3GPP TSG-RAN WG2 Meeting #111-e R2-2008185

e-meeting, 17th – 28th, 2020

Title: Workplan, scope and scenarios email discussion

Source: Thales [Moderator]

Document for: Discussion

Agenda Item: 8.10

Work item: NR\_NTN\_solutions

# Introduction

This document aims to summarize the organization views on :

* WI Reference scenarios, Key assumptions
* Work plan and tasks prioritization

Here under are recalled the description of the email discussion in the Vice Chairman notes in its Report from Break-out session on R16 eMIMO, CLI, PRN, RACS and R17 NTN and REDCAP

* [AT111][105][NTN] Workplan, scope and scenarios (Thales)

Scope: Discuss the workplan in [R2-2007565](file:///C:\Data\3GPP\RAN2\Docs\R2-2007565.zip) and the proposals in [R2-2007572](file:///C:\Data\3GPP\RAN2\Docs\R2-2007572.zip) and [R2-2007537](file:///C:\Data\3GPP\RAN2\Docs\R2-2007537.zip)

Scope: Discuss the workplan in R2-2007565 and the proposals in R2-2007572, R2-2007537, R2-2006630 (and possibly others from contributions in 8.10.1)

Initial intended outcome: revised workplan and summary of the offline discussion with e.g.:

* + - List of agreeable proposals (if any)
    - List of proposals that require online discussions

Initial deadline (for companies' feedback): Thursday 2020-08-20 16:00 UTC

Initial deadline (for rapporteur's summary in R2-2008185): Thursday 2020-08-20 18:00 UTC

# NR\_NTN\_solutions WI reference scenarios and key assumptions

## NTN reference scenarios

#### Views of organizations

* Thales in [11] suggests that

*“Proposal 1: Six transparent payload based satellite reference scenarios are considered for the Rel-17 work item “NR\_NTN\_solutions” characterised in the table below:*

*Table 2-1 Reference satellite scenarios for Rel-17 work item “NR\_NTN\_solutions”*

| *Scenarios* | *C1.1* | *C1.2* | *C2.1* | *C2.2* | *A1* | *A2* |
| --- | --- | --- | --- | --- | --- | --- |
| *Orbit* | *LEO @ 600 km altitude* | *LEO @ 600 km altitude* | *LEO @ 1200 km altitude* | *LEO @ 1200 km altitude* | *GEO @ 35,786 km altitude* | *GEO @ 35,786 km altitude* |
| *Frequency band* | *Sub 6GHz* | *Above 6GHz* | *Sub 6GHz* | *Above 6GHz* | *Sub 6 GHz* | *Above 6 GHz* |
| *Beams generation* | *Earth fixed beams (Note 1)* | *Earth fixed beams (Note 1)* | *Earth moving beams* | *Earth moving beams* | *Earth fixed beams* | *Earth fixed beams* |

|  |
| --- |
| *NOTE 1: Each satellite has the capability to steer beams towards fixed points on earth using beam-forming techniques. This is applicable for a period of time corresponding to the visibility time of the satellite* |

* Nokia in [6] suggests that

*“Observation 1: The reference multiple satellite scenario to be used in RAN2 mobility studies can be defined as one satellite orbit, with 2 or 3 consecutive satellites only, with a certain inter-satellite distance, each satellite having a certain beam layout, beam size and frequency re-use pattern.*

*Proposal 4: RAN2 to define a simplified multiple satellites scenario modelling approach for the reference mobility evaluations, using the existing RAN1 scenarios.”*

#### Discussion

Note 1 from moderator: Instead of defining an inter satellite distance, it is sufficient to set the minimum elevation angle that will be ensured by the constellation.

Note 2 from moderator: Earth moving beams may not be realistic for narrow beams and low altitude, due to excessive Hand-over rate. However, they may be envisaged at higher altitude and wider beams.

Based on the above the following proposals are considered:

**Proposal 2.1: Six transparent payload based satellite reference scenarios are considered for the Rel-17 work item “NR\_NTN\_solutions” characterised in the table 2.1 of [11]:**

|  |  |
| --- | --- |
| **Organizations** | **View on the proposals above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree (I think we have already agreed on it in SI) |
| Qualcomm | We are not clear why earth moving beam scenario should be excluded in LEO 600km altitude or fixed beam in LEO 1200km altitude (this is not agreed in SI) as there may be solutions to address the handover issue. For LEO, there is no need to exclude some scenarios at this early stage without discussing solutions. We can just refer the scenario in table 4.2-2 of [TR 38.821] and there is no need to introduce new table. |
| Lenovo | We see no necessity to exclude moving beam for LEO 600km or fixed beam for LEO 1200km. |
| OPPO | Agree. |
| BT | Agree with Lenovo.  It will be convenient to add the maximum distance between the satellite and the UE in Table 2-1. This can be added to orbit row or a new row and will provide an easy value to compare with terrestrial networks. It is easy to confuse altitude with distance when satellite is in the zenith. |
| CATT | From our perspective, the following aspects need further clarification:   1. For the low altitude satellite in scenarios C1.1/C1.2, whether earth moving cell is feasible? In our understanding, it should be feasible at least for scenario C1.1. 2. Whether there is prioritization between earth fixed beam and earth moving beam? In our understanding, we had better take earth moving beam as first priority, and take earth fixed beam as second priority. |
| Sony | Agree |
| Nokia | In our paper [6] we were suggesting a reference scenario for evaluating NTN mobility and not trying to restrict the scope of the entire NTN WI to such reference scenario.  Regarding table 2.1 depicted above, why for LEO @1200 km only Earth-moving beams are considered and similarly why is only Earth-fixed beams considered for LEO @ 600 km?  In your understanding, ‘low altitude’ is 600km and ‘higher altitude’ is 1200km. We suppose 1200km does not qualify as high altitude LEO (MEO?). |
| LG | We agree to consider those six scenarios. |
| Vodafone | To be consistent and to be able to compare performances of various scenarios, we suggest adding LEO 1200Km Fixed Earth beam scenarios and as Qualcomm has suggested a LEO at 600 Km with moving beam scenario. |

## Key parameters of the NTN scenarios

#### Views of organizations

* Thales in [11] suggests that

*“Proposal 2: The key reference scenario parameters can be found in table 4.2-2 of this document. It corresponds to the table 4.2-2 of [TR 38.821] in which the scenarios referring to the regenerative payload option have been removed.”*

*Table 4.2-2: Reference scenario parameters*

|  |  |  |
| --- | --- | --- |
| *Scenarios* | *GEO based non-terrestrial access network (Scenario A)* | *LEO based non-terrestrial access network (Scenario C)* |
| *Orbit type* | *notional station keeping position fixed in terms of elevation/azimuth with respect to a given earth point* | *circular orbiting around the earth* |
| *Altitude* | *35,786 km* | *600 km*  *1,200 km* |
| *Spectrum (service link)* | *<6 GHz (e.g. 2 GHz)*  *>6 GHz (e.g. DL 20 GHz, UL 30 GHz)* | |
| *Max channel bandwidth capability (service link)* | *30 MHz for band < 6 GHz*  *400 MHz for band > 6 GHz* | |
| *Payload* | *Scenario A: Transparent (including radio frequency function only)* | *Scenario C: Transparent (including radio frequency function only)* |
| *Inter-Satellite link* | *No* | *No* |
| *Earth-fixed beams* | *Yes* | *Scenario C1: Yes (steerable beams), see note 1*  *Scenario C2: No (the beams move with the satellite)* |
| *Max beam foot print size (edge to edge) regardless of the elevation angle* | *3500 km (Note 5)* | *1000 km* |
| *Min Elevation angle for both sat-gateway and user equipment* | *10° for service link and 10° for feeder link* | *10° for service link and 10° for feeder link* |
| *Max distance between satellite and user equipment at min elevation angle* | *40,581 km* | *1,932 km (600 km altitude)*  *3,132 km (1,200 km altitude)* |
| *Max Round Trip Delay (propagation delay only)* | *Scenario A: 541.46 ms (service and feeder links)* | *Scenario C: (transparent payload: service and feeder links)*  *25.77 ms (600km)*  *41.77 ms (1200km)* |
| *Max differential delay within a cell (Note 6)* | *10.3 ms* | *3.12 ms and 3.18 ms for respectively 600km and 1200km* |
| *Max Doppler shift (earth fixed user equipment)* | *0.93 ppm* | *24 ppm (600km)*  *21 ppm(1200km)* |
| *Max Doppler shift variation (earth fixed user equipment)* | *0.000 045 ppm/s* | *0.27 ppm/s (600km)*  *0.13 ppm/s(1200km)* |
| *Maximum Delay variation as seen by the UE (note 7)* | *Negligible* | *Up to +/- 48 µs/sec (600 km)*  *Up to +/- 42 µs/sec (1200 km)* |
| *Service link* | *3GPP defined New Radio* | |
| *Feeder link* | *3GPP defined Radio interface* | *3GPP defined Radio interface* |
| *NOTE 1: Each satellite has the capability to steer beams towards fixed points on earth using beamforming techniques. This is applicable for a period of time corresponding to the visibility time of the satellite*  *NOTE 2: Max delay variation within a beam (earth fixed user equipment) is calculated based on Min Elevation angle for both gateway and user equipment*  *NOTE 3: Max differential delay within a beam is calculated based on Max beam foot print diameter at nadir*  *NOTE 4: Speed of light used for delay calculation is 299792458 m/s.*  *NOTE 5: The Maximum beam foot print size for GEO is based on current state of the art GEO High Throughput systems, assuming either spot beams at the edge of coverage (low elevation).*  *NOTE 6: The maximum differential delay at cell level has been computed considering the one at beam level for largest beam size. It does not preclude that cell may include more than one beam when beam size are small or medium size. However the cumulated differential delay of all beams within a cell will not exceed the maximum differential delay at cell level in the table above.*  *NOTE 7: The delay variation measures how fast the round trip delay (function of UE-satellite-NTN gateway distance) varies over time when the satellite moves towards/away from the UE. It is expressed in µs/s and is negligible for GEO scenario* | | |

*The NTN study results apply to GEO scenarios as well as all NGSO scenarios with circular orbit at altitude greater than or equal to 600 km.*

* Nokia in [6] suggests that

*“Observation 1: The reference multiple satellite scenario to be used in RAN2 mobility studies can be defined as one satellite orbit, with 2 or 3 consecutive satellites only, with a certain inter-satellite distance, each satellite having a certain beam layout, beam size and frequency re-use pattern.*

*Proposal 4: RAN2 to define a simplified multiple satellites scenario modelling approach for the reference mobility evaluations, using the existing RAN1 scenarios.”*

* Ericsson in [9] suggests that

*“Observation 2 Many assumptions made in Rel-16 NTN SI will not affect directly specification development and thus there is no need to reach WI agreements on those.*

*Observation 3 Key assumptions that may have design impact are more pertinent for RAN1 to decide.*

*Proposal 4 RAN2 waits for RAN1 input on e.g. delay and Doppler related assumptions.”*

#### Discussion

Note that instead of defining an inter satellite distance, it is sufficient to set the minimum elevation angle that will be ensured by the constellation.

Based on the above the following proposals are considered. RAN2 should focus on the parameters that falls in its area of work:

**Proposal 2.2.1: The key reference scenario parameters can be found in table 4.2-2 of [11]. It corresponds to the table 4.2-2 of [TR 38.821] in which the scenarios referring to the regenerative payload option have been removed.**

|  |  |
| --- | --- |
| **Organizations** | **View on the proposals above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree |
| Qualcomm | There is no need to add new or modify the table, except the case of regenerative payload. However, there is additional change in the table. This table limits the feeder link to only 3GPP radio interface. Non-3GPP feeder link between satellite and NTN GW may also be needed to allow satellite control signals. |
| Lenovo | Agree |
| OPPO | Agree. |
| BT | Agree. It covers Table 2-1 satellite scenarios |
| CATT | Agree |
| Sony | It’s better to take Delay and Doppler parameters out and our overall impression is that these paramaters in table 4.2-2 are more relevant for RAN1 |
| Nokia | Not clear what this proposal is meant to say: we shall agree or disagree the table in [11] corresponds to the TR 38.821? The question should rather be: is the table 4.2-2 of TR 38.821 sufficient and correct? We have the following questions:  Is 10 degrees of minimum elevation angle the correct value? For LEO link budget the 30 degrees was used in TR 38.321. |
| LG | Agree |
| Vodafone | Agree |

**Proposal 2.2.2: RAN2 waits for RAN1 input on e.g. delay and Doppler related assumptions.”**

|  |  |
| --- | --- |
| **Organizations** | **View on the proposals above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree |
| Qualcomm | Agree |
| Lenovo | Agree |
| OPPO | Agree. |
| BT | Agree. We should wait RAN1 inputs |
| CATT | Agree |
| Sony | Agree |
| Nokia | OK, but what exactly does it impact, regarding RAN2 work? We shall agree explicitly what we decide and evaluate later, after receiving such RAN1 input. |
| Vodafone | Agree |

## UE types

#### Views of organizations

* Thales in [11] suggests that

*“Proposal 3: The User equipment considered for the key reference scenario parameters can be found in table 4.3-1 of this document.”*

*Table 4.3-1 Reference satellite scenarios: User equipment types*

|  |  |  |
| --- | --- | --- |
| *User equipment characteristics* | *Handheld* | *VSAT (Note 1)* |
| *~~Antenna type~~* | *~~Omnidirectional antenna~~* | *~~Directive antenna~~* |
| *Motion on the earth* | *500 km/h (e.g. on board a high speed train)* | *Up to 1200 km/h (e.g. aircraft mounted)* |
| *antenna types* | *Omnidirectional antenna* | *Directional antenna*  *(up to 60 cm equivalent aperture diameter)* |
| *Antenna polarisation* | *Linear: +/-45°X-pol* | *circular* |
| *Max transmit power* | *up to 200 mW (power class 3)* | *up to 20 W* |
| *Note 1 : VSAT terminal characteristics could be implemented with phased array antenna. It may be mounted on Moving platforms (e.g., aircrafts, vessels) or building* | | |

#### Discussion

Based on the above the following proposals are considered. RAN2 should focus on the characteristics that falls in its area of work:

**Proposal 2.3.1: The User equipment considered for the key reference scenario parameters can be found in table 4.3-1 of [11] and recalled in the previous clause of this document.**

Note that 1st antenna type row has been erased in the clause above because there was a redundancy

|  |  |
| --- | --- |
| **Organizations** | **View on the proposals above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree |
| Qualcomm | Agree |
| Lenovo | Agree |
| OPPO | Agree with changes.  In our understanding, the motion of handled UE type should be “up to 500 km/h” instead of “fixed” 500 km/h. |
| BT | Agree with changes.  Antenna type should be capture for handheld handsets as antenna polarization may have a directivity which is not expected is such devices. |
| CATT | In our understanding, the most important parameter which will impact RAN2 is the speed parameter. Do we need to make some prioritization corresponding to this parameter: take low speed as first priority and optimization on high speed can be further considered based on the solution for low speed? |
| Sony | Agree |
| Nokia | Again, not sure why this table is copied to [11] and then [11] is used as a basis for this WI. We shall rather refer to the official TR.  Is VSAT type of the UE an NTN-only UE?  Agree with OPPO’s comment, the velocity should be ‘’up to’’, not fixed to 500 km/h. |
| LG | Agree |
| Vodafone | Agree |

## UE with GNSS capability

#### Views of organizations

* Samsung in [3] suggests that

*“Observation 1. The WID RP-201256 mentions in Section 3 that the UEs with GNSS capabilities and UEs without GNSS capabilities should considered for LEO scenarios. The same WID RP-201256 assumes in Section 4 that UEs with GNSS capabilities are assumed.*

*Proposal 1. RAN2 can clarify if GNSS capabilities are mandatory or optional for UEs in R17. We prefer to support the UEs with GNSS capabilities and the UEs without GNSS capabilities.”*

* Thales in [11] suggests that

*“Proposal 4 UEs with capability on timing and frequency pre-compensation using their GNSS capabilities are assumed. However the support of UEs without capability on timing and frequency pre-compensation is not precluded in the subsequent release.”*

### Discussion

In the NR\_NTN\_solutions WI, it is stated that

* *“UEs with GNSS capabilities are assumed.”*
* *“Enhancement on the PRACH sequence and/or format and extension of the ra-ResponseWindow duration (in the case of UE with GNSS capability but without pre-compensation of timing and frequency offset capabilities) [RAN1/2].”*

Furthermore, several organizations have expressed their interest in the support of UE without GNSS capability. Therefore the scope of the WI could be further clarified as follow:

**Proposal 2.4.1: As part of Rel-17 NR\_NTN\_solutions WI, UEs with GNSS capabilities and with capability on timing and frequency pre-compensation using their GNSS capabilities are assumed. The support of UEs with GNSS capability but without capability on timing and frequency pre-compensation and the support of UE without GNSS capability are not precluded in subsequent releases. This needs to be clarified in a revision of the WI objective.**

|  |  |
| --- | --- |
| **Organizations** | **View on the proposal above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree, with changes mentioned below:  There is no need to make assumptions of subsequent releases at this point. Hence, the revision of the WI objective is un-necessary. |
| Qualcomm | Agree. Also agree with MediaTek the revision of WI objective is not necessary. |
| Lenovo | Agree. No need to update WI objective. |
| OPPO | Disagree. The current WID assumes UEs have GNSS capabilities, and covers UEs with and without capabilities on timing and frequency pre-compensation. We think these two kinds of UE should be considered in Rel-17, i.e. no change to the WID.  Below is the excerpt of the WID:   * Enhancement on the PRACH sequence and/or format and extension of the ra-ResponseWindow duration (in the case of UE with GNSS capability but without pre-compensation of timing and frequency offset capabilities) [RAN1/2]. * Adaptation for Msg-3 scheduling   + Only for the case with pre-compensation of timing and frequency offset at UE side) |
| BT | Agree if the baseline is:   * UEs with GNSS capabilities and with capability on timing and frequency pre-compensation using their GNSS capabilities and; * UEs with GNSS capability but without capability on timing and frequency pre-compensation.   We don’t see any commercial reason for NTN UEs without GNSS capability. |
| CATT | In our understanding, the prioritization rule should be:  1st priority: UE with both GNSS capability and pre-compensation capability;  2nd priority: UE with both GNSS capability but without pre-compensation capability;  3rd priority: UE without GNSS capability and pre-compensation capability.  1st priority should be studied first, only if there is remaining time, the 2nd priority and 3rd priority can be further considered. |
| Sony | Agree with changes.  We think that UEs with GNSS capability should be the starting point.  Other capabilities like pre-compensation and/or UEs without GNSS capability should be considered subsequently but within the WI phase if time permits. |
| Nokia | Disagree. The scope shall not be limited to UEs with GNSS capability. GNSS capability does not automatically mean the UE has accurate enough location and timing information. That is why we need to consider the cases where the pre-compensation based on GNSS is not possible. |
| LG | We agree to assume UEs with GNSS capabilities, but WID revision seems not necessary.  We wonder pre-compensation capability is really needed, because common TA broadcast by network would work enough regardless of whether UE supports GNSS capability or not. |
| Vodafone | We agree that there is no need to change the work Item etc.  The flip side of this is that the UEs without GNSS Capabilities will not work properly. |

## Earth fixed versus Earth moving beams

#### Views of organizations

* CATT in [1] suggests that

*“Proposal 4: Study on the earth moving cell should be prioritized in Rel-17 NTN.*

*Proposal 5: It had better design common solution for earth moving cell and earth fixed cell, and earth fixed cell specific solution can only be considered when justified.”*

* Ericsson in [9] suggests that

*“Proposal 2 Rel-17 NR NTN WI to prioritize considering solutions specific to Earth fixed cells”*

* Nokia in [6] suggests that

*“Observation 3: A reference cell-switch functionality needs to be defined and evaluated for earth-fixed cells scenarios. The modelling assumptions for the reference earth fixed cells scenario could include parameters such as:*

*• minimum beam width (potentially vs. elevation angle),*

*• how the beams are shaped vs. time (or elevation angle) and what is the update rate,*

*• beam pointing accuracy,*

*• cell-switch model.*

*Proposal 7: RAN2 to define evaluation assumptions specific for the reference earth-fixed cells scenario, including the time duration one satellite is pointing a beam towards a fixed location and the potential use of beam-shaping and cell-switch functionalities.”*

#### Discussion

While at low altitude and for narrow beam, Earth moving beams are not realistic due to excessive Hand-over rate, they may be envisaged at higher altitude and larger beam size. Hence

**Proposal 2.5.1: Both Earth fixed and earth moving beam scenarios should be considered with NGSO constellation (see the six reference scenarios proposed)**

|  |  |
| --- | --- |
| **Organizations** | **View on the proposal above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree |
| Qualcomm | Agree, both earth-fixed (i.e., temporarily fixed in LEO) and earth-moving beam scenarios can be considered. However, to note, there is no need to preclude a specific case, i.e., moving beams with LEO 600km. There may be solutions to address the frequent handover. Note that we see support of earth-moving beams to be more useful for following reasons: (1). simplifies satellite requirements and may enable earlier deployment, (2). UE supporting earth moving beams automatically can support earth-fixed beams. |
| Lenovo | We see no necessity to exclude moving beam for LEO 600km or fixed beam for LEO 1200km. |
| OPPO | Agree |
| BT | Agree to consider Earth fixed and Earth moving beams. We don’t see the need to preclude one solution at this stage neither scenarios commented by Lenovo. |
| CATT | Same comment as listed in Proposal 2.1. |
| Sony | Agree |
| Nokia | Not sure if this proposal actually reflects what the companies want (based on what you have quoted above), but OK to try with both Earth-fixed and Earth-moving, if the time allows. We have the same concern as Lenovo: why is Earth fixed removed from 1200 km or Earth-moving from 600km scenario? |
| LG | Yes, we agree to consider both earth fixed beam and earth moving beam cases. General solution can be discussed first. |
| Vodafone | Agree and hence please update Table 2-1 earlier in this document ! |

**Proposal 2.5.2: the standard should be defined without any dependence to the implementation of beam shaping techniques on board**

|  |  |
| --- | --- |
| **Organizations** | **View on the proposal above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree |
| Qualcomm | Agree, this is also the reason why earth moving beam scenario needs to be considered together with earth fixed beam scenario. Standard should also be defined without any dependence on the implementation of antenna/beam steering technologies. |
| Lenovo | Agree |
| OPPO | Agree |
| BT | Fully agree.  From a UE point of view, Earth fixed and Earth moving beams should be completely transparent and therefore, the standard shouldn’t be done for a specific solution. |
| CATT | Agree, it had better design common solution for earth fixed beam and earth moving beam. |
| Sony | Agree |
| Nokia | Disagree. It would be good to do it this way. However, is it realistically achievable (do we need to put such restriction formally, already now)? The knowledge on beam layout used by the satellites could be essential for a proper UE operation in NTN. The reference NTN beams should be standardized, at least at the same level as for terrestrial scenarios beamforming, i.e. assumption on array size, parameters, etc., so that the required beams and shapes can be generated, even if they are theoretical beams. |
| LG | We agree to discuss common solutions first, but we wonder if a case exists that a UE should apply different criterion for earth fixed cell and earth moving cell, because cell coverage on the ground of earth moving cell changes very rapidly. So especially UEs in idle mode, it may need to apply different parameters to neighbor NTN cells of earth fixed and earth moving. |
| Vodafone | Agree it should be left to implantation |

## Feeder link and switch over

#### Views of organizations

* Ericsson in [9] suggests that

*“Observation 1 As transparent payload is assumed in Rel-17, both feeder link and service link use the NR Uu interface.”*

* Thales in [11] suggests that

*“Proposal 11: For feeder link switchover (e.g. for Non GSO), satellites may be connected to at least one NTN GW (hard switch) or at least two NTN GWs (soft switch). The Doppler shift on the feeder links are pre compensated by the NTN GW.”*

Nokia in [6] suggests that

*“Proposal 5 RAN2 to define a reference NTN-GW - satellite feeder link delay function vs. time.*

*Proposal 6 Define the feeder and service link type of amplification model of a transparent satellite including potential limitations.”*

#### Discussion

As per Nokia’s proposal, the delay and Doppler experienced over the feeder link will depend on the satellite altitude and the min elevation angle. Moreover, the amplification model of the transparent payload is probably more a RAN 1 or 4 issue than a RAN2 issue.

As per Ericsson’s observation, it is indeed assumed that for transparent payload considered in Rel-17, both feeder link and service link use the NR Uu interface.

The organizations are invited to discuss the Thales proposal:

**Proposal 2.6.1: For feeder link switchover (e.g. for Non GSO), satellites may be connected to at least one NTN GW (hard switch) or at least two NTN GWs (soft switch). The Doppler shift on the feeder links are pre compensated by the NTN GW.**

|  |  |
| --- | --- |
| **Organizations** | **View on the proposal above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree. |
| Qualcomm | We are open to look into both hard and soft switch solutions. We agree that feeder links should be pre-compensated by GW as this simplifies the work. However, it may be more effective to agree performance requirements for feeder link switchover and leave solutions to satellite vendors and operators (there may be non 3GPP interface between satellite and NTN GWs that connect to the gNB). These requirements will determine what additional support would be needed from UEs and gNBs. |
| Lenovo | Hard switch and soft switch are supported. |
| OPPO | We can consider hard switch and soft switch. |
| BT | Agree |
| CATT | In our understanding, the Doppler shift impact on feeder link should be studied in RAN1. |
| Sony | Agree |
| Nokia | Disagree. It is a simplification instead of real modelling. It does not say anything about delay impact and thus how some timers may need to be extended. Without knowledge about how transparent satellite amplifies the signal it is also hard to evaluate mobility and define triggering events. |
| LG | We agree. By the way, we wonder whether hard switch and soft switch is visible from UE perspective. Therefore, it would be up to network implementation whether to perform hard switch or soft switch, does RAN2 need to discuss solution for each hard switch and soft switch? |
| Vodafone | Both hard and soft switching is supported. |

## UE location by NTN based NG-RAN

#### Views of organizations

* Fraunhofer in [2] reviewed several existing positioning methods defined by 3GPP and suggests that

**“***Proposal 1: RAN2 shall specify the accuracy needed for the location of the UE on the mentioned scenario (regulatory services).*

*Proposal 2: RAN2 shall consider whether support for other use cases are needed from positioning using NTN.*

*Proposal 2: RAN2 shall agree to further investigate on Rel-16 “UE-assisted, LMF-based” and “NG-RAN node-assisted” options only for methods to be used in NTN.*

*Proposal 3: RAN2 shall agree to investigate on Rel-16 positioning methods based on New Radio (NR) as NR is to be considered for NTN. These positioning methods are: DL-TDOA, DL-AoD, Multi-RTT, NR E-CID, UL-TDOA, UL-AoA.***”**

* Sony in [5] suggests that

*“Proposal 1: RAN node should be aware of UE location in order to support NTN operation.*

*Proposal 2: UE will only send location report when it moves by a distance beyond a pre-configured threshold from its last reported location.”*

* Thales in [11] suggests that

*“Proposal 12 The NTN based positioning of UE shall should provide an accuracy comparable with terrestrial networks (typical Cell size). Location Services (LCS) framework/application protocols from Rel.16 is the basis for the NTN to locate the UE.”*

And proposed a working method to address this issue

*“Proposal 13 To meet the objective of identifying potential issues associated to the use of the existing Location Services (LCS) application protocols to locate UE in the context of NTN and specify adaptations if any [RAN2/3] as part of the “NR\_NTN\_solutions » work item in RP-201256 [1], the following stepped approach is proposed:*

* *Step 1: Review of the applicability to NTN of the existing network-based location methods, adapt these methods or propose new ones if need be, and evaluate these methods.*
* *Step 2: Assessment the LCS framework ([5] to [9], in particular but not excluding other TS) and its applicability to NTN*
* *Step 3: Following Step 1 & 2, down-selection of a method to be specified for locating UE by an NTN NG-RAN.”*
* Samsung in [3] suggests that

*“Observation 6. The Agenda Item 8.10.1 asks about the role of and the architecture for Location Service.*

*Proposal 6. Reuse and enhance the R16 positioning framework for an NTN.“*

* Ericsson in [9] suggests that

*“Observation 4: The location services should work as per current standard and we do not foresee any immediate changes needed.”*

#### Discussion

The need to define a procedure to locate UE by the NG-RAN has been identified by SA2 in [14] and confirmed by SA3LI in [13] which recalled about “the importance of extending the LCS capabilities onto the non-terrestrial networks”.

The accuracy needed for the location of the UE on the mentioned scenario (regulatory services) has been clarified by SA3-Li in [13] which suggests that satellite access should be able to locate the UE with a “network location accuracy comparable with terrestrial networks” in order to meet the “fundamental LI requirements”.

In line with the above, the objectives of the NR\_NTN\_solutions WI include “Identify potential issues associated to the use of the existing Location Services (LCS) application protocols to locate UE in the context of NTN and specify adaptations if any [RAN2/3]”

Based on the above, the organizations are invited to discuss the working method for this issue:

**Proposal 2.7.1: The following stepped approach is proposed:**

* **Step 1: Review of the applicability to NTN of the existing network-based location methods, adapt these methods or propose new ones if need be, and evaluate these methods.**
* **Step 2**: **Assessment the LCS framework ([5] to [9], in particular but not excluding other TS) and its applicability to NTN**
* **Step 3**: **Following Step 1 & 2, down-selection of a method to be specified for locating UE by an NTN NG-RAN.**

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| **Organizations** | **View on the proposal above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree |
| Qualcomm | We believe that GNSS will be a preferred positioning capability for NTN due to the following probable conditions: 1. NTN capable UEs for Rel-17 are GNSS capable, 2. UEs accessing NTN are outdoors (a preferred scenario for GNSS), 3. Terrestrial LTE/NR/WLAN coverage is not available (thereby precluding terrestrial positioning), 4. GNSS can have 10 meter accuracy in open sky and better than 50 meters where there are obstructions. GNSS can be used in a UE based (UEB) mode (where the UE calculates the location) or UE assisted (UEA) mode (where the network calculates the location). UEB mode would be easiest except where regulatory requirements may require UEA. GNSS can be supplemented by NTN based positioning which might be based on NR positioning methods for Rel-16 and Rel-17. Steps 1, 2 and 3 above seem an appropriate way to confirm these expectations and agree details (e.g. which NTN position methods from Rel-16 and Rel-17 are most useful in addition to GNSS). |
| Lenovo | Agree. We also think that GNSS is the most preferred positioning capability for NTN. |
| OPPO | Agree |
| BT | Agree  We consider Thale’s proposal 12 should be taken as baseline. |
| CATT | Agree |
| Sony | Agree with changes . The LCS framework will not allow the gNB being aware of UE location but MDT framework does allow. We should assess both LCS and MDT framework. |
| Nokia | OK to start with Step 1. Please beware that evaluation of location techniques is quite a large effort if it means simulations etc. We risk to spend too much time on this, while the evaluations would require some assumption on constellations, etc. |
| LG | Agree |
| Vodafone | Agree to use GNSS for positioning |

## NTN-TN Service continuity

#### Views of organizations

* Thales in [11] suggests that

*“Proposal 9 For TN / NTN mobility, the UE is assumed to have TN and NTN access capabilities not necessarily simultaneously. It may use different antenna types for TN and NTN (e.g. directional antenna for NTN)*

*Proposal 10 For TN / NTN mobility, TN access may be configured by the operators as preferred access (to be selected whenever available). TN to NTN mobility (hand-out) can be triggered at least when TN is no longer available. NTN to TN mobility (hand-in) can be triggered when UE moves into an area with available TN coverage.”*

#### Discussion

The organizations are invited to discuss the following proposal:

**Proposal 2.8.1: For TN / NTN mobility, the UE is assumed to have TN and NTN access capabilities not necessarily simultaneously. It may use different antenna types for TN and NTN (e.g. directional antenna for NTN)**

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| **Organizations** | **View on the proposals above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree, but should be discussed with low priority. |
| Qualcomm | Agree. In fact, simultaneous TN and NTN access seems unlikely and of little use except when moving from TN to NTN or from NTN to TN. |
| Agree | Agree. There is no need to have such limit. |
| OPPO | TN/NTN mobility should be treated as low priority, as indicated in the WID. |
| BT | Disagree.  It is not clear to us the implications of “necessarily”. Assuming simultaneously is Dual Connectivity (DC), we consider RAN4 has the responsibility to decide if DC TN – NTN is considered in Rel-17.  There are scenarios like emergency services where TN – NTN DAPS may result beneficial. |
| CATT | In our understanding, this WID should focus on intra-NTN mobility, and TN/NTN mobility should be de-prioritized in this stage. |
| Sony | Agree |
| Nokia | OK, if the intention is to say: the UE is not required to simultaneously have TN and NTN access capability.  How the assumption made in the question corresponds to ‘omnidirectional antenna assumption’ for the UEs, made earlier in the document? |
| LG | Basically we agree, and we have one question to the proposal 2.3.1 – Does “It may use different antenna types for TN and NTN (e.g. directional antenna for NTN)) mean TN and NTN are deployed in different frequencies? In other words, is there a possibility that TN and NTN cells are deployed in same frequency? It is important to clarify. |
| Vodafone | One of the main network criteria is the mobility between the Terrestrial and Non-Terrestrial Networks and this is a key operational issue as discussed before: Hand-out to NTN and Hand-in to TN is a crucial piece of the overall solution. We do not envisage a simultaneous connection to NTN and TN networks, but the UE, for handover, needs to have different antennas to connect to TN and NTN. |

**Proposal 2.8.2: For TN / NTN mobility, TN access may be configured by the operators as preferred access (to be selected whenever available). TN to NTN mobility (hand-out) can be triggered at least when TN is no longer available. NTN to TN mobility (hand-in) can be triggered when UE moves into an area with available TN coverage.”**

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| **Organizations** | **View on the proposals above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree, but should be discussed with low priority. |
| Qualcomm | From network perspective, this should be possible configuration. But as specified in WID, we also would prefer to wait further progress on NTN handover to discuss TN/NTN mobility. |
| Lenovo | Agree with MediaTek. |
| OPPO | TN/NTN mobility should be treated as low priority, as indicated in the WID. |
| BT | Agree.  We consider this flexibility is key to design the network in RRC\_IDLE and RRC\_CONNECTED mode. |
| CATT | Same comment as in Proposal 2.8.1. |
| Sony | Agree with changes. The triggers for NTN to TN service continuity should be considered e.g. not based (or only based) on UE measurement. |
| Nokia | Agree with QC. We do not need to agree it explicitly. Does it bring anything new? Can be progressed after NTN HO is worked out. |
| LG | We agree with the proposal, but same opinion with MediaTek that intra-NTN mobility should be discussed first. |
| Voafone | Mobility between the TN and NTN is one of the key operational issue.  Operators see this as coverage enhancement and as extension of their networks and if the handover/cell selection etc is not dealt with the entire solution will be useless.  I strongly suggest we keep Mobility in the top features and pay attention on the ease of mobility and remove latencies |

## HAPS

#### Views of organizations

* Ericsson in [9] suggests that

“Proposal 3 Clarify that the HAPS objective is about using HAPS as IMT base stations, i.e., HIBS.”

#### Discussion

The current WI objective is to address HAPS with transparent payload. Hence it may refer to HIBS with IMT base stations on the ground.

**Proposal 2.9.1: Clarify that the HAPS objective is about using HAPS as IMT base stations, i.e., HIBS..**

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| **Organizations** | **View on the proposal above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree |
| Qualcomm | Agree |
| Lenovo | Agree |
| OPPO | Agree |
| BT | Agree |
| CATT | Agree. |
| Sony | Agree |
| Nokia | Scope clarification is needed. The transparent HAPS is quite clear that it assumes the IMT BS is on the ground and the HAPS is a relay (same as for satellites, right?) |
| LG | Agree |
| Vodafone | Agree |

## LEO versus GEO

#### Views of organizations

* Ericsson in [9] suggests that

*“Proposal 1 Rel-17 NR NTN WI to prioritize discussing solutions for LEO NTNs.”*

#### Discussion

RAN#86 agreed that GEO and LEO based scenarios are on the same priority. It is not appropriate to re-open this debate in RAN2.

## RACH enhancements

#### Views of organizations

* NEC in [8] and [12] suggests that

*“Proposal 1: RAN2 to solve the problem of the limited amount of ROs and RACH capacity due to resolving preamble ambiguity*

*Proposal 2: RAN2 to support separated RACH resources depending on whether pre-compensation is achieved for UL or not.*

*Proposal 2: RAN2 to support separated RACH resources depending on whether pre-compensation is achieved at UE side for UL or not.*

*Proposal 3: RAN2 to discuss other possible options to solve the issue of limited RACH capacity.”*

#### Discussion

The RACH enhancement should be discussed in RAN1 and in RAN2 as part of the sub agenda item on user plane/MAC aspects.

## Impact of propagation delay

#### Views of organizations

* Samsung in [3] suggests that

*“Observation 2. Due to long propagation delays in an NTN, RAN2 has decided to add timing offsets for time-based parameters and extend the ranges of selected non-timer parameters.*

*Proposal 2. Since timers are affected by the RTT, a common increase to multiple timers at various layers (e.g., MAC, RLC, and PDCP) may be more efficient from a signaling perspective. “*

as well as *“Observation 3. The QoS requirements of standardized 5QIs cannot be met for certain NTN Types.*

*Proposal 3. Send LS to SA2 because adjustments to the R16 QoS framework are needed to enable an NTN to meet the target QoS.”*

#### Discussion

The timing offset enhancement should be discussed as part of RAN1 and in RAN2 under the sub agenda item on user plane aspects.

The 5QI enhancement should be discussed as part of the sub agenda item on user plane/Other aspects.

## RRC inactive state

#### Views of organizations

* CATT in [1] considers that this (RRC inactive) state might be beneficial and therefore suggest to ask RAN3 their views about it in the context of NTN.

*“Proposal 3: Send LS to RAN3 to check whether RRC\_IANCTIVE state should be supported for Rel-17 NTN UE.”*

#### Discussion

This subject should be addressed as part of the agenda item control plane/idle mode.

## Bandwidth part

#### Views of organizations

* CATT in [1] suggests that

*“Proposal 1: Multiple carriers and Multiple BWPs are not considered in Rel-17 NTN.”*

#### Discussion

This topics should be addressed in RAN1 under the Other agenda item.

[CATT]：It is related to scenarios, we had better made it clear and we are not sure whether RAN1 will discuss this issue, do we need to send LS to RAN1 to check their view?

## RNTI enhancements

#### Views of organizations

* Samsung in [3] suggests that

*“Observation 4. When a large NTN cell supports smartphones and a massive number of IoT devices, the existing 16-bit RNTI may be inadequate.*

*Proposal 4. Support a larger-size RNTI.”*

#### Discussion

This issue of RNTI enhancement impact should be discussed as part of the sub agenda item on control plane/idle mode aspects.

## Supplementary uplink (SUL)

#### Views of organizations

* CATT in [1] suggests that

*“Proposal 2: SUL is not supported in Rel-17 NTN.”*

#### Discussion

This topic has not been raised during the study phase, so it should be assumed that it will not be addressed in Rel-17 NR\_NTN\_solutions WI.

## Propagation channel model aspects

#### Views of organizations

* Nokia in [6] suggests that

*“Proposal 1: RAN2 to select channel models to facilitate evaluation of mobility aspect in NTN scenarios*

*Observation 1: The reference multiple satellite scenario to be used in RAN2 mobility studies can be defined as one satellite orbit, with 2 or 3 consecutive satellites only, with a certain inter-satellite distance, each satellite having a certain beam layout, beam size and frequency re-use pattern.*

*Proposal 2: RAN2 to discuss a LOS probability model with time correlation for mobility evaluation. If needed, consult other RAN WGs.*

*Observation 3: A reference cell-switch functionality needs to be defined and evaluated for earth-fixed cells scenarios.*

*Proposal 3: RAN2 to discuss how the shadow fading and fast fading channel model parameters can be gradually changed as a function of satellite elevation angle.”*

#### Discussion

It is expected that channel model is a topic to be addressed in RAN1 instead of RAN2. Nokia is invited:

* To further clarify the rational to define a specific model for mobility between satellites (Nokia’s Proposal 1 & 2).
* To further explain why the shadow fading and fast fading channel model parameters defined in TR 38.811 do not depend on the satellite elevation angle (Nokia’s Proposal 3)

# NR\_NTN\_solutions WI work plan and prioritisation

## Work plan

#### Views of organizations

* Thales in [10] provided a draft work plan for the NR\_NTN\_solutions WI applicable to RAN1, 2 and 3

#### Discussion

Based on the above, the organizations are invited to discuss the following proposal:

**Proposal 3.1.1: The work plan described in [10] be considered as basis for work**

## Task prioritisations

#### Views of organizations

* Huawei in [4] suggests that the RAN2 topics be prioritized as follow

*“1st priority for fundamental design*

* *Common part:*
* *MAC (RACH, DRX, Scheduling Request)*
* *RLC (t-Reassembly, Sequence Numbers extension for GEO (if needed))*
* *PDCP (SDU discard timer, Sequence Numbers extension for GEO (if needed))*
* *NTN specific information in SIB*
* *ephemeris data related enhancements*
* *Feeder link switch*
* *Location based PLMN selection*
* *Only for moving beam case:*
* *how to handle frequent cell reselection*
* *Handover enhancement for moving beam case*
* *Fixed tracking area*
* *Only for earth fixed beam case:*
* *How to handle Varying RTT in both UP and CP*

*2nd priority for optimization:*

* *MAC (Enhancement on UL scheduling, HARQ)*
* *SMTC measurement gap adaptation*
* *Service continuity for mobility from TN to NTN and from NTN to TN systems*

*3rd priority for other scenarios and services:*

* *Identify potential issues associated to the use of the existing Location Services (LCS) application protocols*
* *Verify the applicability of existing Rel-16 ANR techniques to solve PCI confusion in order to support co-channel operation between HAPS & terrestrial networks*
* *HAPS/ATG enhancements”*
* CMCC in [6] suggests that the RAN2 topics be prioritized as follow

*”First priority:*

* *RACH, HARQ, DRX, SR, UL scheduling*
* *RLC*
* *PDCP*
* *UE location, ephemeris data related enhancements*
* *Specific information in SIB*
* *Cell selection/reselection, HO for LEO*
* *Absolute propagation delay difference between satellites for GEO*

*Second priority*

* *Service continuity for mobility from TN to NTN and from NTN to TN systems*
* *HAPS / ATG enhancements*
* *Identify potential issues associated to the use of the existing Location Services (LCS) application protocols”*

Furthermore, CMCC clarified the challenges associated to the support of ATG (Extreme large ISD & coverage range, Interference between ATG & terrestrial, Powerful ATG terminal) and consequently the potential standardization impacts (RACH procedure enhancement, Mobility management, Interference between ATG & terrestrial)

* Ericsson in [9] suggests that

*“Proposal 5: As the objective on HAPS is of secondary priority, its discussion can be deferred until sufficient progress has been made for the first-priority objectives.”*

* CATT in [1] suggests that

*“Proposal 6: Service continuity within the NTN system should be prioritized in Rel-17 NTN. Only when there is remaining time, service continuity between NTN and TN can be addressed.*

*Proposal 7: From RAN2 perspective, intra-satellite HO and inter-satellite intra-gateway HO can be studied first, and inter-gateway HO can be pending for RAN3 solution.”*

#### Discussion

Based on the above, the organizations are invited to discuss the following proposal:

**Proposal 3.2.1: The work plan should be based on the following prioritization principles:**

* **1st priority: User plane, idle mode aspects**
* **2nd priority: Connected mode aspects, Network based UE Location**
* **3rd priority: NTN-TN Service continuity**
* **4th priority: HAPS/ATG enhancements**

|  |  |
| --- | --- |
| **Organizations** | **View on the proposals above: Agree, Agree with changes, disagree and justify** |
| MediaTek | Agree |
| Qualcomm | As mentioned in WID, we agree HAPS enhancement can be lower priority and NTN/TN service continuity can be addressed once we have good progress in connected mode mobility.  However, connected mode mobility and UE positioning mechanism (including UE based solution) as early as possible in the RRC connection are also important so it can be part of 1st priority. |
| Lenovo | Connected mode aspects should be 1st priority as well. |
| OPPO | We think connected mode control-plane aspects should also be studied as 1st priority. |
| BT | Disagree:  Our first priority is to design an operational system. Following that reasoning, we propose:   * **1st priority: Control and user plane, idle and connected mode aspects;** * **2rd priority: NTN-TN Service continuity;** * **3nd priority: Network based UE Location;** * **4th priority: HAPS/ATG enhancements.** |
| CATT | 1st and 2nd priority should be treated equally, not deprioritize the connected mode aspects. Because they both need to be solved in order to make the NTN can work. |
| Sony | We think NTN-TN service continuity is of the same priority as the 2nd priority listed above. |
| Nokia | 1st priority should be user plane, idle mode, control plane (why was CP deprioritized)?  NW-based UE location should be deprioritized.  Is 3rd priority within RAN2 scope entirely? |
| Vodafone | Agree,  Also, as one of the 1st priority we need to also look at the Signaling / control plane aspect of the idle as well as connected scenarios |

# Conclusion

To be completed based on the outcome of the email discussion.

# Reference

[1] R2-2006630 Further Clarifications on the NTN WID CATT

[2] R2-2006699 NR-NTN: Positioning Methods Fraunhofer IIS, Fraunhofer HHI

[3] R2-2006941 NTN WI- Overall Observations and Proposals SAMSUNG

[4] R2-2007143 Discussion on task prioritization for NR NTN Huawei, HiSilicon

[5] R2-2007185 Location Services in NTN Sony

[6] R2-2007363 On the scenarios and simulation assumptions for evaluating NTN mobility Nokia, Nokia Shanghai Bell

[7] R2-2007431 Discussion on NTN workplan CMCC

[8] R2-2007519 Impact of pre-compensation on RACH capacity for NTN NEC Telecom MODUS Ltd.

[9] R2-2007537 NTN scope, scenarios, architecture, and requirements Ericsson

[10] R2-2007565 NR\_NTN\_solutions work plan THALES

[11] R2-2007572 NR NTN Reference scenarios definition for Rel-17 normative phase THALES

[12] R2-2007712 Impact of pre-compensation on RACH capacity for NTN NEC Telecom MODUS Ltd.

[13] S3i200056 Response LS on the “LS OUT on Location of UEs and associated key issues” SA3-LI

[14] 3GPP TR 23.737 “Study on architecture aspects for using satellite access in 5G”

***END***