**3GPP TSG-RAN WG4 Meeting #112 R4-24xxxxx**

**Maastricht, Netherlands, August 19 – August 23, 2024**

**Title:** Ad-hoc minutes for [127] NR\_IoT\_NTN\_HPUE

**Agenda Item:** 8.8.5

**Source:** Ad-hoc chair (Samsung)

**Document for:** Approval

# NTN HPUE Co-existence study (45 minutes)

## 1.2 Scenarios for coexistence study

**Issue 2-2-2: TN scenarios for co-ex study**

* Proposals
  + Option 1: Scenario consider scenarios in TR 38.863 as a baseline, which includes Rural Macro and Urban Macro (CATT, Xiaomi)
  + Option 2: Urban Macro as worst case (vivo, MTK, Samsung)
  + Option 3: To discuss whether Dense Urban scenarios are needed (Ericsson)
* Table 6.3.2-1: Selected option for each scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scenario | Aggressor system | Victim system | Environment | Contributing |
| 1 | TN DL | NTN GEO DL | Urban | NTN UE ACS |
| 2 | TN UL | NTN GEO UL | Urban | NTN SAN ACS |
| 3 | NTN LEO-600 DL | TN DL | Rural | NTN SAN LEO ACLR |
| NTN GEO DL | TN DL | Rural | NTN SAN GEO ACLR |
| **4** | **NTN GEO UL** | **TN UL** | **Urban** | **NTN UE ACLR** |
| **5** | **NTN GEO UL** | **TN DL** | **Rural** | **NTN UE ACLR** |

* Ad-hoc agreement:
  + Prioritize Urban Macro for Scenario 4 and Rural Macro for Scenario 5

## 1.3 Deployment and layout

**Issue 2-3-2 TN network topology**

* Proposals
  + Option 1: To disable wrap-around function for Scenario 4 and/or 5 for TN. (Qualcomm)
* Way forward:
  + Consider wrap-around method for TN cluster as baseline
  + Disable wrap-around for TN cluster can be optional

**Discussion:**

QC: It’s not new issue, in legacy co-existence simulation the assumption on wrap-around function is unclear. With offline other companies, seems different companies have different consideration.

Moderator (Samsung): We offline other companies, seems majority consider wrap-around in previous assumption.

QC: Reuse existing method from TR 38.863 as baseline, and encourage companies to further evaluate any performance impact with and w/o wrap-around functionality.

* Ad-hoc Agreement:
  + Reuse existing method from TR 38.863 as baseline, and encourage companies to further evaluate any performance impact with and w/o wrap-around functionality.

**Issue 2-3-3 NTN UE dropping methods**

* Proposals
  + Option 1: Uniformly dropped on the circle for IoT-NTN HPUE coex. (Qualcomm)
  + Option 2: Randomly dropped on the circle for both NR-NTN HPUE coex and IoT-NTN HPUE coex. (Reuse TR 38.863, WF R4-2217473)
* Ad-hoc agreement:
  + Random dropping on circle, and to use uniform distribution for random.

**Issue 2-3-4 Observed TN cells for Scenario 4 evaluation in Table 6.2.1.1-1 in TR 38.863**

| No. | Combination | Aggressor | Victim | Which NTN cell/UE to observe? | Which TN/UE to observe? | Which TN cells in a TN to observe? |
| --- | --- | --- | --- | --- | --- | --- |
| 4 | TN with NTN satellite | NTN UL | TN UL | NTN cell:  Nadir point.  NTN UE:  NTN UEs dropped at the edge of TN clusters | TN randomly placed in this NTN beam | **Option 1: All active TN clusters which has the NTN UE(s) at its edge.**  **Option 2: Only the TN sectors which have NTN UE(s) at their edges.**  **Option 1 is the baseline and it is not precluded companies can follow Option 2 to bring results** |
| 5 | TN with NTN satellite | NTN UL | TN DL | NTN cell:  Nadir point  NTN UE:  NTN UEs dropped at the edge of TN clusters | TN clusters randomly placed in this NTN beam | All active TN clusters which has the NTN UE(s) at its edge |
| NTN cell:  NTN cell with satellite at low elevation (45° for GEO and LEO，Interested companies can bring analysis and results for other values).  NTN UE:  NTN UEs dropped at the edge of TN clusters | TN clusters randomly placed in this NTN beam | All active TN clusters which has the NTN UE(s) at its edge. |

Moderator note: The table from TR 38.863 v18.2.0 is provided here to help discussion.

* Proposals
  + Option 1: All active TN clusters which has the NTN UE(s) at its edge. (Samsung)
* Way forward
  + Down scope to Option 1 as it was only considered in previous NR/IoT-NTN studies at the end.

**Discussion:**

Ericsson: We prefer to follow legacy approach with option 1 as baseline assumption and other options not precluded.

Samsung: We have isolation distance on NTN-TN co-existence, option 2 seems not useful.

* Ad-hoc Agreement: Option 1 as baseline assumption, other options not precluded.

**Issue 2-3-5 NTN HPUE ratio**

* Proposals
  + Option 1: Discuss the ratio of NTN HPUE in all NTN UE (vivo)

Moderator note: any proposed value for this ratio?

* + Option 2: Other option
* Ad-hoc agreement:
  + Assuming all NR-NTN/IoT-NTN UEs are HPUE, i.e. 100% HPUE ratio as baseline.
  + FFS other ratio values

**Issue 2-3-6: NR and NR-NTN channel bandwidth**

* Proposals
  + Option 1: Consider 5MHz for NR-TN and NR-NTN (Huawei)
  + Option 2: Consider 5/10/15/20 MHz channel bandwidth for NR-NTN and 20MHz for NR-TN (TR38.863)
* Ad-hoc agreement
  + Consider 20MHz system bandwidth for NR-NTN and NR in co-existence study.

**Discussion:**

Moderator (Samsung): We already clarify with companies in offline.

## 1.4 Detailed parameters modifications

**Issue 2-4-1: NR-NTN SAN parameter set**

* Proposals
  + Option 1: Consider Set-1 for NR-NTN (Samsung, Xiaomi)
  + Option 2: Consider both set-1 and set-2 for NR-NTN (TR 38.863, CATT)
* Ad-hoc agreement:
  + To use Set-1 as NTN SAN parameters.

**Issue 2-4-2: IoT-NTN UL UE number and SCS**

|  |
| --- |
| 2. Way forward on discussion points The following way forward is proposed:   * Number of active UL NTN UEs: 9 UEs for 15kHz, 18 and 36UEs for 3.75kHz |

Moderator note: WF R4-2217473 provided above for reference.

* Proposals
  + Option 1: 9 UEs for 15kHz, 18 and 36UEs for 3.75kHz (R4-2217473)
  + Option 2: 36 UEs for 3.75kHz as worst case (Samsung)
  + Option 3: 9 UE for 15kHz and 36 UE for 3.75kHz (Qualcomm)
* Ad-hoc agreement:
  + Consider 9 UEs for 15kHz, 18 and 36UEs for 3.75kHz single tone as starting point
  + FFS whether to down scope.

**Discussion:**

Thales: We support the proposal considering worst case in co-existence study even real network deployment maynot match above assumption.

**Issue 2-4-3: NR-NTN UE parameter for PC2**

* Proposals
  + Option 1: 5GAA proposal for automotive NR NTN UE for PC2 and LEO600 (Ericsson)
    - **NF: 7dB**
    - Max Gain: 0 dBi
    - Tx power: 26 dBm
  + Option 2: Below parameters for PC2 as an example (CATT)
    - **NF: 9dB**
    - Max Gain 0 dBi
    - Tx power: 26 dBm
* Ad-hoc agreement
  + Baseline: Use NF as 9dB, and Tx power 26/29/31 dBm for PC2/1.5/1 NTN HPUE
  + FFS option of 7dB NF for PC2 and LEO600.

**Discussion:**

Ericsson: Our proposal is for non-handheld device type only.

**Issue 2-4-4: NTN HPUE uplink power control**

* Proposals
  + Option 1: To update the existing uplink power control parameters considering different power classes and bandwidth (Samsung, Qualcomm, Huawei)
    - Update Pmax to 26/29/31 for PC2/1.5/1;
    - Update Rmin to -66/-69/-71 assuming Pmin as -40;
    - Update BW to corresponding transmission BW.
* Ad-hoc agreement:
  + Agree on Option 1.
  + Agree on the following detailed parameters
* 

where:

- Pmax = 26dBm for PC2, 29 dBm for PC1.5, 31 dBm for PC1.

- Rmin = -66 dB for PC2, -69 dB for PC1.5, -71 dB, assuming -40dBm minimum output power,

- CLx-ile and γ are set as following:

- CLx-ile = 10\*log10(Pmax) – (SNRtarget + 10\*log10(kTB) + NF ),

* + Where:
  + SNRtarget and BW

For NR-NTN HPUE:

* + - Option 1: 3 dB SNR target and 5MHz UL BW (One company proposed for LEO only)
    - Option 2: 15 dB SNR target and 2RB UL BW as baseline assumption
  + NF is the SAN noise figure, i.e. 4.3dB.
  + 10log10(kT) = -174dBm/Hz.
  + γ = 1 For uplink scenario.

# 2. NTN HPUE UE RF – Tx requirements (30 miniutes)

## 2.1 General considerations

**Issue 3-1-3: Consideration of power classes**

* Proposals
  + Option 1: Power class 1/1.5/2 for NR-NTN and Power class 1/2 for IoT-NTN (MTK, Xiaomi, vivo, Samsung, ZTE, China Telecom)
    - Option 1-1: The power classes 2, 1.5 and 1 for NR-NTN, power classes 2 and 1 for IoT-NTN are all considered for RF requirement discussion at starting point, and it will depend on the outcomes of co-existence studies. (Samsung)
  + Option 2: Remove PC 1.5 (Ericsson)
  + Option 3: Prioritize PC 2, and other PC to be confirmed by co-ex and feasibility study. (Ericsson)
  + Option 4: PC 1 considered for non-handheld only for both IoT-NTN and NR-NTN. (Ericsson, Huawei)
  + Option 5: PC2 for both handheld and non-handheld (Huawei)
* Ad-hoc agreement:
  + All power classes in WID, including Power class 1/1.5/2 for NR-NTN and Power class 1/2 for IoT-NTN, will be further discussed.

**Discussion:**

Ericsson: According the WID, we are considering these PCs and still depending on feasibility study and co-existence. We are fine to consider PC1.5 if vendors can confirm feasibility.

Huawei: We share similar view as Ericsson.

**Issue 3-1-4: Consideration of regulation(s)**

* Proposals
  + Option 1: RAN4 shall carefully study the corresponding emission limit from regulators and specify the method to ensure the 3GPP HPUE IoT NTN does not violate them. (Sony)
  + Option 2: RAN4 may wait for ETSI to specify the new harmonized standard for HPUE IoT NTN before capturing any emission limit from ETSI in HPUE. (Sony)
  + Option 3: RAN4 should study applicable regulatory requirements in ECC/CEPT region and take those requirements into account in MPR and A-MPR evaluations. (Qualcomm)
    - Option 3-1: Based on the study outcome, necessary corrections should be made also for PC3 in 36.102 and 38.101-5 (Qualcomm)
  + Option 4: In case ETSI TC SES identifies later that some requirements are not required for market access in Europe, those requirements should be removed from 3GPP. (Qualcomm)
* Ad-hoc agreement:
  + Applicable regulations should be taken into account for requirements discussions.
  + If any identified corrections to be made for PC3, those should be considered in another work item, it is not in the current scope of this WI.

**Issue 3-1-5: Consideration of HPUE Architecture**

* Proposals
  + Option 1: Different MPR and AMPR requirements may need to be specified for 1Tx and 2Tx architectures. (CATT)
  + Option 2: the MPR and AMPR values of the HPUE need to be re-evaluated based on reasonable implementations of IoT devices. (Sony)
  + Option 3: one Tx RF architecture and Dual Tx RF architecture can be reused for NR NTN PC2 UE (Huawei)
  + Option 4: At least for NB-NTN HPUE, single Tx operation should not be ruled out from higher power classes (Qualcomm)
* Ad-hoc agreement:
  + For PC2 (NR NTN), 1 Tx and 2 Tx, are to be considered for requirements.
  + For PC2 IoT NTN, at least 1Tx shall be considered
  + For other PCs (both IoT NTN and NR NTN), FFS
    - ~~At least 1Tx shall be considered~~ 
      * ~~FFS for applicable for device types~~
    - ~~Other options not precluded~~

Discussion:

QC: Does this apply for both NR NTN and IoT NTN? Can we consider some starting point for other PCs i.e. at least 1Tx shall be considered for PC1 and other options not precluded?

vivo: For IoT NTN, we don’t have 2Tx reference architecture at current moment.

Huawei: Not sure whether we can conclude 1Tx for PC1.5, we prefer to keep it open.

Ericsson: Regarding PC1.5, we may need to further discuss the feasibility.

QC: PC1 is feasible for FDD, not sure why PC1.5 can’t be supported as well.

## 2.2 Feasibility

**Issue 3-2-1: NR-NTN HPUE feasibility for different power classes**

* Proposals
  + Option 1: For NR-NTN, including handheld and non-handheld (vivo)
    - Power Class 2 is feasible;
    - Power Class 1.5 is feasible [with possible restrictions on components]
    - Power Class 1 is FFS

**Issue 3-2-2: NB-IoT based IoT-NTN HPUE feasibility for different power classes**

* Proposals
  + Option 1: For NB-Iot based Iot-NTN, including handheld and non-handheld (vivo)
    - Power Class 2 is feasible;
    - Power Class 1 is likely to be feasible

**Issue 3-2-3: eMTC based IoT-NTN HPUE feasibility for different power classes**

* Proposals
  + Option 1: For eMTC based IoT-NTN, including handheld and non-handheld (vivo)
    - Power Class 2 is likely to be feasible for handheld and non-handheld;
    - Power Class 1 feasibility is FFS

Ad-hoc agreement:

* For PC2, it is feasible to support both handheld and non-handheld devices.
* FFS other power classes for applicable device type.

## 2.3 Detailed requirements

**Issue 3-3-1: Maximum output power**

* Proposals
  + Option 1: Using +2/-3 tolerance for PC1, PC1.5 and PC2 for NTN HPUE including NR-NTN and IoT-NTN (Xiaomi)
  + Option 2: Reuse nominal MOP and study the related parameters such as tolerances (vivo)
* Ad-hoc agreement
  + Re-use NR TN TS 38.101-1 nominal MOP and +2/-3 tolerance can be considered as starting point for PC2/1.5/1 for NTN HPUE including NR-NTN and IoT-NTN.

**Discussion:**

Huawei: Not sure the low bound -3dB consistent with existing NTN specification for PC3.

Moderator (Samsung): We don’t have HPUE for NTN.

Vivo: For HPUE in TN specification, we can use -3dB as starting point.

**Issue 3-3-2: MPR**

* Proposals
  + Option 1: MPR, A-MPR and ACLR for NTN HPUE need further evaluate based on the simulation results of co-existence study (Xiaomi)
  + Option 2: Consider reusing TS.38.101-1 [2] PC2 MPR specification from NR TN UE for NR NTN UE as starting point. For NR NTN UE, the final PC2 MPR values in TS 38.101-5 [5] would be decided after NR NTN PC2 ACLR is completed. (MTK)
  + Option 3: Considering the reuse of components and feasibility, the MPR requirements for NR NTN are as following, provided that the corresponding ACLR be reused from TN and not violate co-existence (vivo)
    - Power class 2: Reuse the current TN PC2 MPR requirements.
    - Power class 1.5: Use the current TN PC1.5 MPR requirements as starting point
    - Power class 1: FFS
  + Option 4: MPR for Iot-NTN HPUE is FFS (vivo)
  + Option 5: If the NTN HPUE ACLR value is different from TN HPUE, MPR simulation is needed to specify the MPR requirement for NTN HPUE (LGE)
  + Option 6: MPR for NTN HPUE should be further evaluated according to the agreed ACLR value, PA model and other limiting factor for MPR evaluation. In addition, regarding the SAR requirement for FDD NTN HPUE, we could follow the legacy approach to leave it up to p-MPR design instead of defining any uplink duty cycle to guarantee the SAR limits. (ZTE)
  + Option 7: Assumptions for DC-leakage and IQ-image for NTN HPUE need to be discussed
* Ad-hoc agreement:
  + FFS the MPR requirements. Following potential factors to be further discussed:
    - ACLR from co-existence study
    - Current TN MPR requirements
    - MPR simulation assumptions
    - Other factors not precluded if identified.

**Discussion:**

**Inmarsat: we shall further study MPR and A-MPR.**

**Issue 3-3-3: A-MPR**

* Proposals
  + Option 1: MPR, A-MPR and ACLR for NTN HPUE need further evaluate based on the simulation results of co-existence study (Xiaomi)
  + Option 2: To reduce number of A-MPR simulations for the FR1 satellite bands, we suggest not considering scenarios/combinations that are not expected for the satellite bands: large RB allocations, CP-OFDM, higher-order modulations (Apple)
  + Option 3: Regardless of ACLR difference based on co-existence study, A-MPR is needed for NTN HPUE (LGE)
  + Option 4: Regarding the A-MPR requirements, once HPUE e.g. PC2/PC1.5or PC1 are supported in any specific bands, then the A-MPR requirement should be revisited again to identify the appropriate the A-MPR requirements. (ZTE)
* Ad-hoc agreement
  + FFS A-MPR requirements. Following potential factors to be further discussed:
    - Simulation reduction by not considering large RB allocations, CP-OFDM, higher-order modulations
    - A-MPR simulation assumption including ACLR from co-existence study
    - Applicable bands
    - Regional requirements for A-MPR
    - Other factors

**Discussion:**

**Issue 3-3-4: SAR for handheld**

**Ad-hoc Agreement:**

* Using P-MPR as the starting point
* The other solutions are not precluded
  + E.g., the solution similar to TN duty cycle based on UE capability and network scheduling

**Issue 3-3-5: SEM**

* Proposals
  + Option 1: This depends on the outcome of coexistence study, however it’s most likely that the existing SEM requirement for PC3 could be reused for other PCs. (ZTE)
  + Option 2: Discussion on NB.IoT SEM for higher power classes is needed.
* Ad-hoc agreement:
  + For NR-NTN: further discuss whether to reuse existing SEM requirements from PC3 to other PCs
  + For IoT-NTN: further discuss whether to reuse existing SEM requirements from PC3 to other PCs

**Discussion:**

Huawei: Why we treat NR-NTN and IoT-NTN separately?

QC: NB-IoT SEM is specified with assioated PC3 assumption with power scaling.

Vivo: NB-IoT SEM may not relevant to PC3, it’s scaling with measurement BW based on 33dB GSM power.

Huawei: Given ACLR is still on discussion, we prefer to keep it open for SEM requirements.

Samsung: Refer to existing TN specification, different PCs follow same SEM requirements even with different ACLR.

Huawei: In existing spec, ACLR is increased with higher power. Not sure that’s the case for NTN HPUE.

**Issue 3-3-6: ACLR**

* Proposals
  + Option 1: Discuss whether to use PC2 ACLR of [-31dB] as a starting point. Decide the final ACLR value pending on the NTN PC2 coexistence analysis results. (MTK)
  + Option 2: Discuss whether to use TS 38.101-1 [2] PC2 ACLR of -31dB as a starting reference for specifying PC2 ACLR values for CBW of 1.4MHz and 3MHz in TS 36.101 [3] and TS 36.102[4]. Decide the final ACLR values pending on the NTN PC2 coexistence analysis results. (MTK)
  + Option 3: Regarding IoT NTN Cat-NB1/NB2 UE, discuss whether to use TS 36.102 [4] PC3 ACLR values with [1dB] improvement as a starting reference for specifying PC2 ACLR values in TS 36.102. Decide the final ACLR values pending on the NTN PC2 coexistence analysis results. (MTK)
  + Option 4: Considering the reuse of components and feasibility, the ACLR requirements for NR NTN are as following, provided that the condition that co-existence can be satisfied (vivo)
    - Power class 2/1.5: Reuse the current TN PC2/1.5 ACLR requirements.
    - Power class 1: FFS
  + Option 5: For Iot NTN, the ACLR for HPUE is FFS. (vivo)
  + Option 6: Up to co-existence study (LGE, Samsung, ZTE)
* Ad-hoc agreement:
  + The ACLR requirements will depend on co-existence study outcomes.

**Discussion:**

Inmarsat: We shall try to reuse existing ACLR from TN specification for same PC as much as possible considering input from regulatory requirement.

Thales:We already have preliminary simulation results, we didn’t observe any impact to TN network.

# 3. NTN HPUE UE RF – Rx requirements (15 minutes)

**Issue 4-1: General considerations**

* Proposals
  + Option 1: Use Reference Sensitivity Degradation (RSD) for the NTN HPUE Rx requirements. (vivo)
  + Option 2: The RX requirements including max input level, ACS, blocking characteristics, spurious response, intermodulation characteristics, spurious emissions with PC3 in current TS 38.101-5 should apply to other power class. (OPPO)
  + Option 3: When RAN4 discussed RSD requirements, it’s better to confirm whether the flexible Tx-Rx frequency separation is allowed or not. (Huawei)
  + Option 4: Study the introduction of a table on reference sensitivity degradation from PC3 to PC2 in clause 7.3.2 of TS38.101-5. (Ericsson)
  + Option 5: Study the introduction of tables/adding additional rows in the existing tables on reference sensitivity degradation from PC3 to PC2 in clauses 7.3A and 7.3B of TS36.102. (Ericsson)
* Ad-hoc agreement
  + Rx RF requirements including Max input level, ACS, blocking characteristics, spurious response, intermodulation characteristics, Rx spurious emissions in existing spec can be applied to other power class.

**Issue 4-2: RSD for NR-NTN**

* Proposals
  + Option 1: Regarding NR NTN UE operated in PC2, define the RX RSD values as shown in tables below for bands n256 and n255. (MTK)

**Table 1 RSD from PC3 to PC2 for FDD bands for NR NTN UE not supporting Tx Diversity**

| Operating Band | 5  MHz (dB) | 10  MHz (dB) | 15  MHz (dB) | 20  MHz (dB) |
| --- | --- | --- | --- | --- |
| n256 | 0 | 0 | 0 | 0 |
| n255 | [0.4] | [0.4] | [0.5] | [0.5] |

**Table 2 RSD from PC3 to PC2 for FDD bands for NR NTN UE supporting Tx Diversity**

| Operating Band | 5  MHz (dB) | 10  MHz (dB) | 15  MHz (dB) | 20  MHz (dB) |
| --- | --- | --- | --- | --- |
| n256 | 0 | 0 | 0 | 0 |
| n255 | [0.8] | [0.8] | [0.9] | [0.9] |

* + Option 2: The study method of NR NTN Rx requirements can be similar to FDD HPUE WIs (vivo)
    - Option 2-1: For power class 2, at least n256 and n254 can have 0dB RSD for NR-NTN
    - Option 2-2: For power class 1.5, more study on RSD is needed for NR-NTN
    - Option 2-3: Power class 1 is FFS for NR NTN
  + Option 3: Depending on the agreement from co-existence study and ACLR (ZTE, Samsung,
  + Option 4: Use RSD of n1 as starting point for band n256
* Ad-hoc agreement
  + Reference sensitivity degradation (RSD) requirements is needed for NTN HPUE.
    - Further discuss the following aspects:
      * Use similar way in TN spec by introducing a new table of RSD compared to the PC3
      * Whether default Tx-Rx frequency separation is used for test point

**Discussion:**

QC: What does mean for last bullet?

Ericsson: Does this flexible Tx-Rx separation related to asymmetric channel bandwidth?

QC: RAN4 is now discussing whether or not considering other cases besides of default Tx-Rx frequency separation.

**Issue 4-3: RSD for IoT-NTN**

* Proposals
  + Option 1: Regarding PC2 IoT NTN IoT NB1 and NB2 UEs operated in half-duplex FDD mode, no RX RSD for bands 256 and 255. (MTK)
  + Option 2: Although IoT NTN category M1 (Cat-M1) supports both FDD and HD-FDD modes, RX RSD is not needed for bands 256 and 255 when PC2 IoT NTN Cat-M1 UE operates in HD-FDD mode. (MTK)
  + Option 3: For NB-Iot based Iot-NTN, the sensitivity would not be impacted by HPUE (vivo)
  + Option 4: For eMTC based Iot-NTN and half duplex, the sensitivity would not be impacted by HPUE. (vivo)
  + Option 5: For eMTC based Iot-NTN and full duplex, reference NR NTN method, but only consider 1TX. (vivo)
* Ad-hoc agreement:
  + For NB-Iot based Iot-NTN, no RSD needed for HPUE
  + For eMTC based Iot-NTN with half duplex, no RSD needed for HPUE
  + For eMTC based Iot-NTN with full duplex, further discuss RSD impact