NGMN KPIs and Deployment Scenarios for Consideration for IMT2020

by NGMN Alliance

Version:	**1.0**
Date:	**15th February 2016**
Document Type:	**Final Deliverable (approved)**
Confidentiality Class:	**P - Public**
Authorised Recipients: (for CR documents only)	

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Annex A - Key Performance Indicators and Evaluation Approach

Table 1: General KPIs and their high level evaluation approach

KPI	Definition	Evaluation method	Remarks
Bandwidth	The highest aggregated total system bandwidth. It may be supported by single or multiple RF carriers.	Inspection	
Bandwidth scalability	The ability of the access technology to operate with different bandwidth allocations.	Inspection	This bandwidth may be supported by single or multiple RF carriers. Bandwidth scalability's relevance includes providing higher occupancy for the various spectrum block sizes encountered internationally, including those not multiples of 5/10/20 MHz.
Control plane latency	The time it takes for a mobile device in its most "battery efficient" state (e.g. RRC Idle) to start transmission of a large volume of Mobile Originated application layer data over the radio interface, from the time when data arrives at its radio protocol layer 2/3 SDU ingress point.	Analytical	The states for 5G are not yet defined, but this should typically be a state transition time between the idle state and a RRC-connected state that supports efficient transfer of large data volumes.
User plane latency	The 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 via the radio interface in both uplink and downlink directions, where neither device nor Base Station reception is restricted by DRX.	Analytical	In the general case the evaluation should include an assessment of the applicable procedural delays when no resource is already allocated (e.g. request/grant, contention channel access). The value should be an average latency value, including the averaged HARQ delay.

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			However in special cases for providing a minimum latency (e.g. for URLLC use case), it can be assumed that resources are already allocated. Furthermore extra robustness can be assumed to reduce the HARQ probability, although the link efficiency impacts of that should then also be evaluated.
Latency for infrequent small packets	For infrequent application layer small packet/message transfer, the time it takes to successfully deliver an application layer packet/message from the radio protocol layer 2/3 SDU ingress point at the mobile device to the radio protocol layer 2/3 SDU egress point in the RAN, when the mobile device starts from its most “battery efficient” state .	Analytical	This requirement shall be evaluated for at least when the device is operating in a scenario where extreme battery life and extreme coverage requirements also need to be simultaneously met.
Mobility interruption time	The shortest time duration supported by the system during which a user terminal cannot exchange user plane packets with any base station during transitions.	Analytical	Possibly different requirements for intra-frequency and inter-frequency mobility interruption and for different services.
Inter-system handover interruption time	The shortest time duration supported by the system during which a user terminal cannot exchange user plane packets with any base station during transitions between 5G new radio and another radio access technology (RAT). Other RATs include at least LTE evolution.	Analytical	Possibly different requirements for handovers between new 5G RAT and different RATs.
Support for wide range of services	The ability of the access technology to meet the connectivity requirements of a range of existing and future (as yet unknown) services to be operable on a single continuous block of spectrum in an efficient manner.	Inspection	
Duplexing flexibility	The ability of the access technology to adapt its allocation of resources flexibly for uplink and downlink for both paired and unpaired frequency bands.	Inspection	Applicable for frequency bands in at least existing and future IMT-bands. This flexibility may be used for a wide range of requirements such as uplink/downlink traffic patterns, latency, load, etc.

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Network energy efficiency	The capability of a radio access network (RAN) to minimize the RAN energy consumption while providing a much better area traffic capacity.	At least inspection	Inspection: Introduce design principles taking into account energy consumption, e.g., 1) Low transmission power when there is no traffic (data to transmit) 2) No or limited increase of BS power with more antenna elements and 3) No or limited increase of BS power with larger bandwidth.
Peak data rate	The highest theoretical data rate 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 (i.e., excluding radio resources that are used for physical layer synchronisation, reference signals or pilots, guard bands and guard times).	Analytical	
Peak spectral efficiency	The peak data rate normalized by bandwidth.	Analytical	

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Table 2: Deployment-scenario specific KPIs and their high level evaluation approach

KPI	Definition	Evaluation method	Remarks
Transmission/ Reception Point (TRP) average spectrum efficiency	The aggregate throughput of all users (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) divided by the channel bandwidth divided by the number of TRPs. The channel bandwidth for this purpose is defined as the effective bandwidth times the frequency reuse factor, where the effective bandwidth is the operating bandwidth normalized appropriately considering the uplink/downlink ratio. The TRP spectral efficiency is measured in bit/s/Hz/TRP. A 3 sector site consists of 3 TRPs.	System-level simulation (full-buffer)	How to evaluate outdoor and indoor users independently needs to be considered.
User experienced data rate	The 5%-percentile of the user throughput. User throughput (during active time) of an individual burst is defined as the size of a burst divided by the time between the arrival of the first packet of a burst and the reception of the last packet of the burst.	Analytical or system-level simulation	This KPI needs to be achieved at the target area traffic capacity (non-full buffer) for each relevant deployment scenario. An analytical evaluation of user experienced data rate could be estimated from full buffer to reduce evaluation burden.
5th percentile user spectrum efficiency	The cell edge user spectral efficiency is defined as 5% point of the cumulative distribution function (CDF) of the normalized user throughput. The (normalized) user throughput is defined as the average user throughput (the number of correctly received bits by users, i.e., the number of bits contained in the SDU delivered to Layer 3, over a certain period of time, divided by the channel bandwidth and is measured in bit/s/Hz. The channel bandwidth for this purpose is defined as the effective bandwidth times the frequency reuse factor,	System-level simulation (full buffer)	How to evaluate outdoor and indoor users independently needs to be considered.

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	where the effective bandwidth is the operating bandwidth normalised appropriately considering the uplink/downlink ratio.		
Area traffic capacity	Full buffer: Total traffic throughput served per geographic area (in Mbit/s/m^2). The computation of this metric is based on full buffer traffic.	Analytical	This KPI could be computed from the TRP spectral efficiency, site density and bandwidth.
	Non full buffer: Total traffic throughput served per geographic area (in Mbit/s/m^2). Both the user experienced data rate and the area traffic capacity need to be evaluated at the same time using the same traffic model.	Analytical or system level simulation	This KPI is used to derive the burst arrival rate for the FTP simulations. This KPI could be estimated from full buffer traffic to reduce evaluation burden.
Connection density	Total number of devices fulfilling specific QoS per unit area (per km^2).	Analytical or simulation	Foreseen as most relevant for mMTC. Report bandwidth used in evaluation.
Mobility	Maximum user speed at which a defined QoS can be achieved (in km/h).	Simulation (link and system level)	Mobility classes and QoS will be defined for each scenario.
Reliability	The success probability of transmitting a layer 2/3 packet of [x bytes] within a maximum time of [t ms], 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.	Link-level simulation	Foreseen as most relevant for URLLC.
Device battery life	The battery life of the device without recharge. For at least mMTC, device battery life in extreme coverage shall be based on the activity of mobile originated data transfer.	Analytical or link-level simulation	An analytical method could be used to estimate this KPI to reduce evaluation burden.
Extreme Coverage	"Maximum coupling loss" in uplink and downlink between device and Base Station site (antenna connector(s)) for a defined data rate, where the data rate is observed at the egress/ingress point of the radio protocol stack in uplink and downlink.	Analytical or link-level simulation	Foreseen as most relevant for mMTC. An analytical method could be used to estimate this KPI to reduce evaluation burden.
UE energy efficiency	The capability of a UE to reduce UE modem energy consumption while sustaining better performance (e.g., mobile broadband data rate).	Inspection	Foreseen as most relevant for eMBB.

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Annex B – Deployment scenarios and spectrum options

Table 3: Deployment scenarios and spectrum options

Deployment scenario	Deployment options[1]	Spectrum options	Comments
Indoor hotspot (eMBB-InH)	One layer[2] Indoor floor, ISD 20 m 100% indoors	Above 6 GHz and/or below 6 GHz	
Dense urban (eMBB-UMx)	One layer (baseline) Macro only, ISD 200 m 20% outdoor (3 km/h) and 80% indoor (3 km/h)	Above 6 GHz and/or below 6 GHz	
	Two layers (tbc) Macro cells with outdoor small cells Macro ISD: 200m Small cell ISD: [3] small cell per macro sector. Users: 20% outdoor (3 km/h) and 80% indoor (3 km/h)	Above 6 GHz and/or below 6 GHz	

[1] These are the options currently under consideration in NGMN. The final goal is to arrive at the same order of number of deployment scenarios and options as in IMT-Advanced.

[2] A layer indicates either of macro, micro, pico, etc. site layout.

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Rural macro (eMBB-RMa)	One layer Macro only ISD: 1732 m or 5 km Users: Baseline: 100% in cars (120 km/h); Optional: mix of outdoor (3km/h) and in cars (120 km/h)	Below 6 GHz	
High speed (eMBB-HS)	High mobility up to 500 km/h	Above 6 GHz and/or below 6 GHz	Baseline: Link level Optional: System level simulations

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