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| 3GPP TR 38.808 V0.0.3 (2020-11) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Radio Access Network;  Study on supporting NR from 52.6 GHz to 71 GHz  (Release 17) | |
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Contents

Foreword 5

Introduction 6

1 Scope 7

2 References 7

3 Definitions of terms, symbols and abbreviations 8

3.1 Terms 8

3.2 Symbols 8

3.3 Abbreviations 8

4 Study of Required Changes to NR 8

4.1 RAN1 Aspects 8

4.1.1 Candidate numerology and bandwidth 8

4.2 RAN4 aspects 9

5 Study of channel access mechanism for 60GHz 9

5.1 Identification of regulatory aspects for consideration 9

Annex <A> (informative): Evaluation Methodology 10

A.1 Link level evaluation assumptions 10

A.2 System level evaluation assumptions 10

A.2.1 [Evaluation A] 10

A.2.1 [Evaluation B] 10

Annex <B> (informative): Change history 11

# 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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In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# Introduction

This clause is optional. If it exists, it shall be the second unnumbered clause.

# 1 Scope

In order to support wide range of services, 5G NR system aims to be flexible enough to meet the connectivity requirements of a range of existing and future (yet unknown) services to be deployable in an efficient manner. NR considers supporting potential use of frequency range up to 100 GHz [1].

NR specifications that have been developed in Rel-15 and Rel-16 define operation for frequencies up to 52.6 GHz, where all physical layer channels, signals, procedures, and protocols are designed to be optimized for uses under 52.6 GHz.

However, frequencies above 52.6 GHz are faced with more difficult challenges, such as higher phase noise, larger propagation loss due to high atmospheric absorption, lower power amplifier efficiency, and strong power spectral density regulatory requirements in unlicensed bands, compared to lower frequency bands. Additionally, the frequency ranges above 52.6 GHz potentially contain larger spectrum allocations and larger bandwidths that are not available for bands lower than 52.6 GHz.

As an initial effort to enable and optimize 3GPP NR system for operation in above 52.6 GHz, 3GPP RAN has studied requirements for NR beyond 52.6GHz up to 114.25GHz including global spectrum availability and regulatory requirements (including channelization and licensing regimes), potential use cases and deployment scenarios, and NR system design requirements and considerations on top of regulatory requirements [2]. The potential use cases identified in the study include high data rate eMBB, mobile data offloading, short range high-data rate D2D communications, broadband distribution networks, integrated access backhaul (IAB), factory automation, industrial IoT (IIoT), wireless display transfer, augmented reality (AR)/virtual reality (VR) wearables, intelligent transport systems (ITS) and V2X, data center inter-rack connectivity, smart grid automation, private networks, and support of high positioning accuracy. The use cases span over several deployment scenarios identified in the study. The deployment scenarios include, but not limited to, indoor hotspot, dense urban, urban micro, urban macro, rural, factor hall, and indoor D2D scenarios. The study also identified several system design requirements around waveform, MIMO operation, device power consumption, channelization, bandwidth, range, availability, connectivity, spectrum regime considerations, and others.

Among the frequencies of interest, frequencies between 52.6 GHz and 71 GHz are especially interesting relatively in the short term because of their proximity to sub-52.6 GHz for which the current NR system is optimized and the imminent commercial opportunities for high data rate communications, e.g., unlicensed spectrum but also licensed spectrum between 57 GHz and 71 GHz. Therefore, it would be beneficial to make a study focused on feasibility of using existing waveforms and required changes for frequencies between 52.6 GHz and 71 GHz, so as to take advantage of imminent commercial opportunities for the specific frequency regime by minimizing the specification burden and maximizing the leverage of FR2 based implementations.

# 2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 38.913: "Study on Scenarios and Requirements for Next Generation Access Technologies"

[2] 3GPP TR 38.807: "Study on requirements for NR beyond 52.6 GHz".

[3] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[4] ETSI EN 302 567 v2.1.20: "Multiple-Gigabit/s radio equipment operating in the 60 GHz band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU".

[5] R1-2007549 "Further discussion on B52 numerology" FUTUREWEI.

[6] R1-2007558 "Discussion on physical layer impacts for NR beyond 52.6 GHz" Lenovo, Motorola Mobility.

[7] R1-2007604 "PHY design in 52.6-71 GHz using NR waveform" Huawei, HiSilicon.

[8] R1-2007642 "Physical layer design for NR 52.6-71GHz" Beijing Xiaomi Software Tech.

[9] R1-2007652 "Discussion on required changes to NR using existing DL/UL NR waveform" vivo.

[10] R1-2007785 "Consideration on required changes to NR using existing NR waveform" Fujitsu.

[11] R1-2007790 "Consideration on supporting above 52.6GHz in NR" InterDigital, Inc.

[12] R1-2007847 "System Analysis of NR opration in 52.6 to 71 GHz" CATT.

[13] R1-2007883 "Required changes to NR using existing DL/UL NR waveform" TCL Communication Ltd.

[14] R1-2007926 "Required changes to NR using existing DL/UL NR waveform" Nokia, Nokia Shanghai Bell.

[15] R1-2007929 "On phase noise compensation for NR from 52.6GHz to 71GHz" Mitsubishi Electric RCE.

[16] R1-2009379 "Discussion on Required Changes to NR in 52.6 – 71 GHz" Intel Corporation.

[17] R1-2007965 "On the required changes to NR for above 52.6GHz" ZTE, Sanechips.

[18] R1-2007982 "On NR operations in 52.6 to 71 GHz" Ericsson.

[19] R1-2008045 "Consideration on required physical layer changes to support NR above 52.6 GH" LG Electronics.

[20] R1-2008076 "Discussion on required changes to NR using existing DL/UL NR waveform in 52.6GHz ~ 71GHz" CMCC.

[21] R1-2008082 "Study on the numerology to support 52.6 GHz to 71GHz" NEC.

[22] R1-2008872 "Design aspects for extending NR to up to 71 GHz" Samsung.

[23] R1-2008250 "Discusson on required changes to NR using DL/UL NR waveform" OPPO.

[24] R1-2008353 "Considerations on required changes to NR from 52.6 GHz to 71 GHz" Sony.

[25] R1-2008457 "A Discussion on Physical Layer Design for NR above 52.6GHz" Apple.

[26] R1-2008493 "Discussions on required changes on supporting NR from 52.6GHz to 71 GHz" CAICT.

[27] R1-2008501 "On required changes to NR using existing DL/UL NR waveform for operation in 60GHz band" MediaTek Inc.

[28] R1-2008516 "On NR operation between 52.6 GHz and 71 GHz" Convida Wireless.

[29] R1-2009062 "Evaluation Methodology and Required Changes on NR from 52.6 to 71 GHz" NTT DOCOMO, INC.

[30] R1-2008615 "NR using existing DL-UL NR waveform to support operation between 52p6 GHz and 71 GHz" Qualcomm Incorporated.

[31] R1-2008726 "Discussion on physical layer aspects for NR beyond 52.6GHz" WILUS Inc.

[32] R1-2008769 "Waveform considerations for NR above 52.6 GHz" Charter Communications.

[33] R1-2007550 "On channel access modes in 60GHz" FUTUREWEI.

[34] R1-2007559 "Discussion on channel access for NR beyond 52.6 GHz" Lenovo, Motorola Mobility.

[35] R1-2008976 "Channel access mechanism for 60 GHz unlicensed operation" Huawei, HiSilicon.

[36] R1-2007643 "Channel access mechanism for NR on 52.6-71 GHz" Beijing Xiaomi Software Tech.

[37] R1-2007653 "Discussion on channel access mechanism" vivo.

[38] R1-2007791 "On Channel access mechanisms" InterDigital, Inc.

[39] R1-2007848 "Channel Access Mechanism in support of NR operation in 52.6 to 71 GHz" CATT.

[40] R1-2007884 "Channel access mechanism" TCL Communication Ltd.

[41] R1-2007918 "Channel access mechanisms for NR from 52.6-71GHz" AT&T.

[42] R1-2007927 "Design of NR channel access mechanisms for 60 GHz unlicensed band" Nokia, Nokia Shanghai Bell.

[43] R1-2009380 "Channel Access Procedure for NR in 52.6 - 71 GHz" Intel Corporation.

[44] R1-2007966 "On the channel access mechanism for above 52.6GHz" ZTE, Sanechips.

[45] R1-2007983 "Channel Access Mechanism" Ericsson.

[46] R1-2008046 "Considerations on channel access mechanism to support NR above 52.6 GHz" LG Electronics.

[47] R1-2008091 "Discussion on channel access mechanism for above 52.6GHz" Spreadtrum Communications.

[48] R1-2008157 "Channel access mechanism for 60 GHz unlicensed spectrum" Samsung.

[49] R1-2008251 "Discussion on channel access" OPPO.

[50] R1-2008354 "Channel access mechanism for 60 GHz unlicensed spectrum" Sony.

[51] R1-2008458 "Views on Channel Access Mechanisms for Unlicensed Access above 52.6 GHz" Apple.

[52] R1-2008494 "Discussions on channel access mechanism on supporting NR from 52.6GHz to 71 GHz" CAICT.

[53] R1-2008517 "On Channel Access Mechanism and Interference Handling for Supporting NR from 52.6 GHz to 71 GHz" Convida Wireless.

[54] R1-2008548 "Channel Access Mechanism for NR in 60 GHz unlicensed spectrum" NTT DOCOMO, INC.

[55] R1-2008563 "Discussion on channel access mechanism" ITRI.

[56] R1-2009362 "Channel access mechanism for NR in 52p6 to 71GHz band" Qualcomm Incorporated.

[57] R1-2008717 "Discussion on channel access mechanism for 52.6 to 71GHz unlicensed ban" Potevio

[58] R1-2008770 "Further aspects of channel access mechanisms" Charter Communications.

[59] R1-2007560 "Additional evaluations for NR beyond 52.6GHz" Lenovo, Motorola Mobility.

[60] R1-2007654 "Evaluation on different numerologies for NR using existing DL/UL NR waveform" vivo.

[61] R1-2007792 "Evaluation results for above 52.6 GHz" InterDigital, Inc.

[62] R1-2007928 "Simulation Results for NR from 52.6 GHz to 71 GHz" Nokia, Nokia Shanghai Bell.

[63] R1-2007943 "Considerations on performance evaluation for NR in 52.6-71GHz" Intel Corporation.

[64] R1-2007967 "Simulation results for NR above 52.6GHz" ZTE, Sanechips.

[65] R1-2007984 "Evaluation results for NR in 52.6 - 71 GHz" Ericsson.

[66] R1-2008047 "Considerations on phase noise compensation to support NR above 52.6 GHz" LG Electronics.

[67] R1-2008873 "Evaluation results for extending NR to up to 71 GHz" Samsung.

[68] R1-2009615 "Discussion on other aspects" OPPO.

[69] R1-2008459 "Evaluation results for Physical Layer Design for NR above 52.6GHz" Apple.

[70] R1-2009062 "Potential Enhancements for NR on 52.6 to 71 GHz" NTT DOCOMO, INC.

[71] R1-2008771 "Performance evaluations for NR above 52.6 GHz" Charter Communications.

[72] R1-2009610 "Link level and System level evaluation for NR system operating in 52.6GHz to 71GHz" Huawei, HiSilicon.

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [3] 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 [3].

## 3.2 Symbols

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

B transmission bandwidth

G antenna gain

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [3] 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 [3].

BS Base Station

EIRP Equivalent Isotropic Radiated Power

FDD Frequency Duplex Division

IAB Integrated Access Backhaul

ISM Industrial, Scientific and Medical

ITU International Telecommunication Union

LBT Listen Before Talk

MCOT Maximum Channel Occupancy Time

NR New Radio

OCB Occupied Bandwidth

OOBE Out-Of-Band Emission

PSD Power Spectral Density

PTP Point to point

SI Study Item

SID Study Item Description

TDD Time Duplex Division

UE User Equipment

V2X Vehicle to Everything

WAN Wide Area Network

# 4 Study of required changes to NR

## 4.1 RAN1 Aspects

*Editor’s Note: This section will be further categorized into sub-sections depending on discussions*

### 4.1.1 General description of study in RAN1

*Editor’s Note: Some descriptions on prioritized deployment scenarios (if such description is needed) could be specified here.*

For supporting NR operation in both licensed and unlicensed band in the frequency range from 52.6 GHz to 71 GHz, FR2 numerologies and additional numerologies beyond that supported currently in NR are studied. Existing framework for numerology scaling is considered i.e. 2μ ×15 subcarrier spacing to select the candidates. For SSB transmissions, it is investigated whether or not µ > 4 (larger than 240 kHz) is needed and corresponding impacts, if any, on the aspects including at least SSB pattern, multiplexing of other signal/channels, and transmission window, if supported. For data and control channel transmissions, it is investigated if µ > 3 (larger than 120 kHz) is needed and corresponding impacts, if any, on aspects including at least processing timelines, PDCCH monitoring capability (BD/CCE), scheduling enhancements, beam-management, and reference signal design. For investigating the need for higher numerologies, some of the key aspects that are studied are the impact due to phase noise, delay spread, TAE, analog beam switching delay, and impact to coverage, spectral efficiency and peak data rates, and relative delay in intra-cell/inter-cell multi-TRP operations.

### 4.1.2 Candidate numerology and bandwidth

*Editor’s Note: This section can include discussion on CP length, subcarrier spacing, and channel bandwidth issues*

### 4.1.3 Investigation of physical layer impact from candidate numerology and bandwidths

*Editor’s Note: This section can include discussion on potential specification impact that stem from introduction of candidate numerology and bandwidths*

## 4.2 RAN4 aspects

*Editor’s Note: This section will be further categorized into sub-sections depending on discussions*

# 5 Study of channel access mechanism for 60 GHz

*Editor’s Note: This section will be further categorized into sub-sections depending on discussions*

## 5.1 Identification of regulatory aspects for consideration

*Editor’s Note: This section can include list of identified regulatory aspects that is needed for consideration of channel access mechanism for 60 GHz unlicensed operation.*

## 5.2 Channel access and interference mitigation techniques

*Editor’s Note: This section can include study of channel access and interference mitigation techniques.*

# 6 Summary of evaluation study

## 6.1 Summary of link level evaluations

Key findings from xxx

## 6.2 Summary of system level evaluations

Key findings from xxx

# Annex A: Evaluation methodology

## A.1 Link level evaluation assumptions

This subclause describes the link level simulation assumptions used for evaluations. The link level simulation assumption is given in Tables A.1-1. The primary objective of the evaluation is to evaluate performance of PDSCH/PUSCH including study of phase noise impairment impact for various numerology (i.e. subcarrier spacing, CP length) and possibly for various carrier frequencies. The evaluation KPI(s) include BLER. The secondary objective of the evaluation is to evaluate performance of SSB/PRACH including study of phase noise impairment impact for various numerology (i.e. subcarrier spacing, CP length) and possibly for various carrier frequencies. Evaluation KPI(s) include miss-detection, and false alarm.

Table A.1-1: Link level evaluation assumptions and parameters

| Assumptions | Value |
| --- | --- |
| Carrier Frequency [GHz] | 60 GHz    Optional: 70 GHz |
| Subcarrier Spacing [kHz] | PDSCH/PUSCH:  - {120, 240, 480, 960} kHz  -optional: 1920 kHz  Optional:  - if evaluated companies are asked to provide information on other channels/signals and subcarrier spacing |
| Bandwidth [MHz] | PDSCH/PUSCH:  - {400, 2000} MHz    Optional:  - Companies are asked to provide information if other bandwidths are evaluated  Note: Evaluation of listed channel bandwidth does not mean RAN1 has agreed to support such channel bandwidth and are only for evaluation purposes to obtain useful insights. |
| Number of RB | For 400 MHz:  - 256 (120 kHz),  - 128 (240 kHz),  - 64 (480 kHz),  - 32 (960 kHz),  - N/A (1920 kHz)  For 2000 MHz:  - N/A (120 kHz),  - N/A (240 kHz),  - 320 (480 kHz) (optional),  - 160 (960 kHz),  - 80 (1920 kHz),    For other channel bandwidths:  - Companies are asked to provide information. Companies are encouraged to utilize linearly scaled PRB sizes for a given bandwidth based on above.  Note: Other bandwidth and sub-carrier spacing combinations can be optionally used. |
| Waveform | For PDSCH:  CP-OFDM  For PUSCH:  CP-OFDM and DFT-s-OFDM |
| CP Type | Normal CP  Extended CP  Note: ECP is not expected to be applicable in all SCS and channel conditions, and companies providing results for ECP are encouraged to provide evaluation results with motivation/justification of simulated ECP cases |
| Channel Model | TDL model as defined in of TR38.901 Section 7.7.2:  - TDL-A (5ns, 10ns, 20ns DS)  - optional DS for consideration: 40ns, 60ns DS  CDL model as defined in of TR38.901 Section 7.7.1:  - CDL-B (20ns, 50ns DS)  - CDL-D (20ns, 30ns DS) with K-factor = 10 dB  - optional DS for consideration: 100ns DS  Optional modification CDL-B/D model  (a) Indoor Office NLOS: CDL-B (20 ns DS), and Indoor Office LOS: CDL-D (20 ns DS)  - Use mean angular spread values from Table 7.5.6-Part2 (for ASD, ASA, and ZSA) and Table 7.5-10 (for ZSD)  - Use mean angles of CDL-B/D for desired mean angles as baseline (no angle translation)  - Note that the angular spread values in the table are quoted in log units  - Mean K-factor for CDL-D from Table 7.5.6-Part2 (9 dB)  (b) UMi – Street Canyon NLOS: CDL-B (50 ns DS), and UMi – Street Canyon LOS: CDL-D (30 ns)  - Use mean angular spread values from Table 7.5.6-Part1 (for ASD, ASA, and ZSA) and Table 7.5-8 (for ZSD).  - Use mean angles of CDL-B/D for desired mean angles as baseline (no angle translation)  - Note that the angular spread values in the table are quoted in log units  - Use mean K-factor for CDL-D from Table 7.5.6-Part1 (7 dB)  Note: Mean angular spread values are used as desired AS value to scale the ray angles as described in TR38.901 section 7.7.5.1. As baseline, the ray angles are not translated, meaning (TR38.901 section 7.7.5.1). If companies perform translation of the ray angles they are encouraged to report the details. The mean K-factor is used to scale the tap powers as described in TR38.901 section 7.7.6.  Note 2: for TDL/CDL model, the delay spread (DS) value mentioned is the delay spread scaling value (i.e. corresponding to normalized delay of 1.0).  Note 3: Other models (either TDL or CDL) with DS values not listed are optional.  Note 4: Companies are encouraged to provide evaluation results with motivation/justification of simulated DS values. |
| Antenna Configuration (Mg,Ng,M,N,P) | For TDL model:  - 2x2  - 1x2 (optional)  For CDL model:  Configuration 1:  - (Mg,Ng,M,N,P) = (1,1,8,16,2) BS with (0.5 dv, 0.5 dH)  - (Mg,Ng,M,N,P) = (1,1,4,4,2) UE with (0.5 dv, 0.5 dH)  Configuration 2:  - (Mg,Ng,M,N,P) = (1,1,4,8,2) BS with (0.5 dv, 0.5 dH)  - (Mg,Ng,M,N,P) = (1,1,2,2,2) UE with (0.5 dv, 0.5 dH) |
| Mobility | 3 km/hr |
| PA Model | Optional:  - Companies to provide modelling (in lieu of pre-loaded Tx EVM) |
| gNB TRP PN Model | 3GPP TR38.803 example 2 BS PN profile  Optional:  - If other PN profile is used, companies to provide information on the modelling used  Note: companies to provide information about the LO distribution model assumed in the simulations. |
| UE PN Model | 3GPP TR38.803 example 2 UE PN profile  Optional:  - If other PN profile is used, companies to provide information on the modelling used  Note: companies to provide information about the LO distribution model assumed in the simulations. |
| Pre-loaded Tx EVM | Optional:  - 3% at Tx (In lieu of PA model),  - If other values are used companies are asked to provide information on the values selected for simulation. |
| Additive Rx EVM | Optional:  - 5% at Rx,  - If other values are used companies are asked to provide information on the values selected for simulation. |
| I-Q Imbalance | Optional:  - (-26dBc),  - (-31dBc),  - If other values are used companies are asked to provide information on the values selected for simulation. |
| Frequency Offset | Optional:  - 0.1 ppm (for PDSCH/PUSCH)  - 5, 10, 20 ppm (for initial access) |
| Channel Estimation | Realistic channel estimation |
| Transmission Rank | Rank 1  Note: companies are asked to provide information the precoding scheme (including granularity) used in the evaluations. |
| PDSCH SLIV | (S=2, L=12)  Optional:(S=0, L=14)  Note: Starting symbol, S, (indexed from 0) and length, L. |
| DMRS Configuration | 1 DMRS symbol (front loaded), or 2 DMRS symbols at (2,11) symbol index  Note: no data multiplexing is assumed in DMRS symbols |
| PTRS Configuration | For CP-OFDM:  (K = 4, L = 1) or (K = 2, L = 1)  Note: PTRS per K number of PRBs, and PTRS every L number of OFDM symbols  For DFT-s-OFDM:  (Ng = 2, Ns = 2, L = 1)  (Ng = 2, Ns = 4, L = 1)  (Ng = 4, Ns = 2, L = 1)  (Ng = 4, Ns = 4, L = 1)  (Ng = 8, Ns = 4, L = 1)  Note: Ng number of PT-RS groups, Ns number of samples per PT-RS group, and PTRS every L number of DFT-s-OFDM symbols  Note 2: companies are asked to provide the PT-RS configuration used for DFT-s-OFDM simulation among the listed above, where the selection of the PT-RS is chosen such that it provides similar overhead as the chosen PT-RS configuration for PUSCH CP-OFDM (if simulated). |
| CSI-RS / TRS | CSI-RS/TRS is assumed to be off (for RS overhead) |
| MCS/TBS | From MCS Table 1 (TS38.214):  - MCS 7 (QPSK),  - MCS 16 (16QAM),  - MCS 22 (64QAM),  From MCS Table 2 (TS38.214):  - MCS 27 (256QAM) (optional)  Assume NohPRB = 0 for MCS calcuations.  Note: If normal CP and extended CP are to be compared, companies are asked to provide information on the MCS values used that provide similar payload sizes for the comparison. Companies to provide actual code rate used in the evaluations. |

## A.2 System level evaluation assumptions

This subclause describes the system level simulation assumptions used for evaluations. The system level simulation assumption is given in Tables A.2-1. The primary objective is evaluation of single operator and multi-operator deployments including study of interference impact and coexistence between nodes. The evaluation KPI(s) include user throughput, latency, average buffer occupancy, ratio of mean served throughput and offered cell throughput, and resource utilization. The secondary objective is to obtain delay spread profiles (and inter-symbol interference statistics) for deployment scenarios of interest. Note that performance impact from delay spread should be conducted in link level simulations, the system level simulations would be used to supplement the findings.

Table A.2-1: System level evaluation assumptions and parameters

| Assumptions | Value |
| --- | --- |
| Carrier Frequency [GHz] | 60 GHz  Optional: 70 GHz |
| Subcarrier Spacing [kHz] | For 2000MHz BW:  - 960 kHz  - optional: 120, 240, 480 kHz  For 400MHz BW:  - 120 kHz  - optional: 240, 480, 960 kHz  Note: Other than value above, companies are encouraged to evaluating using subcarrier spacing values determined to be feasible from LLS study. Values for the subcarrier spacing may be revisited after further investigation from LLS study. |
| Bandwidth [MHz] | 2000 MHz  400 MHz  Note: Channel bandwidth evaluated may be revisited after further investigation. |
| Number of RB | For 2000 MHz:  - N/A (120 kHz),  - N/A (240 kHz),  - 320 (480 kHz) (optional),  - 160 (960 kHz),  - 80 (1920 kHz),  For 400 MHz:  - 256 (120 kHz),  - 128 (240 kHz),  - 64 (480 kHz),  - 32 (960 kHz),  - N/A (1920 kHz)    For other channel bandwidths:  - Companies are asked to provide information. Companies are encouraged to utilize linearly scaled PRB sizes for a given bandwidth based on above. |
| Deployment Scenario | - Scenario indoor-A (for two operator case)  - Scenario indoor-C (for single operator case)  **Secondary scenarios:**  - Scenario outdoor-B  Optional:  - other scenarios listed below  **Indoor Office:**  **Scenario Indoor-A)** InH open office model:  Office box 120m x 50 m, 12 BS per operator, 2 operator, BS height at 3m (ceiling), UE height 1m, x-axis ISD = 20m and y-axis ISD = 25m, where ISD is define by the distance between two adjacent 10m x 10m virtual box, BS randomly deployed within 10m x 10m virtual box, minimum distance between BS of different operators is 2m.  Optional: single operator deployment in Scenario Indoor-A    **Scenario Indoor-B)** small InH open office model:  Office box 20m x 20 m, 1 BS per operator, 2 operator, BS height at 3m (ceiling), UE height 1m, BS randomly deployed within 10m x 10m virtual box, minimum distance between BS of different operators is 2m.    **Scenario Indoor-C)** InH open office model:  Office box 120m x 50 m, 12 BS per operator, 1 operator, BS height at 3m (ceiling), UE height 1m, BS fixed position, ISD = 20m      **Scenario Indoor-D)** InH open office model:  Office box 120m x 50 m, 6 BS per operator, 2 operator, BS height at 3m (ceiling), UE height 1m, BS fixed position, ISD = 20m  FFS: if the office box scenario can be reduced down to 50m x 50m      **Scenario Indoor-E)** InH open office model:  Office box 120m x 80 m, 3 BS per operator, 2 operator, BS height at 3m (ceiling), UE height 1m, BS fixed position, a=20m, b=40m, c=20m, and d=40m  image001    **Dense Urban:**  **Scenario Outdoor-A)** Dense Urban with 1 layer  Hexagonal grid, single layer, 3 sectors per site, 7 sites locations, BS height 10m, UE height 1.5m, ISD = 150m  FFS: whether ISD needs to be smaller  optional: Reducing deployment size from 7 sites to 1 site with wrap around      **Scenario Outdoor-B)** Dense Urban with 2 layers  Macro layer (sub 7GHz – not necessarily need to be simulated for the 60GHz evaluation):  Hexagonal grid, single layer, 3 sectors per site, 7 sites locations  BS height 25m, UE height 1.5m, ISD = 100m, fixed BS position  Micro layer (above 52.6 GHz):  BS height 10m, UE height 1.5m, 2 operator, 2 BS per hexgrid per operator, random position within macro hexagonal grid per operator, minimum distance between TRP and UE: 10m, minimum distance between micro gNBs’ of the same operator: 10m  optional: Reducing deployment size from 7 sites to 1 site with wrap around.      **Scenario Outdoor-C)** Dense Urban with 1 layer  Hexagonal grid, single layer, 3 sectors per site, 3 sites locations, BS height 10m, UE height 1.5m, ISD = 150m    **Indoor Factory Hall:**  **Scenario Factory-A)** Indoor factory with Dense cluster & low BS (InF-DL)  Grid, 300m x 150m x 10m factor hall  ISD 50m, BS height 1.5m, UE height 1.5m, Typical clutter size 2m, Clutter height 6m, Clutter density 60%  **Scenario Factory-B)** Indoor factory with sparse clutter & High BS (InF-SH)  Grid, 300m x 150m x 10m factor hall  ISD 50m, BS height 8m, UE height 1.5m, Typical clutter size 10m, Clutter height 2m, Clutter density 20% |
| UE distribution | Average of 5 or 10 UE per BS    UE are either 100% indoor or 100% outdoor depending on deployment scenario. |
| Channel Model | **InH open office:**  - gNB-to-gNB and gNB-to-UE links: InH – office channel & PL model from TR38.901, indoor – open office LOS probability from TR38.901 (optional: indoor – mixed office LOS probability from TR38.901)  - UE-to-UE links: InH – office channel & PL model from TR38.901, indoor – mixed office LOS probability from TR38.901    **Dense Urban:**  - gNB-to-gNB and gNB-to-UE links: UMi street canyon channel & PL model from TR38.901  - UE-to-UE links: [outdoor to outdoor D2D channel & PL model from TR36.843 Section A.2.1.2], [(optional: UMi street canyon channel & PL model from TR38.901)]    **Indoor factory:**  - gNB-to-gNB and gNB-to-UE links: InF channel & PL model from TR38.901  - UE-to-UE links: [InF channel & PL model from TR38.901]  Note: 3D distance between an gNB and a UE is applied. 3D distance is also used for LOS probability and break point distance.  Note: channel models in brackets, [ ], are working assumption and may be revisited.  Note: For D2D channel model used for UE-to-UE links companies should report how they scaled the model to 60 GHz. |
| Mobility | 3 km/hr |
| BS Antenna Configuration (Mg,Ng,M,N,P) | For outdoor macro/sectorized scenarios:  (Mg,Ng,M,N,P) = (1,1,8,16,2)  with (0.5 dv, 0.5 dH)  For outdoor micro-layer scenarios:  (Mg,Ng,M,N,P) = (1,3,8,16,2)  with (0.5 dv, 0.5 dH)  Note: 3 Panel single sector gNB with {0,+120,-120} degree boresight orientations. The gNB will only utilize 1 panel at given moment.  For indoor scenarios:  (Mg,Ng,M,N,P) = (1,1,4,8,2) with (0.5 dv, 0.5 dH)  optional: (Mg,Ng,M,N,P) = (1,1,8,16,2) per pol with (0.5 dv, 0.5 dH) |
| BS Antenna Pattern | For outdoor scenarios:  - Antenna power pattern given in Table 7.3-1 of TR38.901  (with exception of antenna element gain)  For indoor scenarios:  - Antenna power pattern given in Table A.2.1-7 of TR38.802 for ceiling mount  (with exception of antenna element gain)  For factory scenarios:  Companies to provide information on the antenna orientation and pattern used. |
| BS Antenna element gain | 5 dBi |
| UE Antenna Configuration (Mg,Ng,M,N,P) | Configuration 1:  (Mg,Ng,M,N,P) = (1,2,2,2,2)  with (0.5 dv, 0.5 dH)  Configuration 2 (optional):  (Mg,Ng,M,N,P) = (1,2,4,4,2)  with (0.5 dv, 0.5 dH)  Note: In both configurations, the 2 panels are back-to-back with panel selection done the at receiver. The UE will only utilize 1 panel at a given moment. |
| UE Antenna Pattern | Antenna power pattern given in Table A.2.1-8 of TR38.802  For indoor factory scenarios:  Boresight orientation should be fixed in all simulation drops  For other scenarios:  Boresight orientation should be randomized between [0°, 360°) in the horizontal plane in each simulation drop  Note: Companies to provide information about boresight orientation (e.g. random orientation, vertical to ground, parallel to ground, etc) |
| UE Antenna element gain | 5 dBi |
| BS Power Limitation | 40 dBm EIRP  Optional: 60 dBm EIRP  Maximum TxP adjusted to meet EIRP limits |
| UE Power Limitation | 25 dBm EIRP with 21 dBm max TxP    Optional: 40dBm EIRP with 21 dBm max TxP |
| BS NF | 7 dB |
| UE NF | 10 dB  Optional: 13dB |
| Transmission Rank | Rank adaptative transmission between Rank 1 and 2 |
| PDCCH Overhead | 2 symbol per slot |
| DMRS Overhead | 1 symbol per slot |
| CSI-RS Overhead | Companies to provide information |
| SRS Overhead | Companies to provide information |
| Other Overhead | Companies to provide information |
| Data Processing Latency | UE processing timeline in microseconds are assumed to be same as 120 kHz SCS PDSCH/PUSCH processing latency  Optional:  UE processing timeline in microseconds are assumed to be half of 120 kHz SCS PDSCH/PUSCH processing latency |
| TDD DL/UL Ratio | Companies to provide information (if applicable) |
| CSI feedback | Ideal feedback |
| Additive Rx EVM | Note: additive Rx EVM values may be revisited after LLS study |
| Traffic Model | FTP Model 3 (27Mbyte file)    Optional:  - Full buffer,  - FTP Model 1 (27, 8 Mbyte file),  - FTP Model 3 (0.5, 2, 8, 16 Mbyte file) |
| UE Receiver | MMSE-IRC |
| Cell selection criteria | Random select from strongest RSRP with 1 dB HO Margin  Note: UE with RSRP below a -71 dBm + 10 log10( bandwidth/2GHz ) are not considered in simulation and not counted toward UE distribution count |
| DL/UL Traffic Ratio | 50% DL, 50% UL    Optional:  100% DL, 0% UL,  80% DL, 20% UL  0% DL, 100% UL |
| Channel access modelling | Companies to report details of LBT procedure and parameters (e.g. ED, CWmax, COT, etc.) if LBT procedure is used in the evaluations. |
| Synchronization Assumption | Companies are asked to provide information on the synchronization assumption made between operators for 2 operator deployment scenarios. |

## A.3 LBT procedure for system level evaluation

This subclause describes the LBT procedure assumed for system level simulation evaluations. Figure A.3-1 shows an illustration of the LBT procedure assumed for system level simulation evaluations. LBT procedures in draft v2.1.20 of EN 302 567 as the baseline system evaluation with LBT [4]. When the node is performing CCA before initiating transmission, during count down, when an observation slot fails energy detect (ED), the counter freezes, and will continue count down 8 μs after the interference is detected to be gone. Any enhancements to ED threshold, contention window sizes, Zmin and Zmax, can be considered as part of the evaluations. The smallest value of Zmax for contention window size is 3, and Zmin is equal to 0.



Figure A.3-1: Illustration of LBT procedure assumed for system level simulation evaluations

# Annex B: Evaluations results

## B.1 Link level evaluation results

*Editor’s Note: This section will be potentially sub-divided into further sub-sections depending on case and/or scenario.*

### B.1.1 Evaluation results for PDSCH/PUSCH

*Editor’s Note: template for the evaluation results is presented as a placeholder for now.*

Table B.1.1-1: LLS template: SINR in dB achieving PDSCH/PUSCH BLER of 10% /1%

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Tdoc /  Source | MCS | Channel | 120KHz /400MHz | 240KHz /400MHz | 480KHz /400MHz | 960KHz /400MHz | 960KHz /2GHz |
| R1-xxxxxxx / Source 1 | 7 | TDL-A, 5ns | X / Y (X for 10% BLER, Y for 1% BLER) |  |  |  |  |
| TDL-A, 10ns |  |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |  |
| CDL-D, 20ns |  |  |  |  |  |
| CDL-D, 30ns |  |  |  |  |  |
| 16 | TDL-A, 5ns |  |  |  |  |  |
| TDL-A, 10ns |  |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |  |
| CDL-D, 20ns |  |  |  |  |  |
| CDL-D, 30ns |  |  |  |  |  |
| 22 | TDL-A, 5ns |  |  |  |  |  |
| TDL-A, 10ns |  |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |  |
| Additional report/notes:   1. CP type 2. antenna configuration for CDL model 3. waveform in case of PUSCH 4. PTRS configuration 5. DMRS configuration 6. any optional or other assumption/parameters used not as in the baseline | | | | | | |

### B.1.2 Evaluation results for PSS/SSS

*Editor’s Note: template for the evaluation results is presented as a placeholder for now.*

Table B.1.2: LLS template: SINR in dB achieving cell ID detection probability of 90% by one-shot detection from PSS/SSS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tdoc /  Source | Channel | 120KHz | 240KHz | 480KHz | 960KHz |
| R1-xxxxxxx / Source 1 | TDL-A, 5ns |  |  |  |  |
| TDL-A, 10ns |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |
| CDL-D, 20ns |  |  |  |  |
| CDL-D, 30ns |  |  |  |  |
| Additional report/notes:   1. frequency offset 2. the number and granularity of the frequency locations 3. antenna configuration for CDL model 4. any optional or other assumption/parameters used not as in the baseline 5. false alarm rate 6. criteria for PSS detection success | | | | |

### B.1.3 Evaluation results for PRACH

*Editor’s Note: template for the evaluation results is presented as a placeholder for now.*

Table B.1.3-1: LLS template: SINR in dB achieving PRACH preamble misdetection probability of 1% and corresponding false alarm probability

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tdoc /  Source | Channel | 120KHz | 240KHz | 480KHz | 960KHz |
| R1-xxxxxxx / Source 1 | TDL-A, 5ns | X / Y (X for SINR in dB to reach 1% misdetection, Y for corresponding false alarm probability in % at that SINR) |  |  |  |
| TDL-A, 10ns |  |  |  |  |
| TDL-A, 20ns |  |  |  |  |
| CDL-B, 20ns |  |  |  |  |
| CDL-B, 50ns |  |  |  |  |
| CDL-D, 20ns |  |  |  |  |
| CDL-D, 30ns |  |  |  |  |
| Additional report/notes:  1. PRACH format  2. values of  3. antenna configuration for CDL model  4. any optional or other assumption/parameters used not as in the baseline | | | | |

## B.2 System level evaluation results

*Editor’s Note: This section will be potentially sub-divided into further sub-sections depending on case and/or scenario. Template for the evaluation results is presented as a placeholder for now.*

Table B.2-1: System level evaluation results for scenario

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tdoc /  Source | Cases | | Case 1 | | | Case 2 | | |
| R1-xxxxxxx / Source 1 | Traffic load  Metrics | | Low load  10%~25% BO | Medium load  35%~50% BO | High load  above 55% BO | Low load  10%~25% BO | Medium load  35%~50% BO | High load  above 55% BO |
| DL UPT (Mbps) | 5%ile |  |  |  |  |  |  |
| 50%ile |  |  |  |  |  |  |
| 95%ile |  |  |  |  |  |  |
| mean |  |  |  |  |  |  |
| DL delay (s) | 5%ile |  |  |  |  |  |  |
| 50%ile |  |  |  |  |  |  |
| 95%ile |  |  |  |  |  |  |
| mean |  |  |  |  |  |  |
| UL UPT (Mbps) | 5%ile |  |  |  |  |  |  |
| 50%ile |  |  |  |  |  |  |
| 95%ile |  |  |  |  |  |  |
| mean |  |  |  |  |  |  |
| UL delay (s) | 5%ile |  |  |  |  |  |  |
| 50%ile |  |  |  |  |  |  |
| 95%ile |  |  |  |  |  |  |
| mean |  |  |  |  |  |  |
| Arrival rate (files/s) | |  |  |  |  |  |  |
| 𝜌DL | |  |  |  |  |  |  |
| 𝜌UL | |  |  |  |  |  |  |
| BO | |  |  |  |  |  |  |
| Additional report/notes:  1. LBT procedure and parameters  2. any assumptions/parameters used not as in the agreed baseline  3. Details of case: e.g., single or two operators; no-LBT, omni-directional LBT, directional LBT schemes etc.  4. Other metric(s) and definition if reported  5. Details of COT sharing if used in evaluation | | | | | | | |

# Annex C: Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2020-10 |  | R1- R1-2007958 |  |  |  | Draft skeleton TR | V0.0.2 |
| 2020-11 |  | R1-200xxxx |  |  |  | Updated TR based on agreements from RAN1 #103-e. | V0.0.3 |
| 2020-11 | RAN#90e | RP-20xxxx |  |  |  |  | V1.0.0 |