ATIS 3GPP SPECIFICATION

ATIS.3GPP.38.889.V1600

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Study on NR-based access to unlicensed spectrum
(Release 16**)**

Approved by

WTSC

Wireless Technologies and Systems Committee

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3GPP TR 38.889 V16.0.0 (2018-12)

Published by
Alliance for Telecommunications Industry Solutions

1200 G Street, NW, Suite 500

Washington, DC 20005

Printed in the United States of America.

Contents

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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Introduction

A study item, "Study on NR-based Access to Unlicensed Spectrum", was approved at 3GPP TSG RAN #77 [2] and revised in 3GPP TSG RAN #80 [30]. This study is to determine a single global solution for NR-based access to unlicensed spectrum, to be compatible with the NR concepts.

The objectives of the study include:

- Study NR-based operation in unlicensed spectrum (RAN1, RAN2, RAN4) including
  - Physical channels inheriting the choices of duplex mode, waveform, carrier bandwidth, subcarrier spacing, frame structure, and physical layer design made as part of the NR study and avoiding unnecessary divergence with decisions made in the NR WI
    - Consider unlicensed bands below 7GHz
    - Consider similar forward compatibility principles made in the NR WI
  - Initial access, channel access. Scheduling/HARQ, and mobility including connected/inactive/idle mode operation and radio-link monitoring/failure
  - Coexistence methods within NR-based and between NR-based operation in unlicensed and LTE-based LAA and with other incumbent RATs in accordance with regulatory requirements in e.g., 5GHz , 6GHz bands
    - Coexistence methods already defined for 5GHz band in LTE-based LAA context should be assumed as the baseline for 5GHz operation. Enhancements in 5GHz over these methods should not be precluded. NR-based operation in unlicensed spectrum should not impact deployed Wi-Fi services (data, video and voice services) more than an additional Wi-Fi network on the same carrier

The above study will address the following architectural scenarios (RAN2):

- An NR-based LAA cell(s) connects with an LTE or NR anchor cell operating in licensed spectrum
  - The study assumes the techniques for linking between Pcell (LTE or NR licensed CC) and Scell (NR unlicensed CCs) according to the NR WI
- An NR-based cell operating standalone in unlicensed spectrum, connected to a 5G-CN network, e.g., for private network deployments;
- Study how to ensure from a RAN level that connection and security management can be integrated with the E-UTRAN, NG RAN and 5G CN architecture, including service continuity requirements for users moving between cells of licensed and unlicensed frequency bands, liaising with SA2 as required

The results and findings of the study are documented in this technical report.

1 Scope

The present document contains the results and findings from the study item, "Study on NR-based Access to Unlicensed Spectrum" [2]. The purpose of this TR is to document the identified NR enhancements and corresponding evaluations for a single global solution framework for NR based access to unlicensed spectrum.

This document addresses evaluation methodology and possible scenarios for NR based unlicensed deployments.

This technical report documents the existing regulatory requirements for unlicensed spectrum deployment in the 5GHz bands, [and other bands]

This document identifies and captures coexistence evaluations of physical layer options and enhancements to NR and, if necessary, NR RAN protocols to meet the requirements and targets for unlicensed spectrum deployments.

This document contains an assessment of the feasibility of base station and terminal operation of 5GHz band (based on regulatory limits) in conjunction with relevant licensed frequency bands.

This document is a 'living' document, i.e. it is permanently updated and presented to TSG-RAN meetings.

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 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP RP-172021: "Revised SID on NR-based Access to Unlicensed Spectrum".

[3] FCC Part 15 ruling, http://www.ecfr.gov/cgi-bin/text-idx?SID=3c5e2d1533490603e0131fcdc041030d&node=pt47.1.15&rgn=div5

[4] FCC 13-22, "Notice of proposed rulemaking" , Feb 20, 2013.

[5] ETSI EN 301 893, Harmonized European Standard, "Broadband Radio Access Networks (BRAN); 5 GHz high performance RLAN"

[6] ETSI EN 302 502, Harmonized European Standard, "Broadband Radio Access Networks (BRAN); 5,8 GHz fixed broadband data transmitting systems"

[7] ETSI EN 302 571, Harmonized European Standard, "Intelligent Transport Systems (ITS); Radio communications equipment operating in the 5 855 MHz to 5 925 MHz frequency band"

[8] "Commission decision of 11 July 2005 on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of wireless access systems including radio local area networks (WAS/RLANs)" (2005/513/EC).

[9] "Commission decisions of 12 February 2007 amending Decision 2005/513/EC on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs)" (2007/90/EC).

[10] ECC/DEC (04)08, "ECC Decision of 09 July 2004 on the harmonised use of the 5 GHz frequency bands for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs)"

[11] KDB 443 999, FCC Office of Engineering and Technology – Laboratory Division: "Interim Plans to Approve UNII Devices Operating in the 5470-5725 MHz Band with Radar Detection and DFS Capabilities" (14th October 2010).

[12] FCC 12-148, "Notice of Proposed Rulemaking and Order: amendment of the Commission's Rules with regard to Commercial Operations in the 3550-3650 MHz Band" (GN Docket No. 12-354), adopted and released December 12, 2012.

[13] FCC 13-154, "Public Notice. Commission Seeks Comment on Licensing Models and Technical Requirements in the 3550-3650 MHz Band", released November 1, 2013

[14] ECC Recommendation ECC/REC (06)04: "Use of the band 5725- 5875 MHz for Broadband Fixed Wireless Access (BFWA)"

[15] Commission Decision 2008/671/EC of 5th August2008 on the harmonised use of radio spectrum in the 5875-5905 MHz frequency band for safety related application of Intelligent Transport Systems (IOTS)

[16] ECC Decision (08)01: "ECC Decision of 14 March 2008 on the harmonized use of the 5875-5925 frequency band for Intelligent Transport Systems (ITS)"

[17] ECC Recommendation (08)01:"Use of band 5855-5875 MHz for Intelligent Transport Systems (ITS)".

[18] ETSI EN 300 440-1 v1.6.1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short range devices; Radio equipment to be used in the 1 GHz to 40 GHz frequency range; Part 1: Technical characteristics and test methods"

[19] Document RSCOM 13-32rev3: "Mandate to CEPT to study and identify harmonised compatibility and sharing conditions for Wireless Access Systems including Radio Local Area Networks in the bands 5350-5470 MHz and 5725-5925 MHz ('WAS/RLAN extension bands') for the provision of wireless broadband services"

[20] Group of Administrative Co-operation Under the R&TTE Directive (ADCO R&TTE): Report on the 5th joint cross-border R&TTE Market Surveillance Campaign on WLAN 5 GHz (2013)

[21] RSS-210 Issue 8 (December 2010): Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

[22] National Frequency Allocation Plan 2011 (In-Force): http://www.wpc.gov.in/WriteReadData/userfiles/file/National_Frequency_Allocation_Plan-2011.pdf

[23] http://legislacao.anatel.gov.br/resolucoes/2008/104-resolucao-506 , Resolução nº 506, de 1º de julho de 2008, Regulamento sobre Equipamentos de Radiocomunicação de Radiação Restrita.

[24] 3GPP TR 36.872: "Small cell enhancements for E-UTRA and E-UTRAN - Physical layer aspects".

[25] Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, IEEE Std 802.11-2012.

[26] https://mentor.ieee.org/802.11/dcn/14/11-14-0571-08-00ax-evaluation-methodology.docx

[27] 3GPP TR 36.942 V11.0.0, "Radio Frequency (RF) system scenarios," Sept. 2012.

[28] 3GPP TR 38.802, "Study on new radio access technology Physical layer aspects"

[29] 3GPP TS 38.901, "Study on channel model for frequencies from 0.5 to 100 GHz"

[30] 3GPP RP-181339: "Revision of Study on NR-based Access to Unlicensed Spectrum".

[31] 3GPP TR 36.889, "Feasibility Study on Licensed-Assisted Access to Unlicensed Spectrum"

[32] 3GPP TR 37.890 "Technical Specification Group Radio Access Network; Feasibility Study on 6 GHz for LTE and NR in Licensed and Unlicensed Operations".

[33] 3GPP TR 36.942 V11.0.0, "Radio Frequency (RF) system scenarios," Sept. 2012.

[34] void

[35] GSR No. 46(E) Dated: 28th Jan. 2005, Rule - Indoor Use of low power wireless equipment in the frequency band 5 GHz (Exemption from Licensing Requirement) Rules, 2005.

[36] GSR No. 37(E) Dated: 10th Jan. 2007, Rule - Indoor use of low power wireless equipment in the frequency band 5 GHz (Exemption from Licensing Requirement) Amendment Rules, 2006. (GSR No. 46(E) Ammendment).

[37] GSR No. 38(E) Dated: 19th Jan. 2007, Rule - the Outdoor Use of wireless Equipment (Exemption from Licensing Requirement) Rules, 2007.[38] RESOLUTION 229 (Rev. WRC-12), "Use of the bands 5 150-5 250, 5 250-5 350 MHz and 5 470-5 725 MHz by the mobile service for the implementation of wireless access systems including radio local area networks".

[38] to be added

[39] Recommendation ITU-R M.1652-1 (05/2011) "Dynamic frequency selection in wireless access systems including radio local area networks for the purpose of protecting the radiodetermination service in the 5 GHz band".

[40] http://www.ncc.gov.tw/chinese/law_detail.aspx?site_content_sn=260&is_history=0&law_sn=1807&sn_f=1807, the regulations for low-power transmitters in Taiwan, June 28, 2011 (in Chinese).

[41] http://www.motc.gov.tw/post/home.jsp?id=369&parentpath=0,364, the frequency allocation in Taiwan (in Chinese)

[42] R1-1812431, "Evaluation Results for NR-U", ZTE, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[43] R1-1812556, "Evaluation results for NR unlicensed operation", LG Electronics, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[44] R1-1812659, "Evaluation Results for NR-U", Nokia, Nokia Shanghai Bell, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[45] R1-1814085, "Coexistence evaluation of NR unlicensed bands", Huawei, HiSilicon, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[46] R1-1814074, "Evaluation result for NR-U", Samsung, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[47] R1- 1814062, "NR-U coexistence evaluation results", InterDigital Inc., RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[48] R1-1813409, "Coexistence evaluation results for NR unlicensed", Qualcomm Incorporated, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[49] R1-1814018, "Coexistence evaluation results for NR-U and Wi-Fi", Ericsson, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[50] R1-1814020, "Channel access mechanisms for NR-U", Ericsson, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[51] R1-1814021, "On the use of a preamble in NR-U", Ericsson, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[52] R1-1814019, "Frame Structure for NR-U", Ericsson, RAN1#95, Spokane, USA, Nov. 12-16, 2018.

[53] R1-1811460, "Evaluation of NR-U – Wi-Fi coexistence in the NR-U Indoor Sub 7GHz topology", Broadcom, RAN1#94bis, Chengdu, China, Oct. 8-10, 2018.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 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 TR 21.905 [1].

3.2 Symbols

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

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 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 TR 21.905 [1].

1x RTT	CDMA2000 1x Radio Transmission Technology
ACK	Acknowledgement
ACLR	Adjacent Channel Leakage Ratio
AP	Access Point
AUL-UCI	AUL uplink control information
BCH	Broadcast Channel
CA	Carrier Aggregation
CAT	Category
CBG	Code Block Group
CBGTI	Code block group transmission information
CCA	Clear Channel Assesment
CFI	Control Format Indicator
CG	Cell Group
CIF	Carrier Indicator Field
CP	Cyclic prefix
CPICH	Common Pilot Channel
CQI	Channel Quality Indicator
CRB	Common resource block
CRC	Cyclic Redundancy Check
CRI	CSI-RS resource indicator
CRS	Cell-specific Reference Signal
CSI	Channel-State Information
CSI-IM	CSI-interference measurement
CTS	Clear To Send
CWS	Contention Window Size
DAI	Downlink Assignment Index
DC	Dual Connectivity
DFI	Downlink Feedback Information
DFS	Dynamic Frequency Selection
DL-SCH	Downlink Shared Channel
DMRS	Dedicated demodulation reference signal
DM-RS	Demodulation reference signal
DMTC	DRS Measurement Timing Configuration
DRS	Discovery Reference Signal
DTX	Discontinuous Transmission
ECCE	Enhanced Control Channel Element
ED	Energy Detection
EDT	Early Data Transmission
EN-DC	E-UTRA NR dual connectivity with MCG using E-UTRA and SCG using NR
EPDCCH	Enhanced Physical Downlink Control CHannel
EPRE	Energy Per Resource Element
EREG	Enhanced Resource-Element Group
E-SMLC	Enhanced Serving Mobile Location Centre

E-UTRA	Evolved UTRA
E-UTRAN	Evolved UTRAN
FBE	Frame Based Equipment
FDD	Frequency Division Duplex
FR1	Frequency range 1 as defined in [8, TS 38.104]
FR2	Frequency range 2 as defined in [8, TS 38.104]
FR	Frequency range
FWA	Fixed Wireless Access
GNSS	Global Navigation Satellite System
GSCN	Global synchronization channel number
GSM	Global System for Mobile communication
HARQ	Hybrid automatic repeat request
HI	HARQ indicator
HRPD	CDMA2000 High Rate Packet Data
IE	Information element
ISD	Inter Site Distance
LAA	Licensed-Assisted Access
LBE	Load Based Equipment
LBT	Listen Before Talk
LDPC	Low density parity check
LI	Layer indicator
LMU	Location Measurement Unit
MCG	Master Cell Group
MCH	Multicast channel
MCS	Modulation and Coding Scheme
MMSE	Minimum Mean Squared Error
MUST	Multiuser Superposition Transmission
MWUS	MTC Wake-Up Signal
NACK	Negative Acknowledgement
NCCE	Narrowband Control Channel Element
NDI	New Data Indication
NN-DC	NR NR dual connectivity
NPBCH	Narrowband Physical Broadcast channel
NPDCCH	Narrowband Physical Downlink Control channel
NPDSCH	Narrowband Physical Downlink Shared channel
NPRACH	Narrowband Physical Random Access channel
NPRS	Narrowband Positioning Reference Signal
NPUSCH	Narrowband Physical Uplink Shared channel
NRS	Narrowband Reference Signal
NR-U	New Radio Unlicensed
NSSS	Narrowband Secondary Synchronization Signal
OCB	Occupied Channel Bandwidth
OFDM	Orthogonal frequency division multiplex
PBCH	Physical Broadcast Channel
P-CCPCH	Primary Common Control Physical Channel
PCell	Primary cell
PCFICH	Physical Control Format Indicator CHannel
PDCCH	Physical Downlink Control CHannel
PD	Packet Detection
PDSCH	Physical Downlink Shared CHannel
PHICH	Physical Hybrid-ARQ Indicator CHannel
PMCH	Physical Multicast CHannel
PMI	Precoding matrix indicator
PRACH	Physical Random Access CHannel
PRG	Precoding Resource Block Group
PSBCH	Physical Sidelink Broadcast CHannel
PSCCH	Physical Sidelink Control CHannel
PSCell	Primary Secondary cell
PSDCH	Physical Sidelink Discovery CHannel
PSD	Power Spectral Density
PSSCH	Physical Sidelink Shared CHannel

PSSS	Primary Sidelink Synchronisation Signal
PTI	Precoding Type Indicator
PTRS	Phase-tracking reference signal
PUCCH	Physical Uplink Control CHannel
PUSCH	Physical Uplink Shared CHannel
QCL	Quasi-collocation
RACH	Random Access channel
RAT	Radio Access Technology
RBG	Resource Block Group
REG	Resource-Element Group
RE	Resource Element
RI	Rank indicator
RLAN	Radio Local Area Network
RLM	Radio link monitoring
RRM	Radio resource management
RSCP	Received Signal Code Power
RS	Reference Signal
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
RSTD	Reference Signal Time Difference
RTS	Request To Send
RVID	Redundancy Version ID
SA	Stand Alone
SCCE	Short Control Channel Element
SCI	Sidelink Control Information
SCS	Subcarrier Spacing
SINR	Signal to Interference plus Noise Ratio
SL-BCH	Sidelink Broadcast Channel
SL-DCH	Sidelink Discovery Channel
SL-SCH	Sidelink Shared Channel
SPDCCH	Short Physical Downlink Control CHannel
SPS C-RNTI	Semi-Persistent Scheduling C-RNTI
SPUCCH	Short Physical Uplink Control CHannel
SREG	Short Resource-Element Group
SRI	SRS resource indicator
SRS	Sounding Reference Symbol
SSSS	Secondary Sidelink Synchronisation Signal
STA	Station or UE
SUL	Supplementary uplink
TAG	Timing Advance Group
TBS	Transport Block Size
TDD	Time Division Duplex
TPC	Transmit power control
TPMI	Transmitted Precoding Matrix Indicator
TrCH	Transport channel
TRP	Tx/Rx Point
UE	User Equipment
UL-SCH	Uplink Shared Channel
UMi	Urban Micro
UTRAN	Universal Terrestrial Radio Access Network
WAS	Wireless Access Systems
ZP CSI-RS	Zero power CSI-RS

4 Regulatory requirements

4.1 Regulatory requirements for 5GHz band

The range 5150-5925 MHz, or parts thereof, is potentially available for license-assisted access to unlicensed operation. This represents a significant amount of spectrum that can be used by operators to augment their service offerings in licensed bands. The range above can be operated under a license-exempt regime or ISM but must be shared with existing mobile services and other incumbent services. The quality of service offered by a licensed regime can therefore not be matched. Hence, unlicensed access is viewed as complementary, and does not reduce the need for additional allocations for licensed operation in view of the increased demand for wireless broadband access.

It is relevant to consider the global (International) ITU-R allocations and technical provisions first. These could be basis for defining globally harmonised bands for LAA and starting points for requirements and limits before the local variations are considered.

5150-5350 and 5470-5725 MHz

WRC 2003 allocated the bands 5 150-5 350 MHz and 5 470-5 725 MHz on a co-primary basis to the mobile service for the implementation of "wireless access systems (WAS), including radio local area networks (RLANs)". This was subject to technical and regulatory provisions included in the radio regulations given in Resolution 229 (WRC-03), which was subsequently revised at WRC-12 to Resolution 229 (Rev. WRC-12) [38]. These provisions are followed by many Administrations and resolves:

1) that the use of these bands by the mobile service will be for the implementation of WAS, including RLANs, as described in the most recent version of Recommendation ITU-R M.1450;

2) that in the band 5 150-5 250 MHz, stations in the mobile service shall be restricted to indoor use with a maximum mean e.i.r.p. of 200 mW and a maximum mean e.i.r.p. density of 10 mW/MHz in any 1 MHz band or equivalently 0.25 mW/25 kHz in any 25 kHz band;

3) that administrations may monitor whether the aggregate pfd levels given in Recommendation ITU-R S.1426 have been, or will be exceeded in the future, in order to enable a future competent conference to take appropriate action;

4) that in the band 5 250-5 350 MHz, stations in the mobile service shall be limited to a maximum mean e.i.r.p. of 200 mW and a maximum mean e.i.r.p. density of 10 mW/MHz in any 1 MHz band. Administrations are requested to take appropriate measures that will result in the predominant number of stations in the mobile service being operated in an indoor environment. Furthermore, stations in the mobile service that are permitted to be used either indoors or outdoors may operate up to a maximum mean e.i.r.p. of 1 W and a maximum mean e.i.r.p. density of 50 mW/MHz in any 1 MHz band, and, when operating above a mean e.i.r.p. of 200 mW, these stations shall comply with the following e.i.r.p. elevation angle mask where θ is the angle above the local horizontal plane (of the Earth):

   –13 dB(W/MHz) for $0° \leq \theta < 8°$

   –13 – 0.716(θ-8) dB(W/MHz) for $8° \leq \theta < 40°$

   –35.9 – 1.22(θ-40) dB(W/MHz) for $40° \leq \theta \leq 45°$

   –42 dB(W/MHz) for $45° < \theta$;

5) that administrations may exercise some flexibility in adopting other mitigation techniques, provided that they develop national regulations to meet their obligations to achieve an equivalent level of protection to the EESS (active) and the SRS (active) based on their system characteristics and interference criteria as stated in Recommendation ITU-R RS.1632;

6) that in the band 5 470-5 725 MHz, stations in the mobile service shall be restricted to a maximum transmitter power of 250 mW[3] (administrations with existing regulations prior to WRC 03 may exercise some flexibility in determining transmitter power limits) with a maximum mean e.i.r.p. of 1 W and a maximum mean e.i.r.p. density of 50 mW/MHz in any 1 MHz band;

7) that in the bands 5 250-5 350 MHz and 5 470-5 725 MHz, systems in the mobile service shall either employ transmitter power control to provide, on average, a mitigation factor of at least 3 dB on the maximum average output power of the systems, or, if transmitter power control is not in use, then the maximum mean e.i.r.p. shall be reduced by 3 dB;

8) that, in the bands 5 250-5 350 MHz and 5 470-5 725 MHz, the mitigation measures found in Annex 1 to Recommendation ITU-R M.1652-1 shall be implemented by systems in the mobile service to ensure compatible operation with radiodetermination systems,

This resolution makes DFS as described in the Annex 1 of ITU-R Recommendation M.1652-1 [39] mandatory, the basis for the DFS requirements developed e.g. in Europe and the US.

WAS is defined as end-user radio connections to public or private core networks, while primary allocation means that the services can claim protection from services of the secondary service. However, the WAS/RLAN services must protect the incumbent primary services.

Even if primary in the International table of allocations, this may not be the case in all countries. The bands are not allocated on a primary basis in the US allocation table, but to the Part 15 rules that provide for operation of low power radio transmitters without a license (secondary service operated on a non-interference basis).

5725-5850 MHz

The 5725-5875 MHz is allocated for ISM applications by means a footnote in the allocation table. Radiolocation is allocated on primary basis up to 5850 MHz so DFS is required up to this limit. Operation in 5725-5850 MHz is allowed in the US under the Part 15 rules (15.247 and 15.407).

5850-5925 MHz

The band is allocated to the mobile service on a primary basis in all regions. In Europe it has been decided (2008) to harmonise the use of the 5875-5925 MHz frequency band for Intelligent Transport Systems (ITS). Similarly, according to the US allocation table, the use of the non-Federal mobile service in the band 5850-5925 MHz is limited to Dedicated Short Range Communications operating in the Intelligent Transportation System radio service.

4.1.1 ITU Region 1

4.1.1.1 Europe

The European regulation is determined by the European Commission and the ECC. The relevant regulations for the 5 GHz bands are found in two Commission Decisions [8, 9] and one ECC Decision [10]. These are interpreted by ETSI and used as a basis for harmonized standards, which are used for conformance declaration when products are placed on the European market. Harmonized European standards have a higher regulatory relevance than other product standards, since they are produced based on a mandate from the Commission with reference to an EU directive. They also go through a public enquiry and voting process, and are cited by the Commission. The European requirements on 5 GHz unlicensed deployment are specified in three ETSI harmonized standards [5, 6, and 7]. Figure 4.1.1.1-1 summarizes the relevant parts of the 5 GHz band set aside for unlicensed spectrum usage. The 5150-5350 MHz and the 5470-5725 MHz bands are referred here as the broadband radio access networks (BRAN) bands where the wireless access systems (WAS) including RLAN equipment are operating in. Moreover, the 5725-5875 MHz band (in the BRAN domain) is used by the fixed wireless access (FWA) networks and finally the intelligent transport systems (ITS) utilize the 5855-5925 MHz band.

The BFWA and the ITS are designated by the ECC for use as parts of the 5 GHz band and the relevant regulations are found in:

- An ECC Recommendation for FBWA [14], and
- A Commission Decision [15], an ECC Decision [16] and an ECC Recommendation for ITS [17].

General purpose SRD devices can also operate in the band 5725-5875 MHz under the provisions of the ETSI harmonised standard EN 300 440 [18], but with reduced max EIRP of 25 mW.

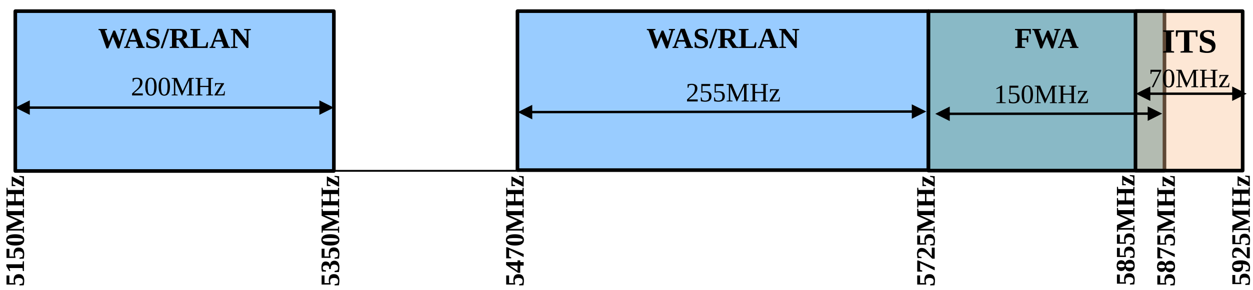


Figure 4.1.1.1-1: 5 GHz spectrum allocations in Europe.

The European Commission has recently submitted to CEPT a mandate to study the conditions for the extension of the 5 GHz range designated for WAS/RLANs [19] in order to allow the use by WAS/RLANs of the whole 5150-5925 MHz band.

ECC approved CEPT Report 57 in March 2015 in response to the mandate based on the results of the Public Consultation. CEPT has carried out a significant amount of work but studies on mitigation techniques have not been completed in the timeframe and there are still a number of open issues ongoing.

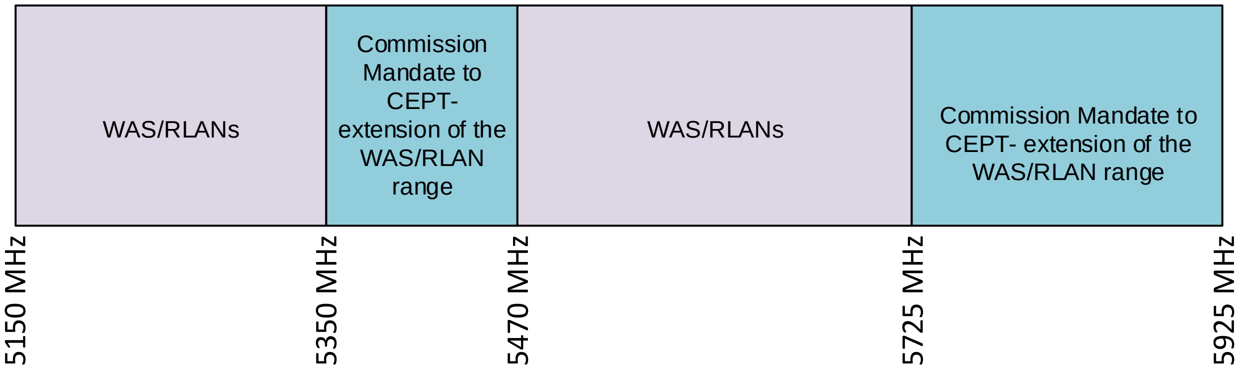


Figure 4.1.1.1-2: Summary of existing and proposed EU regulations for WAS/RLANs in the 5GHz band

In the rest of this section, the specified ETSI requirements for the WAS/RLAN and FWA bands are summarized. Table 4.1.1.1-1 provides the limits on the transmit power control (TPC), the RF output power and power density given by the mean EIRP and the mean EIRP density at the highest power level. Additionally the requirements on the transmitter out of band emissions are listed in Table 4.1.1.1-2, Figures 4.1.1.1-3a, and Figure 4.1.1.1-3b. Table 4.1.1.1-4 illustrates the DFS requirements for some of these bands in Europe. Moreover, the 5150-5350 MHz is restricted to indoor deployments.

Transmit Power Control (TPC) is a mechanism to be used by the RLAN device to ensure a mitigation factor of at least 3 dB on the aggregate power from a large number of devices. This requires the RLAN device with TPC to have a TPC range for which the lowest value is at least 6 dB below the values for mean EIRP given in Table 4.1.1.1-1.

In ETSI EN 301 893 [5], the requirements on the Nominal Channel Bandwidth and the Occupied Channel Bandwidth are defined for unlicensed spectrum in the 5 GHz region. The Nominal Channel Bandwidth, i.e., the widest band of frequencies inclusive of guard bands assigned to a single channel, shall be at least 5MHz at all times. The Occupied Channel Bandwidth, i.e., the bandwidth containing 99 % of the power of the signal, shall be between 80 % and 100 % of the declared Nominal Channel Bandwidth. During an established communication, a device is allowed to operate temporarily in a mode where its Occupied Channel Bandwidth may be reduced to as low as 40 % of its Nominal Channel Bandwidth with a minimum of 4 MHz. The Occupied Channel Bandwidth is determined by the test procedure defined in Section 5.3.3.2 in [5].

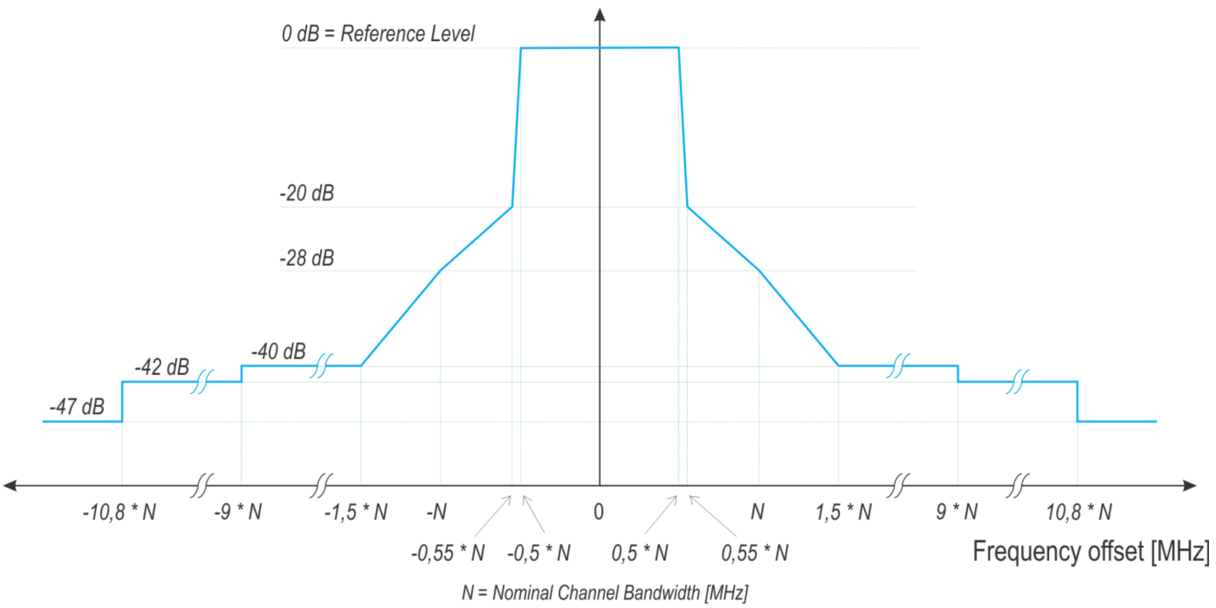
ETSI mandates the usage of DFS in some bands as shown in Table 4.1.1.1-4. Furthermore, a Listen-Before-Talk (LBT) mechanism is requested independently of whether the channel is occupied or not (Section 4.2.7 of [5]). Note that no LBT requirement is requested in [6] for the FWA band.

Table 4.1.1.1-1: TPC, Transmit power and power spectral density requirements in Europe

	Freq. range (MHz)	Max Mean EIRP (dBm)	Max Mean EIRP density (dBm/MHz)	Comment
WAS/RLAN	5150-5350	23	10	20 MHz and 40 MHz channels
	5470-5725	30	17	
FWA	5725-5875	33	23	10 MHz channels
	5725-5875	36	23	20 MHz channels
Transmit Power Control (TPC): TPC ensures an average reduction in the aggregated transmission power by at least 3 dB (5 dB for FWA) compared with the maximum permitted transmission power. TCP is not required for channels within the band 5150-5250 MHz. Without TPC, the highest permissible average EIRP (density) are reduced by 3 dB.				

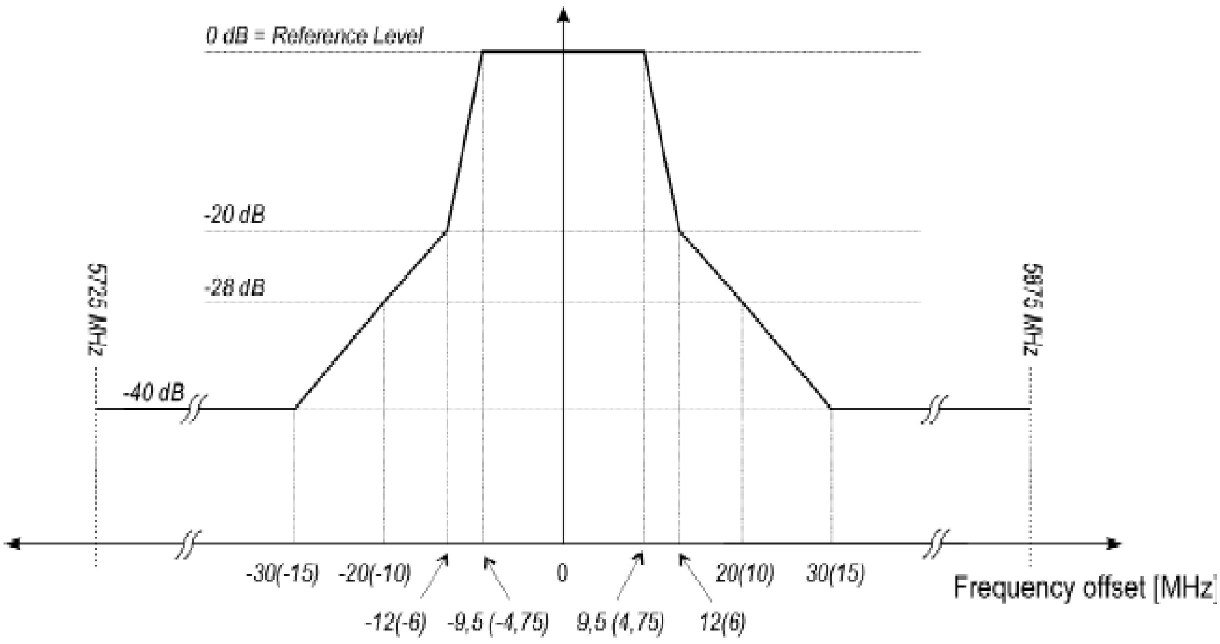
Table 4.1.1.1- 2: Requirements on out of band emissions in Europe

	Frequency range	Max. power	Bandwidth
WAS/RLAN, FWA	30-47 MHz	-36 dBm	100 kHz
	47-74 MHz	-54 dBm	100 kHz
	75-87.5 MHz	-36 dBm	100 kHz
	87.5-118 MHz	-54 dBm	100 kHz
	118-174 MHz	-36 dBm	100 kHz
	174-230 MHz	-54 dBm	100 kHz
	230-470 MHz	-36 dBm	100 kHz
	470-862 MHz	-54 dBm	100 kHz
	0.862-1 GHz	-36 dBm	100 kHz
	1-5.15 GHz	-30 dBm	1 MHz
	5.35-5.5.47 GHz	-30 dBm	1 MHz
	5.725-26 GHz	-30 dBm	1 MHz



NOTE: dBc is the spectral density relative to the maximum spectral power density of the transmitted signal.

Figure 4.1.1.1-3a: Transmit spectral power mask for RLAN equipment operating within the frequency bands 5150-5250 MHz; 5250-5350 MHz or 5470-5725 MHz



NOTE1: 0 dB Reference Level is the spectral density relative to the maximum spectral power density of the transmitted signal.
NOTE2: On the Frequency Offset axis, the figures apply to ChS = 20 MHz whereas the figures in parentheses apply to ChS = 10 MHz.
NOTE3: Emissions that fall outside the lower and upper band frequency limits of 5 725 MHz and 5 875 MHz, respectively shall instead meet the unwanted emission limits of clause 4.3.1 [6].

Figure 4.1.1.1-3b: Transmit spectral power mask for FBWA equipment operating within the frequency band 5725-5875 MHz

FWA devices in the 5.8 GHz range are also subject to an additional requirement of EIRP spectral density limit in the elevation plane, see Table 5.

Table 4.1.1.1-3: EIRP spectral density limits in the elevation plane (5.8 GHz frequency range)

EIRP spectral density	Elevation angle
For sectorised (e.g. P-MP Central or Base Station) and Omni-directional deployments:	
−7 dB(W/MHz)	0° ≤ θ <4°
−2.2 - (1.2*θ) dB(W/MHz)	4° ≤ θ ≤ 15°
−18.4 - (0.15*θ) dB(W/MHz)	θ > 15°
For P-MP Customer Terminal Station and P-P deployments:	
−7 dB(W/MHz)	for 0° ≤ θ <8°
−2.68 -(0.54*θ) dB(W/MHz)	8° ≤ θ < 32°
−20 dB(W/MHz)	32° ≤ θ ≤50°
−10 - (0.2*θ) dB(W/MHz)	θ > 50°

Table 4.1.1.1-4: DFS requirements in Europe

Parameter	Requirement	Comments
DFS Threshold (dBm) for WAS/RLAN	-62(dBm) + 10(dBm/MHz) - EIRP Spectral density (dBm/MHz) + G(dBi)	*No DFS requirements on 5150 MHz – 5250 MHz *G denotes antenna gain
DFS Threshold (dBm) for FWA	-69 (dBm) + 23(dBm/MHz) - EIRP Spectral density (dBm/MHz) + G(dBi)	*No DFS requirements on 5850 MHz – 5875 MHz *G denotes antenna gain
Channel Availability check	60 seconds outside 5600-5650 MHz	Master mode
	10 minutes inside 5600-5650 MHz	
Channel move time	10 seconds	Master and slave modes
Non-occupancy time	30 minutes	After radar detection in either channel availability check or in-service monitoring
Uniform Spreading is required across the frequency ranges 5150 -5350 MHz and 5470-5725 MHz. *Uniform Spreading* is not applicable for equipment that only operates in 5150-5250 MHz band.		

Interference to Weather Radars

Interference to Weather Radars is also a hot topic in the EU. The two last versions of EN 301 893 (1.6.1 and 1.7.1) have included amendments to better protect these radars, like the prohibition to give the user access to the configuration control settings that would allow him to disconnect the DFS functionality.

The use of the band 5.60-5.65 GHz by WLANs is allowed in Europe, and a Market Surveillance campaign on WLANs 5 GHz has been led at EU level by the ADCO R&TTE Group. The report [20] of the campaign has proposed specific recommendations to improve the situation. These recommendations do not require amendments to the last version of EN 301 893.

4.1.1.2 Israel

In Israel the bands 5150-5250 MHz and 5250-5350 MHz are open to RLANs.

4.1.1.3 Russia

In the Russian Federation the bands 5150-5350 MHz, the band 5470-5725 MHz above 5650 MHz and the band 5725-5825 MHz [20] are allowed to RLANs. Use of DFS is not mandated.

4.1.1.4 South Africa

In South Africa the bands 5150-5250 MHz and 5250-5350 MHz are available to RLANs but restricted to indoor use. The band 5470-5725 MHz is also open to RLANs.

4.1.1.5 Turkey

In Turkey the bands 5150-5250 MHz and 5250-5350 MHz are restricted to indoor use. DFS and TPC are mandated in the band 5470-5725 MHz.

4.1.2 ITU Region 2

4.1.2.1 USA

The use of unlicensed 5 GHz spectrum in USA is governed by FCC part 15 regulations [3]. In Feb 2013, potential new rules were proposed in FCC 13-22 [4]. Figure 4.1.2.1-1 summarizes the relevant part 15 rules for 5GHz unlicensed spectrum usage:

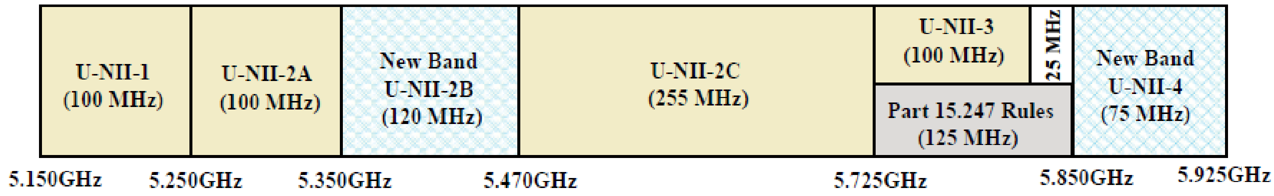


Figure 4.1.2.1-1 : Summary of existing and proposed new FCC part 15 rules for 5GHz unlicensed spectrum usage

In Figure 4.1.2.1-1, U-NII-x bands denote frequency bands for Unlicensed National Information Infrastructure devices usage that are governed by §15.407 [3]. As shown in the figure, there is also an overlapping ruling of §15.247 from 5.725 to 5.85 GHz. A device could choose to follow either U-NII rulings or §15.247 rulings when operating within the frequency range.

In the rest of this section, we summarize FCC paragraphs 15.407 and 15.247 rules. In general either frequency hopping or digital modulation techniques are permitted under part 15 rules. Since LTE is not designed as a frequency hopping system, the rest of the document will focus on regulations related to digital modulation.

Paragraph 15.247 rules relevant for LTE point to multi-point communications are summarized in 4 aspects:

- Transmission Bandwidth:
  - The minimum 6 dB bandwidth shall be at least 500 kHz.
- Maximum Transmit Power:
  - Peak conducted output power shall not exceed 1 W. An alternative to peak power measurements is maximum conducted output power, which is the total transmit power over all antennas and antenna elements when the transmitter is operating at its maximum power control level.
  - Note that, the conducted output power limit is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
- Out of Band Emission:
  - In any 100 kHz bandwidth outside the frequency band, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
- Power Spectrum Density:
  - The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. The same method of determining the conducted output power shall be used to determine the power spectral density.

Paragraph15.407 rules for UNII devices are summarized in following tables. In Table 4.1.2.1-1, the maximum transmit power, PSD and out of band emission requirements are listed for UNII-1/2/3 bands. In Table 4.1.2.1-2, the dynamic frequency selection requirements for radar detection are summarized for UNII-2 devices.

Table 4.1.2.1-1: Transmit power requirements for UNII devices

		UNII-1	UNII-2A	UNII-2C	UNII-3	Comments
Frequency Range (GHz)		5.15 – 5.25	5.25-5.35	5.47-5.725	5.725-5.85	
Max conducted output power < min(a, b) (dBm)	a	eNB: 30 UE: 24	24	24	30	
	b		11+10logB	11+10logB		B is the 26-dB emission bandwidth in MHz
Peak PSD (dBm/MHz)		eNB: 17 UE: 11	11	11	30dBm in 500kHz	
Assumed Antenna Gain (dBi)		6	6	6	6*	Peak power is reduced by G-6 dB for directional antennas with gain > 6 dBi; * UNII-3 fixed point to point operation power scaling threshold is 23 dBi
Out of band emission	Frequency Support (GHz)	Outside 5.15 – 5.35	Outside 5.15 – 5.35	Outside 5.47-5.725	Outside 5.715-5.865	
	EIRP (dBm/MHz)	-27	-27	-27	-27	Resolution bandwidth 1 MHz
	Frequency Support (GHz)				5.715-5.725 5.85-5.86	
	EIRP (dBm/MHz)				-17	Resolution bandwidth 1 MHz
Transmit Power Control		N/A	TPC to 6 dB below a mean EIRP of 30 dBm. No TPC for mean EIRP < 27 dBm		N/A	

Table 4.1.2.1-2: DFS requirements for UNII-2 devices

	Levels	Comments
Max EIRP (dBm)	23 to 30	* DFS power is averaged in 1 micro-second for 0 dBi antenna. * Uniform spread over available channels.
DFS Threshold (dBm)	-64	
Max EIRP (dBm)	<23	
DFS Threshold (dBm)	-62	
Channel Availability check	60 seconds	Master mode
Channel move time	10 seconds	Master and slave modes
	200 ms normal operation	
Non-occupancy time	30 minutes	After radar detection in either channel availability check or in-service monitoring

Interference to Weather Radars

In order to resolve interference to Terminal Doppler Weather Radar (TDWR) the FCC has defined interim plans to approve UNII devices operating in the 5470-5725 MHz band [11]. These interim plans provide specific actions for equipment authorization and installation, as detailed below. The main elements in the interim plan are:

- Master devices shall not transmit on channels overlapping with the range 5600-5650 MHz band used by TDWRs;
- Professional installation of equipment operating within the band 5470-5720 MHz;
- Prohibition to include configuration controls (like country code settings) that would allow to change the frequency of operations to any frequency other than those specified on the grant of certification for US operation.

In parallel FCC is continuing its work to develop long-term equipment authorization test procedures that will ensure that the devices comply with the rules that protect the TDWR operations.

4.1.2.2 Canada

In Canada, the use of RLANs is forbidden in the band 5600-5650 MHz in order to protect the meteorological radars from interference caused by RLANs. The regulations for RLANs in the 5 GHz range in Canada are defined in RSS-210 Annex 9 [21]. Table 4.1.2.2-1 presents the transmit power requirements for RLAN devices while Table 4.1.2.2-1 provides the EIRP spectral density limits in the elevation plane required from RLAN devices operating with an EIRP level higher than 200 mW in the frequency range 5250-5350 MHz.

Table 4.1.2.2-1: Transmit power requirements for RLAN devices in Canada

Frequency Range (GHz)		5.15 – 5.25	5.25-5.35	5.47-5.60 and 5.65-5.725	5.725-5.825	
Max conducted output power < min(a, b) (dBm)	a		24	24	30	
	b		11+10logB	11+10logB	17+10logB	B is the 26-dB emission bandwidth in MHz
Peak PSD (dBm/MHz)		4	11	11	17	Resolution bandwidth 1 MHz
Max e.i.r.p. < min(a, b) (dBm)	a	23	30	30	36	
	b	10+10logB	17+10logB	17+10logB	23+10logB	
Max e.i.r.p density (dBm/MHz)		10				Resolution bandwidth 1 MHz
Out of band emission	Frequency Support (GHz)	Outside 5.15 – 5.25	Outside 5.25 – 5.35	Outside 5.47-5.725	Outside 5.725-5.825	
	EIRP (dBm/MHz)	-27	-27	-27	-17 within 5.715-5.725 and 5.825-5.835; -27 outside	Resolution bandwidth 1 MHz
Transmit Power Control		N/A	TPC to 6 dB below a mean EIRP of 30 dBm. No TPC for mean EIRP < 27 dBm			
DFS		N/A	Required			
e.i.r.p. elevation mask		N/A	If e.i.r.p. > 23 dBm compliance with e.i.r.p. elevation mask required	N/A	N/A	

Table 4.1.2.2-1: EIRP spectral density limits in the elevation plane for devices with EIRP > 200 mW (5.25-5.35 GHz frequency range)

EIRP spectral density	**Elevation angle**
−13 dB(W/MHz)	0° ⩽ θ <8°
–13 – 0.716(θ-8) dB(W/MHz)	8° ≤ θ < 40°
–35.9 – 1.22(θ-40) dB(W/MHz)	40° ≤ θ < 45°
–42 dB(W/MHz)	44° ≤ θ

4.1.2.3 Brazil

In Brazil, nearly all the 5 GHz spectrum is allocated for Restricted Radiation, which means low-power unlicensed bands (i.e. any low-power-device can use it on a secondary basis). The bands 5250-5350 MHz, 5470-5650 MHz, 5650-5725 MHz and 5725-5850 MHz are allowed to RLANs [22]. Bands 5150-5250 MHz and 5250-5350 MHz are restricted to indoor use, and DFS is mandated in the bands 5250-5350 MHz and 5470-5725 MHz.

The relevant restrictions by band are as follows [23]:

From (MHz)	To (MHz)	Service	Restriction [insert reference]
5150	5350	Restricted radiation	Indoor use only, EIRP limited to 200mW, EIRP spectral power density limited to 10mW/MHz. DFS mandated between 5250-5350MHz.
5350	5470	Unregulated	
5470	5650	Restricted radiation	DFS mandated. Max transmitter output power limited to 250mW, EIRP limited to 1W, EIRP spectral power density limited to 50mW/MHz
5650	5725	Restricted radiation or amateur radio	DFS mandated. Max transmitter output power limited to 250mW, EIRP limited to 1W, EIRP spectral power density limited to 50mW/MHz
5725	5875	Restricted radiation (ISM Band)	Max transmitter output power limited to 1W, max EIRP EMF density of 50,000 microvolt per meter (measured at 3 meter distance)

NOTE: Note that the 5350-5470MHz band is not regulated.

4.1.2.4 Mexico

In Mexico, the bands 5150-5250 MHz, 5250-5350 MHz, 5470-5600 MHz, 5650-5725 MHz and 5725-5875 MHz are open to RLANs [22].

4.1.3 ITU Region 3

4.1.3.1 China

The 5150-5350 MHz frequency band is open to unlicensed WAS/RLANs indoor deployment in China. Furthermore, mandatory DFS / TPC (no less than 6 dB) or DFS only with a 3 dB backoff of the max mean EIRP, Power spectrum density and max emission is required for 5250-5350 MHz.

The key regulatory restrictions include:

- EIRP: ≤200mW
- Power Spectrum Density: ≤10dBm/MHz (EIPR)
- Max Emission at edges of the used frequency: ≤-80dBm/Hz (EIRP)
- Spurious Emission (corresponding to frequency range outside 2.5*carrier bandwidth)
  - 30-1000MHz: -36dBm/100kHz
  - 48.5-72.5MHz, 76-118MHz, 167-223MHz, 470-798MHz: -54dBm/100kHz
  - 2400-2483.5MHz: -40dBm/1MHz
  - 5150-5350MHz: -33dBm/100kHz
  - 5470-5850MHz: -40dBm/1MHz
  - Other frequency in 1-40GHz: -30dBm/1MHz

The 5725-5850 MHz frequency band was assigned as light licensed in 2009, shared among operators and traffic control bureau, open for both WAS (wireless access system) and RLAN, for both indoor and outdoor deployment in China. The key regulatory restrictions as below:

- Transmit Power: ≤500mW and ≤27dBm;
- EIRP: ≤2W and ≤33dBm
- Power Spectrum Density: ≤13dBm/MHz and ≤19dBm/MHz(EIRP)
- Out of Band Emission: ≤-80dBm/Hz(≤5725MHz and ≥5850MHz)
- Spurious emission
    - 30-1000MHz: ≤-36dBm/100kHz
    - 2400-2483.5MHz: ≤-40dBm/1MHz
    - 3400-3530MHz: ≤-40dBm/1MHz
    - 5725-5850MHz: ≤-33dBm/100kHz
    - corresponding to frequency range outside 2.5*carrier bandwidth
    - Other frequency in 1-40 GHz: -30dBm/1MHz

In the end of 2014, the regulation requirements of this band were adjusted from light license to fully unlicensed. Meanwhile, some restrictions for equipment were proposed to be updated such as spurious emission etc., which was publicly inquired on the website of ministry of industry and information technology of China without formal issued so far. The proposed key regulation restrictions update in 5725-5850MHz can be found in the table below.

Table 4.1.3.1-1 Proposed key regulatory restrictions update in 5725-5850MHz

Parameter	Requirement
EIRP	≤25mW for Micro power(short range) station ≤2W for others
Power Spectrum Density(EIRP)	≤19dBm/MHz (other than ITS system)
Max Emission at edges of the used frequency	≤-80dBm/Hz（EIRP）
Spurious Emission (corresponding to frequency range outside 2.5*carrier bandwidth)	-36dBm/100kHz (30-1000MHz) -54dBm/100kHz (48.5-72.5MHz, 76-118MHz, 167-223MHz, 470-798MHz) -40dBm/1MHz (2400-2483.5MHz, 5150-5350MHz) -33dBm/100kHz (5470-5850MHz) -30dBm/1MHz(Other frequency in 1-40GHz)

The band 5470-5725 MHz has not yet been officially open for WAS/RLAN (is put on hold). However, this band as a potential WAS/RLAN frequency band has been widely discussed, while the related regulation restrictions are also publicly inquired on the website of ministry of industry and information technology of China in the year of 2014. In order to protect the incumbent services (such as radio-determination service), DFS and TPC (no less than 6dB) are strictly required and DFS function can not be closed. The details of the proposed key regulation restrictions in 5470-5725MHz are listed as table below.

Table 4.1.3.1-2 Proposed key regulatory restrictions in 5470-5725MHz

Parameter	Requirement
EIRP	≤1W
Power Spectrum Density(EIRP)	≤50mW/MHz
Max Emission at edges of the used frequency	≤-80dBm/Hz（EIRP）
Spurious Emission (corresponding to frequency range outside 2.5*carrier bandwidth)	-36dBm/100kHz (30-1000MHz) -54dBm/100kHz (48.5-72.5MHz, 76-118MHz, 167-223MHz, 470-798MHz) -40dBm/1MHz (2400-2483.5MHz) -33dBm/100kHz (5470-5850MHz) -30dBm/1MHz (Other frequency in 1-40GHz)

4.1.3.2 Japan

With regard to the use of 5 GHz spectrum for RLAN in Japan, the following frequency bands are available:

- 5150-5250 MHz;
- 5250-5350 MHz;
- 5470-5725 MHz.

Table 4.1.3.2-1 summarizes overview of technical regulatory requirements in Japan based on those for IEEE 802.11a/n/ac. As shown in the table, it should be noted that "Max Burst Length" is specified as less than 4 msec for RLAN systems in Japan.

Table 4.1.3.2-1: Summary of basic regulatory requirements

Frequency		5.15-5.25 GHz	5.25-5.35 GHz	5.47~5.725 GHz
Location		Limited to indoor		Indoor and outdoor
Channel bandwidth		20/40/80/160 MHz		
Modulation	20/40/80/160 MHz	OFDM		
Maximum output power	20/40/80/160 MHz	10/5/2.5/1.25 mW/MHz		
Maximum antenna gain		Any		
Maximum e.i.r.p	20/40/80/160 MHz	10/5/2.5/1.25 mW/MHz		50/25/12.5/6.25 mW/MHz
Carrier sense	20/40/80/160 MHz	Required		
Max Burst Length		< 4 ms		
DFS, TPC (Note 1)		Not required	Required (only for master control station)	
Connection topology		Any	Any (connection between the stations not controlled by master control station is not allowed)	
NOTE 1: DFS（Dynamic Frequency Selection）, TPC（Transmitter Power Control）				

Figure 4.1.3.2-1 indicates the spectrum and channelling arrangements available for different channel bandwidth. This figure also provides information on incumbent systems to be coexisting with RLAN systems in Japan.

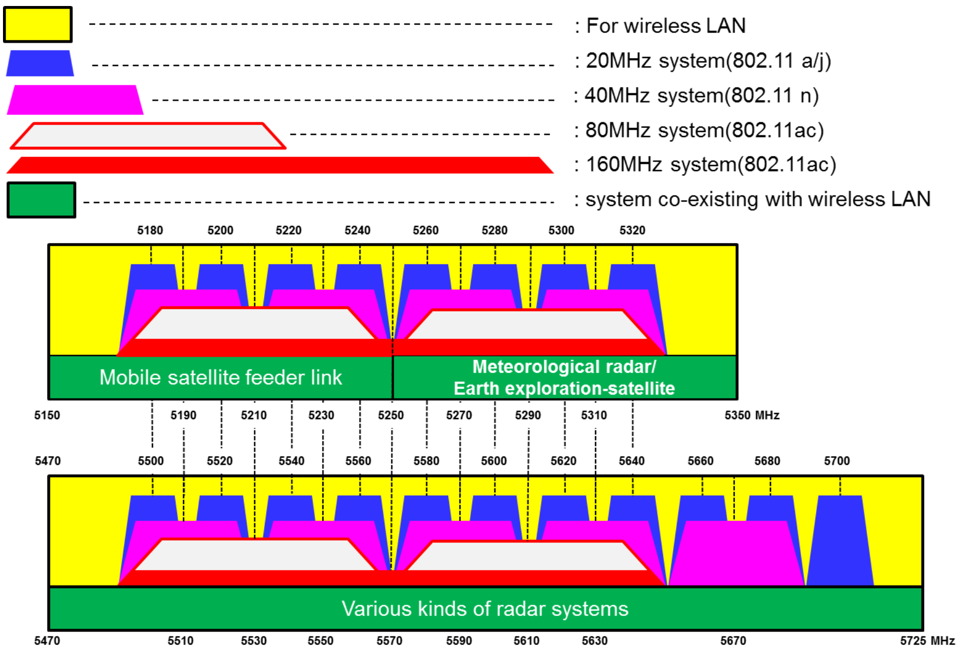


Figure 4.1.3.2-1: Spectrum and channel arrangement

Further detailed regulatory requirements, such as ACLR, SEM and peak data rate for the respective frequency bands are provided in the following sub-sections. Note that for "78 MHz < Occupied bandwidth ≤ 158 MHz" (covers the 160 MHz system), there are no ACLR1 and ACLR2 requirements specified.

4.1.3.2.1 5150-5250 and 5250-5350 MHz

Table 4.1.3.2.1-1: Adjacent Channel Leakage Ratio (ACLR) 1

Occupied bandwidth	≤ 18MHz	> 18MHz and ≤ 19MHz	> 19MHz and ≤ 38MHz	> 38MHz and ≤ 78MHz
ACLR 1	≥ 25 dB	≥ 25 dB	≥ 25 dB	≥ 25 dB
Measurement bandwidth	18 MHz	19 MHz	38 MHz	78 MHz
Adjacent channel centre frequency offset [MHz]	+20 / -20	+20 / -20	+40 / -40	+80 / -80

Table 4.1.3.2.1-2: Adjacent Channel Leakage Ratio (ACLR) 2

Occupied bandwidth	≤ 18MHz	> 18MHz and ≤ 19MHz	> 19MHz and ≤ 38MHz	> 38MHz and ≤ 78MHz
ACLR 2	≥ 40 dB	≥ 40 dB	≥ 40 dB	-
Measurement bandwidth	18 MHz	19 MHz	38 MHz	-
Adjacent channel centre frequency offset [MHz]	+40 / -40	+40 / -40	+80 / -80	-

Occupied bandwidth ≤ 18 MHz:

Table 4.1.3.2.1-3: SEM: Occupied bandwidth ≤ 18 MHz

Centre Frequency (MHz)	Frequency range(f) (MHz)	Frequency difference between centre frequency – the edges of frequency range(MHz)	e.i.r.p/MHz
5240	5140 ≤ f ≤ 5142	≥ 98 and ≤ 100	≤ 2.5 μW
	5142 < f ≤ 5150	≥ 90 and < 98	≤ 15 μW
	5250 ≤ f < 5251	≥ 10 and < 11	≤ $10^{1-(f-9)}$ mW
	5251 ≤ f < 5260	≥ 11 and < 20	≤ $10^{-1-(\frac{8}{90})(f-11)}$ mW
	5260 ≤ f < 5266.7	≥ 20 and < 26.7	≤ $10^{-1.8-(\frac{6}{50})(f-20)}$ mW
	5266.7 ≤ f ≤ 5360	≥ 26.7 and ≤ 120	≤ 2.5 μW
5260	5140 ≤ f ≤ 5233.3	≥ 26.7 and ≤ 120	≤ 2.5 μW
	5233.3 < f ≤ 5240	≥ 20 and < 26.7	≤ $10^{-1.8-(\frac{6}{50})(f-20)}$ mW
	5240 < f ≤ 5249	≥ 11 and < 20	≤ $10^{-1-(\frac{8}{90})(f-11)}$ mW
	5249 < f ≤ 5250	≥ 10 and < 11	≤ $10^{1-(f-9)}$ mW
	5350 ≤ f ≤ 5360	≥ 90 and ≤ 100	≤ 2.5 μW

18 MHz < Occupied bandwidth ≤ 19 MHz:

Table 4.1.3.2.1-4: SEM: 18 MHz < Occupied bandwidth ≤ 19 MHz

Centre Frequency (MHz)	Frequency range(f) (MHz)	Frequency difference between centre frequency – the edges of frequency range(MHz)	e.i.r.p/MHz
5180	5135 ≤ f ≤ 5142	≥ 38 and ≤ 45	≤ 2.5 μW
	5142 < f ≤ 5150	≥ 30 and < 38	≤ 15 μW
5240	5250 ≤ f < 5251	≥ 10 and < 11	≤ $10^{1-(f-9)}$ mW
	5251 ≤ f < 5260	≥ 11 and < 20	≤ $10^{-1-(\frac{8}{90})(f-11)}$ mW
	5260 ≤ f < 5266.7	≥ 20 and < 26.7	≤ $10^{-1.8-(\frac{6}{50})(f-20)}$ mW
	5266.7 ≤ f ≤ 5365	≥ 26.7 and ≤ 125	≤ 2.5 μW
5260	5135 ≤ f ≤ 5233.3	≥ 26.7 and ≤ 125	≤ 2.5 μW
	5233.3 < f ≤ 5240	≥ 20 and < 26.7	≤ $10^{-1.8-(\frac{6}{50})(f-20)}$ mW
	5240 < f ≤ 5249	≥ 11 and < 20	≤ $10^{-1-(\frac{8}{90})(f-11)}$ mW
	5249 < f ≤ 5250	≥ 10 and < 11	≤ $10^{1-(f-9)}$ mW
5320	5350 ≤ f ≤ 5365	≥ 30 and ≤ 45	≤ 2.5 μW

19 MHz < Occupied bandwidth ≤ 38 MHz:

Table 4.1.3.2.1-5: SEM: 19 MHz < Occupied bandwidth ≤ 38 MHz

Centre Frequency (MHz)	Frequency range(f) (MHz)	Frequency difference between centre frequency – the edges of frequency range(MHz)	e.i.r.p/MHz
5190	5100 ≤ f ≤ 5141.6	≥ 48.4 and ≤ 90	≤ 2.5 μW
	5141.6 < f ≤ 5150	≥ 40 and < 48.4	≤ 15 μW
5230	5250 ≤ f < 5251	≥ 20 and < 21	≤ $10^{-(f-20)+log(1/2)}$ mW
	5251 ≤ f < 5270	≥ 21 and < 40	≤ $10^{-\left(\frac{8}{190}\right)(f-21)-1+log(1/2)}$ mW
	5270 ≤ f < 5278.4	≥ 40 and < 48.4	≤ $10^{-\left(\frac{3}{50}\right)(f-40)-1.8+log(1/2)}$ mW
	5278.4 ≤ f ≤ 5400	≥ 48.4 and ≤ 170	≤ 2.5 μW
5270	5100 ≤ f ≤ 5210	≥ 60 and ≤ 170	≤ 2.5 μW
	5210 < f ≤ 5221.6	≥ 48.4 and < 60	≤ 2.5 μW
	5221.6 < f ≤ 5230	≥ 40 and < 48.4	≤ $10^{-\left(\frac{3}{50}\right)(f-40)-1.8+log(1/2)}$ mW
	5230 < f ≤ 5249	≥ 21 and < 40	≤ $10^{-\left(\frac{8}{190}\right)(f-21)-1+log(1/2)}$mW
	5249 < f ≤ 5250	≥ 20 and < 21	≤ $10^{-(f-20)+log(1/2)}$ mW
5310	5350 ≤ f < 5358.4	≥ 40 and < 48.4	≤ 15 μW
	5358.4 ≤ f ≤ 5400	≥ 48.4 and ≤ 90	≤ 2.5 μW

38 MHz < Occupied bandwidth ≤ 78 MHz:

Table 4.1.3.2.1-6: SEM: 38 MHz < Occupied bandwidth ≤ 78 MHz

Centre Frequency (MHz)	Frequency range(f) (MHz)	Frequency difference between centre frequency – the edges of frequency range(MHz)	e.i.r.p/MHz
5210	5020 ≤ f ≤ 5123.2	≥ 86.8 and ≤ 190	≤ 2.5 μW
	5123.2 < f ≤ 5150	≥ 60 and < 86.8	≤ 15 μW
	5250 ≤ f < 5251	≥ 40 and < 41	≤ $10^{-(f-40)+log(1/4)}$ mW
	5251 ≤ f < 5290	≥ 41 and < 80	≤ $10^{-\left(\frac{8}{390}\right)(f-41)-1+log(1/4)}$ mW
	5290 ≤ f < 5296.7	≥ 80 and < 86.7	≤ $10^{-\left(\frac{3}{100}\right)(f-80)-1.8+log(1/4)}$ mW
	5296.7 ≤ f ≤ 5480	≥ 86.7 and ≤ 270	≤ 2.5 μW
5290	5020 ≤ f ≤ 5203.3	≥ 86.7 and ≤ 270	≤ 2.5 μW
	5203.3 < f ≤ 5210	≥ 80 and < 86.7	≤ $10^{-\left(\frac{3}{100}\right)(f-80)-1.8+log(1/4)}$ mW
	5210 < f ≤ 5249	≥ 41 and < 80	≤ $10^{-\left(\frac{8}{390}\right)(f-41)-1+log(1/4)}$ mW
	5249 < f ≤ 5250	≥ 40 and < 41	≤ $10^{-(f-40)+log(1/4)}$ mW
	5350 ≤ f < 5376.8	≥ 60 and < 86.8	≤ 15 μW
	5376.8 ≤ f ≤ 5480	≥ 86.8 and ≤ 190	≤ 2.5 μW

78 MHz < Occupied bandwidth ≤ 158 MHz:

Table 4.1.3.2.1-7: SEM: 78 MHz < Occupied bandwidth ≤ 158 MHz

Centre Frequency (MHz)	Frequency range(f) (MHz)	Frequency difference between centre frequency – the edges of frequency range(MHz)	e.i.r.p/MHz
5250	4916 ≤ f ≤ 5099.6	≥ 150.4 and ≤ 334	≤ 2.5 μW
	5099.6 < f ≤ 5150	≥ 100 and < 150.4	≤ 15 μW
	5350 ≤ f < 5400.4	≥ 100 and < 150.4	≤ 15 μW
	5400.4 ≤ f ≤ 5584	≥ 150.4 and ≤ 334	≤ 2.5 μW

Table 4.1.3.2.1-8: Peak data rate

Occupied bandwidth(MHz)	Peak data rate (Mbps)
≤ 19	≥ 20
> 19 and ≤ 38	≥ 40
> 38 and ≤ 78	≥ 80
> 78 and ≤ 158	≥ 160

4.1.3.2.2 5470-5725 MHz

Table 4.1.3.2.2-1: Adjacent Channel Leakage Ratio (ACLR) 1

Occupied bandwidth	≤ 19.7MHz	> 19.7MHz and ≤ 38MHz	> 38MHz and ≤ 78MHz
ACLR 1	≥ 25 dB	≥ 25 dB	≥ 25 dB
Measurement bandwidth	19 MHz	38 MHz	78 MHz
Adjacent channel centre frequency offset [MHz]	+20 / -20	+40 / -40	+80 / -80

Table 4.1.3.2.2-2: Adjacent Channel Leakage Ratio (ACLR) 2

Occupied bandwidth	≤19.7MHz	> 19.7MHz and ≤ 38MHz	> 38MHz and ≤ 78MHz
ACLR 2	≥ 40 dB	≥ 40 dB	-
Measurement bandwidth	19 MHz	38 MHz	-
Adjacent channel centre frequency offset [MHz]	+40 / -40	+80 / -80	-

Occupied bandwidth ≤ 19.7 MHz:

Table 4.1.3.2.2-3: SEM: Occupied bandwidth ≤ 19.7 MHz

Frequency range(f) (MHz)	e.i.r.p/MHz
5455 ≤ f ≤ 5460	≤ 2.5 µW
5460 < f ≤ 5470	≤ 12.5 µW
5725 ≤ f < 5740	≤ 12.5 µW
5740 ≤ f ≤ 5745	≤ 2.5 µW

19.7 MHz < Occupied bandwidth ≤ 38 MHz:

Table 4.1.3.2.2-4: SEM: 19.7 MHz < Occupied bandwidth ≤ 38 MHz

Frequency range(f) (MHz)	e.i.r.p/MHz
5420 ≤ f ≤ 5460	≤ 12.5 µW
5460 < f ≤ 5470	≤ 50 µW
5725 ≤ f ≤ 5760	≤ 12.5 µW

38 MHz < Occupied bandwidth ≤ 78 MHz:

Table 4.1.3.2.2-5: SEM: 38 MHz < Occupied bandwidth ≤ 78 MHz

Frequency range(f) (MHz)	e.i.r.p/MHz
5340 ≤ f ≤ 5460	≤ 12.5 µW
5460 < f ≤ 5469.5	≤ 50 µW
5469.5 < f ≤ 5470	≤ 51.2 µW
5725 ≤ f ≤ 5800	≤ 12.5 µW

78 MHz < Occupied bandwidth ≤ 158 MHz:

Table 4.1.3.2.2-6: SEM: 78 MHz < Occupied bandwidth ≤ 158 MHz

Frequency range(f) (MHz)	e.i.r.p/MHz
5236 ≤ f ≤ 5419.6	≤ 12.5 µW
5419.6 < f ≤ 5470	≤ 50 µW
5725 ≤ f ≤ 5904	≤ 12.5 µW

Table 4.1.3.2.2-7: Peak data rate

Occupied bandwidth(MHz)	Peak data rate (Mbps)
≤ 19.7	≥ 20
> 19.7 and ≤ 38	≥ 40
> 38 and ≤ 78	≥ 80
> 78 and ≤ 158	≥ 160

4.1.3.2.3 Simultaneous use of 5150-5250 and 5470-5725 MHz / 5250-5350 and 5470-5725 MHz

When simultaneous use of non-contiguous two channels in 5150-5250 and 5470-5725 MHz or that in 5250-5350 and 5470-5725MHz is employed, the following regulatory requirements are also applied. It should be note that total channel bandwidth is less and equal to 160 MHz in these usages.

Table 4.1.3.2.3-1: SEM: 78 MHz < Occupied bandwidth ≤ 158 MHz

Case	Combination of simultaneous transmission Centre Frequencies	
	Centre Frequency 1 (MHz)	Centre Frequency 2 (MHz)
1	5210	5530
2		5610
3	5290	5530
4		5610

Side conditions

- Occupied bandwidth for respective Carrier for Centre frequency is > 38 MHz and ≤ 78 MHz.
- Maximum Output power ≤ 1.25 mW
- e.i.r.p.≤ 1.25 mW

Table 4.1.3.2.3-2: Adjacent Channel Leakage Ratio (ACLR)

Occupied bandwidth	> 38MHz and ≤ 78MHz
ACLR	≥ 25 dB
Measurement bandwidth	78 MHz
Adjacent channel centre frequency offset [MHz]	+80 / -80
Note: Applicable to respective carrier	

Table 4.1.3.2.3-3: SEM: Case 1 and 2

Centre Frequency (MHz)	Frequency range(f) (MHz)	Frequency difference between centre frequency – the edges of frequency range(MHz)	e.i.r.p/MHz
5,210	5,020 ≤ f ≤ 5,134.8	≥ 75.2 and ≤ 190	≤ 2.5 □W
	5,134.8 < f ≤ 5,150	≥ 60 and < 75.2	≤ 12.5 □W
	5,250 ≤ f < 5,251	≥ 40 and < 41	≤ $10^{-(f-40)+\log(1/8)}$ mW
	5,251 ≤ f < 5,285.2	≥ 41 and < 75.2	≤ $10^{-\left(\frac{8}{390}\right)(f-41)-1+\log(1/8)}$ mW
	5,285.2 ≤ f < 5,370	≥ 75.2 and < 160	≤ 2.5 □W
5,530	5,370 ≤ f ≤ 5,454.8	≥ 75.2 and ≤ 160	≤ 2.5 □W
	5,454.8 < f ≤ 5,470	≥ 60 and < 75.2	≤ 15 □W
5,610	5,725 ≤ f ≤ 5,800	≥ 115 and ≤ 190	≤ 15 □W

Table 4.1.3.2.3-4: SEM: Case 3 and 4

Centre Frequency (MHz)	Frequency range(f) (MHz)	Frequency difference between centre frequency – the edges of frequency range(MHz)	e.i.r.p/MHz
5,290	5,020 ≤ f ≤ 5,214.8	≥ 75.2 and ≤ 270	≤ 2.5 □W
	5,214.8 < f ≤ 5,249	≥ 41 and < 75.2	≤ $10^{-\left(\frac{8}{390}\right)(f-41)-1+\log(1/8)}$ mW
	5,249 < f ≤ 5,250	≥ 40 and < 41	≤ $10^{-(f-40)+\log(1/8)}$ mW
	5,350 ≤ f < 5,365.2	≥ 60 and < 75.2	≤ 15 □W
	5,365.2 ≤ f < 5,410	≥ 75.2 and < 120	≤ 2.5 □W
5,530	5,410 ≤ f ≤ 5,454.8	≥ 75.2 and ≤ 120	≤ 2.5 □W
	5,454.8 < f ≤ 5,470	≥ 60 and < 75.2	≤ 15 □W
5,610	5,725 ≤ f ≤ 5,800	≥ 115 and ≤ 190	≤ 15 □W

Table 4.1.3.2.3-5: Peak data rate

Peak data rate (Mbps)
≥ 160

4.1.3.3 Korea

Table 4.1.3.3-1: Transmit power requirements for 5GHz Devices

Frequency Range(MHz)	5100-5250		5250-5350		5470-5650		5725-5825, 2400~2483.5 (Note 7)	
Average PSD requirement (mW/MHz)	BW(MHz)	PSD	BW(MHz)	PSD	BW(MHz)	PSD	BW(MHz)	PSD
	0.5-20	≤2.5	0.5-20	≤10	0.5-20	≤10	0.5-26	≤10
	20-40	≤1.25	20-40	≤5	20-40	≤5	26-40	≤5
	40-80	≤0.625	40-80	≤2.5	40-80	≤2.5	40-80	≤2.5
							40-60 (Note 1)	≤0.1 (Note 1)
Assumed antenna gain G (dBi) (Note 4)	6		7		7		6, 20 (PTP) (Notes 2, 3)	
Out of band emission, EIRP (dBm/MHz)	-27		-27		-27		For any 100kHz in outside band, less than -30dBm(2400-2483.5MHz) -27dBm/MHz (5725-5825MHz)	
DFS (Note 5)	No		Yes		Yes		No	
TPC (Note 6)	No		Yes		Yes		No	

NOTE 1: 2400-2483.5MHz devices
NOTE 2: Fixed point to point operation power scaling threshold is 20 dBi
NOTE 3: PTP: Point to Point communication
NOTE 4: Peak power is reduced by G-THR dB for directional antennas with gain > THR dBi (THR = 6 dBi for 51005250MHz and 5725-5825MHz or 7dBi for 5250-5350MHz and 5470-5650MHz)
NOTE 5: DFS: Dynamic Frequency Selection
NOTE 6: TPC: Transmit Power Control
NOTE 7: 5725-5825MHz, 2400-2483.5MHz are not allowed to be used for point-to-multipoint service for the same information and omni-directional electro-magnetic wave transmission

Table 4.1.3.3-2: DFS requirements for 5GHz Devices

	Levels	Comments
DFS Threshold (dBm) for interference detection	-62dBm	Average power considering antenna gain: <10mW/MHz
	-64dBm	Average power considering antenna gain: 10mW/MHz ~50mW/MHz
Channel availability check time	> 60 seconds	
Channel move time	< 10 seconds	
Non-occupancy time	> 30 minutes	After radar detection in either channel availability check or in-service monitoring

Korean regulatory requirements are summarized as follows:

- Average PSD requirement (mW/MHz)
  - It covers both power spectral density and Max transmission power
  - The maximum PSD is defined for a given spectrum range
  - Maximum transmission power :

    - 50mW, 200mW, 200mW and 200/260mW for 5150-5250, 5250-5350, 5470-5650, and 5725-5825 MHz band respectively

- Antenna gain assumed:
  - 6 dBi for 5150-5250 and 5725-5825MHz band
  - 7 dBi for 52505350 and 5470-5650MHz band
- Out of Band Emission (EIRP (dBm/MHz))
  - <-27 dBm/MHz
- DFS & TPC
  - DFS is defined for 5250-5350MHz and 5470-5650MHz
  - TPC is defined for 5250-5350MHz and 5470-5650MHz
    - TPC ensures wireless devices with average Tx power including antenna gain larger than 25mW/MHz can reduce its average Tx power by at least 3dB (below 12.5mW/MHz)
- Maximum bandwidth occupancy
  - < 80MHz for 5GHz
- Maximum power spectral density for bandwidth aggregation (contiguous or non-contiguous)
  - Among 5150-5250, 5250-5350, 5470-5650, and 5725-5825 MHz bands, multiple of 80MHz bandwidth can be aggregated in contiguous or non-contiguous manner to form 160MHz bandwidth
  - In this case, maximum power spectral density for 5150-5250MHz should be lower than 0.625mW/MHz while it should be lower than 1.25mW/Hz in the other bands
- Modulation scheme
  - Digital modulation for 5GHz
- Difference from FCC regulation
  - Maximum transmission power in case of 5725 to 5825MHz is still 200mW for 20MHz bandwidth (a bit lower compared to 1W power in UNII-3)
  - 5825-5850MHz is not for WAS (Wireless Access System)

4.1.3.4 India

In India the bands 5150-5250 MHz, 5250-5350 MHz, 5570-5725 MHz and 5725-5875 MHz are open to RLANs [22], [35], [36], [37]. Table 4.1.3.4-1 and Table 4.1.3.4-2 summarize regulatory requirements in India for indoor and outdoor deployments respectively. Some parts of the 5 GHz band shall follow usage "on non-interference, non-protection and shared (non-exclusive) basis". These are the 5725-5825 MHz band open to licensed WAS including RLANs, and the 5150-5350 MHz and 5725-5875 MHz bands open for unlicensed WAS including RLANs for indoor deployment.

Table 4.1.3.4-1: Summary of regulatory requirements for indoor deployment in India

Regulation code	NFAP2011-IND 67, GSR No 46E, 37E	NFAP2011-IND 69
Band (MHz)	5150-5350, 5725-5875	5570-5725
License Type	Unlicensed	Licensed
Maximum mean EIRP	200mW (23dBm)	1W (30dBm)
Maximum mean EIRP density	10 mW/MHz	50 mW/MHz
Band usage	Low power WAS including RLAN	Low power WAS including RLAN

Table 4.1.3.4-2: Summary of regulatory requirements for outdoor deployment in India

Regulation code	NFAP2011-IND 68	NFAP2011-IND 69	NFAP2011-IND 71	NFAP2011-IND 72, GSR No 38E
Band (MHz)	5150-5250	5570-5725	5725-5825	5825-5875
License Type	Licensed	Licensed	Licensed	Unlicensed
Maximum transmitter output power			1 W (30dBm) in spread of 10 MHz or higher	1 W (30dBm) in spread of 10 MHz or higher
Maximum mean EIRP	200mW (23dBm)	1W (30dBm)	4W (36dBm)	4W (36dBm)
Maximum mean EIRP density	10 mW/MHz	50 mW/MHz		
Band usage	Low power WAS including RLAN	Low power WAS including RLAN	Low power WAS including RLAN and Dedicated Short Range Communications (DSRC) for Intelligent Transport Networks	Low power WAS including RLAN

4.1.3.5 Taiwan

In Taiwan the bands 5250-5350 MHz, 5470-5600 MHz, 5650-5725 MHz and 5725-5850 MHz are allocated to RLANs [22][40]. Table 4.1.3.5-1 and Table 4.1.3.5-2 summarize the current regulatory requirements for transmit power and DFS in Taiwan [40]. DFS is mandate for 5470-5725 MHz [41]. Recently, work for specifying requirements for allowing RLANs in 5150-5250 MHz and 5600-5650 MHz has started but the detailed regulatory requirements for this has not yet been specified. Additionally specification work for allowing 5250-5350 MHz outdoor has started, this assumes that DFS will be performed, but detailed requirements are not yet defined.

Table 4.1.3.5-1 Transmit power requirements for 5GHz band in Taiwan

Frequency Range (GHz)		5.25-5.35 *	5.47-5.60 and 5.65-5.725	5.725-5.825	*For indoor use only
Peak transmit power < min(a, b) (dBm)	A	17	24	30	
	B	4+10logB	11+10logB	17+10logB	B is the 26-dB emission bandwidth in MHz
Peak PSD (dBm/MHz)		4	11	17	Resolution bandwidth 1 MHz
Assumed Antenna Gain (dBi)		6	6	6**	Peak power is reduced by G-6 dB for directional antennas with gain > 6 dBi; ** Fixed point to point operation power scaling threshold is 23 dBi
Out of band emission	Frequency Support (GHz)	Outside 5.25 – 5.35	Outside 5.47-5.725	Outside 5.715-5.835	
	EIRP (dBm/MHz)	-27	-27	-27	Resolution bandwidth 1 MHz
	Frequency Support (GHz)			5.715-5.725 5.825-5.835	
	EIRP (dBm/MHz)			-17	Resolution bandwidth 1 MHz
Transmit Power Control		N/A	TPC to 6 dB below a mean EIRP of 30 dBm. No TPC for mean EIRP < 27 dBm	N/A	
DFS		Required	Required	N/A	

Table 4.1.3.5-2 DFS requirements for 5.470-5.725GHz band in Taiwan

	Levels	Comments
DFS Detection Threshold (dBm)	-64 for EIRP between 200mW and 1W	DFS power is averaged in 1 micro-second for 0 dBi antenna. Uniform spread over available channels.
	-62 for EIRP < 200mW	
Channel availability check time	60 seconds	Master mode
Channel move time	<10 seconds	Master and slave mode After detection of radar signal: at most 200ms for normal communication manage and control signals can be transmitted discontinuously in the remaining time within 10 seconds
Non-occupancy time	>30 minutes	After radar detection in either channel availability check or in-service monitoring

4.1.3.6 Singapore

In Singapore the bands 5150-5250 MHz, 5250-5350 MHz, 5470-5725MHz and 5725-5850 MHz are open to RLANs.

4.1.3.7 Australia

In Australia the band bands 5150-5250 MHz, 5250-5350 MHz and 5470-5725 MHz, except the sub-band 5600-5650 MHz, are open to RLANs. DFS and TPC are mandatory in the bands 5250-5350 MHz and 5470-5725 MHz.

4.1.4 Applicability of DFS requirements

The concept surfaced around 2001 in the ECC for handling uniform spread of WLAN interference into satellite and radar services, but was soon extended to include methods for discovery and avoidance of frequencies used by the radar service in the preparation work for WRC 2003.

Use of DFS in accordance with Annex 1 of ITU-R Recommendation M.1652 [39] is mandated as per Resolution 229 [38]. The 5 GHz Harmonized European Standard developed by ETSI TC BRAN was the first to include these DFS rules (EN 301 893 V1.2.3 in 2003), the DFS test specification included in this standard therefore became the basis for the development of the FCC DFS test specification and other test specifications in other countries.

For NR-U, it appears that conformance testing would only have to be performed for the BS. Already at the outset in ITU-R M.1652 it was made clear that full DFS functionality may not have to be implemented in all devices, only those controlling the transmission [39]:

2.1 Detection requirements

The DFS mechanism should be able to detect interference signals above a minimum DFS detection threshold of –62 dBm for devices with a maximum e.i.r.p. of < 200 mW and –64 dBm for devices with a maximum e.i.r.p. of 200 mW to 1 W[3] averaged over 1 μs.

This is defined as the received signal strength (RSS) (dBm), normalized to the output of a 0 dBi receive antenna, that is required to be detected within the WAS channel bandwidth.

2.2 Operational

with the footnote 3 stating:

In practice, it may not be necessary for each device to implement full DFS functionality, provided that such devices are only able to transmit under the control of a device that ensures that all DFS requirements are fulfilled.

This is reflected in both regulation for Europe and the Part 15 rules by the FCC. The harmonized ETSI BRAN standard cited in the EC commission rules is also followed by many other countries outside Europe.

4.1.4.1 DFS according to ECC

In accordance with the ECC Decision [10], "Every Master Device will use the Radar Interference Detection function in order to check for any co-channel radar signal prior to use a channel but also during normal operation. In addition to this Radar Interference Detection function, every Master Device shall also implement a channel selection mechanism to ensure a near uniform spread of the loading of available spectrum." In the latest version of the EN 301 893 [5], the applicability of the DFS requirements is listed as follows:

Table 5 lists the DFS related technical requirements and their applicability for every operational mode. If the RLAN device is capable of operating in more than one operational mode then every operating mode shall be assessed separately.

Table 5 (from EN 301 893): Applicability of DFS requirements

Requirement	**DFS Operational mode**		
	Master	**Slave without radar detection** (see table D.2, note 2)	**Slave with radar detection** (see table D.2, note 2)
Channel Availability Check	✓	Not required	✓ (see note 2)
Off-Channel CAC (see note 1)	✓	Not required	✓ (see note 2)
In-Service Monitoring	✓	Not required	✓
Channel Shutdown	✓	✓	✓
Non-Occupancy Period	✓	Not required	✓
Uniform Spreading	✓	Not required	Not required
NOTE 1: Where implemented by the manufacturer. NOTE 2: A slave with radar detection is not required to perform a CAC or *Off-Channel CAC* at initial use of the channel but only after the slave has detected a radar signal on the *Operating Channel* by *In-Service Monitoring.*			

The radar detection requirements specified in clauses 4.7.2.2 to 4.7.2.4 assume that the centre frequencies of the radar signals fall within the central 80 % of the *Occupied Channel Bandwidth* of the RLAN channel (see clause 4.3).

Notice also the assumption that the radar signal falls within 80% of the occupied bandwidth, which is linked to the requirements on occupied emission bandwidth in EN 801 893 (clause 4.7).

4.1.4.2 DFS in the Part 15 rules

The rules with regard to implementation of DFS functionality are similar in the Part 15 rules [3]; the required functionality is limited for the slave,

> (2) Radar Detection Function of Dynamic Frequency Selection (DFS). U-NII devices operating with any part of its 26 dB emission bandwidth in the 5.25-5.35 GHz and 5.47-5.725 GHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems. Operators shall only use equipment with a DFS mechanism that is turned on when operating in these bands. The device must sense for radar signals at 100 percent of its emission bandwidth. The minimum DFS detection threshold for devices with a maximum e.i.r.p. […]
>
> (i) Operational Modes. The DFS requirement applies to the following operational modes:
>
> (A) The requirement for channel availability check time applies in the master operational mode.
>
> (B) The requirement for channel move time applies in both the master and slave operational modes.

(ii) Channel Availability Check Time. A U-NII device shall check if there is a radar system already operating on the channel before it can initiate a transmission on a channel and when it has to move to a new channel. The U-NII device may start using the channel if no radar signal with a power level greater than the interference threshold values listed in paragraph (h)(2) of this section, is detected within 60 seconds.

(iii) Channel Move Time. After a radar's presence is detected, all transmissions shall cease on the operating channel within 10 seconds. Transmissions during this period shall consist of normal traffic for a maximum of 200 ms after detection of the radar signal. In addition, intermittent management and control signals can be sent during the remaining time to facilitate vacating the operating channel.

Similar to the ETSI BRAN harmonized standard, there is also a requirement that "the device must sense for radar signals at 100 percent of its emission bandwidth". In deriving the minimum DFS detection threshold for the WAS receiver, it was assumed that above this threshold the emissions within the RLAN bandwidth would desensitize the radar receiver. Reciprocity was thus assumed, the WAS should be able to detect a radar within its emission bandwidth. The bandwidth of the WAS affects the probability of detecting a radar signal and its side lobes and the probability of causing interference (the WAS emissions).

4.2 Regulatory requirements for 6GHz band

Currently, CEPT and FCC have started initiatives to investigate potentialities for deployment of IMT services in the 5.925-7.125 GHz frequency range (e.g. US 5925 – 7125 MHz, or European 5925 – 6425 MHz, or parts thereof), with considerations for all or part of this range being made available for unlicensed operation [32].

5 Spectrum considerations

For the NR-U study item, different unlicensed bands or shared bands have been discussed, such as 2.4 GHz band, 3.5 GHz band, 5 GHz band, and 6 GHz band. Some bands are available globally and some bands are only available in some specific regions, and some bands may be made available after the completion of this study [32].

Follow the NR design principles, from RAN1 design perspective, this NR-U study is not limited to a particular unlicensed band. Instead, the target NR-U design is applicable to a set of frequency ranges to be further defined. There is no prioritization between unlicensed bands. On the other hand, the NR-U study does not target sub-1 GHz unlicensed bands, due to the lack of spectrum in the band to support efficient NR-U operation.

6 Deployment scenarios

This section describes possible deployment scenarios for NR-U.

Five deployment scenarios have been identified:

- Scenario A: Carrier aggregation between licensed band NR (PCell) and NR-U (SCell)
  - NR-U SCell may have both DL and UL, or DL-only.
- Scenario B: Dual connectivity between licensed band LTE (PCell) and NR-U (PSCell)
- Scenario C: Stand-alone NR-U
- Scenario D: An NR cell with DL in unlicensed band and UL in licensed band
- Scenario E: Dual connectivity between licensed band NR (PCell) and NR-U (PSCell)

7 Design targets, functionalities and solutions

In the discussions in the NR-U study item, references to sub-7 GHz are intended to include unlicensed bands in the 6 GHz region that are being discussed in regulatory discussions which may have some region exceeding 7 GHz (e.g., 7.125 GHz).

7.1 Design targets and functionalities

The NR-U study targets identification of additional functionality needed for a PHY layer design (except channel access procedures) for operation in unlicensed spectrum that may be applicable over a particular frequency range (e.g., sub-7 GHz, 7-52.6 GHz, > 52.6 GHz). The definition of the frequency ranges is to be further defined. On the other hand, the optimizations for a particular frequency band may be necessary due to different requirements, such as PSD limitation or OCB requirement, for each band. Channel bandwidths below 5 MHz are not targeted in this study.

The study targets the design of channel access procedures for frequency bands based on coexistence and regulatory considerations applicable to the band. The study includes identification of procedures for technology neutral channel access for frequency bands that may become available subject to regulations. The study assumes regulation will provide the framework concerning the protection for the technologies not using unlicensed access in those bands.

7.2 Solutions for operation in unlicensed spectrum

7.2.1 Physical layer aspects

According to the study item description [30], physical channels inheriting the choices of duplex mode, waveform, carrier bandwidth, subcarrier spacing, frame structure, and physical layer design made as part of the NR study and avoiding unnecessary divergence with decisions made in the NR WI.

NR-U supports both Type-A and Type-B mapping already supported in NR.

Initial active DL/UL BWP is approximately 20MHz for 5GHz band, though the final value will be quantized to number of PRBs. Initial active DL/UL BWP is approximately 20MHz for 6GHz band if similar channelization as 5GHz band is used for 6GHz band.

7.2.1.1 Frame structure

Single and multiple DL to UL and UL to DL switching points within a shared gNB COT is identified to be beneficial and can be supported. LBT requirements to support single or multiple switching points has been identified (Section 7.2.1.3.1).

For NR-U DL operation, it is identified that being able to operate all DL signal/channels with the same numerology for a carrier and at least for intra-band CA on serving cells on unlicensed bands has at least the following benefits (at least for standalone operation)

- Lower implementation complexity (e.g., a single FFT, no switching gaps)
- Lower specification impact
- No need for gaps for measurements on frequencies with a configured serving cell in unlicensed bands

For NR-U UL operation, it is identified that being able to operate all UL signal/channels (except PRACH) with the same numerology for a carrier and at least for intra-band CA on serving cells on unlicensed bands has at least the following benefits:

- Lower implementation complexity (e.g., a single FFT, no switching gaps)
- Lower specification impact
- Common interlace structure
- No need for gaps for transmission of SRS on a configured serving cell in unlicensed bands

For unlicensed PCell, the UE assumes single SSB numerology per band.

It has been identified to be beneficial for the NR-U design to not require the gNB to change a pre-determined TBS for a PDSCH transmission depending on the LBT outcome, at least when the PDSCH is transmitted at the beginning of the gNB's COT.

The following options have been identified as possible candidates for PDSCH transmission in the partial slot at least for the first PDSCH(s) transmitted in the DL transmission burst. The options are not mutually exclusive.

- Option 1: PDSCH(s) as in Rel-15 NR

- Option 2: Punctured PDSCH depending on LBT outcome
- Option 3: PDSCH mapping type B with durations other than 2/4/7 symbols
- Option 4: PDSCH across slot boundary

In addition to the functionalities provided by DCI format 2_0 in Rel-15 NR, indication of the COT structure in the time domain has been identified as being beneficial.

It has been identified to be beneficial for the NR-U design to not require the UE to change a granted TBS for a PUSCH transmission depending on the LBT outcome.

The following options have been identified as possible candidate at least for the first PUSCH(s) transmitted in the UL transmission burst.

- Option 1: PUSCH(s) as in Rel-15 NR
- Option 2: Multiple starting positions in one or multiple slot(s) are allowed for PUSCH(s) scheduled by a single UL grant (i.e., not a configured grant) and one of the multiple PUSCH starting positions can be decided depending on LBT outcome.

It is noted that for above options, the ending position of the PUSCH is fixed as indicated by the UL grant.

It is noted that above options are not mutually exclusive.

It has been identified that FBE operation for the scenario where it is guaranteed that LBE nodes are absent on a long term basis (e.g., by level of regulation) and FBE gNBs are synchronized can achieve the following: Ability to use frequency reuse factor 1; Lower complexity for channel access due to lack of necessity to perform random backoff. It is noted that this does not imply that LBE does not have benefits in similar scenarios although there are differences between the two modes of operation. It is also noted that FBE may also have some disadvantages compared to other modes of operation such as LBE, e.g., a fixed overhead for idle time during a frame.

For wideband operation for both DL and UL,

- Bandwidth larger than 20 MHz can be supported with multiple serving cells.
- NR-U should support that a serving cell can be configured with bandwidth larger than 20 MHz.

For DL operation, the following options for BWP-based operation within a carrier with bandwidth larger than 20 MHz can be considered.

- Option 1a: Multiple BWPs configured, multiple BWPs activated, transmission of PDSCH on one or more BWPs
- Option 1b: Multiple BWPs configured, multiple BWPs activated, transmission of PDSCH on single BWP
- Option 2: Multiple BWPs can be configured, single BWP activated, gNB transmits PDSCH on a single BWP if CCA is successful at gNB for the whole BWP
- Option 3: Multiple BWPs can be configured, single BWP activated, gNB transmits PDSCH on parts or whole of single BWP where CCA is successful at gNB

For UL operation, the following options for BWP-based operation within a carrier with bandwidth larger than 20 MHz can be considered.

- Option 1a: Multiple BWPs configured, multiple BWPs activated, transmission of PUSCH on one or more BWPs
- Option 1b: Multiple BWPs configured, multiple BWPs activated, transmission of PUSCH on single BWP
- Option 2: Multiple BWPs can be configured, single BWP activated, UE transmits PUSCH on a single BWP if CCA is successful at UE for the whole BWP
- Option 3: Multiple BWPs can be configured, single BWP activated, UE transmits PUSCH on parts or whole of single BWP where CCA is successful at UE

It is noted that CCA is declared to be successful or not in multiples of 20 MHz.

Detailed design and potential selection from the above options can be further discussed when specifications are developed considering protocol and RF aspects.

7.2.1.2 Physical layer channel designs

For physical layer channel design, NR design will be used as baseline, and the following potential design changes are to be studied to support the following channels/signals in NR-U.

- PDCCH/PDSCH
- PUCCH/PUSCH
- PSS/SSS/PBCH
- PRACH
- DL and UL reference signals applicable to the operational frequency range

For SS/PBCH block transmission, extended CP is not supported for NR-U operation.

For PSS/SSS/PBCH transmission, NR-U should have a signal that contains at least SS/PBCH block burst set transmission. The design of this signal should consider the following characteristics specific to unlicensed band operation:

- There are no gaps within the time span the signal is transmitted at least within a beam
- The occupied channel bandwidth is satisfied (although this may not be a requirement)
- Strive to minimize the channel occupancy time of the signal
- Characteristics that may facilitate fast channel access

Inclusion of the CSI-RS and RMSI-CORESET(s)+PDSCH(s) (carrying RMSI) associated with SS/PBCH block(s) in addition to the SS/PBCH burst set in one contiguous burst (referred to as the NR-U DRS) can be beneficial for

- Meeting OCB requirement
- Compacting signals in time domain to limit the required number of channel access and for short channel occupancy
- Support of stand-alone NR-U deployments
- Support of automatic neighbour relations (ANR) functionality in an NR-U deployment
- Resolution of PCI confusion in an NR-U deployment

The transmission of additional signals such as OSI and paging within the NR-U DRS is allowed and can be beneficial.

Support of Pattern 1 is recommended for multiplexing of SS/PBCH block(s) and CORESET(s)#0 in NR-U, where Pattern 1 is understood as CORESET#0 and an SS/PBCH block occuring in different time instances, and the CORESET#0 bandwidth overlaping with the transmission bandwidth of the SS/PBCH block.

As one element to facilitate a NR-U DRS design without gaps in the time domain, the CORESET#0 configuration(s) and/or Type0-PDCCH common search space configuration(s) may need enhancements compared to NR Rel-15, such as additional time domain configurations of the common search space(s).

The detection of a gNB's transmission burst by the UE has been studied, and concerns on the UE power consumption required for Tx burst detection e.g. if the UE needs to frequently detect/monitor the PDCCH have been raised. The proposals that have been made by contributions regarding these topics include existing NR signal(s) with potential enhancement(s), a channel such as PDCCH with potential enhancement(s), and the 802.11a/802.11ax preamble with potential enhancement(s); consensus was not achieved on any of these proposals. The detection/decoding reliability of each of the proposals has not been sufficiently evaluated for a complete evaluation of the proposals against each other. The power consumption and detection/decoding complexity of each of the proposals have not been sufficiently evaluated for a complete evaluation of the proposals against each other. The relation of a proposal with C-DRX and/or measurement gap(s) may need further consideration when specifications are being developed.

Compared to NR Rel-15, it has been identified to be beneficial if the time domain instances in which the UE is expected to receive PDCCH can change dynamically, e.g. by implicit determination related to the gNB's COT, or explicitly signalled by the gNB.

For UL waveform for PUSCH, PUCCH, and PRACH, it has been identified that an interlaced waveform can have benefits in some scenarios including link budget limited cases with given PSD constraint, and as one option to efficiently meet the occupied channel bandwidth requirement.

On the other hand, it is RAN1's understanding that the temporal allowance of not meeting occupied channel bandwidth by regulation can be exploited if the minimum bandwidth requirement, e.g., 2 MHz, is satisfied. Therefore, a waveform contiguous in frequency may be adequate in some scenarios, which implies that Release 15 NR contiguous allocation designs can be used for NR-U as well.

Support for Rel-15 NR PUSCH can be considered. However, it has been identified that block-interlaced based PUSCH can be beneficial.

Support for Rel-15 NR PUCCH formats can be considered, however, not necessarily all Release 15 NR PUCCH formats are applicable to NR-U. It has been identified that legacy PUCCH formats PF2 and PF3 are beneficial for NR-U for the scenario of contiguous allocations due to the fact that they may be configured with bandwidth that meets the minimum temporal allowance of 2 MHz (12/6/3 PRBs for 15/30/60 kHz SCS). It has been identified that legacy PUCCH formats PF0/1/4 are not well-suited for NR-U for the scenario of contiguous allocations since they support only single PRB.

When new block interlace waveform for PUCCH is to be defined, it is beneficial to use the same block interlace structure for PUCCH and PUSCH.
It has been identified that enhancement of one or more legacy PUCCH formats is feasible to support block interlaced PUCCH transmission. There is consensus that enhanced PUCCH with both short and long duration is beneficial for NR-U; however, no consensus has been achieved about which legacy PUCCH format(s) should be the starting point for an enhanced PUCCH design. Some sources suggest introducing just one or two new enhanced PUCCH formats, while other sources suggest enhancing all or almost all legacy PUCCH formats (PF0,1,2,3,4). Regardless of which format(s) is(are) chosen as a starting point for enhancement, the following common aspects have been identified as important to consider in the detailed design of the enhanced PUCCH format(s) when specifications are developed:

- Flexible number of OFDM symbols
    - Short duration, e.g., 1 or 2 OFDM symbols
    - Long duration, e.g., 4 – 14 OFDM symbols
- Flexible UCI payload
    - Small payload, e.g., 1 or 2 bit
    - Larger payloads, e.g., > 2 bits
- Coding of UCI payload, e.g.,
    - Extend legacy (NR Rel-15) PUCCH encoder to handle small payloads
    - Repetition of coded UCI bits across PRBs of an interlace
    - UCI Codebits over all PRBs, i.e. no repetition coding.
- Number of supported PUCCH formats
- Support for user multiplexing of both UCI payload and DMRS on an interlace, e.g.,
    - OCCs
    - Cyclic shifts
    - FDM within an interlace
- Multiplexing method of UCI payload and DMRS, e.g,
    - TDM

  - FDM
- Mechanism to control PAPR, e.g.,
  - OCC cycling
  - Bit level processing
  - PRB level processing
  - Sequence hopping
- PUCCH waveform, e.g.,
  - CP-OFDM
  - DFT-s-OFDM
- Performance, e.g.,
  - Required SNR to achieve a target BLER
  - Required SNR to achieve target ACK to NACK rate, NACK to ACK rate and DTX to ACK rate
  - Coverage considering CM/PAPR

Support for Rel-15 NR PRACH formats can be considered, however, not necessarily all Release 15 NR PRACH formats are applicable to NR-U. It is RAN1's understanding that certain formats do not meet the minimum bandwidth requirement by regulation. Exclusion of the support of certain formats is to be identified.

It is identified that interlaced based PRACH can be beneficial.

It has been identified that enhancement of one or more legacy PRACH formats is feasible for NR-U. Four potential design alternatives, including no interlacing, have been identified for the frequency mapping of PRACH sequences for NR-U, where consensus on which one(s) to support for NR-U has not yet been achieved:

- Alt-1: Uniform PRB-level interlace mapping
  - In this approach a PRACH sequence for a particular PRACH occasion is mapped to all of the PRBs of one or more of the interlaces in the PRB-based block interlace structure. Within a PRB, either all or a subset of REs are used. Different PRACH occasions are defined using an orthogonal set of PRBs, or an orthogonal set of REs within the PRBs, from one or more same/different interlaces.
  - It has been identified that a uniform mapping (equal spacing of PRBs) in the frequency domain produces a zero-autocorrelation zone, of which the duration is inversely proportional to the frequency spacing between the PRBs.
- Alt-2: Non-uniform PRB-level interlace mapping
  - In this approach a PRACH sequence for a particular PRACH occasion is mapped to some or all of the PRBs of one or more of the interlaces in the same PRB-based block interlace structure used for PUSCH/PUCCH. Within a PRB, either all or a subset of REs are used. Different PRACH occasions are defined using an orthogonal set of PRBs, or an orthogonal set of REs within the PRBs, from one or more same/different interlaces.
  - It has been identified that an irregular mapping (non-equal spacing of PRBs/REs) in the frequency domain reduces the false peaks in the PRACH preamble auto-correlation function.
- Alt-3: Uniform RE-level interlace mapping
  - In this approach, a PRACH sequence for a particular PRACH occasion consists of a "comb-like" mapping in the frequency domain with equal spacing between all used REs. Different PRACH occasions are defined by way of different comb offsets.

  - Since this approach does not fit with the common PUSCH/PUCCH interlace structure, one source suggests that only TDM multiplexing of PUSCH/PUCCH and PRACH should be supported. Another source suggests that puncturing/rate matching PUSCH/PUCCH around the used PRACH REs may be used.

- Alt-4: Non-interlaced mapping

  - In this approach, a PRACH sequence for a particular PRACH occasion is mapped to a number of contiguous PRBs, same or similar to NR Rel-15.

  - Some sources propose that to fulfill the minimum OCB requirement, that the PRACH sequence is mapped to a set of contiguous PRBs, and the PRACH sequence mapping is repeated across the frequency domain, potentially with guard RE(s)/PRB(s) between repetitions. For each repetition, a different cyclic shift or different base sequence may or may not be applied.

It has been identified that the long PRACH sequence length defined in NR Rel-15 (L = 839) is not beneficial for NR-U, since PRACH formats based on this length are tailored toward large cells not expected in an NR-U deployment. However, when it comes to shorter sequence lengths, some sources propose reusing the short sequence length (L = 139) defined in NR-Rel-15, whereas other sources propose defining new sequence lengths depending on which of the 4 alternatives above is supported.

It has been identified that the following common design attributes need to be considered in the detailed design of an interlaced PRACH waveform for 4-step random access for NR-U when specifications are developed:

- Multiplexing of PRACH and PUSCH/PUCCH, considering block interlaced structure used for PUSCH/PUCCH, e.g.,

  - FDM

  - TDM

- Supported PRACH sequence and PRACH sequence length(s)

- PRACH capacity

  - Number of PRACH preambles per cell

  - Number of root sequences

  - Number of cyclic shifts

  - Number of PRACH occasions

- Maximum supported Tx power

- PAPR/CM

- Number of PRACH formats

- Simulation assumptions for evaluation of performance, e.g.,

  - Single vs. multi-cell assumptions

- Performance metrics

  - Timing estimation error

  - Miss-detection probability

  - False-detection probability

  - False-alarm probability

For scenarios in which a block-interlaced waveform is used for PUCCH/PUSCH, it has been identified that from FDM-based user-multiplexing standpoint it can be beneficial to have UL channels on a common interlace structure, at least for PUSCH, PUCCH, associated DMRS, and potentially PRACH

On the other hand, for scenarios in which a contiguous allocation for PUSCH and PUCCH is used, it is beneficial to use contiguous resource allocation for PRACH

For scenarios in which a block-interlaced waveform is used for UL transmission, a PRB-based block-interlace design has been identified as beneficial at least for 15 and 30 kHz SCS, and potentially for 60 kHz SCS. One identified benefit is better link budget with given PSD constraint. However, it has been observed that power boosting gains decrease with increasing SCS. Another identified benefit is as one option to efficiently meet the occupied channel bandwidth requirement. Compared with sub-PRB interlace design, the PRB-based block-interlace design has comparatively less specification impact.

For sub-PRB block interlace designs, in some scenarios, sub-PRB block interlacing can be beneficial in terms of power boosting. However, the sub-PRB block interlace design has at least the following specification impacts: Reference signal design (e.g., DMRS); Channel estimation aspects; Resource allocation.

Both PRB and sub-PRB interlacing for 60 kHz have been studied. For sub-PRB interlacing the following aspects have been considered:

- Power boosting potential depending on resource allocation size
- PUSCH DMRS configuration aspects
- Channel estimation performance
- Number of REs per interlace unit

It has been identified as beneficial to support a block-interlaced structure in which the number of interlaces (M) decreases with increasing SCS, and the nominal number of PRBs per interlace (N) is similar for each SCS (in a given bandwidth) at least for 15 and 30 kHz SCS, and potentially 60 kHz depending on supported interlace design.

From a RAN1 perspective it has been identified that supporting a non-uniform interlace structure in which the number of PRBs per interlace is allowed to be different for different interlaces is beneficial from a spectrum utilization point of view. It is up to RAN4 to investigate whether or not the non-uniform interlace structure has an impact on MPR/A-MPR requirements for PUSCH.

Within a 20 MHz bandwidth, the following candidate PRB-based interlace designs have been identified where M is the number of interlaces and N is the number of PRBs per interlace in a 20 MHz bandwidth. Where two values are listed for N, it means that some interlaces have one more PRB than others (non-uniform interlace design)

SCS	M	N
15 kHz	12	8 or 9
	10	10 or 11
	8	13 or 14
30 kHz	6	8 or 9
	5	10 or 11
	4	12 or 13
60 kHz	4	6
	3	8
	2	12
60 kHz (if 26 PRBs is supported in a 20 MHz bandwidth)	4	6 or 7
	2	13
	3	8 or 9

For carriers with bandwidth larger than 20 MHz, two candidate interlace designs have been identified:

- Alt-1: Same interlace spacing for all interlaces regardless of carrier BW. This alternative uses Point A as a reference for the interlace definition
- Alt-2: Interlacing defined on a sub-band (20 MHz) basis. (Note: Possible interlace spacing discontinuity at edges of sub-band).

Additional candidates have been identified, but consensus has not been achieved, e.g., (1) for carriers with bandwidth larger than 20 MHz, retain the same number of PRBs per interlace (N) for all interlaces regardless of carrier BW; (2)

Partial interlace allocation. Detailed design can be further discussed when specifications are developed taking RF aspects into account.

It has been identified that support of different numerology candidates at least has the following specification impacts:

- For PRB-based block-interlace design for 15, 30, and 60 kHz SCS, the following spec impacts have been identified: Number of interlaces and number of PRBs per interlace need to be defined; the resource allocation mechanism needs to be defined; channel estimation aspects need to be considered, such as impact on PRG. In addition to the above impact, for sub-PRB-based block-interlace design for 60 kHz SCS, reference signal design (such as DMRS) needs to be revisited and alternative resource allocation mechanism is needed.

- For NR-U DRS design for 15 and 30 kHz SCS, the SS/PBCH block time domain pattern is already supported in Rel-15. For 60 kHz SCS, there is no SS/PBCH block time domain pattern defined in Rel-15. SS/PBCH block to CORESET configuration tables (38.213 Section 13) need to be defined as well.

- For PRACH design for 15, 30, and 60 kHz SCS, signalling mechanism of RACH configuration indicating PRACH numerology may need modification to support more than two numerologies for PRACH for NR-U.

It has been identified as beneficial for NR-U to introduce additional flexibility in configuring/triggering SRS compared to NR Rel-15. The following candidate enhancements have been discussed; design details can be further discussed when specifications are developed:

- Additional OFDM symbol locations for an SRS resource within a slot other than the last 6 symbols

- Interlaced waveform

- Additional flexibility in frequency domain configuration

It may be beneficial to apply restrictions on the use of DFT-s-OFDM in NR-U to avoid significant design efforts specific to operation in unlicensed spectrum.

7.2.1.3 Physical layer procedure designs

7.2.1.3.1 Channel access procedures

If absence of Wi-Fi cannot be guaranteed (e.g. by regulation) in the band (sub-7 GHz) where NR-U is operating, the baseline assumption is, the NR-U operating bandwidth is an integer multiple of 20MHz.

Channel access mechanisms need to comply with regulations and may therefore need to be adapted for particular frequency ranges.

For channel access mechanism, LTE-LAA LBT mechanism is adopted as baseline for 5GHz band and adopted as the starting point of the design for 6GHz band. At least for band where absence of Wi-Fi cannot be guaranteed (e.g. by regulation), LBT can be performed in units of 20 MHz.

For 5GHz band, having a 16 µs gap to accommodate for the transceiver turnaround before the immediate transmission of the responding node is beneficial for NR-U, such as for supporting fast A/N feedback, and is permitted per regulation. Restrictions/conditions on when this option can be used will be further identified, e.g., in consideration of fair coexistence.

A 16 µs gap to accommodate for the transceiver turnaround before the immediate transmission of the responding node can also be applied to 6GHz band if allowed by regulation, and restrictions/conditions on when this option can be used will be further identified, if fair coexistence criterion is defined for 6GHz band.

For CWS adjustment procedure in NR-U, in addition to aspects considered in LTE LAA, NR-U may additionally consider at least the following aspects: CBG based HARQ-ACK operation, NR scheduling and HARQ-feedback delays and processing times, wideband (>20 MHz) operation including BWPs, Configured grant operation.For initiation of a COT by the gNB (operating as an LBE device), the channel access schemes in Table 7.2.1.3.1-1 are used.

Table 7.2.1.3.1-1: Channel access schemes for initiating a COT by gNB as LBE device

	Cat 2 LBT	Cat 4 LBT
DRS alone or multiplexed with non-unicast data (e.g. OSI, paging, RAR)	When the DRS duty cycle ≤1/20, and the total duration is up to 1 ms: 25 µs Cat 2 LBT is used (as in LAA)	When DRS duty cycle is > 1/20, or total duration > 1 ms
DRS multiplexed with unicast data	N/A except for the cases discussed in the Note below	Channel access priority class is selected according to the multiplexed data
PDCCH and PDSCH	N/A except for the cases discussed in the Note below	Channel access priority class is selected according to the multiplexed data

Note: Applicability of an LBT scheme other than Cat 4 LBT for control messages related to initial/random access, mobility, paging, reference signals only, and PDCCH-only transmissions, e.g. "RACH message 4", handover command, GC-PDCCH, or short message paging transmitted either alone or when multiplexed with DRS have been discussed. Further details related to exceptions in this note can be determined when specifications are developed.

At least for the case where a DL burst follows a UL burst within a gNB-initiated COT and there is no gap larger than 25 µs between any two transmissions in the COT, the channel access schemes in Table 7.2.1.3.1-2 apply for the DL burst following a UL burst.

Table 7.2.1.3.1-2: Channel access schemes for a DL burst follows a UL burst within a gNB-initiated COT as LBE device

Cat 1 Immediate transmission	Cat 2 LBT
When the gap from the end of the scheduled UL transmission to the beginning of the DL burst is up to 16 µsec	When the gap from the end of the scheduled UL transmission to the beginning of the DL burst is larger than 16 µsec but not more than 25 µsec

Note: a DL burst is defined as a set of transmissions from a given gNB having no gaps or gaps of no more than 16 µs. Transmissions from a gNB having a gap of more than 16 µs are considered as separate DL bursts.

Within a gNB-initiated COT, an UL burst for a UE consisting of one or more of PUSCH, PUCCH, PRACH, and SRS follows the channel access schemes in Table 7.2.1.3.1-3.

Table 7.2.1.3.1-3: Channel access schemes for a UL burst within a gNB-initiated COT as LBE device

Cat 1 Immediate transmission	Cat 2 LBT	Cat 4 LBT
When the gap from the end of the DL transmission to the beginning of the UL burst is not more than 16 µsec. Note: Maximum limits of the duration of the UL burst other than those already derived from MCOT duration limits should be further discussed when specifications are developed.	For any of the following cases: - When the gap between any two successive scheduled/granted transmissions in the COT is not greater than 25 µsec - For the case where a UL transmission in the gNB initiated COT is not followed by a DL transmission in the same COT - Note: the duration from the start of the first transmission within the channel occupancy until the end of the last transmission in the same channel occupancy shall not exceed 20 ms.	N/A

Note: An UL burst is defined as a set of transmissions from a given UE having no gaps or gaps of no more than 16 µs. Transmissions from a UE having a gap of more than 16 µs are considered as separate UL bursts. The number of LBT attempts within a COT should be determined when specifications are developed.

For initiation of a COT by the UE, the channel access schemes in Table 7.2.1.3.1-4 are used.

Table 7.2.1.3.1-4: Channel access schemes for initiating a COT by UE as LBE device

	Cat 2 LBT	Cat 4 LBT
PUSCH (including at least UL-SCH with user plane data)	N/A except for the cases discussed in Note 2 below	Channel access priority class is selected according to the data
SRS-only	N/A	Cat4 with lowest channel access priority class value (as in LTE eLAA)
RACH-only	(see Note 2)	Cat4 with lowest channel access priority class value
PUCCH-only	(see Note 2)	Cat4 with lowest channel access priority class value

Note 1: If the COT includes multiple signals/channels with different channel access categories / priority classes, the highest channel access priority class value and highest channel access category among the channel access priority classes and channel access categories corresponding to the multiple signals/channels applies.

Note 2: Applicability of a channel access scheme other than Cat 4 for the following signals / channels have been discussed and details are to be determined when the specifications are developed:

- UL control information including UCI only on PUSCH, e.g. HARQ-ACK, Scheduling Request, and Channel State Information

- Random Access

For FBE mode of operation, gNB acquires COT with Cat2 immediately prior to the fixed frame period. Within the gNB acquired COT, if a gap is <= 16 μs, Cat 1 channel access scheme can be used by the gNB and associated UEs. Within the gNB acquired COT, if a gap is > 16 μs, Cat 2 channel access scheme should be used by the gNB and associated UEs. Note this channel access mechanisms are intended to be aligned with any regulations for FBE operation.

Means to reduce or mitigate the impact of interference e.g. from hidden nodes with UE assistance have been studied. Possible mechanisms include at least enhancements to L1 measurement and reporting of interference observed by a UE, and handshaking procedures between transmitter and the receiver. Further consideration is required regarding the detailed solutions and their benefits for mitigation of impact of interference on NR-U when the specifications are to be developed.

Means to facilitate spatial reuse, or frequency reuse 1 operation of NR-U have been studied. Possible mechanisms include at least: alignment of starting points for transmission (and consequently time instances for at least the last CCA); exchange and coordination of LBT related parameters amongst different NR-U gNBs or UEs; means to determine whether interference originates from other NR-U nodes; enhancements to L1 measurement and reporting of interference observed by a UE; and adjustment of energy/signal detection thresholds. Further consideration is required regarding the detailed solutions and their benefits for facilitating spatial reuse in NR-U when the specifications are to be developed, taking into account regulations.

Channel access mechanisms for beamformed transmissions have been studied. It has been identified that omni-directional LBT should be supported. Using directional LBT for beamformed transmissions, i.e. LBT performed in the direction of the transmitted beam has also been studied. Further consideration is required regarding directional LBT and its benefits for beamformed transmissions when the specifications are to be developed, taking into account regulations and fair co-existence with other technologies.

7.2.1.3.2 Initial access and mobility

For initial access and mobility procedures, the main issue identified for NR operation in unlicensed band is the reduced transmission opportunities for different signals and channels due to LBT failure.

The following modifications to initial access procedures have been identified as beneficial:

- Modifications to initial access procedures considering limitations on access to the channel based on LBT. NR-U needs to develop techniques to handle reduced SS/PBCH block and RMSI transmission opportunities due to LBT failure.

- Enhancement to 4-step RACH, including developing mechanisms to handle reduced msg 1/2/3/4 transmission opportunities due to LBT failure.

It is also identified that a 2-step RACH procedure potentially has benefit for channel access.

For SS/PBCH block transmission, it is recommended to define a mechanism to transmit SS/PBCH blocks dropped due to LBT failure. It is also recommended to define a mechanism when specifications are developed for UE(s) to determine the frame timing and QCL assumptions from the detected SS/PBCH block. The feasibility and benefits of beam repetition for soft combining reception of SSBs within the same DRS transmission may be further considered.

For SS/PBCH block transmissions as part of DRS, it is considered beneficial to expand the maximum number of candidate SS/PBCH block positions within the DRS transmission window to Y, for e.g., $Y \leq 64$, where the choice of Y may depend on the numerology of the SS/PBCH blocks. The transmitted SS/PBCH blocks do not overlap and the maximum number of transmitted SS/PBCH blocks is X within DRS transmission window with $X \leq 8$. The time-domain positions of the actually transmitted SS/PBCH blocks are selected from a set of Y candidate SS/PBCH block positions. Proposals for shift granularity between candidate time domain SSB positions/candidate groups of SSBs, duration of DRS transmission window, and duration of the transmitted DRS within the window including SSBs and other multiplexed signals/channels, were discussed without reaching consensus, and can be considered further when specifications are developed.

Modifications to paging procedures due to reduced transmission opportunities for paging due to LBT failure are beneficial and have been identified and studied. It is therefore considered beneficial to enhance paging opportunities using the following mechanism:

- Increased time-domain paging occasions or paging monitoring occasions.
    - This can enable additional paging occasions outside of DRS.

Note: Parts or all of the above enhancement may fall under the purview of higher-layer enhancements and may not require any further study from a L1 perspective

For potential RACH resource enhancements, the following options have been identified for NR-U, beyond the flexibility already available in Rel-15, but consensus was not achieved. These options may be further considered when specifications are developed:

- Frequency-domain enhancement: Multiple PRACH resources across multiple LBT sub-bands/carriers for both contention-free and contention-based RA
- Time-domain enhancements:
    - For connected mode UE, scheduling of PRACH resources via DCI.
        - Triggered PRACH within gNB acquired COT can use a new resource indicated by the DCI
    - For idle mode UE, scheduling of PRACH resources via paging
        - Note: potential inefficiency in network resource due to paging across multiple cells
    - Additional, new RACH resources are used immediately following detection of DRS transmission
    - Multiple PRACH transmissions before Msg2 reception in RAR window for initial access
        - Number of allowed transmissions is pre-defined or indicated, e.g., in RMSI
    - Group wise SSB-to-RO mapping by frequency first-time second manner, where grouping is in time domain

For msg1 transmission of 4-step RACH procedure, if preamble transmissions are dropped due to LBT failure, then from RAN1 perspective, it is recommended that preamble power ramping is not performed and that the preamble transmission counter is not incremented.

For msg 2 transmission in the 4-step RACH procedure, in some scenarios it is beneficial for the maximum RAR window size to be extended beyond 10 ms to improve robustness to DL LBT failure for RAR transmission. Other candidate mechanisms that were identified without reaching consensus include preconfigured/pre-indicated/scheduled multiple opportunities in time and/or frequency domain in different LBT subbands for message 2/3/4 transmissions and/or reducing the latency of the RACH procedure and can be considered further when specifications are to be developed.

Potential modifications to RLM/RRM procedures due to reduced transmission opportunities for DL signals and channels due to LBT failure have been identified and studied.

For RLM on an unlicensed SpCell and RRM, it is considered beneficial to configure DMTCs (DRS Measurement Time Configuration) in which UEs can perform measurements. It is considered beneficial that these time-domain measurement windows for RRM measurements and RLM can be different. RLM DMTC may coincide with DRS transmission window. For RLM, the following recommendations are considered beneficial for further design when the specifications are developed:

- Identifying a set of RLM-RS, e.g., DRS, SS/PBCH blocks, CSI-RS. The transmission of the RS in a COT may be subject to LBT.

- Identifying which set(s) of RLM-RS are used for in-sync and out-of-sync evaluations. For example, determining which RLM-RS within or outside the RLM measurement window can be utilized for in-sync and out-of-sync evaluations.

- Potential definition of a metric, e.g., Rel-15 out-of-sync indication or new metric, to accurately identify instances of unsuccessful detection of RLM-RS. Whether/how to report such a metric to higher layers is determined when the specifications are developed.

It is beneficial to support reporting of RSSI. Furthermore, it is considered beneficial to report a metric to represent channel occupancy or medium contention in addition to RSSI, as also noted from a higher-layer perspective in Section 7.2.2.3.1. The exact definition of the metric(s) can be considered when specifications are developed.

7.2.1.3.3 Potential HARQ enhancements

NR-U uses NR HARQ feedback mechanisms as baseline, and enhancements can be identified.

Transmission of HARQ A/N for the corresponding data in the same shared COT is identified as beneficial. For NR-U, the design strives to support transmitting all HARQ A/N for the corresponding data in the same shared COT, if possible, considering the current NR UE processing time required. A gap of up to 16 μs should be allowed between the end of the DL transmission and the immediate transmission of feedback to accommodate for the hardware turnaround time. It is beneficial to be able to support transmissions (e.g. CSI reporting or SRS, or other PUSCH, or CSI-RS, or other PDSCH) in the time between one DL data transmission for a UE and the corresponding UL transmission of DL HARQ feedback for the same UE within a shared COT. Potential enhancements for such type of operation, e.g. by possibly pre-configured or pre-determined uplink transmissions for reducing signaling overhead for these transmissions, may be beneficial.

However, it is understood in some cases, the HARQ A/N has to be transmitted in a separate COT from the one the corresponding data was transmitted. Introduce signaling a value of the PDSCH-to-HARQ-timing-indicator in the DCI scheduling the PDSCH that tells the UE that the timing and resource for HARQ-ACK feedback for the corresponding PDSCH will be determined later.

Techniques to handle reduced HARQ A/N transmission opportunities for a given HARQ process due to LBT failure are identified as beneficial. Potential techniques include mechanisms to provide multiple and/or supplemental time and/or frequency domain transmission opportunities.

When UL HARQ feedback is transmitted on unlicensed band, NR-U considers mechanisms to support flexible triggering and multiplexing of HARQ feedback for one or more DL HARQ processes

NR-U should support both the HARQ feedback corresponding to some or all the PDSCHs of a channel occupancy can be reported in the same channel occupancy and HARQ feedback corresponding to PDSCHs of a channel occupancy can be reported outside of that channel occupancy.

To support the HARQ feedback corresponding to some or all the PDSCHs of a channel occupancy to be reported in the same channel occupancy, it is found beneficial to extend the PDSCH-to-HARQ-timing to support indicating timings up to the end of the longest COT allowed by regulations. One or more of the following would be needed: Allow values larger than 15 by RRC signalling; Allow more bits for the PDSCH-to-HARQ-timing-indicator.

To support HARQ feedback corresponding to PDSCHs of a channel occupancy can be reported outside of that channel occupancy, the following possible candidate solutions can be considered:

- Alt1: gNB requests/triggers feedback for PDSCH from earlier COT(s)

- Alt2: UE is configured to report HARQ feedback for PDSCH from earlier COT(s) without an explicit request/trigger

- Alt3: by PDSCH-to-HARQ-timing-indicator in the DCI scheduling the PDSCH

The alternatives above are at least applicable for the case where there is no HARQ feedback expected in the same channel occupancy as the PDSCH.

Further details on potential solutions to allow cross-COT HARQ-ACK feedback and multiple opportunities for HARQ-ACK feedback are provided in Table 7.2.1.3.3-1.

Table 7.2.1.3.3-1: Possible alternatives to support multiple HARQ-ACK opportunities

	Cross-COT HARQ-ACK feedback	**Multiple opportunities for HARQ-ACK feedback**
Alt1: gNB requests/triggers feedback for PDSCH from earlier COT(s) or additional reporting of earlier HARQ feedback, where the exact HARQ feedback timing and resource is provided to the UE in another DCI (in the same or in another COT)	**Alt1a**: request/trigger reporting of HARQ feedback for earlier COT(s) or additional reporting of earlier HARQ feedback without explicit signaling of HARQ process ID, possibly along with other HARQ feedback reports (e.g. for the current COT) **Alt1b**: request/trigger reporting for a set of HARQ processes, either for all configured HARQ processes (e.g. group feedback), or for a set of HARQ process IDs or HARQ process ID groups	
Alt2: UE is configured/allowed to report HARQ feedback for PDSCH from earlier COT(s) without an explicit request/trigger	UE autonomously reports UCI with additional information about HARQ processes - e.g. corresponding to PDSCH from earlier COT(s) - that are reported in PUSCH [or PUCCH] along with the HARQ-ACK feedback.	
Alt3: gNB requests feedback outside the COT by PDSCH-to-HARQ-timing-indicator in the DCI scheduling the PDSCH	The UE will attempt reporting at the indicated time and resource (e.g. in a UE-initiated channel occupancy), even if the PDSCH-to-HARQ-timing-indicator indicates a slot that falls outside the gNB-initiated COT.	Not a solution if PDSCH-to-HARQ-timing-indicator can only indicate a single value
Alt4: preconfigured/pre-indicated multiple opportunities in frequency domain in different LBT subbands	Possible if this is combined with Alt1 or Alt2 or Alt3	Possible for indicating multiple candidate PUCCH or PUSCH carrying HARQ-ACK feedback
Alt5: preconfigured/pre-indicated multiple opportunities in time domain	The UE will attempt reporting at the preconfigured/pre-indicated times and resources (e.g. in a UE-initiated channel occupancy)	Alt5a: Multiple candidate opportunities by providing multiple timings in PDSCH-to-HARQ-timing-indicator and/or other DCI fields Alt5b: Multiple candidate slots in a window with size configured by RRC. There could be some activation/deactivation by DCI

A possible enhancement for dynamic HARQ codebook is to support a larger DAI field to accommodate for possibly missing more than 4 PDSCH transmissions, which is more likely to occur on unlicensed spectrum. Enhancements are necessary for aligning the dynamic HARQ codebook between UE and gNB. Alt. 1 in Table 7.2.1.3.3-1 allows triggering/requesting a report for missed or unreported HARQ-ACK feedback in case of LBT failure for PUCCH/PUSCH transmission, or in case of PUCCH/PUSCH detection failure at gNB, or in case of PDCCH detection failure at UE, or in case of HARQ-ACK feedback pending from earlier COT(s). Alt. 2 in the table allows reporting unreported HARQ-ACK feedback in case of LBT failure for PUCCH/PUSCH transmission, or in case of HARQ-ACK feedback pending from earlier COT(s).

Scheduling multiple TTIs for PUSCH each using a separate UL grant in the same PDCCH monitoring occasion is identified as beneficial. Scheduling multiple TTIs for PUSCH, i.e., scheduling multiple TBs with different HARQ process IDs over multiple slots, using a single UL grant, is identified as beneficial and should be supported in NR-U.

In case of CBG-based HARQ and LBT category 4, enhancements for defining how to adjust the contention window size (CWS) based on TB-level HARQ-ACK and CBG-level HARQ-ACK would be beneficial.

7.2.1.3.4 Potential enhancements to configured grant

NR already defined Type-1 and Type-2 configured grant mechanism. For NR-U, there is no necessity to exclude Type-1 or Type-2 configured grant mechanism for operation of NR in unlicensed spectrum.

The following modifications to the configured grant procedures are beneficial.

- Removing dependencies of HARQ process information to the timing. This can be achieved by introducing UCI on PUSCH to carry HARQ process ID, NDI, RVID
  - Additional information fields can be considered to be included in the UCI, e.g. UE-ID, COT sharing information, PUSCH duration, etc.
  - It was identified that the resources utilized by the UCI, and multiplexing of UCI and data information of PUSCH require consideration of DMRS placement and starting and ending symbols of the configured grant based transmissions. Details on multiplexing UCI and data information of configured grant PUSCH can be determined when specifications are developed.
- Introducing Downlink Feedback Information (DFI) including HARQ feedback for configured grant transmission
- Increased flexibility on time domain resource allocation for the configured grant transmissions
- As for potential solutions to providing flexibility on time domain resource allocation, bitmap based approach and NR Rel-15 based time domain resource allocation approach, which includes {periodicity, offset in the frame, start symbol and length of PUSCH and K-repetition signaling}, are identified as potential candidates. Additional aspects such as finer granularity of resource allocation, and multiple resources within a period may be considered for enhancing flexibility on time domain resource allocation.- Supporting retransmissions without explicit UL grant

Allowing consecutive configured grant resources in time without any gaps in between the resources and non-consecutive configured grant resources (not necessarily periodic) with gaps in between the resources is beneficial and should be considered for NR in unlicensed spectrum

UE selects the HARQ process ID from an RRC configured set of HARQ IDs for NR-unlicensed configured grant transmission.

It is identified to be beneficial to support DFI to include pending HARQ ACK feedback for prior configured grant transmissions from the same UE.

It was identified that it is problematic for the UE to assume ACK in absence of reception of feedback, which may include explicit feedback or feedback in the form of uplink grants. It was additionally identified that assuming NACK upon timer expiration can be a candidate solution to avoid LBT impact on reception of feedback. It was also identified that possible conflicts, with respect to NDI and RNTI for the same HARQ process, between configured grant transmission and scheduled grant transmission may have to be addressed. Details can be determined when specifications are developed.

For the retransmission of a HARQ process that was initially transmitted via configured grant resource, both retransmission via same configured grant resource and retransmission via resource scheduled by UL grant are supported.

UE may autonomously initiate retransmission for a HARQ process that was initially transmitted via configured grant mechanism for NR-unlicensed when it receives NACK feedback via DFI for the corresponding HARQ process.

It is identified to be beneficial to consider UE multiplexing and collision avoidance mechanisms between configured grant transmissions and between configured grant and scheduled grant transmissions.

NR-unlicensed configured grant transmission is not allowed during the time when it overlaps with occasions configured for potential NR-U DRS of the serving cell irrespective of the configured time domain resource for configured grant transmission.

It was identified that CBG based retransmissions for configured grant based transmissions is beneficial. Details on which CBG related control information is transmitted as part of DFI and UCI, and how such control information is conveyed through DFI and UCI can be determined when specifications are developed.

It was identified that collision avoidance between configured grant and scheduled grant based transmission can be achieved by management of starting point of the transmission for configured grant and scheduled grant based transmission. Further details on the management of the starting point of the transmission can be determined when specifications are developed.

It was identified that sharing resources with gNB within COT(s) that is acquired by UE(s) as part of configured grant based transmissions should be supported. It was also identified that allowing configured grant based transmissions within a gNB acquired COT should be supported. Details of identification of situations when COT(s) sharing is possible and the details of potential resource sharing mechanisms and rules can be determined when specifications are developed.

7.2.2 Higher layer aspects

7.2.2.1 Inactive and Idle procedures (38.304 related)

For Inactive and Idle mode procedures, Rel-15 NR design is considered as the baseline. As such, NR licensed measurement framework (cell and beam quality derivation for RSRP, RSRQ, and SINR, filtering and combining multiple beams) is also used as the baseline.

The UE measurements in Idle/Inactive mode will assume recurring transmissions of SSB/PBCH and RMSI but possibly with reduced opportunities due to LBT. The impact of LBT on Idle/Inactive measurement is not captured in RAN2 specifications.

In unlicensed bands, multiple PLMNs can use the same carriers without any coordination. Therefore, the best cell found by a UE on a frequency may not belong the registered PLMN. In this case, the UE should be enabled to camp on a non-best cell on a carrier if the best cell does not belong to the registered PLMN (or E-PLMN), where the non-best cell would still be the best cell of the registered PLMN.

For paging, it may be beneficial to introduce more opportunities per DRX cycle for the UE to receive the page. The additional locations can be provided in time domain by configuring an extended paging occasion (i.e. a paging window) or configuring multiple paging occasions to a UE. In any specified solution(s) based on additional paging opportunities, the UE power consumption should also be taken into account; to this end, it is beneficial that the paging occasions are transmitted in close time to or overlap with the reference signals.

7.2.2.2 L2 impacts

7.2.2.2.1 RACH (4-step, 2-step)

Both 4-step and 2-step RACH will be supported for NR-U. Here 2-step RACH refers to the procedure which can complete contention-based RACH (CBRA) in two steps as explained below. One additional benefit of 2-step RACH is due to less LBT impact with the reduced number of messages. However, in order to alleviate the impact of LBT failures further, additional opportunities for the RACH messages may be introduced, e.g. in time or frequency domain, for both 4-step and 2-step RACH. The additional opportunities for 4-step RACH will be applicable to both msg1 and msg3.

NR-U will support contention-free RACH (CFRA) and CBRA for both 2-step and 4-step RACH. On SCells, CFRA is supported as a baseline while both CBRA and CFRA are supported on SpCells.

For 4-step RACH, the messages in time order are named as msg1, msg2, msg3, msg4 and for 2-step RACH, they are named msgA and msgB.

A single RACH procedure i will be used and thus multiple RACH procedures in parallel will not be supported for NR-U.As a baseline, the random-access response to msg1 will be on SpCell and msg3 is assumed to use a predetermined HARQ ID.

In legacy RACH, the counters for preamble transmission and power ramping are increased with every attempt. In NR-U, power ramping is not applied when preamble is not transmitted due to LBT failure. This will require an indication from the physical layer to the MAC. In addition, ra-ResponseWindow is not started when the preamble is not transmitted due to LBT failure.

It is assumed that ra-ContentionResolutionTimer may need to be extended with larger values to overcome the LBT impact.

For 2-step RACH, the msgA is a signal to detect the UE and a payload while the second message is for contention resolution for CBRA with a possible payload. msgA will at least include the equivalent information which is transmitted in msg3 for 4-step RACH.

NOTE: Further input from RAN1 will be needed for the payload size of msgA.

As a baseline, all the triggers for 4-step RACH are also applicable to 2-step RACH; however further analysis is needed on SI request and BFR as well as how timing advance and grants can be obtained for msgA.

The contention resolution in 2-step RACH will be performed by including a UE identifier in the first message which is echoed in the second message. The type of UE identifier(s) is FFS.

Fall-back from 2-step RACH to 4-step RACH will be supported. The fallback after msgA transmission is feasible only if detection of the UE without the decoding of the payload is possible and thus relies on such support at the physical layer.

If 2-step RACH is used for initial access, the parameters for 2-step RACH procedure including resources for msgA will be broadcasted.

NOTE: 2-step RACH if applied to licensed operation would not take into account LBT.

7.2.2.2.2 MAC (except RACH)

For scheduling request (SR), a prohibit timer as in NR licensed can be used. However, this should not prevent the UE from attempting to transmit an SR again if the triggered SR was not transmitted due to LBT failure.

7.2.2.2.3 Other

For channel access and transmissions in NR-U the mechanisms and associated signaling adopted by LTE LAA (e.g. standardized QCI to access priority mapping for DL and UL, how access priority per logical channel is determined for scheduled UL and AUL transmissions etc) are used as the baseline. Any changes due to new physical layer design and channel access mechanisms for NR-U (e.g. introduction of PRACH, support of FBE) can also be introduced.

In addition, access priority for control signaling (transmissions over SRBs) over unlicensed carriers should be introduced for stand-alone and DC NR-U. In this case, it is assumed that control signaling will have the highest access priority.

7.2.2.3 Control plane impacts

7.2.2.3.1 RLM/RLF and mobility (conn mode)

For non-standalone NR-U deployments, connected mode mobility is supported on licensed spectrum using the baseline mobility procedure specified for the concerned licensed radio access technology (LTE or NR).

For standalone NR-U deployments, the following mobility scenarios shall be supported:

- Inter-cell handover between NR-U and NR-U;
- Inter-cell handover between NR-U and NR.

In addition, the following mobility scenarios shall be supported based on the mobility between NR-U and NR and and the mobility between NR and (e)LTE, however further optimizations to this scenarios will be considered possibly with lower priority:

- Inter-RAT handover between NR-U and LTE connected to EPC;
- Inter-RAT handover between NR-U and LTE connected to 5GC.

For connected mode mobility, the main issue identified for NR operation in unlicensed band is the reduced transmission opportunities for different signalings due to LBT failure.

The following modifications to mobility-related procedures have been identified as beneficial to study:

- Modifications to mobility-related measurements considering limitations to the transmission of reference signals due to LBT. NR-U needs to consider techniques to handle reduced RS (e.g. SS/PBCH block and CSI-RS) transmission opportunities due to LBT failure.
- Modifications to mobility-related measurements and/or triggers considering limitations related to high channel occupancy. NR-U needs to consider techniques to handle increased interference levels in the unlicensed channel for mobility-related decisions.
- Modifications to mobility-related procedures and/or triggers considering limitations related to the transmission of control plane signalling due to LBT. NR-U needs to consider whether NR-U specific techniques to handle additional signaling delays due to LBT failure are required, if not resolved by general mobility enhancement solutions [RP-181433].

Potential modifications to the measurement reporting quantities, to the measurement reporting triggers and to the condition used by the UE when delaying the time at which it applies a reconfiguration for mobility that are based at least on channel occupancy and RSSI should be studied.

For RRM, RLM, and mobility procedures, NR licensed specification in Rel-15 are considered as a baseline for NR-U. However, changes to these due to new physical layer design and LBT for the unlicensed operation can be introduced. These will support both synchronous and, except for LAA case, asynchronous deployments.

The RRM and RLM framework for NR-U will also support multiple beam operation. The measurement of multiple beams in NR-U will use the framework in TS 38.300 Section 9.2.4 as a baseline and the measurement model captured in Figure 9.2.4-1 is also applicable for NR-U.

For UE measurements, it is assumed that recurring transmissions of SSB/PBCH and RMSI will be available with possibly reduced opportunities due to LBT. The NR licensed measurement framework (cell and beam quality derivation for RSRP, RSRQ, and SINR, filtering and combining multiple beams) is used as a baseline. The handling of missing measurements due to LBT are expected to be captured at physical layer specifications.

In addition to the existing measurement quantities, channel occupancy and RSSI, similar to adopted for LTE LAA, are considered useful.

In unlicensed spectrum, multiple PLMNs from different operators can share the same channel and coordination between different operators may not happen. This may cause PCI collisions or confusion. As one possible solution, the gNBs can scan different frequencies to identify the PCIs of neighbour cells and use this information in setting the PCIs of their own cells in order to avoid PCI collisions. In addition, ANR can be used, as in NR licensed, to detect and solve PCI collision and confusion.

7.2.2.3.2 Other

Since System Information (SI) transmissions will be subject to LBT, it is beneficial to add more transmission opportunities in time domain for SI transmission, e.g. by configuring a longer SI window.

If there is need to have multiple SI messages then with existing NR design, different SI messages require separate LBT procedures. It may be beneficial not to require multiple LBTs for different SI messages to increase the success probability of the transmission.

In response to a RAN2 LS requesting study of system level aspects of NR-U, SA2 has discussed this topic and concluded as follows:

- Based on SA2 analysis, only system impact identified specifically for NR-U is the need for introducing RAT type for NR-U, if desired, for "subscription based access restriction", policy and charging purpose.

- If a non-public network operator wants to leverage NR-U, Network Identification & Network selection aspects for operators with no globally unique PLMN ID are already being addressed within FS_Vertical_LAN study ongoing in SA2. Thus NR-U is not resulting in additional system impacts work.

- The same impact identified for 5GS applies also for EPS. SA2 understanding is that for NR-U in EPS it is only for NR-U as secondary RAT (ENDC case) following similar approach in terms of subscription based access restriction, policy and charging as LAA/LWA. As such, similar solution can be adopted as the one that already exists in EPS.

Based on the SA2 analysis and response, there is no impact to RAN for the possible changes to 5GS and EPS for NR-U. The support for "subscription based access restriction", policy and charging is contained to CN signalling and the support for non-public operator network identification will not result in additional work specific to NR-U.

8 Performance evaluations

For performance evaluation, coexistence with other networks will be evaluation, such as Wi-Fi, LTE-LAA, or other NR-U network.

When coexistence with Wi-Fi is evaluated, following the study item description [2], NR-based operation in unlicensed spectrum should not impact deployed Wi-Fi services (data, video and voice services) more than an additional Wi-Fi network on the same carrier, where the deployed Wi-Fi includes 11ac in 5GHz band.

For sub-7 GHz bands other than 5GHz band, though it is not in the scope of this study to define a fairness criterion with other RATs, a fairness criterion for coexistence has been discussed but no conclusions were reached. Coexistence simulations with other RATs have been performed using technology neutral assumptions (eg. channel access mechanism) at an arbitrary carrier frequency in 5GHz band for application to bands other than 5GHz which may become available subject to regulations. The study assumes regulation will provide the framework concerning the protection for the technologies not using unlicensed access in those bands. For this coexistence evaluation, as the regulations on channel access is not yet available, companies have provided description on the assumptions used for technology neutral channel access mechanism when providing simulation results.

8.1 Scenarios and methodology

For the NR-U study evaluation, to reuse the simulation platform already developed for NR study, the 5GCM in [29] is used for NR-U simulation evaluation. The evaluation deployment scenarios are derived from NR evaluation deployment scenarios as defined in [28] with proper modifications to introduce the second operator. For coexistence evaluations below 7GHz, for parameters not provided in this section, the evaluations assumptions specified for LTE (e)LAA coexistence evaluations [31] apply. The base metrics for NR-U evaluation are the same as in LTE-LAA in [31].

NR-U simulation evaluation considers the following layout scenarios:

- Indoor sub-7GHz, 2 operators
- Outdoor Sub-7 GHz, 2 operators
- Stadium scenario for sub-7GHz, 2 operators, can be optionally considered by interested companies.

The following deployment scenarios for simulation are identified:

- CA between NR licensed cell and NR unlicensed cell
- DC (with LTE and with NR)
- SA
- An NR cell with DL in unlicensed band and UL in licensed band

In the simulations, only unlicensed cell(s) is to be simulated. The licensed cell may not be explicitly modelled in the simulation. Necessary assumptions regarding the presence of the licensed carriers can be made and provided.

It was also noted that a single set of evaluations may be applicable to multiple deployment scenarios. For example, DC and SA deployment scenarios can share the same set of simulations, possibly with some minor differences on how the overhead (say for system information delivery) is captured in the result.

8.1.1 Sub7 GHz indoor scenario

For sub7 GHz indoor simulation evaluation, two operators each with 3 gNBs are deployed in a room of size 120 meters by 80 meters as shown in Figure 1. In the figure, the gNB of the same color belongs to the same operator. The parameters are of value a=20 meters, b=40 meters, c=20 meters, and d=40 meters. The deployment scenario is selected to achieve a target serving link RSSI distribution with 10%-15% serving link below -72dBm.

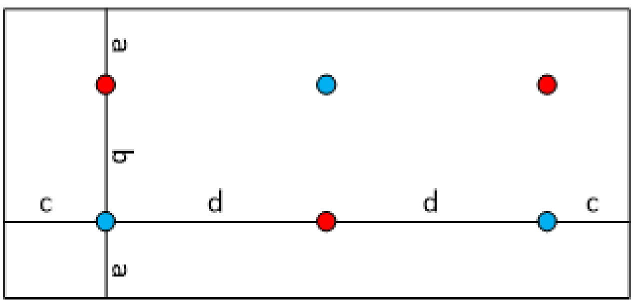


Figure 1: Indoor sub7 simulation office layout

Additional evaluation parameters are provided in Annex A.1.1.

8.1.2 Sub7GHz outdoor scenario

For sub 7 GHz outdoor simulation evaluation, two scenarios are considered. The two scenarios differ in the inter-gNB distance within the same macro cell.

- Scenario 1: Within each macro cell coverage, two operators each drop one micro gNB with a maximum distance of 30 meters between the gNBs
- Scenario 2: Within each macro cell coverage, two operators each drop one micro gNB with no limitation on the inter-gNB distance.

The layout of the gNBs are defined as follows:

- Macro deployment with ISD=200×A meters
  - A=1.0 for scenario 1
- A=1.5 for scenario 2- Each operator randomly drops 1 micro-layer TRP within each macro cell sector with minimum distance between micro-layer TRPs equals 57.9×A meters
- Independent dropping between two operators
  - Use 10 meters as the inter-operator micro-layer TRP minimum distance
  - For the inter-operator micro-layer TRP maximum distance
    - Outdoor scenario 1: 30
    - Outdoor scenario 2: No limit as long as the TRP is within the macro cell

The layout of UEs are defined as follows:

- UE randomly dropped within macro cell sector with a minimum serving cell RSSI of -82dBm
- All UEs dropped outdoor

Additional evaluation parameters are provided in Annex A.1.2.

8.2 Channel access schemes

The channel access schemes for NR-based access for unlicensed spectrum can be classified into the following categories:

- *Category 1: Immediate transmission after a short switching gap*
  - This is used for a transmitter to immediately transmit after a switching gap inside a COT.
  - The switching gap from reception to transmission is to accommodate the transceiver turnaround time and is no longer than 16 µs.
- *Category 2: LBT without random back-off*
  - The duration of time that the channel is sensed to be idle before the transmitting entity transmits is deterministic.
- *Category 3: LBT with random back-off with a contention window of fixed size*
  - The LBT procedure has the following procedure as one of its components. The transmitting entity draws a random number N within a contention window. The size of the contention window is specified by the minimum and maximum value of N. The size of the contention window is fixed. The random number N is used in the LBT procedure to determine the duration of time that the channel is sensed to be idle before the transmitting entity transmits on the channel.
- *Category 4: LBT with random back-off with a contention window of variable size*

- The LBT procedure has the following as one of its components. The transmitting entity draws a random number N within a contention window. The size of contention window is specified by the minimum and maximum value of N. The transmitting entity can vary the size of the contention window when drawing the random number N. The random number N is used in the LBT procedure to determine the duration of time that the channel is sensed to be idle before the transmitting entity transmits on the channel.

For different transmissions in a COT and different channels/signals to be transmitted, different categories of channel access schemes can be used.

8.3 Evaluation results

For coexistence evaluation, WiFi+WiFi, WiFi+NR-U and NR-U+NR-U evaluations are baseline with equal priority.

When submitting coexistence evaluation results, the following information should be reported

- The COT assumptions of Wi-Fi and NR-U
- Is RTS/CTS enabled for Wi-Fi
- PD/ED threshold assumptions
- Max modulation order supported in each technology
- MIMO scheme and number of MIMO layers used for both technologies
- Wi-Fi MAC layer A-MPDU/A-MSDU aggregation level, MPDU size
- NR-U SCS,
- Wi-Fi guard interval
- NR UE processing time capability (#1 or #2)
- NR PDSCH/PUSCH mapping type, PDCCH monitoring configuration
- Link adaptation assumptions
- NR assumption on self scheduling or using cross carrier scheduling

Evaluation results are included in Annex B.

8.3.1 Coexistence evaluation results for 5GHz

Key findings of the evaluation results in Annex B.1 for 5GHz band are discussed in this section. The single carrier scenario with stand-alone deployment and LAA deployment for NR-U were both evaluated.

8.3.1.1 Detailed findings for indoor scenarios

Key findings from Tables in Annex B.1, which captured the results for an indoor deployment with one shared unlicensed carrier and FTP traffic are summarized below.

- Nine sources evaluated NR-U with a category 4 LBT scheme with CCA-ED threshold of -72dBm for NR-U.
    - Five sources evaluated licensed assisted access scheme.
        - One source provided results for two subcarrier spacing settings and reported an improvement in all measured metrics for the non-replaced Wi-Fi operator.
        - Two sources reported an improvement in all measured metrics for the non-replaced Wi-Fi operator while one source reported an improvement in 44 of the 48 metrics for the non-replaced Wi-Fi operator.
        - One source also provided results for DL only traffic and UL only traffic on the unlicensed carrier and reported an improvement in all measured metrics for the non-replaced Wi-Fi operator.

    - One source also provided results with mixed traffic for Wi-Fi operator and reported an improvement in all measured metrics for the non-replaced Wi-Fi operator. The source also reported improvement in VoIP performance for the non-replaced Wi-Fi operator.

    - One source also provided results comparing coexistence performance for three cases, NR-U node using CCA-ED threshold of -72, -82 and third case where NR-U node enables Wi-Fi preamble detection and reported that all 3 schemes co-exist fairly with Wi-Fi and that using ED threshold of -82dBm provides better coexistence performance for both NR-U and Wi-Fi nodes than enabling Wi-Fi preamble detection.

    - One source provided results for mixed traffic with two LBT modes (category 1 immediate transmission and category 2) for scheduled UL in gNB acquired COT. The source provided results only for high buffer occupancy and reported a degradation in most metrics for the non-replaced Wi-Fi operator for both cases. The source also provided results with Wi-Fi preamble detection enabled a the NR-U node and reported an improvement in 15 out of the16 metrics (only high buffer occupancy metrics) for the non-replaced Wi-Fi operator. The source reported a degradation in VoIP performance for the non-replaced Wi-Fi operator for all three cases.

- Four sources evaluated for a stand-alone NR-U deployment on an unlicensed carrier.

    - One source reported an improvement in 47 of the 48 measured metrics for the non-replaced Wi-Fi operator with a maximum degradation under 5%.

    - One source reported an improvement in 35 of the 48 measured metrics for the non-replaced Wi-Fi operator.

    - One source provided results with RTS/CTS enabled for Wi-Fi operator, DRS modelled with DRS using category 2 LBT for channel access in the DMTC window for the NR-U operator and reported an improvement in 40 of the 48 measured metrics for the non-replaced Wi-Fi operator with a maximum degradation under 10%. The source also provided results for the case where HARQ-ACK feedback is sent within a gap of 16us after the end of DL transmission and showed improvements in the coexistence performance compared to the case where the HARQ-ACK feedback is sent at a gap of 24us after the end of DL transmission using category 2 LBT.

    - One source provided results with RTS/CTS enabled, DRS modelled with DRS using category 2 LBT for channel access in the DMTC window, and with multiple switching points with switching gaps no longer than 16 µs in the COT used for control information transmission and reported an improvement in all of the measured metrics for the non-replaced Wi-Fi operator. The source also provided results with RTS/CTS enabled and DRS modelling enabled for a second COT structure that utilized a preparation stage for fast CSI exchange and reported an improvement in all of the measured metrics for the non-replaced Wi-Fi operator.

    - One source also provided results comparing NRU-WiFi coexistence performance for two cases, NR-U node using CCA-ED threshold of -77, and second case where NR-U node enables Wi-Fi preamble detection and reported that enabling Wi-Fi preamble detection degrades the coexistence performance as compared to using ED threshold of -77dBm

    - One source also provided results comparing NRU-NRU coexistence performance for two cases, NR-U node using CCA-ED threshold of -72, and second case where NR-U node enables Wi-Fi preamble detection and reported that enabling Wi-Fi preamble detection degrades the coexistence performance as compared to using ED threshold of -72dBm.

    - One source provided results with DRS with transmit duration of 1ms using category 2 LBT for channel access in the 6ms DRS transmission window for the NR-U operator and reported an improvement in 47 of the 48 measured metrics for the non-replaced Wi-Fi operator.

    - One source provided results for the case where NR-U follows COT sharing procedure as permitted by EN 301 893 (category 1 LBT for gaps <=16us, for gap of above 16us but does not exceed 25us, and gaps that exceed 25us category LBT is used) and showed improvement in all measured metrics and in VoIP performance for the non-replaced Wi-Fi operator.

    - One source provided results where it is assumed that 20% of the UL transmissions are UL RACH transmissions with category 2 LBT and reported an improvement in 47 of the 48 measured metrics for the non-replaced Wi-Fi operator.

8.3.1.2 Detailed findings for outdoor scenario 1

Key findings from Tables in Annex B.2, which captured the results for an outdoor deployment scenario 1 with one shared unlicensed carrier and FTP traffic are summarized below.

- Three sources evaluated NR-U with a category 4 LBT scheme with CCA-ED threshold of -72dBm for a stand-alone NR-U deployment on an unlicensed carrier.
  - One source provided results with RTS/CTS enabled, DRS modelled with DRS using category 2 LBT for channel access in the DMTC window, and with multiple switching points with switching gaps no longer than 16 µs in the COT used for control information transmission and reported an improvement in all of the measured metrics for the non-replaced Wi-Fi operator. The source also provided results with RTS/CTS enabled and DRS modelling enabled for a second COT structure that utilized a preparation stage for fast CSI exchange and reported an improvement in 45 of the 48 measured metrics for the non-replaced Wi-Fi operator.
  - One source reported an improvement in 45 of the 48 measured metrics for the non-replaced Wi-Fi operator.
  - One source reported an improvement in 47 of the 48 measured metrics for the non-replaced Wi-Fi operator with a maximum degradation under 0.3%.
  - One source also provided results comparing NRU-WiFi coexistence performance for two cases, NR-U node using CCA-ED threshold of -72, and second case where NR-U node enables Wi-Fi preamble detection and reported that enabling Wi-Fi preamble detection degrades the coexistence performance as compared to using ED threshold of -72dBm.
  - One source also provided results comparing NRU-NRU coexistence performance for two cases, NR-U node using CCA-ED threshold of -72, and second case where NR-U node enables Wi-Fi preamble detection and reported that enabling Wi-Fi preamble detection degrades the coexistence performance as compared to using ED threshold of -72dBm
- Two sources evaluated NR-U with a category 4 LBT scheme with CCA-ED threshold of -72dBm for an LAA NR-U deployment on an unlicensed carrier.
  - One source provided results for two subcarrier spacing settings and reported an improvement in all measured metrics for the non-replaced Wi-Fi operator.
  - One source provided coexistence results when both Wi-Fi and NR-U have DL only traffic. The source reported an improvement in 23 of the 24 metrics for the non-replaced Wi-Fi operator, with the maximum degradation under 5%.

8.3.1.3 Detailed findings for outdoor scenario 2

Key findings from Tables in Annex B.3 which captured the results for an outdoor deployment scenario 2 with one shared unlicensed carrier and FTP traffic are summarized below.

- Three sources evaluated NR-U with a category 4 LBT scheme with CCA-ED threshold of -72dBm for a stand-alone NR-U deployment on an unlicensed carrier.
  - One source reported an improvement in all measured metrics for the non-replaced Wi-Fi operator.
  - One source reported an improvement in 47 of the 48 measured metrics for the non-replaced Wi-Fi operator with a maximum degradation under 3%.
  - One source provided results with RTS/CTS enabled, DRS modelled with DRS using category 2 LBT for channel access in the DMTC window, and with multiple switching points with gaps no longer than 16 µs in the COT used for control information transmission and reported an improvement in all of the measured metrics for the non-replaced Wi-Fi operator. The source also provided results with RTS/CTS enabled and DRS modelling enabled for a second COT structure that utilized a preparation stage for fast CSI exchange and reported an improvement in all of the measured metrics for the non-replaced Wi-Fi operator.
- Two sources evaluated NR-U with a category 4 LBT scheme with CCA-ED threshold of -72dBm for an LAA NR-U deployment on an unlicensed carrier.

- One source provided results for two subcarrier spacing settings and reported an improvement in all measured metrics for the non-replaced Wi-Fi operator.

- One source provided coexistence results when both Wi-Fi and NR-U have DL only traffic. The source reported an improvement in 22 of the 24 metrics for the non-replaced Wi-Fi operator, with the maximum degradation under 5%.

8.3.1.4 Summary of observations

In all evaluation results submitted, category 4 LBT with -72 dBm ED threshold was the primary scheme used in the evaluations for obtaining the COT. In all simulation when a Wi-Fi preamble was used, a fixed CCA-PD threshold of -82dBm was assumed. Other LBT schemes used in the evaluations include immediate transmission for switching of transmission direction with switching gap < 16us and category 2 LBT for switching of transmission direction with gap > 16us, for scheduled UL in gNB acquired COT, for DRS transmission, and for PRACH transmission. Companies evaluated the three agreed scenarios defined in Section 8.1. The parameters listed in Section 8.3 were left for companies to choose, and are provided together with the evaluation results in Annex B.

Eight out of nine sources showed combinations of DL and UL LBT schemes for NR-U with CCA-ED of -72dBm and no CCA-PD do not impact Wi-Fi more than another Wi-Fi network in any of the measured performance metrics in all three evaluated scenarios. One of nine sources indicated degradation of Wi-Fi performance when coexist with NR-U in some scenarios (Section 8.3.1.1).

Three sources submitted results with NR-U transmitting and receiving Wi-Fi 802.11a preamble and showed combinations of DL and UL LBT schemes for NR-U with CCA-ED of -62dBm and CCA-PD of -82dBm do not impact Wi-Fi more than another Wi-Fi network in any of the measured performance metrics in all evaluated scenarios.

Three sources submitted results with NR-U transmitting and receiving Wi-Fi 802.11a preamble. For indoor scenario, two sources indicated fair coexistence with mostly improved performance for both Wi-Fi and NR-U when NR-U with CCA-ED of -62dBm and CCA-PD of -82dBm compared with NR-U with CCA-ED of -72dBm and no Wi-Fi 802.11a preamble. For outdoor scenario 1, one source indicated fair coexistence with mostly degraded performance for both Wi-Fi and NR-U when NR-U with CCA-ED of -62dBm and CCA-PD of -82dBm compared with NR-U with CCA-ED of -72dBm and no Wi-Fi 802.11a preamble.

Two sources submitted results for indoor scenario and one source submitted results for outdoor scenario 1 with NR-U transmitting and receiving Wi-Fi 802.11a preamble for NR-U and NR-U coexistence in the absence of Wi-Fi, and showed combinations of DL and UL LBT schemes for NR-U with CCA-ED of -62dBm and CCA-PD of -82dBm degrades NR-U performance compared with NR-U with CCA-ED of -72dBm and no Wi-Fi 802.11a preamble.

Two sources submitted results for indoor scenario with NR-U with CCA-ED reduced below -72dBm for all NR-U devices. The sources indicated fair coexistence with mostly improved performance for both Wi-Fi and NR-U when NR-U with CCA-ED reduced below -72dBm compared with NR-U with CCA-ED of -62dBm and CCA-PD of -82dBm Wi-Fi 802.11a preamble.

For the case where an NR-U network coexists with an 802.11ac network in the indoor scenario and a NR-U DL/UL switching gap less than 16 μs, and NR-U UL data transmission after the gap with Category 1 channel access without any additional restrictions on duration other than the MCOT limits, one source has shown that there is a degradation to the throughput and VoIP outage performance of 802.11ac, while another source has shown that the throughput and VoIP outage performance of 802.11ac improves, when compared to the case where two 802.11ac networks coexist.

8.3.2 Coexistence evaluation results for 6GHz

Key findings of the evaluation results in Annex B.1 for 6GHz band are discussed in this section. Due to its greenfield nature, coexistence evaluations were performed using technology neutral assumptions (eg. channel access mechanism) and the companies provided simulation results along with their assumptions on technology neutral channel access schemes and coexistence performance metrics.

8.3.2.1 Detailed findings for indoor scenarios

Key findings from Tables in Annex B.1 which captured the results for an indoor deployment with one shared unlicensed carrier and FTP traffic are summarized below.

- Two sources provided evaluation results for a stand-alone NR-U deployment on an unlicensed carrier specifically for 6GHz.

  - One source provided results of Wi-Fi operator with RTS/CTS disabled using CCA-ED of -72dBm and PD of -82dBm and reported an improvement in 37 of the 48 metrics (agreed to be used for the 5GHz bands) for the non-replaced Wi-Fi operator with the maximum degradation being < 4% compared to the case where the Wi-Fi operator was using CCA-ED of -62dBm and PD of -82dBm. In both these cases, all reported metrics for the non-replaced Wi-Fi operator are better with NR-U network as neighbour than Wi-Fi network as neighbour.
  - One source also provided results comparing NRU-WiFi coexistence performance for two cases: (Case 1) Wi-Fi node using CCA-ED threshold of -72 and PD of -82dBm; and NR-U node using CCA-ED threshold of -72 dBm, and (Case 2) Wi-Fi node using CCA-ED threshold of -62 and PD of -82dBm; and NR-U node using CCA-ED threshold of -72 dBm and reported that Case 1 provides better coexistence performance than Case 2 for both NRU and Wi-Fi nodes.
- One source provided evaluation results for a non-stand-alone NR-U deployment on an unlicensed carrier specifically for 6GHz.
  - One source provided results for CCA-ED threshold varying between -62dBm to -82dBm for case when Wi-Fi operator uses the same CCA-ED and CCA-PD threshold and the NR-U operator uses the same CCA-ED threshold as the Wi-Fi operator and observed that the higher ED threshold of -62dBm provides the best performance. The results showed that Wi-Fi operator using CCA-ED -72 dBm and CCA-PD of -72 dBm gives better Wi-Fi UPT performance than Wi-Fi using CCA-ED -62 dBm and CCA-PD of -82 dBm for the Wi-Fi operator, while NR-U operator uses CCA-ED -72 dBm. The results showed that Wi-Fi operator using CCA-ED -72 dBm and CCA-PD of -72 dBm while NR-U operator uses CCA-ED -72 dBm gives better Wi-Fi UPT performance than Wi-Fi using CCA-ED -82 dBm and CCA-PD of -82 dBm for the Wi-Fi operator while NR-U operator uses CCA-ED -82 dBm. The results showed that Wi-Fi operator using CCA-ED -72 dBm and CCA-PD of -72 dBm gives better Wi-Fi UPT performance than Wi-Fi using CCA-ED -62 dBm and CCA-PD of -82 dBm for the Wi-Fi operator, while NR-U operator uses CCA-ED of -62dBm and CCA-NRU-PD of -82dBm. The results showed that Wi-Fi operator using CCA-PD of -82dBm and CCA-ED of -62dBm while NRU operator using CCA-ED of -62dBm gives better UPT performance for both Wi-Fi and NRU operator than Wi-Fi operator using CCA-PD of -82dBm and CCA-ED of -72dBm while NRU operator using CCA-ED of -72dBm. In all these cases, all reported metrics for the non-replaced Wi-Fi operator are better with NR-U network as neighbour than Wi-Fi network as neighbour.

8.3.2.2 Detailed findings for outdoor scenario 1

Key findings from Tables in Annex B.2 which captured the results for an indoor deployment with one shared unlicensed carrier and FTP traffic are summarized below.

- One source provided evaluation results for a stand-alone NR-U deployment on an unlicensed carrier specifically for 6GHz.
  - One source provided results of Wi-Fi operator with RTS/CTS disabled using CCA-ED of -72dBm and PD of -82dBm and reported an improvement in 47 of the 48 metrics (agreed to be used for the 5GHz bands) for the non-replaced Wi-Fi operator with the maximum degradation being < 0.2% compared to the case where the Wi-Fi operator was using CCA-ED of -62dBm and PD of -82dBm. In both these cases, all reported metrics for the non-replaced Wi-Fi operator are better with NR-U network as neighbour than Wi-Fi network as neighbour.

8.3.2.3 Summary of observations

For 6 GHz bands, though it is not in the scope of this study to define a fairness criterion with other RATs, a fairness criterion for coexistence has been discussed but no conclusions were reached. For 6GHz coexistence evaluation, the parameters and behaviour of Wi-Fi 802.11ax system and the fairness criterion were left for companies to choose, and are provided together with the evaluation results in Annex B. In the submitted evaluation results, the assumption on the technology neutral channel access mechanism is equal CCA-ED threshold.

Given the assumptions used in the evaluations, all three sources provided results that show that Wi-Fi and NR-U performance is improved when a common CCA-ED threshold is used between Wi-Fi and NR-U compared to when different CCA-ED thresholds are used between Wi-Fi and NR-U. This was shown for the case where Wi-Fi uses CCA-PD at -82 dBm, and for the case where Wi-Fi uses CCA-PD at the same threshold as CCA-ED. For indoor scenario, one source observed that Wi-Fi and NR-U performance is improved when a common CCA-ED threshold of -62dBm is used compared to when a common CCA-ED threshold of -72dBm is used.

8.4 Adjacent channel interference analysis

The aim of this section is to evaluate the impact of Adjacent Channel Interference (ACI) on system performance. Therefore, a generic scenario is considered in which the aggressor system and the victim system use adjacent channels. 3GPP has a consolidated procedure to evaluate the impact of ACI. This methodology is based on modelling Adjacent Channel Interference Ratio (ACIR) as described in [33].

Numerous evaluations on adjacent channel coexistence with a similar setup as above were done under Rel-13 LAA SI. These results were extensively documented in [31].

Since similar deployment scenarios are also considered in NR-U compared to LAA, and similar output power levels are considered, then the previous adjacent channel coexistence evaluation between LAA and WiFi can be directly used for comparison between NR-U and WiFi.

Note that, NR-U may have higher spectrum utilization compared to LAA. It is considered to define the same ACLR (and ACS) requirements for LAA and NR-U (in 5GHz as an example), since ACLR (and ACS) requirements for NR FR1 are the same as for LTE. So, regardless of the higher spectrum utilization in NR, the same ACLR has to be met by NR-U devices.

In NR-U, there will be higher channel bandwidth (CBW) than 20MHz. However, this will not change the already understood conclusions from LAA regarding ACLR and ACS, since the ACLR and ACS values specified in LAA are the same for single carrier operation and contiguous CA operation, meaning in both cases, an LAA BS has to satisfy 35dB ACLR outside its channel bandwidth.

Thus the following is concluded:

- The deployment scenario in Rel-15 NR-U is very similar to Rel-13 LAA deployment scenario and the regulatory requirements remain the same for 5GHz spectrum, so the conclusions of Rel-13 LAA adjacent channel coexistence evaluations are equally applicable to Rel-15 NR-U.

- It is possible to assume same ACLR (and ACS) requirements for LAA and NR-U (in 5GHz as an example), following the principle that, ACLR (and ACS) requirements for other NR FR1 bands are the same as LTE.

9 Conclusions

This technical report presents the results of a study on the operation of NR in sub 7 GHz unlicensed spectrum (NR-U). Multiple deployment scenarios for NR-U have been identified, including carrier aggregation (CA) with NR, dual connectivity (DC) with LTE or NR, stand-alone (SA), and SA with DL in unlicensed band and UL in licensed band.

The modifications to NR needed to allow it to operate in unlicensed spectrum as a Secondary cell through carrier aggregation, as a PSCell through DC, and as a primary cell in stand-alone deployment are studied and documented. The relevant regulatory requirements have been summarized in section 4. The study concludes that it is feasible to modify NR to operate in unlicensed spectrum in carrier aggregation (CA) with a licensed band NR carrier(s), dual connectivity (DC) with LTE or NR in a licensed band, stand-alone (SA) with DL and UL in unlicensed band, and SA with DL in unlicensed band and UL in licensed band.

When deployed in unlicensed bands, NR-U needs to coexist with other deployments with same or other RATs, and coexistence performance has been evaluated. For the coexistence evaluation, three scenarios (indoor, outdoor scenario 1, and outdoor scenario 2) have been defined, as documented in section 8.

For 5GHz band, where Wi-Fi 802.11ac has been widely deployed, the coexistence evaluation assumes two independent networks (e.g., NR-U+Wi-Fi or Wi-Fi+Wi-Fi) are deployed in the same area, and the fairness criterion is defined as the NR-U network not degrading Wi-Fi 802.11ac network performance when NR-U and Wi-Fi 802.11ac are deployed in the area compared to the case where two Wi-Fi 802.11ac networks are deployed in the area, i.e., the same fairness criterion as used in the LTE LAA studies [31].

For 6GHz band (e.g. US 5925 – 7125 MHz, or European 5925 – 6425 MHz, or parts thereof), since both NR-U and Wi-Fi are new systems to be deployed in these bands (band definitions depending on regulations), a technology neutral fairness criterion is required for the coexistence evaluation. Though it is not in the scope of this study to define a fairness criterion with other RATs, a fairness criterion for coexistence has been discussed but no conclusions were reached. For the 6 GHz coexistence evaluation in this study, the assumption of same CCA-ED threshold across technologies is applied as the technology neutral channel access mechanism.

The coexistence evaluations performed during the study item are documented in section 8.3. The 5GHz band coexistence evaluation results are listed in Section 8.3.1. The studies show that when the appropriate channel access schemes, as defined in Section 8.2, are used, it is feasible for NR-U to achieve fair coexistence with Wi-Fi, and for NR-U to coexist with itself, under conditions described in Section 8.3.1.4. The 6GHz band coexistence evaluation results are listed in Section 8.3.2.

Wideband operation in integer multiple of 20MHz is supported in NR-U and channel access can be performed at least in units of 20MHz, at least for band where absence of Wi-Fi cannot be guaranteed. Options to support wideband operation have been identified (Section 7.2.1.1)

For LBE mode of operation, it is recommended that NR-U supports single DL/UL switching point operation within a gNB initiated COT, as in LTE-LAA, as well as multiple DL/UL switching points within a gNB initiated COT. It is recommended that Cat 4 channel access is used for gNB or UE to initiate a COT for normal data transmissions, while gNB can use Cat 2 channel access for DRS transmission when DRS satisfies some conditions (Section 7.2.1.3.1). It is recommended that for a switching point gap of up to 16 µs, where the gap accommodates for the transceiver turnaround time, immediate transmission can take place within the same COT. It is recommended that for a gap of more than 16 µs but less than 25 µs, Cat 2 LBT can be used within the same COT. It is also recommended that for the case of a single switching point within a COT, where the switching gap exceeds 25 µs, Cat 2 LBT can be used within the same COT (Section 7.2.1.3.1). Partial slot transmission at the beginning of the gNB or UE initiated COT is identified as beneficial and multiple techniques to support partial slot transmissions have been studied.

For FBE mode of operation, according to regulation, the channel access of FBE is in unit of fixed frame periods. A Cat 2 LBT is used before each fixed frame period to determine if the fixed frame period can be occupied. Within an occupied fixed frame period, for a gap of up to 16 µs, Cat 1 channel access can be used. For a gap of more than 16 µs in an occupied fixed frame period, Cat 2 LBT should be used.

The enhancements needed for initial access and mobility procedures are captured in Section 7.2.1.3.2. The issue of reduced transmission opportunities due to LBT failure for SS/PBCH block transmission, message 1/2/3/4 transmission in 4-step RACH procedure, RLM/RRM, and paging has been identified, and some enhancements are described.

For HARQ, benefits of supporting the transmission of all HARQ A/N within the same shared COT as the PDSCH(s), have been identified. Multiple techniques to handle reduced HARQ A/N transmission opportunities due to LBT failure have been identified (Section 7.2.1.3.3). Furthermore, enhancements to UL scheduling, such as scheduling multiple slots for PUSCH(s) using a single UL grant, as is possible for LTE-eLAA, were identified as beneficial.

For configured grant, benefits of enhancing the NR design for NR-U have been identified (Section 7.2.1.3.4). Introducing UCI on PUSCH to carry HARQ process ID, NDI, RVID has been identified as beneficial in removing dependencies of HARQ process information to the timing. The identified enhancements also include introducing Downlink Feedback Information (DFI) including HARQ feedback for configured grant transmission, increased flexibility on time domain resource allocation for the configured grant transmissions and supporting retransmissions without explicit UL grant.

The enhancements identified for physical layer signal and channels are captured in Section 7.2.1.2. For SS/PBCH block transmission in NR-U DRS, it has been identified as beneficial to include CSI-RS and RMSI-CORESET(s) and RMSI-PDSCH(s) in the same contiguous burst when transmission of CSI-RS/RMSI are configured. Optionally OSI and paging can be transmitted in the same DRS if there are available resources. For UL signals/channels, a study on the waveform design to satisfy the Occupied Channel Bandwidth requirement and Power Spectral Density requirements of unlicensed bands was conducted, and it was determined that it is feasible to introduce a block-interlaced waveform for PUCCH and PUSCH for UL as enhancements to existing NR UL waveforms to satisfy the requirements. It has been identified that enhancement of one or more Rel.15 NR PRACH formats is feasible. Several enhancements to SRS design have been identified.

From RAN2 perspective, the radio interface architecture and protocols between UE and RAN to support operation in unlicensed spectrum were studied. This included MAC, RLM, RRM, mobility, and other layer 2/3 user and control plane aspects. The recommended enhancements to NR baseline are of two types:

- A set of enhancements to alleviate the impact of LBT (e.g., impacts of reduced transmission opportunities);
- Enhancements needed due to the unique nature of operation in unlicensed spectrum (e.g. support for multiple operators in the same frequency).

It was concluded that the NR licensed baseline along with the enhancements captured in this TR can support NR-U operation in CA, DC, and stand-alone (SA) modes.

The system level aspects of NR-U were also studied. It was concluded that, other than support of differentiated policy and charging, no other impact to EPS and 5GS is expected. Furthermore, it is expected that aspects associated with non-public networks will be covered under ongoing work in SA groups.

From RAN4 perspective, based on the discussions in Section 8.4, it can be concluded that, if NR-U has similar adjacent channel leakage as LAA, then NR-U and Wi-Fi can coexist in adjacent channels. If NR-U has similar leakage and selectivity requirements as LAA, the LAA study can be used to conclude that NR-U will cause less adjacent channel interference to a Wi-Fi system compared to another Wi-Fi system.

It is feasible for UEs and BSs to operate in the 5GHz unlicensed spectrum as NR-U systems. Suitable RF requirements should be specified taking into account issues including implementation complexity and performance.

Annex A: Evaluation methodology

A.1 General evaluation assumptions

A.1.1 Evaluation assumptions for sub 7GHz indoor scenario

The evaluation parameters for sub7 GHz indoor scenario are as given in Table A.1.1-1. Other parameters not explicitly included in the table will use values defined in [28] and [29].

Table A.1.1-1: Evaluation parameters for sub7 GHz indoor scenario

Parameter	Value
Carrier Frequency	5GHz
Carrier Channel Bandwidth	20MHz baseline , 80MHz optional
Number of carriers	1
Number of users per operator	5 UEs associated with each gNB per 20MHz
SCS	To be reported together simulation results
Channel Model	NR InH Mixed Office model
BS/AP Tx Power	23dBm (total across all TX antennas)
UE/STA Tx Power	18dBm (total across all TX antennas)
BS/AP Antenna gain	0dBi
UE/STA Antenna gain	0dBi
BS/AP Noise Figure	5dB
UE/STA Receiver Noise Figure	9dB
Minimum received power from serving cell for UE dropping	-82dBm
UE receiver	MMSE-IRC as the baseline receiver
BS/AP antenna Array configuration	(M, N, P, M_g, N_g) = (1, 2, 2, 1, 1), dH = dV = 0.5 λ
UE/STA antenna Array configuration	Baseline Tx/Rx: (M, N, P, Mg, Ng) = (1, 1, 2, 1, 1), dH = dV = 0.5 λ Optional Tx/Rx: (M, N, P, Mg, Ng) = (1, 2, 2, 1, 1), dH = dV = 0.5 λ
Traffic model	Use 36.889 Table A.1.1. Note: Results based on the mixed traffic models can be used to determine the design.
UE/STA to UE/STA link pathloss model	Directly use InH office pathloss model with proper d_3D with indoor mixed office LOS probability
gNB to gNB link pathloss model	Directly use InH office pathloss model with proper d_3D with indoor mixed office LOS probability

A.1.2 Evaluation assumptions for sub 7GHz outdoor scenarios

The evaluation parameters for sub7 GHz outdoor scenarios are as given in Table A.1.2-1. Other parameters not explicitly included in the table will use values defined in [28] and [29].

Table A.1.2-1: Evaluation parameters for sub7 GHz outdoor scenario

Parameters	Outdoor Sub-7GHz
Carrier Frequency	5GHz
Carrier Channel Bandwidth	20MHz baseline , 80MHz optional
Number of carriers	1
Number of users per operator	5 UEs associated with each gNB per 20MHz
SCS	To be reported together simulation results
Channel Model	NR UMi street canyon
BS/AP Tx Power	23dBm (total across all TX antennas)
UE/STA Tx Power	18dBm (total across all TX antennas)
BS/AP Antenna gain	0 dBi
UE/STA Antenna gain	0 dBi
BS/AP Noise Figure	5dB
UE/STA Receiver Noise Figure	9dB
Minimum received power from serving cell for UE dropping	-82dBm
UE receiver	MMSE-IRC as the baseline receiver
BS/AP antenna Array configuration	$(M, N, P, M_g, N_g) = (1, 2, 2, 1, 1)$, dH = dV = 0.5 λ
UE/STA antenna Array configuration	Baseline Tx/Rx: (M, N, P, Mg, Ng) = (1, 1, 2, 1, 1), dH = dV = 0.5 λ Optional Tx/Rx: (M, N, P, Mg, Ng) = (1, 2, 2, 1, 1), dH = dV = 0.5 λ
Traffic model	Use 36.889 Table A.1.1. Note: Results based on the mixed traffic models can be used to determine the design.
UE/STA to UE/STA link pathloss model	Directly use UMi street canyon pathloss model with proper d_3D with UMi street canyon LOS probability
gNB to gNB link pathloss model	Directly use UMi street canyon pathloss model with proper d_3D with UMi street canyon LOS probability

Annex B: Evaluation results

B.1 Evaluation results for sub7GHz indoor

B.1.1 Wi-Fi and NR-U coexistence evaluation with 20MHz and FTP traffic

Table B.1.1-1: Wi-Fi and NR-U coexistence evaluation with 20MHz and FTP traffic

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1812431/ SOURCE 1	**DL:** UPT CDF [Mbps]	5%	40.958	50.921	12.749	20.9086	19.582	42.015	6.059	24.4146	7.768	42.348	2.854	24.2027
		50%	51.341	58.429	44.530	83.6427	32.045	51.229	30.037	78.1366	22.447	49.634	15.259	75.6554
		95%	61.063	64.120	63.951	114.0128	40.058	58.609	47.489	99.3320	28.934	55.007	36.573	100.7447
		Mean	51.903	59.083	47.601	76.3185	32.107	52.505	32.781	72.6793	21.242	49.544	21.404	70.5092
	DL: Delay CDF [s]	5%	0.060	0.060	0.047	0.034	0.061	0.060	0.051	0.035	0.073	0.060	0.060	0.035
		50%	0.066	0.062	0.088	0.047	0.142	0.065	0.153	0.052	0.297	0.072	0.277	0.053
		95%	0.207	0.112	0.333	0.153	0.739	0.163	0.817	0.252	3.268	0.211	1.933	0.307
		Mean	0.096	0.072	0.130	0.068	0.232	0.088	0.276	0.083	0.817	0.096	0.527	0.087
	UL: UPT CDF [Mbps]	5%	40.245	49.152	12.083	16.3911	23.012	48.127	4.081	15.4290	13.400	40.174	3.018	59.8555
		50%	49.537	58.413	42.110	74.4228	34.770	50.625	29.733	62.8715	23.108	49.411	17.757	16.4273
		95%	60.993	64.496	76.645	92.7418	39.682	54.735	55.973	90.0290	36.185	54.341	42.229	62.9272
		Mean	50.859	58.871	49.220	68.3392	34.875	51.439	32.720	62.3984	23.966	48.391	22.963	84.8273
	UL: Delay CDF [s]	5%	0.060	0.060	0.042	0.041	0.062	0.060	0.042	0.041	0.065	0.060	0.047	0.041
		50%	0.068	0.062	0.082	0.054	0.127	0.066	0.162	0.061	0.211	0.076	0.248	0.064
		95%	0.192	0.132	0.363	0.259	0.454	0.174	0.792	0.274	0.864	0.187	1.392	0.290
		Mean	0.092	0.074	0.128	0.097	0.173	0.089	0.282	0.106	0.306	0.096	0.448	0.113
	ρ_{DL}		1.00	1.00	1.00	1.00	0.99	0.93	1.00	99.8339	0.96	0.92	0.97	1.00
	ρ_{UL}		1.00	1.00	1.00	1.00	1.00	0.93	0.98	99.8333	1.00	0.92	0.95	1.00
	BO		23.677	36.875	14.704	5.260	41.023	40.448	45.818	11.154	59.295	45.374	72.597	15.094
	λ		DL:1Mbps; UL:1Mbps				DL:2Mbps; UL:2Mbps				DL:2.5Mbps; UL:2.5Mbps			
			Additional comments: - TxOP assumptions of WiFi and NR-U: 4.096 ms TxOP for both DL/UL WiFi and upto 4ms DL/UL NR-U transmission - Is RTS/CTS enabled for WiFi: No - PD/ED threshold assumptions: For WiFi, -82/62 dBm PD/ED threshold and for NR-U, -72 dBm ED threshold - Max modulation order supported in each technology: 256 QAM for both WiFi and NR-U - MIMO scheme and number of MIMO layers used for both technologies: 2Tx2Rx antenna configuration and 2 layer for both Wi-Fi and NR-U - WiFi MAC layer A-MPDU/A-MSDU aggregation level, MPDU size: 802.11ac - NR-U SCS: 15 kHz - WiFi guard interval: 0.8 μsec - NR UE processing time capability (#1 or #2): Processing time capability #1 - NR PDSCH/PUSCH mapping type, PDCCH monitoring configuration: type A; monitoringSlotPeriodicityAndOffset: 1slot; coreset duration: 2 symbol; monitoringSymbolswithinSlot: [1 0 0 0 0 0 0 0 0 0 0 0 0 0] - Cross-carrier scheduling for NR-U **Note:** A fixed time slot ratio of downlink-uplink is used for NR-U, i.e. DL:UL = {5:5}.											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1812431/SOURCE 1	**DL:** UPT CDF [Mbps]	5%	40.958	50.315	32.719	62.8229	19.582	44.334	18.189	54.2921	7.768	44.419	11.733	52.0858
		50%	51.341	61.638	109.690	179.0133	32.045	54.118	75.648	164.9158	22.447	49.424	62.421	156.4768
		95%	61.063	64.916	136.431	207.9165	40.058	59.754	105.746	202.6525	28.934	55.316	93.050	204.5259
		Mean	51.903	60.768	96.879	162.1622	32.107	54.513	66.707	150.6907	21.242	50.293	57.011	145.9356
	DL: Delay CDF [s]	5%	0.060	0.060	0.026	0.019	0.061	0.060	0.026	0.019	0.073	0.060	0.026	0.019
		50%	0.066	0.062	0.047	0.022	0.142	0.063	0.080	0.024	0.297	0.069	0.097	0.024
		95%	0.207	0.110	0.156	0.077	0.739	0.146	0.457	0.131	3.268	0.177	0.662	0.139
		Mean	0.096	0.069	0.063	0.034	0.232	0.081	0.137	0.039	0.817	0.093	0.197	0.041
	UL: UPT CDF [Mbps]	5%	40.245	50.386	-	-	23.012	46.349	-	-	13.400	45.585	-	-
		50%	49.537	60.834	-	-	34.770	50.113	-	-	23.108	50.104	-	-
		95%	60.993	65.066	-	-	39.682	57.205	-	-	36.185	55.314	-	-
		Mean	50.859	60.523	-	-	34.875	52.000	-	-	23.966	51.155	-	-
	UL: Delay CDF [s]	5%	0.060	0.060	-	-	0.062	0.060	-	-	0.065	0.060	-	-
		50%	0.068	0.062	-	-	0.127	0.066	-	-	0.211	0.069	-	-
		95%	0.192	0.106	-	-	0.454	0.152	-	-	0.864	0.161	-	-
		Mean	0.092	0.069	-	-	0.173	0.086	-	-	0.306	0.089	-	-
	ρ_{DL}		1.00	0.95	1.00	1.00	0.99	0.96	0.97	1.00	0.96	91.821	0.97	1.00
	ρ_{UL}		1.00	0.96	-	-	1.00	0.95	-	-	1.00	93.255	-	
	BO		23.677	36.156	6.923	3.952	41.023	39.764	26.174	8.783	59.295	44.171	41.198	11.427
	λ		DL:1Mbps; UL:1Mbps				DL:2Mbps;				DL:2Mbps; UL:2Mbps			
			Additional comments: - TxOP assumptions of WiFi and NR-U: 4.096 ms TxOP for both DL/UL WiFi and upto 4ms DL NR-U transmission - Is RTS/CTS enabled for WiFi: No - PD/ED threshold assumptions: For WiFi, -82/62 dBm PD/ED threshold and for NR-U, -72 dBm ED threshold - Max modulation order supported in each technology: 256 QAM for both WiFi and NR-U - MIMO scheme and number of MIMO layers used for both technologies: 2Tx2Rx antenna configuration and 2 layer for both Wi-Fi and NR-U - WiFi MAC layer A-MPDU/A-MSDU aggregation level, MPDU size: 802.11ac - NR-U SCS: 15 kHz - WiFi guard interval: 0.8 μsec - NR UE processing time capability (#1 or #2): Processing time capability #1 - NR PDSCH/PUSCH mapping type, PDCCH monitoring configuration: type A; monitoringSlotPeriodicityAndOffset: 1slot; coreset duration: 2 symbol; monitoringSymbolswithinSlot: [1 0 0 0 0 0 0 0 0 0 0 0 0 0] - Cross-carrier scheduling for NR-U											

Tdoc/Source	Reported parameters		Low load BO range for Wi-Fi in WiFi+WiFi: 10%~25%				Medium load BO range for Wi-Fi in WiFi+WiFi: 35%~50%				High load BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1812431/SOURCE 1	**DL:** UPT CDF [Mbps]	5%	40.958	47.276	-	-	19.582	44.392	-	-	7.768	41.229	-	-
		50%	51.341	60.190	-	-	32.045	51.535	-	-	22.447	48.156	-	-
		95%	61.063	64.231	-	-	40.058	57.314	-	-	28.934	50.807	-	-
		Mean	51.903	59.268	-	-	32.107	51.647	-	-	21.242	47.494	-	-
	DL: Delay CDF [s]	5%	0.060	0.060	-	-	0.061	0.060	-	-	0.073	0.060	-	-
		50%	0.066	0.062	-	-	0.142	0.066	-	-	0.297	0.077	-	-
		95%	0.207	0.130	-	-	0.739	0.170	-	-	3.268	0.250	-	-
		Mean	0.096	0.072	-	-	0.232	0.089	-	-	0.817	0.107	-	-
	UL: UPT CDF [Mbps]	5%	40.245	50.842	26.834	34.9247	23.012	42.962	14.354	33.1597	13.400	38.706	9.914	32.3721
		50%	49.537	61.343	114.239	141.0299	34.770	48.151	72.546	126.7055	23.108	48.265	57.714	126.1715
		95%	60.993	65.154	157.121	185.7409	39.682	55.809	112.481	178.2521	36.185	54.055	98.468	174.1342
		Mean	50.859	60.017	102.352	135.9199	34.875	49.242	68.307	126.5704	23.966	48.418	53.314	123.3722
	UL: Delay CDF [s]	5%	0.060	0.060	0.022	0.021	0.062	0.060	0.022	0.021	0.065	0.060	0.022	0.021
		50%	0.068	0.062	0.040	0.027	0.127	0.071	0.089	0.030	0.211	0.077	0.128	0.031
		95%	0.192	0.117	0.193	0.111	0.454	0.193	0.474	0.125	0.864	0.187	0.738	0.137
		Mean	0.092	0.071	0.067	0.045	0.173	0.095	0.151	0.052	0.306	0.098	0.224	0.056
	ρ_{DL}		1.00	95.070	-	-	0.99	0.96	-	-	0.96	0.93	-	-
	ρ_{UL}		1.00	95.620	1.00	1.00	1.00	0.95	0.98	1.00	1.00	0.92	0.93	1.00
	BO		23.677	36.196	8.38	5.280	41.023	40.487	36.885	11.545	59.295	44.734	40.175	14.749
	λ		DL:1Mbps; UL:1Mbps				UL:2Mbps;				DL:2Mbps; UL:2Mbps			

Additional comments:

- TxOP assumptions of WiFi and NR-U: 4.096 ms TxOP for both DL/UL WiFi and upto 4ms UL NR-U transmission
- Is RTS/CTS enabled for WiFi: No
- PD/ED threshold assumptions: For WiFi, -82/62 dBm PD/ED threshold and for NR-U, -72 dBm ED threshold
- Max modulation order supported in each technology: 256 QAM for both WiFi and NR-U
- MIMO scheme and number of MIMO layers used for both technologies: 2Tx2Rx antenna configuration and 2 layer for both Wi-Fi and NR-U
- WiFi MAC layer A-MPDU/A-MSDU aggregation level, MPDU size: 802.11ac
- NR-U SCS: 15 kHz
- WiFi guard interval: 0.8 μsec
- NR UE processing time capability (#1 or #2): Processing time capability #1
- NR PDSCH/PUSCH mapping type, PDCCH monitoring configuration: type A; monitoringSlotPeriodicityAndOffset: 1slot; coreset duration: 2 symbol; monitoringSymbolswithinSlot: [1 0 0 0 0 0 0 0 0 0 0 0 0 0]
- Cross-carrier scheduling for NR-U

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1- 1812659/ Source 3	**DL:** UPT CDF [Mbps]	5%	6.89	7.59	39.87	42.19	3.38	3.23	23.87	42.12	1.34	1.49	7.05	36,50
		50%	35.83	36,97	120,95	97,80	22,79	24,96	100,97	94,25	11,26	14,17	74,25	87,78
		95%	77,98	79,51	190,84	186,51	61,50	62,42	172,75	182,16	40,72	51,33	143,82	177,31
		Mean	39,91	37,63	120,04	106,00	26,77	28,10	100,36	102,11	14,91	18,57	75,30	95,65
	DL: Delay CDF [s]	5%	42,23	45,77	19,76	20,79	49,01	49,52	20,67	20,70	68,97	59,83	21,84	21,03
		50%	116,70	112,65	31,06	42,11	211,95	183,95	40,22	43,36	448,90	325,72	57,77	45,74
		95%	577,53	521,78	101,94	111,14	1234,80	931,37	205,60	137,24	2895,40	2041,24	430,25	181,75
		Mean	194,41	191,64	43,98	52,49	370,92	306,45	67,79	58,06	832,30	571,74	114,17	83,90
	UL: UPT CDF [Mbps]	5%	5,36	5,86	6,00	15,49	2,29	2,59	4,46	16,07	0,19	0,29	0,87	13,38
		50%	32,30	33,15	33,98	33,30	22,48	23,60	24,10	30,82	12,00	14,19	14,97	28,35
		95%	48,09	49,77	51,90	52,79	41,25	42,11	46,86	49,24	30,34	34,02	36,36	47,76
		Mean	32,44	31,29	32,51	33,53	22,68	23,22	24,68	31,51	13,32	15,27	16,65	29,13
	UL: Delay CDF [s]	5%	74,44	77,59	67,16	68,58	77,41	81,41	69,98	69,75	91,63	87,31	76,77	70,20
		50%	124,75	116,30	108,33	116,65	201,97	178,00	172,55	129,67	398,35	304,75	274,75	138,97
		95%	550,71	548,54	496,94	269,00	1301,15	1140,48	824,32	292,93	3245,64	2660,31	1694,62	376,14
		Mean	190,20	192,89	197,54	186,67	379,81	352,00	301,40	172,35	869,47	700,39	517,89	202,12
	ρ_{DL}		0,92	0,88	0,97	1,00	0,89	0,85	0,96	1,00	0,85	0,78	0,93	0,99
	ρ_{UL}		0,99	0,95	0,93	0,99	0,98	0,94	0,88	0,98	0,93	0,87	0,82	0,96
	BO		15,15	17,12	11,14	6,70	34,80	33,12	21,72	11,06	61,52	54,18	37,67	16,32
	λ													
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2 in the DL, Rank 1 in the UL **Wi-Fi assumptions:** RTS/CTS enabled, ED/PD threshold -62/-82 dBm, Wi-Fi Guard Interval short, Minstrel Algorithm for rate prediction, max TXOP duration 4.096 ms **NRU assumptions:** ED threshold -72 dBm, SCS 30 kHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), realistic modelling of delays for HARQ, realistic delays in CSI reports, stand-alone operation with self-scheduling, asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms prior to data slot, Cat-2 or Cat-1 LBT prior to PUCCH at the beginning of the UL burst, 1 symbol DMRS overhead, 4 symbols for ACK/CQI feedback at the beginning of UL burst, UL grant modelled. DRS transmission with a periodicity 40 ms, DRS duration of 1 slot.											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814085/ Source 4	**DL:** UPT CDF [Mbps]	5%	15.66	21.56	31.42	36.39	7.53	15.89	26.17	30.57	3.11	13.19	23.9	26.84
		50%	48.84	66.4	87.54	97.08	35.61	56.64	75.05	87.45	27.16	51.13	67.41	81.65
		95%	77.93	78.23	103.9	104.8	77.3	78.02	103.9	104.8	75.23	77.93	103.7	104.8
		Mean	49.69	59.5	78.05	83.71	38.52	53.61	71.56	78.44	30.88	50.07	67.9	75.28
	DL: Delay CDF [s]	5%	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04
		50%	0.08	0.06	0.05	0.04	0.11	0.08	0.05	0.05	0.15	0.08	0.06	0.05
		95%	0.25	0.19	0.13	0.11	0.51	0.25	0.15	0.13	1.13	0.30	0.17	0.15
		Mean	0.11	0.08	0.06	0.05	0.18	0.10	0.07	0.06	0.32	0.11	0.07	0.07
	UL: UPT CDF [Mbps]	5%	18.43	26.83	18.46	29.85	6.98	18.39	13.13	24	1.49	13.13	9.97	20.6
		50%	53.63	72.26	56.06	76.68	38.48	59.77	42.8	66.15	29.2	56.98	37.55	60.15
		95%	79.2	79.44	72.22	83.73	78.72	79.32	72.1	83.56	77.61	79.34	71.91	83.5
		Mean	53.4	62.72	51.35	66.81	40.75	56.58	44.75	61.31	31.98	53.54	40.72	58.36
	UL: Delay CDF [s]	5%	0.05	0.05	0.06	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.06	0.05
		50%	0.07	0.06	0.07	0.05	0.10	0.07	0.09	0.06	0.14	0.07	0.10	0.07
		95%	0.21	0.15	0.21	0.13	0.56	0.22	0.30	0.17	1.89	0.28	0.39	0.19
		Mean	0.10	0.07	0.09	0.07	0.18	0.09	0.12	0.08	0.43	0.11	0.15	0.09
	ρ_{DL}		99.68%	99.74%	99.73%	100%	99.64%	99.69%	100%	99.91%	98.46%	99.70%	99.80%	99.86%
	ρ_{UL}		99.60%	99.87%	99.52%	100%	99.56%	99.64%	99.63%	99.73%	96.78%	99.56%	99.52%	99.69%
	BO		17%	13.00%	13.00%	11.00%	35%	22.00%	22.00%	17.00%	55%	28.00%	28.00%	21.00%
	λ		0.2 files/s				0.3 files/s				0.35 files/s			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-72dBm; 256 QAM LDPC; 30 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ac assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=-62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,312.5kHz SCS GI= 0.8us											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814085/Source 4	**DL:** UPT CDF [Mbps]	5%	15.66	19.43	36.84	41.97	7.53	14.67	29	34.94	3.11	10.98	24.29	30.57
		50%	48.84	61.14	95.91	101.8	35.61	53.78	83.89	91.97	27.16	47.46	76	87.3
		95%	77.93	78.16	107.1	107.2	77.3	78	107.2	107.2	75.23	77.83	107.1	107.2
		Mean	49.69	57.19	85.24	88.05	38.52	51.51	77.5	82.54	30.88	47.84	72.89	79.57
	DL: Delay CDF [s]	5%	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04
		50%	0.08	0.06	0.04	0.04	0.11	0.07	0.05	0.04	0.15	0.08	0.05	0.05
		95%	0.25	0.21	0.11	0.10	0.51	0.27	0.14	0.11	1.13	0.34	0.16	0.13
		Mean	0.11	0.09	0.05	0.05	0.18	0.11	0.06	0.06	0.32	0.12	0.07	0.06
	UL: UPT CDF [Mbps]	5%	18.43	25.52	27.56	34.53	6.98	17.7	19.27	27.88	1.49	12.15	15.54	24.38
		50%	53.63	70.6	78.99	85.97	38.48	58.61	63.04	77.35	29.2	53.89	55.19	70.51
		95%	79.2	79.41	93.45	93.47	78.72	79.34	93.44	93.46	77.61	79.23	93.38	93.44
		Mean	53.4	62	71.19	75.7	40.75	55.84	62.69	69.87	31.98	52.07	57.53	66.71
	UL: Delay CDF [s]	5%	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04
		50%	0.07	0.06	0.05	0.05	0.10	0.07	0.06	0.05	0.14	0.07	0.07	0.06
		95%	0.21	0.16	0.14	0.12	0.56	0.22	0.20	0.14	1.89	0.31	0.25	0.16
		Mean	0.10	0.08	0.07	0.06	0.18	0.09	0.08	0.07	0.43	0.11	0.10	0.07
	ρ_{DL}		99.68%	99.69%	99.72%	100%	99.64%	99.67%	99.99%	99.89%	98.46%	99.72%	99.75%	99.83%
	ρ_{UL}		99.60%	99.85%	99.61%	100%	99.56%	99.61%	99.74%	99.76%	96.78%	99.55%	99.63%	99.73%
	BO		17%	14.00%	11.00%	10.00%	35%	23.00%	18.00%	16.00%	55%	29.00%	23.00%	19.00%
	λ		0.2 files/s				0.3 files/s				0.35 files/s			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-72dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ac assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=-62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,312.5kHz SCS GI= 0.8us											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814074 / Source 5	**DL:** UPT CDF [Mbps]	5%	2.077	2.086	3.529	12.000	0.103	0.436	4.184	4.700	0.04	0.267	0.057	0.797
		50%	30.508	35.679	63.412	63.704	12.735	21.654	38.000	39.07	1.62	4.936	14.045	20.731
		95%	52.927	56.945	74.133	74.078	49.774	53.152	73.624	74.058	33.656	32.256	42.991	66.636
		Mean	28.461	31.821	54.791	55.576	17.523	22.865	36.523	39.550	8.016	9.708	16.644	23.482
	DL: Delay CDF [s]	5%	0.050	0.05	0.054	0.054	0.050	0.050	0.054	0.054	0.050	0.05	0.054	0.054
		50%	0.086	0.056	0.058	0.058	0.183	0.100	0.100	0.106	0.800	0.624	0.333	0.219
		95%	1.760	1.121	0.308	0.378	5.535	1.913	0.801	0.698	6.56	5.244	1.787	1.403
		Mean	0.362	0.289	0.131	0.112	1.060	0.418	0.206	0.194	1.809	1.301	0.516	0.392
	UL: UPT CDF [Mbps]	5%	1.450	1.895	8.945	19.057	0.216	0.396	2.490	5.646	0.022	0.018	1.738	2.071
		50%	35.542	39.754	57.249	57.542	16.897	23.044	31.288	38.075	3.016	4.215	14.792	21.480
		95%	53.493	53.399	73.471	73.5533	53.622	48.525	72.538	73.230	32.975	40.011	43.120	59.95
		Mean	30.904	33.153	51.827	54.91	20.958	23.444	33.162	39.735	9.049	10.498	18.290	24.595
	UL: Delay CDF [s]	5%	0.050	0.050	0.054	0.054	0.050	0.050	0.054	0.054	0.050	0.05	0.055	0.054
		50%	0.070	0.059	0.070	0.064	0.132	0.111	0.130	0.103	0.805	0.754	0.279	0.209
		95%	2.165	1.334	0.434	0.204	5.584	3.672	1.309	0.739	5.748	5.106	1.563	1.388
		Mean	0.360	0.295	0.128	0.092	1.04	0.647	0.299	0.203	1.505	1.4	0.474	0.426
	ρ_{DL}		0.988	0.993	0.992	0.997	0.874	0.944	0.945	0.962	0.733	0.8385	0.870	0.932
	ρ_{UL}		0.99	0.99	0.986	0.988	0.894	0.940	0.936	0.977	0.747	0.771	0.944	0.969
	BO		16.5%	13.4%	12.2%	7.1%	48.6%	34.5%	37%	26.3%	76%	70.5%	65.4%	52.1%
	λ		0.15				0.22				0.3			
			Additional comments: - 4ms for both Wi-Fi and NR-U - No - For Wi-Fi, PDT = -82 dBm, EDT = -62 dBm; for NR-U EDT = -72 dBm (baseline) - 256 QAM for both Wi-Fi and NR-U - NR-U with array radiation pattern according to TR38.802 and max BF gain of 5 dBi; omni-directional for Wi-Fi - MPDU size = 3250 bytes by default, 1ms per MPDU - 30 kHz - 0.8 µs - Capability #1 - Mapping type B in the starting slot of TxOP; per-symbol PDCCH monitoring for flexible starting position - No fast link adaptation utilizing multiple switching points within COT for NR-U - Cross-carrier scheduling in UL											

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			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1- 1814062 /Source 6	**DL:** UPT CDF [Mbps]	5%	17.154	17.711	41.850	63.416	3.943	4.645	9.842	22.380	1.500	1.402	2.691	23.185
		50%	77.534	86.665	148.551	171.191	32.930	36.844	82.630	146.557	13.770	19.858	53.544	122.645
		95%	128.170	133.654	198.427	198.431	110.541	113.586	197.805	198.370	73.161	97.293	194.578	197.587
		Mean	76.170	80.257	140.165	155.393	42.386	47.433	94.770	131.612	21.862	31.864	75.520	120.925
	DL: Delay CDF [s]	5%	0.032	0.031	0.021	0.021	0.036	0.036	0.021	0.021	0.063	0.044	0.021	0.021
		50%	0.056	0.050	0.027	0.025	0.133	0.129	0.055	0.30	0.385	0.280	0.094	0.034
		95%	0.215	0.232	0.094	0.064	1.063	1.391	1.116	0.187	2.866	2.908	2.647	0.191
		Mean	0.085	0.081	0.043	0.037	0.278	0.325	0.225	0.055	0.782	0.658	0.505	0.062
	UL: UPT CDF [Mbps]	5%	28.220	31.549	30.852	26.097	13.497	10.113	7.552	18.442	7.330	3.494	4.978	16.160
		50%	81.430	95.070	147.554	157.696	44.765	52.213	66.107	67.717	28.108	31.130	40.481	65.771
		95%	125.537	129.270	198.879	198.460	113.807	116.741	167.788	171.151	77.057	109.554	162.036	170.362
		Mean	80.987	89.301	133.846	141.838	53.162	56.365	75.220	79.673	33.345	41.111	59.763	78.704
	UL: Delay CDF [s]	5%	0.033	0.031	0.021	0.032	0.035	0.036	0.026	0.024	0.060	0.038	0.030	0.024
		50%	0.050	0.044	0.027	0.024	0.095	0.085	0.072	0.063	0.150	0.160	0.160	0.063
		95%	0.128	0.127	0.134	0.122	0.306	0.913	0.726	0.224	0.659	1.241	1.241	0.226
		Mean	0.064	0.058	0.044	0.044	0.125	0.223	0.203	0.086	0.227	0.338	0.338	0.084
	ρ_{DL}		0.9990	0.9994	0.9994	1.00	0.9916	0.9960	0.9960	1.00	0.9786	0.967	0.9760	1.00
	ρ_{UL}		0.9984	0.9995	1.00	1.00	0.9980	0.9974	1.00	1.00	0.9957	0.976	0.9673	0.9870
	BO		11.00	10.4	5.83	4.68	39.50	42.00	28.60	16.6	67.88	62.00	40.60	18.00
	λ		0.167/0.167				0.3/0.3				0.4/0.4			
			Additional comments: Laypout and parameters for Indoor Sub-7GHz deployment Scenario are from R1-1807384. WiFi settings: 802.11ac MCS table including 256 QAM, 2Tx2Rx in DL (cross-polarized, open loop), 2Tx2Rx in UL, 2 streams in both DL and UL. GI:0.8 µs, TXOP=4 ms, LDPC, A-MPDU enabled, RTS/CTS enabled, link adaptation: Minstrel algorithm, CWS: DL{15,63} and UL{15,1023}, CCA: CS=-82dBm, ED=-62dBm. NR-U settings: 4Tx2Rx in DL, Cross-polarized. MCS=4/16/64/256QAM, scheduling: proportional fair, link adaptation realistic, ED=-72 dBm, CP=Normal, SCS=30KHz, TXOP=4 ms, UE Capability #1, MCS: DL{15,63} and UL{15,1023}, COT sharing enabled, COT details: flexible DL/UL only and mixed DL/UL based on traffic needs, 3/11 DL control/data symbols, 3/11 symbols UL control/data.											

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			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 /Source 7	**DL:** UPT CDF [Mbps]	5%	31.00	36.97	67.65	80.12	3.56	17.46	42.46	70.49	0.12	3.16	28.4	61.97
		50%	70.47	81.84	129.98	146.32	42.25	59.81	96.86	132.4	30.03	48.11	75.5	123.69
		95%	109.34	126.11	160.27	167.33	81.53	103.99	144.27	162.31	67.07	96.02	135.97	158.18
		Mean	70.45	80.54	124.22	138.4	43.61	61.02	95.74	126.42	30.79	49.75	78.81	119.78
	DL: Delay CDF [s]	5%	0.028	0.024	0.02	0.02	0.031	0.029	0.021	0.02	0.04	0.03	0.022	0.021
		50%	0.061	0.051	0.028	0.026	0.123	0.074	0.043	0.028	0.198	0.098	0.058	0.03
		95%	0.25	0.197	0.117	0.064	2.287	0.544	0.263	0.088	54.959	1.929	0.54	0.107
		Mean	0.092	0.074	0.044	0.032	3.348	0.819	0.083	0.039	10.506	5.201	0.165	0.044
	UL: UPT CDF [Mbps]	5%	17.13	20.95	41.54	50.06	0.39	9.6	22.67	38.81	0.03	0.1	10.98	33.44
		50%	62.13	69.72	112.84	131.13	33.93	49.09	73.86	112.6	24.07	37.17	52.94	100.38
		95%	103.57	117.82	150.09	160.99	73.5	95.04	129.4	148.55	61.69	88.23	113.94	140.78
		Mean	61.52	70.21	107.6	121.67	36.78	50.85	73.52	105.14	26.02	41.08	56.19	96.02
	UL: Delay CDF [s]	5%	0.029	0.026	0.021	0.021	0.034	0.03	0.021	0.021	0.042	0.032	0.022	0.021
		50%	0.074	0.063	0.034	0.029	0.162	0.1	0.073	0.036	0.254	0.13	0.115	0.043
		95%	0.411	0.307	0.196	0.108	7.523	1.026	0.615	0.179	108.027	3.7	1.417	0.24
		Mean	0.131	0.103	0.063	0.043	7.214	1.713	0.169	0.061	16.787	8.03	0.378	0.076
	ρ_{DL}		1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	0.97	0.98	1.00	1.00
	ρ_{UL}		1.00	0.99	1.00	1.00	0.98	1.00	1.00	1.00	0.94	0.98	1.00	0.99
	BO		0.17	0.14	0.09	0.06	0.50	0.36	0.26	0.13	0.70	0.52	0.41	0.18
	λ		1.5 Mbps				2.5 Mbps				3.0 Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS enabled, ED/PD threshold -62/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval short, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. Switching points no longer than 16 µs every 2ms for CSI feedback, UL grant update.											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 / Source 7	**DL:** UPT CDF [Mbps]	5%	31.00	34.36	64.17	77.4	3.56	16.93	38.99	65.54	0.12	1.74	24.3	59.97
		50%	70.47	79.89	123.64	142.29	42.25	58.61	91.44	128.66	30.03	45.96	70.35	119.53
		95%	109.34	124.51	156.48	163.03	81.53	101.14	140.5	156.6	67.07	96.64	131.88	153.45
		Mean	70.45	78.99	119.81	134.46	43.61	59.61	90.96	122.27	30.79	49.41	74.28	114.92
	DL: Delay CDF [s]	5%	0.028	0.025	0.02	0.02	0.031	0.029	0.02	0.02	0.04	0.03	0.022	0.02
		50%	0.061	0.053	0.029	0.027	0.123	0.075	0.046	0.029	0.198	0.099	0.064	0.032
		95%	0.25	0.203	0.127	0.068	2.287	0.58	0.314	0.095	54.959	2.206	0.717	0.12
		Mean	0.092	0.077	0.047	0.033	3.348	1.016	0.096	0.041	10.506	5.613	0.249	0.048
	UL: UPT CDF [Mbps]	5%	17.13	20.72	42.8	49.8	0.39	9.16	22.29	37.47	0.03	0.19	10.82	32.13
		50%	62.13	69.33	112.77	134.82	33.93	46.82	73.23	112.81	24.07	36.08	51.95	99.59
		95%	103.57	117.96	154.06	163.25	73.5	94.78	126.26	150.15	61.69	87.22	115.27	142.33
		Mean	61.52	69.52	108.46	123.47	36.78	49.32	72.75	105.91	26.02	40.47	55.01	95.84
	UL: Delay CDF [s]	5%	0.029	0.028	0.02	0.02	0.034	0.03	0.021	0.021	0.042	0.031	0.022	0.021
		50%	0.074	0.062	0.034	0.029	0.162	0.103	0.075	0.037	0.254	0.133	0.125	0.044
		95%	0.411	0.318	0.211	0.11	7.523	1.099	0.716	0.19	108.027	3.287	1.904	0.268
		Mean	0.131	0.104	0.065	0.043	7.214	1.806	0.188	0.063	16.787	9.138	0.525	0.083
	ρ_{DL}		1.00	0.99	1.00	1.00	0.99	1.00	1.00	1.00	0.97	0.98	1.00	1.00
	ρ_{UL}		1.00	1.00	1.00	1.00	0.98	1.00	0.99	1.00	0.94	0.96	1.00	1.00
	BO		0.17	0.14	0.09	0.07	0.50	0.37	0.28	0.14	0.70	0.53	0.45	0.19
	λ		1.5 Mbps				2.5 Mbps				3.0 Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS enabled, ED/PD threshold -62/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval short, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. COT structure includes a preparation stage for CSI exchange leading to total of 2 switching points.											

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			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 / Source 7	**DL:** UPT CDF [Mbps]	5%	22.94	28	62.3	70.69	14.61	24.45	50.22	67.02	1.83	17.69	38.7	59.74
		50%	61.23	71.65	124.97	142.3	48.34	62.44	110.42	135.79	38.45	54.9	93.18	127.03
		95%	109.37	124.11	160.51	167.97	98.69	117.26	153.25	165.12	87.09	108.19	146.81	162.44
		Mean	63.36	74.51	119.86	134.15	51.71	68.02	106.8	128.18	40.64	59.64	92.17	121.98
	DL: Delay CDF [s]	5%	0.029	0.028	0.02	0.02	0.031	0.029	0.021	0.02	0.035	0.029	0.021	0.021
		50%	0.065	0.058	0.029	0.026	0.086	0.062	0.035	0.028	0.12	0.071	0.046	0.029
		95%	0.317	0.217	0.122	0.071	0.656	0.294	0.179	0.083	4.491	0.494	0.303	0.1
		Mean	0.11	0.081	0.047	0.034	0.315	0.104	0.061	0.037	5.567	0.987	0.099	0.042
	UL: UPT CDF [Mbps]	5%	13.07	16.53	40.04	42.83	7.03	12.05	31.51	39.66	0.08	8.55	22.51	33.72
		50%	49.41	58.56	105.98	125.05	38.4	53.27	91.8	116.74	30.41	45.83	67.52	105.87
		95%	102.22	121.4	147.19	160.27	93.14	110.99	138.3	154.81	83.44	104.12	123.81	147.5
		Mean	52.89	64.21	102.17	116.19	42.07	57.13	87.14	108.72	32.76	49.37	69.99	100.33
	UL: Delay CDF [s]	5%	0.03	0.029	0.021	0.021	0.033	0.029	0.021	0.021	0.037	0.03	0.022	0.021
		50%	0.088	0.067	0.038	0.031	0.123	0.081	0.052	0.035	0.167	0.101	0.079	0.04
		95%	0.556	0.371	0.231	0.123	1.301	0.551	0.409	0.156	19.42	0.988	0.792	0.205
		Mean	0.172	0.12	0.072	0.047	0.602	0.172	0.114	0.055	9.271	1.706	0.213	0.068
	ρ_{DL}		1.00	0.99	1.01	1.00	0.99	1.00	0.99	1.00	0.98	1.00	1.00	1.00
	ρ_{UL}		1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.99	1.00	1.00
	BO		0.20	0.16	0.10	0.07	0.35	0.24	0.17	0.10	0.56	0.36	0.28	0.14
	λ		1.5 Mbps				2.0 Mbps				2.5 Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS disabled, Preamble detection enabled, ED/PD threshold -62/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval short, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. Switching points no longer than 16 µs every 2ms for CSI feedback, UL grant update.											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 / Source 7	**DL:** UPT CDF [Mbps]	5%	24.73	28.8	62.58	70.69	18.15	23.54	54.84	67.02	7.31	18.07	39.05	59.74
		50%	61.49	71.51	126.51	142.3	51.42	63.13	115.66	135.79	40.52	55.96	96.85	127.03
		95%	110.75	124.67	161.52	167.97	100.96	119.1	154.61	165.12	89.1	109.07	147.22	162.44
		Mean	65.1	75.06	121.21	134.15	54.95	68.03	110.2	128.18	43.76	59.22	96.14	121.98
	DL: Delay CDF [s]	5%	0.029	0.027	0.02	0.02	0.03	0.029	0.021	0.02	0.034	0.029	0.021	0.021
		50%	0.065	0.058	0.029	0.026	0.081	0.063	0.034	0.028	0.111	0.073	0.043	0.029
		95%	0.283	0.216	0.11	0.071	0.457	0.29	0.143	0.083	1.517	0.482	0.219	0.1
		Mean	0.102	0.081	0.044	0.034	0.206	0.102	0.055	0.037	2.555	0.26	0.075	0.042
	UL: UPT CDF [Mbps]	5%	12.54	16.79	40.72	42.83	8.47	12.95	31.14	39.66	2.11	8.48	22.2	33.72
		50%	50.29	60.7	107.17	125.05	41.76	52.3	92.76	116.74	32.35	45.56	72.5	105.87
		95%	104.61	116.74	148.37	160.27	94.54	109.1	137.83	154.81	83.02	104.62	127.41	147.5
		Mean	54.86	64.54	102.69	116.19	45.61	57.58	88.34	108.72	35.93	50.09	72.53	100.33
	UL: Delay CDF [s]	5%	0.029	0.029	0.021	0.021	0.03	0.029	0.021	0.021	0.035	0.03	0.021	0.021
		50%	0.084	0.067	0.037	0.031	0.112	0.081	0.051	0.035	0.154	0.102	0.073	0.04
		95%	0.501	0.366	0.221	0.123	0.879	0.528	0.343	0.156	4.109	0.95	0.599	0.205
		Mean	0.156	0.118	0.07	0.047	0.321	0.162	0.102	0.055	4.145	0.889	0.164	0.068
	ρ_{DL}		1.00	1.00	0.99	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00
	ρ_{UL}		1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00	1.00
	BO		0.19	0.16	0.09	0.07	0.31	0.24	0.16	0.10	0.49	0.36	0.26	0.14
	λ		1.5 Mbps				2.0 Mbps				2.5 Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS disabled, Preamble detection enabled, ED/PD threshold -72/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval short, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. Switching points no longer than than 16 µs every 2ms for CSI feedback, UL grant update.											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814018 / Source 8	**DL:** UPT CDF [Mbps]	5%	37.34	41.40	43.88	52.48	20.79	30.06	32.88	47.80	10.03	19.63	20.23	41.76
		50%	82.65	87.99	103.86	109.39	53.52	70.17	82.95	100.69	26.09	47.35	53.00	91.71
		95%	101.71	107.64	128.32	131.27	75.85	96.08	110.96	125.58	50.83	77.18	81.33	122.77
		Mean	80.59	85.85	101.63	106.44	54.14	71.08	83.27	98.89	30.03	51.30	55.92	93.23
	DL: Delay CDF [s]	5%	0.036	0.033	0.027	0.027	0.043	0.045	0.061	0.028	0.081	0.080	0.130	0.029
		50%	0.153	0.047	0.043	0.033	0.419	0.181	0.352	0.039	0.795	0.728	1.233	0.047
		95%	1.330	0.133	0.144	0.085	4.769	1.281	1.357	0.114	8.227	3.623	4.757	0.155
		Mean	0.447	0.071	0.069	0.045	1.536	0.447	0.609	0.060	2.768	1.473	2.075	0.073
	UL: UPT CDF [Mbps]	5%	42.00	44.75	41.41	45.44	22.36	34.18	31.51	39.79	9.59	19.35	16.65	34.78
		50%	82.62	88.39	80.06	85.38	52.08	71.33	61.99	75.66	24.37	46.54	38.21	67.85
		95%	100.22	106.42	99.98	102.96	74.51	93.30	84.68	97.05	48.94	74.92	60.96	91.67
		Mean	81.03	86.68	79.98	83.83	53.70	71.61	63.79	75.65	28.86	50.74	41.09	69.67
	UL: Delay CDF [s]	5%	0.036	0.033	0.035	0.034	0.059	0.042	0.044	0.036	0.092	0.061	0.083	0.040
		50%	0.092	0.047	0.058	0.045	0.478	0.136	0.263	0.061	0.820	0.295	1.079	0.073
		95%	1.147	0.135	0.159	0.100	4.177	1.001	1.816	0.167	7.586	2.958	7.736	0.199
		Mean	0.377	0.071	0.083	0.059	1.556	0.377	0.662	0.091	2.565	0.987	2.790	0.105
	ρ_{DL}		97%	100%	100%	100%	81%	97%	96%	100%	65%	92%	86%	100%
	ρ_{UL}		98%	100%	100%	100%	86%	99%	94%	100%	74%	95%	75%	100%
	BO		10%	5.4%	5.4%	4.4%	35%	%17	%17	8%	60%	37%	39%	11%
	λ		0.19 file/s				0.29 file/s				0.37 file/s			
			Additional comments: **Simulation setup:** NR-U indoor scenario, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm+3dBi, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** ED threshold -72dBm, SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling, COT sharing enabled (gNB initiated COT).											

Tdoc/Source	Reported parameters		Low load BO range for Wi-Fi in WiFi+WiFi: 10%~25% Wi-Fi in WiFi+WiFi	Low load Wi-Fi in WiFi+NR-U	Low load NR-U in WiFi+NR-U	Low load NR-U in NR-U+NR-U	Medium load BO range for Wi-Fi in WiFi+WiFi: 35%~50% Wi-Fi in WiFi+WiFi	Medium load Wi-Fi in WiFi+NR-U	Medium load NR-U in WiFi+NR-U	Medium load NR-U in NR-U+NR-U	High load BO range for Wi-Fi in WiFi+WiFi: above 55% Wi-Fi in WiFi+WiFi	High load Wi-Fi in WiFi+NR-U	High load NR-U in WiFi+NR-U	High load NR-U in NR-U+NR-U
R1-1814020/ Source 8	DL: UPT CDF [Mbps]	5%	36.07	36.72	40.01		20.58	28.27	30.45		8.01	16.81	18.02	
		50%	82.07	84.66	97.06		51.12	69.15	77.49		26.77	45.49	48.81	
		95%	101.56	108.41	126.90		76.09	93.57	108.07		52.36	73.29	78.57	
		Mean	79.66	84.17	96.94		53.74	69.22	79.15		31.05	48.27	52.77	
	DL: Delay CDF [s]	5%	0.036	0.033	0.027		0.052	0.045	0.054		0.063	0.061	0.129	
		50%	0.153	0.047	0.043		0.592	0.328	0.315		0.766	0.674	1.250	
		95%	1.330	0.133	0.144		5.923	1.644	1.620		7.578	4.717	5.346	
		Mean	0.447	0.071	0.069		1.865	0.611	0.667		2.534	1.694	2.280	
	UL: UPT CDF [Mbps]	5%	37.38	37.22	38.36		20.29	29.29	28.78		8.04	17.35	15.39	
		50%	79.95	82.84	79.06		48.77	64.94	59.72		24.69	41.37	36.21	
		95%	98.55	104.38	97.12		72.06	90.24	82.12		48.73	69.64	58.61	
		Mean	78.64	81.87	78.15		50.86	66.43	61.12		28.66	45.68	39.17	
	UL: Delay CDF [s]	5%	0.024	0.033	0.028		0.076	0.046	0.059		0.106	0.069	0.140	
		50%	0.055	0.047	0.058		0.566	0.158	0.490		0.826	0.359	1.186	
		95%	0.112	0.135	0.159		5.351	1.105	2.151		7.660	3.326	6.159	
		Mean	0.130	0.071	0.083		1.750	0.454	0.927		2.582	1.176	2.407	
	ρ_{DL}		97%	100%	100%		83%	97%	96%		66%	88%	86%	
	ρ_{UL}		99%	100%	100%		88%	98%	95%		76%	93%	83%	
	BO		10%	16%	2.6%		35%	17%	16%		60%	39%	39%	
	λ		0.17 file/s				0.24 file/s				0.33 file/s			

Additional comments:

Simulation setup: NR-U indoor scenario, 50/50 DL/UL traffics.

Common assumptions: Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}.

Wi-Fi assumptions: RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval.

NR-U assumptions: ED threshold -72dBm, SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling. COT sharing enabled (gNB initiated COT).

Other assumptions:

- Two VoIP UEs are modelled per operator for the non-replaced operator
- The shared COT is modelled as following exactly as permitted by EN 301 893. The following is assumed:
  - hardware turnaround time is less than 16us.
  - For gap of above 16us but does not exceed 25us: one-shot LBT is used

For gap exceeding 25us: one-shot LBT is used

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814020/ Source 8	DL: UPT CDF [Mbps]	5%	37.34	35.48	41.46		20.79	26.38	32.47		10.03	16.82	18.11	
		50%	82.65	81.62	97.56		53.52	65.42	76.81		26.09	46.09	51.99	
		95%	101.71	103.75	123.09		75.85	92.94	105.80		50.83	75.27	82.38	
		Mean	80.59	80.78	95.92		54.14	66.81	78.40		30.03	49.20	54.21	
	DL: Delay CDF [s]	5%	0.036	0.034	0.029		0.043	0.054	0.061		0.081	0.061	0.107	
		50%	0.153	0.050	0.046		0.419	0.267	0.382		0.795	0.558	1.018	
		95%	1.330	0.207	0.215		4.769	1.362	1.734		8.227	3.519	3.883	
		Mean	0.447	0.090	0.097		1.536	0.526	0.746		2.768	1.385	1.733	
	UL: UPT CDF [Mbps]	5%	42.00	39.55	38.97		22.36	26.79	28.29		9.59	18.07	15.67	
		50%	82.62	82.61	76.13		52.08	65.68	57.62		24.37	43.63	36.81	
		95%	100.22	102.75	94.69		74.51	91.29	78.41		48.94	73.29	60.47	
		Mean	81.03	81.57	75.49		53.70	66.42	59.10		28.86	48.28	40.21	
	UL: Delay CDF [s]	5%	0.036	0.034	0.037		0.059	0.045	0.048		0.092	0.057	0.063	
		50%	0.092	0.052	0.065		0.478	0.154	0.334		0.820	0.279	0.936	
		95%	1.147	0.181	0.250		4.177	1.017	1.961		7.586	2.582	6.071	
		Mean	0.377	0.086	0.108		1.556	0.392	0.823		2.565	0.909	2.283	
	ρ_{DL}		97%	100%	100%		81%	97%	96%		65%	91%	87%	
	ρ_{UL}		98%	100%	100%		86%	98%	93%		74%	96%	75%	
	BO		10%	6.3%	6.2%		35%	19%	19%		60%	37%	38%	
	λ		0.19 file/s				0.29 file/s				0.37 file/s			
			Additional comments: **Simulation setup:** NR-U indoor scenario, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** ED threshold -72dBm, SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling. COT sharing enabled (gNB initiated COT). **Other assumptions for NR-U:** - 1 ms long DRS is transmitted using 40ms periodicity and a DRS transmission window of 6 ms 25us LBT is used for DRS transmission												

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814020/ Source 8	DL: UPT CDF [Mbps]	5%	37.34	39.55	42.27		20.79	30.58	36.29		10.03	18.05	22.99	
		50%	82.65	86.13	101.46		53.52	73.21	85.70		26.09	51.70	58.63	
		95%	101.71	105.96	127.76		75.85	97.03	113.45		50.83	80.59	88.05	
		Mean	80.59	84.07	99.63		54.14	72.78	85.86		30.03	54.31	61.44	
	DL: Delay CDF [s]	5%	0.036	0.036	0.027		0.043	0.044	0.043		0.081	0.058	0.069	
		50%	0.153	0.053	0.045		0.419	0.173	0.176		0.795	0.432	0.758	
		95%	1.330	0.221	0.200		4.769	0.947	1.214		8.227	3.157	3.177	
		Mean	0.447	0.104	0.087		1.536	0.367	0.434		2.768	1.154	1.372	
	UL: UPT CDF [Mbps]	5%	42.00	42.41	37.74		22.36	33.36	26.97		9.59	18.82	15.85	
		50%	82.62	86.91	78.08		52.08	70.71	61.68		24.37	50.15	41.49	
		95%	100.22	104.90	96.85		74.51	93.64	85.94		48.94	77.51	62.82	
		Mean	81.03	85.37	77.13		53.70	71.39	62.85		28.86	52.97	43.53	
	UL: Delay CDF [s]	5%	0.036	0.034	0.036		0.059	0.041	0.057		0.092	0.053	0.235	
		50%	0.092	0.051	0.066		0.478	0.117	0.486		0.820	0.265	1.305	
		95%	1.147	0.172	0.210		4.177	0.782	1.625		7.586	1.784	4.950	
		Mean	0.377	0.088	0.105		1.556	0.287	0.733		2.565	0.717	2.140	
	ρ_{DL}		97%	100%	100%		81%	97%	97%		65%	90%	90%	
	ρ_{UL}		98%	100%	100%		86%	98%	95%		74%	95%	80%	
	BO		10%	6.2%	6.4%		35%	16%	16%		60%	33%	34%	
	λ		0.19 file/s				0.29 file/s				0.37 file/s			
			Additional comments: **Simulation setup:** NR-U indoor scenario, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** ED threshold -72dBm, SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling. COT sharing enabled (gNB initiated COT). **Other assumption for NR-U:** 20% of the UL transmissions are UL RACH transmissions with 25us LBT.											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
1-1812556 / SOURCE 2	**DL:** UPT CDF [Mbps]	5%	18.268	28.927	25.728	54.975	1.726	17.915	16.285	50.416	0.265	9.445	7.807	46.640
		50%	54.361	58.016	65.082	69.197	39.992	51.877	57.588	64.352	16.689	48.522	52.069	62.491
		95%	61.681	61.704	70.643	70.686	56.865	59.919	68.391	70.239	54.012	58.880	65.850	68.941
		Mean	49.522	53.936	60.081	66.666	34.027	47.806	52.259	62.680	22.774	44.045	46.999	60.818
	DL: Delay CDF [s]	5%	0.068	0.068	0.059	0.059	0.077	0.071	0.062	0.060	0.084	0.073	0.067	0.061
		50%	0.082	0.074	0.068	0.061	0.170	0.092	0.092	0.070	1.274	0.107	0.133	0.075
		95%	1.028	0.243	2.193	0.140	20.978	0.597	2.855	0.672	50.726	1.492	5.518	0.732
		Mean	0.615	0.177	1.537	0.145	3.480	0.268	1.519	0.173	9.934	0.516	1.950	0.179
	UL: UPT CDF [Mbps]	5%	3.249	21.607	5.012	40.063	0.148	12.103	2.399	24.877	0.003	5.661	0.030	25.941
		50%	53.859	57.058	50.527	54.950	37.878	51.712	40.200	49.174	16.032	48.471	34.614	46.898
		95%	61.790	61.815	58.788	59.297	57.646	60.269	54.446	56.350	54.671	58.894	51.578	55.014
		Mean	47.340	52.428	43.627	53.066	33.050	46.962	34.726	46.746	22.271	43.239	29.886	44.700
	UL: Delay CDF [s]	5%	0.068	0.068	0.071	0.071	0.075	0.070	0.080	0.075	0.082	0.073	0.087	0.078
		50%	0.086	0.077	0.090	0.079	0.205	0.098	0.171	0.097	0.787	0.115	0.280	0.109
		95%	6.556	0.350	8.910	0.866	46.665	1.200	18.475	2.292	104.829	12.454	96.034	2.234
		Mean	7.374	7.033	5.254	0.372	11.062	7.123	6.520	1.012	16.938	7.643	12.172	0.893
	ρ_{DL}		1.00	1.00	0.99	1.00	1.00	1.00	0.98	1.00	0.88	1.00	0.97	1.00
	ρ_{UL}		0.96	0.97	0.94	0.99	0.90	0.96	0.92	0.97	0.81	0.96	0.87	0.98
	BO		0.17	0.18	0.20	0.06	0.39	0.23	0.35	0.15	0.58	0.28	0.44	0.17
	λ		0.07				0.14				0.174			
			Additional comments: - COT assumptions of WiFi and NR-U: Up to 4 msec COT for both DL/UL Wi-Fi and DL/UL NR-U transmission - Is RTS/CTS enabled for WiFi: No - PD/ED threshold assumptions: For Wi-Fi, -82/62 dBm PD/ED threshold and for NR-U, -72 dBm ED threshold - Max modulation order supported in each technology: 64 QAM for both Wi-Fi and NR-U - MIMO scheme and number of MIMO layers used for both technologies: 1Tx2Rx antenna configuration for both Wi-Fi and NR-U - WiFi MAC layer A-MPDU/A-MSDU aggregation level, MPDU size: 802.11ac - NR-U SCS: 15 kHz - WiFi guard interval: 0.8 μsec - NR UE processing time capability (#1 or #2): Processing time capability #1 - NR PDSCH/PUSCH mapping type, PDCCH monitoring configuration: For PDSCH, PDSCH mapping type A and B (with 7 symbols), for PUSCH, PUSCH mapping type A with 14 symbols, for PDCCH, PDCCH monitoring every 7 symbols - Link adaptation assumptions: For Wi-Fi, open loop rate adaptation, for NR-U, realistic closed loop link adaptation - Cross-carrier scheduling for NR-U											

Table B.1.1-2: Wi-Fi and NR-U coexistence evaluation with 20MHz and FTP traffic with and without NR-U PD

Tdoc / Source	Reported parameters		Low load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 10%~25%			Medium load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 35%~50%			High load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: above 55%		
			NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	NR-U in NR-U + Wi-Fi, with NR-U uses ED = -77dBm	NR-U in NR-U + Wi-Fi, with NR-U uses preamble	NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	NR-U in NR-U + Wi-Fi, with NR-U uses ED = -77dBm	NR-U in NR-U + Wi-Fi, with NR-U uses preamble	NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	NR-U in NR-U + Wi-Fi, with NR-U uses ED = -77dBm	NR-U in NR-U + Wi-Fi, with NR-U uses preamble
R1-1814021/ Source 8	DL: UPT CDF [Mbps]	5%	37.93	40.83	43.46	22.31	29.57	29.97	7.77	14.55	10.87
		50%	93.51	95.18	97.42	57.82	70.99	68.70	24.82	40.29	30.47
		95%	120.76	121.81	122.11	86.46	102.10	97.17	48.64	68.93	54.55
		Mean	92.96	93.87	96.01	60.44	73.38	70.83	28.72	44.18	34.22
	DL: Delay CDF [s]	5%	0.038	0.028	0.031	0.121	0.087	0.060	0.178	0.100	0.154
		50%	0.126	0.119	0.129	1.105	0.498	0.530	1.911	1.108	1.603
		95%	0.470	0.446	0.539	4.212	1.916	2.730	7.922	4.527	7.550
		Mean	0.217	0.212	0.240	1.856	0.808	1.037	3.266	1.937	2.984
	UL: UPT CDF [Mbps]	5%	35.65	39.05	38.10	18.70	25.76	23.10	6.29	10.84	6.79
		50%	70.55	73.56	73.38	41.95	52.63	50.44	16.86	27.90	20.41
		95%	92.92	93.58	93.04	65.06	74.67	73.10	34.89	49.33	38.99
		Mean	71.61	73.82	73.83	44.69	54.88	52.85	20.37	31.26	23.51
	UL: Delay CDF [s]	5%	0.039	0.036	0.039	0.075	0.059	0.050	0.156	0.122	0.197
		50%	0.108	0.153	0.153	0.942	0.536	0.540	1.926	1.011	1.961
		95%	0.586	0.526	0.670	6.920	2.621	3.578	11.836	5.838	9.880
		Mean	0.231	0.263	0.324	2.486	1.041	1.228	4.362	2.353	3.797
	ρ_{DL}		99%	99%	99%	88%	95%	90%	73%	81%	72%
	ρ_{UL}		98%	99%	98%	78%	91%	88%	50%	68%	64%
	BO		10%	09%	10%	35%	23%	27%	60%	46%	58%
	λ		0.25 file/s			0.36 file/s			0.48 file/s		
			Additional comments: **Simulation setup:** NR-U indoor scenario, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling. COT sharing enabled (gNB initiated COT).								

Evaluation results of Wi-Fi in an NR-U + Wi-Fi coexistence in indoor scenario											
Tdoc / Source	Reported parameters		Low load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 10%~25%			Medium load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 35%~50%			High load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: above 55%		
			Wi-Fi in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	Wi-Fi in NR-U + Wi-Fi, with NR-U uses ED = -77dBm	Wi-Fi in NR-U + Wi-Fi, with NR-U uses preamble	Wi-Fi in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	Wi-Fi in NR-U + Wi-Fi, with NR-U uses ED = -77dBm	Wi-Fi in NR-U + Wi-Fi, with NR-U uses preamble	Wi-Fi in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	Wi-Fi in NR-U + Wi-Fi, with NR-U uses ED = -77dBm	Wi-Fi in NR-U + Wi-Fi, with NR-U uses preamble
R1-1814021/ Source 8	DL: UPT CDF [Mbps]	5%	36.00	36.99	35.89	21.37	26.47	24.58	8.97	14.08	10.40
		50%	78.53	83.05	82.75	51.09	67.01	60.71	25.08	41.67	29.13
		95%	102.74	104.15	103.38	80.38	91.80	85.20	57.27	71.88	54.89
		Mean	78.56	81.13	81.05	54.61	67.01	61.56	31.12	44.93	33.24
	DL: Delay CDF [s]	5%	0.036	0.034	0.037	0.076	0.046	0.050	0.094	0.088	0.086
		50%	0.081	0.069	0.098	0.670	0.200	0.589	0.969	0.570	0.994
		95%	0.477	0.296	0.634	3.188	1.064	2.606	6.670	3.621	6.885
		Mean	0.176	0.126	0.224	1.312	0.416	1.071	2.388	1.308	2.487
	UL: UPT CDF [Mbps]	5%	39.30	40.53	39.01	21.54	29.15	26.16	7.62	14.50	10.67
		50%	79.42	83.43	81.81	50.43	63.95	60.45	24.42	38.09	29.54
		95%	100.50	102.76	101.66	77.94	90.60	84.28	56.90	70.67	56.14
		Mean	79.00	81.76	81.12	54.08	66.07	61.51	31.42	44.07	33.57
	UL: Delay CDF [s]	5%	0.036	0.034	0.036	0.058	0.043	0.051	0.083	0.063	0.090
		50%	0.077	0.067	0.081	0.271	0.149	0.246	0.432	0.284	0.491
		95%	0.388	0.286	0.590	2.639	1.171	1.849	4.849	2.642	4.917
		Mean	0.163	0.128	0.229	0.888	0.417	0.700	1.560	0.984	1.635
	ρ_{DL}		99%	100%	99%	93%	97%	92%	80%	91%	75%
	ρ_{UL}		100%	100%	99%	95%	99%	96%	89%	94%	87%
	BO		11%	8.7%	9.6%	34%	21%	28%	59%	43%	57%
	λ		0.25 file/s			0.36 file/s			0.48 file/s		
			Additional comments: **Simulation setup:** NR-U indoor scenario, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling. COT sharing enabled (gNB initiated COT).								

Table B.1.1-3: Evaluation results for NR-U with using different SCS in a single NR-U indoor network deployment

Tdoc /Sourc	Reported parameters		Low load BO range for NR-U with 15 kHz SCS: 10%~25%				Medium load BO range for NR-U with 15 kHz SCS: 35%~50%				High load BO range for NR-U with 15 kHz SCS: above 55%			
			NR-U with SCS = 15 kHz	NR-U with SCS = 30 kHz	NR-U with SCS = 60 kHz		NR-U with SCS = 15 kHz	NR-U with SCS = 30 kHz	NR-U with SCS = 60 kHz		NR-U with SCS = 15 kHz	NR-U with SCS = 30 kHz	NR-U with SCS = 60 kHz	
R1-1814019/Source 8	DL: UPT CDF [Mbps]	5%	45.76	45.65	43.84		30.44	30.23	30.30		14.61	15.83	16.46	
		50%	102.66	105.01	97.29		73.61	76.32	70.56		43.23	48.01	44.76	
		95%	127.84	128.03	121.30		105.71	106.15	103.64		77.31	80.52	78.27	
		Mean	101.23	101.99	95.85		76.03	77.27	73.88		48.42	52.11	49.49	
	DL: Delay CDF [s]	5%	0.028	0.027	0.029		0.037	0.037	0.037		0.075	0.063	0.058	
		50%	0.037	0.035	0.038		0.074	0.072	0.073		0.248	0.171	0.177	
		95%	0.077	0.077	0.086		0.242	0.201	0.225		0.952	0.673	0.666	
		Mean	0.047	0.045	0.050		0.118	0.103	0.104		0.405	0.297	0.291	
	UL: UPT CDF [Mbps]	5%	35.40	42.16	41.93		21.17	24.96	24.77		8.38	11.57	10.79	
		50%	65.65	79.95	83.71		44.07	55.15	57.67		24.12	31.89	31.97	
		95%	79.60	99.91	104.84		65.65	81.00	85.76		46.12	58.91	59.88	
		Mean	65.19	80.08	83.38		46.55	57.61	60.54		28.02	36.02	36.42	
	UL: Delay CDF [s]	5%	0.044	0.036	0.034		0.059	0.049	0.045		0.097	0.099	0.095	
		50%	0.057	0.046	0.046		0.146	0.105	0.109		0.334	0.271	0.334	
		95%	0.105	0.090	0.090		0.498	0.325	0.316		1.991	1.301	1.538	
		Mean	0.069	0.057	0.057		0.224	0.182	0.156		0.736	0.568	0.627	
	ρ_{DL}		100%	100%	100%		99%	99%	100%		96%	97%	97%	
	ρ_{UL}		100%	99%	99%		99%	98%	99%		90%	91%	91%	
	BO		12%	11%	11%		35%	32%	32%		60%	56%	56%	
	λ		0.5 file/s				1.1 file/s				1.5 file/s			
			Additional comments: **Simulation setup:** NR-U indoor scenario, 50/50 DL/UL traffics, single NR-U operator, NR-U uses 15kHz, 30kHz, and 60kHz SCSs. **NR-U assumptions:** ED threshold -72dBm, Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS and 2 for UE, BF scheme: Tx and Rx BF at BS, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS transmit power 20dBm, UE transmit power 18dBm, MMSE-IRC receiver, . CW {min,max} DL{15,63} UL{15,1023}. UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling. COT sharing enabled (gNB initiated COT).												

Table B.1.1-4: Evaluation results for Wi-Fi and NRU coexistence using different SCS for NR-U in an indoor deployment

Tdoc /Source	Reported parameters		Low load BO range for WiFi in NR-U+WiFi with NR-U uses 15 kHz SCS: 10%~25%				Medium load BO range for WiFi in NR-U+WiFi with NR-U uses 15 kHz SCS: 35%~50%				High load BO range for WiFi in NR-U+WiFi with NR-U use 15 kHz SCS: above 55%			
			NR-U with SCS = 15 kHz	NR-U with SCS = 30 kHz	NR-U with SCS = 60 kHz		NR-U with SCS = 15 kHz	NR-U with SCS = 30 kHz	NR-U with SCS = 60 kHz		NR-U with SCS = 15 kHz	NR-U with SCS = 30 kHz	NR-U with SCS = 60 kHz	
R1-1814019/Source 8	DL: UPT CDF [Mbps]	5%	37.58	38.68	36.81		20.53	20.00	19.94		5.08	7.89	6.39	
		50%	90.49	93.88	86.31		54.62	52.63	49.33		22.27	25.86	21.70	
		95%	120.41	121.31	112.82		84.76	81.61	75.09		46.45	50.51	45.51	
		Mean	90.67	93.20	86.40		57.59	56.18	51.94		26.33	30.32	26.51	
	DL: Delay CDF [s]	5%	0.034	0.030	0.037		0.170	0.109	0.131		0.225	0.168	0.251	
		50%	0.219	0.099	0.219		1.020	1.210	1.221		2.326	1.758	1.761	
		95%	1.074	0.543	1.458		3.984	5.008	6.284		9.477	7.743	7.913	
		Mean	0.411	36.46	0.489		1.747	2.115	2.366		3.944	3.151	3.307	
	UL: UPT CDF [Mbps]	5%	29.47	36.46	36.58		15.22	17.49	16.79		3.54	6.42	5.31	
		50%	55.38	71.12	72.63		33.00	39.70	38.75		12.06	18.15	16.83	
		95%	73.31	92.86	96.49		49.54	61.51	60.87		25.13	36.27	35.35	
		Mean	56.80	71.88	73.66		35.03	42.22	41.40		14.65	21.43	19.90	
	UL: Delay CDF [s]	5%	0.048	0.039	0.040		0.126	0.074	0.087		0.146	0.117	0.171	
		50%	0.304	0.112	0.151		1.019	1.573	1.020		2.030	1.903	1.835	
		95%	1.438	0.970	1.389		5.895	7.188	8.400		13.762	10.763	12.443	
		Mean	0.606	0.334	0.430		2.197	2.778	2.917		4.942	4.171	4.510	
	ρ_{DL}		98%	99%	98%		88%	88%	86%		72%	76%	74%	
	ρ_{UL}		97%	98%	97%		77%	77%	74%		48%	53%	52%	
	BO		13%	10%	12%		37%	37%	40%		63%	58%	61%	
	λ		0.25 file/s				0.38 file/s				0.48 file/s			
			Additional comments: **Simulation setup:** NR-U indoor scenario, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** ED threshold -72dBm, SCSs: 15kHz, 30kHz, and 60kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling, COT sharing enabled (gNB initiated COT).												

Table B.1.1-5 Evaluation results for 11ax and NR-U in 11ax+NR-U coexistence in indoor scenario. Two cases are considered: (1) 11ax uses ED = -62dBm; and (2) 11ax uses ED=-72dBm.

Tdoc /Source	Reported parameters		Low load BO range for NR-U in 11ax+NR-U with 11ax using ED = -62dBm: 10%~25%				Medium load BO range for NR-U in 11ax+NR-U with 11ax using ED = -62dBm: 35%~50%				High load BO range for NR-U in 11ax+NR-U with 11ax using ED = -62dBm: above 55%			
			11ax when 11ax uses ED = -62dBm	11ax when 11ax uses ED = -72dBm	NR-U when11ax uses ED =-62dBm	NR-U when 11ax uses ED = -72dBm	11ax when 11ax uses ED = -62dBm	11ax when 11ax uses ED = -72dBm	NR-U when 11ax uses ED = -62dBm	NR-U when 11ax uses ED = -72dBm	11ax when 11ax uses ED = -62dBm	11ax when 11ax uses ED = -72dBm	NR-U when 11ax uses ED = -62dBm	NR-U when 11ax uses ED = -72dBm
R1-1814020/ Source 8	DL: UPT CDF [Mbps]	5%	34.47	35.06	42.91	45.32	19.69	23.81	23.21	29.09	7.73	10.56	8.32	12.87
		50%	85.92	87.86	93.48	99.59	53.19	61.04	55.16	70.13	24.20	31.53	25.01	35.86
		95%	108.87	111.00	123.48	125.69	81.96	88.03	88.96	104.38	53.36	58.99	54.62	70.73
		Mean	84.06	86.13	94.26	98.08	56.08	62.86	59.93	72.61	30.12	36.24	30.98	42.03
	DL: Delay CDF [s]	5%	0.034	0.032	0.030	0.029	0.088	0.086	0.113	0.047	0.169	0.159	0.195	0.093
		50%	0.086	0.051	0.062	0.043	0.774	0.419	0.580	0.193	1.560	1.225	1.457	0.531
		95%	0.540	0.249	0.286	0.167	2.627	1.598	3.295	0.899	5.650	4.421	6.918	3.000
		Mean	0.205	0.104	0.127	0.080	1.204	0.681	1.300	0.373	2.444	1.892	2.814	1.142
	UL: UPT CDF [Mbps]	5%	34.98	38.18	42.16	45.55	18.40	23.38	19.11	25.10	5.92	8.10	5.71	8.30
		50%	78.76	83.02	86.16	91.22	46.82	53.78	46.47	57.49	21.21	25.80	17.15	24.02
		95%	106.81	108.13	117.65	119.12	75.02	79.84	76.93	89.50	44.59	50.23	38.95	51.63
		Mean	80.39	83.09	88.30	91.26	49.89	56.25	51.03	61.10	25.10	29.54	21.52	29.51
	UL: Delay CDF [s]	5%	0.036	0.034	0.034	0.031	0.096	0.098	0.110	0.103	0.177	0.186	0.251	0.230
		50%	0.092	0.066	0.111	0.062	0.418	0.451	0.990	0.483	0.959	1.234	2.254	1.306
		95%	0.366	0.242	0.520	0.221	3.540	1.903	4.595	2.210	6.068	5.078	9.311	6.682
		Mean	0.172	0.113	0.211	0.102	1.167	0.825	1.917	0.934	2.243	2.153	3.820	2.599
	ρ_{DL}		99.7%	99.7%	99.8%	99.9%	94.4%	97.1%	93.2%	98.8%	86.8%	89.6%	82.2%	95.1%
	ρ_{UL}		99.8%	99.9%	99.4%	99.8%	95.7%	96.9%	85%	94.7%	87.6%	88.5%	63.5%	81.6%
	BO		10.1%	8.5%	10%	7.8%	33.6%	28%	35%	25.8%	57.8%	53.4%	60%	50.1%
	λ		0.26 file/s				0.42 file/s				0.55 file/s			
			Additional comments: **Simulation setup:** NR-U indoor scenario, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi 11ax assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm or -72/-82dBm, A-MPDU frame aggregation, Wi-Fi guard interval 1.6us, UL OFDMA with 16us carrier sensing. **NR-U assumptions:** ED threshold -72dBm, SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, control on the unlicensed channel. COT sharing enabled (gNB initiated COT).											

Table B.1.1-6: Wi-Fi/NR-U coexistence when NR-U uses -82 dBm EDT or NR-U enables preamble detection

Tdoc /Source	Reported parameters		Low load BO range for Wi-Fi in WiFi+WiFi: 10%~25%				Medium load BO range for Wi-Fi in WiFi+WiFi: 35%~50%				High load BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ NR-U with -82 dBm EDT for NR-U	NR-U in WiFi+ NR-U with -82 dBm EDT for NR-U	Wi-Fi in WiFi+ NR-U with preamble for NR-U	NR-U in WiFi+ NR-U with preamble for NR-U	Wi-Fi in WiFi+ NR-U with -82 dBm EDT for NR-U	NR-U in WiFi+ NR-U with -82 dBm EDT for NR-U	Wi-Fi in WiFi+ NR-U with preamble for NR-U	NR-U in WiFi+ NR-U with preamble for NR-U	Wi-Fi in WiFi+ NR-U with -82 dBm EDT for NR-U	NR-U in WiFi+ NR-U with -82 dBm EDT for NR-U	Wi-Fi in WiFi+ NR-U with preamble for NR-U	NR-U in WiFi+ NR-U with preamble for NR-U
R1-1814074 / Source 5	**DL:** UPT CDF [Mbps]	5%	11.844	20.740	6.704	15.359	3.058	3.269	4.072	4.121	0.459	0.792	0.417	0.862
		50%	39.777	64.211	39.299	58.714	27.595	37.322	26.132	31.967	12.037	14.931	6.926	16.210
		95%	54.888	74.117	59.415	73.970	53.332	74.131	50.016	74.092	43.630	73.584	40.343	45.916
		Mean	35.605	58.521	35.192	54.882	26.831	36.968	26.143	36.561	15.475	21.909	14.680	18.319
	DL: Delay CDF [s]	5%	0.050	0.054	0.050	0.054	0.050	0.054	0.050	0.054	0.050	0.054	0.050	0.054
		50%	0.052	0.056	0.051	0.057	0.100	0.093	0.094	0.110	0.231	0.227	0.371	0.273
		95%	0.200	0.196	0.319	0.179	3.260	0.925	1.321	0.900	3.837	1.757	4.572	1.541
		Mean	0.153	0.084	0.133	0.099	0.413	0.212	0.348	0.249	0.832	0.493	1.007	0.484
	UL: UPT CDF [Mbps]	5%	8.691	24.543	2.276	23.232	1.364	5.109	4.791	4.106	0.264	1.971	0.193	3.017
		50%	40.088	59.708	39.980	58.156	29.692	31.916	24.888	30.161	10.969	17.435	9.216	16.412
		95%	53.620	73.467	53.514	73.455	54.812	73.199	42.643	73.054	43.156	56.293	40.145	51.652
		Mean	39.350	56.899	35.535	56.401	27.623	36.432	25.310	35.882	17.170	21.645	14.194	21.738
	UL: Delay CDF [s]	5%	0.050	0.054	0.050	0.054	0.050	0.054	0.050	0.054	0.050	0.055	0.050	0.055
		50%	0.050	0.060	0.053	0.070	0.094	0.116	0.125	0.131	0.243	0.261	0.391	0.241
		95%	0.265	0.201	2.338	0.205	2.458	0.741	1.499	0.843	4.341	1.507	4.090	1.390
		Mean	0.089	0.088	0.270	0.091	0.459	0.198	0.364	0.251	0.928	0.430	1.112	0.415
	ρ_{DL}		0.992	0.992	0.99	1	0.959	0.973	0.993	0.976	0.906	0.967	0.910	0.905
	ρ_{UL}		0.987	0.996	1	0.995	0.962	0.956	0.975	0.942	0.888	0.915	0.86	0.921
	BO		0.057	0.061	0.105	0.096	0.244	0.32	0.26	0.321	0.541	0.566	0.572	0.550
	λ		0.15				0.22				0.3			
			Additional comments: - 4ms for both Wi-Fi and NR-U - No - For Wi-Fi, PDT = -82 dBm, EDT = -62 dBm; for NR-U, if preamble is enabled PDT = -82 dBm and EDT = -72 dBm; for NR-U with -82 dBm EDT, preamble detection is not enabled - 256 QAM for both Wi-Fi and NR-U - NR-U with array radiation pattern according to TR38.802 and max BF gain of 5 dBi; omni-directional for Wi-Fi - MPDU size = 3250 bytes by default, 1ms per MPDU - 30 kHz - 0.8 µs - Capability #1 - Mapping type B in the starting slot of TxOP; per-symbol PDCCH monitoring for flexible starting position - No fast link adaptation utilizing multiple switching points within COT for NR-U - Cross-carrier scheduling in UL											

Table B.1.1-7: NR-U/NR-U coexistence when NR-U uses -82 dBm EDT or NR-U enables preamble detection

Tdoc /Source	Reported parameters		Low load BO range for Wi-Fi in WiFi+WiFi: 10%~25%		Medium load BO range for Wi-Fi in WiFi+WiFi: 35%~50%		High load BO range for Wi-Fi in WiFi+WiFi: above 55%	
			NR-U in NR-U+ NR-U with -82 dBm EDT for NR-U	NR-U in NR-U+ NR-U with preamble for NR-U	NR-U in NR-U+ NR-U with -82 dBm EDT for NR-U	NR-U in NR-U+ NR-U with preamble for NR-U	NR-U in NR-U+ NR-U with -82 dBm EDT for NR-U	NR-U in NR-U+ NR-U with preamble for NR-U
R1-1814074 / Source 5	**DL:** UPT CDF [Mbps]	5%	7.381	7.145	7.594	5.92	2.152	0.838
		50%	64.293	64.227	42.450	41.796	26.792	19.590
		95%	74.074	74.017	72.321	73.868	73.921	73.523
		Mean	55.454	55.155	41.821	40.578	30.035	25.640
	DL: Delay CDF [s]	5%	0.054	0.054	0.054	0.054	0.054	0.054
		50%	0.056	0.055	0.113	0.118	0.160	0.197
		95%	0.300	0.277	0.441	0.679	1.233	1.266
		Mean	0.105	0.107	0.162	0.203	0.325	0.344
	UL: UPT CDF [Mbps]	5%	21.794	18.683	12.913	3.75	3.052	2.554
		50%	55.064	55.591	41.878	41.489	30.016	19.780
		95%	73.547	73.566	72.849	73.248	72.988	61.286
		Mean	54.467	53.842	42.875	40.371	30.031	26.182
	UL: Delay CDF [s]	5%	0.054	0.054	0.054	0.054	0.054	0.054
		50%	0.067	0.064	0.085	0.106	0.165	0.164
		95%	0.175	0.205	0.540	0.910	1.260	1.089
		Mean	0.088	0.111	0.149	0.227	0.320	0.321
	ρ_{DL}		1	1	0.988	0.968	0.985	0.931
	ρ_{UL}		1	1	0.991	0.992	0.984	0.978
	BO		0.075	0.081	0.199	0.252	0.395	0.51
	λ		0.15		0.22		0.3	
			Additional comments: - 4ms - No - for NR-U, if preamble is enabled PDT = -82 dBm and EDT = -72 dBm; for NR-U with -82 dBm EDT, preamble detection is not enabled - 256 QAM for NR-U - NR-U with array radiation pattern according to TR38.802 and max BF gain of 5 dBi - 30 kHz - Capability #1 - Mapping type B in the starting slot of TxOP; per-symbol PDCCH monitoring for flexible starting position - No fast link adaptation utilizing multiple switching points within COT for NR-U - Cross-carrier scheduling in UL					

Table B.1.1-8: coexistence results of 11ax and NRU in indoor scenario of scheme 1

	Reported parameters		11ax PD=ED = -82dbm NRU ED=-82dbm			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R-1814085(Source 4)	**DL:** UPT CDF [Mbps]	5%	16.54	18.31	22.78	23.7
		50%	55.92	62.74	60.73	70.72
		95%	100.97	101.1	96.67	99.12
		Mean	58.21	62.87	62.37	68.40
	DL: Delay CDF [s]	5%	0.04	0.04	0.04	0.04
		50%	0.07	0.06	0.07	0.06
		95%	0.24	0.22	0.17	0.17
		Mean	0.1	0.09	0.08	0.07
	UL: UPT CDF [Mbps]	5%	13.05	15.91	11.96	17.21
		50%	49.55	54.82	37.97	52.34
		95%	90.84	91.08	76.75	84.96
		Mean	52.10	55.44	42.26	53.95
	UL: Delay CDF [s]	5%	0.04	0.04	0.05	0.05
		50%	0.08	0.07	0.1	0.08
		95%	0.3	0.25	0.33	0.23
		Mean	0.12	0.1	0.14	0.1
	ρ_{DL}		99.80%	99.71%	99.87%	99.88%
	ρ_{UL}		99.67%	99.72%	99.63%	99.68%
	BO		23%	21%	25%	20%
	λ		0.3 files/s			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-82dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ax assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=--82dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,78.125kHz SCS GI= 0.8us, HE MU PPDU in DL and HE TB PPDU in UL.			

Table B.1.1-9: coexistence results of 11ax and NRU in indoor scenario of scheme 2

	Reported parameters		11ax PD=ED= = 72dbm NRU ED=-72dbm			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R-1814085(Source 4)	**DL:** UPT CDF [Mbps]	5%	14.76	18.62	29.88	30.67
		50%	67.54	72.49	78.04	83.06
		95%	101.74	101.66	96.79	99.24
		Mean	65.34	68.89	72.01	75.01
	DL:	5%	0.04	0.04	0.04	0.04
	Delay CDF [s]	50%	0.06	0.06	0.05	0.05
		95%	0.26	0.21	0.13	0.13
		Mean	0.11	0.08	0.07	0.06
	UL: UPT CDF [Mbps]	5%	12.77	19.28	18.3	24.58
		50%	65.55	68.14	54.13	67.12
		95%	91.73	91.69	76.83	85.02
		Mean	60.35	63.39	53.12	62.43
	UL: Delay CDF [s]	5%	0.04	0.04	0.05	0.05
		50%	0.06	0.06	0.07	0.06
		95%	0.3	0.21	0.22	0.16
		Mean	0.11	0.08	0.09	0.08
	ρ_{DL}		99.61%	99.73%	99.86%	99.89%
	ρ_{UL}		99.68%	99.80%	99.73%	99.74%
	BO		22%	19%	20%	17%
	λ		0.3 files/s			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-72dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ax assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-72dBm/ED=--72dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,78.125kHz SCS GI= 0.8us, HE MU PPDU in DL and HE TB PPDU in UL.			

Table B.1.1-10: coexistence results of 11ax and NRU in indoor scenario of scheme 3

	Reported parameters		11ax PD=ED= - 62dbm NRU ED= - 62dbm			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R-1814085(Source 4)	**DL:** UPT CDF [Mbps]	5%	9.13	18.86	30.89	32.71
		50%	69.11	74.88	81.65	86.55
		95%	101.84	102.03	96.84	99.23
		Mean	65.66	70.40	74.14	76.87
	DL:	5%	0.04	0.04	0.04	0.04
	Delay CDF [s]	50%	0.06	0.05	0.05	0.05
		95%	0.41	0.21	0.13	0.12
		Mean	0.13	0.08	0.06	0.06
	UL: UPT CDF [Mbps]	5%	9.85	19.31	23.09	28.83
		50%	68.81	75.71	65.13	76.65
		95%	91.8	91.86	76.85	85.04
		Mean	61.88	66.62	58.40	66.81
	UL: Delay CDF [s]	5%	0.04	0.04	0.05	0.05
		50%	0.06	0.05	0.06	0.05
		95%	0.4	0.2	0.17	0.14
		Mean	0.13	0.08	0.08	0.07
	ρ_{DL}		99.52%	99.67%	99.79%	99.88%
	ρ_{UL}		99.64%	99.67%	99.78%	99.77%
	BO		24%	18%	18%	16%
	λ		0.3 files/s			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-62dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ax assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-62dBm/ED=--62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,78.125kHz SCS GI= 0.8us, HE MU PPDU in DL and HE TB PPDU in UL.			

Table B.1.1-11: coexistence results of 11ax and NRU in indoor scenario of scheme 4

	Reported parameters		11ax PD=-82dbm, ED=-62dbm NRU PD=-82dbm, ED=-62dbm			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R-1814085(Source 4)	**DL:** UPT CDF [Mbps]	5%	14.9	17.69	30.39	23.7
		50%	57.96	68.55	78.15	70.72
		95%	101.19	101.79	96.79	99.12
		Mean	59.46	66.85	72.52	68.40
	DL: Delay CDF [s]	5%	0.04	0.04	0.04	0.04
		50%	0.07	0.06	0.05	0.06
		95%	0.27	0.22	0.13	0.17
		Mean	0.1	0.08	0.06	0.07
	UL: UPT CDF [Mbps]	5%	14	18.79	22.73	17.21
		50%	53.98	65.81	61.76	52.34
		95%	91.19	91.74	76.83	84.96
		Mean	55.32	62.56	57.11	53.95
	UL: Delay CDF [s]	5%	0.04	0.04	0.05	0.05
		50%	0.07	0.06	0.06	0.08
		95%	0.28	0.21	0.17	0.23
		Mean	0.11	0.09	0.08	0.1
	ρ_{DL}		99.83%	99.89%	99.99%	99.88%
	ρ_{UL}		99.69%	99.86%	99.78%	99.68%
	BO		23%	19%	18%	20%
	λ		0.3 files/s			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; PD= -82dBm, ED=-62dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ax assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=--62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,78.125kHz SCS GI= 0.8us, HE MU PPDU in DL and HE TB PPDU in UL.			

Table B.1.1-12: coexistence results of 11ax and NRU in indoor scenario of scheme 5

	Reported parameters		11ax: ED = -62dbm, PD=-82dbm NRU: ED = -72dbm			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R-1814085(Source 4)	**DL:** UPT CDF [Mbps]	5%	14.9	18.99	28.05	30.67
		50%	57.96	70.27	76.15	83.06
		95%	101.19	101.89	96.8	99.24
		Mean	59.46	68.03	70.85	75.01
	DL: Delay CDF [s]	5%	0.04	0.04	0.04	0.04
		50%	0.07	0.06	0.05	0.05
		95%	0.27	0.21	0.14	0.13
		Mean	0.1	0.08	0.07	0.06
	UL: UPT CDF [Mbps]	5%	14	19.78	17.78	24.58
		50%	53.98	66.55	53.6	67.12
		95%	91.19	91.39	76.83	85.02
		Mean	55.32	62.89	52.62	62.43
	UL: Delay CDF [s]	5%	0.04	0.04	0.05	0.05
		50%	0.07	0.06	0.07	0.06
		95%	0.28	0.2	0.23	0.16
		Mean	0.11	0.09	0.1	0.08
	ρ_{DL}		99.83%	99.68%	99.85%	99.89%
	ρ_{UL}		99.69%	99.72%	99.62%	99.74%
	BO		23%	19%	20%	17%
	λ		0.3 files/s			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-72dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ax assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=--62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,78.125kHz SCS GI= 0.8us, HE MU PPDU in DL and HE TB PPDU in UL.			

Table B1.1-13: coexistence results of 11ax and NRU in indoor scenario of scheme 6

	Reported parameters		11ax: ED = -72dbm, PD=-82dbm NRU: ED = -72dbm			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R-1814085(Source 4)	**DL:** UPT CDF [Mbps]	5%	15.82	18.64	29.8	30.67
		50%	57.3	68.45	77.53	83.06
		95%	100.87	101.7	96.86	99.24
		Mean	59.38	66.68	71.81	75.01
	DL: Delay CDF [s]	5%	0.04	0.04	0.04	0.04
		50%	0.07	0.06	0.05	0.05
		95%	0.25	0.21	0.14	0.13
		Mean	0.1	0.08	0.07	0.06
	UL: UPT CDF [Mbps]	5%	13.02	18	18.16	24.58
		50%	52.69	59.95	54.28	67.12
		95%	91.05	91.69	76.83	85.02
		Mean	54.07	59.82	52.86	62.43
	UL: Delay CDF [s]	5%	0.04	0.04	0.05	0.05
		50%	0.08	0.07	0.07	0.06
		95%	0.31	0.22	0.22	0.16
		Mean	0.11	0.09	0.09	0.08
	ρ_{DL}		99.77%	99.60%	99.86%	99.89%
	ρ_{UL}		99.68%	99.70%	99.65%	99.74%
	BO		23%	19%	20%	17%
	λ		0.3 files/s			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-72dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ax assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=--72dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,78.125kHz SCS GI= 0.8us, HE MU PPDU in DL and HE TB PPDU in UL.			

Table B.1.1-14: coexistence results of 11ax and NRU in indoor scenario of scheme 7

	Reported parameters		11ax: ED = -62dbm, PD=-82dbm NRU: ED = -62dbm			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R-1814085(Source 4)	**DL:** UPT CDF [Mbps]	5%	14.9	17.72	30.29	32.71
		50%	57.96	69.19	80.72	86.55
		95%	101.19	101.81	96.87	99.23
		Mean	59.46	67.08	73.72	76.87
	DL: Delay CDF [s]	5%	0.04	0.04	0.04	0.04
		50%	0.07	0.06	0.05	0.05
		95%	0.27	0.23	0.13	0.12
		Mean	0.1	0.08	0.06	0.06
	UL: UPT CDF [Mbps]	5%	14	18.74	23.44	28.83
		50%	53.98	66.53	64.89	76.65
		95%	91.19	91.8	76.85	85.04
		Mean	55.33	62.82	58.26	66.81
	UL: Delay CDF [s]	5%	0.04	0.04	0.05	0.05
		50%	0.07	0.06	0.06	0.05
		95%	0.28	0.21	0.17	0.14
		Mean	0.11	0.09	0.08	0.07
	ρ_{DL}		99.83%	99.85%	99.87%	99.88%
	ρ_{UL}		99.69%	99.70%	99.72%	99.77%
	BO		23%	19%	18%	16%
	λ		0.3 files/s			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-62dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ax assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=--62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,78.125kHz SCS GI= 0.8us, HE MU PPDU in DL and HE TB PPDU in UL.			

B.1.2 Wi-Fi and NR-U coexistence evaluation with 20MHz and mixed traffic

Table B.1.2-1: Wi-Fi and NR-U coexistence evaluation with 20MHz and mixed traffic

Tdoc / Source	Reported parameters		Low load BO range for Wi-Fi in WiFi+WiFi: 10%~25%			Medium load BO range for Wi-Fi in WiFi+WiFi: 35%~50%			High load BO range for Wi-Fi in WiFi+WiFi: above 55%		
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U
R1-1812556 / SOURCE 2	**DL:** UPT CDF [Mbps]	5%	11.845	17.576	10.459	1.504	11.294	6.872	0.392	8.180	4.933
		50%	48.261	52.692	56.665	30.353	46.675	50.226	14.451	43.011	44.292
		95%	61.006	61.163	70.429	56.713	59.760	67.631	50.558	57.934	65.325
		Mean	44.053	48.2196	50.420	30.1075	42.783	44.870	18.945	39.168	40.457
	DL: Delay CDF [s]	5%	0.069	0.069	0.060	0.076	0.070	0.063	0.094	0.074	0.067
		50%	0.095	0.083	0.082	0.253	0.104	0.116	1.558	0.129	0.165
		95%	1.615	0.442	8.361	18.513	0.782	9.628	37.181	1.296	9.323
		Mean	0.559	0.211	2.812	3.816	0.321	2.866	7.723	0.434	3.028
	UL: UPT CDF [Mbps]	5%	4.112	15.514	0.224	0.057	10.791	0.787	0.003	4.825	0.027
		50%	45.472	49.085	40.040	31.349	44.644	32.840	13.472	40.906	24.945
		95%	60.703	61.251	57.964	55.631	59.234	54.085	49.442	57.907	50.253
		Mean	41.35	46.203	35.636	29.192	41.656	29.668	18.145	38.301	24.805
	UL: Delay CDF [s]	5%	0.069	0.068	0.072	0.079	0.071	0.080	0.099	0.074	0.089
		50%	0.106	0.090	0.121	0.272	0.117	0.215	1.170	0.143	0.406
		95%	7.043	0.655	43.810	52.377	2.011	30.033	110.253	6.593	86.192
		Mean	7.396	7.060	10.243	11.316	7.205	8.287	15.990	7.411	12.311
	VoIP outage		0.06	0.01		0.2	0.01		0.39	0.025	
	VoIP outage(DL)		0.03	0		0.07	0		0.14	0.005	
	VoIP outage(UL)		0.05	0.01		0.2	0.01		0.39	0.025	
	ρ_{DL}		1.00	1.00	0.98	0.96	1.00	0.98	0.90	1.00	0.97
	ρ_{UL}		0.96	0.97	0.92	0.91	0.96	0.90	0.82	0.96	0.87
	BO		0.17	0.19	0.32	0.38	0.25	0.44	0.61	0.30	0.54
	λ		0.06			0.11			0.14		
			Additional comments: - TxOP assumptions of WiFi and NR-U: Up to 4 msec TxOP for both DL/UL Wi-Fi and DL/UL NR-U transmission - Is RTS/CTS enabled for WiFi: No - PD/ED threshold assumptions: For Wi-Fi, -82/62 dBm PD/ED threshold and for NR-U, -72 dBm ED threshold - Max modulation order supported in each technology: 64 QAM for both Wi-Fi and NR-U - MIMO scheme and number of MIMO layers used for both technologies: 1Tx2Rx antenna configuration for both Wi-Fi and NR-U - WiFi MAC layer A-MPDU/A-MSDU aggregation level, MPDU size: 802.11ac - NR-U SCS: 15 kHz - WiFi guard interval: 0.8 μsec - NR UE processing time capability (#1 or #2): Processing time capability #1 - NR PDSCH/PUSCH mapping type, PDCCH monitoring configuration: For PDSCH, PDSCH mapping type A and B (with 7 symbols), for PUSCH, PUSCH mapping type A with 14 symbols, for PDCCH, PDCCH monitoring every 7 symbols - Link adaptation assumptions: For Wi-Fi, open loop rate adaptation, for NR-U, realistic closed loop link adaptation - Cross-carrier scheduling for NR-U								

Table B.1.2-2: Wi-Fi and NR-U coexistence evaluation with 20MHz and mixed traffic

Tdoc/ Source	Reported parameters		High load : BO range for Wi-Fi in Wi-Fi+Wi-Fi: above 55%							
			baseline		Configuration 1		Configuration 2		Configuration 3	
			Wi-Fi	Wi-Fi	Wi-Fi	NR-U	Wi-Fi	NR-U	Wi-Fi	NR-U
R1-1811460/ Source 9	DL: UPT CDF (Mbps)	5%	5.49	6.15	3.12	9.15	6.75	12.98	7.55	21.21
		50%	43.18	45.81	37.95	47.11	42.06	48.27	48.36	60.21
		95%	94.95	93.69	94.57	116.18	92.26	112.36	96.47	125.65
		Mean	49.41	50.15	43.02	57.52	51.01	59.94	57.02	77.07
	DL: Latency CDF (s)	5%	0.05	0.06	0.06	0.02	0.05	0.03	0.04	0.02
		50%	0.72	0.81	0.82	0.63	0.71	0.60	0.61	0.55
		95%	1.35	1.13	1.74	1.16	1.13	1.04	0.78	0.64
		Mean	0.76	0.72	0.89	0.64	0.74	0.61	0.62	0.50
	UL: UPT CDF (Mbps)	5%	4.06	4.01	2.14	6.61	4.62	8.09	6.65	12.38
		50%	42.43	42.27	25.43	36.01	37.17	35.46	42.74	44.85
		95%	106.45	109.80	94.42	95.95	94.10	90.43	92.41	87.24
		Mean	50.54	50.99	34.09	42.26	45.00	43.23	51.67	52.72
	UL: Latency CDF (s)	5%	0.04	0.04	0.05	0.04	0.05	0.03	0.04	0.02
		50%	0.70	0.70	0.95	0.90	0.75	0.92	0.66	0.70
		95%	1.61	1.69	2.35	1.21	1.51	1.27	1.54	1.32
		Mean	0.76	0.75	0.97	0.86	0.86	0.87	0.72	0.69
	VoIP outage		9.09	NA	31.18	NA	27.27	NA	18.18	NA
	ρ (DL)		0.97	0.97	0.95	0.97	0.97	0.97	0.98	0.99
	ρ (UL)		0.97	0.97	0.94	0.96	0.96	0.95	0.98	0.98
	BO		0.56	0.57	0.67	0.58	0.59	0.51	0.48	0.43
		λ	0.81							
	Additional Comments **Wi-Fi 802.11ac**: DL and UL transmissions use independent CAT4 LBT. No COT sharing between AP and Client, since it is not allowed by 802.11ac. Only ACK transmitted with no-LBT within 16us of the corresponding data transmission. Short guard interval, beam-forming and closed loop link adaptation based on channel reciprocity, MCS and rank update based on measured and target error, spatial probing and Null Data Packets. **Licensed Assisted NR-U**: UL always transmitted within a shared COT won by the gNB. The gNB COT won with CAT4 LBT and UL transmissions occur within 16us of the preceding DL transmission. DRS transmitted with CAT4 LBT with the access priority of Voice. **Configuration 1:** NR-U LBT is ED-only with ED = -72dBm and no LBT in the 16us gap before UL transmission within the gNB COT. **Configuration 2:** NR-U LBT is ED-only with ED = -72dBm and fixed duration LBT with ED = -72dBm in the 16us gap before UL transmission within the gNB COT. **Configuration 3:**NR-U LBT consists of ED = -62dBm and PD = -82dBm and fixed duration LBT with ED = -62dBm in the 16us gap before UL transmission within the gNB COT. NR-U assumptions: SCS 30KHz, MCOT 6ms for UL and 8ms for DL for best effort, and 2ms for DL/UL for VoIP.									

B.2 Evaluation results for sub7GHz outdoor scenario 1

B.2.1 Wi-Fi and NR-U coexistence evaluation with 20MHz and FTP traffic

Table B.2.1-1: Wi-Fi and NR-U coexistence evaluation with 20MHz and FTP traffic

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814085/ Source 4	**DL:** UPT CDF [Mbps]	5%	12.65	16.99	27.10	26.11	1.14	8.09	15.33	18.34	0.06	3.89	8.83	13.68
		50%	45.79	55.25	78.00	76.88	18.42	40.32	56.81	60.68	10.22	31.13	40.25	50.70
		95%	77.19	77.55	100.88	100.91	68.22	77.05	100.26	100.48	53.68	75.15	98.67	100.18
		Mean	46.02	52.38	72.04	71.35	24.58	41.90	58.17	61.38	16.28	33.91	46.59	54.64
	DL: Delay CDF [s]	5%	0.05	0.05	0.04	0.04	0.06	0.05	0.04	0.04	0.07	0.05	0.04	0.04
		50%	0.09	0.07	0.05	0.05	0.21	0.10	0.07	0.07	0.35	0.13	0.10	0.08
		95%	0.31	0.23	0.15	0.15	2.45	0.48	0.26	0.22	5.44	0.93	0.44	0.29
		Mean	0.13	0.10	0.07	0.07	0.59	0.16	0.10	0.09	1.04	0.28	0.15	0.11
	UL: UPT CDF [Mbps]	5%	9.82	15.94	20.73	22.60	0.13	6.04	11.24	15.23	0.00	2.27	5.13	10.83
		50%	53.34	61.85	64.43	67.16	21.97	49.45	44.78	51.61	10.85	37.78	32.18	44.13
		95%	78.72	78.94	83.22	83.27	74.24	78.63	82.95	83.10	65.55	78.07	82.45	82.91
		Mean	50.04	56.20	59.64	61.19	27.91	46.73	47.22	52.26	19.15	38.77	37.81	46.70
	UL: Delay CDF [s]	5%	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05
		50%	0.07	0.06	0.06	0.06	0.17	0.08	0.09	0.08	0.30	0.10	0.12	0.09
		95%	0.39	0.25	0.19	0.18	5.07	0.63	0.35	0.26	8.00	1.51	0.70	0.36
		Mean	0.13	0.10	0.08	0.08	0.83	0.19	0.13	0.11	1.39	0.38	0.22	0.13
	ρ_{DL}		100.0%	100.0%	100.0%	100.0%	99.6%	100.0%	100.0%	100.0%	98.0%	99.9%	100.0%	100.0%
	ρ_{UL}		100.0%	100.0%	100.0%	100.0%	97.8%	100.0%	100.0%	100.0%	94.1%	99.6%	100.0%	100.0%
	BO		13.5%	10.7%	8.5%	8.3%	48.4%	21.0%	15.3%	13.5%	66.6%	33.5%	23.7%	17.7%
	λ		0.13				0.17				0.19			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-72dBm; 256 QAM LDPC; 30 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ac assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=-62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,312.5kHz SCS GI= 0.8us											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814085/ Source 4	**DL:** UPT CDF [Mbps]	5%	12.65	17.18	28.67	31.65	1.14	9.73	17.90	25.19	0.06	4.72	10.28	20.36
		50%	45.	56.78	85.04	87.18	18.42	41.94	61.98	73.61	10.22	32.83	46.49	65.43
		95%	77.19	77.77	105.64	105.64	68.22	77.20	105.38	105.53	53.68	76.06	104.41	105.45
		Mean	46.02	53.63	77.18	79.34	24.58	43.43	63.36	71.22	16.28	35.91	52.18	66.05
	DL: Delay CDF [s]	5%	0.05	0.05	0.04	0.04	0.06	0.05	0.04	0.04	0.07	0.05	0.04	0.04
		50%	0.09	0.07	0.05	0.05	0.21	0.10	0.06	0.05	0.35	0.12	0.09	0.06
		95%	0.31	0.23	0.14	0.13	2.45	0.41	0.22	0.16	5.44	0.80	0.37	0.19
		Mean	0.13	0.10	0.06	0.06	0.59	0.14	0.09	0.07	1.04	0.25	0.13	0.08
	UL: UPT CDF [Mbps]	5%	9.82	16.08	25.53	29.25	0.13	7.83	14.05	21.25	0.00	2.83	7.07	17.86
		50%	53.34	63.65	76.09	80.89	21.97	50.69	53.75	65.80	10.85	39.49	40.01	58.05
		95%	78.72	79.01	93.43	93.45	74.24	78.65	93.29	93.39	65.55	78.36	93.06	93.33
		Mean	50.04	57.01	68.73	71.52	27.91	47.94	55.80	63.71	19.15	40.20	45.24	58.95
	UL: Delay CDF [s]	5%	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04	0.06	0.05	0.04	0.04
		50%	0.07	0.06	0.05	0.05	0.17	0.08	0.07	0.06	0.30	0.10	0.10	0.07
		95%	0.39	0.25	0.16	0.14	5.07	0.50	0.28	0.19	8.00	1.24	0.54	0.22
		Mean	0.13	0.09	0.07	0.07	0.83	0.16	0.11	0.08	1.39	0.34	0.17	0.09
	ρ_{DL}		100.0%	100.0%	100.0%	100.0%	99.6%	100.0%	100.0%	100.0%	98.0%	100.0%	100.0%	100.0%
	ρ_{UL}		100.0%	100.0%	100.0%	100.0%	97.8%	100.0%	100.0%	100.0%	94.1%	99.8%	100.0%	100.0%
	BO		13.5%	10.4%	7.6%	7.1%	48.4%	19.4%	13.3%	10.9%	66.6%	31.4%	20.5%	13.5%
	λ		0.13				0.17				0.19			
			Additional comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-72dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ac assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=-62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,312.5kHz SCS GI= 0.8us											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 / Source 7	**DL:** UPT CDF [Mbps]	5%	22.15	26.85	65.59	80.74	10.8	13.69	39.89	73.09	1.48	1.96	25.17	67.11
		50%	58.38	69.04	119.83	139.14	42.64	53.74	97.39	132.23	28.99	34.27	69.27	123.92
		95%	92.06	100.73	146.38	159.23	71.86	86.45	135.37	155.23	55.1	66.48	113.51	149.93
		Mean	57.8	67.65	115.46	133.23	42.17	52.03	93.96	126.75	29	35.01	69.36	119.08
	DL: Delay CDF [s]	5%	0.03	0.029	0.021	0.021	0.036	0.034	0.022	0.021	0.043	0.039	0.024	0.021
		50%	0.079	0.062	0.031	0.026	0.126	0.09	0.043	0.028	0.213	0.155	0.067	0.03
		95%	0.414	0.305	0.135	0.072	1.049	0.711	0.25	0.085	16.009	3.592	0.504	0.102
		Mean	0.148	0.103	0.05	0.034	0.99	0.928	0.081	0.038	6.301	5.514	0.156	0.042
	UL: UPT CDF [Mbps]	5%	10.66	15.32	34.56	45.84	4.6	6.85	18.88	40.08	0.04	0.1	7.78	34.84
		50%	47.54	53.83	93.96	116.77	29.75	35.74	66.55	105.77	18.6	20.98	36.26	94.6
		95%	73.16	84.02	127.68	146.13	58.6	69.19	108.39	138.23	43.8	49.61	79.79	129.62
		Mean	45.26	52.75	90.12	109.82	30.93	37.31	65.42	100.84	19.92	23.2	39.65	91
	UL: Delay CDF [s]	5%	0.035	0.035	0.022	0.022	0.042	0.037	0.023	0.022	0.057	0.052	0.028	0.022
		50%	0.111	0.087	0.047	0.033	0.197	0.147	0.084	0.038	0.338	0.263	0.182	0.046
		95%	0.768	0.544	0.311	0.132	2.332	1.638	0.736	0.168	47.548	7.623	1.759	0.224
		Mean	0.241	0.167	0.093	0.05	2.098	1.097	0.212	0.06	12.036	8.295	0.608	0.074
	ρ_{DL}		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.97	0.99	1.00
	ρ_{UL}		1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	0.96	0.96	1.00	1.00
	BO		0.21	0.17	0.10	0.06	0.41	0.33	0.20	0.08	0.67	0.58	0.39	0.12
	λ		1.2Mbps				1.5Mbps				1.8Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS enabled, ED/PD threshold -62/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval long, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. Switching points no longer than than 16 µs every 2ms for CSI feedback, UL grant update.											

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			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 / Source 7	**DL:** UPT CDF [Mbps]	5%	22.15	28.73	61.1	76.71	10.8	12.12	37.04	70.95	1.48	0.88	17.93	62.72
		50%	58.38	70.21	114.44	136	42.64	49.87	91.36	127.98	28.99	30.64	58.8	119.67
		95%	92.06	100.09	140.99	154.49	71.86	81.22	126.52	150.1	55.1	64.17	104.12	144.52
		Mean	57.8	66.75	110.54	129.38	42.17	49.54	87.52	122.4	29	32.19	60.77	114.67
	DL: Delay CDF [s]	5%	0.03	0.03	0.02	0.02	0.036	0.035	0.021	0.02	0.043	0.04	0.026	0.02
		50%	0.079	0.064	0.033	0.027	0.126	0.097	0.048	0.029	0.213	0.173	0.082	0.032
		95%	0.414	0.328	0.151	0.076	1.049	0.808	0.308	0.091	16.009	7.014	0.769	0.112
		Mean	0.148	0.109	0.055	0.036	0.99	1.031	0.098	0.04	6.301	7.385	0.217	0.045
	UL: UPT CDF [Mbps]	5%	10.66	14.93	33.54	45.52	4.6	5.43	15.52	39.28	0.04	0.05	5.34	33.67
		50%	47.54	51.75	92.67	117.9	29.75	34.28	63.25	107.57	18.6	18.99	30.04	94.92
		95%	73.16	82.6	129.02	148.02	58.6	66.25	107.24	139.89	43.8	49.21	76.47	132.16
		Mean	45.26	51.62	89.82	111.49	30.93	35.36	62.66	101.79	19.92	21.31	35.19	91.25
	UL: Delay CDF [s]	5%	0.035	0.035	0.021	0.021	0.042	0.038	0.022	0.021	0.057	0.057	0.03	0.022
		50%	0.111	0.089	0.047	0.033	0.197	0.155	0.094	0.038	0.338	0.293	0.228	0.046
		95%	0.768	0.601	0.339	0.136	2.332	1.721	0.926	0.178	47.548	20.827	2.622	0.239
		Mean	0.241	0.18	0.1	0.05	2.098	1.831	0.266	0.062	12.036	9.764	1.198	0.078
	ρ_{DL}		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.97	1.00	1.00
	ρ_{UL}		1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	0.96	0.95	0.99	1.00
	BO		0.21	0.17	0.10	0.06	0.41	0.36	0.23	0.09	0.67	0.63	0.46	0.12
	λ		1.2 Mbps				1.5 Mbps				1.8 Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS enabled, ED/PD threshold -62/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval long, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. COT structure includes a preparation stage for CSI exchange leading to total of 2 switching points.											

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			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 / Source 7	**DL:** UPT CDF [Mbps]	5%	26.13	38.54	72.29	84.56	7.82	25.52	56.73	76.19	0.56	17.81	34.62	69.39
		50%	63.27	81.48	134.03	147.14	33.99	63.43	110.67	137.91	24.5	52.16	95.71	133.27
		95%	93.83	113.44	154.94	163.63	67.76	95.79	140.37	158.94	53.37	86.73	129.68	154.86
		Mean	62.52	78.57	127.32	139.54	35.67	62.49	106.23	131.48	25.15	52.63	90.34	127.29
	DL: Delay CDF [s]	5%	0.034	0.029	0.02	0.02	0.039	0.034	0.021	0.021	0.05	0.035	0.022	0.021
		50%	0.066	0.047	0.027	0.025	0.148	0.066	0.035	0.027	0.23	0.082	0.046	0.028
		95%	0.348	0.208	0.1	0.062	1.862	0.359	0.188	0.075	38.46	0.622	0.354	0.083
		Mean	0.117	0.075	0.041	0.031	2.353	0.119	0.066	0.035	9.439	1.126	0.132	0.037
	UL: UPT CDF [Mbps]	5%	14.34	22.76	44.74	50.92	2.36	13.09	30.95	44.87	0.03	7.1	15.92	41.32
		50%	46.55	63.76	112.64	125.83	21.72	44.32	85.68	114.1	14.03	35.69	67.15	107.98
		95%	80.98	97.52	141.37	155.32	54.88	82.84	118.07	145.1	40.71	74.52	103.97	140.52
		Mean	47.11	63.05	106.4	118.3	23.83	46.4	80.51	106.99	15.86	37.49	62.95	101.59
	UL: Delay CDF [s]	5%	0.035	0.034	0.022	0.022	0.058	0.035	0.022	0.022	0.072	0.037	0.023	0.022
		50%	0.096	0.066	0.033	0.03	0.258	0.101	0.056	0.034	0.391	0.136	0.091	0.037
		95%	0.633	0.337	0.199	0.104	5.15	0.679	0.495	0.139	78.754	1.24	1.192	0.161
		Mean	0.198	0.109	0.063	0.042	4.003	0.21	0.143	0.052	15.221	1.649	0.407	0.058
	ρ_{DL}		1.00	1.00	1.00	1.01	0.99	1.00	1.00	1.00	0.97	1.00	1.00	0.99
	ρ_{UL}		0.99	1.00	0.99	1.01	0.99	1.00	1.01	1.00	0.94	1.00	1.00	1.00
	BO		0.13	0.08	0.05	0.04	0.45	0.19	0.13	0.06	0.67	0.30	0.23	0.08
	λ		0.8 Mbps				1.2 Mbps				1.4 Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS disabled, Preamble detection enabled, ED/PD threshold -62/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval long, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. Switching points no longer than than 16 µs every 2ms for CSI feedback, UL grant update.											

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			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 / Source 7	**DL:** UPT CDF [Mbps]	5%	29.01	41.01	75.62	84.56	16.74	29.07	61.5	76.19	8.8	20.1	53.08	69.39
		50%	70.59	81.96	137.01	147.14	47.62	65.55	119.37	137.91	36.12	58.72	107.35	133.27
		95%	100.54	113.27	157.14	163.63	77.53	97.46	145.32	158.94	66.91	90.32	138.98	154.86
		Mean	68.46	79.2	129.9	139.54	48.3	65.61	112.96	131.48	37.13	57.97	102.71	127.29
	DL: Delay CDF [s]	5%	0.03	0.029	0.02	0.02	0.035	0.031	0.021	0.021	0.038	0.034	0.021	0.021
		50%	0.06	0.047	0.026	0.025	0.098	0.064	0.032	0.027	0.143	0.074	0.038	0.028
		95%	0.275	0.196	0.09	0.062	0.598	0.303	0.131	0.075	1.263	0.424	0.171	0.083
		Mean	0.095	0.072	0.038	0.031	0.226	0.102	0.05	0.035	1.625	0.139	0.061	0.037
	UL: UPT CDF [Mbps]	5%	16.17	22.94	46.12	50.92	7.28	17.06	33.21	44.87	3.69	12.09	27.53	41.32
		50%	55.57	67.8	115.86	125.83	34.08	50.05	91.38	114.1	24.5	42.25	77.04	107.98
		95%	87.93	98.91	144.01	155.32	68.23	86.13	124.17	145.1	56.53	79.04	112.83	140.52
		Mean	54.48	65.38	109.12	118.3	35.32	50.67	86.68	106.99	25.98	43.14	73.75	101.59
	UL: Delay CDF [s]	5%	0.035	0.034	0.022	0.022	0.04	0.035	0.022	0.022	0.048	0.036	0.023	0.022
		50%	0.08	0.065	0.032	0.03	0.152	0.089	0.049	0.034	0.235	0.115	0.067	0.037
		95%	0.458	0.313	0.171	0.104	1.233	0.533	0.327	0.139	2.91	0.784	0.496	0.161
		Mean	0.144	0.102	0.057	0.042	0.434	0.162	0.097	0.052	2.821	0.238	0.14	0.058
	ρ_{DL}		1.00	0.99	0.99	1.01	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
	ρ_{UL}		1.00	1.00	0.99	1.01	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00
	BO		0.11	0.08	0.05	0.04	0.27	0.17	0.10	0.06	0.44	0.24	0.15	0.08
	λ		0.8 Mbps				1.2 Mbps				1.4 Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS disabled, Preamble detection enabled, ED/PD threshold -72/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval long, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. Switching points no longer than than 16 µs every 2ms for CSI feedback, UL grant update.											

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			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814018 / Srouce 8	**DL:** UPT CDF [Mbps]	5%	17.63	28.68	40.63	44.29	6.86	23.71	34.25	39.91	0.94	16.34	21.51	36.91
		50%	61.31	75.90	93.31	99.31	32.85	67.99	84.77	95.14	11.25	56.09	67.55	90.81
		95%	90.10	102.08	122.51	124.68	63.61	97.22	117.64	122.39	37.92	89.19	105.17	119.97
		Mean	59.49	73.55	90.68	95.60	34.73	66.77	83.03	91.93	14.94	56.91	68.59	87.97
	DL: Delay CDF [s]	5%	0.038	0.032	0.028	0.027	0.062	0.034	0.028	0.027	0.087	0.037	0.031	0.028
		50%	0.106	0.050	0.040	0.035	0.462	0.060	0.047	0.038	0.958	0.083	0.081	0.041
		95%	0.528	0.122	0.094	0.075	4.481	0.188	0.133	0.085	10.790	0.444	0.480	0.090
		Mean	0.190	0.064	0.050	0.042	1.244	0.086	0.064	0.046	2.921	0.176	0.159	0.050
	UL: UPT CDF [Mbps]	5%	18.02	23.64	27.71	32.92	5.55	18.96	23.64	27.68	0.80	13.26	14.13	24.39
		50%	54.43	57.44	65.55	70.51	26.87	59.71	57.44	65.11	8.90	46.82	43.75	61.63
		95%	86.45	86.22	90.73	93.67	56.83	93.81	86.22	91.60	32.07	83.91	75.56	89.08
		Mean	54.84	57.55	64.70	68.92	29.53	60.59	57.55	64.66	12.42	49.08	45.34	61.16
	UL: Delay CDF [s]	5%	0.042	0.038	0.037	0.037	0.079	0.035	0.038	0.037	0.135	0.041	0.046	0.038
		50%	0.120	0.080	0.061	0.053	0.482	0.075	0.080	0.059	1.004	0.108	0.164	0.065
		95%	0.599	0.228	0.139	0.106	5.409	0.229	0.228	0.123	11.114	0.711	1.058	0.149
		Mean	0.214	0.103	0.075	0.062	1.490	0.103	0.103	0.069	3.021	0.236	0.443	0.078
	ρ_{DL}		99%	100%	100%	100%	88%	100%	100%	100%	73%	99%	99%	100%
	ρ_{UL}		99%	100%	100%	100%	93%	100%	100%	100%	86%	99%	98%	100%
	BO		10%	4.6%	4.1%	3.6%	35%	7%	6.3%	4.6%	60%	12%	12%	5.8%
	λ		0.15 file/s				0.17 file/s				0.20 file/s			
			Additional comments: **Simulation setup:** NR-U outdoor scenario 1, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** ED threshold -72dBm, SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling, COT sharing enabled (gNB initiated COT).											

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			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814074 / Source 5	**DL:** UPT CDF [Mbps]	5%	2.686	3.225	11.137	27.422	0.897	1.313	2.133	12.965	0.360	0.525	1.368	3.483
		50%	9.141	10.743	42.626	56.850	5.653	7.154	21.888	45.770	3.850	4.780	11.284	23.963
		95%	26.689	29.385	73.956	75.709	21.635	24.113	63.013	74.355	15.410	19.642	40.608	62.633
		Mean	11.335	12.798	43.159	55.530	7.480	9.017	25.785	44.736	5.380	6.515	14.891	27.253
	DL: Delay CDF [s]	5%	0.077	0.069	0.053	0.051	0.116	0.099	0.056	0.053	0.145	0.114	0.076	0.056
		50%	0.267	0.216	0.094	0.066	0.490	0.371	0.186	0.091	0.640	0.528	0.346	0.173
		95%	0.876	0.905	0.451	0.179	2.692	1.731	1.039	0.320	3.647	3.015	1.426	0.875
		Mean	0.348	0.323	0.152	0.090	0.761	0.586	0.311	0.133	1.077	0.899	0.476	0.273
	ρ		0.965	0.982	0.973	0.988	0.898	0.910	0.852	0.982	0.786	0.859	0.782	0.918
	BO		0.152	0.127	0.078	0.042	0.348	0.299	0.258	0.092	0.547	0.497	0.443	0.260
	λ		0.1				0.15				0.2			
			Additional comments: - 4ms for both Wi-Fi and NR-U - No - For Wi-Fi, PDT = -82 dBm, EDT = -62 dBm; for NR-U EDT = -72 dBm (baseline) - 256 QAM for both Wi-Fi and NR-U - NR-U with array radiation pattern according to TR38.802 and max BF gain of 5 dBi; omni-directional for Wi-Fi - MPDU size = 3250 bytes by default, 1ms per MPDU - 15 kHz - 0.8 µs - Capability #1 - Mapping type B in the starting slot of TxOP; per-symbol PDCCH monitoring for flexible starting position - No fast link adaptation utilizing multiple switching points within COT for NR-U - Cross-carrier scheduling in UL											

Tdoc /Source	Reported parameters		Low load BO range for Wi-Fi in Wi-Fi+Wi-Fi: 10%~25%				Medium load BO range for Wi-Fi in Wi-Fi+Wi-Fi: 35%~50%				High load BO range for Wi-Fi in Wi-Fi+Wi-Fi: above 55%			
			Wi-Fi in Wi-Fi+ Wi-Fi	Wi-Fi in Wi-Fi+ NR-U	NR-U in Wi-Fi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in Wi-Fi+ Wi-Fi	Wi-Fi in Wi-Fi+ NR-U	NR-U in Wi-Fi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in Wi-Fi+ Wi-Fi	Wi-Fi in Wi-Fi+ NR-U	NR-U in Wi-Fi+ NR-U	NR-U in NR-U+ NR-U
R1- 1814062 /Source 6	DL UPT CDF [Mbps]	5%	11.891	12.482	27.214	40.856	1.566	4.815	7.408	13.925	0.961	2.345	5.858	8.077
		50%	63.790	80.543	134.350	142.631	20.597	41.713	69.150	89.247	12.230	18.196	34.205	57.872
		95%	116.687	127.743	201.932	199.782	98.768	106.480	181.136	198.498	71.163	78.572	117.063	179.804
		Mean	64.637	73.768	131.201	148.222	31.725	47.200	79.495	104.393	20.757	26.668	46.786	80.682
	DL Delay CDF [s]	5%	0.033	0.030	0.021	0.021	0.042	0.039	0.024	0.021	0.054	0.052	0.038	0.030
		50%	0.06	0.051	0.031	0.023	0.205	0.145	0.080	0.038	0.325	0.304	0.196	0.116
		95%	0.355	0.359	0.165	0.162	1.654	1.319	0.612	0.301	2.264	2.700	1.162	0.645
		Mean	0.116	0.110	0.056	0.050	0.439	0.338	0.163	0.092	0.634	0.612	0.344	0.240
	UL UPT CDF [Mbps]	5%	10.305	10.514	26.193	31.033	1.327	5.022	6.596	12.632	0.737	2.713	3.013	8.462
		50%	63.356	77.355	119.294	128.471	18.200	35.384	58.210	66.122	11.274	20.049	23.930	32.478
		95%	110.755	117.296	191.984	194.520	93.601	94.371	160.740	177.824	78.363	81.837	117.751	164.475
		Mean	64.278	71.860	110.596	118.240	31.913	43.966	69.836	77.030	22.160	28.613	38.368	57.172
	UL Delay CDF [s]	5%	0.032	0.032	0.021	0.020	0.042	0.041	0.027	0.024	0.050	0.050	0.043	0.033
		50%	0.063	0.052	0.033	0.319	0.222	0.168	0.113	0.110	0.371	0.315	0.291	0.287
		95%	0.308	0.309	0.144	0.144	2.195	1.283	1.101	0.060	3.004	2.988	2.029	1.629
		Mean	0.114	0.099	0.059	0.057	0.514	0.362	0.256	0.246	0.752	0.741	0.551	0.367
	ρ_{DL}		0.9813	0.9800	0.9800	1.00	0.9280	0.9560	0.9560	1.00	0.8882	0.8880	0.8880	0.9530
	ρ_{UL}		0.9740	0.9700	1.00	1.00	0.9285	0.9530	0.9846	1.00	0.9026	0.8950	0.9325	0.9244
	BO		10.0	8.7	4.05	3.90	40.0	30.70	17.80	13.65	58.0	54.90	34.80	21.10
	λ		0.086/0.086				0.114/0.114				0.143/0.143			
			Additional comments: Outdoor Sub-7GHz deployment Scenario 1 WiFi settings: 802.11ac MCS table including 256 QAM, 2Tx2Rx in DL (cross-polarized, open loop), 2Tx2Rx in UL, 2 streams in both DL and UL. GI:0.8 µs, TXOP=4 ms, LDPC, A-MPDU enabled, RTS/CTS disabled, link adaptation: Minstrel algorithm, CWS: DL{15,63} and UL{15,1023}, CCA: CS=-82dBm, ED=-62dBm. NR-U settings: 4Tx2Rx in DL, Cross-polarized. MCS=4/16/64/256QAM, scheduling: proportional fair, link adaptation realistic, ED=-72 dBm, CP=Normal, SCS=30KHz, TXOP=4 ms, UE Capability #1, MCS: DL{15,63} and UL{15,1023}, COT sharing enabled, COT details: flexible DL/UL only and mixed DL/UL based on traffic needs, 3/11 DL control/data symbols, 3/11 symbols UL control/data.											

Table B.2.1-2: Wi-Fi and NR-U coexistence evaluation (20MHz/FTP traffic) with & without NR-U PD (@-82)

Evaluation results of NR-U in an NR-U + NR-U coexistence in outdoor scenario 1								
Tdoc /Source	Reported parameters		Low load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 10%~25%		Medium load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 35%~50%		High load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: above 55%	
			NR-U in NR-U + NR-U, with NR-U uses ED = -72dBm	NR-U in NR-U + NR-U, with NR-U uses preamble	NR-U in NR-U + NR-U, with NR-U uses ED = -72dBm	NR-U in NR-U + NR-U, with NR-U uses preamble	NR-U in NR-U + NR-U, with NR-U uses ED = -72dBm	NR-U in NR-U + NR-U, with NR-U uses preamble
R1-1814021 / Source 8	DL: UPT CDF [Mbps]	5%	38.85	35.91	31.86	26.86	25.32	13.87
		50%	93.10	88.38	81.68	72.67	71.41	46.15
		95%	120.45	118.35	116.42	105.82	109.36	83.77
		Mean	89.65	85.97	81.00	71.29	71.74	48.95
	DL: Delay CDF [s]	5%	0.027	0.028	0.029	0.034	0.030	0.046
		50%	0.039	0.042	0.047	0.064	0.058	0.201
		95%	0.089	0.102	0.118	0.276	0.160	1.441
		Mean	0.048	0.053	0.059	0.110	0.076	0.445
	UL: UPT CDF [Mbps]	5%	25.35	24.11	18.14	15.20	13.69	6.94
		50%	63.03	59.33	52.18	45.47	42.20	26.70
		95%	89.95	85.51	82.85	73.39	76.12	55.42
		Mean	62.61	59.12	52.81	46.40	44.45	29.27
	UL: Delay CDF [s]	5%	0.037	0.040	0.042	0.050	0.045	0.081
		50%	0.063	0.069	0.083	0.120	0.111	0.423
		95%	0.140	0.155	0.214	0.619	0.310	2.998
		Mean	0.075	0.082	0.101	0.217	0.148	0.880
	ρ_{DL}		100%	100%	99.9%	99.5%	99.9%	96.7%
	ρ_{UL}		99.9%	100%	99.9%	99.4%	99.8%	96.8%
	BO		5.4%	5.9%	8.4%	11.6%	12.1%	26.6%
	λ		0.19 file/s		0.24 file/s		0.28 file/s	
			Additional comments: **Simulation setup:** NR-U outdoor scenario 1, NR-U+NR-U coexistence, 50/50 DL/UL traffics. **NR-U assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS and 2 for UE, BF scheme: Tx and Rx BF at BS, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS transmit power 20dBm, UE transmit power 18dBm, MMSE-IRC receiver, CW {min,max} DL{15,63} UL{15,1023}. UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling. COT sharing enabled (gNB initiated COT).					

Evaluation results of NR-U in an NR-U + Wi-Fi coexistence in outdoor scenario 1								
Tdoc /Source	Reported parameters		Low load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 10%~25%		Medium load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 35%~50%		High load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: above 55%	
			NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	NR-U in NR-U + Wi-Fi, with NR-U uses preamble	NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	NR-U in NR-U + Wi-Fi, with NR-U uses preamble	NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	NR-U in NR-U + Wi-Fi, with NR-U uses preamble
R1-1814021 / Source 8	DL: UPT CDF [Mbps]	5%	26.29	28.06	8.67	2.15	1.35	0.18
		50%	72.79	73.75	34.89	20.76	11.29	7.05
		95%	110.03	106.60	72.10	53.85	42.05	33.89
		Mean	73.48	71.96	37.92	25.20	15.87	11.64
	DL: Delay CDF [s]	5%	0.029	0.031	0.072	0.065	0.138	0.091
		50%	0.066	0.088	0.498	0.849	1.417	1.416
		95%	0.283	0.531	3.807	7.306	8.852	10.218
		Mean	0.107	0.170	1.064	2.061	2.716	3.120
	UL: UPT CDF [Mbps]	5%	16.25	15.63	3.93	1.13	0.27	0.08
		50%	48.19	44.63	19.37	10.76	4.89	2.56
		95%	79.28	75.77	45.48	31.67	22.92	17.22
		Mean	49.45	46.61	22.07	13.76	8.02	5.10
	UL: Delay CDF [s]	5%	0.043	0.049	0.087	0.139	0.150	0.260
		50%	0.123	0.179	1.030	2.028	2.888	3.048
		95%	0.607	0.748	9.170	12.641	21.958	18.534
		Mean	0.244	0.286	2.537	3.885	6.157	5.826
	ρ_{DL}		99.9%	99.3%	96.2%	83.8%	85.7%	71%
	ρ_{UL}		99.4%	99.2%	85.8%	80.6%	62.1%	65.6%
	BO		10%	10.6%	35%	50.2%	60%	69%
	λ		0.19 file/s		0.24 file/s		0.28 file/s	
			Additional comments: **Simulation setup:** NR-U outdoor scenario 1, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling. COT sharing enabled (gNB initiated COT).					

Evaluation results of Wi-Fi in an NR-U + Wi-Fi coexistence in outdoor scenario 1								
Tdoc /Source	Reported parameters		Low load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 10%~25%		Medium load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: 35%~50%		High load BO range for NR-U in NR-U + Wi-Fi, with NR-U uses ED = -72dBm: above 55%	
			Wi-Fi in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	Wi-Fi in NR-U + Wi-Fi, with NR-U uses preamble	Wi-Fi in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	Wi-Fi in NR-U + Wi-Fi, with NR-U uses preamble	Wi-Fi in NR-U + Wi-Fi, with NR-U uses ED = -72dBm	Wi-Fi in NR-U + Wi-Fi, with NR-U uses preamble
R1-1814021 / Source 8	DL: UPT CDF [Mbps]	5%	18.39	19.46	6.03	1.84	1.24	0.21
		50%	60.32	60.98	31.16	16.85	15.65	6.53
		95%	92.65	91.97	69.59	50.32	54.04	32.60
		Mean	60.23	59.96	35.26	21.53	21.26	10.97
	DL: Delay CDF [s]	5%	0.036	0.037	0.053	0.069	0.066	0.098
		50%	0.075	0.084	0.216	0.514	0.405	1.005
		95%	0.335	0.386	2.110	7.152	4.478	10.134
		Mean	0.145	0.145	0.631	1.773	1.239	2.664
	UL: UPT CDF [Mbps]	5%	14.46	14.49	5.31	1.53	0.99	0.19
		50%	51.17	49.31	24.28	12.87	11.73	5.46
		95%	88.77	87.53	59.90	43.87	43.83	27.64
		Mean	52.77	51.46	28.71	17.56	16.78	9.38
	UL: Delay CDF [s]	5%	0.038	0.039	0.061	0.090	0.083	0.130
		50%	0.097	0.112	0.244	0.584	0.399	0.898
		95%	0.492	0.586	1.731	6.791	3.975	9.463
		Mean	0.179	0.203	0.607	1.680	1.160	2.500
	ρ_{DL}		99.8%	99.2%	97.2%	84.5%	93.1%	74.3%
	ρ_{UL}		99.7%	99.4%	98.1%	93.2%	96.4%	89%
	BO		10.3%	11%	28.2%	50.5%	45.1%	67.3%
	λ		0.19 file/s		0.24 file/s		0.28 file/s	
			Additional comments: **Simulation setup:** NR-U indoor scenario, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling. COT sharing enabled (gNB initiated COT).					

B.3 Evaluation results for sub7GHz outdoor scenario 2

B.3.1 Wi-Fi and NR-U coexistence evaluation with 20MHz and FTP traffic

Table B.3.1-1: Wi-Fi and NR-U coexistence evaluation with 20MHz and FTP traffic

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814085/Source 4	**DL:** UPT CDF [Mbps]	5%	12.99	15.17	29.74	27.96	2.75	9.54	20.96	21.64	0.61	5.25	17.28	16.80
		50%	49.24	53.40	80.19	78.03	26.27	42.85	64.26	64.80	14.38	33.25	52.21	56.83
		95%	77.43	77.62	101.02	100.93	72.25	77.20	100.91	100.84	60.86	76.54	100.52	100.66
		Mean	47.95	51.31	73.89	72.61	30.52	43.38	65.34	65.35	20.58	36.64	57.39	59.65
	DL: Delay CDF [s]	5%	0.05	0.05	0.04	0.04	0.06	0.05	0.04	0.04	0.07	0.05	0.04	0.04
		50%	0.08	0.07	0.05	0.05	0.15	0.09	0.06	0.06	0.26	0.12	0.08	0.07
		95%	0.30	0.26	0.13	0.14	1.17	0.41	0.19	0.18	2.81	0.66	0.23	0.23
		Mean	0.12	0.10	0.06	0.07	0.34	0.15	0.08	0.08	0.69	0.21	0.10	0.09
	UL: UPT CDF [Mbps]	5%	10.36	14.29	22.31	22.70	0.65	6.25	15.30	16.50	0.00	2.92	11.63	12.52
		50%	53.43	57.96	67.92	70.26	27.47	44.33	54.11	56.26	13.01	35.75	42.02	46.68
		95%	78.74	78.88	83.49	83.41	77.26	78.85	83.19	83.20	67.14	78.43	83.00	83.16
		Mean	49.79	53.56	61.30	62.22	31.68	44.15	53.33	54.73	21.15	37.92	46.27	49.64
	UL: Delay CDF [s]	5%	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.05
		50%	0.07	0.07	0.06	0.06	0.14	0.09	0.07	0.07	0.26	0.11	0.09	0.09
		95%	0.38	0.27	0.18	0.18	2.51	0.60	0.26	0.24	8.00	1.16	0.33	0.31
		Mean	0.13	0.10	0.08	0.08	0.54	0.17	0.10	0.10	1.24	0.30	0.13	0.12
	ρ_{DL}		100.0 %	100.0%	100.0%	100.0%	99.9%	100.0%	100.0%	100.0%	99.4%	100.0%	100.0%	100.0%
	ρ_{UL}		100.0 %	100.0%	100.0%	100.0%	99.3%	100.0%	100.0%	100.0%	95.5%	100.0%	100.0%	100.0%
	BO		13.1%	11.4%	8.2%	8.2%	38.2%	20.7%	12.9%	12.7%	61.3%	30.5%	17.3%	16.3%
	λ		0.13				0.17				0.19			
			Additional Comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-72dBm; 256 QAM LDPC; 30 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ac assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=-62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,312.5kHz SCS GI= 0.8us											

Tdoc/Source	Reported parameters		Low load BO range for Wi-Fi in WiFi+WiFi: 10%~25%				Medium load BO range for Wi-Fi in WiFi+WiFi: 35%~50%				High load BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814085/Source 4	**DL:** UPT CDF [Mbps]	5%	12.99	16.74	32.07	33.77	2.75	10.44	23.45	28.06	0.61	6.04	18.44	24.52
		50%	49.24	55.91	85.60	86.91	26.27	45.01	70.72	76.77	14.38	35.56	57.75	70.73
		95%	77.43	77.67	105.66	105.66	72.25	77.45	105.63	105.65	60.86	76.94	105.42	105.60
		Mean	47.95	52.65	78.98	80.07	30.52	44.85	70.09	74.29	20.58	38.31	61.77	70.66
	DL: Delay CDF [s]	5%	0.05	0.05	0.04	0.04	0.06	0.05	0.04	0.04	0.07	0.05	0.04	0.04
		50%	0.08	0.07	0.05	0.05	0.15	0.09	0.06	0.05	0.26	0.11	0.07	0.06
		95%	0.30	0.23	0.12	0.12	1.17	0.38	0.17	0.14	2.81	0.61	0.21	0.16
		Mean	0.12	0.10	0.06	0.06	0.34	0.14	0.07	0.07	0.69	0.19	0.09	0.07
	UL: UPT CDF [Mbps]	5%	10.36	15.45	26.17	31.08	0.65	7.69	19.20	24.99	0.00	3.35	13.76	21.39
		50%	53.43	59.34	79.22	83.40	27.47	46.83	63.13	72.74	13.01	36.87	50.52	66.67
		95%	78.74	79.01	93.44	93.44	77.26	78.82	93.37	93.41	67.14	78.61	93.25	93.37
		Mean	49.79	54.60	70.25	73.51	31.68	45.66	61.59	67.37	21.15	39.12	53.76	63.78
	UL: Delay CDF [s]	5%	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04	0.06	0.05	0.04	0.04
		50%	0.07	0.07	0.05	0.05	0.14	0.09	0.06	0.05	0.26	0.11	0.08	0.06
		95%	0.38	0.26	0.15	0.13	2.51	0.48	0.21	0.16	8.00	1.05	0.28	0.19
		Mean	0.13	0.10	0.07	0.06	0.54	0.15	0.09	0.07	1.24	0.27	0.11	0.08
	ρ_{DL}		100.0 %	100.0%	100.0%	100.0%	99.9%	100.0%	100.0%	100.0%	99.4%	100.0%	100.0%	100.0%
	ρ_{UL}		100.0 %	100.0%	100.0%	100.0%	99.3%	100.0%	100.0%	100.0%	95.5%	100.0%	100.0%	100.0%
	BO		13.1%	10.9%	7.4%	6.9%	38.2%	19.2%	11.5%	10.1%	61.3%	28.4%	15.5%	12.3%
	λ		0.13				0.17				0.19			
			Additional Comments: **Common assumption:** 4 antenna at gNB/AP, 2 antenna at UE/STA, close loop BF with single stream **NRU assumption:** 8ms MCOT; ED=-72dBm; 256 QAM LDPC; 60 kHz SCS NCP; UE processing time capability #1; NR type B for PDSCH, type A for PUSCH **802.11ac assumption:** 4ms TXOP; RTS/CTS disabled for WiFi, NAV set based on L-SIG; PD=-82dBm/ED=-62dBm EDCA; 256 QAM BCC; A-MPDU, 1500B MSDU + 14 B header; Immediate ACK,312.5kHz SCS GI= 0.8us											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 / Source 7	**DL:** UPT CDF [Mbps]	5%	16.06	19.62	52.83	62.56	9.41	14.19	39.03	59.09	0.52	3.1	25.12	53.42
		50%	54.85	62.45	115.47	132.3	41.38	46.29	99.83	126.88	31.67	34.31	76.09	119.36
		95%	90.83	93.26	154.09	163.9	78.41	85.02	145.77	160.43	69.85	77.01	132.15	157.06
		Mean	53.99	60.02	111.99	125.72	42.24	49.26	97.24	120.68	32.62	37.05	77.82	114.94
	DL: Delay CDF [s]	5%	0.034	0.034	0.021	0.021	0.036	0.035	0.021	0.021	0.04	0.037	0.023	0.021
		50%	0.085	0.072	0.032	0.028	0.124	0.095	0.04	0.03	0.173	0.143	0.058	0.032
		95%	0.463	0.341	0.138	0.08	1.103	0.613	0.211	0.092	34.405	2.524	0.389	0.108
		Mean	0.16	0.117	0.051	0.037	1.469	0.212	0.072	0.04	9.289	5.248	0.123	0.045
	UL: UPT CDF [Mbps]	5%	7.17	8.86	28.49	32.51	3.18	5.53	17.09	29.72	0.05	0.28	9.6	26.68
		50%	36.71	40.29	86.67	105.44	26.09	31.37	65.57	96.89	18.49	20.23	45.02	88.92
		95%	77.26	83.32	138.06	154.76	64.74	73.95	125.2	148.87	55.13	60.19	106.54	141.95
		Mean	39.7	44.24	85.8	100.69	29.15	34.06	68.42	94.05	21.67	24.36	49.33	86.96
	UL: Delay CDF [s]	5%	0.036	0.035	0.022	0.022	0.042	0.039	0.022	0.022	0.05	0.047	0.025	0.022
		50%	0.136	0.115	0.05	0.038	0.212	0.165	0.076	0.042	0.302	0.259	0.13	0.049
		95%	0.962	0.674	0.302	0.152	2.602	1.4	0.559	0.182	84.716	10.972	1.158	0.231
		Mean	0.292	0.207	0.093	0.057	2.502	0.462	0.159	0.065	15.042	8.563	0.334	0.078
	ρ_{DL}		1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.97	0.98	1.00	1.00
	ρ_{UL}		1.00	1.00	1.00	1.00	0.99	0.99	1.00	1.00	0.95	0.96	1.00	0.99
	BO		0.24	0.20	0.10	0.07	0.43	0.34	0.17	0.09	0.65	0.57	0.31	0.12
	λ		1.2 Mbps				1.5Mbps				1.8 Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS enabled, ED/PD threshold -62/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval long, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. Switching points no longer than than 16 µs every 2ms for CSI feedback, UL grant update.											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1813409 / Source 7	**DL:** UPT CDF [Mbps]	5%	16.06	19.1	49.88	59.68	9.41	12.27	35.44	55.47	0.52	1.28	23.03	50.53
		50%	54.85	61.16	113.38	129.12	41.38	45.95	93.74	123.69	31.67	33.86	71.75	117.47
		95%	90.83	94.38	150.83	158.81	78.41	86.7	140.54	155.38	69.85	77.11	128.07	152.05
		Mean	53.99	59.32	108.96	122.14	42.24	47.7	92.09	116.97	32.62	35.58	73.15	111.64
	DL: Delay CDF [s]	5%	0.034	0.034	0.02	0.02	0.036	0.035	0.021	0.02	0.04	0.038	0.024	0.02
		50%	0.085	0.072	0.033	0.029	0.124	0.101	0.044	0.031	0.173	0.148	0.063	0.033
		95%	0.463	0.353	0.146	0.085	1.103	0.747	0.248	0.099	34.405	4.087	0.457	0.115
		Mean	0.16	0.12	0.054	0.039	1.469	0.335	0.082	0.043	9.289	6.583	0.144	0.047
	UL: UPT CDF [Mbps]	5%	7.17	8.86	27.71	34.11	3.18	5.27	15.56	30.2	0.05	0.11	7.71	26.19
		50%	36.71	40.32	86.39	106.33	26.09	29.54	64.09	98.62	18.49	19.43	41.66	89.33
		95%	77.26	83.14	143.06	156.57	64.74	73.01	127.52	150.31	55.13	58.78	106.36	143.48
		Mean	39.7	43.59	86.29	102.15	29.15	33.17	67.07	94.89	21.67	23.46	47.69	87.64
	UL: Delay CDF [s]	5%	0.036	0.035	0.021	0.021	0.042	0.04	0.022	0.021	0.05	0.048	0.025	0.022
		50%	0.136	0.117	0.051	0.037	0.212	0.173	0.081	0.043	0.302	0.27	0.142	0.049
		95%	0.962	0.697	0.32	0.156	2.602	1.702	0.661	0.193	84.716	36.709	1.361	0.242
		Mean	0.292	0.214	0.097	0.058	2.502	0.832	0.184	0.068	15.042	10.457	0.383	0.081
	ρ_{DL}		1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.96	0.99	1.00
	ρ_{UL}		1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	0.95	0.96	1.00	1.00
	BO		0.24	0.20	0.10	0.07	0.43	0.36	0.19	0.09	0.65	0.59	0.33	0.13
	λ		1.2 Mbps				1.5 Mbps				1.8 Mbps			
			Additional comments: **Common assumptions:** 2Tx, 2Rx, Primary LBT : Cat-4 LBT with exponential CW backoff, MCOT duration: 5.5 ms, Max modulation supported 256 QAM, MIMO scheme with Tx BF upto rank 2. **Wi-Fi assumptions:** RTS/CTS enabled, ED/PD threshold -62/-82 dBm, A-MPDU size is chosen to get MPDU duration of 1ms, Wi-Fi Guard Interval long, Wi-Fi beacons enabled (periodicity 100ms), Minstrel Algorithm for rate prediction **NRU assumptions:** ED threshold -72 dBm, SCS 30 KHz, UE processing time capability #1, NR PDCCH monitoring is 4 times per slot (slot size = 0.5ms), Link adaptation assumptions : Reciprocity based BF, realistic delays in CSI reports, stand-alone with self-scheduling, DRS enabled (250us, cat-2 LBT every 250us, 40ms periodicity), asynchronous nodes, UL LBT in gNB acquired COT: Cat-2 LBT with granularity of 0.5ms, 1 symbol DMRS overhead, 1 symbol for every ACK/CQI feedback, UL grant. COT structure includes a preparation stage for CSI exchange leading to total of 2 switching points.											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+WiFi	Wi-Fi in WiFi+NR-U	NR-U in WiFi+NR-U	NR-U in NR-U+NR-U	Wi-Fi in WiFi+WiFi	Wi-Fi in WiFi+NR-U	NR-U in WiFi+NR-U	NR-U in NR-U+NR-U	Wi-Fi in WiFi+WiFi	Wi-Fi in WiFi+NR-U	NR-U in WiFi+NR-U	NR-U in NR-U+NR-U
R1-1814018 / Source 8	**DL:** UPT CDF [Mbps]	5%	12.44	16.72	25.49	27.70	5.87	15.32	21.61	27.47	1.77	8.38	13.87	24.32
		50%	52.52	62.63	76.60	82.92	30.94	56.31	70.24	81.53	12.84	40.51	50.60	77.29
		95%	92.08	100.05	121.49	124.26	67.71	99.99	118.81	123.52	41.40	85.31	102.27	121.11
		Mean	54.47	62.56	78.11	82.79	34.39	58.78	72.92	81.23	16.70	44.67	55.47	77.16
	DL: Delay CDF [s]	5%	0.035	0.033	0.027	0.027	0.054	0.033	0.027	0.027	0.067	0.040	0.035	0.028
		50%	0.096	0.060	0.047	0.041	0.520	0.071	0.056	0.043	0.865	0.151	0.124	0.046
		95%	0.467	0.226	0.153	0.109	5.633	0.324	0.292	0.118	12.329	1.468	1.156	0.132
		Mean	0.182	0.093	0.069	0.054	1.497	0.120	0.094	0.055	3.005	0.434	0.319	0.060
	UL: UPT CDF [Mbps]	5%	13.06	12.68	16.29	25.54	5.98	10.44	13.53	22.38	1.67	5.75	7.37	19.05
		50%	49.67	51.40	51.62	64.61	27.39	45.25	48.13	61.60	11.32	32.11	32.02	58.47
		95%	90.43	96.95	91.32	96.40	64.76	95.53	86.72	93.96	37.94	77.49	74.19	90.19
		Mean	51.50	54.34	54.27	64.59	31.32	50.52	50.18	61.93	15.31	36.89	36.13	58.07
	UL: Delay CDF [s]	5%	0.039	0.034	0.037	0.036	0.070	0.034	0.038	0.036	0.100	0.040	0.050	0.037
		50%	0.117	0.077	0.076	0.057	0.574	0.093	0.096	0.059	1.139	0.174	0.278	0.068
		95%	0.620	0.286	0.226	0.131	6.804	0.438	0.423	0.152	12.704	1.421	2.288	0.182
		Mean	0.220	0.114	0.102	0.068	1.719	0.150	0.154	0.074	3.526	0.409	0.635	0.086
	ρ_{DL}		98%	100%	100%	100%	84%	100%	100%	100%	67%	98%	99%	100%
	ρ_{UL}		99%	100%	100%	100%	93%	100%	100%	100%	85%	99%	98%	100%
	BO		10%	6.1%	5.1%	3.9%	35%	8.2%	7%	4.7%	60%	19%	17%	6.4%
	λ		0.14 file/s				0.16 file/s				0.19 file/s			
			Additional comments: **Simulation setup:** NR-U outdoor scenario 2, 50/50 DL/UL traffics. **Common assumptions:** Primary LBT: Cat-4 LBT with exponential CW back-off, MCOT duration: 6ms, Max modulation: 256 QAM, Antennas: 4 for BS/AP and 2 for UE/STA, BF scheme: Tx and Rx BF at BS/AP, Maximal number of layers: 2 for DL and 2 for UL, single carrier with 20MHz BW, BS/AP transmit power 20dBm, UE/STA transmit power 18dBm, MMSE-IRC receiver. CW {min,max} DL{15,63} UL{15,1023}. **Wi-Fi assumptions:** RTS/CTS disabled, ED/PD threshold -62/-82dBm, A-MPDU frame aggregation, MPDU size: 1500B MSDU plus 14B header, short Wi-Fi guard interval. **NR-U assumptions:** ED threshold -72dBm, SCS 30kHz, UE processing time capability #1, PUSCH mapping Type A, PDSCH mapping Type B, PDCCH monitoring every 1OS, Scheduling: proportional fair, self-scheduling, COT sharing enabled (gNB initiated COT).											

Tdoc/Source	Reported parameters		**Low load** BO range for Wi-Fi in WiFi+WiFi: 10%~25%				**Medium load** BO range for Wi-Fi in WiFi+WiFi: 35%~50%				**High load** BO range for Wi-Fi in WiFi+WiFi: above 55%			
			Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in WiFi+ WiFi	Wi-Fi in WiFi+ NR-U	NR-U in WiFi+ NR-U	NR-U in NR-U+ NR-U
R1-1814074 / Source 5	**DL:** UPT CDF [Mbps]	5%	3.519	4.356	12.183	19.404	1.597	2.191	5.388	5.999	0.696	0.663	0.567	1.845
		50%	11.330	13.595	52.143	57.899	8.117	9.779	29.397	31.273	5.940	6.412	18.017	19.871
		95%	34.731	36.983	75.486	75.607	29.071	31.368	67.317	69.602	28.158	27.612	52.986	62.053
		Mean	14.302	16.122	49.356	53.813	10.426	13.254	31.864	33.551	8.857	9.250	20.917	23.771
	DL: Delay CDF [s]	5%	0.066	0.057	0.053	0.052	0.080	0.066	0.055	0.054	0.088	0.082	0.063	0.058
		50%	0.187	0.167	0.076	0.066	0.334	0.279	0.136	0.127	0.454	0.410	0.204	0.193
		95%	0.641	0.506	0.377	0.264	1.590	1.343	0.628	0.627	2.497	2.478	1.174	1.196
		Mean	0.256	0.217	0.132	0.108	0.518	0.443	0.215	0.206	0.747	0.709	0.343	0.342
	ρ		0.982	0.986	0.985	0.971	0.935	0.966	0.898	0.890	0.847	0.877	0.782	0.836
	BO		0.106	0.096	0.06	0.06	0.323	0.265	0.217	0.223	0.509	0.470	0.442	0.389
	λ		0.1				0.175				0.25			
			Additional comments: - 4ms for both Wi-Fi and NR-U - No - For Wi-Fi, PDT = -82 dBm, EDT = -62 dBm; for NR-U EDT = -72 dBm (baseline) - 256 QAM for both Wi-Fi and NR-U - NR-U with array radiation pattern according to TR38.802 and max BF gain of 5 dBi; omni-directional for Wi-Fi - MPDU size = 3250 bytes by default, 1ms per MPDU - 15 kHz - 0.8 µs - Capability #1 - Mapping type B in the starting slot of TxOP; per-symbol PDCCH monitoring for flexible starting position - No fast link adaptation utilizing multiple switching points within COT for NR-U - Cross-carrier scheduling in UL												

Tdoc /Source	Reported parameters		Low load BO range for Wi-Fi in Wi-Fi+Wi-Fi: 10%~25%				Medium load BO range for Wi-Fi in Wi-Fi+Wi-Fi: 35%~50%				High load BO range for Wi-Fi in Wi-Fi+Wi-Fi: above 55%			
			Wi-Fi in Wi-Fi+ Wi-Fi	Wi-Fi in Wi-Fi+ NR-U	NR-U in Wi-Fi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in Wi-Fi+ Wi-Fi	Wi-Fi in Wi-Fi+ NR-U	NR-U in Wi-Fi+ NR-U	NR-U in NR-U+ NR-U	Wi-Fi in Wi-Fi+ Wi-Fi	Wi-Fi in Wi-Fi+ NR-U	NR-U in Wi-Fi+ NR-U	NR-U in NR-U+ NR-U
R1- 1814062 /Source 6	DL UPT CDF [Mbps]	5%	3.714	4.364	30.880	37.545	1.541	3.672	16.983	18.597	0.707	1.552	6.490	12.252
		50%	43.175	62.566	123.093	147.561	23.461	37.345	100.256	109.054	15.120	22.544	46.490	52.998
		95%	105.741	117.282	201.034	191.196	102.653	112.321	181.664	182.641	96.035	101.527	180.281	188.214
		Mean	53.272	61.646	126.294	135.740	37.662	52.038	107.190	124.808	27.231	35.182	69.630	89.052
	DL Delay CDF [s]	5%	0.039	0.033	0.021	0.022	0.035	0.034	0.021	0.020	0.042	0.041	0.023	0.021
		50%	0.091	0.060	0.035	0.031	0.164	0.088	0.046	0.040	0.277	0.161	0.106	0.097
		95%	1.032	0.581	0.126	0.120	1.840	0.990	0.260	0.240	3.313	3.001	1.054	0.797
		Mean	0.276	0.198	0.054	0.053	0.458	0.262	0.086	0.068	0.690	0.594	0.253	0.171
	UL UPT CDF [Mbps]	5%	4.938	11.565	14.560	32.995	1.879	5.905	7.896	26.318	0.310	1.703	3.515	15.488
		50%	57.731	84.192	110.640	121.620	24.350	62.856	75.543	80.462	13.294	22.741	35.754	49.990
		95%	106.614	114.090	190.409	190.086	91.471	111.718	168.420	170.992	73.424	92.983	133.636	137.900
		Mean	57.767	70.590	103.105	106.134	34.531	59.456	84.700	87.968	20.858	33.784	49.572	65.205
	UL Delay CDF [s]	5%	0.036	0.032	0.021	0.021	0.040	0.034	0.022	0.021	0.047	0.040	0.031	0.300
		50%	0.074	0.049	0.041	0.037	0.176	0.073	0.062	0.060	0.363	0.200	0.167	0.127
		95%	0.737	0.369	0.360	0.184	1.809	0.604	0.528	0.163	2.641	2.254	1.533	0.377
		Mean	0.198	0.108	0.082	0.080	0.443	0.178	0.144	0.142	0.786	0.544	0.402	0.273
	ρ_{DL}		0.9716	0.9716	0.9714	1.00	0.9130	0.9371	0.9371	1.00	0.9107	0.9102	0.9102	1.00
	ρ_{UL}		0.9662	0.9736	1.00	1.00	0.9467	0.9670	1.00	1.00	0.8828	0.9373	0.9735	1.00
	BO		13.0	8.44	3.02	3.00	35.0	16.48	7.90	5.60	59.0	40.40	22.40	15.60
	λ		0.06/0.06				0.086/0.086				0.114/0.114			
			Additional comments: Outdoor Sub-7GHz deployment Scenario 2 WiFi settings: 802.11ac MCS table including 256 QAM, 2Tx2Rx in DL (cross-polarized, open loop), 2Tx2Rx in UL, 2 streams in both DL and UL. GI:0.8 µs, TXOP=4 ms, LDPC, A-MPDU enabled, RTS/CTS disabled, link adaptation: Minstrel algorithm, CWS: DL{15,63} and UL{15,1023}, CCA: CS=-82dBm, ED=-62dBm. NR-U settings: 4Tx2Rx in DL, Cross-polarized. MCS=4/16/64/256QAM, scheduling: proportional fair, link adaptation realistic, ED=-72 dBm, CP=Normal, SCS=30KHz, TXOP=4 ms, UE Capability #1, MCS: DL{15,63} and UL{15,1023}, COT sharing enabled, COT details: flexible DL/UL only and mixed DL/UL based on traffic needs, 3/11 DL control/data symbols, 3/11 symbols UL control/data.											

Annex C: Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2018-02	RAN1#92	R1-1803272				First version of TR	0.0.1
2018-05	RAN1#93	R1-1807383				Update to capture the agreements reached in RAN1 #92 and #92bis	0.0.2
2018-08	RAN1#94	R1-1809795				Update to capture the agreements reached in RAN1 #93	0.0.3
2018-08	RAN1#94	R1-1810047				MCC clean-up based on endorsed R1-1809795	0.1.0
2018-10	RAN1#94b	R1-1811910				Update to capture the agreements reached in RAN1 #94	0.1.1
2018-10	RAN1#94b	R1-1812049				Update to capture the agreements reached in RAN1 #94bis, and RAN2 TPs	0.1.2
2018-10	RAN1#94b	R1-1812080				MCC clean-up based on endorsed R1-1812049	0.2.0
2018-11	RAN1#95	R1-1814346				Update to capture the agreemensts reached in RAN1 #95, evaluation results, and RAN2 inputs	0.2.1
2018-11	RAN1#95	R1-1814385				Merge in RAN4 imput	0.3.0
2018-11	RAN1#95	R1-1814386				MCC clean-up based on endorsed R1-1814385 – for one-step approval by plenary	1.0.0
2018-12	RAN1#95	R1-1814408				Remove outdated tables	1.1.0
2018-12	RAN#82					Following RAN#82 decision, Rel-16 specification goes under change control	16.0.0