3GPP TSG-RAN WG4 (Radio) Meeting #94 rev-R4-2000674

Online, 24 February – 6 March 2020

**Agenda Item:** **10.3.8.4**

**Source:** **Nokia, Nokia Shanghai Bell**

**Title:** **TP to TR 38.820: Update of BS receiver requirements for 7-24 GHz frequency range**

**Document for:** **Approval**

**1. Introduction**

The TP [1] to TR 38.820 [2] for BS ICS requirements for 7 - 24 GHz frequency range was approved during RAN4#93. It has been identified that there are some issues in this approved TP. This contribution provides a TP to update TR 38.820 to rectify the identified issues.

**2. Discussion**

In the approved TP [1], the term ‘are expected to be defined’ is used in the following statements:

* For the FR1-like frequency range, the conducted requirements should not be precluded. Hence, both conducted as well as radiated requirements are expected to be defined.
* Similar to the FR1 requirements, BS class specific requirements are expected to be defined for conducted ICS.
* BS class specific requirements are expected to be defined for OTA ICS.

The term ‘expected to be defined’ can be interpreted that RAN4 has already agreed to define such requirements. On the other hand, it is stated in section 7.2.2 of the TR that:

* However, at this stage, xFR-C and xFR-H requirements cannot be ruled out for BS operating within example frequency sub-ranges 1 and 2.

Therefore, whether both conducted as well as radiated ICS requirements are defined for each frequency sub-range should be decided in the WI phase.

Moreover, the current NR BS OTA ICS requirements in FR2 are defined agnostic to the BS class [3], and indeed the BS classes applicable to the 7 - 24 GHz frequency range (or each frequency sub-range) is yet to be concluded, hence it is pre-mature to declare BS class specific ICS requirements are expected to be defined within the 7 - 24 GHz frequency range (or each frequency sub-range).

In view of the above points, it is proposed to change the term ‘are expected to be defined’ to ‘need to be considered in the WI phase’ which is commonly used term in a FS TR. The TP is provided below, where other identified errors in the receiver spurious emissions section are also corrected.

**3. Text proposal**

**<Start of change>**

#### 7.4.2.1 Rx requirements overview

Summary of the conducted and radiated Rx requirements specified in Rel-15 for the NR BS is presented in this subclause. More detailed elaboration on the motivation on selected requirements is provided in dedicated subclauses below.

All the findings captured for the conducted requirements in table 7.4.2.1-1 and related subclauses below are considered to be applicable to the (sub)-range of the 7 – 24 GHz for which the conducted requirements will be found to be feasible during related WI.

While radiated requirements are considered to be applicable to the whole 7 – 24 GHz range, their definitions, values and levels may differ across the 7 – 24 GHz range.

Table 7.4.2.1-1: Overview of conducted Rx requirements for NR BS in 7 – 24 GHz range

|  |  |  |  |
| --- | --- | --- | --- |
| Rx requirement | | Conclusions from SI | Items to be completed in related WI |
| Reference sensitivity level | | Based on BW of FRC and NF assumptions.  Indicative noise figure values was concluded in the SI where for 10, 15 and 20 GHz example frequencies, the NF value of 7, 8 and 9 dB respectively. | CBW and reference measurement channels to be confirmed.  Frequency specific NF assumptions to be confirmed. |
| Dynamic range | | Requirement will have to be re-calculated to account for an updated NF, IM and the supported set of NRB and SCS. Required SNR for the wanted signal to be re-simulated.  For the derivation of the requirement: reuse the 95% throughput threshold, reuse the 16QAM-based FRC (if possible). | Value(s) of the NF, IM and required SNR. Consider capturing this aspect by demodulation requirements as for FR2. |
| In-band selectivity and blocking | ACS |  |  |
| In-band blocking | As the 7 to 24 GHz specification has to deal with all the BS types and implementation architectures the in-band blocking level should be set based on the wanted signal to interferer level in the same way as the FR2 levels. The conducted requirement can then be extracted by using the same delta on the conducted REFSENS value. As there are no existing conducted requirements to maintain equivalence to and the 7 to 24 GHz range will primarily consider beam forming systems it is suitable to derive the OTA requirements 1st and then apply the same methodology to the conducted. | Over the 7 to 24 GHz range it is possible there are multiple in-band blocking deltas covering different bands |
| Out-of-band blocking | General out-of-band blocking | The interferer level is -15 dBm below 7.125 GHz. | Range above 7.125 GHz to be concluded in the WI. |
| Co-location |  | Need to establish antenna port isolation for specific band in WI. |
| Receiver spurious emissions | |  | In certain regions, receiver spurious emission limit will be specified during the WI based on applicable regional regulations. |
| Receiver intermodulation | |  | Requirement to be concluded in the WI. |
| In-channel selectivity | | BS class specific requirements will have to be re-calculated to account for an updated NF and the supported set of NRB and SCS. Required SNR for the wanted signal to be re-simulated.  For the derivation of the requirement: reuse the 95% throughput threshold, reuse the QPSK-based FRC. | Value(s) of the NF, required SNR for wanted signal. ICS for the interferer to be verified. |

Table 7.4.2.1-2: Overview of radiated Rx requirements for NR BS in 7 – 24 GHz range

|  |  |  |  |
| --- | --- | --- | --- |
| OTA Rx requirement | | Conclusions from SI | Items to be completed in related WI |
| OTA sensitivity | | The OTA sensitivity requirement is a minimum sensitivity requirement for FR1 and ensures correct operation of the receiver including the integral antenna. OTA sensitivity is a declared parameter, the minimum sensitivity over an associated range of angle of arrivals (RoAoA) are declared (the declaration also allows for the RoAoA to be redirected by non-real time means but this distinction is not needed for simple analysis). | Confirm if minimum sensitivity can be supplied by OTA REFSENS requirement. |
| OTA reference sensitivity level | | The 7 to 24GHz BS is expected to require beam forming and whilst there may be conducted requirements there is no legacy so there is no need to provide equivalence between OTA and conducted requirements. As such the FR2 type of OTA REFSENS requirement may be used even if conducted specifications are specified.  Indicative noise figure values was concluded in the SI where for 10, 15 and 20 GHz example frequencies, the NF value of 7, 8 and 9 dB respectively. | The appropriate NF and ranges of expected antenna gain can be agreed when the exact operating bands are known. |
| OTA dynamic range | | For FR1-like (sub)-range: reuse FR1 approach of deriving the OTA requirement.  For FR2-like (sub)-range: further investigation will be required to decide if the OTA dynamic range requirement in the FR2-like (sub)-range of 7 – 24 GHz range can be skipped.  Value(s) of the NF, IM and required SNR to be reused from the conducted requirement for 7 – 24 GHz.  For the derivation of the requirement: reuse the 95% throughput threshold, reuse the 16QAM-based FRC (if possible). | Evaluations for the FR2-like (sub)-range. |
| OTA in-band selectivity and blocking | OTA ACS |  |  |
| OTA in-band blocking | In-band requirements dependent on the sensitivity requirements, as the sensitivity is used as a metric of the receiver performance under interference conditions. The in-band blocking requirement for 7 to 24 GHz must therefore be consistent worth the methodology used for sensitivity.  The delta value for the 7 to 24 GHz range would be expected to be between the FR1 and FR2 values (52.7 to 27 dB), however the precise values would have to be found by blocking simulation once the operating frequencies are known and co-existence simulation parameters have been defined. | Over the 7 to 24 GHz range it is possible there are multiple in-band blocking deltas covering different frequency ranges.  To be concluded in WI when system scenarios, specific frequency bands are defined, and proper co-existence studies are performed. |
| OTA out-of-band blocking | General out-of-band blocking | The interferer level is 0.36 V/m below 7.125 GHz and 0.1 V/m above 24.125 GHz. | The interferer signal within the range 7.125 to 24.125 GHz is defined in the WI. |
| Co-location |  | Need to establish antenna port isolation for specific band in WI. A new concept of injecting the interferer signal is required. |
| OTA receiver spurious emissions | |  | In certain regions, receiver spurious emission limit will be specified during the WI based on applicable regional regulations. |
| OTA receiver intermodulation | |  | Requirement to be concluded in WI. |
| OTA in-channel selectivity | | For FR1-like sub-range: reuse FR1 approach for deriving the BS class specific OTA requirement, based on offsetting the conducted requirement.  For FR2-like sub-range: reuse FR2 approach for deriving wanted and interferer levels based on offsetting the declared sensitivity EISREFSENS\_50M.  For the derivation of the requirement: reuse the 95% throughput threshold, reuse the QPSK-based FRC. | Required ICS level for FR2-like interferer. |

**<Next change>**

#### 7.4.2.6 Receiver spurious emissions

For conducted systems, receiver spurious emissions are specified separately for FDD and TDD systems.

For conducted FDD systems, as the transmitter and the receiver are both on at the same time and can be specified on separate connectors, the receiver spurious emissions should not significantly increase the total spurious emission level. The receiver spurious emission limit is therefore lower than the transmitter spurious emission limit, so the total is approximately equal to the transmitter spurious emission level.

For OTA FDD systems, the requirement is over the air and hence the transmitter and receiver cannot be separated, so there are no receiver spurious emission requirements needed.

For OTA TDD systems in applicable regions, the receiver spurious emission requirements are the same as the Category B transmitter spurious emission requirements as discussed in subclause 7.4.1.8.

In certain regions, receiver spurious emission limit will be specified during the WI based on applicable regional regulations.

#### 7.4.2.7 In-channel selectivity

##### 7.4.2.7.1 In-channel selectivity for FR1 and FR2

In-channel selectivity (ICS) is a measure of the receiver’s ability to receive a wanted signal at its assigned resource block locations in the presence of another in-channel wanted signal received at a much larger power spectral density.

The ICS requirement applies to FR1 (conducted and radiated requirements) and FR2 (radiated requirement).

The conducted requirement is derived similar to E-UTRA requirement which assumes that the UL signal is defined for 2 users, one being the “wanted” signal and the other one being the “interfering” signal at elevated power. Following equations are used for interfering signal and wanted signal correspondingly.

Interfering signal power level = -174dBm/Hz + 10\*log10(BW) + NF + ICS

Wanted signal power level = -174dBm/Hz + 10\*log10(BW) + NF + SNR + IM + 3 dB

The type of interfering signal is DFT-s-OFDM NR signal and BW is corresponding to number of RBs and SCS.

25 dBc ICS is used based on 16 dB interference-over-thermal (IOT) and 9 dB SNR considering the modulation and link level simulation.

For this conducted requirement, the modulation scheme for interfering signal is assumed as 16QAM and modulation scheme for wanted signal is assumed as QPSK.

For the OTA requirement, the OTA ICS for FR1 is based on conducted requirement and an offset of ΔminSENS is used for transferring the conducted requirement to OTA requirement. However, for FR2 requirement there is no conducted requirement to be referred to. Hence the OTA ICS for FR2 is derived using the same equation as for conducted requirement, with additional offset for the gain G:

Interfering signal power level = -174dBm/Hz + 10\*log10(BW) + NF + ICS - G,

Wanted signal power level = -174dBm/Hz + 10\*log10(BW) + NF + SNR + IM + 3dB - G;

14 dBc ICS is used based on the simulation result of IOT with 9 dB SNR and the worst case is applied.

For radiated requirement, the modulation scheme for interfering signal is assumed as 16QAM and modulation scheme for wanted signal is assumed as QPSK. This is the same as the conducted requirement.

##### 7.4.2.7.2 In-channel selectivity for 7 - 24 GHz

For the FR1-like frequency range, the conducted requirements should not be precluded. Hence, both conducted as well as radiated requirements need to be considered in the WI phase.

The conducted in-channel selectivity for 7 – 24 GHz will have to be re-calculated with the following considerations:

* The wanted and interfering signal levels of the ICS requirement will have to be re-calculated to account for an updated NF values and the supported set of bandwidths. For the wanted signal, the required SNR will be subject to the simulation campaigns.
* Similar to the FR1 requirements, BS class specific requirements for conducted ICS need to be considered in the WI phase.
* Selection of FRC to be used for the ICS requirement will depend on the set of supported channel bandwidths and SCS in 7 – 24 GHz. QPSK can be reused from FR1.

The throughput threshold (i.e. 95%) to derive the required SNR for the wanted signal can be reused for 7 – 24 GHz range.

For the OTA in-channel selectivity the following was concluded:

* For the OTA ICS, reuse the QPSK for the wanted signal (subject to the supported channel bandwidths and SCS in 7 – 24 GHz).
* For the FR1-like sub-range of the 7 – 24 GHz range:
  + BS class specific requirements for OTA ICS need to be considered in the WI phase.
  + The same approach of deriving the OTA requirement from the conducted one can be reused, i.e. conducted requirement plus ΔminSENS offset for both the wanted and interfering signals.
* For the FR2-like sub-range of the 7 – 24 GHz range:
  + The interfere signal and the wanted signal will be based on specific FRC, SCS and also the OTA reference sensitivity requirements.

**<End of change>**

**References**

[1] R4-1916111, “TP to TR 38.820 on ICS 7-24GHz”, ZTE.

[2] RP-192655, “TR 38.820, Study on 7 - 24 GHz frequency range for NR”, Huawei.

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