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Contents

Foreword

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1 Scope

This report presents the self evaluation results of 3GPP 5G SRIT and 5G NR RIT.

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.
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[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 38.101-1: "User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[3] 3GPP TS 38.101-2: "User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[4] Report ITU-R M.2410: "Minimum requirements related to technical performance for IMT-2020 radio interface(s)".

[5] Report ITU-R M.2411: "Requirements, evaluation criteria and submission templates for the development of IMT-2020".

[6] Report ITU-R M.2412: "Guidelines for evaluation of radio interface technologies for IMT-2020".

[7] 3GPP TS 38.211: "Physical channels and modulation".

[8] 3GPP TR 38.817-01: "General aspects for User Equipment (UE) Radio Frequency (RF) for NR".

[9] 3GPP TS 38.214: "Physical layer procedures for data".

[10] 3GPP TS 38.306: "User Equipment (UE) radio access capabilities".

[11] 3GPP TS 36.211: "Physical channels and modulation".

[12] 3GPP TS 38.133: "Requirements for support of radio resource management".

[13] 3GPP TS 36.133: "Requirements for support of radio resource management".

[14] 3GPP TS 36.300: "Overall description; Stage 2".

[15] 3GPP TS 38.104: "Base Station (BS) radio transmission and reception".

[16] 3GPP TS 38.331: "Radio Resource Control (RRC) protocol specification".

[17] 3GPP TS 36.101: "User Equipment (UE) radio transmission and reception".

[18] 3GPP TS 36.331: "Radio Resource Control (RRC); Protocol specification".

[19] 3GPP TR 36.873: "Study on 3D channel model for LTE".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

3.2 Symbols

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

SE_{p_j} Peak spectral efficiency for *j-th* component carrier (CC); see clause 5.1.1
$v_{Layers}^{(j)}$ Maximum number of layers for *j-th* CC; see clause 5.1.1
$Q_m^{(j)}$ Maximum modulation order for *j-th* CC; see clause 5.1.1
$f^{(j)}$ Scaling factor for *j-th* CC; see clause 5.1.1
μ Numerology as defined in TS 38.211
T_s^{μ} Average OFDM symbol duration in a subframe for numerology; see clause 5.1.1
$N_{PRB}^{BW(j),\mu}$ Maximum RB allocation in bandwidth $BW^{(j)}$ with numerology μ; see clause 5.1.1
$OH^{(j)}$ Overhead calculated as the average ratio of the number of REs not used for data transmission
$\alpha^{(j)}$ Normalized scalar of downlink/uplink ratio
R Peak data rate; see clause 5.2
W_j Effective bandwidth; see clause 5.2
P_{SSB} SSB set periodicity; see clause 5.8.1
P_{RMSI} RMSI periodicity; see clause 5.8.1
$Sleep\_ratio_{Slot\_based}$ Sleep ratio per slot basis; see clause 5.8.1
$Sleep\_ratio_{Symbol\_based}$ Sleep ratio per symbol basis; see clause 5.8.1
N_{PC_RF} The paging frame and subframe with the period of N_{PC_RF} radio frame; see clause 5.8.2
$SINR_{pre-proc}$ Pre-processing SINR; see clause B.1
$RSRP_p$ Reference signal receiving power; see clause B.1
PL The value of pathloss
SF The value of shadow fading

3.3 Abbreviations

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

CF Carrier frequency
CSI-RS CSI reference signal
DC Dual connectivity
DM-RS Demodulation reference signal
DL Downlink
eMBB Enhanced mobile broadband
eMTC Enhanced machine type communication
FDD Frequency division duplexing
FeMBMS Further evolved multimedia broadcast multicast service
FR1 Frequency range 1
FR2 Frequency range 2
ISD Inter-site distance
LMLC Low mobility large cell
LOS Line of sight
MeNB Master E-UTRAN NodeB
MIMO Multiple input multiple output

mMTC	Massive machine type communication
MU	Multiple user
NB-IoT	Narrow band internet of things
NLOS	Non line of sight
OH	Overhead
OS	OFDM symbol
PSCell	Primary secondary cell
PSS	Primary synchronization signal
PT-RS	Phase-tracking reference signal
RIT	Radio interface technology
RMa	Rural macro
RMSI	Remaining minimum system information
RTT	Round-trip time
SCS	Subcarrier spacing
SeNB	Secondary E-UTRAN NodeB
SIMO	Single input multiple output
SISO	Single input single output
SRI	SRS resource indicator
SRIT	Set of RITs
SRS	Sounding reference signal
SS	Synchronization signal
SSB	SS/PBCH Block
SSS	Secondary synchronization signal
SU	Single user
TDD	Time division duplexing
TRxP	Transmission reception point
UL	Uplink
UMa	Urban macro
URLLC	Ultra reliable and low latency communication

4 Introduction

This report presents the self evaluation results of 5G[1] developed by 3GPP, which includes two submissions:

- Submission 1: SRIT. It consists of two component RITs
  - Component RIT 1: NR
  - Component RIT 2: E-UTRA/LTE (including LTE-NR DC)
- Submission 2: NR RIT.
  - It is the same as in NR component RIT in submission 1.

From evaluation perspective, NR RIT and LTE RIT are evaluated against the technical performance requirements as defined in Report ITU-R M.2410 for eMBB, mMTC and URLLC usage scenarios, as well as spectrum requirements and service requirements as defined in Report ITU-R M.2411, using the evaluation criteria as defined by Report ITU-R M.2412. Detailed self evaluation results are provided through Section 5 to 8.

The conclusion is given in Section 9 for SRIT and NR RIT.

[1] Developed by 3GPP as 5G, Release 15 and beyond.

5 Self evaluation of eMBB technical performance

In the following, frequency ranges indicated by FR1 and FR2 are evaluated. The definition are given in Table 5-1 (see also [2] and [3]).

Table 5-1 Definition of frequency ranges

Frequency range designation	Corresponding frequency range
FR1	410 MHz – 7125 MHz
FR2	24250 MHz – 52600 MHz

5.1 Peak spectral efficiency

As defined in Report ITU-R M.2410 [4], Peak spectral efficiency is the maximum data rate under ideal conditions normalized by channel bandwidth (in bit/s/Hz), where the maximum data rate is the received data bits assuming error-free conditions assignable to a single mobile station, when all assignable radio resources for the corresponding link direction are utilized (i.e. excluding radio resources that are used for physical layer synchronization, reference signals or pilots, guard bands and guard times).

5.1.1 NR

The generic formula for peak spectral efficiency for FDD and TDD for a specific component carrier (say *j-th CC*) is given by

$$SE_{p_j} = \frac{v_{Layers}^{(j)} \cdot Q_m^{(j)} \cdot f^{(j)} \cdot R_{\max} \cdot \frac{N_{PRB}^{BW(j),\mu} \cdot 12}{T_s^{\mu}} \cdot (1 - OH^{(j)})}{BW^{(j)}} \quad (5.1.1\text{-}1)$$

wherein

- R_{max} = 948/1024
- For the *j*-th CC,
  - $v_{Layers}^{(j)}$ is the maximum number of layers
  - $Q_m^{(j)}$ is the maximum modulation order
  - $f^{(j)}$ is the scaling factor
    - The scaling factor can at least take the values 1 and 0.75.
    - $f^{(j)}$ is signalled per band and per band per band combination as per UE capability signalling
  - μ is the numerology (as defined in TS 38.211 [7])
  - T_s^{μ} is the average OFDM symbol duration in a subframe for numerology μ, i.e. $T_s^{\mu} = \frac{10^{-3}}{14 \cdot 2^{\mu}}$. Note that normal cyclic prefix is assumed.
  - $N_{PRB}^{BW(j),\mu}$ is the maximum RB allocation in bandwidth $BW^{(j)}$ with numerology μ, as given in TR 38.817-01 [8] section 4.5.1, where $BW^{(j)}$ is the UE supported maximum bandwidth in the given band or band combination.

- $OH^{(j)}$ is the overhead calculated as the average ratio of the number of REs occupied by L1/L2 control, Synchronization Signal, PBCH, reference signals and guard period (for TDD), etc. with respect to the total number of REs in effective bandwidth time product as given by $\left(\alpha^{(j)} \cdot BW^{(j)} \cdot (14 \times T_s^{\mu})\right)$.

  - $\alpha^{(j)}$ is the normalized scalar considering the downlink/uplink ratio; for FDD $\alpha^{(j)}=1$ for DL and UL; and for TDD and other duplexing $\alpha^{(j)}$ for DL and UL is calculated based on the DL/UL configuration.

  - For guard period (GP), 50% of GP symbols are considered as downlink overhead, and 50% of GP symbols are considered as uplink overhead.

5.1.1.1 DL peak spectral efficiency

A range of configurations are considered in the evaluation of downlink peak spectral efficiency. The evaluation considers the maximum potential capability as indicated in TS 38.214 [9]. Note that the DL and UL max data rate supported by the UE is indicated in TS38.306 [10].

For NR FDD, DL peak spectral efficiency of frequency range 1 (FR1) for 450 MHz – 7125 MHz is evaluated. The evaluated configurations for FDD generally assume 8-layer downlink transmission, with 256QAM modulation, and a maximum coding rate of 0.9258. The difference among the evaluated configurations lays in the overhead of control and reference signals, etc. The evaluation results are provided in Table 5.1.1.1-1. The detailed assumptions are provided in Annex B.3.1.1.

Table 5.1.1.1-1 NR FDD DL peak spectral efficiency (bit/s/Hz)

SCS [kHz]		5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Req.
FR1	15	40.8~ 42.8	44.5~ 45.5	45.1~ 46.5	45.4~ 47.0	45.5~ 47.2	45.7~ 47.4	46.2~ 48.2	46.2~ 48.3	-	-	-	-	30
	30	32.1~ 37.7	39.4~ 41.1	43.0~ 44.2	43.7~ 44.8	44.5~ 45.9	44.5~ 46.1	45.4~ 47.1	45.5~ 47.4	46.2~ 48.2	46.4~ 48.5	48.5~ 48.7	46.7~ 48.9	30
	60	-	32.4~ 37.7	38.4~ 41.1	39.6~ 41.3	41.8~ 43.1	43.2~ 44.3	43.7~ 44.9	44.5~ 46.0	45.1~ 46.8	45.8~ 47.7	47.6~ 47.8	46.2~ 48.2	30

For NR TDD, DL peak spectral efficiency for both FR1 and FR2 for 24.25 GHz – 52.6 GHz are evaluated.

For NR TDD in FR1, the evaluated configurations generally assume 8-layer downlink transmission, with 256QAM modulation, and a maximum coding rate of 0.9258. The DL/UL configurations of DDDSU (with 'S' slot = 11DL:1GP:2UL) and DSUUD (with 'S' slot = 6DL:2GP:6UL and 11DL:1GP:2UL respectively) are evaluated.

The evaluation results of DDDSU for FR1 are provided in Table 5.1.1.1-2. In the evaluation, different control overhead assumptions are considered due to the different transmission schemes. The detailed assumptions are provided in Annex B.3.1.1.

Table 5.1.1.1-2 NR TDD DL peak spectral efficiency for FR1 (bit/s/Hz)
(Frame structure: DDDSU; α_{DL}=0.7643; with OH1 and OH2)

SCS [kHz]		5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Req.
FR1	15	39.6~ 41.5	43.6~ 44.5	44.9~ 45.6	45.6~ 46.1	46.1~ 46.4	46.3~ 46.6	47.1~ 47.3	47.2~ 47.4	-	-	-	-	30
	30	31.7~ 35.2	38.4~ 40.3	42.1~ 43.3	43.1~ 44.0	44.4~ 45.1	44.6~ 45.3	45.9~ 46.3	46.3~ 46.6	47.1~ 47.4	47.5~ 47.7	47.7~ 47.9	47.9~ 48.1	30
	60	-	31.8~ 35.3	37.5~ 40.1	38.7~ 40.5	40.9~ 42.3	42.3~ 43.5	43.3~ 44.2	44.5~ 45.3	45.4~ 46.0	46.4~ 46.9	46.8~ 47.2	47.1~ 47.4	30

The evaluation results of DSUUD for the two S-slot configurations for FR1 are provided in Table 5.1.1.1-3. The detailed assumptions are provided in Annex B.3.1.1.

Table 5.1.1.1-3 NR TDD DL peak spectral efficiency for FR1 (bit/s/Hz)
(Frame structure: DSUUD)

(a) S slot = 11DL:1GP:2UL, α_{DL}=0.5643, with OH3

SCS [kHz]		5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Req.
FR1	15	39.1	43.1	44.5	45.2	45.6	45.9	46.7	46.8	-	-	-	-	30
	30	30.4	38.0	41.7	42.7	44.0	44.3	45.5	45.9	46.8	47.1	47.4	47.6	30
	60	-	31.0	37.1	38.4	40.6	42.0	42.9	44.2	45.1	46.1	46.5	46.8	30

(b) S slot = 6DL:2GP:6UL, α_{DL}=0.5, with OH4

SCS [kHz]		5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Req.
FR1	15	39.1	42.4	43.5	44.0	44.4	44.6	45.3	45.4	-	-	-	-	30
	30	33.1	37.4	40.7	41.6	42.7	42.9	44.0	44.4	45.2	45.5	45.7	45.9	30
	60	-	33.1	36.4	37.4	39.4	40.7	41.6	42.7	43.5	44.5	44.8	45.1	30

For NR TDD in FR2, the DL/UL configurations of DDDSU (with 'S' slot = 11DL:1GP:2UL) and DSUUD (with 'S' slot = 6DL:2GP:6UL and 11DL:1GP:2UL respectively) are evaluated. For FR2 evaluation, the number of layers is assumed to be 6. This is because larger than 6-port DMRS is difficult due to the phase noise impact on FR2. Besides, the highest modulation order of 256QAM and the maximum coding rate of 0.9258 are assumed.

The evaluation results of DDDSU and DSUUD for FR2 are provided in Table 5.1.1.1-4 and Table 5.1.1.1-5, respectively. The detailed assumptions are provided in Annex B.3.1.1.

Table 5.1.1.1-4 NR TDD DL peak spectral efficiency for FR2 (bit/s/Hz)
(Frame structure: DDDSU, α_{DL}=0.7643, Number of layer = 6)

SCS [kHz]		50 MHz	100 MHz	200 MHz	400 MHz	Req.
FR2	60	33.7	34.5	34.9	-	30
	120	31.7	34.0	34.7	35.0	30

Table 5.1.1.1-5 NR TDD DL peak spectral efficiency for FR2 (bit/s/Hz)
(Frame structure: DSUUD, S slot = 11DL:1GP:2UL, α_{DL}=0.5643, Number of layer = 6)

SCS [kHz]		50 MHz	100 MHz	200 MHz	400 MHz	Req.
FR2	60	32.9	33.8	34.2	-	30
	120	31.1	33.5	34.2	34.6	30

If phase noise does not exist for FR2, the 8- layer transmission can be supported for FR2. The evaluation of this capability together with DSUUD is provided in Table 5.1.1.1-6.

Table 5.1.1.1-6 NR TDD DL peak spectral efficiency for FR2 (bit/s/Hz)
(Frame structure: DSUUD, S slot = 6DL:2GP:6UL, α_{DL}=0.5, Number of layer = 8)

SCS [kHz]		50 MHz	100 MHz	200 MHz	400 MHz	Req.
FR2	60	41.9	43.2	43.8	-	30
	120	38.0	41.9	43.2	43.8	30

Based on the above analysis, NR fulfils DL peak spectral efficiency requirement with a range of configurations.

5.1.1.2 UL peak spectral efficiency

A range of configurations are considered in the evaluation of uplink peak spectral efficiency.

For NR FDD, UL peak spectral efficiency of FR1 is evaluated. The evaluated configurations for FDD generally assume 4-layer downlink transmission, with 256QAM modulation, and a maximum coding rate of 0.9258. The difference among the evaluated configurations lays in the overhead of control and reference signals, etc. The evaluation results are provided in Table 5.1.1.2-1. The detailed assumptions are provided in Annex B.3.1.2.

Table 5.1.1.2-1 NR FDD UL peak spectral efficiency (bit/s/Hz)

SCS [kHz]	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Req.

FR1	15	22.9~ 23.5	23.8~ 24.5	24.1~ 24.8	24.3~ 25.0	24.4~ 25.1	24.4~ 25.2	24.7~ 25.5	24.7~ 25.5	0.0	0.0	0.0	0.0	15
	30	20.1~ 20.7	22.0~ 22.6	23.2~ 23.9	23.4~ 24.1	23.8~ 24.6	23.8~ 24.6	24.3~ 25.1	24.4~ 25.2	24.7~ 25.5	24.8~ 25.7	24.9~ 25.3	25.0~ 25.8	15
	60	0.0	20.1~ 20.7	22.0~ 22.6	22.0~ 22.7	22.7~ 23.4	23.2~ 23.9	23.4~ 24.1	23.8~ 24.6	24.1~ 24.9	24.5~ 25.3	24.9~ 25.0	24.7~ 25.6	15

For NR TDD, UL peak spectral efficiency for both FR1 and FR2 are evaluated.

For NR TDD in FR1, the evaluated configurations generally assume 4-layer uplink transmission, with 256QAM modulation, and a maximum coding rate of 0.9258. The DL/UL configurations of DDDSU (with 'S' slot = 11DL:1GP:2UL) and DSUUD (with 'S' slot = 6DL:2GP:6UL and 11DL:1GP:2UL respectively) are evaluated.

The evaluation results of DDDSU for FR1 are provided in Table 5.1.1.2-2. In the evaluation, different control overhead assumptions are considered due to the different transmission schemes. The detailed assumptions are provided in Annex B.3.1.2.

Table 5.1.1.2-2 NR TDD UL peak spectral efficiency for FR1 (bit/s/Hz)
(Frame structure: DDDSU, α_{UL}=0.2357, with OH1 and OH2)

SCS [kHz]		5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Req.
FR1	15	20.6~ 21.6	21.5~ 22.6	21.8~ 22.9	22.0~ 23.0	22.0~ 23.1	22.1~ 23.2	22.4~ 23.5	22.4~ 23.5	-	-	-	-	15
	30	18.2~ 19.1	20.0~ 20.9	21.1~ 22.1	21.3~ 22.3	21.7~ 22.8	21.7~ 22.8	22.2~ 23.2	22.2~ 23.2	22.6~ 23.7	22.7~ 23.8	22.8~ 23.9	22.8~ 23.9	15
	60	-	18.3~ 19.1	20.0~ 21.0	20.1~ 21.0	20.8~ 21.8	21.2~ 22.2	21.4~ 22.4	21.8~ 22.9	22.1~ 23.2	22.5~ 23.5	22.6~ 23.7	22.7~ 23.8	15

The evaluation results of DSUUD for the two S-slot configurations for FR1 are provided in Table 5.1.1.2-3. The detailed assumptions for the two configurations are provided in Annex B.3.1.2.

Table 5.1.1.2-3 NR TDD UL peak spectral efficiency for FR1 (bit/s/Hz)
(Frame structure: DSUUD)

(a) S slot = 11DL:1GP:2UL, α_{UL}=0.4357, with OH3

SCS [kHz]		5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Req.
FR1	15	22.1	23.1	23.4	23.6	23.7	23.8	24.0	24.0	-	-	-	-	15
	30	19.4	21.3	22.5	22.7	23.1	23.1	23.6	23.7	24.1	24.2	24.3	24.3	15
	60	-	19.4	21.3	21.3	22.0	22.5	22.7	23.2	23.4	23.8	24.0	24.0	15

(b) S slot = 6DL:2GP:6UL, α_{UL}=0.5, with OH4

SCS [kHz]		5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	80 MHz	90 MHz	100 MHz	Req.
FR1	15	21.7	23.0	23.4	23.6	23.7	23.8	24.1	24.1	-	-	-	-	15
	30	18.3	20.8	22.2	22.5	23.0	23.1	23.6	23.7	24.2	24.3	24.4	24.2	15
	60	-	18.3	20.6	20.8	21.7	22.2	22.5	23.0	23.8	23.9	24.1	23.8	15

For NR TDD in FR2, the evaluated configurations generally assume 4-layer uplink transmission, with 256QAM modulation, and a maximum coding rate of 0.9258. The DL/UL configurations of DDDSU (with 'S' slot = 11DL:1GP:2UL) and DSUUD (with 'S' slot = 6DL:2GP:6UL and 11DL:1GP:2UL respectively) are evaluated.

The evaluation results of DDDSU and DSUUD for FR2 are provided in Table 5.1.1.2-4 and Table 5.1.1.2-5, respectively. The detailed assumptions are provided in Annex B.3.1.2.