**3GPP TSG-RAN WG4 Meeting # 97-e R4-201XXXX**

**Electronic Meeting, 2nd Nov. – 13th Nov, 2020**

**Agenda item:** 12.8.1, 12.8.2, 12.8.3

**Source:** THALES

**Title:** Email discussion summary for [97e][312] NTN\_Solutions

**Document for:** Information

# Introduction

This lead summary document captures issues related to NR NTN RF core requirements and demodulation aspects. The document also provides information with respect to use cases, deployment scenarios and regulatory information to be considered, including exemplary band discussions. It contains a summary of the contributions under sections 12.8.1, 12.8.2, 12.8.3 at TSG-RAN WG4 #97e, together with identified key open issues and recommends topics/questions to be handled via email discussions. The goal of this document is also to provide recommendation on prioritization of discussion and whether any issues should be postponed.

Please also note the TSG-RAN WG4 #97e meeting agenda provided in R4-2014000 with respect to NTN topic:

*12.8 Solutions for NR to support non-terrestrial networks (NTN) [NR\_NTN\_solutions]*

*12.8.1 General and work plan [NR\_NTN\_solutions]*

*12.8.2 Use cases, deployment scenarios, and regulatory information [NR\_NTN\_solutions-Core]*

*\* Include exemplary bands discussion*

*12.8.3 Coexistence aspects [NR\_NTN\_solutions -Core]*

*12.8.3.1 Simulation assumptions [NR\_NTN\_solutions -Core]*

*12.8.3.2 UE requirements aspects [NR\_NTN\_solutions -Core]*

*12.8.3.3 BS requirements aspects [NR\_NTN\_solutions -Core]*

*12.8.4 RRM requirements [NR\_NTN\_solutions-Core]*

According to RAN4#97-e E-meeting Arrangements and Guidelines, the following schedule has been proposed in R4-2016599:

* + *Stage 1: Moderators kick off email discussion (Monday Nov. 2)*
  + *Stage 2: Companies provide comments for the 1st round (Nov. 2 – Wednesday 6pm UTC Nov. 4)*
  + *Stage 3: Moderators summarize the status and possible proposals, recommending what decisions can be made for 1st round. A formal t-doc will be used (Thursday 6pm UTC, Nov. 5)*
  + *Stage 4: After receiving the summary from moderators, session chair may approve documents, make agreements or assign new CRs, WFs, LSs, etc. (no later than Monday 8am UTC, Nov. 9)*
  + *Stage 5: Companies provide comments for 2nd round.*
    - *Draft WF/LS and revised CRs/TPs shall be shared by Wednesday 1am UTC, Nov. 11.*
    - *Commenting shall stop by Wednesday 11pm UTC, Nov. 11.*
    - *Formal tdocs of WF/LS/CRs/TPs shall be uploaded to the Inbox (except Cat A CRs) by Thursday 1am UTC, Nov. 12.*
    - *Draft moderator summary shall be shared by Thursday 9am UTC, Nov. 12, but moderators are strongly encouraged to share it earlier if possible and delegates to comment as early as possible.*
  + *Stage 6: Moderators provide 2nd round summary with a formal tdoc by Thursday 6pm UTC, Nov. 12.*
  + *Stage 7: Session chairs announce close of sessions (no later than 6pm UTC, Nov. 13). Final decisions will be captured in Chairman meeting report (to be shared after the meeting is closed)*

A total of 16 TDOCs have been provided for this agenda, while 1 TDOC has been reserved and not submitted:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***TDoc Number*** | ***TDoc Type*** | ***Title*** | ***Company*** | ***Status*** | ***General Purpose*** | ***Agenda Item*** |
| [*R4-2015905*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015905.zip) | *other* | *Specification structure for NTN nodes* | *Ericsson* | *available* | *Approval* | *12.8.1* |
| [*R4-2014785*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014785.zip) | *discussion* | *Views on NTN bands and coexistence study* | *Samsung* | *available* | *Approval* | *12.8.1* |
| *R4-2014880* | *discussion* | *Discussion on the applicability of DFT-S-OFDM for NTN* | *CAICT* | *Reserved,*  *Not available* | *-* | *12.8.1* |
| [*R4-2014381*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014381.zip) | *Work Plan* | *NR\_NTN\_solutions work plan* | *THALES* | *available* | *Endorsement* | *12.8.1* |
| [*R4-2014066*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014066.zip) | *discussion* | *On the status of NTN in 3GPP* | *Fraunhofer HHI, Fraunhofer IIS* | *available* | *-* | *12.8.1* |
| [*R4-2014467*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014467.zip) | *discussion* | *Possible FR2 exemplary band for NR based satellite networks* | *HUGHES Network Systems Ltd, Thales* | *available* | *Discussion* | *12.8.2* |
| [*R4-2015906*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015906.zip) | *other* | *NTN Scenarios and Regulatory overview* | *Ericsson* | *available* | *Approval* | *12.8.2* |
| [*R4-2015915*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015915.zip) | *discussion* | *Possible FR1 exemplary band for NR satellite networks* | *THALES* | *available* | *Discussion* | *12.8.2* |
| [*R4-2015913*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015913.zip) | *discussion* | *NTN use case scenarios and architectures* | *THALES* | *available* | *Discussion* | *12.8.2* |
| [*R4-2015263*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015263.zip) | *other* | *Initial discussion for NR to support non-terrestrial networks* | *Xiaomi* | *available* | *Approval* | *12.8.2* |
| [*R4-2015252*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015252.zip) | *discussion* | *NTN - On use cases and deployment scenarios* | *Nokia, Nokia Shanghai Bell* | *available* | *Approval* | *12.8.2* |
| [*R4-2015547*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015547.zip) | *other* | *General discussion about NTN topic* | *Huawei, HiSilicon* | *available* | *Approval* | *12.8.2* |
| [*R4-2015945*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015945.zip) | *discussion* | *NTN Proposed RF Core Requirements* | *THALES* | *available* | *Discussion* | *12.8.3* |
| [*R4-2015907*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015907.zip) | *other* | *NTN Simulations discussion* | *Ericsson* | *available* | *Approval* | *12.8.3.1* |
| [*R4-2016112*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016112.zip) | *other* | *Discussion on simulation assumptions for NTN coexistence study* | *ZTE Corporation* | *available* | *Approval* | *12.8.3.1* |
| [*R4-2015548*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015548.zip) | *discussion* | *General discussion on NTN simulation assumptions* | *Huawei, HiSilicon* | *available* | *Discussion* | *12.8.3.1* |
| [*R4-2015908*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015908.zip) | *discussion* | *NTN coexistence - BS requirements aspects* | *Ericsson* | *available* | *Discussion* | *12.8.3.3* |

Contribution summaries are as follows:

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015905*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015905.zip) | Ericsson | **Proposal 1:** RAN4 should consider (NTN gateway + satellite) as a repeater or alternatively as a relay. The corresponding requirements shall be specified in a new repeater specification, or alternatively a new relay specification. |
| [*R4-2014785*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014785.zip) | Samsung | **View 1:** At least the Radio Regulations should be taken as basic reference for NTN band selection.  **View 2:** It is necessary to prioritize the candidate NTN frequency bands to identify 1 or 2 example bands, which should be within the range of FR1 or FR2, while the confirmed and practical needs from operators should be well taken into account.  **View 3:** ITU-R Recommendations/Reports on characteristics of satellite systems can be used as references for developing or cross-check the assumptions of coexistence studies in RAN4.  **View 4:** As usual, 3GPP RAN4 should conduct relative independent adjacent channel coexistence studies to develop RF requirements (such as ACLR, ACS) for NTN. |
| [*R4-2014381*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014381.zip) | THALES | **General and work plan** [NR\_NTN\_solutions], updated with RAN4 activity |
| [*R4-2014066*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014066.zip) | Fraunhofer HHI, Fraunhofer IIS | During the early study items, several architectures and deployment scenarios were investigated.  **Observation 1:** In general, two different satellite architectures can be considered: Transparent and Regenerative satellites.  **Observation 3:** The propagation delay for a transparent payload is twice as long as for a regenerative payload.  **Observation 2:** Deployment scenarios in FR1 and FR2 are considered in geostationary (GEO) and low earth orbit (LEO).  A study on the propagation characteristics of non-terrestrial scenarios was conducted and an initial channel model was defined, featuring dynamic attenuation, Doppler effects and fading.  **Observation 5:** Only outdoor conditions are considered for satellite operations.  **Observation 6:** The propagation channel for NTN is a combination of satellite and terrestrial channels.  **Observation 7:** The propagation channel for satellites in medium and low earth orbit features strong variation in delay and Doppler shift due to the fast movement of the satellite.  **Observation 9:** The propagation losses can be as high as 217 dB in GEO and 188 dB in LEO scenarios.  **Observation 4:** The one-way propagation delay can be up to 272 ms in GEO and 14 ms in LEO scenarios.  Based on the investigations, several key issues were identified.  **Observation 12:** Long propagation delays, large Doppler effects and moving cells were identified as key issues.  **Observation 8:** In both architectures (transparent and regenerative), timers have to be extended to cope with the longer delays.  **Observation 11:** Release 15 and 16 NR functionalities are found to form a good basis for supporting LEO and GEO NTN scenarios.  **Observation 10:** While Release 15/16 beam management and BWP procedures are considered as baseline for NTN, they should be further discussed.  In the ongoing Release 17 work item NR\_NTN\_solutions, RAN4 has several objectives.  **Observation 13:** For the current WI, LEO and GEO based satellites with both Earth fixed and moving cells are considered. FDD and UEs with GNSS capabilities are assumed.  **Observation 14:** RAN4 is to specify UE RRM and RF core requirements, study bands related to NTN and investigate and specify UE timing and frequency pre-compensation requirements.  **Observation 15:** All requirements shall be specified for both FR1 and FR2.  **Observation 16:** Although RAN4 will select exemplary band(s) in the current NR-NTN-solutions WI, the definition of additional NR bands for NTN will be part of dedicated RAN4 led Release 17 work items. |
| [*R4-2014467*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014467.zip) | HUGHES Network Systems Ltd, Thales | **Proposal 1:** RAN4 work should consider an exemplary FR2 band for NTN.  **Proposal 2:** RAN4 to use an FR2 exemplary band of 17.7 – 20.2 GHz for DL and 27.5 – 30.0 GHz for UL with FDD duplex mode. |
| [*R4-2015906*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015906.zip) | Ericsson | In this contribution, based on Radio Regulations, we made following proposal and observations:  **Observation 1**: A NTN BS might be considered as a “Relay node” or “Remote Radio Head” unit.  **Observation 2:** A NTN UE operating in FR1 might be considered as NR FR1 UE.  **Observation 3:** A NTN UE operating in FR2 might be considered as a relay UE, but most likely not a NR FR2 UE.  **Observation 4:** According to the RR definitions, HAPS vehicles fly between 20-50 km.  **Proposal 1:** Only HIBS are in the scope of NTN. The NTN WI shall be updated to clarify this, replacing “HAPS” (*High Altitude Platforms*) with “HIBS” *(HAPS operating as an IMT base station).*  **Proposal 2:** The frequency ranges considered for NTN should be spectrum allocated by ITU to the Mobile satellite as a primary service.  **L-band:**  **Observation 5:** The Radio Regulations have allocated mobile satellite service for the suggested part of L-band for NTN, the mobile service is also allocated in the ranges 1518-1525 MHz (primary service) and 1525-1535 MHz (secondary service).  **Observation 6:** The Radio Regulations have allocated mobile satellite service for the suggested part of L-band for NTN, mobile service is also allocated in the ranges 1668.4-1675 MHz (primary service) and 1668-1668.4 MHz (secondary service).  **Observation 7:** According to past ITU-R discussions on this band for mobile and mobile satellite services, L-band would be used for sensitive mobile satellite service. Further consideration would be needed if NTN would also be using this band.  **S-band:**  **Observation 8:** The Radio Regulations have allocated mobile satellite service for the suggested part of S-band for NTN. These ranges are also allocated to mobile. The proposed frequency ranges might be considered for NTN.  **C-band:**  **Observation 9:** The Radio Regulations have not allocated mobile satellite service for the suggested part of C-band for NTN. The proposed frequency ranges should not be considered for NTN.  **Ku-band:**  **Observation 10:** The proposed frequency ranges in Ku-band are currently not covered by RAN4 specifications TS 38.104 and TS 38.101-1/-2.  **Observation 11:** The Radio Regulations have not allocated mobile satellite service for the suggested part of Ku-band in downlink for NTN. The proposed frequency ranges should not be considered for NTN.  **Observation 12:** The Radio Regulations have not allocated mobile satellite service for the suggested part of Ku-band in uplink for NTN, except for the 14-14.5 GHz frequency range but as secondary service only.  **Ka-band:**  **Observation 13:** The proposed frequency ranges in Ka-band downlink are currently not covered by RAN4 specifications TS 38.104 and TS 38.101-1/-2.  **Observation 14:** The Radio Regulations have allocated mobile satellite service for the 19.7-20.2 GHz range of the suggested part of Ka-band in downlink for NTN. However, it is a secondary allocation in the range 19.7-20.1 GHz in Region 1 and Region 3.  **Observation 15:** The Radio Regulations have allocated mobile satellite service for the 29.5-30.0 GHz range of the suggested part of Ka-band in uplink for NTN.  **Q/V-band:**  **Observation 16:** The Radio Regulations have allocated mobile satellite service for the 39.5-40.5 GHz range of the suggested part of Q/V-band in downlink for NTN.  **Observation 17:** The Radio Regulations have allocated mobile satellite as secondary service for the 50.4-51.4 GHz range of the suggested part of Q/V-band in downlink for NTN.  HIBS  **Observation 18:** The Radio Regulations include HIBS usage in the 2 GHz, further frequency bands below 2.7 GHz will be studied for WRC-23. Decision on introducing HIBS will be taken at WRC-23.  Based on previous proposal and observations, following frequency ranges are allocated to mobile satellite and would need further discussion. The ranges highlighted in red are neither part of FR1 nor FR2 and would then require extra specification effort:  - L-band  Downlink (space to earth) 1518 – 1559 MHz, 1613.8 – 1626.5 MHz  Uplink (earth to space) 1626.5 – 1660.5 MHz & 1668 – 1675 MHz, 1610.0 – 1626.5 MHz  - S-band  Downlink (space to earth) 2170 - 2200 MHz & 2483.5 - 2500 MHz  Uplink (earth to space) 1980 - 2010 MHz  - C-band:  None  - Ku-band  Downlink (space to earth) None  Uplink (earth to space) 14.0 - 14.5 GHz (secondary)  - Ka-band  Downlink (space to earth) 19.7 – 20.2 GHz in Region 2  Uplink (earth to space) 29.9-30 GHz  - Q/V band  Downlink (space to earth) 39.5 – 40.5 GHz  Uplink (earth to space) ??  For HIBS, following frequency ranges might be considered:  Regions 1 and 3: 1 885-1 980 MHz, 2 010-2 025 MHz, 2 110-2 170 MHz  Region 2: 1 885-1 980 MHz, 2 110-2 160 MHz |
| [*R4-2015915*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015915.zip) | THALES | **Proposal 1:** RAN4 work should consider an exemplary FR1 band for NTN.  **Proposal 2:** Propose to use an FDD exemplary band with 1980-2010 MHz for UL and 2170-2200 MHz for DL, for RAN4 KPI evaluation.  **Proposal 3:** RAN4 work should consider previous 3GPP relevant references (such as TR 36.861, TR 36.862, TR 38.891), ETSI relevant standardization sources (e.g. ETSI EN 302 574-2), ITU-R regulations (e.g. Resolution 212), regional/national regulations (e.g. ECC/DEC(06)09, EC Decision 2007/98/EC), and coexistence studies approved by regulatory bodies (e.g. ECC Report 298). |
| [*R4-2015913*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015913.zip) | THALES | **Proposal 1:** Consider SCS 15 & 30 kHz for FR1 exemplary band for RAN4 work.  **Proposal 2:** Consider frequency reuse schemes with frequency reuse > 1 for RAN4 work.  **Proposal 3:** Consider exemplary frequency bandwidths of 5, 10, 15, 20 MHz for FR1 RAN4 work.  **Proposal 4:** RAN4 needs to identify coexistence scenarios in adjacent bands.  **Proposal 5:** For exemplary band S, RAN4 should consider scenarios C1.1, C2.1 (LEO Earth Fixed Beams and Earth Moving Beams) and A1 (GEO).  **C1.1:** LEO @ 600 km altitude, FR1, Earth fixed beams  **C2.1:** LEO @ 600 km altitude, FR1, Earth moving beams  **A1:** GEO @ 35,786 km altitude, FR1, Earth fixed beams  **Proposal 6:** RAN4 should consider the following UE key reference scenario parameters:  **Handheld:** Omnidirectional antenna, 500 km/h (e.g. on board a high speed train), Linear: +/-45°X-pol, up to 200 mW (UE power class 3)  **VSAT:** Directive antenna (up to 60 cm equivalent aperture diameter), Up to 1200 km/h (e.g. aircraft mounted), Circular, up to 20 W  **Proposal 7:** UE with GNSS capabilities are assumed for RAN4 work.  **Proposal 8:** UE with/without capability for timing and/or frequency pre-compensation should be supported in NTN WI and further considered by RAN4.  **Proposal 9:** RAN4 should follow RAN1 outcomes for the synchronization solutions to be considered.  **Proposal 10:** RAN4 should use TR 38.821 assumptions for satellite parameters. |
| [*R4-2015263*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015263.zip) | Xiaomi | **Proposal 1:** it is proposed at least the type of handheld UE with PC3 should be considered first for FR1.  **Proposal 2:** it is proposed the UE reference architecture with 1Tx/2Rx could be as baseline to define UE requirements |
| [*R4-2015252*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015252.zip) | Nokia, Nokia Shanghai Bell | **Proposal 1:** The discussion related to this WI within RAN4 should focus only on LEO, GEO and HAPS deployment until decision for ATG have been made by RAN.  **Observation 1:** ITU separates spectrum for satellite and HAPS deployments in separate groups.  **Observation 2:** RAN4 should within this WI only consider example NR bands/frequencies.  **Proposal 2:** Choose example NR bands/frequencies in both the FR1 and FR2 range.  **Observation 3:** New NR bands should be defined at least for LEO and GEO deployments. Reusing existing bands can be discussed for HAPS deployments.  **Observation 4:** A HAPS as seen from the UE is a serving gNB and therefore the UE should expect same RF characteristics as a terrestrial gNB.  **Observation 5:** The RF requirements for the service link provided by LEO and GEO deployments should be at least same level as those for a terrestrial gNB.  **Proposal 3:** RF requirements for a terrestrial gNB should be used as baseline for HAPS, LEO and GEO deployments.  **Proposal 4:** Satellites both in transparent and regenerative deployments should provide same performance in terms of RF characteristics. |
| [*R4-2015547*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015547.zip) | Huawei, HiSilicon | **Observation 1:** RAN4 should consider the frequency band which are allocated for MSS as the example band firstly. And RAN4 can focus on the MSS scenario when co-existence study is performed.  **Observation 2:** In order to reduce the regulation risk, we can start the work with a frequency band in which there is no incumbent service except for MSS.  **Observation 3:** Band 65/n65 is specified in RAN4’s specification as a terrestrial IMT band instead of MSS. RAN4 can’t simply reuse band n65 as a NTN example band because of the regulation risk.  **Observation 4:** The RF requirements of satellite are different from the base station considering the large propagation distance between UE and satellite.  **Observation 5:** RF requirements of VSAT is totally different from the traditional 3GPP UE. For handheld UE, the general UE RF requirements can be considered as baseline.  **Proposal 1:** It’s proposed to choose 1.6GHz L band as a NTN example band. |
| [*R4-2015945*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015945.zip) | THALES | **Proposal 1:** 3GPP does not define RF Tx requirements for a given transparent payload to allow flexibility in the space segment design;  **Proposal 2:** 3GPP does not define RF Tx requirements for a BS in NTN;  **Proposal 3:** 3GPP defines equivalent BS Tx requirements at UE reception level, by taking into account e.g. a frequency spectrum mask corresponding to the cumulated self-interferences generated by the satellite network infrastructure at UE level.  **Proposal 4:** 3GPP should re-use for NTN UE RAN4 core requirements definition the existent TN framework.  **Proposal 5:** Consider parameters from ETSI EN 302 574-2 V2.1.1 for defining specific RAN4 NTN UE core requirements for exemplary FR1 NTN band.  **Proposal 6:** NTN shall consider equivalent ETSI ACS and ACLR parameters.  **Proposal 7:** Consider 3GPP KPIs from TS 38.101-1 for defining RAN4 core requirements for exemplary FR1 NTN band.  **Proposal 8:** Down-select 3GPP core requirements from 3GPP KPI list, for exemplary FR1 NTN proposed RAN4 band.  **Proposal 9:** Define in RAN4 at least specific NTN core requirements for UE Tx Power, UE Output Power Dynamics, UE Tx Frequency Error, UE Tx EVM, UE Tx ACLR, UE Rx ACS, Spectrum Mask, Blocking Characteristics.  **Proposal 10:** A similar exemplary band definition approach should be applied for FR2. |
| [*R4-2015907*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015907.zip) | Ericsson | **Proposal 1:** Co-channel coexistence and coexistence with adjacent services are out of NTN WI’s scope.  **Observation 1:** For FR1 bands above 3 GHz and for all FR2 bands, NR bands are TDD only while NTN would use FDD duplex mode. This would be a major issue for coexistence.  **Proposal 2:** A down-selection of coexistence NTN/NR scenarios is needed, further consideration would be needed to select the most relevant and stringent ones.  **Observation 2:** Networks layout and NTN UEs distribution would need further alignement.  **Proposal 3:** For NR and NB-IoT, ACLR and ACS specified in TS 38.104 and 38.101 shall be assumed for NR BS and NR UE when running coexistence simulations. |
| [*R4-2016112*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016112.zip) | ZTE Corporation | **Proposal 1:** to adopt the coexistence scenarios in Table 2.1-1 for NTN coexistence study.  1 eMBB; NTN, 30MHz; TN, 30MHz; DL to DL; 2 GHz Rural  2 eMBB; NTN, 30MHz; TN, 30MHz; UL to UL; 2 GHz Rural  3 eMBB; NTN, 30MHz; NTN, 30MHz; DL to DL; 2 GHz Rural  4 eMBB; NTN, 30MHz; NTN, 30MHz; UL to UL; 2 GHz Rural  5 eMBB; NTN, 200MHz; TN, 200MHz; DL to DL; 20 GHz Rural [Note1]  6 eMBB; NTN, 200MHz; TN, 200MHz; UL to UL ; 20 GHz Rural [Note1]  7 eMBB; NTN, 200MHz; NTN, 200MHz; DL to DL; 20 GHz Rural  8 eMBB; NTN, 200MHz; NTN, 200MHz; UL to UL; 20 GHz Rural  **Proposal 2:** only one satellite is assumed for coexistence study at the beginning.  **Proposal 3:** consider the frequency reuse factor 1 as worst case for coexistence study.  Note 1: there are no rural cases above 3GHz according to ITU-R M.2292, coexistence between FR2 NTN and TN should be deprioritized  Note 2: the baseline scenario for NTN coverage should be rural area, FFS for other scenarios.  Note 3: TN should be NR based and it’s not necessary to evaluate LTE based or UTRA based as requirements should be close. |
| [*R4-2015548*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015548.zip) | Huawei, HiSilicon | **Observation 1:** It isn’t expected that the co-existence simulation of NTN will have an impact on RF requirements of terrestrial IMT UE/BS.  **Observation 2:** Some scenarios, such as LEO, GEO, HAPS and ATG are considered for NTN system. The outer scenario, such as rural macro, urban macro and dense urban, are considered for terrestrial network. The simulation scenarios are based on the permutation and combination between NTN scenario and TN scenario.  **Observation 3:** RAN4 need to consider how to match two heterogeneous network (NTN and IMT network).  **Observation 4:** For the co-existence scenario between two NTN systems, RAN4 need to consider whether to assume the same orbits and partial overlapping about foot print.  **Simulation Parameter/Potential Choice:**  Satellite orbits/GEO, LEO-1200, LEO-600  Center frequency /It depends on the decision about the example band.  Satellite antenna model/Passive reflector antenna or AAS. Antenna Gain and 3dB beam width  Channel bandwidth/It depends on operators’ spectrum allocations, no more than 100MHz.  Transmitter power/Different satellite orbits need different transmitter power  Noise figure/FFS  UE’s type/VSAT or handheld UE  Power control/FFS |
| [*R4-2015908*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015908.zip) | Ericsson | The proposed approach i.e. handling NTN gateway+ satellite as either a repeater or alternatively a relay.  It should be noted that 3GPP specifications E-UTRA contain repeater specification and relay specification where the repeater requirements were derived from various studies, including co-existence studies. The repeater RF requirements overview and structure from TS 36.106 is as following:  - Output power  - Frequency stability  - Out-of-band gain  - Unwanted emissions  - Error Vector Magnitude  - Input intermodulation  - Output intermodulation  - Adjacent channel rejection ration  The Relay requirements overview and structure from specification TS 36.116 is as following. More comprehensive requirements are specified due to the additional signal processing covering both access and backhaul link.  - Output power  - Output power dynamics including ON/OFF masks and transient handling for unpaired spectrum  - Transmit signal quality  - Unwanted emissions covering spurious emission, ACLR and operating band unwanted emission  - Transmit intermodulation  - Receiver sensitivity  - Receiver dynamic range  - In-channel selectivity  - Receiver blocking  - Receiver spurious emission  - Receiver intermodulation  - Access performance Requirements for PUSCH, PUCCH and PRACH  - Backhaul performance requirement covering PDSCH and PDCCH (for NR context)  Considering the relay requirements are more comprehensive, if there is any additional signal processing occurs performed within either the gateway or the satellite, the relay approach should be preferred. It looks then essential to conclude on this choice to progress further. |

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

# Topic #1: General RAN4 use cases related aspects

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

General RAN4 RF NTN related aspects discussions are required to decide on the way forward and to provide an initial RF core list of parameters/requirements to be considered by RAN4 RF and demodulation work.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2014785*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014785.zip) | Samsung | **View 1:** At least the Radio Regulations should be taken as basic reference for NTN band selection.  **View 2:** It is necessary to prioritize the candidate NTN frequency bands to identify 1 or 2 example bands, which should be within the range of FR1 or FR2, while the confirmed and practical needs from operators should be well taken into account.  **View 3:** ITU-R Recommendations/Reports on characteristics of satellite systems can be used as references for developing or cross-check the assumptions of coexistence studies in RAN4.  **View 4:** As usual, 3GPP RAN4 should conduct relative independent adjacent channel coexistence studies to develop RF requirements (such as ACLR, ACS) for NTN. |
| [*R4-2014381*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014381.zip) | THALES | **General and work plan** [NR\_NTN\_solutions], updated with RAN4 activity |
| [*R4-2014066*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014066.zip) | Fraunhofer HHI, Fraunhofer IIS | During the early study items, several architectures and deployment scenarios were investigated.  **Observation 1:** In general, two different satellite architectures can be considered: Transparent and Regenerative satellites.  **Observation 3:** The propagation delay for a transparent payload is twice as long as for a regenerative payload.  **Observation 2:** Deployment scenarios in FR1 and FR2 are considered in geostationary (GEO) and low earth orbit (LEO).  A study on the propagation characteristics of non-terrestrial scenarios was conducted and an initial channel model was defined, featuring dynamic attenuation, Doppler effects and fading.  **Observation 5:** Only outdoor conditions are considered for satellite operations.  **Observation 6:** The propagation channel for NTN is a combination of satellite and terrestrial channels.  **Observation 7:** The propagation channel for satellites in medium and low earth orbit features strong variation in delay and Doppler shift due to the fast movement of the satellite.  **Observation 9:** The propagation losses can be as high as 217 dB in GEO and 188 dB in LEO scenarios.  **Observation 4:** The one-way propagation delay can be up to 272 ms in GEO and 14 ms in LEO scenarios.  Based on the investigations, several key issues were identified.  **Observation 12:** Long propagation delays, large Doppler effects and moving cells were identified as key issues.  **Observation 8:** In both architectures (transparent and regenerative), timers have to be extended to cope with the longer delays.  **Observation 11:** Release 15 and 16 NR functionalities are found to form a good basis for supporting LEO and GEO NTN scenarios.  **Observation 10:** While Release 15/16 beam management and BWP procedures are considered as baseline for NTN, they should be further discussed.  In the ongoing Release 17 work item NR\_NTN\_solutions, RAN4 has several objectives.  **Observation 13:** For the current WI, LEO and GEO based satellites with both Earth fixed and moving cells are considered. FDD and UEs with GNSS capabilities are assumed.  **Observation 14:** RAN4 is to specify UE RRM and RF core requirements, study bands related to NTN and investigate and specify UE timing and frequency pre-compensation requirements.  **Observation 15:** All requirements shall be specified for both FR1 and FR2.  **Observation 16:** Although RAN4 will select exemplary band(s) in the current NR-NTN-solutions WI, the definition of additional NR bands for NTN will be part of dedicated RAN4 led Release 17 work items. |
| [*R4-2014467*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014467.zip) | HUGHES Network Systems Ltd, Thales | **Proposal 1:** RAN4 work should consider an exemplary FR2 band for NTN. |
| [*R4-2015906*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015906.zip) | Ericsson | In this contribution, based on Radio Regulations, we made following proposal and observations:  **Observation 1**: A NTN BS might be considered as a “Relay node” or “Remote Radio Head” unit.  **Observation 2:** A NTN UE operating in FR1 might be considered as NR FR1 UE.  **Observation 3:** A NTN UE operating in FR2 might be considered as a relay UE, but most likely not a NR FR2 UE.  **Observation 4:** According to the RR definitions, HAPS vehicles fly between 20-50 km.  **Proposal 1:** Only HIBS are in the scope of NTN. The NTN WI shall be updated to clarify this, replacing “HAPS” (*High Altitude Platforms*) with “HIBS” *(HAPS operating as an IMT base station).*  **Proposal 2:** The frequency ranges considered for NTN should be spectrum allocated by ITU to the Mobile satellite as a primary service. |
| [*R4-2015915*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015915.zip) | THALES | **Proposal 1:** RAN4 work should consider an exemplary FR1 band for NTN.  **Proposal 3:** RAN4 work should consider previous 3GPP relevant references (such as TR 36.861, TR 36.862, TR 38.891), ETSI relevant standardization sources (e.g. ETSI EN 302 574-2), ITU-R regulations (e.g. Resolution 212), regional/national regulations (e.g. ECC/DEC(06)09, EC Decision 2007/98/EC), and coexistence studies approved by regulatory bodies (e.g. ECC Report 298). |
| [*R4-2015913*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015913.zip) | THALES | **Proposal 4:** RAN4 needs to identify coexistence scenarios in adjacent bands.  **Proposal 2:** Consider frequency reuse schemes with frequency reuse > 1 for RAN4 work.  **Proposal 5:** For exemplary band S, RAN4 should consider scenarios C1.1, C2.1 (LEO Earth Fixed Beams and Earth Moving Beams) and A1 (GEO).  **C1.1:** LEO @ 600 km altitude, FR1, Earth fixed beams  **C2.1:** LEO @ 600 km altitude, FR1, Earth moving beams  **A1:** GEO @ 35,786 km altitude, FR1, Earth fixed beams  **Proposal 6:** RAN4 should consider the following UE key reference scenario parameters:  **Handheld:** Omnidirectional antenna, 500 km/h (e.g. on board a high speed train), Linear: +/-45°X-pol, up to 200 mW (UE power class 3)  **VSAT:** Directive antenna (up to 60 cm equivalent aperture diameter), Up to 1200 km/h (e.g. aircraft mounted), Circular, up to 20 W  **Proposal 7:** UE with GNSS capabilities are assumed for RAN4 work.  **Proposal 9:** RAN4 should follow RAN1 outcomes for the synchronization solutions to be considered.  **Proposal 10:** RAN4 should use TR 38.821 assumptions for satellite parameters. |
| [*R4-2015263*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015263.zip) | Xiaomi | **Proposal 1:** it is proposed at least the type of handheld UE with PC3 should be considered first for FR1.  **Proposal 2:** it is proposed the UE reference architecture with 1Tx/2Rx could be as baseline to define UE requirements |
| [*R4-2015252*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015252.zip) | Nokia, Nokia Shanghai Bell | **Proposal 1:** The discussion related to this WI within RAN4 should focus only on LEO, GEO and HAPS deployment until decision for ATG have been made by RAN.  **Observation 1:** ITU separates spectrum for satellite and HAPS deployments in separate groups.  **Observation 2:** RAN4 should within this WI only consider example NR bands/frequencies.  **Proposal 2:** Choose example NR bands/frequencies in both the FR1 and FR2 range.  **Observation 3:** New NR bands should be defined at least for LEO and GEO deployments. Reusing existing bands can be discussed for HAPS deployments.  **Observation 4:** A HAPS as seen from the UE is a serving gNB and therefore the UE should expect same RF characteristics as a terrestrial gNB.  **Observation 5:** The RF requirements for the service link provided by LEO and GEO deployments should be at least same level as those for a terrestrial gNB.  **Proposal 3:** RF requirements for a terrestrial gNB should be used as baseline for HAPS, LEO and GEO deployments.  **Proposal 4:** Satellites both in transparent and regenerative deployments should provide same performance in terms of RF characteristics. |
| [*R4-2015547*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015547.zip) | Huawei, HiSilicon | **Observation 4:** The RF requirements of satellite are different from the base station considering the large propagation distance between UE and satellite.  **Observation 5:** RF requirements of VSAT is totally different from the traditional 3GPP UE. For handheld UE, the general UE RF requirements can be considered as baseline. |
| [*R4-2015945*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015945.zip) | THALES | **Proposal 1:** 3GPP does not define RF Tx requirements for a given transparent payload to allow flexibility in the space segment design;  **Proposal 2:** 3GPP does not define RF Tx requirements for a BS in NTN;  **Proposal 3:** 3GPP defines equivalent BS Tx requirements at UE reception level, by taking into account e.g. a frequency spectrum mask corresponding to the cumulated self-interferences generated by the satellite network infrastructure at UE level.  **Proposal 4:** 3GPP should re-use for NTN UE RAN4 core requirements definition the existent TN framework.  **Proposal 5:** Consider parameters from ETSI EN 302 574-2 V2.1.1 for defining specific RAN4 NTN UE core requirements for exemplary FR1 NTN band.  **Proposal 6:** NTN shall consider equivalent ETSI ACS and ACLR parameters.  **Proposal 7:** Consider 3GPP KPIs from TS 38.101-1 for defining RAN4 core requirements for exemplary FR1 NTN band.  **Proposal 8:** Down-select 3GPP core requirements from 3GPP KPI list, for exemplary FR1 NTN proposed RAN4 band.  **Proposal 9:** Define in RAN4 at least specific NTN core requirements for UE Tx Power, UE Output Power Dynamics, UE Tx Frequency Error, UE Tx EVM, UE Tx ACLR, UE Rx ACS, Spectrum Mask, Blocking Characteristics.  **Proposal 10:** A similar exemplary band definition approach should be applied for FR2. |
| [*R4-2015907*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015907.zip) | Ericsson | **Proposal 1:** Co-channel coexistence and coexistence with adjacent services are out of NTN WI’s scope.  **Proposal 2:** A down-selection of coexistence NTN/NR scenarios is needed, further consideration would be needed to select the most relevant and stringent ones.  **Observation 2:** Networks layout and NTN UEs distribution would need further alignement.  **Proposal 3:** For NR and NB-IoT, ACLR and ACS specified in TS 38.104 and 38.101 shall be assumed for NR BS and NR UE when running coexistence simulations. |
| [*R4-2016112*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016112.zip) | ZTE Corporation | **Proposal 1:** to adopt the coexistence scenarios in Table 2.1-1 for NTN coexistence study.  1 eMBB; NTN, 30MHz; TN, 30MHz; DL to DL; 2 GHz Rural  2 eMBB; NTN, 30MHz; TN, 30MHz; UL to UL; 2 GHz Rural  3 eMBB; NTN, 30MHz; NTN, 30MHz; DL to DL; 2 GHz Rural  4 eMBB; NTN, 30MHz; NTN, 30MHz; UL to UL; 2 GHz Rural  5 eMBB; NTN, 200MHz; TN, 200MHz; DL to DL; 20 GHz Rural [Note1]  6 eMBB; NTN, 200MHz; TN, 200MHz; UL to UL ; 20 GHz Rural [Note1]  7 eMBB; NTN, 200MHz; NTN, 200MHz; DL to DL; 20 GHz Rural  8 eMBB; NTN, 200MHz; NTN, 200MHz; UL to UL; 20 GHz Rural  **Proposal 2:** only one satellite is assumed for coexistence study at the beginning.  **Proposal 3:** consider the frequency reuse factor 1 as worst case for coexistence study.  Note 1: there are no rural cases above 3GHz according to ITU-R M.2292, coexistence between FR2 NTN and TN should be deprioritized  Note 2: the baseline scenario for NTN coverage should be rural area, FFS for other scenarios.  Note 3: TN should be NR based and it’s not necessary to evaluate LTE based or UTRA based as requirements should be close. |
| [*R4-2015548*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015548.zip) | Huawei, HiSilicon | **Observation 1:** It isn’t expected that the co-existence simulation of NTN will have an impact on RF requirements of terrestrial IMT UE/BS.  **Observation 2:** Some scenarios, such as LEO, GEO, HAPS and ATG are considered for NTN system. The outer scenario, such as rural macro, urban macro and dense urban, are considered for terrestrial network. The simulation scenarios are based on the permutation and combination between NTN scenario and TN scenario.  **Observation 3:** RAN4 need to consider how to match two heterogeneous network (NTN and IMT network).  **Observation 4:** For the co-existence scenario between two NTN systems, RAN4 need to consider whether to assume the same orbits and partial overlapping about foot print.  **Simulation Parameter/Potential Choice:**  Satellite orbits/GEO, LEO-1200, LEO-600  Center frequency /It depends on the decision about the example band.  Satellite antenna model/Passive reflector antenna or AAS. Antenna Gain and 3dB beam width  Channel bandwidth/It depends on operators’ spectrum allocations, no more than 100MHz.  Transmitter power/Different satellite orbits need different transmitter power  Noise figure/FFS  UE’s type/VSAT or handheld UE  Power control/FFS |
| [*R4-2015908*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015908.zip) | Ericsson | The proposed approach i.e. handling NTN gateway+ satellite as either a repeater or alternatively a relay.  The repeater RF requirements overview and structure from TS 36.106 is as following:  - Output power  - Frequency stability  - Out-of-band gain  - Unwanted emissions  - Error Vector Magnitude  - Input intermodulation  - Output intermodulation  - Adjacent channel rejection ration  The Relay requirements overview and structure from specification TS 36.116 is as following. More comprehensive requirements are specified due to the additional signal processing covering both access and backhaul link.  - Output power  - Output power dynamics including ON/OFF masks and transient handling for unpaired spectrum  - Transmit signal quality  - Unwanted emissions covering spurious emission, ACLR and operating band unwanted emission  - Transmit intermodulation  - Receiver sensitivity  - Receiver dynamic range  - In-channel selectivity  - Receiver blocking  - Receiver spurious emission  - Receiver intermodulation  - Access performance Requirements for PUSCH, PUCCH and PRACH  - Backhaul performance requirement covering PDSCH and PDCCH (for NR context)  Considering the relay requirements are more comprehensive, if there is any additional signal processing occurs performed within either the gateway or the satellite, the relay approach should be preferred. It looks then essential to conclude on this choice to progress further. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

From provided documents, some general open issues have been identified and should be considered for decision/agreed working assumptions/possible WF:

* Sources of information;
* Frequency ranges to be considered
* Coexistence studies to be performed;
* HAPS/HIBS discussions
* UE types;
* Satellite types to be considered (transparent, regenerative);
* Satellite constellation to be considered (LEO, GEO);
* Satellite specific parameters to be considered;
* RAN4 should start considering a list of potential RF core and demodulation KPIs with respect to considered NTN use cases
* Earth fixed beam vs. Earth moving beam
* Simulation Scenarios

### Sub-topic 1-1 : Sources of Information

*Sub-topic description: Sources of information to be considered by RAN4 work*

*Open issues and candidate options before e-meeting:*

**Issue 1-1:** Sources of Information

* Proposals
  + Option 1:
    - At least the Radio Regulations should be taken as basic reference for NTN band selection.
    - ITU-R Recommendations/Reports on characteristics of satellite systems can be used as references for developing or cross-check the assumptions of coexistence studies in RAN4.
    - As usual, 3GPP RAN4 should conduct relative independent adjacent channel coexistence studies to develop RF requirements (such as ACLR, ACS) for NTN.
  + Option 2:
    - RAN4 work should consider previous 3GPP relevant references (such as TR 36.861, TR 36.862, TR 38.891), ETSI relevant standardization sources (e.g. ETSI EN 302 574-2), ITU-R regulations (e.g. Resolution 212), regional/national regulations (e.g. ECC/DEC(06)09, EC Decision 2007/98/EC), and coexistence studies approved by regulatory bodies (e.g. ECC Report 298).
* Recommended WF
  + RAN4 should use ITU-R sources & relevant radio regulations, ETSI relevant standardization sources, regional/national regulations, and coexistence studies approved by regulatory bodies.
  + 3GPP RAN4 should provide/conduct relative independent adjacent channel coexistence studies to develop RF requirements for NTN.

### Sub-topic 1-2 : Frequency Ranges to be considered

*Sub-topic description:* Frequency Ranges to be considered by RAN4 work

*Open issues and candidate options before e-meeting:*

**Issue 1-2:** Frequency Ranges

* Proposals
  + Option 1:
    - It is necessary to prioritize the candidate NTN frequency bands to identify 1 or 2 example bands, which should be within the range of FR1 or FR2, while the confirmed and practical needs from operators should be well taken into account.
  + Option 2:
    - The frequency ranges considered for NTN should be spectrum allocated by ITU to the Mobile satellite as a primary service.
  + Option 3:
    - RAN4 work should consider an exemplary FR1 band for NTN.
  + Option 4:
    - RAN4 work should consider an exemplary FR2 band for NTN.
  + Option 5:
    - New NR bands should be defined at least for LEO and GEO deployments. Reusing existing bands can be discussed for HAPS deployments.
  + Option 6:
    - Although RAN4 will select exemplary band(s) in the current NR-NTN-solutions WI, the definition of additional NR bands for NTN will be part of dedicated RAN4 led Release 17 work items.
* Recommended WF
  + At least one FR1 and FR2 exemplary frequency bands should be considered
  + Although RAN4 will select exemplary band(s) in the current NR-NTN-solutions WI, the definition of additional NR bands for NTN will be part of dedicated RAN4 led Release 17 work items.

### Sub-topic 1-3 : Coexistence studies to be performed

*Sub-topic description:* Coexistence studies to be performed by RAN4

*Open issues and candidate options before e-meeting:*

**Issue 1-3:** Coexistence studies

* Proposals
  + Option 1:
    - to adopt the coexistence scenarios in Table 2.1-1 for NTN coexistence study.
    - only one satellite is assumed for coexistence study at the beginning.
    - consider the frequency reuse factor 1 as worst case for coexistence study.
    - there are no rural cases above 3GHz according to ITU-R M.2292, coexistence between FR2 NTN and TN should be deprioritized
  + Option 2:
    - RAN4 needs to identify coexistence scenarios in adjacent bands.
    - Consider frequency reuse schemes with frequency reuse > 1 for RAN4 work.
  + Option 3: NTN to TN in adjacent bands for both FR1 and FR2
  + Option 4: NTN to TN in adjacent bands for FR1 only
  + Option 5: NTN to NTN in adjacent bands for both FR1 & FR2
  + Option 6: Both NTN to TN and NTN to NTN in adjacent bands for both FR1 & FR2
  + Option 7: Both NTN to TN (for FR1 only) and NTN to NTN (for both FR1 & FR2) in adjacent bands
  + Option 8:
    - Co-channel coexistence and coexistence with adjacent services are out of NTN WI’s scope.
    - A down-selection of coexistence NTN/NR scenarios is needed, further consideration would be needed to select the most relevant and stringent ones.
  + Option 9:
    - It isn’t expected that the co-existence simulation of NTN will have an impact on RF requirements of terrestrial IMT UE/BS.
    - RAN4 need to consider how to match two heterogeneous network (NTN and IMT network).
    - For the co-existence scenario between two NTN systems, RAN4 need to consider whether to assume the same orbits and partial overlapping about foot print.
  + Option 10:
    - One key assumption when introducing NTN is to minimize as much as possible the impacts on legacy NR networks.
    - Based on this assumption, the ACLR and ACS values for legacy NR BS and UE shall be as specified in TS 36.104 (BS NB-IoT), TS 36.101 (UE NB-IoT), TS 38.104 (NR BS), TS 38.101-1 (NR UE FR1) and TS 38.101-2 (NR UE FR2).
* Recommended WF1
  + Consider frequency reuse schemes with frequency reuse > 1 for RAN4 work.

OR

* + Consider the frequency reuse factor 1 as worst case for coexistence study.
* Recommended WF2
  + Option 5, if at least 2 satellites are assumed;

OR

* + Option 4, if at least 1 satellite is assumed.
* Recommended WF3
  + It isn’t expected that the co-existence simulation of NTN will have an impact on RF requirements of terrestrial IMT UE/BS.
  + One key assumption when introducing NTN is to minimize as much as possible the impacts on legacy NR networks. Based on this assumption, the ACLR and ACS values for legacy NR BS and UE shall be as specified in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | **2GHz** | **20 GHz and 30 GHz** |
| **BS** | **ACLR** | 45 dB | 28 dB |
| **ACS** | 45 dB |  |
| **UE** | **ACLR** | 30dB (ACLR1)  43dB (ACLR2) | 17 dB |
| **ACS** | 33 | 23 dB |

### Sub-topic 1-4 : HAPS/HIBS discussions

*Sub-topic description:* HAPS/HIBS discussions

*Open issues and candidate options before e-meeting:*

**Issue 1-4:** HAPS/HIBS

* Proposals
  + Option 1:
    - According to the RR definitions, HAPS vehicles fly between 20-50 km.
    - Only HIBS are in the scope of NTN.
    - The NTN WI shall be updated to clarify this, replacing “HAPS” (High Altitude Platforms) with “HIBS” (HAPS operating as an IMT base station).
  + Option 2: Do not change/update HAPS to HIBS in the NTN WI
  + Option 3: ITU separates spectrum for satellite and HAPS deployments in separate groups.
  + Option3: TBA
* Recommended WF
  + RAN4 should decide if HAPS/HIBS exemplary bands should be on its own. The range should be covered under FR1 or FR2 category.
  + RAN4 should decide if change/update “HAPS” to “HIBS” in the NTN WI

### Sub-topic 1-5 : UE types

*Sub-topic description:* UE types to be considered by RAN4 work

*Open issues and candidate options before e-meeting:*

**Issue 1-5:** UE types

* Proposals
  + Option 1:
    - it is proposed at least the type of handheld UE with PC3 should be considered first for FR1.
    - it is proposed the UE reference architecture with 1Tx/2Rx could be as baseline to define UE requirements
  + Option 2:
    - A NTN UE operating in FR1 might be considered as NR FR1 UE.
    - A NTN UE operating in FR2 might be considered as a relay UE, but most likely not a NR FR2 UE.
  + Option 3:
    - RF requirements of VSAT is totally different from the traditional 3GPP UE.
    - For handheld UE, the general UE RF requirements can be considered as baseline.
  + Option 4: RAN4 should consider the following UE key reference scenario parameters:
    - Handheld: Omnidirectional antenna, 500 km/h (e.g. on board a high speed train), Linear: +/-45°X-pol, up to 200 mW (UE power class 3)
    - VSAT: Directive antenna (up to 60 cm equivalent aperture diameter), Up to 1200 km/h (e.g. aircraft mounted), Circular, up to 20 W
    - UE with GNSS capabilities are assumed for RAN4 work
  + Option 5: ESIM under FR2
* Recommended WF
  + Handheld UE & VSAT UE with described characteristics:
    - Handheld: Omnidirectional antenna, 500 km/h (e.g. on board a high speed train), Linear: +/-45°X-pol, up to 200 mW (UE power class 3)
    - VSAT: Directive antenna (up to 60 cm equivalent aperture diameter), Up to 1200 km/h (e.g. aircraft mounted), Circular, up to 20 W
  + ESIM to be considered for FR2

### Sub-topic 1-6 : Satellite types to be considered (transparent, regenerative);

*Sub-topic description: The RP to be used concerns only Rel-17 with transparent payload.*

*Open issues and candidate options before e-meeting:*

**Issue 1-6:** Satellite types

* Proposals
  + Option 1: Transparent payload in Rel-17
  + Option 2: In general, two different satellite architectures can be considered: Transparent and Regenerative satellites.
  + Option 3: Satellites both in transparent and regenerative deployments should provide same performance in terms of RF characteristics.
  + Option 4: TBA
* Recommended WF
  + Transparent payload in Rel-17

### Sub-topic 1-7 : Satellite constellation to be considered (LEO, GEO);

*Sub-topic description: Several scenarios have been considered with LEO, GEO, HAPS, etc. and different exemplary bands in FR1 and FR2.*

*Open issues and candidate options before e-meeting:*

**Issue 1-7:** Satellite constellation

* Proposals
  + Option 1: For exemplary band S, RAN4 should consider scenarios C1.1, C2.1 (LEO Earth Fixed Beams and Earth Moving Beams) and A1 (GEO).
    - C1.1: LEO @ 600 km altitude, FR1, Earth fixed beams
    - C2.1: LEO @ 600 km altitude, FR1, Earth moving beams
    - A1: GEO @ 35,786 km altitude, FR1, Earth fixed beams
  + Option 2: The discussion related to this WI within RAN4 should focus only on LEO, GEO and HAPS deployment until decision for ATG have been made by RAN.
  + Option 3:
    - Some scenarios, such as LEO, GEO, HAPS and ATG are considered for NTN system.
    - Satellite orbits/GEO, LEO-1200, LEO-600
  + Option 4: TBA
* Recommended WF1
  + Down-scope the number of scenarios to LEO @600km (Earth Fixed Beams and Earth Moving Beams) and GEO.
* Recommended WF2
  + Focus only on LEO, GEO and HAPS deployment until decision for ATG have been made by RAN.
* Recommended WF3
  + Focus only on LEO @600km (Earth Fixed Beams and Earth Moving Beams), GEO and HAPS deployment until decision for ATG have been made by RAN.

### Sub-topic 1-8 : Satellite specific parameters to be considered

*Sub-topic description:* Satellite specific parameters to be considered by RAN4 work

*Open issues and candidate options before e-meeting:*

**Issue 1-8:** Satellite specific parameters

* Proposals
  + Option 1: RAN4 should use TR 38.821 assumptions for satellite parameters.
  + Option 2: TBA
* Recommended WF
  + Down-scope the number of scenarios for satellite specific parameters in TS 38.821

### Sub-topic 1-9 : RAN4 should start considering a list of potential RF core and demodulation KPIs with respect to considered NTN use cases

*Sub-topic description: An initial list with potential (core) NTN RF core and demodulation KPIs should be considered*

*Open issues and candidate options before e-meeting:*

**Issue 1-9:** Potential list of NTN-related RF KPIs

* Proposals
  + Option 1: RAN4 should start to establish a list with (preliminary) RF core parameters for NTN
  + Option 2: TBA
* Recommended WF
  + Use 3GPP TS 38.101-1 and 38.101-2 for choosing RF UE parameters to be considered with priority for NTN
  + Use ETSI essential parameters from harmonized standard when possible (e.g. ETSI EN 302 574-2 V2.1.1 (2016-06))
  + Companies are invited to select/recommend parameters to be considered with priority for NTN
  + Identify other required (NTN-specific) parameters
  + Where is possible, down-scope parameters only to some essential NTN parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Essential Parameter**  **(**ETSI EN 302 574-2 V2.1.1 (2016-06)**)** | **Parameter Name** | **Parameter Meaning** | **Company view**  [please add comment only if the parameter should be treated with priority] |
| Spectrum emissions mask | Spectrum emission mask | The spectrum emission mask of the UE applies to frequencies (ΔfOOB) starting from the +/- edge of the assigned channel bandwidth. | Company A:  Company B:  Company C: |
| Adjacent Channel Leakage Power Ratio (ACLR) | Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency. | Company A:  Company B:  Company C: |
| Conducted spurious emissions from the transmitter antenna connector | Transmitter spurious emissions | Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out-of-band emissions.  The spurious emission limits are specified in terms of general requirements in line with Recommendation ITU-R SM.329-12.  To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth. |  |
| Accuracy of maximum output power | Maximum output power | UE Power Classes define the maximum output power for any transmission bandwidth within the channel bandwidth. The period of measurement shall be at least one sub-frame (1 ms). The nominal maximum output power and its tolerance are defined according to the power class of the UE. |  |
| Prevention of harmful interference through control of power | Minimum output power | The minimum controlled output power of the UE is defined as the broadband transmit power of the UE, i.e. the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value. The minimum controlled output power of the UE is when the power is set to a minimum value. The minimum transmit power is defined as a mean power in one time slot. |  |
| Conducted spurious emissions from the receiver antenna connector | Receiver spurious emissions | The spurious emissions power is the power of emissions generated or amplified in a receiver that appear at the UE antenna connector. |  |
| Impact of interference on receiver performance | Blocking characteristics | The blocking characteristic is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the spurious response or the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit. The blocking performance shall apply at all frequencies except those at which a spurious response occur.  The throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified (e.g. in ETSI TS 136 521-1). |  |
| Receiver spurious response | Spurious response is a measure of the receiver's ability to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted Continuous Wave (CW) interfering signal at any other frequency at which a response is obtained i.e. for which the out-of-band blocking limit (as specified) is not met.  The throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified in (e.g. in ETSI TS 136 521-1). |  |
| Receiver inter-modulation characteristics | Intermodulation response rejection is a measure of the capability of the receiver to receive a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal.  The throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified (e.g. in ETSI TS 136 521-1). |  |
| Receiver adjacent channel selectivity | Receiver Adjacent Channel Selectivity (ACS) | Adjacent Channel Selectivity (ACS) is a measure of a receiver's ability to receive a signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).  The throughput Rav shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified in ETSI (e.g. TS 136 521-1) under the specified conditions. |  |
| (Optional) Control and monitoring functions | Control and monitoring functions | This requirement verifies that the control and monitoring functions of the UE prevent it from transmitting in the absence of a valid network. |  |
| Out of synchronisation handling of output power | The UE shall monitor the downlink signal (associated to the transmission signal of the two ways services) in order to detect a loss of the signal. Upon quality level threshold detection, the UE shall stop transmitting. |  |
| .. |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Essential Parameter**  (e.g. 3GPP TS 38.101-1) | **Parameter Name** | **Parameter Meaning** | **Company view**  [please add comment only if the parameter should be treated with priority] |
| Transmitter characteristics - Transmitter power | UE maximum output power | UE Power Classes define the maximum output power for any transmission bandwidth within the channel bandwidth of NR carrier unless otherwise stated. The period of measurement shall be at least one sub frame (1ms). | Company A:  Company B:  Company C: |
| UE maximum output power reduction | UE is allowed to reduce the maximum output power due to higher order modulations and transmit bandwidth configurations. | Company A:  Company B:  Company C: |
| UE additional maximum output power reduction | To meet the additional requirements, additional maximum power reduction (A-MPR) is allowed for the maximum output power. Each additional emission requirement is associated with a unique network signalling (NS) value indicated in RRC signalling by an NR frequency band number of the applicable operating band and an associated value in the field *additionalSpectrumEmission.* |  |
| Configured transmitted power | The UE is allowed to set its configured maximum output power PCMAX,f,c for carrier f of serving cell c in each slot. The configured maximum output power PCMAX,f,c is set within some defined bounds. |  |
| Transmitter characteristics – Output power dynamics | Minimum output power | The minimum controlled output power of the UE is defined as the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value. The minimum output power is defined as the mean power in at least one sub-frame 1 ms. |  |
| Transmit OFF power | Transmit OFF power is defined as the mean power in the channel bandwidth when the transmitter is OFF. The transmitter is considered OFF when the UE is not allowed to transmit on any of its ports. The “transmit OFF” power is defined as the mean power in a duration of at least one sub-frame (1 ms) excluding any transient periods. |  |
| Transmit ON/OFF time mask | The transmit power time mask defines the transient period(s) allowed 1) between transmit OFF power as defined and transmit ON power symbols (transmit ON/OFF) and 2) between continuous ON-power transmissions with power change or RB hopping. |  |
| Power control | The absolute power tolerance is the ability of the UE transmitter to set its initial output power to a specific value for the first sub-frame (1 ms) at the start of a contiguous transmission or non-contiguous transmission with a transmission gap larger than 20 ms.  The tolerance includes the channel estimation error.  The relative power tolerance is the ability of the UE transmitter to set its output power in a target sub-frame (1 ms) relatively to the power of the most recently transmitted reference sub-frame (1 ms) if the transmission gap between these sub-frames is less than or equal to 20 ms.  The aggregate power control tolerance is the ability of the UE transmitter to maintain its power in a sub-frame (1 ms) during non-contiguous transmissions within 21 ms in response to 0 dB commands with respect to the first UE transmission and all other power control parameters as specified in TS 38.213 kept constant. |  |
| Transmitter characteristics – Transmit signal quality | Frequency error | The UE basic measurement interval of modulated carrier frequency is 1 UL slot. The mean value of basic measurements of UE modulated carrier frequency shall be accurate to within ± 0.1 PPM observed over a period of 1 ms of cumulated measurement intervals compared to the carrier frequency received from the NR Node B. |  |
| Transmit modulation quality - Error Vector Magnitude (EVM) | The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform. This difference is called the error vector. Before calculating the EVM the measured waveform is corrected by the sample timing offset and RF frequency offset. Then the carrier leakage shall be removed from the measured waveform before calculating the EVM.. |  |
| Transmit modulation quality - Carrier leakage | Carrier leakage is an additive sinusoid waveform whose frequency is the same as the modulated waveform carrier frequency. The measurement interval is one slot in the time domain. The relative carrier leakage power is a power ratio of the additive sinusoid waveform and the modulated waveform. The relative carrier leakage power shall not exceed the specified values. |  |
| Transmit modulation quality - In-band emissions | The in-band emission is defined as the average emission across 12 sub-carriers and as a function of the RB offset from the edge of the allocated UL transmission bandwidth. The in-band emission is measured as the ratio of the UE output power in a non–allocated RB to the UE output power in an allocated RB.  The basic in-band emissions measurement interval is defined over one slot in the time domain; however, the minimum requirement applies when the in-band emission measurement is averaged over 10 sub-frames. The average of the basic in-band emission measurement over 10 sub-frames shall not exceed the specified values. |  |
| Transmit modulation quality - EVM equalizer spectrum flatness | The zero-forcing equalizer correction applied in the EVM measurement process (as specified by 3GPP) must meet a spectral flatness requirement for the EVM measurement to be valid. The EVM equalizer spectrum flatness is defined in terms of the maximum peak-to-peak ripple of the equalizer coefficients (dB) across the allocated uplink block. The basic measurement interval is the same as for EVM.  The peak-to-peak variation of the EVM equalizer coefficients contained within the frequency range of the uplink allocation shall not exceed the maximum ripple specified for normal conditions.  The EVM equalizer spectral flatness shall not exceed the values specified for extreme conditions. |  |
| Transmitter characteristics – Output RF spectrum emissions | Occupied bandwidth | Occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel. The occupied bandwidth for all transmission bandwidth configurations (Resources Blocks) shall be less than the specified channel bandwidth. |  |
| Out of band emission - Spectrum emission mask | The spectrum emission mask of the UE applies to frequencies (ΔfOOB) starting from the edge of the assigned NR channel bandwidth.  For frequencies offset greater than ΔfOOB, the spurious requirements are applicable. |  |
| Out of band emission - Additional spectrum emission mask | Additional spectrum emission requirements are signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message. |  |
| Out of band emission - Adjacent channel leakage ratio (ACLR) | Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.  To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.  NR Adjacent Channel Leakage power Ratio (NRACLR) is the ratio of the filtered mean power centred on the assigned NR channel frequency to the filtered mean power centred on an adjacent NR channel frequency at nominal channel spacing. The assigned NR channel power and adjacent NR channel power are measured with rectangular filters with specified measurement bandwidths. |  |
| Spurious emissions | Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions unless otherwise stated. The spurious emission limits are specified in terms of general requirements in line with SM.329 and NR operating band requirement to address UE co-existence.  Unless otherwise stated, the spurious emission limits apply for the frequency ranges that are more than FOOB (MHz) from the edge of the channel bandwidth. The spurious emission limits apply for all considered transmitter band configurations (NRB) and channel bandwidths.  Additional spurious emission requirements may be signalled by the network to indicate that the UE shall meet an additional requirement for a specific deployment scenario as part of the cell handover/broadcast message. |  |
| Transmit intermodulation | The transmit intermodulation performance is a measure of the capability of the transmitter to inhibit the generation of signals in its nonlinear elements caused by presence of the wanted signal and an interfering signal reaching the transmitter via the antenna.  UE transmit intermodulation is defined by the ratio of the mean power of the wanted signal to the mean power of the intermodulation product when an interfering Continuous Wave (CW) signal is added at a level below the wanted signal at each transmitter antenna port with the other antenna port(s) if any terminated. Both the wanted signal power and the intermodulation product power are measured through NR rectangular filter |  |
| Receiver characteristics | Diversity characteristics | The UE is required to be equipped with a minimum of two Rx antenna ports in all operating bands (except for the bands n7, n38, n41, n77, n78, n79 where the UE is required to be equipped with a minimum of four Rx antenna ports). This requirement applies when the band is used as a standalone band or as part of a band combination.  The UE shall be verified with two Rx antenna ports in all supported frequency bands.  Additional requirements for four Rx ports shall be verified in operating bands where the UE is equipped with four Rx antenna ports. |  |
| Reference sensitivity | The reference sensitivity power level REFSENS is the minimum mean power applied to each one of the UE antenna ports for all UE categories, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.  The throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified. |  |
| Maximum input level | Maximum input level is defined as the maximum mean power received at the UE antenna port, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel.  The throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified. |  |
| Adjacent channel selectivity (ACS) | Adjacent channel selectivity (ACS) is a measure of a receiver's ability to receive an NR signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).  These requirements apply for all values of an adjacent channel interferer up to -25 dBm and for any SCS specified for the channel bandwidth of the wanted signal. However, it is not possible to directly measure the ACS; instead a lower and upper range of test parameters are chosen for the verification of the specified requirements.  For these test parameters, the throughput shall be ≥ 95 % of the maximum throughput of the reference measurement channels as specified. |  |
| Blocking characteristics - In-band blocking | For NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz in-band blocking (IBB) is defined for an unwanted interfering signal falling into the UE receive band or into the first 15 MHz below or above the UE receive band.  The throughput of the wanted signal shall be ≥ 95 % of the maximum throughput of the specified reference measurement channels.  The relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal. |  |
| Blocking characteristics - Out-of-band blocking | For NR bands with FDL\_high < 2700 MHz and FUL\_high < 2700 MHz out-of-band band blocking is defined for an unwanted CW interfering signal falling outside a frequency range 15 MHz below or above the UE receive band.  The throughput of the wanted signal shall be ≥ 95% of the maximum throughput of the specified reference measurement channels.  The relative throughput requirement shall be met for any SCS specified for the channel bandwidth of the wanted signal. |  |
| Blocking characteristics - Narrow band blocking | This requirement is measure of a receiver's ability to receive a NR signal at its assigned channel frequency in the presence of an unwanted narrow band CW interferer at a frequency, which is less than the nominal channel spacing.  The relative throughput shall be ≥ 95 % of the maximum throughput of the specified reference measurement channels. |  |
| Spurious response | Spurious response is a measure of the ability of the receiver to receive a wanted signal on its assigned channel frequency without exceeding a given degradation due to the presence of an unwanted CW interfering signal at any other frequency for which a response is obtained, i.e. for which the out-of-band blocking limit (as specified) is not met.  The throughput shall be ≥ 95 % of the maximum throughput of the specified reference measurement channels. |  |
| Intermodulation characteristics | Intermodulation response rejection is a measure of the capability of the receiver to receive a wanted signal on its assigned channel frequency in the presence of two or more interfering signals which have a specific frequency relationship to the wanted signal.  The wide band intermodulation requirement is defined using a CW carrier and modulated NR signal as interferer 1 and interferer 2 respectively.  The throughput shall be ≥ 95 % of the maximum throughput of the specified reference measurement channels. |  |
| Spurious emissions | The spurious emissions power is the power of emissions generated or amplified in a receiver that appear at the UE antenna connector.  The power of any narrow band CW spurious emission shall not exceed the specified maximum level. |  |
| .. |  |  |  |

### Sub-topic 1-10 : Earth fixed beam & Earth moving beam

*Sub-topic description: RAN4 should consider both Earth fixed beam & Earth moving beam; Please also note that fixed Tracking Area is considered on ground level.*

*Open issues and candidate options before e-meeting:*

**Issue 1-10:** Earth fixed beam & Earth moving beam

* Proposals
  + Option 1: RAN4 should consider both Earth fixed beam & Earth moving beam
  + Option 2: TBA
* Recommended WF
  + Consider both Earth fixed beam & Earth moving beam for RAN4 scenarios

### Sub-topic 1-11 : Simulation scenarios

*Sub-topic description:* Simulation scenarios to be taken into account by RAN4 work

*Open issues and candidate options before e-meeting:*

**Issue 1-11:**

* Proposals
  + Option 1: The simulation scenarios are based on the permutation and combination between NTN scenario and TN scenario.
  + Option 2: Networks layout and NTN UEs distribution would need further alignment.
  + Option 3: Incorporate parameters from previous sub-topics 1-1 to 1-10
* Recommended WF
  + Incorporate parameters from previous sub-topics/issues 1-1 to 1-10
  + The simulation scenarios are based on the permutation and combination between NTN scenario and TN scenario.
  + Networks layout and NTN UEs distribution would need further alignment.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  Sub topic 1-3:  Sub topic 1-4:  Sub topic 1-5:  Sub topic 1-6:  Sub topic 1-7:  Sub topic 1-8:  Sub topic 1-9:  Sub topic 1-10:  Sub topic 1-11:  ….  Others: |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: System NTN RF core requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015905*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015905.zip) | Ericsson | **Proposal 1:** RAN4 should consider (NTN gateway + satellite) as a repeater or alternatively as a relay. The corresponding requirements shall be specified in a new repeater specification, or alternatively a new relay specification. |
| [*R4-2015906*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015906.zip) | Ericsson | In this contribution, based on Radio Regulations, we made following proposal and observations:  **Observation 1**: A NTN BS might be considered as a “Relay node” or “Remote Radio Head” unit. |
| [*R4-2015252*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015252.zip) | Nokia, Nokia Shanghai Bell | **Observation 4:** A HAPS as seen from the UE is a serving gNB and therefore the UE should expect same RF characteristics as a terrestrial gNB.  **Observation 5:** The RF requirements for the service link provided by LEO and GEO deployments should be at least same level as those for a terrestrial gNB.  **Proposal 3:** RF requirements for a terrestrial gNB should be used as baseline for HAPS, LEO and GEO deployments.  **Proposal 4:** Satellites both in transparent and regenerative deployments should provide same performance in terms of RF characteristics. |
| [*R4-2015547*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015547.zip) | Huawei, HiSilicon | **Observation 4:** The RF requirements of satellite are different from the base station considering the large propagation distance between UE and satellite. |
| [*R4-2015945*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015945.zip) | THALES | **Proposal 1:** 3GPP does not define RF Tx requirements for a given transparent payload to allow flexibility in the space segment design;  **Proposal 2:** 3GPP does not define RF Tx requirements for a BS in NTN;  **Proposal 3:** 3GPP defines equivalent BS Tx requirements at UE reception level, by taking into account e.g. a frequency spectrum mask corresponding to the cumulated self-interferences generated by the satellite network infrastructure at UE level. |
| [*R4-2015907*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015907.zip) | Ericsson | **Proposal 1:** Co-channel coexistence and coexistence with adjacent services are out of NTN WI’s scope.  **Proposal 3:** For NR and NB-IoT, ACLR and ACS specified in TS 38.104 and 38.101 shall be assumed for NR BS and NR UE when running coexistence simulations. |
| [*R4-2015548*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015548.zip) | Huawei, HiSilicon | **Observation 1:** It isn’t expected that the co-existence simulation of NTN will have an impact on RF requirements of terrestrial IMT UE/BS.  **Observation 4:** For the co-existence scenario between two NTN systems, RAN4 need to consider whether to assume the same orbits and partial overlapping about foot print.  **Simulation Parameter/Potential Choice:**  Satellite orbits/GEO, LEO-1200, LEO-600  Center frequency /It depends on the decision about the example band.  Satellite antenna model/Passive reflector antenna or AAS. Antenna Gain and 3dB beam width  Channel bandwidth/It depends on operators’ spectrum allocations, no more than 100MHz.  Transmitter power/Different satellite orbits need different transmitter power  Noise figure/FFS  UE’s type/VSAT or handheld UE  Power control/FFS |
| [*R4-2015908*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015908.zip) | Ericsson | The proposed approach i.e. handling NTN gateway+ satellite as either a repeater or alternatively a relay.  It should be noted that 3GPP specifications E-UTRA contain repeater specification and relay specification where the repeater requirements were derived from various studies, including co-existence studies. The repeater RF requirements overview and structure from TS 36.106 is as following:  - Output power  - Frequency stability  - Out-of-band gain  - Unwanted emissions  - Error Vector Magnitude  - Input intermodulation  - Output intermodulation  - Adjacent channel rejection ration  The Relay requirements overview and structure from specification TS 36.116 is as following. More comprehensive requirements are specified due to the additional signal processing covering both access and backhaul link.  - Output power  - Output power dynamics including ON/OFF masks and transient handling for unpaired spectrum  - Transmit signal quality  - Unwanted emissions covering spurious emission, ACLR and operating band unwanted emission  - Transmit intermodulation  - Receiver sensitivity  - Receiver dynamic range  - In-channel selectivity  - Receiver blocking  - Receiver spurious emission  - Receiver intermodulation  - Access performance Requirements for PUSCH, PUCCH and PRACH  - Backhaul performance requirement covering PDSCH and PDCCH (for NR context)  Considering the relay requirements are more comprehensive, if there is any additional signal processing occurs performed within either the gateway or the satellite, the relay approach should be preferred. It looks then essential to conclude on this choice to progress further. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1 NTN satellite system view

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 2-1:** Proposals

* + Option 1:
    - RAN4 should consider (NTN gateway + satellite) as a repeater or alternatively as a relay.
    - The corresponding requirements shall be specified in a new repeater specification, or alternatively a new relay specification.
    - A NTN BS might be considered as a “Relay node” or “Remote Radio Head” unit.



Figure 1 Gateway and satellite as repeater

* + Option 2:
    - The RF requirements of satellite are different from the base station considering the large propagation distance between UE and satellite.
    - Different satellite orbits need different transmitter power
  + Option 3:
    - A HAPS as seen from the UE is a serving gNB and therefore the UE should expect same RF characteristics as a terrestrial gNB.
    - The RF requirements for the service link provided by LEO and GEO deployments should be at least same level as those for a terrestrial gNB.
    - RF requirements for a terrestrial gNB should be used as baseline for HAPS, LEO and GEO deployments.
    - Satellites both in transparent and regenerative deployments should provide same performance in terms of RF characteristics.
  + Option 4:
    - 3GPP should not define RF Tx requirements for a given transparent payload to allow flexibility in the space segment design;
    - 3GPP should not define RF Tx requirements for a BS in NTN;
    - 3GPP should define equivalent BS Tx requirements at UE reception level, by taking into account e.g. a frequency spectrum mask corresponding to the cumulated self-interferences generated by the satellite network infrastructure at UE level.



Figure 2: Satellite System with Transparent Payload

* Recommended WF1:
  + HAPS should use same RF characteristics as a terrestrial gNB.
* Recommended WF2:
  + In order to allow flexibility in the space segment design, 3GPP should not define RF Tx requirements for NTN Satellite payload

**Note:** Rational is related to several justifications:

- Satellite component composed from several system sub-components: transparent payload, feeder link, GW. The requirements that apply to the satellite network infrastructure results from a performance allocation trade-off between multiple sub-components, which are not specified one by one.

- Multiple satellites can cover a given area. Therefore, multiple adjacent channel interferences may sum together at UE level, and it might be required to define a maximum allowed level of interference in the adjacent band of the UE, at UE Rx level.

* Recommended WF3:
  + 3GPP may define additional NTN UE Rx parameters

### Sub-topic 2-2 Payload specification

*Sub-topic description: Satellite Payload*

*Open issues and candidate options before e-meeting:*

**Issue 2-2:** Transparent Payload

* Proposals
  + Option 1: RAN4 should consider (NTN gateway + satellite) as a repeater or alternatively as a relay. The corresponding requirements shall be specified in a new repeater specification, or alternatively a new relay specification.
  + Option 2: 3GPP should not define RF Tx requirements for a given transparent payload to allow flexibility in the space segment design;
  + Option 3: TBA
* Recommended WF
  + TBA

### Sub-topic 2-3 Improved NTN UE specification

*Sub-topic description: UE specification in RAN4*

*Open issues and candidate options before e-meeting:*

**Issue 2-3:** Improved NTN UE specification(s)

* Proposals
  + Option 1: multiple adjacent channel interferences may sum together at UE level, and it might be required to define a maximum allowed level of interference in the adjacent band of the UE, at UE Rx level.
  + Option 2: TBA
* Recommended WF
  + Improved NTN UE specification may be considered
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 2-1:  Sub topic 2-2:  Sub topic 2-3:  ….  Others: |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: FR1 proposed Exemplary Frequency band for NTN

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2014785*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014785.zip) | Samsung | **View 2:** It is necessary to prioritize the candidate NTN frequency bands to identify 1 or 2 example bands, which should be within the range of FR1 or FR2, while the confirmed and practical needs from operators should be well taken into account. |
| [*R4-2014066*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014066.zip) | Fraunhofer HHI, Fraunhofer IIS | **Observation 2:** Deployment scenarios in FR1 and FR2 are considered in geostationary (GEO) and low earth orbit (LEO).  **Observation 15:** All requirements shall be specified for both FR1 and FR2.  **Observation 16:** Although RAN4 will select exemplary band(s) in the current NR-NTN-solutions WI, the definition of additional NR bands for NTN will be part of dedicated RAN4 led Release 17 work items. |
| [*R4-2015906*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015906.zip) | Ericsson | In this contribution, based on Radio Regulations, we made following proposal and observations:  **Observation 3:** A NTN UE operating in FR2 might be considered as a relay UE, but most likely not a NR FR2 UE.  **L-band:**  **Observation 5:** The Radio Regulations have allocated mobile satellite service for the suggested part of L-band for NTN, the mobile service is also allocated in the ranges 1518-1525 MHz (primary service) and 1525-1535 MHz (secondary service).  **Observation 6:** The Radio Regulations have allocated mobile satellite service for the suggested part of L-band for NTN, mobile service is also allocated in the ranges 1668.4-1675 MHz (primary service) and 1668-1668.4 MHz (secondary service).  **Observation 7:** According to past ITU-R discussions on this band for mobile and mobile satellite services, L-band would be used for sensitive mobile satellite service. Further consideration would be needed if NTN would also be using this band.  **S-band:**  **Observation 8:** The Radio Regulations have allocated mobile satellite service for the suggested part of S-band for NTN. These ranges are also allocated to mobile. The proposed frequency ranges might be considered for NTN.  **C-band:**  **Observation 9:** The Radio Regulations have not allocated mobile satellite service for the suggested part of C-band for NTN. The proposed frequency ranges should not be considered for NTN.  Based on previous proposal and observations, following frequency ranges are allocated to mobile satellite and would need further discussion:  - L-band  Downlink (space to earth) 1518 – 1559 MHz, 1613.8 – 1626.5 MHz  Uplink (earth to space) 1626.5 – 1660.5 MHz & 1668 – 1675 MHz, 1610.0 – 1626.5 MHz  - S-band  Downlink (space to earth) 2170 - 2200 MHz & 2483.5 - 2500 MHz  Uplink (earth to space) 1980 - 2010 MHz  - C-band:  None |
| [*R4-2015915*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015915.zip) | THALES | **Proposal 1:** RAN4 work should consider an exemplary FR1 band for NTN.  **Proposal 2:** Propose to use an FDD exemplary band with 1980-2010 MHz for UL and 2170-2200 MHz for DL, for RAN4 KPI evaluation. |
| [*R4-2015913*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015913.zip) | THALES | **Proposal 1:** Consider SCS 15 & 30 kHz for FR1 exemplary band for RAN4 work.  **Proposal 2:** Consider frequency reuse schemes with frequency reuse > 1 for RAN4 work.  **Proposal 3:** Consider exemplary frequency bandwidths of 5, 10, 15, 20 MHz for FR1 RAN4 work.  **Proposal 4:** RAN4 needs to identify coexistence scenarios in adjacent bands. |
| [*R4-2015263*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015263.zip) | Xiaomi | **Proposal 1:** it is proposed at least the type of handheld UE with PC3 should be considered first for FR1. |
| [*R4-2015252*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015252.zip) | Nokia, Nokia Shanghai Bell | **Observation 2:** RAN4 should within this WI only consider example NR bands/frequencies.  **Proposal 2:** Choose example NR bands/frequencies in both the FR1 and FR2 range.  **Observation 3:** New NR bands should be defined at least for LEO and GEO deployments. |
| [*R4-2015547*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015547.zip) | Huawei, HiSilicon | **Observation 1:** RAN4 should consider the frequency band which are allocated for MSS as the example band firstly. And RAN4 can focus on the MSS scenario when co-existence study is performed.  **Observation 2:** In order to reduce the regulation risk, we can start the work with a frequency band in which there is no incumbent service except for MSS.  **Observation 3:** Band 65/n65 is specified in RAN4’s specification as a terrestrial IMT band instead of MSS. RAN4 can’t simply reuse band n65 as a NTN example band because of the regulation risk.  **Observation 4:** The RF requirements of satellite are different from the base station considering the large propagation distance between UE and satellite.  **Observation 5:** RF requirements of VSAT is totally different from the traditional 3GPP UE. For handheld UE, the general UE RF requirements can be considered as baseline.  **Proposal 1:** It’s proposed to choose 1.6GHz L band as a NTN example band. |
| [*R4-2015907*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015907.zip) | Ericsson | **Observation 1:** For FR1 bands above 3 GHz, NR bands are TDD only while NTN would use FDD duplex mode. This would be a major issue for coexistence. |
| [*R4-2016112*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016112.zip) | ZTE Corporation | **Proposal 1:** to adopt the coexistence scenarios in Table 2.1-1 for NTN coexistence study.  1 eMBB; NTN, 30MHz; TN, 30MHz; DL to DL; 2 GHz Rural  2 eMBB; NTN, 30MHz; TN, 30MHz; UL to UL; 2 GHz Rural  3 eMBB; NTN, 30MHz; NTN, 30MHz; DL to DL; 2 GHz Rural  4 eMBB; NTN, 30MHz; NTN, 30MHz; UL to UL; 2 GHz Rural  Note 2: the baseline scenario for NTN coverage should be rural area, FFS for other scenarios.  Note 3: TN should be NR based and it’s not necessary to evaluate LTE based or UTRA based as requirements should be close. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 3-1 Candidate FR1 exemplary bands

*Sub-topic description:* Candidate FR1 exemplary band(s) for RAN4

*Open issues and candidate options before e-meeting:*

**Issue 3-1:** Candidate FR1 exemplary band(s) for RAN4

* Proposals
  + Option 1:
    - Propose to use an FDD exemplary band with 1980-2010 MHz for UL and 2170-2200 MHz for DL, for RAN4 KPI evaluation.
  + Option 2:
    - RAN4 should consider the frequency band which are allocated for MSS as the example band firstly. And RAN4 can focus on the MSS scenario when co-existence study is performed.
    - It’s proposed to choose 1.6GHz L band as a NTN example band.
  + Option 3:
* Recommended WF
  + Consider MSS S-band as exemplary FR1 band

OR

* + Consider L band as exemplary FR1 band

OR

* + Consider both MSS S-band and L band as exemplary FR1 bands

### Sub-topic 3-2 Candidate FR1 band configurations

*Sub-topic description:* Candidate FR1 band configurations

*Open issues and candidate options before e-meeting:*

**Issue 3-2:** Candidate FR1 band configurations

* Proposals
  + Option 1:
    - Consider SCS 15 & 30 kHz for FR1 exemplary band for RAN4 work.
    - Consider frequency reuse schemes with frequency reuse > 1 for RAN4 work.
    - Consider exemplary frequency bandwidths of 5, 10, 15, 20 MHz for FR1 RAN4 work.
    - RAN4 needs to identify coexistence scenarios in adjacent bands.
  + Option 2: TBA
* Recommended WF
  + Consider SCS 15 & 30 kHz for FR1 exemplary band for RAN4 work.
  + Consider exemplary frequency bandwidths of 5, 10, 15, 20 MHz for FR1 RAN4 work.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 3-1:  Sub topic 3-2:  ….  Others: |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #4: FR2 proposed Exemplary Frequency band for NTN

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2014785*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014785.zip) | Samsung | **View 2:** It is necessary to prioritize the candidate NTN frequency bands to identify 1 or 2 example bands, which should be within the range of FR1 or FR2, while the confirmed and practical needs from operators should be well taken into account. |
| [*R4-2014066*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014066.zip) | Fraunhofer HHI, Fraunhofer IIS | **Observation 2:** Deployment scenarios in FR1 and FR2 are considered in geostationary (GEO) and low earth orbit (LEO).  **Observation 15:** All requirements shall be specified for both FR1 and FR2.  **Observation 16:** Although RAN4 will select exemplary band(s) in the current NR-NTN-solutions WI, the definition of additional NR bands for NTN will be part of dedicated RAN4 led Release 17 work items. |
| [*R4-2014467*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014467.zip) | HUGHES Network Systems Ltd, Thales | **Proposal 1:** RAN4 work should consider an exemplary FR2 band for NTN.  **Proposal 2:** RAN4 to use an FR2 exemplary band of 17.7 – 20.2 GHz for DL and 27.5 – 30.0 GHz for UL with FDD duplex mode. |
| [*R4-2015906*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015906.zip) | Ericsson | In this contribution, based on Radio Regulations, we made following proposal and observations:  **Observation 3:** A NTN UE operating in FR2 might be considered as a relay UE, but most likely not a NR FR2 UE.  **Ku-band:**  **Observation 10:** The proposed frequency ranges in Ku-band are currently not covered by RAN4 specifications TS 38.104 and TS 38.101-1/-2.  **Observation 11:** The Radio Regulations have not allocated mobile satellite service for the suggested part of Ku-band in downlink for NTN. The proposed frequency ranges should not be considered for NTN.  **Observation 12:** The Radio Regulations have not allocated mobile satellite service for the suggested part of Ku-band in uplink for NTN, except for the 14-14.5 GHz frequency range but as secondary service only.  **Ka-band:**  **Observation 13:** The proposed frequency ranges in Ka-band downlink are currently not covered by RAN4 specifications TS 38.104 and TS 38.101-1/-2.  **Observation 14:** The Radio Regulations have allocated mobile satellite service for the 19.7-20.2 GHz range of the suggested part of Ka-band in downlink for NTN. However, it is a secondary allocation in the range 19.7-20.1 GHz in Region 1 and Region 3.  **Observation 15:** The Radio Regulations have allocated mobile satellite service for the 29.5-30.0 GHz range of the suggested part of Ka-band in uplink for NTN.  **Q/V-band:**  **Observation 16:** The Radio Regulations have allocated mobile satellite service for the 39.5-40.5 GHz range of the suggested part of Q/V-band in downlink for NTN.  **Observation 17:** The Radio Regulations have allocated mobile satellite as secondary service for the 50.4-51.4 GHz range of the suggested part of Q/V-band in downlink for NTN.  Based on previous proposal and observations, following frequency ranges are allocated to mobile satellite and would need further discussion. The ranges highlighted in red are neither part of FR1 nor FR2 and would then require extra specification effort:  - Ku-band  Downlink (space to earth) None  Uplink (earth to space) 14.0 - 14.5 GHz (secondary)  - Ka-band  Downlink (space to earth) 19.7 – 20.2 GHz in Region 2  Uplink (earth to space) 29.9-30 GHz  - Q/V band  Downlink (space to earth) 39.5 – 40.5 GHz  Uplink (earth to space) ?? |
| [*R4-2015263*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015263.zip) | Xiaomi | **Proposal 1:** it is proposed at least the type of handheld UE with PC3 should be considered first for FR1. |
| [*R4-2015252*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015252.zip) | Nokia, Nokia Shanghai Bell | **Observation 2:** RAN4 should within this WI only consider example NR bands/frequencies.  **Proposal 2:** Choose example NR bands/frequencies in both the FR1 and FR2 range.  **Observation 3:** New NR bands should be defined at least for LEO and GEO deployments. |
| [*R4-2015547*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015547.zip) | Huawei, HiSilicon | **Observation 1:** RAN4 should consider the frequency band which are allocated for MSS as the example band firstly. And RAN4 can focus on the MSS scenario when co-existence study is performed.  **Observation 2:** In order to reduce the regulation risk, we can start the work with a frequency band in which there is no incumbent service except for MSS.  **Observation 3:** Band 65/n65 is specified in RAN4’s specification as a terrestrial IMT band instead of MSS. RAN4 can’t simply reuse band n65 as a NTN example band because of the regulation risk.  **Observation 4:** The RF requirements of satellite are different from the base station considering the large propagation distance between UE and satellite.  **Observation 5:** RF requirements of VSAT is totally different from the traditional 3GPP UE. For handheld UE, the general UE RF requirements can be considered as baseline.  **Proposal 1:** It’s proposed to choose 1.6GHz L band as a NTN example band. |
| [*R4-2015907*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015907.zip) | Ericsson | **Observation 1:** for all FR2 bands, NR bands are TDD only while NTN would use FDD duplex mode. This would be a major issue for coexistence. |
| [*R4-2016112*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016112.zip) | ZTE Corporation | **Proposal 1:** to adopt the coexistence scenarios in Table 2.1-1 for NTN coexistence study.  5 eMBB; NTN, 200MHz; TN, 200MHz; DL to DL; 20 GHz Rural [Note1]  6 eMBB; NTN, 200MHz; TN, 200MHz; UL to UL ; 20 GHz Rural [Note1]  7 eMBB; NTN, 200MHz; NTN, 200MHz; DL to DL; 20 GHz Rural  8 eMBB; NTN, 200MHz; NTN, 200MHz; UL to UL; 20 GHz Rural  Note 1: there are no rural cases above 3GHz according to ITU-R M.2292, coexistence between FR2 NTN and TN should be deprioritized  Note 2: the baseline scenario for NTN coverage should be rural area, FFS for other scenarios.  Note 3: TN should be NR based and it’s not necessary to evaluate LTE based or UTRA based as requirements should be close. |
| [*R4-2015548*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015548.zip) | Huawei, HiSilicon | **Simulation Parameter/Potential Choice:**  Channel bandwidth/It depends on operators’ spectrum allocations, no more than 100MHz. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 4-1 Candidate FR2 exemplary bands

*Sub-topic description:* Candidate FR2 exemplary band(s)

*Open issues and candidate options before e-meeting:*

**Issue 4-1:** Candidate FR2 exemplary band

* Proposals
  + Option 1:
    - RAN4 work should consider an exemplary FR2 band for NTN.
    - RAN4 to use an FR2 exemplary band of 17.7 – 20.2 GHz for DL and 27.5 – 30.0 GHz for UL with FDD duplex mode.
  + Option 2:
    - The proposed frequency ranges in Ka-band downlink are currently not covered by RAN4 specifications TS 38.104 and TS 38.101-1/-2.
    - The Radio Regulations have allocated mobile satellite service for the 19.7-20.2 GHz range of the suggested part of Ka-band in downlink for NTN. However, it is a secondary allocation in the range 19.7-20.1 GHz in Region 1 and Region 3.
    - The Radio Regulations have allocated mobile satellite service for the 29.5-30.0 GHz range of the suggested part of Ka-band in uplink for NTN.
  + Option 3:
    - Based on previous proposal and observations, following frequency ranges are allocated to mobile satellite and would need further discussion. The ranges highlighted in red are neither part of FR1 nor FR2 and would then require extra specification effort:
    - - Ka-band
      * Downlink (space to earth) 19.7 – 20.2 GHz in Region 2
      * Uplink (earth to space) 29.9-30 GHz
  + Option 4: TBA
* Recommended WF
  + Consider at least one FR2 Ka band

### Sub-topic 4-2 Candidate FR2 band configurations

*Sub-topic description:* Candidate FR2 band configurations

*Open issues and candidate options before e-meeting:*

**Issue 4-2:** Candidate FR2 band configurations

* Proposals
  + Option 1: Channel bandwidth/It depends on operators’ spectrum allocations, up to 400 MHz in FR2.
  + Option 2: Channel bandwidth/It depends on operators’ spectrum allocations, no more than 100MHz.
* Recommended WF
  + Consider 100, 200, 400 MHz in FR2; then try to downscope.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 4-1:  Sub topic 4-2:  ….  Others: |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #5: Exemplary Frequency band for HAPS/HIBS

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

*Decide if HAPS HIBS exemplary frequency band is required.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2014785*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014785.zip) | Samsung | **View 2:** It is necessary to prioritize the candidate NTN frequency bands to identify 1 or 2 example bands, which should be within the range of FR1 or FR2, while the confirmed and practical needs from operators should be well taken into account. |
| [*R4-2015906*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015906.zip) | Ericsson | HIBS  **Observation 18:** The Radio Regulations include HIBS usage in the 2 GHz, further frequency bands below 2.7 GHz will be studied for WRC-23. Decision on introducing HIBS will be taken at WRC-23.  Based on previous proposal and observations, following frequency ranges are allocated to mobile satellite and would need further discussion:  - L-band  Downlink (space to earth) 1518 – 1559 MHz, 1613.8 – 1626.5 MHz  Uplink (earth to space) 1626.5 – 1660.5 MHz & 1668 – 1675 MHz, 1610.0 – 1626.5 MHz  - S-band  Downlink (space to earth) 2170 - 2200 MHz & 2483.5 - 2500 MHz  Uplink (earth to space) 1980 - 2010 MHz  - C-band:  None  For HIBS, following frequency ranges might be considered:  Regions 1 and 3: 1 885-1 980 MHz, 2 010-2 025 MHz, 2 110-2 170 MHz  Region 2: 1 885-1 980 MHz, 2 110-2 160 MHz |
| [*R4-2015263*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015263.zip) | Xiaomi | **Proposal 1:** it is proposed at least the type of handheld UE with PC3 should be considered first for FR1. |
| [*R4-2015252*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015252.zip) | Nokia, Nokia Shanghai Bell | **Observation 2:** RAN4 should within this WI only consider example NR bands/frequencies.  **Proposal 2:** Choose example NR bands/frequencies in both the FR1 and FR2 range.  **Observation 3:** Reusing existing bands can be discussed for HAPS deployments. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 5-1 Candidate HAPS/HIBS exemplary bands

*Sub-topic description:* Candidate HAPS/HIBS exemplary bands

*Open issues and candidate options before e-meeting:*

**Issue 5-1:** TBA Candidate HAPS/HIBS exemplary bands

* Proposals
  + Option 1: For HIBS, following frequency ranges might be considered:
    - Regions 1 and 3: 1 885-1 980 MHz, 2 010-2 025 MHz, 2 110-2 170 MHz
    - Region 2 : 1 885-1 980 MHz, 2 110-2 160 MHz
  + Option 2: Reusing existing bands can be discussed for HAPS deployments.
  + Option 3: RAN4 should decide if HAPS/HIBS exemplary bands should be on its own. The range should be covered under FR1 or FR2 category.
  + Option 3: TBA
* Recommended WF
  + RAN4 should decide if HAPS/HIBS exemplary bands should be on its own.

### Sub-topic 5-2 Candidate HAPS/HIBS band configurations

*Sub-topic description* Candidate HAPS/HIBS band configurations depending on the HAPS/HIBS way forward

*Open issues and candidate options before e-meeting:*

**Issue 5-2:** Candidate HAPS/HIBS band configurations

* Proposals
  + Option 1: For FR1 5, 10, 15, 20 MHz
  + Option 2: For FR2 100, 200, 400 MHz
  + Option 3: TBA
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 5-1:  Sub topic 5-2:  ….  Others: |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #6: RAN4 Proposed RF core requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2014785*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014785.zip) | Samsung | **View 4:** As usual, 3GPP RAN4 should conduct relative independent adjacent channel coexistence studies to develop RF requirements (such as ACLR, ACS) for NTN. |
| [*R4-2014066*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014066.zip) | Fraunhofer HHI, Fraunhofer IIS | **Observation 14:** RAN4 is to specify UE RRM and RF core requirements, study bands related to NTN and investigate and specify UE timing and frequency pre-compensation requirements.  **Observation 15:** All requirements shall be specified for both FR1 and FR2. |
| [*R4-2014467*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014467.zip) | HUGHES Network Systems Ltd, Thales | **Proposal 1:** RAN4 work should consider an exemplary FR2 band for NTN.  **Proposal 2:** RAN4 to use an FR2 exemplary band of 17.7 – 20.2 GHz for DL and 27.5 – 30.0 GHz for UL with FDD duplex mode. |
| [*R4-2015263*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015263.zip) | Xiaomi | **Proposal 1:** it is proposed at least the type of handheld UE with PC3 should be considered first for FR1.  **Proposal 2:** it is proposed the UE reference architecture with 1Tx/2Rx could be as baseline to define UE requirements |
| [*R4-2015945*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015945.zip) | THALES | **Proposal 4:** 3GPP should re-use for NTN UE RAN4 core requirements definition the existent TN framework.  **Proposal 5:** Consider parameters from ETSI EN 302 574-2 V2.1.1 for defining specific RAN4 NTN UE core requirements for exemplary FR1 NTN band.  **Proposal 6:** NTN shall consider equivalent ETSI ACS and ACLR parameters.  **Proposal 7:** Consider 3GPP KPIs from TS 38.101-1 for defining RAN4 core requirements for exemplary FR1 NTN band.  **Proposal 8:** Down-select 3GPP core requirements from 3GPP KPI list, for exemplary FR1 NTN proposed RAN4 band.  **Proposal 9:** Define in RAN4 at least specific NTN core requirements for UE Tx Power, UE Output Power Dynamics, UE Tx Frequency Error, UE Tx EVM, UE Tx ACLR, UE Rx ACS, Spectrum Mask, Blocking Characteristics.  **Proposal 10:** A similar exemplary band definition approach should be applied for FR2. |
| [*R4-2015907*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015907.zip) | Ericsson | **Proposal 3:** For NR and NB-IoT, ACLR and ACS specified in TS 38.104 and 38.101 shall be assumed for NR BS and NR UE when running coexistence simulations. |
| [*R4-2015548*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015548.zip) | Huawei, HiSilicon | **Observation 1:** It isn’t expected that the co-existence simulation of NTN will have an impact on RF requirements of terrestrial IMT UE/BS.  **Simulation Parameter/Potential Choice:**  Satellite orbits/GEO, LEO-1200, LEO-600  Center frequency /It depends on the decision about the example band.  Satellite antenna model/Passive reflector antenna or AAS. Antenna Gain and 3dB beam width  Channel bandwidth/It depends on operators’ spectrum allocations, no more than 100MHz.  Transmitter power/Different satellite orbits need different transmitter power  Noise figure/FFS  UE’s type/VSAT or handheld UE  Power control/FFS |
| [*R4-2015908*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015908.zip) | Ericsson | The proposed approach i.e. handling NTN gateway+ satellite as either a repeater or alternatively a relay.  It should be noted that 3GPP specifications E-UTRA contain repeater specification and relay specification where the repeater requirements were derived from various studies, including co-existence studies. The repeater RF requirements overview and structure from TS 36.106 is as following:  - Output power  - Frequency stability  - Out-of-band gain  - Unwanted emissions  - Error Vector Magnitude  - Input intermodulation  - Output intermodulation  - Adjacent channel rejection ration  The Relay requirements overview and structure from specification TS 36.116 is as following. More comprehensive requirements are specified due to the additional signal processing covering both access and backhaul link.  - Output power  - Output power dynamics including ON/OFF masks and transient handling for unpaired spectrum  - Transmit signal quality  - Unwanted emissions covering spurious emission, ACLR and operating band unwanted emission  - Transmit intermodulation  - Receiver sensitivity  - Receiver dynamic range  - In-channel selectivity  - Receiver blocking  - Receiver spurious emission  - Receiver intermodulation  - Access performance Requirements for PUSCH, PUCCH and PRACH  - Backhaul performance requirement covering PDSCH and PDCCH (for NR context)  Considering the relay requirements are more comprehensive, if there is any additional signal processing occurs performed within either the gateway or the satellite, the relay approach should be preferred. It looks then essential to conclude on this choice to progress further. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 6-1 RF core requirements

*Sub-topic description:* RAN4 Proposed RF core requirements

*Open issues and candidate options before e-meeting:*

**Issue 6-1:** Proposed RF core requirements

* Proposals
  + Option 1:
    - 3GPP should re-use for NTN UE RAN4 core requirements definition the existent TN framework.
    - Consider parameters from ETSI EN 302 574-2 V2.1.1 for defining specific RAN4 NTN UE core requirements for exemplary FR1 NTN band.
    - NTN shall consider equivalent ETSI ACS and ACLR parameters.
    - Consider 3GPP KPIs from TS 38.101-1 for defining RAN4 core requirements for exemplary FR1 NTN band.
    - Down-select 3GPP core requirements from 3GPP KPI list, for exemplary FR1 NTN proposed RAN4 band.
    - Define in RAN4 at least specific NTN core requirements for UE Tx Power, UE Output Power Dynamics, UE Tx Frequency Error, UE Tx EVM, UE Tx ACLR, UE Rx ACS, Spectrum Mask, Blocking Characteristics.
  + Option 2:
* Recommended WF
  + Define in RAN4 at least specific NTN core requirements for UE Tx Power, UE Output Power Dynamics, UE Tx Frequency Error, UE Tx EVM, UE Tx ACLR, UE Rx ACS, Spectrum Mask, Blocking Characteristics.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 6-1:  ….  Others: |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |