside evaluation activities

Step 6: Review to assess compliance with minimum requirements

Step 7: Consideration of evaluation results, consensus building and decision

Step 8: Development of radio interface Recommendation(s)

Critical milestones in radio interface development process:

(0): issue an invitation to propose RITs

(1): ITU proposed cut off for submission of candidate RIT proposals

March 2008

October 2009

(2): Cut off for evaluation report to ITU

(3): WP 5D decides framework and key characteristics of IMT-Advanced RITs and SRITs

(4): WP 5D completes development of radio interface specification Recommendations

June 2010

October 2010

February 2011

IMT-Advanced standardization progress

- ❖ Issuance of Circular Letter (2008. 2)
- ❖ IMT-Advanced homepage in WP5D under SG5 in ITU-R
- ❖ Minimum requirements (2008. 6)
- ❖ Technology Description Template : ITU-R Report M.2133
- ❖ Compliance Template : ITU-R Report M.2134
- ❖ Evaluation guideline : ITU-R Report M.2135
- ❖ ITU-R Workshop on IMT-Advanced
 - 1st: Kyoto, Japan, (2007. 5. 22)
 - 2nd: Seoul, Korea (2008. 10. 7.)
 - 3rd: Dresden, Germany (2009. 10. 15.)

Six IMT-Advanced Candidate Proposals

(submitted at WP5D 6th meeting at Dresden, Germany, 2009. 10.)

Candidate Proposals	Proponent	Contents
IEEE 802.16m	IEEE	IEEE 802.16m (TDD/FDD)
	Japan	IEEE Technology excluding IPR
	Korea	IEEE Technology excluding IPR
LTE-Advanced	3GPP 39 members	LTE Release10&Beyond (TDD/FDD)
	Japan	LTE Release10&Beyond (TDD/FDD)
	China	LTE Release10&Beyond (TDD)

Documents submitted to ITU-R WP5D

(from 3GPP and IEEE)

- Technology description template, compliance template
- Self-evaluation report
- Statement of compliance of ITU policy on IPR

Registered Evaluation Groups

- [ARIB Evaluation Group](#)
- [ATIS WTSC](#)
- [Canadian Evaluation Group \(CEG\)](#)
- [Chinese Evaluation Group \(ChEG\)](#)
- [ETSI](#)
- [Israeli Evaluation Group \(IEG\)](#)
- [Russian Evaluation Group\(REG\)](#)
- [TCOE India](#)
- [TR-45 - TR-45 Evaluation Group web site](#)
- [TTA PG707](#)
- [UADE, Instituto de Tecnología \(Argentina\)](#)
- [WiMAX Forum Evaluation Group \(WFEG\)](#)
- [Wireless Communications Association International \(WCAI\)](#)
- [WINNER+ - Winner+ Evaluation Group web site](#)

Preliminary Evaluation Reports

submitted at WP5D 7th meeting (Torino, Italy)

●(submission) ○(partial submission) □(expected) ☆(under consideration) X(No evaluation) (Evaluation Groups)		Contributor #	3GPP LTE-Advanced						IEEE 802.16m						Remarks
			FDD			TDD			FDD			TDD			
			I	A	S	I	A	S	I	A	S	I	A	S	
1	ARIB(일)	628	X	X	X	X	X	X	X	X	X	X	X	X	
2	ATIS(미)	670/671	●	●	□	●	●	□	●	●	□	●	●	□	670(3GPP), 671(IEEE)
3	CEG(캐)	668	○	○	□	○	○	□	○	○	□	○	○	□	
4	ChEG(중)	650	●	●	●	●	●	●	□	□	□	□	□	□	
5	REG(러)	662	□	□	□	□	□	□	○	○	●	○	○	●	
6	TCOE(인)	657	●	○	□	●	○	□	□	□	□	□	□	□	*
7	TR-45(미)	669	○	○	□	○	○	□	○	○	□	○	○	□	
8	TTA PG707(한)	652/653	□	□	○	☆	☆	☆	□	□	○	□	□	○	652(3GPP), 653(IEEE)
9	WCAI(미)	667	-	-	-	-	-	-	●	●	●	●	●	●	
10	WFEG(와이맥스)	651	-	-	-	-	-	-	-	-	●	-	-	●	
11	WINNER+(유)	661	●	●	□	●	●	□	-	-	-	-	-	-	
12	Argentina														
13	Israel	-	-	-	-	-	-	-	-	-	-	-	-	-	
14	ETSI(유)														

Review Results of Preliminary Evaluation Reports

- Preliminary Evaluation Reports from 14 Evaluation Groups submitted at WP5D 7th meeting (Torino, 02/2010)
- All Preliminary Evaluation Reports state that

3GPP LTE-Advanced and IEEE 802.16m IMT-Advanced candidate technologies satisfy the minimum requirements of ITU-R IMT-Advanced.

IMT-Advanced standardization Workplan -1

- ❖ 3GPP/IEEE-Evaluation Coordination meeting
(Beijing, China, :2010.05.17~05.18)
- ❖ WP5D 8th meeting (Danang, Vietnam, 2010. 6. 9. – 2010. 6. 16.)
 - Consideration of *final Independent Evaluation Group reports*
 - Initial consideration on decisions on IMT-Advanced technology
 - Consensus building actions
- ❖ WP5D 9th meeting (China, 2010. 10.13. – 10. 20.)
 - WP 5D decision on IMT-Advanced
 - *Finalization of consensus building*
 - Development of a deliverable ITU.R M.[IMT.RADIO]

IMT-Advanced standardization Workplan -2

- ❖ WP5D 10th meeting (2011. 3. 9. 2011. 3. 16.)
 - *End of IMT-Advanced standardization*
 - Development of a deliverable ITU.R M.[IMT.RSPEC]
- ❖ SG5 meeting (Geneva, Swiss, 2011. 11. 22. – 2011. 11. 23.)
 - *Approval of IMT-Advanced standardization results*
- ❖ RA-12 meeting (Geneva, Swiss, 2012. 1. 16. – 2012. 1. 20.)
 - *Approval of IMT-Advanced standardization results*

Future Plan for Beyond IMT-Advanced

- Standardization of beyond IMT-Advanced (2012~2020) was just started at WP5D 7th meeting at Torino, Italy, 2010. 2.
 - ◆ in response to change of users' usage pattern (eg. Smart phone like i-Phone) and,
 - ◆ to meet the users' need of same application quality either in wire or wireless environments and etc.
 - ◆ may need for reviewing the market research report of ITU-R (2005) .
- Beyond IMT-Advanced Workshop will be held at WP5D 9th meeting (China, 2010. 10.).

Thank you!

Minimum Requirements of IMT-Advanced

Evaluation of IMT-Advanced

Minimum requirements of IMT-Advanced

- Cell spectral efficiency
- Peak spectral efficiency
- Bandwidth
- Cell edge user spectral efficiency
- Latency
- Mobility
- Handover
- VoIP capacity

1. Cell spectral efficiency

: the number of correctly received bits over a certain period of time divided by the channel bandwidth divided by the number of cells
(*b/s/Hz/cell*)

Test environment	downlink	uplink
Indoor	3	2.25
Microcellular	2.6	1.8
Base coverage urban	2.2	1.4
High speed	1.1	0.7

Assuming an antenna configuration of downlink 4x2, uplink 2x4

Test environments

- Indoor: an indoor environment targeting isolated cells **at offices and/or in hotspot based on stationary and pedestrian users**
- Microcellular: an urban micro-cellular environment with **higher user density focusing on pedestrian and slow vehicular users**
- Base coverage urban: an urban macro-cellular environment targeting continuous coverage **for pedestrian up to fast vehicular users**
- High speed: macro cells environment **with high speed vehicular and trains**

2. Peak spectral efficiency

: the highest theoretical data rate (normalised by bandwidth), which is the received data bits assuming error-free conditions assignable to a single mobile station, when all available radio resources for the corresponding link direction are utilised

- 15 bits/s/Hz for downlink
- 6.75 bits/s/Hz for uplink

Assuming an antenna configuration of downlink 4x4, uplink 2x4

3. Bandwidth

Scalable bandwidth up to and including 40MHz

- ✧ scalable bandwidth: ability to operate with different bandwidth allocations
 - ✧ *The bandwidth may be supported by single or multiple RF carriers*
 - ✧ *It is encouraged to consider extensions to support operation in wider bandwidths (e.g. up to 100MHz)*
- Example Downlink peak data rate in 40 MHz is 600 Mb/s.
 - Example Downlink peak data rate in 100 MHz is 1500 Mb/s.
 - Example Uplink peak data rate in 40 MHz is 270 Mb/s.

4. Cell edge user spectral efficiency

: defined as 5% point of CDF of the normalized user throughput ($b/s/Hz$)

Test environment	downlink	uplink
Indoor	0.1	0.07
Microcellular	0.075	0.05
Base coverage urban	0.06	0.03
High speed	0.04	0.015

Assuming an antenna configuration of downlink 4x2, uplink 2x4

5. Latency

5.1 Control plane latency

measured as transition time from different connection modes, e.g. from idle to active state; **less than 100ms**

5.2 User plane latency (transport delay)

defined as the one-way transit time between an SDU packet being available at the IP layer in the user terminal/base station and the availability of this packet (PDU) at IP layer in the base station/user terminal; **less than 10ms**

6. Mobility - 1

Mobility classes supported by each test environment			
Indoor	Microcellular	Base coverage urban	High speed
stationary pedestrian	stationary, pedestrian, vehicular (up to 30km/h)	stationary, pedestrian, vehicular	high speed vehicular, vehicular

- Stationary: 0 km/h
- Pedestrian: > 0 km/h to 10 km/h
- Vehicular: 10 to 120 km/h
- High speed vehicular: 120 to 350 km/h

6. Mobility - 2

Traffic channel link data mobility

Test environment	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

Assuming an antenna configuration of downlink 4x2, uplink 2x4

7. Handover

Handover interruption time is defined as the time duration during which a user terminal cannot exchange user plane packets with any base station

Handover Type	Interruption Time (ms)
Intra-frequency	27.5
Inter-frequency	
- within a spectrum band	40
- between spectrum bands	60

8. VoIP capacity (active users/sector/MHz)

It is the minimum of the calculated capacity for either link direction divided by the effective bandwidth in the respective link direction. The effective bandwidth is the operating bandwidth normalized appropriately considering the uplink/downlink ratio.

Test environment	Min VoIP capacity
Indoor	50
Microcellular	40
Base coverage urban	40
High speed	30

Assuming an antenna configuration of downlink 4x2, uplink 2x4

Evaluation of IMT-Advanced

Compliance templates

- Compliance template for services
- Compliance template for spectrum
- Compliance template for technical performance

Compliance template for services

	Service related minimum capabilities within the RIT/SRIT	Evaluator's comments
4.2.4.1.1	<p align="center">Support of a wide range of services</p> <p align="center">Does the proposal support a wide range of services?: If bullets 4.2.4.1.1.1 - 4.2.4.1.1.3 are marked as "yes" then 4.2.4.1.1 is a "yes". <input type="checkbox"/> YES / <input type="checkbox"/> NO</p>	
4.2.4.1.1.1	<p align="center">Ability to support basic conversational service class</p> <p align="center">Is the proposal able to support basic conversational service class?: <input type="checkbox"/> YES / <input type="checkbox"/> NO</p>	
4.2.4.1.1.2	<p align="center">Support of rich conversational service class</p> <p align="center">Is the proposal able to support rich conversational service class?: <input type="checkbox"/> YES / <input type="checkbox"/> NO</p>	
4.2.4.1.1.3	<p align="center">Support of conversational low delay service class</p> <p align="center">Is the proposal able to support conversational low-delay service class?: <input type="checkbox"/> YES / <input type="checkbox"/> NO</p>	

Compliance template for spectrum

	Spectrum capability requirements
4.2.4.2.1	<p>Spectrum bands</p> <p>Is the proposal able to utilize at least one band identified for IMT?: <input type="checkbox"/> YES / NO</p> <p>Specify in which band(s) the candidate RIT or candidate SRIT can be deployed.</p>

Compliance template for technical performance

-1

	Category		required	Value	Requirement met?	Comments
	Test environment	Downlink or uplink				
4.2.4.3.1 Cell spectral efficiency (bit/s/Hz/cell) (4.1)	Indoor	Downlink	3		<input type="checkbox"/> Yes/No	
		Uplink	2.25		<input type="checkbox"/> Yes/No	
	Microcellular	Downlink	2.6		<input type="checkbox"/> Yes/No	
		Uplink	1.8		<input type="checkbox"/> Yes/No	
	Base coverage urban	Downlink	2.2		Yes/ No	
		Uplink	1.4		<input type="checkbox"/> Yes/No	
	High speed	Downlink	1.1		<input type="checkbox"/> Yes/No	
		Uplink	0.7		<input type="checkbox"/> Yes/No	

Compliance template for technical performance –2

	Category		required	Value	Requirement met?	Comments
	Test environment	Downlink or uplink				
4.2.4.3.2 Peak spectral efficiency (bit/s/Hz) (4.2)	Not applicable	Downlink	15		<input type="checkbox"/> Yes <input type="checkbox"/> No	
		Uplink	6.75		<input type="checkbox"/> Yes <input type="checkbox"/> No	
4.2.4.3.3 Bandwidth (MHz) (4.3)	Not applicable	Up to and including	40		<input type="checkbox"/> Yes <input type="checkbox"/> No	
		Scalability			<input type="checkbox"/> Yes <input type="checkbox"/> No	

Support of at least three bandwidth values

Selected deployment scenarios

Test environment	Base coverage urban	Microcellular	Indoor	High speed
Deployment scenario	Urban macro-cell scenario	Urban micro-cell scenario	Indoor hotspot scenario	Rural macro-cell scenario

- **The number of test environments required for IMT-Advanced is 3.**

Baseline evaluation parameters -1

Deployment scenario for the evaluation process	Urban macro-cell	Urban micro-cell	Indoor hotspot	Rural macro-cell	Suburban macro-cell
Base Station (BS) antenna height	25 m, above rooftop	10 m, below rooftop	6 m, mounted on ceiling	35 m, above rooftop	35 m, above rooftop
Number of BS antenna elements	Up to 8 rx Up to 8 tx	Up to 8 rx Up to 8 tx	Up to 8 rx Up to 8 tx	Up to 8 rx Up to 8 tx	Up to 8 rx Up to 8 tx
Total BS TX power at antenna feed point	46dBm for 10MHz, 49dBm for 20MHz	41 dBm for 10MHz, 44 dBm for 20MHz	24dBm for 40 MHz, 21 dBm for 20 MHz	46dBm for 10MHz, 49dBm for 20MHz	46dBm for 10MHz, 49dBm for 20MHz
User Terminal (UT) power class	24dBm	24dBm	21dBm	24dBm	24dBm
UT antenna system	Up to 2 tx Up to 2 rx	Up to 2 tx Up to 2 rx	Up to 2 tx Up to 2 rx	Up to 2 tx Up to 2 rx	Up to 2 tx Up to 2 rx

Baseline evaluation parameters - 2

Deployment scenario for the evaluation process	Urban macro-cell	Urban micro-cell	Indoor hotspot	Rural macro-cell	Suburban macro-cell
Minimum distance between UT and serving cell	≥ 25 meters	≥ 10 meters	≥ 3 meters	≥ 35 meters	≥ 35 meters
Carrier Frequency (CF) for evaluation (representative of IMT bands)	2GHz	2.5 GHz	3.4 GHz	800 MHz	Same as Urban macro-cell
Outdoor to Indoor building penetration loss	N.A.	see Annex 1 Table A1-1	N.A.	N.A.	20 dB
Outdoor to in-car penetration loss	9 dB (LN, $\sigma = 5$ dB)	N.A.	N.A.	9 dB (LN, $\sigma = 5$ dB)	9 dB (LN, $\sigma = 5$ dB)