NGMN KPIs and Deployment Scenarios for Consideration for IMT2020

by NGMN Alliance

Version:	**1.0**
Date:	**04-December-2015**
Document Type:	**Final Deliverable (approved)**
Confidentiality Class:	**P - Public**
Authorised Recipients: (for CR documents only)	

Project:	**P1 WS#3 BBTS**
Editor / Submitter:	
Contributors:	
Approved by / Date:	**NGMN Board, 4th December 2015**

For all Confidential documents (CN, CL, CR):
This document contains information that is confidential and proprietary to NGMN Ltd. The information may not be used, disclosed or reproduced without the prior written authorisation of NGMN Ltd., and those so authorised may only use this information for the purpose consistent with the authorisation.
For Public documents (P):
© 2015 Next Generation Mobile Networks Ltd. All rights reserved. No part of this document may be reproduced or transmitted in any form or by any means without prior written permission from NGMN Ltd.

The information contained in this document represents the current view held by NGMN Ltd. on the issues discussed as of the date of publication. This document is provided "as is" with no warranties whatsoever including any warranty of merchantability, non-infringement, or fitness for any particular purpose. All liability (including liability for infringement of any property rights) relating to the use of information in this document is disclaimed. No license, express or implied, to any intellectual property rights are granted herein. This document is distributed for informational purposes only and is subject to change without notice. Readers should not design products based on this document.

Commercial Address:
ngmn Ltd.,
Großer Hasenpfad 30 • 60598 Frankfurt • Germany

Phone +49 69/9 07 49 98-04 • Fax +49 69/9 07 49 98-41

Registered Office:
ngmn Ltd.,
Reading Bridge House • George Street • Reading • Berkshire RG1 8LS • UK
Company registered in England and Wales n. 5932387, VAT Number: GB 918713901

Contents

1 USAGE SCENARIOS

The NGMN white paper describes various use cases for 5G [1]. The ITU-R has identified three usage scenarios for 5G [2] which are in general aligned with NGMN's conclusions in the sense that they provide a broad classification of the use cases identified by NGMN:

1. Enhanced mobile broadband (eMBB)
2. Massive machine-type communications (mMTC)
3. Ultra-reliable and low-latency communications (URLLC)

Also, we note that a similar broad classification in three main use cases families has been adopted by 3GPP SA1, for the vertical Building Block of the SMARTER SI:

1. eMBB
2. Massive IoT
3. Critical Communications

To ease the communication with other organizations working on 5G, NGMN P1 adopts the ITU usage scenarios classification for its own work, and the present liaison.

The potential specific service needs applicable to these usage scenarios are quite broad, and as well as existing known service needs, additional service needs are likely to be identified in the future. Therefore, NGMN requires the system to be flexible enough to meet the service needs of known and as yet unknown services, and should target the ability for services across different usage scenarios to be operable on a single continuous block of spectrum in an efficient manner.

2 HIGH LEVEL DESCRIPTION OF DEPLOYMENT SCENARIOS

Table 1 provides a set of deployment scenarios identified by NGMN as representative of how 5G services will be provided.

Table 1: High level description of deployment scenarios

Usage scenario	**Deployment scenario**	**High level description**	
eMBB	**Indoor hotspot (eMBB-InH)** Challenge High capacity, high density, consistent user experience. Example environments include indoor office, shopping mall and stadium.	Carrier frequency	A) above 6 GHz B) above 6 GHz and below 6 GHz [If A) cannot meet requirements, use B)]
		Network layout	Indoor floor
		ISD	20 m
	Dense urban (eMBB-UMx) Challenge High capacity, high density, consistent user experience. Deployment options 1) macro cells only 2) macro cells with outdoor small cells 3) outdoor small cells only	Carrier frequency	Deployment option 1) A) below 6GHz B) above 6 GHz C) below 6 GHz and above 6 GHz combined Deployment option 2) A) below 6GHz for both macro and small cells B) above 6 GHz for both macro and small cells C) below 6 GHz and above 6 GHz combined for macro and small cells D) below 6 GHz for macro and above 6 GHz for small cells Deployment option 3) above 6 GHz

			Note: No priorities for above lists.
		Network layout	TBD
		ISD *Macro* *Small cells*	 200 m Deployment options 2) and 3) FFS
	Urban macro (eMBB-UMa) <u>Challenge</u> Consistent user experience.	Carrier frequency	A) below 6 GHz B) above 6 GHz C) below 6 GHz and above 6 GHz combined Note: No priorities for above lists.
		Network layout	Hexagonal grid
		ISD	500 m
	Rural macro (eMBB-RMa) <u>Challenge</u> Consistent user experience over wide area without extra densification compared to current deployments. Users with high speed.	Carrier frequency	Below 6 GHz. Note: Bands above 6 GHz if needed.
		Network layout	Hexagonal grid
		ISD	Different ISDs (FFS) representative of current rural deployments.
	High speed (eMBB-HS) <u>Challenge</u> Users with very high speed <u>Deployment options</u> 1) outdoor base stations to users in trains 2) outdoor BS to relay on trains, and then from relay to users in trains	Carrier frequency	Deployment option 1) A) below 6 GHz B) above 6 GHz Deployment option 2) For base station to relay: A) below 6 GHz B) above 6 GHz For relay to UE: Above 6 GHz and below 6 GHz Note: No priorities for above lists.
mMTC URLLC	eMBB deployments may possibly be reused to provide mMTC and URLLC services as well.		

3 KEY PERFORMANCE INDICATORS

Table 2 and Table 3 provide the KPIs and their definitions identified by NGMN as relevant for the development of the 5G radio access network. A comprehensive list of KPIs, covering the end-to-end 5G network is provided in the NGMN White Paper [1]. NGMN is still discussing exactly how to evaluate each performance metric, but it is anticipated that the scenarios identified in Table 1 can be considered to further develop evaluation methods (for system level and link level), especially for eMBB. However, this also means that other deployment scenarios may be developed if further requirements for mMTC and URLLC are developed in the near future.

Table 2: General KPIs

Key Performance Indicator (KPI)	Definition	Remarks
Bandwidth	The total system bandwidth. It may be supported by single or multiple RF carriers.	
Channel bandwidth scalability	The ability of the access technology to operate with different bandwidth allocations. This bandwidth may be supported by single or multiple RF carriers.	
Latency	<u>1. Latency from most battery efficient state</u>	NOTE 1: The modelling of the

	(e.g., IDLE) to continuous transfer of large data volume The time it takes to start transmission of a large volume of Mobile Originated application layer data on the radio interface from the UE, when data arrives from the radio protocol layer 2/3 SDU ingress point at the mobile device, when the mobile device starts from its most "battery efficient" state (e.g., RRC IDLE).	impact of the radio channel on latency evaluation is still being discussed within NGMN. NOTE 2: The detailed states for 5G are FFS.
	2. Latency from most battery efficient state (e.g., IDLE) to intermittent transfer of small data packets: For intermittent application layer packet/message transfer of small packets, 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 (e.g., RRC IDLE). This requirement shall be evaluated for the following scenarios: a) When the device is in extreme coverage (e.g. mMTC metering) b) When the device is in normal coverage and operates with normal mobility.	
	3. Latency for data transfer for temporarily inactive device: 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, when the mobile device has not been pre-allocated any radio resources for application layer data transfer, and where neither device nor Base Station reception is restricted by DRX.	
	4. Latency for data transfer for already fully active device: 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, when the mobile device has been pre-allocated radio resources for application layer data transfer, and where neither device nor Base Station reception is restricted by DRX.	
Mobility interruption time	The time duration during which a user terminal cannot exchange user plane packets with any base station during transitions.	Possibly different requirements for intra-frequency and inter-frequency mobility interruption and for different services. In case multi-connectivity is supported, there could be no mobility interruption time.
Inter-system handover interruption time	The time duration 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. Additional other RATs, including non-3GPP RATs, are FFS.	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.	
Spectrum flexibility	The ability of the access technology to be adapted to suit different DL/UL traffic patterns and capacity needs for both paired and unpaired frequency bands.	
Network energy efficiency	FFS	Network energy efficiency should be a basic design principle and energy performance should be evaluated. The KPI definition and its evaluation methodology are FFS.
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).	NGMN will not define requirements for peak data rate and peak spectral efficiency. Consistent user experience is of a higher priority for NGMN than peak data rate.

Peak spectral efficiency	The peak data rate normalized by bandwidth.	See remark for peak data rate (above).

Table 3: Deployment-scenario specific KPIs

Key Performance Indicator (KPI)	Definition	Remarks
Transmission/ Reception Point (TRP) average spectrum efficiency	Average data throughput per unit of spectrum resource and per TRP (bit/s/Hz/TRP). A 3 sector site consists of 3 TRPs.	Evaluation setup should consider small and large packets. Assessment for multi-layer and multi-band is FFS. How to evaluate outdoor and indoor users independently needs to be considered.
User experienced data rate	FFS	The 5G system should be able to deliver a consistent user experience over time for a given service everywhere the service is offered. The definition of the KPI for this important requirement of the NGMN White Paper [1] is still being discussed.
User experienced spectrum efficiency	The user experienced data rate divided by the channel bandwidth measured in bits/s/Hz. 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 normalised appropriately considering the uplink/downlink ratio.	Evaluation setup should consider small and large packets. Assessment for multi-layer and multi-band is FFS. How to evaluate outdoor and indoor users independently needs to be considered.
Connection density	Total number of devices fulfilling specific QoS per unit area (per km^2).	Foreseen as most relevant for mMTC. QoS definition should take into account the amount of data generated within a time t_gen that can be sent or received within a given time, t_sendrx, with x% probability. Report bandwidth used in evaluation.
Area traffic capacity	Total traffic throughput served per geographic area (in $Mbit/s/m^2$)	Can be derived from TRP average spectral efficiency, network deployment (e.g., site density) and bandwidth.
Mobility	Maximum user speed at which a defined QoS can be achieved (in km/h).	Mobility classes and QoS will be defined for each scenario.
Reliability	The success probability of transmitting an IP packet [x bytes] within a maximum time of [t ms] at a certain channel quality.	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 consisting of [200] bytes UL per day followed by [20] bytes DL from MCL of [tbd] dB, assuming a stored energy capacity of [5Wh].	Battery life KPI definition of other terminal types than mMTC is FFS.
Extreme Coverage	“Maximum coupling loss” in uplink and downlink between device and Base Station site (antenna connector(s)) for a data rate of [160bps], where the data rate is observed at the egress/ingress point of the radio protocol stack in uplink and downlink.	Foreseen as most relevant for mMTC.

4 REFERENCES

[1] NGMN Alliance, "5G White Paper," 2015.

[2] ITU-R Recommendation M.2083,"IMT Vision - Framework and overall objectives of the future development of IMT for 2020 and beyond, " 2015.