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3rd Generation Partnership Project;

Technical Specification Group Radio Access Network;

Study on Scenarios and Requirements for  
 Next Generation Access Technologies;

(Release 14)



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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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# 1 Scope

This document is related to the technical report for this study item "Scenarios and Requirements for Next Generation Access Technologies" [1]. The objective of the study item is to identify the typical deployment scenarios associated with attributes such as carrier frequency, inter-site distance, user density, maximum mobility speed, etc, and to develop requirements for next generation access technologies for the identified deployment scenarios taking into account, but not limited to, the ITU-R discussion on IMT-2020 requirements.

This document contains scenarios and requirements for next generation access technologies, which can be used as not only guidance to the technical work to be performed in 3GPP RAN WGs, but also input for ITU-R to take into account when developing IMT-2020 technical performance requirements.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

[1] 3GPP SID FS\_NG\_SReq: "Scenarios and Requirements for Next Generation Access Technologies" RP-152257, “New Study Item Proposal - Study on Scenarios and Requirements for Next Generation Access Technologies”, CMCC, RAN#70, Sitges, Spain, Dec. 7 - 11, 2015

[2] 3GPP TR 22.891, <http://www.3gpp.org/ftp/Specs/archive/22_series/22.891>

[3] Recommendation ITU-R M.2083: [IMT Vision - "Framework and overall objectives of the future development of IMT for 2020 and beyond"](http://www.itu.int/rec/R-REC-M.2083)​ (September 2015),

[4] ITU-R report M.2135, Guidelines for evaluation of radio interface technologies for IMT-Advanced,

[5] 3GPP TR 36.878, <http://www.3gpp.org/ftp/Specs/archive/36_series/36.878>

[6] 3GPP TR 36.885, <http://www.3gpp.org/ftp/Specs/archive/36_series/36.858>

[7] 3GPP TR 23.799, <http://www.3gpp.org/ftp/Specs/archive/23_series/23.799>

[8] 3GPP TS 23.303, <http://www.3gpp.org/ftp/Specs/archive/23_series/23.303>

[9] 3GPP TS 22.179. <http://www.3gpp.org/ftp/Specs/archive/22_series/22.179>

[10] 3GPP TS 22.468. <http://www.3gpp.org/ftp/Specs/archive/22_series/22.468>

[11] 3GPP TR 36.890. <http://www.3gpp.org/ftp/Specs/archive/36_series/36.890>

[12] 3GPP TS 22.101. <http://www.3gpp.org/ftp/Specs/archive/22_series/22.101>

[13] 3GPP TS 22.071. <http://www.3gpp.org/ftp/Specs/archive/22_series/22.071>

[14] 3GPP TS 22.153. <http://www.3gpp.org/ftp/Specs/archive/22_series/22.153>

[15] 3GPP TS 22.268. <http://www.3gpp.org/ftp/Specs/archive/22_series/22.268>

[16] 3GPP TS 33.106. <http://www.3gpp.org/ftp/Specs/archive/33_series/33.106>

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**example:** text used to clarify abstract rules by applying them literally.

**Transmission Reception Point (TRP)**:

Editor's notes: Definition is for further study.

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

t\_gen The time during which data or access request is generated

t\_sendrx The time during which data or access request is sent or received

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply.   
An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

eMBB enhanced Mobile BroadBand

KPI Key Performance Indicator

MCL Maximum Coupling Loss

mMTC massive Machine Type Communications

TRP Transmission Reception Point

URLLC Ultra-Reliable and Low Latency Communications

# 4 Introduction

Editor's note: While this TR is under construction different approaches are used to indicate if text is FFS (for further study), TBD (to be determined), , tbc (to be confirmed) or simply put in [ ] to show that further confirmation is needed.

At the 3GPP TSG RAN #70 meeting, the Study Item description on "Scenarios and Requirements for Next Generation Access Technologies" was approved [1].

The justification of the Study Item was that a fully mobile and connected society is expected in the near future, which will be characterized by a tremendous amount of growth in connectivity, traffic volume and a much broader range of usage scenarios. Some typical trends include explosive growth of data traffic, great increase of connected devices and continuous emergence of new services. Besides the market requirements, the mobile communication society itself also requires a sustainable development of the eco-system, which produces the needs to further improve system efficiencies, such as spectrum efficiency, energy efficiency, operational efficiency and cost efficiency. To meet the above ever-increasing requirements from market and mobile communication society, next generation access technologies are expected to emerge in the near future. A study item to identify typical deployment scenarios for next generation access technologies and the required capabilities in each corresponding deployment scenarios should be considered.

[Brief descriptions of deployment scenarios for next generation access technologies to be developed in this TR]

[Brief descriptions of requirements for next generation access technologies to be developed in this TR]

# 5 Objectives

In order to meet the deployment scenarios and requirements, studies for next generation access technologies should be carried out in at least, but not limited to, the following areas, designs for next generation access technologies RAN should strive for enough flexibility to support current envisaged and future requirements for the different use cases, e.g., from SA1 [2], i.e.,to support for wide range of services.

# 6 Scenarios

## 6.0 General

[This subsection first briefly introduces the three usage scenarios defined by ITU-R, and then describes several deployment scenarios for the three usage scenarios. The mapping between usage scenarios and deployment scenarios needs to be clarified.]

IMT for 2020 and beyond [3] is envisaged to expand and support diverse families of usage scenarios and applications that will continue beyond the current IMT. Furthermore, a broad variety of capabilities would be tightly coupled with these intended different usage scenarios and applications for IMT for 2020 and beyond. The families of usage scenarios for IMT for 2020 and beyond include:

- eMBB (enhanced Mobile Broadband)

- mMTC (massive Machine Type Communications)

- URLLC (Ultra-Reliable and Low Latency Communications)

## 6.1 Deployment scenarios

[xx deployment scenarios are proposed for eMBB, [TBD] deployment scenarios are proposed for mMTC, [TBD] deployment scenarios are proposed for URLLC.]

[For eMBB, they are indoor hotspot, dense urban, rural, urban macro and high speed. Deployment scenarios for mMTC and URLLC need further study.] However, some of eMBB deployment scenarios may possibly be reused to evaluate mMTC and URLLC, or some specific evaluation tests (e.g., link-level simulation) can be developed to check whether the requirements can be achieved.

High-level descriptions on deployment scenarios including carrier frequency, aggregated system bandwidth, network layout / ISD, BS / UE antenna elements, UE distribution / speed and service profile are proposed in this TR. It is assumed that more detailed attributes and simulation parameters, for example, the channel model, BS / UE Tx power, number of antenna ports, etc. should be defined in the new RAT study item.

For mMTC, […]

For URLLC, […]

### 6.1.1 Indoor hotspot

The indoor hotspot deployment scenario focuses on small coverage per site/TRP (transmission and reception point) and high user throughput or user density in buildings. The key characteristics of this deployment scenario are high capacity, high user density and consistent user experience indoor.

Some of its attributes are listed in Table 6.1.1-1.

Table 6.1.1-1: Attributes for indoor hotspot

|  |  |
| --- | --- |
| Attributes | Values or assumptions |
| Carrier Frequency  NOTE1 | Around 30 GHz or Around 70 GHz or Around 4 GHz |
| Aggregated system bandwidth  NOTE2 | Around 30GHz or Around 70GHz: Up to 1GHz (DL+UL) NOTE3  Around 4GHz: Up to 200MHz (DL+UL) |
| Layout | Single layer:  - Indoor floor  (Open office) |
| ISD | 20m  (Equivalent to 12TRPs per 120m x 50m) |
| BS antenna elements NOTE4 | Around 30GHz or Around 70GHz: Up to 256 Tx and Rx antenna elements  Around 4GHz: Up to 256 Tx and Rx antenna elements |
| UE antenna elements NOTE4 | round 30GHz or Around 70GHz: Up to 32 Tx and Rx antenna elements  Around 4GHz: Up to 8 Tx and Rx antenna elements |
| User distribution and UE speed | 100% Indoor, 3km/h,  10 users per TRP |
| Service profile | NOTE: Whether to use full buffer traffic or non-full-buffer traffic is FFS. For certain KPIs, full buffer traffic is desirable to enable comparison with IMT-Advanced values. |

NOTE1: The options noted here are for evaluation purpose, and do not mandate the deployment of these options or preclude the study of other spectrum options. A range of bands from 24 GHz – 40 GHz identified for WRC-19 are currently being considered and around 30 GHz is chosen as a proxy for this range. A range of bands from 66 GHz – 86 GHz identified for WRC-19 are currently being considered and around 70 GHz is chosen as a proxy for this range.

NOTE2: The aggregated system bandwidth is the total bandwidth typically assumed to derive the values for some KPIs such as area traffic capacity and user experienced data rate. It is allowed to simulate a smaller bandwidth than the aggregated system bandwidth and transform the results to a larger bandwidth. The transformation method should then be described, including the modelling of power limitations.

NOTE3: "DL + UL" refers to either of the following two cases:

1. FDD with symmetric bandwidth allocations between DL and UL.

2. TDD with the aggregated system bandwidth used for either DL or UL via switching in time-domain.

NOTE4: The maximum number of antenna elements is a working assumption. 3GPP needs to strive to meet the target with typical antenna configurations.

### 6.1.2 Dense urban

The dense urban microcellular deployment scenario focuses on macro TRPs with or without micro TRPs and high user densities and traffic loads in city centres and dense urban areas. The key characteristics of this deployment scenario are high traffic loads, outdoor and outdoor-to-indoor coverage. This scenario will be interference-limited, using macro TRPs with or without micro TRPs. A continuous cellular layout and the associated interference shall be assumed.

Some of its attributes are listed in Table 6.1.2-1.

Table 6.1.2-1: Attributes for dense urban

|  |  |
| --- | --- |
| Attributes | Values or assumptions |
| Carrier Frequency  NOTE1 | Around 4GHz + Around 30GHz (two layers) |
| Aggregated system bandwidth  NOTE2 | Around 30GHz: Up to1GHz (DL+UL)  Around 4GHz: Up to 200MHz (DL+UL) |
| Layout | Two layers:  - Macro layer: Hex. Grid  - Micro layer: Random drop  Step 1 NOTE3: Around 4GHz in Macro layer  Step 2 NOTE3: Both Around 4GHz & Around 30GHz may be available in Macro & Micro layers (including 1 macro layer, macro cell only) |
| ISD | Macro layer: 200m  Micro layer: 3micro TRPs per macro TRP NOTE4,  All micro TRPs are all outdoor |
| BS antenna elements NOTE5 | Around 30GHz: Up to 256 Tx and Rx antenna elements  Around 4GHz: Up to 256 Tx and Rx antenna elements |
| UE antenna elements NOTE5 | Around 30GHz: Up to 32 Tx and Rx antenna elements  Around 4GHz: Up to 8 Tx and Rx antenna elements |
| User distribution and UE speed | Step1 NOTE3: Uniform/macro TRP, [10] users per TRPNOTE6, NOTE7  Step2 NOTE3: Uniform/macro TRP + Clustered/micro TRP, 10 users per TRPNoTE6, NOTE7  80% indoor (3km/h), 20% outdoor (30km/h) |
| Service profile | NOTE: Whether to use full buffer traffic or non-full-buffer traffic is FFS. For certain KPIs, full buffer traffic is desirable to enable comparison with IMT-Advanced values. |

NOTE1: The options noted here are for evaluation purpose, and do not mandate the deployment of these options or preclude the study of other spectrum options. A range of bands from 24 GHz – 40 GHz identified for WRC-19 are currently being considered and around 30 GHz is chosen as a proxy for this range.

NOTE2: The aggregated system bandwidth is the total bandwidth typically assumed to derive the values for some KPIs such as area traffic capacity and user experienced data rate. It is allowed to simulate a smaller bandwidth than the aggregated system bandwidth and transform the results to a larger bandwidth. The transformation method should then be described, including the modelling of power limitations.

NOTE3: Step 1 shall be used for the evaluation of spectral efficiency KPIs. Step2 shall be used for the evaluation of the other deployment scenario dependant KPIs.

NOTE4: This value is the baseline and other number of micro TRPs per macro TRP (e.g., 6 or 10) is not precluded.

NOTE5: The maximum number of antenna elements is a working assumption. 3GPP needs to strive to meet the target with typical antenna configurations.

NOTE6: 10 users per TRP is the baseline with full buffer traffic. 20 users per macro TRP with full buffer traffic is not precluded.

NOTE7: Other number of users, number of TRPs and traffic models are FFS.

### 6.1.3 Rural

The rural deployment scenario focuses on larger and continuous coverage. The key characteristics of this scenario are continuous wide area coverage supporting high speed vehicles. This scenario will be noise-limited and/or interference-limited, using macro TRPs.

Some of its attributes are listed in Table 6.1.3-1.

Table 6.1.3-1: Attributes for rural scenario

|  |  |
| --- | --- |
| Attributes | Values or assumptions |
| Carrier Frequency NOTE1 | Around 700MHz or Around 4GHz (for ISD 1)  Around 700 MHz and Around 2 GHz combined (for ISD 2) |
| Aggregated system bandwidth  NOTE2 | Around 700MHz: Up to 20MHz(DL+UL) NOTE3  Around 4GHz: Up to 200MHz (DL+UL) |
| Layout | Single layer:  - Hex. Grid |
| ISD | ISD 1: 1732m  ISD 2: 5000m |
| BS antenna elements NOTE4 | Around 4GHz: Up to 256 Tx and Rx antenna elements  Around 700MHz: Up to 64 Tx and Rx antenna elements |
| UE antenna elements NOTE4 | Around 4GHz: Up to 8 Tx and Rx antenna elements  Around 700MHz: Up to 4 Tx and Rx antenna elements |
| User distribution and UE speed | 50% outdoor vehicles (120km/h) and 50% indoor (3km/h), 10 users per TRP |
| Service profile | NOTE: Whether to use full buffer traffic or non-full-buffer traffic is FFS. For certain KPIs, full buffer traffic is desirable to enable comparison with IMT-Advanced values. |

NOTE1: The options noted here are for evaluation purpose, and do not mandate the deployment of these options or preclude the study of other spectrum options.

NOTE2: The aggregated system bandwidth is the total bandwidth typically assumed to derive the values for some KPIs such as area traffic capacity and user experienced data rate. It is allowed to simulate a smaller bandwidth than the aggregated system bandwidth and transform the results to a larger bandwidth. The transformation method should then be described, including the modelling of power limitations.

NOTE3: Consider larger aggregated system bandwidth if 20MHz cannot meet requirement.

NOTE4: The maximum number of antenna elements is a working assumption. 3GPP needs to strive to meet the target with typical antenna configurations.

### 6.1.4 Urban macro

The urban macro deployment scenario focuses on large cells and continuous coverage. The key characteristics of this scenario are continuous and ubiquitous coverage in urban areas. This scenario will be interference-limited, using macro TRPs (i.e. radio access points above rooftop level).

Some of its attributes are listed in Table 6.1.4-1.

Table 6.1.4-1: Attributes for urban macro

|  |  |
| --- | --- |
| Attributes | Values or assumptions |
| Carrier Frequency NOTE1 | Around 2 GHz or Around 4 GHz or Around 30 GHz |
| Aggregated system bandwidth  NOTE2 | Around 4GHz: Up to 200 MHz (DL+UL)  Around 30GHz: Up to 1GHz (DL+UL) |
| Layout | Single layer:  - Hex. Grid |
| ISD | 500m |
| BS antenna elements NOTE3 | Around 30GHz: Up to 256 Tx and Rx antenna elements  Around 4GHz or Around 2GHz: Up to 256 Tx and Rx antenna elements |
| UE antenna elements NOTE3 | Around 30GHz: Up to 32 Tx and Rx antenna elements  Around 4GHz: Up to 8 Tx and Rx antenna elements |
| User distribution and UE speed | 20% Outdoor in cars: 30km/h,  80% Indoor in houses: 3km/h  10 users per TRP NOTE4 |
| Service profile | NOTE: Whether to use full buffer traffic or non-full-buffer traffic is FFS. For certain KPIs, full buffer traffic is desirable to enable comparison with IMT-Advanced values. |

NOTE1: The options noted here are for evaluation purpose, and do not mandate the deployment of these options or preclude the study of other spectrum options. A range of bands from 24 GHz – 40 GHz identified for WRC-19 are currently being considered and around 30 GHz is chosen as a proxy for this range.

NOTE2: The aggregated system bandwidth is the total bandwidth typically assumed to derive the values for some KPIs such as area traffic capacity and user experienced data rate. It is allowed to simulate a smaller bandwidth than the aggregated system bandwidth and transform the results to a larger bandwidth. The transformation method should then be described, including the modelling of power limitations.

NOTE3: The maximum number of antenna elements is a working assumption. 3GPP needs to strive to meet the target with typical antenna configurations.

NOTE4: 10 users per TRP is the baseline with full buffer traffic. 20 users per TRP with full buffer traffic is not precluded.

Editor’s notes: User distribution is 80% indoor and 20% outdoor. Further refinement of outdoor user characteristics being discussed.

### 6.1.5 High speed

The high speed deployment scenario focuses on continuous coverage along track in high speed trains. The key characteristics of this scenario are consistent user experience with very high mobility. In this deployment scenario, dedicated linear deployment along railway line and the deployments including SFN scenarios captured in Section 6.2 of [5] are considered, and UEs are located in train carriages. If the antenna of relay node for eNB-to-Relay is located at top of one carriage of the train, the antenna of relay node for Relay-to-UE could be distributed to all carriages.

Some of its attributes are listed in Table 6.1.5-1.

Table 6.1.5-1: High Speed

|  |  |
| --- | --- |
| Attributes | Values or assumptions |
| Carrier Frequency NOTE1 | Macro NOTE2 only: Around 4GHz (Tbc)  Macro NOTE2+ relay nodes:  1) For BS to relay: Around 4 GHz  For relay to UE: Around 30 GHz or Around 70 GH or Around 4 GHz  2) For BS to relay: Around 30 GHz  For relay to UE: Around 30 GHz or Around 70 GHz or Around 4 GHz |
| Aggregated system bandwidth NOTE3 | Around 4GHz: Up to 200 MHz (DL+UL)  Around 30GHz or Around 70GHz: Up to 1GHz (DL+UL) |
| Layout | Option 1: Macro only  Option 2: Macro + relay nodes NOTE3 |
| ISD | Macro cell: ISD = 1732m  Small cell within carriages: ISD = 25m |
| BS antenna elements NOTE4 | Around 30GHz: Up to 256 Tx and Rx antenna elements  Around 4GHz or Around 2GHz: Up to 256 Tx and Rx antenna elements |
| UE antenna elements NOTE4 | Relay Tx: Left to RAN1 study  Relay Rx: Left to RAN1 study  Around 30GHz: Up to 32 Tx and Rx antenna elements  Around 4GHz: Up to 8 Tx and Rx antenna elements |
| User distribution and UE speed | 100% of users in train  [100] UEs per macro cell (assuming 1000 passengers per high-speed train and at least 10% activity ratio)  Maximum mobility speed: 500km/h |
| Service profile | Note: Whether to use full buffer traffic or non-full-buffer traffic is FFS. For certain KPIs, full buffer traffic is desirable to enable comparison with IMT-Advanced values. |

NOTE1: The options noted here are for evaluation purpose, and do not mandate the deployment of these options or preclude the study of other spectrum options. A range of bands from 24 GHz – 40 GHz identified for WRC-19 are currently being considered and around 30 GHz is chosen as a proxy for this range. A range of bands from 66 GHz – 86 GHz identified for WRC-19 are currently being considered and around 70 GHz is chosen as a proxy for this range

NOTE2: For Macro, it is assumed RRH sharing the same cell ID as captured in Section 6.2 of [5].

NOTE3: The aggregated system bandwidth is the total bandwidth typically assumed to derive the values for some KPIs such as area traffic capacity and user experienced data rate. It is allowed to simulate a smaller bandwidth than the aggregated system bandwidth and transform the results to a larger bandwidth. The transformation method should then be described, including the modelling of power limitations.

NOTE4: The maximum number of antenna elements is a working assumption. 3GPP needs to strive to meet the target with typical antenna configurations.

NOTE5: BS to relay link should be paid more attention than relay to UE link.

### 6.1.6 Extreme rural for the Provision of Minimal Services over long distances

The extreme rural deployment scenario is defined to allow the Provision of minimal services over long distances for Low ARPU and Low density areas including both humans and machines. The key characteristics of this scenario are Macro cells with very large area coverage supporting basic data and voice services, with low to moderate user throughput and low user density.

Some of its attributes are listed in Table 6.1.6-1.

Table 6.1.6-1: Attributes for extreme rural

|  |  |
| --- | --- |
| **Attributes** | **Values or assumptions** |
| Carrier Frequency | Below 3 GHz  With a priority on bands below 1GHz  Around 700 MHz |
| System Bandwidth | 40 MHz (DL+UL) |
| Layout | Single layer:  Isolated Macro cells |
| Cell range | 100 km range (Isolated cell) to be evaluated through system level simulations.  100 km is a starting point, and may be varied to meet traffic density and user experienced data rate targets  Feasibility of Higher Range shall be evaluated through Link level evaluation (for example in some scenarios ranges up to 150-300km may be required). |
| User density and UE speed | [TBD] users/km²  Speed up to 160 km/h |
| Traffic model | [Average data throughput at busy hours/user: 30 kbps  Traffic density: [TBD] kbps/km²  User Experienced Data Rate: up to 2 Mbps while stationary and 384 kbps while moving] |

### 6.1.7 Extreme rural with extreme Long Range

The extreme rural Long Range deployment scenario is defined to allow for the Provision of services for very large areas such as wilderness or areas where only highways are located primarily for humans. The key characteristics of this scenario are Macro cells with very large area coverage supporting basic data speeds and voice services, with low to moderate user throughput and low user density.

Some of its attributes are listed in Table 6.1.7-1.

Table 6.1.7-1: Attributes for extreme long range

|  |  |
| --- | --- |
| **Attributes** | **Values or assumptions** |
| Carrier Frequency | Below 3 GHz |
| System Bandwidth | [40] MHz (DL+UL) |
| Layout | Single layer:  Isolated Macro cells  ad hoc / isolated |
| Cell Range | [150 km] for bands above 1GHz  [250 km] for between 700 MHz and 1 GHz  [400 km] or more for bands below 700 MHz |
| User density and UE speed | [TBD ] users/km²  Speed up to [160km/h] |
| Traffic model | [Average data throughput at busy hours/user: [30kbps]  Traffic density: [380-500kbps/km²]  User Experienced Data Rate: up to [2]Mbps while stationary and [384kbps] while moving] |

### 6.1.8 Urban coverage for massive connection

The urban coverage for massive connection scenario focuses on large cells and continuous coverage to provide mMTC. The key characteristics of this scenario are continuous and ubiquitous coverage in urban areas, with very high connection density of mMTC devices. This deployment scenario is for the evaluation of the KPI of connection density.

Some of its attributes are listed in Table 6.1.8-1.

Table 6.1.8-1: Attributes of urban coverage for massive connection

|  |  |
| --- | --- |
| **Attributes** | **Values or assumptions** |
| Carrier Frequency | 700MHz, 2100 MHz as an option |
| Network deployment including ISD | Macro only, ISD = 1732m, 500m |
| Device deployment | Indoor, and outdoor in-car devices |
| Maximum mobility speed | 20% of users are outdoor in cars (100km/h)  80% of users are indoor (3km/h) |
| Service profile | Non-full buffer with small packets |
| BS antenna elements | Tx: [TBD by RAN1]  Rx: [TBD by RAN1] |
| UE antenna elements | Tx: [1] or [TBD by RAN1]  Rx: [1] or [TBD by RAN1] |

### 6.1.9 Highway Scenario

The highway deployment scenario focuses on scenario of vehicles placed in highways with high speeds. The main KPIs evaluated under this scenario would be reliability/availability under high speeds/mobility (and thus frequent handover operations).

Some of its attributes are listed in Table 6.1.9-1.

[Editor’s notes: It is TBD whether eMBB requirements for eV2X would be evaluated under this scenario or another scenario. Examples of eMBB requirements for eV2X are video streaming and video calls]

[Editor’s notes: This scenario can be further updated to reflect practical highway scenarios.]

Table 6.1.9-1: Attributes of Highway

|  |  |
| --- | --- |
| **Attributes** | **Values or assumptions** |
| Carrier Frequency NOTE1 | Macro only: Below 6 GHz (around 6 GHz)  Macro + RSUs NOTE2:  1) For BS to RSU: Below 6 GHz (around 6 GHz) NOTE3  2) RSU to vehicles or among vehicles: below 6 GHz |
| Aggregated system bandwidth NOTE4 | [TBD] MHz (DL+UL) |
| Layout | Option 1: Macro only  Option 2: Macro + RSUs NOTE2 |
| ISD | Macro cell: ISD = 500m  Inter-RSU distance = [100m] NOTE5 |
| BS antenna elements | Tx: Up to [32 Tx]  Rx: Up to [32 Rx] |
| UE antenna elements | RSU Tx: Up to [32 Tx]  RSU Rx: Up to [32 Rx]  Vehicle Tx: Up to [8 Tx]  Vehicle Rx: Up to [8 Rx] |
| User distribution and UE speed | 100% in vehicles  Average inter-vehicle distance (between two vehicles’ center) in the same lane is [1sec \* average vehicle speed] (average speed: [100-300km/h]) |
| Traffic model | [50 messages] per 1 second with absolute average speed of [100-250 km/h] (relative speed: 200 – 500km/h) |

NOTE1: The options noted here are for evaluation purpose, and do not mandate the deployment of these options or preclude the study of other spectrum options. A range of bands from 24 GHz – 40 GHz identified for WRC-19 are currently being considered and around 30 GHz is chosen as a proxy for this range. A range of bands from 66 GHz – 86 GHz identified for WRC-19 are currently being considered and around 70 GHz is chosen as a proxy for this range.

NOTE2: SA1 defines RSU as a logical entity that combines V2X application logic with the functionality of an eNB (referred to as eNB-type RSU) or UE (referred to as UE-type RSU). Therefore a RSU can communicate with vehicles via D2D link or cellular DL/UL

NOTE3: This frequency may or may not be evaluated depending on communication type between eNB and RSU.

NOTE4: The aggregated system bandwidth is the total bandwidth typically assumed to derive the values for some KPIs such as area traffic capacity and user experienced data rate. It is allowed to simulate a smaller bandwidth than the aggregated system bandwidth and transform the results to a larger bandwidth. The transformation method should then be described, including the modelling of power limitations.

NOTE5: If above 6 GHz is considered for communication between RSU and vehicles, inter-RSU distance can be [30 meter].

Illustrative diagram of freeway mode is as follows (from [6])



Figure 6.1.9-1: Road configuration for highway scenario

### 6.1.10 Urban Grid for Connected Car

The urban macro deployment scenario focuses on scenario of highly densely deployed vehicles placed in urban area. It could cover a scenario where freeways lead through an urban grid. The main KPI evaluated under this scenario are reliability/availability/latency in high network load and high UE density scenarios.

Some of its attributes are listed in Table 6.1.10-1.

[Editor’s notes: It is TBD whether eMBB requirements for eV2X would be evaluated under this scenario or another scenario. Examples of eMBB requirements for eV2X are video streaming and video calls]

Table 6.1.10-1: Attributes of urban grid for connected car

|  |  |
| --- | --- |
| Attributes | Values or assumptions |
| Carrier Frequency NOTE1 | Macro only: Below 6 GHz (around 6 GHz)  Macro + RSUs NOTE2:  1) For BS to RSU: Below 6 GHz (around 6 GHz) NOTE3  2) RSU to vehicles or among vehicles/pedestrians: below 6 GHz |
| Aggregated system bandwidth NOTE4 | [TBD]MHz (DL+UL) |
| Layout | Option 1: Macro only  Option 2: Macro + RSUs NOTE2 |
| ISD | Macro cell: ISD = 500m  RSU at each intersection for Option 2 |
| BS antenna elements | Tx: Up to [32 Tx]  Rx: Up to [32 Rx] |
| UE antenna elements | Vehicle Tx: Up to [8 Tx]  Vehicle Rx: Up to [8 Rx]  Pedestrian/bicycle Tx: Up to [8 Tx]  Pedestrian/bicycle Rx: Up to [8 Rx] |
| User distribution and UE speed NOTE5 | Urban grid model (car lanes and pedestrian/bicycle sidewalks are placed around a road block. [2 lanes] in each direction, [4 lanes] in total, [1 sidewalk], one block size: [433m x 250m])  Average inter-vehicle distance (between two vehicles’ center) in the same lane is [1sec \* average vehicle speed ] (average speed [15 – 120km/h])  Pedestrian/bicycle dropping: average distance between UEs is [20 meters] |
| Traffic model | [TBD] messages per 1 second with [120km/h], [50 messages] per 1 second with [60km/h], [10 messages] per 1 second with [15km/h] |

NOTE1: The options noted here are for evaluation purpose, and do not mandate the deployment of these options or preclude the study of other spectrum options. A range of bands from 24 GHz – 40 GHz identified for WRC-19 are currently being considered and around 30 GHz is chosen as a proxy for this range. A range of bands from 66 GHz – 86 GHz identified for WRC-19 are currently being considered and around 70 GHz is chosen as a proxy for this range

NOTE2: SA1 defines RSU as a logical entity that combines V2X application logic with the functionality of an eNB (referred to as eNB-type RSU) or UE (referred to as UE-type RSU). Therefore a RSU can communicate with vehicles via D2D link or cellular DL/UL

NOTE3: This frequency may or may not be evaluated depending on communication type between eNB and RSU.

NOTE4: The aggregated system bandwidth is the total bandwidth typically assumed to derive the values for some KPIs such as area traffic capacity and user experienced data rate. It is allowed to simulate a smaller bandwidth than the aggregated system bandwidth and transform the results to a larger bandwidth. The transformation method should then be described, including the modelling of power limitations.

NOTE5: More detail information can be found in [6].

Illustrative diagram of urban grid model with UE distribution are the follows (from [6]).

Table 6.1.10-2: Details of vehicle UE drop and mobility model

|  |  |  |
| --- | --- | --- |
| Parameter | Urban case | Freeway case |
| Number of lanes | 2 in each direction (4 lanes in total in each street) | 3 in each direction (6 lanes in total in the freeway) |
| Lane width | 3.5 m | 4 m |
| Road grid size by the distance between intersections | 433 m \* 250 m. NOTE1 | N/A |
| Simulation area size | Minimum [1299 m \* 750 m] | Freeway length >= 2000 m. Wrap around should be applied to the simulation area. |
| Vehicle density | Average inter-vehicle distance in the same lane is 2.5 sec \* absolute vehicle speed. Baseline: The same density/speed in all the lanes in one simulation. | |
| Absolute vehicle speed | 15 km/h, 60 km/h, 120 km/h | 250 km/h, 140 km/h, 70 km/h |



Figure 6.1.10-1: Road configuration for urban grid

NOTE1: 3 m is reserved for sidewalk per direction (i.e., no vehicle or building in this reserved space).

# 7 Key performance indicators

This section describes the definitions of all KPIs.

## 7.1 Peak data rate

Peak data rate is the highest theoretical data rate 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 utilised (i.e., excluding radio resources that are used for physical layer synchronisation, reference signals or pilots, guard bands and guard times).

The target for peak data rate should be 20Gbps for downlink and 10Gbps for uplink.

## 7.2 Peak Spectral efficiency

Peak spectral efficiency is 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 assignable 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).

The target for peak spectral efficiency should be 30bps/Hz for downlink and 15bps/Hz for uplink.

Higher frequency bands could have higher bandwidth but lower spectral efficiency and lower frequency bands could have lower bandwidth but higher spectral efficiency. Thus, peak data rate cannot be directly derived from peak spectral efficiency and bandwidth multiplication.

## 7.3 Bandwidth

Bandwidth means the maximal aggregated total system bandwidth. It may be supported by single or multiple RF carriers.

Quantitative KPI

[Editor’s note: This is an ITU-R requirement from IMT-Advanced. It may not be up to 3GPP to set a value for this requirement.]

## 7.4 Control plane latency

Control plane latency refers to the time to move from a battery efficient state (e.g., IDLE) to start of continuous data transfer (e.g., ACTIVE).

The target for control plane latency should be 10ms.

## 7.5 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.

For URLLC the target for user plane latency should be 0.5ms for UL, and 0.5ms for DL. Furthermore, if possible, the latency should also be low enough to support the use of the next generation access technologies as a wireless transport technology that can be used within the next generation access architecture.

NOTE1: The reliability KPI also provides a latency value with an associated reliability requirement. The value above should be considered an average value and does not have an associated high reliability requirement.

For eMBB, the target for user plane latency should be 4ms for UL, and 4ms for DL.

NOTE2: For eMBB value, the evaluation needs to consider all typical delays associated with the transfer of the data packets in an efficient way (e.g. applicable procedural delay when resources are not preallocated, averaged HARQ retransmission delay, impacts of network architecture).

## 7.6 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.

[Editor’s notes: Detailed definition to be discussed.]

## 7.7 Mobility interruption time

Mobility interruption time means 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 target for mobility interruption time should be 0ms.

This KPI is for intra-system mobility.

Mobility support can be relaxed for extreme rural scenarios for the Provision of minimal services for very low-ARPU areas: Inter RAT mobility functions can be removed. Intra-RAT mobility functions can be simplified if it helps decreasing the cost of infrastructure and devices. Basic idle mode mobility shall be supported as a minimum.

## 7.8 Inter-system mobility

Inter-system mobility refers to the ability to support mobility between the IMT-2020 system and at least one IMT system.

[Editor’s notes: Further study is needed to clarify what is IMT system and maybe to limit it to LTE or LTE evolution. Whether to support voice interoperability is to be clarified.]

## 7.9 Reliability

Reliability can be evaluated by the success probability of transmitting X bytes NOTE1 within 1 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 (e.g., coverage-edge).

The target for reliability should be 1-10-5 within 1ms.

NOTE1: Specific value for X is FFS

Table 7.9-1: Reliability in each deployment scenario for each usage scenario

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Reliability | Indoor Hotspot | Dense Urban | Rural | Urban Macro | High Speed |
| eMBB |  |  |  |  |  |
| mMTC |  |  |  |  |  |
| URLLC |  |  |  |  |  |

[Editor’s notes: The relevant use cases (V2V, V2I, or any others), deployment scenarios and the traffic model should be clarified.]

Communication availability and resilience for eV2X can be evaluated by the success probability of transmitting [X bytes] with user plane latency requirement (7.5) of [TBD] msec at a certain communication range (e.g., 500 meters) [, and a latency for small packets (7.6) within [TBD] ms].

The target communication availability and resilience for eV2X should [TBD].

[Editor’s notes: other KPIs and use cases for eV2X may be added if needed after progress in SA1.]

3GPP system shall support reliability up to be 1-10-5 within 1ms.for use cases such as eHealth surgical robots operating mainly in very deep indoor environment. This reliability performance shall be supported together with user experienced data rate in the order of [300Mbps].

[Editor’s notes: The requirement expressed above as specific to eHealth can be moved later to a separate section if we agree to have a dedicated section to use cases special combinations of KPIs to be met together]

## 7.10 Coverage

"Maximum coupling loss" (MCL) in uplink and downlink between device and Base Station site (antenna connector(s)) for a data rate of [X bps], where the data rate is observed at the egress/ingress point of the radio protocol stack in uplink and downlink.

The target for coverage should be [164dB].

### 7.10.1 Extreme Coverage

Maximum coupling loss” to device from Base Station site to deliver successfully voice services, Data services (up to [2Mbps] for stationary services and up [384kbps] for moving devices) and all necessary control channels in UL and DL for a UE assuming a propagation distance of [100km].

[To be defined for Long Distance communication]

The 3GPP system should support the following deployment scenarios in terms of very large cell range:

- up to [100] km: with the performance targets defined in section 7.1.8.1.

- up to [200] km: slight degradations in the achieved performance is acceptable.

- up to [400] km: should not be precluded by the specifications.

## 7.11 UE battery life

UE battery life can be evaluated by the battery life of the UE without recharge. For mMTC, UE battery life in extreme coverage shall be based on the activity of mobile originated data transfer consisting of [TBD bytes] UL per day followed by [TBD bytes] DL from MCL of [TBD] dB, assuming a stored energy capacity of [TBD].

The target for UE battery life should be [15 years].

## 7.12 UE energy efficiency

UE energy efficiency means the capability of a UE to sustain much better mobile broadband data rate while minimizing the UE modem energy consumption.

Qualitative KPI

## 7.13 Cell/Transmission Point/TRP spectral efficiency

TRP spectral efficiency NOTE1 is defined as 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. A 3 sector site consists of 3 TRPs. In case of multiple discontinuous "carriers" (one carrier refers to a continuous block of spectrum), this KPI should be calculated per carrier. In this case, the aggregate throughput, channel bandwidth, and the number of TRPs on the specific carrier are employed.

Quantitative KPI NOTE2

NOTE1: 3GPP should strive to meet the target with typical antenna configuration

[NOTE2: The target considered as a starting point for eMBB deployment scenarios is in the order of 3 times IMT-Advanced requirements for full buffer.]

Table 7.13-1: Spectrum efficiency in each deployment scenario for each Usage scenario

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Spectrum efficiency | Indoor Hotspot | Dense Urban | Rural | Urban Macro | High Speed |
| eMBB |  |  |  |  |  |
| mMTC |  |  |  |  |  |
| URLLC |  |  |  |  |  |

Assessment for multi-layer and multi-band is FFS.

Values for relevant deployment scenario(s) are FFS.

## 7.14 Area traffic capacity

Area traffic capacity means total traffic throughput served per geographic area (in Mbit/s/m2). This metric can be evaluated by two different traffic models: Full buffer model and Non full buffer model

- By full buffer model: Total traffic throughput served per geographic area (in Mbit/s/m2). The computation of this metric is based on full buffer traffic.

- By non full buffer model: Total traffic throughput served per geographic area (in Mbit/s/m2). Both the user experienced data rate and the area traffic capacity need to be evaluated at the same time using the same traffic model.

The area traffic capacity is a measure of how much traffic a network can carry per unit area. It depends on site density, bandwidth and spectrum efficiency. In the special case of a single layer single band system, it may be expressed as:

area capacity (bps/m2) = site density (site/m2) × bandwidth (Hz) × spectrum efficiency (bps/Hz/site) NOTE1

NOTE1: Results of TRP spectral efficiency for non-full buffer are also provided separately.

In order to improve area traffic capacity, 3GPP can develop standards with means for high spectrum efficiency. To this end, spectrum efficiency gains in the order of three times IMT-Advanced are targeted. Furthermore, 3GPP can develop standards with means for large bandwidth support. To this end, it is proposed that at least 1GHz aggregated bandwidth shall be supported.

The available bandwidth and site density NOTE2, which both have a direct impact on the available area capacity, are however not under control of 3GPP.

NOTE2: Site here refers to single transmission and reception point (TRP).

Based on this, it is proposed to use the spectrum efficiency results together with assumptions on available bandwidth and site density in order to derive a quantitative area traffic capacity KPI for information.

## 7.15 User experienced data rate

User experienced data rate NOTE1 can be evaluated for non-full buffer traffic and for full buffer traffic.

NOTE1: Non-full buffer simulations are preferred for the evaluation of this KPI.

For non-full buffer traffic, user experienced data rate is the 5%-percentile (5%) of the user throughput. User throughput (during active time) 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.

The target values for the user experienced data rate are associated with non-full buffer evaluation. The non-full buffer user experienced data rate target is applicable at the non-full buffer area traffic capacity traffic level.

For full buffer traffic, user experienced data rate is calculated as:

user experienced data rate = 5% user spectrum efficiency × bandwidth

Here it should be noted that the 5% user spectrum efficiency depends on the number of active users sharing the channel (assumed to be 10 in the ITU evaluations [4]), and that the 5% user spectrum efficiency for a fixed transmit power may vary with bandwidth. To keep a high 5% user spectrum efficiency and a few users sharing the channel, a dense network is beneficial, i.e. 5% user spectrum efficiency may vary also with site density(Site here refers to single transmission and reception point (TRP).

To improve user experienced data rates, 3GPP can develop standards with means for high 5% user spectrum efficiency. To this end, 5% user spectrum efficiency gains in the order of three times IMT-Advanced are proposed. Furthermore, 3GPP can develop standards with means for large bandwidth support. To this end, it is proposed that at least 1GHz aggregated bandwidth shall be supported.

The available bandwidth and site density, which both have a strong impact on the available user experienced data rates, are however not under control of 3GPP.

Based on this, the full buffer experienced user data rate is evaluated for information without numerical requirements.

Table 7.15-1: User experience data rate in each deployment scenario for each usage scenario

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| User experienced data rate | Indoor Hotspot | Dense Urban | Rural | Urban Macro | High Speed |
| eMBB |  |  |  |  |  |
| mMTC |  |  |  |  |  |
| URLLC |  |  |  |  |  |

## 7.16 5th percentile user spectrum efficiency

5th percentile user spectrum efficiency means the 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, where the effective bandwidth is the operating bandwidth normalised appropriately considering the uplink/downlink ratio. In case of multiple discontinuous “carriers” (one carrier refers to a continuous block of spectrum), this KPI should be calculated per carrier. In this case, the user throughput and channel bandwidth on the specific carrier are employed.

Quantitative KPI NOTE1

[NOTE1: The target considered as a starting point for eMBB deployment scenarios is in the order of 3x IMT-Advanced requirements for full buffer]

Table 7.16-1: 5th percentile user spectrum efficiency in each deployment scenario for each usage scenario

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 5th percentile user spectrum efficiency | Indoor Hotspot | Dense Urban | Rural | Urban Macro | High Speed |
| eMBB |  |  |  |  |  |
| mMTC |  |  |  |  |  |
| URLLC |  |  |  |  |  |

Values for relevant deployment scenario(s) are FFS

## 7.17 Connection density

Connection density refers to total number of devices fulfilling specific QoS per unit area (per km2). QoS definition should take into account the amount of data or access request generated within a time t\_gen that can be sent or received within a given time, t\_sendrx, with x% probability.

The target for connection density should be 1 000 000 device/km2 in urban environment.

3GPP should develop standards with means of high connection efficiency (measured as supported number of devices per TRP per unit frequency resource) to achieve the desired connection density.

Table 7.17-1: Connection density in each deployment scenario for each usage scenario

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Connection density | Indoor Hotspot | Dense Urban | Rural | Urban Macro | High Speed |
| eMBB |  |  |  |  |  |
| mMTC |  |  |  |  |  |
| URLLC |  |  |  |  |  |

Editor’s notes: The details of QoS definition is FFS.

Connection density for other environments is FFS

## 7.18 Mobility

Mobility means the maximum user speed at which a defined QoS can be achieved (in km/h).

The target for mobility target should be 500km/h.

## 7.19 Network energy efficiency

The capability is to minimize the RAN energy consumption while providing a much better area traffic capacity.

Qualitative KPI as baseline and quantitative KPI is FFS.

Editor’s notes: Inspection is the baseline method to qualitatively check the capability of the RAN to improve area traffic capacity with minimum RAN energy consumption, e.g., ensure no or limited increase of BS power with more antenna elements and larger bandwidth, etc. As qualitative evaluation, 3GPP should ensure that the new RAT is based on energy efficient design principles. When quantitative evaluation is adopted, one can compare the quantity of information bits transmitted to/received from users, divided by the energy consumption of RAN.

# 8 Requirements for architecture and migration of Next Generation Radio Access Technologies

The RAN design for the Next Generation Radio Access Technologies shall be designed to fulfill the following requirements:

- The RAN architecture shall support tight interworking between the new RAT and LTE.

- Considering high performing inter-RAT mobility and aggregation of data flows via at least dual connectivity between LTE and new RAT. This shall be supported for both collocated and non-collocated site deployments.

- The RAN architecture shall support connectivity through multiple transmission points, either collocated or non-collocated.

- The RAN architecture shall enable a separation of control plane signalling and user plane data from different sites.

- The RAN architecture shall support interfaces supporting effective inter-site scheduling coordination.

- Different options and flexibility for splitting the RAN architecture shall be allowed.

- The RAN architecture shall allow for deployment flexibility e.g. to host relevant RAN, CN and application functions close together at the edges of the network, when needed, e.g. to enable context aware service delivery, low latency services, etc...

- The RAN architecture shall allow for C-plane/U-plane separation.

- The RAN architecture shall allow deployments using Network Function Virtualization.

- The RAN architecture shall allow for the RAN and the CN to evolve independently.

- The RAN architecture shall allow for the operation of Network Slicing[7].

- The RAN architecture shall support sharing of the RAN between multiple operators.

- The design of the RAN architecture shall allow the deployment of new services rapidly and efficiently.

- The design of the RAN architecture shall allow the support of 3GPP defined service classes (e.g. interactive, background, streaming and conversational).

- The design of the RAN architecture shall enable lower CAPEX/OPEX with respect to current networks to achieve the same level of services.

- RAN-CN interfaces and RAN internal interfaces (both between new RAT logical nodes/functions and between new RAT and LTE logical nodes/functions) shall be open for multi-vendor interoperability.

- The RAN architecture shall support operator-controlled sidelink (device-to-device) operation, both in coverage and out of coverage

# 9 Supplementary-Service related requirements

## 9.1 Multimedia Broadcast/Multicast Service

## 9.2 Location/Positioning Service

The target for positioning accuracy is [<1m] Indoor and outdoor.

## 9.3 Critical Communications services

### 9.3.1 Public safety communications

The RAN design for the Next Generation Radio Access Technologies shall provide D2D (e.g., ProSe) support for Public Safety (such as is found in [8]).

The RAN design for the Next Generation Radio Access Technologies shall provide Mission Critical Communications (e.g., MCPTT) support (such as is found in [9]).

The RAN design for the Next Generation Radio Access Technologies shall provide efficient group communications (e.g., GCSE\_LTE, SC-PTM) support (such as is found in [10] and [11] respectively).

### 9.3.2 Emergency communications

The RAN design for the Next Generation Radio Access Technologies shall provide mechanisms to enable emergency calls including positioning/location for emergency calls (such as is found in [12] section 10 for emergency calls and [13] for position/location) when appropriate.

The RAN design for the Next Generation Radio Access Technologies shall provide mechanisms to enable Multimedia Priority Services (such as is found in [14]).

### 9.3.3 Public warning/emergency alert systems

The RAN design for the Next Generation Radio Access Technologies shall provide mechanisms to enable public warning services that provides warning/notifications to users meeting regional regulatory requirements (such as is found in [15]).

# 10 Operational requirements

## 10.0 General

The RAN design for the Next Generation Radio Access Technologies shall be designed to fulfill the following requirements:

- RF requirements for multistandard base stations shall be supported also for the new RAT

- The RAN nodes shall be designed to allow upgrade by software as much as possible

## 10.1 Spectrum

### 10.1.1 Deployment possible in at least one identified IMT-band

### 10.1.2 Channel bandwidth scalability

Bandwidth scalability means the ability to operate with different bandwidth allocations.

Qualitative KPI

Editor’s notes: Whether to add number of bandwidths to be supported is FFS.

### 10.1.3 Spectrum flexibility

### 10.1.4 Duplexing flexibility

Duplexing flexibility means the ability of the access technology to adapt its allocation of resources flexibly for uplink and downlink for both paired and unpaired frequency bands.

### 10.1.5 Support of shared spectrum

Next Generation Radio Access Technologies should support efficient mechanisms to share spectrum with other IMT/Non-IMT systems.

### 10.1.6 Spectrum range

Next Generation Radio Access Technologies should support potential use of frequency range up to 100 GHz.

## 10.2 Support for wide range of services

Support for wide range of services means the system shall be inherently flexible enough to meet the connectivity requirements of a range of existing and future (as yet unknown) services to be deployable on a single continuous block of spectrum in an efficient manner.

## 10.3 Co-existence and interworking with legacy RATs

## 10.4 Control of EMF exposure levels requirements

## 10.5 Interworking with non-3GPP systems

### 10.5.1 General

3GPP system shall support procedures for interworking with non 3GPP RATs.

### 10.5.2 Interworking with WLAN

The next generation access network shall support interworking with WLAN. The number of solutions selected should be minimized.

### 10.5.3 Interworking with other non-3GPP systems

[FFS]

## 10.6 Radio Resource Management requirements

## 10.7 Easy operation and Self Organization requirements

The RAN design for the Next Generation Radio Access Technologies shall be designed to fulfill the following requirements:

- RAN shall support the deployment of RAN SON functions in a hybrid manner (distributed and centralized).

- Collaboration and coordination among RAN SON functions need to be addressed.

- User / application level QoS and QoE monitoring capability by UEs and network elements shall be supported.

## 10.8 Complexity-related requirements

## 10.9 Cost-related requirements

3GPP shall support ultra-low cost network infrastructures, ultra-low cost devices, and ultra-low cost operation and maintenance to enable economically viable deployments for the Provision of minimal services (Data and Voice) for very low-ARPU areas.

## 10.10 Energy-related requirements

## 10.11 Security and Privacy related requirement relevant for Radio Access

## 10.12 Performance monitoring and management

## 10.13 Lawful Interception

The RAN design for the Next Generation Radio Access Technologies shall provide mechanisms to enable lawful intercept for appropriate services (as per [16]).

## 10.14 Backhaul and signaling optimization requirements

The RAN system shall have the capability to minimize the backhaul and signaling load in line with the requirements in section 5.48 of [2]).

## 10.15 Relay requirements

The design of the 5G RAN and Radio Interface Technology shall aim at supporting wireless relay functions.

## 10.16 Other operational requirements

# 11 Testing and Conformance Requirements

Annex A:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **TSG #** | **TSG Doc.** | **CR** | **Rev** | **Subject/Comment** | **Old** | **New** |
| 2015-11 | RP-70 | RP-151761 |  |  | Draft skeleton for the TR | - | 0. 0.0 |
| 2015-11 | RP-70 | RP-152183 |  |  | Revised the reference SI to the updated SI, removed the change mark | 0.0.0 | 0.0.1 |
| 2016-01 | RP-AH | RPa160013 |  |  | Revised the Skeleton TR based on the Report of email discussion RPa-160012 | 0.0.1 | 0.0.2 |
| 2016-01 | RP-AH | RPa160070 |  |  | Merge all requirements into one section, renamed the section as key performance indicator | 0.0.2 | 0.0.3 |
| 2016-01 | RP-AH | RPa160071 |  |  | Move support for wide range of service from KPI section into operational section  Move spectral related sections from KPI section into operational section  Remove E2E latency requirements;  agreed skeleton TR | 0.0.3 | 0.1.0 |
| 2016-01 | RP-AH | RPa160080 |  |  | Implementation of approved pCRs RPa160077, RPa160078 and RPa160079 into the skeleton TR RPa160071 as input for RAN email discussion [5G-AH-01] | 0.1.0 | 0.1.1 |
| 2016-02 | RP-AH | RPa160081 |  |  | Minor editorial corrections on top of RPa160080 (result of RAN email discussion [5G-AH-01]) | 0.1.1 | 0.1.2 |
| 2016-02 | RP-AH | RPa160082 |  |  | RAN agreed TR after ad hoc and email discussion [5G-AH-01] | 0.1.2 | 0.2.0 |
| 2016-03 | RP-71 | RP-160688 |  |  | Updated TR including all agreements of RAN #71, e.g. pCRs RP-16RP-160554, RP-160555, RP-160562, RP-160566, RP-160589, RP-160611, RP-160629, RP-160637, RP-160640, RP-160642, RP-160643, RP-160646, RP-160672 | 0.2.0 | 0.2.1 |
| 2016-03 | RP-71 | RP-160689 |  |  | TR after RAN #71 that was agreed by email discussion [RAN#71-01]: changes from v0.2.1 plus editorial clean-up from MCC | 0.2.1 | 0.3.0 |