Minimum Technical Performance Requirements for IMT-2020 radio interface(s)

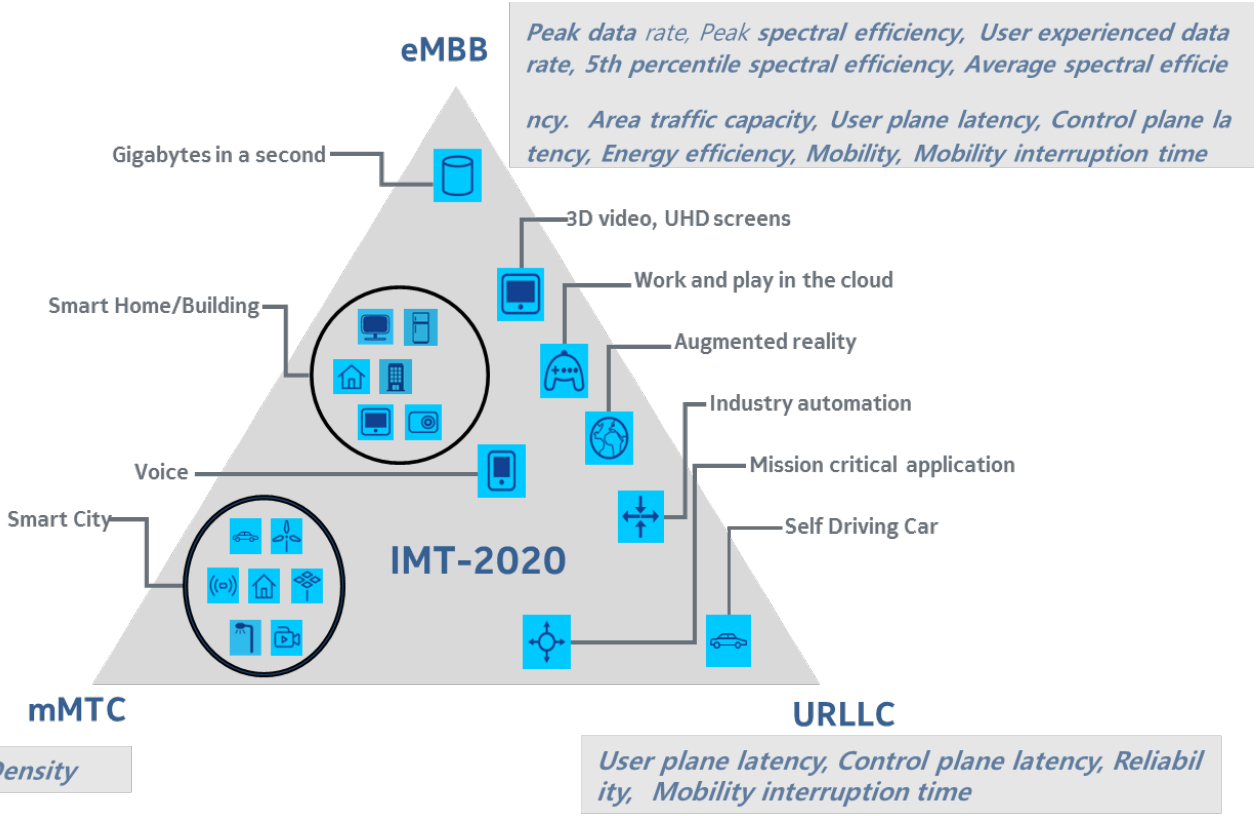
Eiman Mohyeldin

ITU-R Workshop on IMT-2020 terrestrial radio interfaces

Introduction

- The capabilities of IMT-2020 are identified such that IMT-2020 is more **flexible, reliable and secure** than previous IMT and providing **diverse services**
- IMT-2020 can be considered from multiple perspectives, including the users, manufacturers, application developers, network operators, and service and content providers. Therefore, it is recognized that technologies for IMT-2020 can be applied in a **variety of deployment scenarios and can support a range of environments, service capabilities, and technology options**.
- The key minimum technical performance requirements are defined for the purpose of consistent definition, specification, **and evaluation of the candidate IMT-2020 radio interface technologies (RITs)/Set of radio interface technologies (SRIT)**
- The intent of these requirements is to ensure that IMT-2020 technologies are **able to fulfil the objectives of IMT-2020** and to set a specific level of performance that each proposed RIT/SRIT needs to achieve in order to be **considered by ITU-R for IMT-2020.**
- These requirements are **not intended to restrict the full range of capabilities or performance that candidate RITs/SRITs for IMT-2020** might achieve, nor are they intended to describe how the RITs/SRITs might perform in actual deployments under operating conditions that could be different from those presented in other ITU-R Recommendations and Reports on IMT-2020.

Usage scenarios of IMT for 2020 and the key performance requirements



Bandwidth is the capability of the RIT/SRIT, hence it is a generic requirements and applicable to the IMT-2020 system

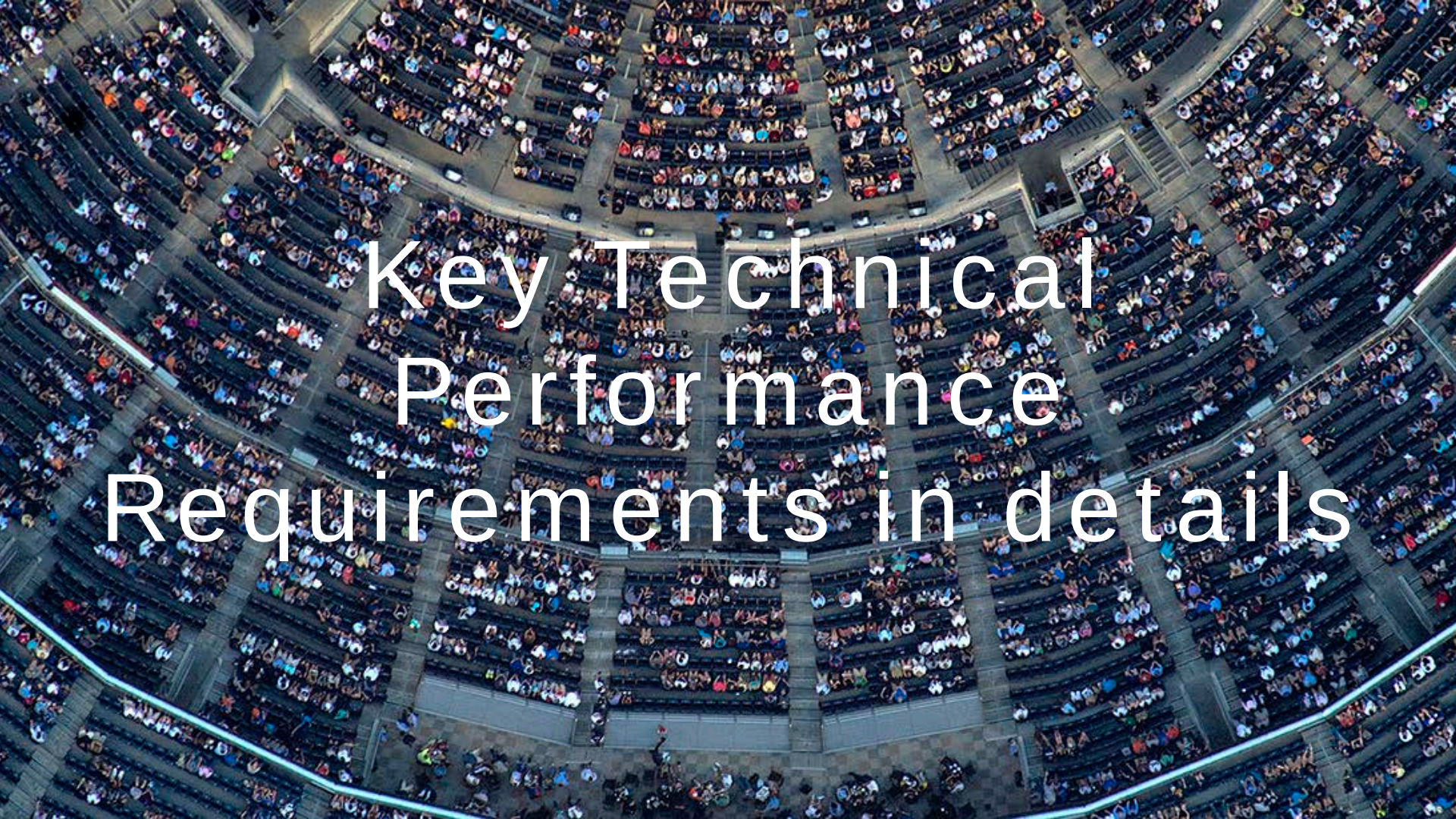
NOKIA

Minimum Technical Performance Requirement in nutshell (1/2)

Technical requirement	Usage scenario applicability				Target value
	eMBB	mMTC	URLLC	General/ Non-specific	
4.1 Peak date rate	√				DL: 20 Gbps UL: 10 Gbps
4.2 Peak spectral efficiency	√				DL: 30 bps/Hz UL: 15 bps/Hz
4.3 User experienced data rate	√				DL 100 Mbps UL 50 Mbps
4.4 5th percentile user spectral efficiency	√				TE / DL (bit/s/Hz) / UL (bit/s/Hz) InH: 0.3 / 0.21 DU: 0.225 / 0.15 RU: 0.12 / 0.045
4.5 Average spectral efficiency	√				TE / DL (bit/s/Hz) / UL (bit/s/Hz) InH: 9 / 6.75 DU: 7.8 / 5.4 RU: 3.3 / 1.6
4.6 Area traffic capacity	√				10 Mbit/s/m^2
4.7.1 User plane latency	√		√		URLLC: 1ms eMBB: 4ms
4.7.2 Control plane latency	√		√		20ms (10ms encouraged)

Minimum Technical Performance Requirement in nutshell (2/2)

Technical requirement	Usage scenario applicability				Target value		
	eMBB	mMTC	URLLC	General/ Non-specific			
4.8 Connection density		√			1,000,000 devices/km2		
4.9 Energy efficiency	√				Qualitative measure		
4.10 Reliability			√		1-10^{-5} Success Probability for TX 32B in 1ms		
4.11 Mobility	√				TE	TCDL(bits/s/Hz)	Mobility(km/h)
					InH	1.5	10
					DU	1.12	30
					RU	0.8	120
					RU	0.45	500
4.12 Mobility interruption time	√		√		0 ms		
4.13 Bandwidth				√	At least 100MHz, up to 1GHz for higher frequency bands		



Key Technical Performance Requirements in details

Minimum Technical Performance Requirement (1/5)

Peak data rate: *is the maximum achievable data rate under ideal conditions (in bit/s), which is the received data bits assuming error-free conditions assignable to a single mobile station, when all assignable radio resources for the corresponding link direction are utilized (i.e., excluding radio resources that are used for physical layer synchronization, reference signals or pilots, guard bands and guard times).*

This requirement is defined for the purpose of evaluation in the eMBB usage scenario. The minimum requirements for peak data rate are as follows:

- *Downlink peak data rate is **20 Gbit/s**.*
- *Uplink peak data rate is **10 Gbit/s***

Peak spectral efficiency: *is the maximum data rate under ideal conditions normalised by channel bandwidth (in bit/s/Hz), where the maximum data rate is the received data bits assuming error-free conditions assignable to a single mobile station, when all assignable radio resources for the corresponding link direction are utilized (i.e. excluding radio resources that are used for physical layer synchronization, reference signals or pilots, guard bands and guard times).*

This requirement is defined for the purpose of evaluation in the eMBB usage scenario.The minimum requirements for peak spectral efficiencies are as follows:

- *Downlink peak spectral efficiency is **30 bit/s/Hz**.*
- *Uplink peak spectral efficiency is **15 bit/s/Hz.***

User experienced data rate: *is the 5% point of the cumulative distribution function (CDF) of the user throughput. User throughput (during active time) is defined as the number of correctly received bits, i.e. the number of bits contained in the service data units (SDUs) delivered to Layer 3, over a certain period of time*

This requirement is defined for the purpose of evaluation in the related eMBB test environment.

The target values for the user experienced data rate are as follows in the Dense Urban – eMBB test environment:

- *Downlink user experienced data rate is **100 Mbit/s.***
- *Uplink user experienced data rate is **50 Mbit/s.***

Minimum Technical Performance Requirement (2/5)

Area traffic capacity: *is the total traffic throughput served per geographic area (in Mbit/s/m2). The throughput is the number of correctly received bits, i.e. the number of bits contained in the SDUs delivered to Layer 3, over a certain period of time. This requirement is defined for the purpose of evaluation in the related eMBB test environment.*

The target value for Area traffic capacity in downlink is $10\ \mathrm{Mbit/s/m^2}$ *in the Indoor Hotspot – eMBB test environment.*

User plane latency : *is the contribution of the radio network to the time from when the source sends a packet to when the destination receives it (in ms). It is defined as the one-way time it takes to successfully deliver an application layer packet/message from the radio protocol layer 2/3 SDU ingress point to the radio protocol layer 2/3 SDU egress point of the radio interface in either uplink or downlink in the network for a given service in unloaded conditions, assuming the mobile station is in the active state. This requirement is defined for the purpose of evaluation in the eMBB and URLLC usage scenarios. The minimum requirements for user plane latency are*

- ***4 ms for eMBB***
- ***1 ms for URLLC***

Control plane latency : *refers to the transition time from a most "battery efficient" state (e.g. Idle state) to the start of continuous data transfer (e.g. Active state). This requirement is defined for the purpose of evaluation in the eMBB and URLLC usage scenarios. The minimum requirement for control plane latency is* ***20 ms****. Proponents are encouraged to consider lower control plane latency, e.g.* ***10 ms****.*

Minimum Technical Performance Requirement (3/5)

Mobility interruption time: *is the shortest time duration supported by the system during which a user terminal cannot exchange user plane packets with any base station during transitions. The mobility interruption time includes the time required to execute any radio access network procedure, radio resource control signalling protocol, or other message exchanges between the mobile station and the radio access network, as applicable to the candidate RIT/SRIT.*
This requirement is defined for the purpose of evaluation in the eMBB and URLLC usage scenarios.. The minimum requirement for mobility interruption time is ***0 ms***

5th percentile user spectral efficiency: *is the 5% point of the CDF of the normalized user throughput. The normalized user throughput is defined as the number of correctly received bits, i.e., the number of bits contained in the SDUs delivered to Layer 3, over a certain period of time, divided by the channel bandwidth and is measured in bit/s/Hz. This requirement is defined for the purpose of evaluation in the eMBB usage scenario. The minimum requirements for 5th percentile user spectral efficiency for various test environments are summarized below*

Test environment	Downlink (bit/s/Hz)	Uplink (bit/s/Hz)
Indoor Hotspot – eMBB	0.3	0.21
Dense Urban – eMBB	0.225	0.15
Rural – eMBB	0.12	0.045

Average spectral efficiency: *is the aggregate throughput of all users (the number of correctly received bits, i.e. the number of bits contained in the SDUs delivered to Layer 3, over a certain period of time) divided by the channel bandwidth of a specific band divided by the number of TRxPs and is measured in bit/s/Hz/TRxP. This requirement is defined for the purpose of evaluation in the eMBB usage scenario.*
The minimum requirements for average spectral efficiency for various test environments are summarized

Test environment	Downlink (bit/s/Hz/TRxP)	Uplink (bit/s/Hz/TRxP)
Indoor Hotspot – eMBB	9	6.75
Dense Urban – eMBB	7.8	5.4
Rural – eMBB	3.3	1.6

Minimum Technical Performance Requirement (4/5)

Connection density : *is the total number of devices fulfilling a specific quality of service (QoS) per unit area (per km2). This requirement should be achieved for a limited bandwidth and number of TRxPs. The target QoS is to support delivery of a message of a certain size within a certain time and with a certain success probability. This requirement is defined for the purpose of evaluation in the mMTC usage scenario. The minimum requirement for connection density is* ***1 000 000 devices per*** km^2.

Reliability : *is the success probability of transmitting a layer 2/3 packet within a required maximum time, which is the time it takes to deliver a small data packet from the radio protocol layer 2/3 SDU ingress point to the radio protocol layer 2/3 SDU egress point of the radio interface at a certain channel quality. This requirement is defined for the purpose of evaluation in the URLLC usage scenario.*

The minimum requirement for the reliability is $1\text{-}10^{-5}$ ***success probability*** *of transmitting a layer 2 PDU (protocol data unit) of* ***32 bytes within 1 ms*** *in channel quality of coverage edge for the Urban Macro-URLLC test environment, assuming small application data (e.g. 20 bytes application data + protocol overhead). Proponents are encouraged to consider larger packet sizes, e.g. layer 2 PDU size of up to 100 bytes.*

Mobility : *is the maximum mobile station speed at which a defined QoS can be achieved (in km/h), there are 4 different mobility classes defined:*

1- Stationary: 0 km/h

2- Pedestrian: 0 km/h to 10 km/h

3-Vehicular: 10 km/h to 120 km/h

4- High speed vehicular: 120 km/h to 500 km/h

A mobility class is supported if the traffic channel link data rate on the uplink, normalized by bandwidth, is as shown in table below. This assumes the user is moving at the maximum speed in that mobility class in each of the test environments. This requirement is defined for the purpose

Test environment	Normalized traffic channel link data rate (Bit/s/Hz)	Mobility (km/h)
Indoor Hotspot – eMBB	1.5	10
Dense Urban – eMBB	1.12	30
Rural – eMBB	0.8	120
	0.45	500

Minimum Technical Performance Requirement (5/5)

Energy efficiency : *Network energy efficiency is the capability of a RIT/SRIT to minimize the radio access network energy consumption in relation to the traffic capacity provided. Device energy efficiency is the capability of the RIT/SRIT to minimize the power consumed by the device modem in relation to the traffic characteristics. Energy efficiency of the network and the device can relate to the support for the following two aspects:*

a) Efficient data transmission in a loaded case;

b) Low energy consumption when there is no data.

This requirement is defined for the purpose of evaluation in the eMBB usage scenario.
The RIT/SRIT shall have the capability to support a high sleep ratio and long sleep duration. Proponents are encouraged to describe other mechanisms of the RIT/SRIT that improve the support of energy efficient operation for both network and device.

Bandwidth: *Bandwidth is the maximum aggregated system bandwidth. The bandwidth may be supported by single or multiple radio frequency (RF) carriers. The bandwidth capability of the RIT/SRIT is defined for the purpose of IMT-2020 evaluation.*
The requirement for bandwidth is at least ***100 MHz.***
The RIT/SRIT shall support bandwidths ***up to 1 GHz for operation in higher frequency bands (e.g. above 6 GHz).***
Proponents are encouraged to consider extensions to support operation in wider bandwidths considering the research targets expressed in Recommendation ITU-R M.2083.The RIT/SRIT shall support scalable bandwidth. Scalable bandwidth is the ability of the candidate RIT/SRIT to operate with different bandwidths.

NOKIA


We create the technology to connect the world
NOKIA