Guidelines for evaluation of radio interface technologies for IMT-2020 "Report ITU-R M.[IMT-2020.EVAL]"

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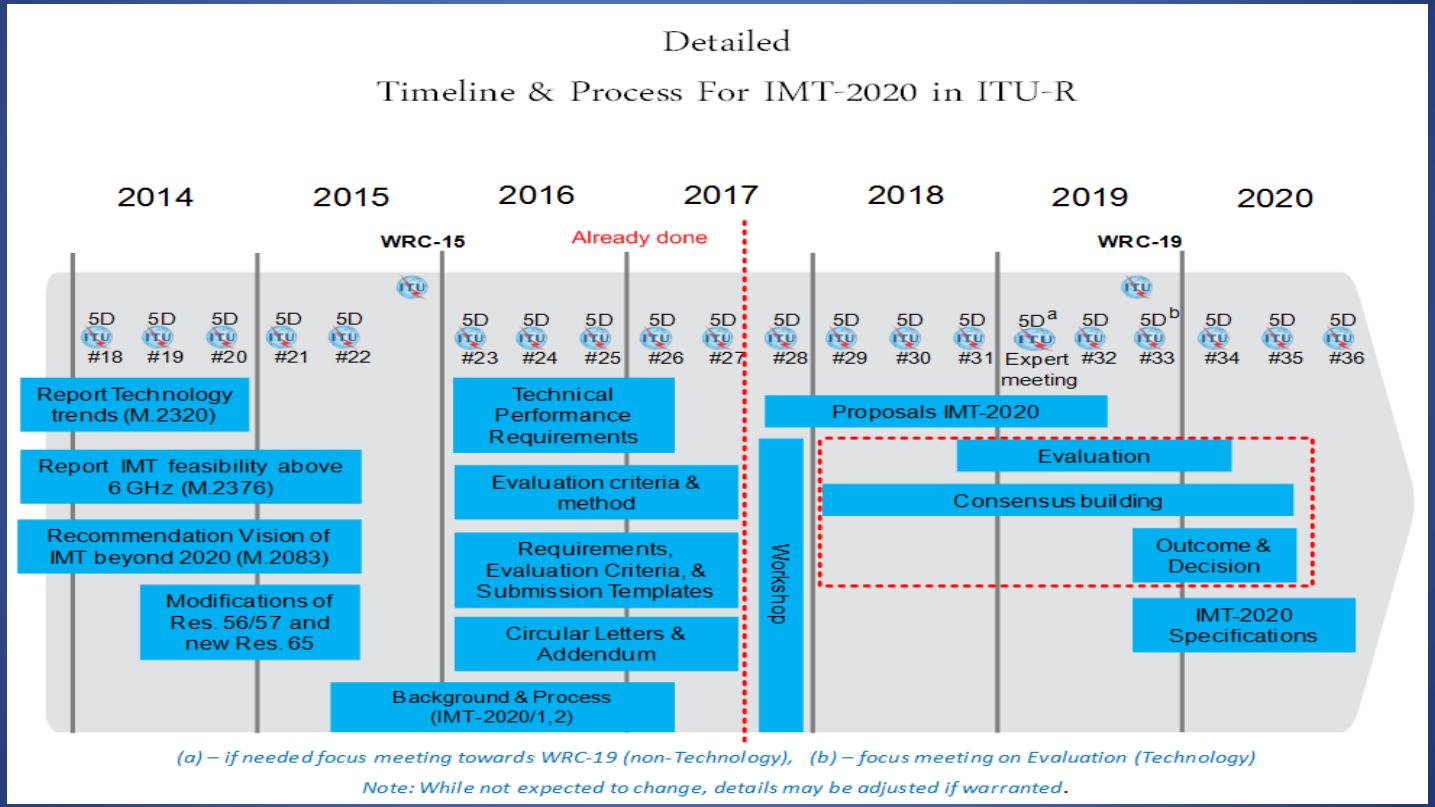
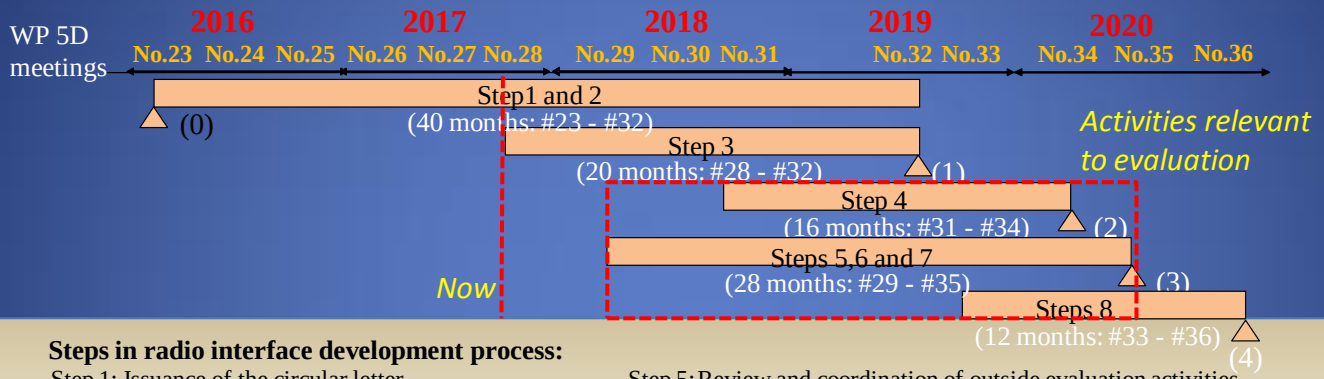
Outline

- Introduction
- Evaluation Criteria and Guidelines
  - General Evaluation Guidelines
  - Test Environments
  - Characteristics for Evaluation
  - Network layout and Evaluation configurations
  - Channel modelling
- Conclusion

Overall work plan for IMT-2020



Overall work plan for IMT-2020



Steps in radio interface development process:

Step 1: Issuance of the circular letter

Step 2: Development of candidate RITs and SRITs

Step 3: Submission/Reception of the RIT and SRIT proposals and acknowledgement of receipt

Step 4: Evaluation of candidate RITs and SRITs by Independent 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 — March 2016

(1): ITU proposed cut off for submission of candidate RIT and SRIT proposals — July 2019

(2): Cut off for evaluation report to ITU — February 2020

(3): WP 5D decides framework and key characteristics of IMT-2020 RIT and SRIT — June 2020

(4): WP 5D completes development of radio interface specification Recommendations — October 2020

IMT-2020 2-01

Introduction to “Report ITU-R M.[IMT-2020.EVAL]”

Activities history

- Initiated at WP-5D #23 (Feb.2016, Beijing)
- Developed during WP-5D #24-#27
- Offline discussions during meeting gaps
- Finalize the report at WP-5D #27 (June 2017, Niagara Falls)

Volume

140 pages including

M.2135: 68 pages in total

- 33-page main body
- 105-page annex for channel modelling
- 2-page annex for optional cell layout

Table of contents

General Evaluation Guidelines

- Principles
  - The evaluation shall be performed based on the submitted technology proposals
  - Proposals' evaluation shall follow this report on:
    - Evaluation guidelines
    - Evaluation methodology
    - Evaluation configurations

- Self evaluation
  - Must be a complete evaluation

- External evaluation group
  - May perform complete or partial evaluation
  - May evaluate one or several technology proposals
  - Evaluations covering several technology proposals are encouraged

Test environments

Test environments are chosen to
- model typical and different deployments are modeled
- investigate critical aspects in system design and performance
- reflect a combination of geographic environment and usage scenario

Usage scenarios	Test environment	Definition
eMBB	Indoor Hotspot - eMBB	An indoor isolated environment at offices and/or in shopping malls based on stationary and pedestrian users with very high user density.
	Dense Urban – eMBB	An urban environment with high user density and traffic loads focusing on pedestrian and vehicular users.
	Rural – eMBB	A rural environment with larger and continuous wide area coverage, supporting pedestrian, vehicular and high speed vehicular users.
mMTC	Urban Macro - mMTC	An urban macro environment targeting continuous coverage focusing on a high number of connected machine type devices.
URLLC	Urban Macro - URLLC	An urban macro environment targeting ultra-reliable and low latency communications

Characteristics for Evaluation

Characteristics chosen for evaluation include
- Service requirements based on M.[IMT-2020.SUBMISSION]
- Spectrum aspect requirements based on M.[IMT-2020.SUBMISSION]
- Technical performance requirements based on M.[IMT-2020.TECH PERF REQ]

Evaluation methodology
- System simulation composed of
  - Link-level simulations and/or
  - System-level simulation
- Analytical approach
  - Straight forward calculation
- Inspection approach
  - Reviewing the functionality and parameterization of a proposal

Requirement	Characteristic for evaluation	High-level assessment method
Service aspect requirements	Support of wide range of services	Inspection
Spectrum aspect requirements	Supported spectrum band(s)/range(s)	Inspection

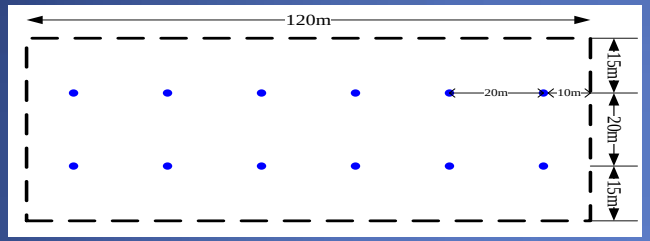
Requirement	Characteristic for evaluation	High-level assessment method	Usage scenario / Test environments
Technical performance requirements	Peak data rate	Analytical	eMBB
	Peak spectral efficiency	Analytical	eMBB
	User experienced data rate	Analytical for single band and single layer; Simulation for multi-layer	Dense urban-eMBB
	5th percentile user spectral efficiency	Simulation	Indoor Hotspot –eMBB; Dense Urban –eMBB; Rural –eMBB
	Average spectral efficiency	Simulation	Indoor Hotspot –eMBB; Dense Urban –eMBB; Rural -eMBB
	Area traffic capacity	Analytical	Indoor hotspot -eMBB
	User plane latency	Analytical	eMBB and URLLC
	Control plane latency	Analytical	eMBB and URLLC
	Connection density	Simulation	Urban Macro –mMTC
	Energy efficiency	Inspection	eMBB
	Reliability	Simulation	Urban Macro –URLLC
	Mobility	Simulation	Indoor Hotspot –eMBB; Dense Urban –eMBB; Rural –eMBB
	Mobility interruption time	Analytical	eMBB and URLLC
	Bandwidth	Inspection	-

8 for eMBB, 3 for eMBB and URLLC,1 for URLLC, 1 for mMTC and 1 for all

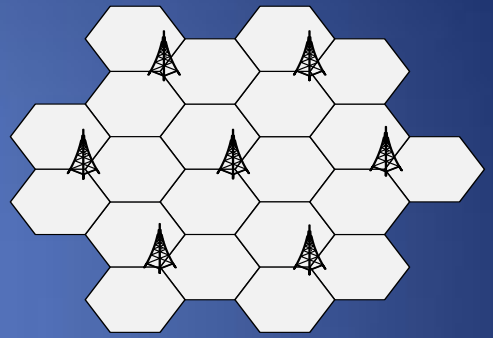
Characteristic for evaluation	Further details of simulation	Applicable for
User experienced data rate	System level simulation (for multi-layer)	Both uplink and downlink
5th percentile user spectral efficiency	System level simulation	Both uplink and downlink
Average spectral efficiency	System level simulation	Both uplink and downlink
Connection density	Two possible evaluation methods: - Non-full buffer system-level simulation - Full-buffer system-level simulation followed by link-level simulation	Uplink
Reliability	System level simulation followed by link level simulation	Uplink or downlink
Mobility	System level simulation followed by link level simulation	Uplink Similar for downlink in case this is additionally evaluated

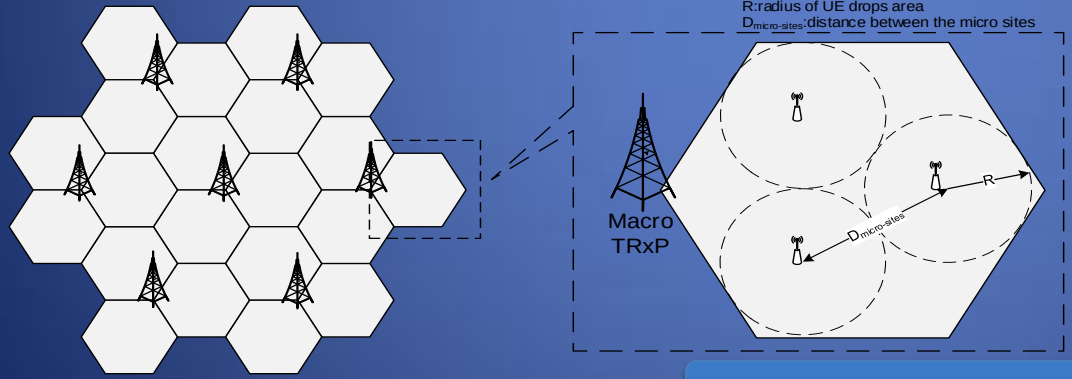
Evaluation methodology of 6 out of 14 TPRs is SIMULATION

Network layout



Indoor Hotspot sites layout





Example sketch of dense urban-eMBB layout

Sketch of hexagonal site layout for
- **Macro-layer of Dense Urban-eMBB**
- **Rural-eMBB**
- **Urban Macro-mMTC**
- **Urban Macro-URLLC**

Evaluation configurations

The parameters (also the propagation and channel model)

- Solely for the purpose of consistent evaluation of the candidate RITs/SRITs and relate only to specific test environments designed for these evaluations
- Should not
  - be considered as those that must be used in any deployment of any IMT-2020 system
  - be taken as the default values for any other or subsequent study in ITU or elsewhere
  - constitute any requirements on the implementation of the system by themselves

Applied in
-Analytical and
-Simulation assessments of candidate RITs/SRITs

Some parameters specified in terms of a range of values

- To provide some flexibilities in the evaluation process

- Meeting the TPR is not necessarily associated with the lowest/highest value in the range

Evaluation configurations

- Evaluation configurations include
  - Evaluation configurations for each of all 5 test environments respectively including (Table 8-2 a-e)
    - Baseline parameters
    - Additional parameters for system-level simulation
  - Additional parameters for link-level simulation for mobility, reliability and connection density (Table 8-3)
  - Evaluation configuration parameters for analytical assessment of peak data rate, peak spectral efficiency (Table 8-4)
  - Additional channel model parameters for link-level simulation (Table 8-5)

Usage scenarios	Test environment	Number of Evaluation configurations	Main differences between configurations
eMBB	Indoor Hotspot - eMBB	3	Config.A: 4GHz Config. B: 30GHz Config. C: 70GHz and corresponding parameters
	Dense Urban – eMBB	2 for spectral efficiency 1 for user experience data rate	Spectral efficiency: Config.A: 1 layer(Macro) with 4GHz Config.B: 1 layer(Macro) with 30GHz User experience data rate Config. C: 1 or 2 layers (Macro+Micro); 4GHz and 30GHz available in macro and micro layers and corresponding parameters
	Rural – eMBB	2 for spectral efficiency and mobility evaluations 1 for average spectral efficiency evaluation	Config.A: 700MHz/ISD 1732m Config. B: 4GHz/ISD 1732m Config. C: 700MHz/ISD 6000m and corresponding parameters
mMTC	Urban Macro - mMTC	2	Config.A: 700MHz/ISD 500m Config. B: 700MHz/ISD 1732m and corresponding parameters
URLLC	Urban Macro - URLLC	2	Config.A: 4GHz Config. B: 700MHz and corresponding parameters

More than 1 evaluation configurations under a specific test environment, and 12 evaluation configurations in total

Evaluation configurations

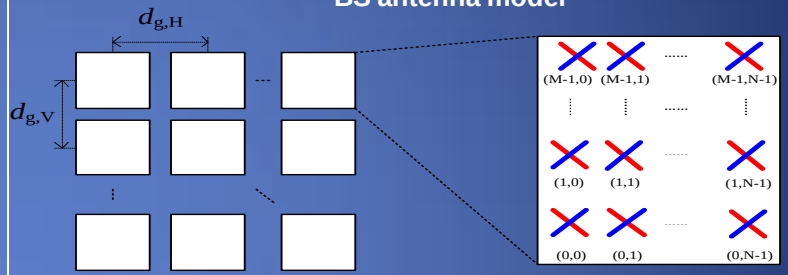
Multiple evaluation configurations

- Multiple evaluation configurations under the selected test environment
  - One of evaluation configurations can be used
  - TPR fulfilled condition under a specific test environment: one of evaluation configurations meets the TPR
  - In addition, for the Rural-eMBB test environment
    - The average spectral efficiency value should meet the threshold values for
      - LMLC evaluation configuration with ISD of 6 000 m
      - Either evaluation configuration with ISD of 1732 m

Antenna characteristics

- Applied for
  - The evaluation in test environments with the hexagonal grid layouts and/or the non-hexagonal layouts
- Used only for the evaluation
- Do not form any kind of requirements

FIGURE 8-F4
BS antenna model

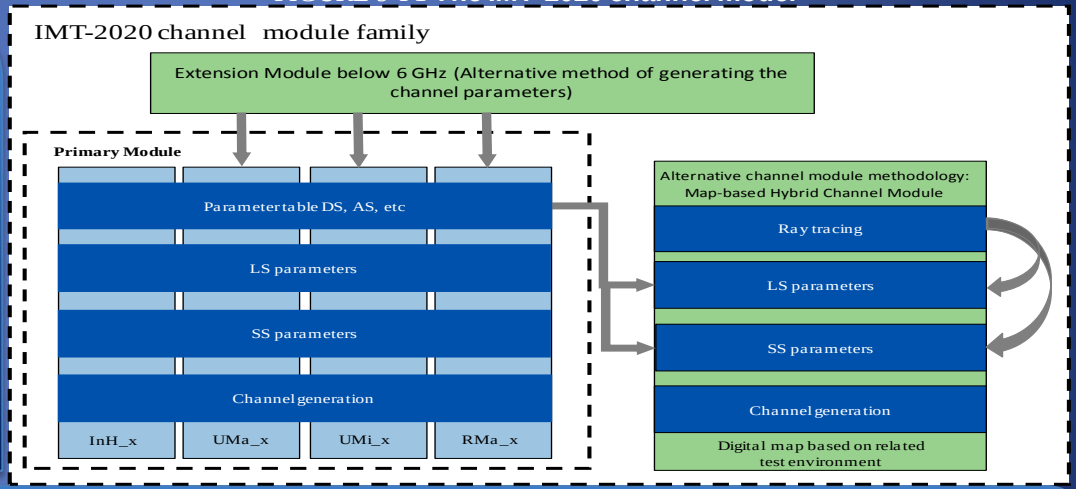


- Including
  - BS antenna
    - BS antenna orientation
  - UE antenna

Channel models approach

- Covering all required TEs and usage scenarios
- Consists of
  - A Primary Module
  - An Extension module (optional means of generating fading parameters)
  - A Map based Hybrid Channel Module (optional channel modelling method)

FIGURE 9-F1 **The IMT-2020 channel model**



New features captured in IMT-2020 channel model compared to IMT-Advanced channel model, such as supporting:
- frequencies up to 100 GHz and large bandwidth
- three dimensional (3D) modelling,
- large antenna array, blockage modelling, and spatial consistency, etc

Channel model for evaluation

Two channel model variants

- For system level simulation
  - Channel model A and B of primary module
  - Can select either to evaluate a test environment while the same variant to all test environments
  - TPR fulfilled condition under a specific test environment:
    - The requirement met for either channel model

Relative submission issues

- Proponent should report
  - Evaluation configuration(s) with their exact values (e.g. antenna element number, bandwidth,etc.) per test environment
  - Channel model variant used
  - Selected methodology of the connection density
  - Other relevant information

Ref. M.[IMT-2020. SUBMISSION]

Conclusion

- ITU-R M.[IMT-2020.EVAL]
  - The guideline for evaluating IMT-2020 technology proposals
    - The report ’s completed at the ITU-R WP 5D #27 (June 2017)
    - The report will be sent to ITU-R SG5 for final approval
- It is encouraged to submit a contribution to WP5D (SWG Evaluation) if proponents or external evaluators have any proposal for update or correction on the report
- Proponents or external evaluators can contact the following people for clarification questions
  - Main body: Dr. Ying Peng (pengying@catt.cn), Dr. Jungsoo Jung (jungsoo@samsung.com)
  - Annex channel model: Dr. Jianhua Zhang (jhzhang@bupt.edu.cn)

Thank You