TSG-RAN Working Group 4 (Radio) meeting #94-eR4-2002869

Electronic Meeting, February 24th – March 06th 2020

**Source:** Ericsson

**Title:** TP to TR 38.820: Addition of technical background for BS classes in subclause 7.3

**Agenda item:** 10.3.5

**Document for:** Approval

# Introduction

At the last RAN4 meeting (RAN4#93 in Reno) many text proposals to technical report (TR 38.820) was approved and captured in the last version [1]. The status of TR 38.820 is now at a point close to completion. However, there are still some pieces of information relevant for 7 to 24 GHz not captured.

The base station RF core specification differentials base stations in different base station classes based on the intended deployment scenario. This means that the specification has requirements for base stations operating in Wide Area, Medium Range and Load Area deployments.

Also, for the frequency band 7 to 24 GHz, the specification needs to differentiate requirement between different base station classes. In this contribution technical background information related to the concept of base station classes have been collected. At the end of the contribution a text proposal with information relevant for 7 to 24 GHz is attached for approval. The text proposal adds missing information to TR 38.820, subclause 7.3.

This is a revised version of R4-2001017.

# Discussion

From TS 38.104, subclause 4.4 the base station classes for base station supporting NR operating within FR1 and FR2 can be found. The base station class concept is in the RF core specification defined as follows;

*The requirements in this specification apply to Wide Area Base Stations, Medium Range Base Stations and Local Area Base Stations unless otherwise stated. The associated deployment scenarios for each class are exactly the same for BS with and without connectors.*

*For BS type 1-O and 2-O, BS classes are defined as indicated below:*

*- Wide Area Base Stations are characterised by requirements derived from Macro Cell scenarios with a BS to UE minimum distance along the ground equal to 35 m.*

*- Medium Range Base Stations are characterised by requirements derived from Micro Cell scenarios with a BS to UE minimum distance along the ground equal to 5 m.*

*- Local Area Base Stations are characterised by requirements derived from Pico Cell scenarios with a BS to UE minimum distance along the ground equal to 2 m.*

*For BS type 1-C and 1-H, BS classes are defined as indicated below:*

*- Wide Area Base Stations are characterised by requirements derived from Macro Cell scenarios with a BS to UE minimum coupling loss equal to 70 dB.*

*- Medium Range Base Stations are characterised by requirements derived from Micro Cell scenarios with a BS to UE minimum coupling loss equals to 53 dB.*

*- Local Area Base Stations are characterised by requirements derived from Pico Cell scenarios with a BS to UE minimum coupling loss equal to 45 dB.*

For the frequency range 7 to 24 GHz, it is foreseen that support for type -C, -H and -O requirements will be supported. Eventually, the frequency range will be split up in terms of supported requirement types. What requirement types that will be supported for a specific band will be decided in the work item introducing the band to RAN4.

For the frequency band 7 to 24 GHz the base station class concept can be summarized as:

For BS specified by OTA requirements (type -O), BS classes are defined as indicated below:

- Wide Area Base Stations are characterised by requirements derived from Macro Cell scenarios with a BS to UE minimum distance along the ground equal to 35 m.

- Medium Range Base Stations are characterised by requirements derived from Micro Cell scenarios with a BS to UE minimum distance along the ground equal to 5 m.

- Local Area Base Stations are characterised by requirements derived from Pico Cell scenarios with a BS to UE minimum distance along the ground equal to 2 m.

For BS specified by conducted requirement set (type -C) or hybrid requirement set (type -H), BS classes are defined as indicated below:

- Wide Area Base Stations are characterised by requirements derived from Macro Cell scenarios with a BS to UE minimum coupling loss equal to 70 dB.

- Medium Range Base Stations are characterised by requirements derived from Micro Cell scenarios with a BS to UE minimum coupling loss equals to 53 dB.

- Local Area Base Stations are characterised by requirements derived from Pico Cell scenarios with a BS to UE minimum coupling loss equal to 45 dB.

Summary of change:

1. The text is now aligned with TS 38.104. The considered base station classes are Wide Area Base Stations, Medium Range Base Stations and Local Area Base Stations. The associated deployment scenarios for each class are exactly the same for BS with and without correctors.
2. Text from R4-2000673 is included.

# Conclusion

The concept with multiple base station classes has been adopted for FR1 and FR2. It therefore reasonable to use the same concept for the frequency range 7 to 24 GHz.

At the end of this contribution a text proposal capturing BS class information relevant for the frequency range 7 to 24 GHz is attached for approval.

# References

[1] R4-1916102, “TR 38.820”, Huawei, RAN4#93

TEXT PROPOSAL:

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 TR 38.913: “Study on Scenarios and Requirements for Next Generation Access Technologies”

[3] 3GPP TS 38.113: “NR; Base Station (BS) ElectroMagnetic Compatibility (EMC)”

[4] 3GPP TR 38.817-02: “NR; General aspects for Base Station (BS) Radio Frequency (RF) for NR”

[5] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception"

[6] 3GPP TS 38.141-2: "NR; Base Station (BS) conformance testing Part 2: Radiated conformance testing"

[7] Recommendation ITU-R SM.329-12: "Unwanted emissions in the spurious domain"

[8] IEC 61000-4-3: 2006+AMD1:2007+AMD2:2010 CSV: "Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test"

[9] Hua Wang et al., "Power Amplifiers Performance Survey 2000-Present," 2008, Available: <https://gems.ece.gatech.edu/PA_survey.html>

[10] 3GPP TS 37.105: “Active Antenna System (AAS) Base Station (BS) transmission and reception”

[11] Hua Wang, Fei Wang, Huy Thong Nguyen, Sensen Li, Tzu-Yuan Huang, Amr S. Ahmed, Michael Edward Duffy Smith, Naga Sasikanth Mannem, Jeongseok Lee, Edgar Garay, Sanghoon Lee, and David Munzer, "Power Amplifiers Performance Survey 2000-Present," 2019.07, <https://gems.ece.gatech.edu/PA_survey.html>

[12] Code of Federal Regulations, Title 47: Telecommunication; Part 2—Frequency Allocations and Radio Treaty Matters; General Rules and Regulations, <https://www.ecfr.gov/cgi-bin/text-idx?SID=983c3dd433919e69fce5a8bd4b565cfb&mc=true&node=pt47.1.2&rgn=div5>

[13] 3GPP TS 38.211: “NR; Physical channels and modulation”

[14] 3GPP TS 38.213: “NR; Physical layer procedures for control”

[15] 3GPP TS 38.214: “NR; Physical layer procedures for data”

[16] 3GPP TS 38.141-1: “NR; Base Station (BS) conformance testing Part 1: Conducted conformance testing”

[17] 3GPP TS 38.101-1: “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”

[18] 3GPP TS 38.101-2: “NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone”

[19] 3GPP TS 38.101-3: “NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios”

[20] 3GPP TS 38.133: “NR; Requirements for support of radio resource management”

[21] R4-1907593: “LS on UE feature list for NR”, RAN4#91

[22] 3GPP TR 25.942: “Radio Frequency (RF) system scenarios”

[23] The European table of frequency allocations and applications in the frequency range 8.3 kHz to 3000 GHz, ECO, <https://www.ecodocdb.dk/document/593>

[24] 3GPP TS 36.104: “Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception”

[25] 3GPP TS 37.104: “NR, E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception”

[26] Kambiz Hadipour, Andrea Ghilioni1, Andrea Mazzanti1, Matteo Bassi1, Francesco Svelto, “A 40GHz to 67GHz Bandwidth 23dB Gain 5.8dB Maximum NF mm-Wave LNA in 28nm CMOS”, 2015 IEEE Radio Frequency Integrated Circuits Symposium

[27] Domenico Pepe, Domenico Zito, “32 dB Gain 28 nm Bulk CMOS W-Band LNA”, IEEE Microwave and Wireless Components Letters, Vol. 25, No. 1, January 2015

[28] Domenico Pepe1, Domenico Zito, “72 GHz CMOS LNA with Transformer-based Input Integrated Matching”, IEEE 2015

[29] Hossein Noori, Miles Sanner, Naveen Yanduru, “A 0.8 dB NF, 4.6 dBm IIP3, 1.8 - 2.2 GHz, Low-Power LNA in 130 nm RF SOI CMOS Technology”, IEEE 2015

[30] Joost Melai, Peter Magnée, Ivo Pouwel, Pieter Weijs, Ihor Brunets, Rob van Dalen, Anurag Vohra, Luuk Tiemeijer, Ralf Pijper, Hans Tuinhout, Nicole Wils, Nicolae Cazana, “QUBiC generation 9, a new BiCMOS process optimized for mmWave applications”, IEEE 2015

[31] Cristina Andrei, Olof Bengtsson, Ralf Doerner, Serguei A. Chevtchenko, Wolfgang Heinrich, Matthias Rudolph, “Dynamic behaviour of a Low-Noise Amplifier GaN MMIC under input power overdrive”, Proceedings of the 45th European Microwave Conference

[32] Recommendation ERC/REC 70-03 "Relating to the use of Short Range Devices (SRD)"

[33] ECC, ECC Recommendation (02)/05 "Unwanted Emissions"

[34] ERC Recommendation 74-01 "Unwanted emissions in the spurious domain" (amended 29 May 2019)

[35] LMX2594, 15 GHz Wideband RF Synthesizer, Texas Instruments. <http://www.ti.com/product/LMX2594>

[36] ADF41513 26.5 GHz, Integer N/Fractional-N, PLL Synthesizer, Analog Devices, https://www.analog.com/en/products/adf41513.html

[37] Staffan Ek et al., A 28-nm FD-SOI 115-fs Jitter PLL-Based LO System for 24-30-GHz Sliding-IF 5G Transceivers, [IEEE Journal of Solid-State Circuits](https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=4) (Volume: 53, [Issue: 7](https://ieeexplore.ieee.org/xpl/tocresult.jsp?isnumber=8396884) , July 2018)

[38] K. Raczkowski et. al. “A 9.2–12.7 GHz Wideband Fractional-N Subsampling PLL in 28 nm CMOS With 280 fs RMS Jitter”, IEEE Journal of Solid-State Circuits, vol. 50, no. 5, pp. 1203-1213, May 2015

[39] Ximenes, G. Vlachogiannakis, R. Staszewski, “An Ultracompact 9.4–14.8-GHz Transformer-Based Fractional-N All-Digital PLL in 40-nm CMOS”, IEEE Transactions on Microwave Theory and Techniques, vol. 65, no. 11, pp. 4241-4254, Nov. 2017

[40] N. Markulic et. al. “A Self-Calibrated 10Mb/s Phase Modulator with -37.4dB EVM Based on a 10.1-to-12.4GHz, -246.6dB-FOM, Fractional-N Subsampling PLL”, IEEE International Solid-State Circuits Conference 2016, pp. 176-177

[41] R4-1700305, "[DRAFT] LS on Characteristics of terrestrial IMT systems for frequency sharing/interference analysis in the frequency range between 24.25 GHz and 86 GHz"

[42] Recommendation ITU-R SM.328-11 (2006), “Spectra and bandwidth of emissions”

[43] Recommendation ITU-R M.1580-5 (02/2014), “Generic unwanted emission characteristics of base stations using the terrestrial radio interfaces of IMT-2000”

[44] Recommendation ITU-R M.2070-1 (02/2017), “Generic unwanted emission characteristic of base stations using the terrestrial radio interfaces of IMT-Advanced”

[45] ECC Recommendation (02)05, “Unwanted emissions” (Amended 30 March 2012)

[46] ETSI TR 101 854: “Fixed Radio Systems; Point-to-point equipment; Derivation of receiver interference parameters useful for planning fixed service point-to-point systems operating different equipment classes and/or capacities”

[47] P. Ökvist, H. Asplund, A. Simonsson, B. Halvarsson, J. Medbo and N. Seifi, "15 GHz propagation properties assessed with 5G radio access prototype," 2015 IEEE 26th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC), Hong Kong, 2015, pp. 2220-2224.

[48] K. Zhao et al., "Channel Characteristics and User Body Effects in an Outdoor Urban Scenario at 15 and 28 GHz," in IEEE Transactions on Antennas and Propagation, vol. 65, no. 12, pp. 6534-6548, Dec. 2017.

[49] R4-1609122, NR RF parameters and template for WP5D, RAN4 #81

[50] R4-168770, Way forward on UE and BS estimated NF for mm-waves and ITU-R related work, RAN4 #80bis

[51] R4-1904127, 7-24GHz discuss implications of FR1 and FR2 architectures, RAN4 #90bis

[52] R4-165001, UE reference architecture and other considerations at millimeter wave, RAN4 #80

[53] R4-168076, NR UE system Noise Figure proposal, RAN4 #80bis

[54] R4-1905846, [7-24GHz] Applicable FR1 UE Technologies, RAN4 #91

[55] RP-170021, Reply LS to ITU-R WP5D/374 (Attachment 4.13) on Characteristics of terrestrial IMT systems for frequency sharing/interference analysis in the frequency range between 24.25 GHz and 86 GHz, RAN #75

[56] 3GPP TS 25.104: “Base Station (BS) radio transmission and reception (FDD)”

[57] 3GPP TS 25.951: “FDD Base Station (BS) classification”

TEXT PROPOSAL:

## 7.3 BS classes

The BS to UE minimum coupling loss of each NR BS class as defined in TS 38.104 [5] is the same as that of UTRAN in TS 25.104 [56] or E-UTRA in TS 36.104 [24], while the BS to UE minimum distance of each NR BS class is calculated using the path-loss formula in TR 25.951 [57]:

Which is derived from the free-space path-loss formula as in TR 25.942 [22]:

Where:

* d is the BS to UE distance in meters,
* c is the speed of light in m/s,
* f is the carrier frequency in Hz.

For FR1 and FR2 studies the carrier frequency was assumed to be 2 GHz, which is also assumed for the intermediate frequency range 7 - 24 GHz.

The considered base station classes are Wide Area Base Stations, Medium Range Base Stations and Local Area Base Stations. The associated deployment scenarios (as disused in subclause 5.6) for each class are exactly the same for BS with and without correctors.

For *BS type xFR****-O***, BS classes are defined as indicated below:

- Wide Area Base Stations are characterised by requirements derived from Macro Cell scenarios with a BS to UE minimum distance along the ground equal to 35 m.

- Medium Range Base Stations are characterised by requirements derived from Micro Cell scenarios with a BS to UE minimum distance along the ground equal to 5 m.

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For *BS type xFR-C* and *BS type xFR-H*, BS classes are defined as indicated below:

- Wide Area Base Stations are characterised by requirements derived from Macro Cell scenarios with a BS to UE minimum coupling loss equal to 70 dB.

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