3GPP TSG-RAN WG2 Meeting #113 R2-20xxxxx

Elbonia, Online, 25 January – 5 February 2021

**Agenda item: 8.10.x**

**Source: Nokia, Nokia Shanghai Bell**

**Title: Report from [Post112-e][153][NTN] Idle mode aspects (Nokia)**

**WID/SID: NR\_NTN\_solutions-Core - Release 17**

**Document for: Discussion and Decision**

# 1 Brief scope of the paper

This document aims at collecting companies’ views regarding the Rel-17 NTN Idle mode:

* [Post112-e][153][NTN] Idle mode aspects (Nokia)

 Scope: Discuss: 1) options for "NTN indication" 2) provision of ephemeris and 3) cell (re)selection principles, trying to resolve the FFS from the meeting agreement

 Intended outcome: email discussion report

 Deadline: Long

The following sections discuss those listed topics, based on RAN2 contributions submitted so far.

# 2 Agreements related to NTN Idle mode

A good starting point would be to list the Rel-17 NTN Idle mode related agreements taken so far in RAN2. These are provided in the box below:

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| **RAN2#111:**1. Cell selection / reselection in NR is the baseline in NTN idle mode procedure.2. Satellite/HAPS ephemeris based cell selection and reselection should be defined for NTN (FFS what the term satellite/HAPS ephemeris actually means). FFS when this ephemeris based cell selection / reselection can be used. FFS whether UE location (and/or other information) based cell selection and reselection should be introduced for NTN3. The satellite ephemeris should be provided to UE, at least for Satellite/HAPS ephemeris based cell selection and reselection (FFS what the term satellite/HAPS ephemeris actually means).4. The network type (i.e. TN or NTN) should be known to UE. FFS whether to achieve this in an implicit or explicit way.5. The existing cell reselection priority configuration can be taken as a baseline in NTN. FFS on any further enhancement.6. Postpone the discussion on whether to introduce a new SIB until we have more progress on the content of NTN specific system information. |

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| **RAN2#112:**1. Existing cell reselection principles are considered as baseline and that information about when a cell is going to stop serving the area and information about new upcoming cell can be further considered. In which form and how this is exactly implemented in the cell reselection principles is FFS. |

The rapporteur believes this is a complete list of IDLE mode related agreements taken so far in Rel-17 NTN work. However, please indicate if something has been forgotten.

# 3 NTN indication

First topic to handle in this e-mail thread is whether there is a need to indicate explicitly the network is terrestrial or non-terrestrial. As quoted above in the agreement box, the network type (TN or NTN) should be known to the UE. However, it remains to be seen whether such indication is made in explicit or implicit way. Both approaches had their supporters and fair motivation behind. For instance, [1] states that TN and NTN will anyway likely use separate PLMN IDs (and this option is actually preferred in TR 38.821), so another (explicit) way of differentiating is not needed. In addition, [1] provides another way how this distinction could be done, claiming the NTN cell will likely broadcast NTN-specific system information, while such SI will be absent in the TN cell. In [2] another implicit way of indicating whether the cell is TN or NTN is provided, namely different scrambling of MIB. While this may be a workable solution, the rapporteur thinks it shall be perhaps discussed and decided by RAN WG1. The implicit way of indicating the NW type is also suggested in [3]. One the other hand, a different approach is favoured in [4], where the authors claim the existence of NTN SIB alone may not be sufficient, as TN cells may provide also the neighbour’s SIBs (such as NTN SIB).

Even thought similar questions have been already asked in the past, RAN2 should eventually decide on the type of this indication.

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| **Question 1: How should the UE be made aware of the network type (TN versus NTN)? In implicit or explicit way?** |
| **Company** | **Implicit/Explicit** | **Details of how to implement your favoured approach and why the other approach is not viable** |
| APT | Implicit | Implicit by separate PLMN IDs.If a UE temps to camp on an NTN cell, reading system information in an NTN cell, e.g., PLMN or NTN SIB, shall be sufficient.* Separate PLMN ID: it was agreed that a separate PLAN is beneficial, e.g., [R2- 1914070] Observation 1: All the companies are in favor to have separate PLMN for the NTN cells from TN cells, but is an implementation choice. Separate PLMN is likely needed.
* New NTN SIB: no clear evidence to show NTN SIB is essential, however [R2-2009774] pointed out single satellite’s ephemeris can consume 56 bytes while the NR System Information Block size is constrained to 372 bytes. In this case, NTN SIB is likely needed.
* New MIB: no discussion in RAN1 so far. We prefer not to introduce it for the minimum specs impact.

**However, if NW needs to prevent non-NTN capability UEs from camping an NTN cell**, e.g., prevent non-registers from camping or prevent Rel-15/Rel-16 UEs from ignoring NTN SIBs or other NTN information, then a separate PLMN would be the way to go.  |
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A somewhat related topic concerns another indication type – the specific NTN scenario (such as GEO, LEO, HAPS, etc.). It has been argued that also the specific LEO/GEO/HAPS scenario could be inferred from some typical values of the configuration parameters [1][2], so there is no need to signal such information separately. [5] proposes that satellite type (GEO vs. non-GEO) is determined implicitly, based on ephemeris data representation. On the other hand, [4] claims such NTN scenario type (e.g. LEO or GEO) is indicated along with the network type (TN or NTN).

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| **Question 2: Do you see the need to signal explicitly the NTN scenario information (e.g. LEO/GEO)? Please motivate your answer.** |
| **Company** | **Yes/No** | **Motivation** |
| APT | No | If UE temps to camp an NTN cell, ephemeris data for the target satellite would be needed for sending a PRACH preamble.  |
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If implicit way of indicating the NTN scenario is preferred, please provide the details how this shall be done. In the papers submitted to RAN2-112 various approaches have been presented (see e.g. [1][2][5]).

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| **Question 3: How to provide the NTN scenario indication using implicit means?** |
| **Company** | **Answer** |
| APT | Implied from the common parameters provided in SIB, e.g., ephemeris data. |
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# 4 Ephemeris

Another important topic that shall be addressed in RAN2 during NTN Rel-17 WI is how to provide the UEs with satellite ephemeris information and what is should contain. As argued in [1] the satellite ephemeris could have an excessive size, quickly overloading the capacity offered by System Information Block (SIB) in NR. Before deciding how to deliver the satellite ephemeris to the UE, it shall be discussed how the ephemeris is actually represented. Two main approaches have been identified and captured during the NTN SI in Rel-16:

* Orbital parameters (including orbital and satellite related parameters)
* Satellite coordinates, e.g. ECEF coordinates to represent satellite’s position (x, y, z), time, velocity, etc.

As usual, both options have pros and cons. The orbital parameters are better in terms of their size and signalling overhead, while the ECEF representation may provide increased accuracy, but at the expense of the need to update them frequently [6].

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| **Question 4: How should the ephemeris be represented (e.g. PVT coordinates or orbital plane parameters)?** |
| **Company** | **Answer** |
| APT | PVT (ECEF representation) to support HAPS/HIBS.Only instant orbital state vector format has the ability for implicit compatibility to support HAPS/HIBS and ATG scenarios since the orbit concept is meaningless in HAPS/HIBS and ATG scenarios.As a price, enhancement on signaling overhead can be FFS, e.g., update more frequently on satellite’s position (x, y, z) and time, but update less frequently on satellite’s velocity. Also, enhancement on RRM can be FFS, e.g., orbital parameters can be pre-stored in u-sim as assistant information to predict long-term satellites’ positions. |
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After selecting how to represent the NTN ephemeris, it is worth checking the details, i.e. what it shall actually contain, (e.g. what parameters and how many bits those would consume, etc.). Please share your view to the following question.

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| **Question 5: What information and parameters should be conveyed in the NTN ephemeris? Please indicate on the content, bit consumption and the required periodicity of broadcasting such information.** |
| **Company** | **Answer** |
| APT | Satellite position and velocity.Based on [R1-2008809] given sufficient accuracy on UL time and frequency pre-compensation, e.g., error ranges for satellite position and velocity are ∆U < ±120m and $∆V<\pm 1.5 m/sec$* Parameters: Satellite position {X, Y, Z} and satellite velocity {Xvel, Yvel, Zvel}
* Bit consumption: 18 Bytes (144 bits)
* Required periodicity: 1 second.

[R1-2008809] Assuming serving satellite ephemeris is broadcast every second. The payload on NTN SIB to indicate serving satellite cell position and velocity is (84+60)/8 = 18 Bytes

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| Information | Range | Resolution | #bits |
| Satellite Location | ±43000 km | 0.33m  | 3\*28=84  |
| Satellite Velocity | ±8 km/s | 0.015 m/s  | 3\*20=60  |

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In [7] it is argued there is a need to provide the UE with the ephemeris for both the camped/serving cell and the neighbours. As per [7] the ephemeris for the neighbours is necessary for the UE to re-adjust the pointing direction towards the neighbouring satellite before performing inter-satellite HO or inter-satellite cell reselection. The camped/serving cell’s ephemeris is claimed to be necessary for maintaining the UL timing and frequency synchronization [7]. It also seems to be important to know whether the cell belongs to the same satellite, in order to avoid potential signalling overhead. Do companies see a need to have a split and provide camped/serving cell’s and neighbour’s ephemeris plus the information on any other association of the cell?

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| **Question 6: Should the ephemeris be divided into camped normally cell’s and neighbour’s part? Is the information on any other association of the cell needed? Please motivate your answer.** |
| **Company** | **Yes/No** | **Motivation** |
| APT | No | Yes, the ephemeris for the target cell is necessary.No, the association of a neighboring cell is not necessary. It can be associated with RA configuration.For random-access (RA), UE needs valid/updated ephemeris data to calculate UL timing and frequency for PRACH preambles. If ephemeris data is only used for RA, then it may only be associated with RA configuration. |
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Besides the format and split of ephemeris, it needs to be discussed and decided how this information is provided to the UE. As argued in [1], the size of ephemeris can be extensive, if orbital plane parameters and satellite parameters are signalled, these can consume 56 bytes for a single satellite (including its orbital related parameters), while the allowable size of NR SIB is 372 bytes. It can be easily noticed the entire SIB’s capacity can be exhausted by the ephemeris for just several satellites. Thus, e.g. [7] discusses other means to provide the UE with the ephemeris, such as storing constellation ephemeris in the uSIM or in the UE. This is expected to work if the network is able to send periodical updates to such static ephemeris, kept at the UE. As a reference, in case of GPS, the almanac is updated every 12.5 minutes while the ephemeris can be updated within 30 s. Companies are asked to provide their views in this area.

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| **Question 7: How should the ephemeris be provided to the UE (e.g. pre-provisioning via uSIM, SIB, and other aspects like how to divide into a static and dynamic part, if necessary)?** |
| **Company** | **Answer** |
| APT | New NTN SIBs to support the PVT (ECEF representation). |
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# 5 Cell reselection

As stated in section 2, the NR cell reselection framework, including the existing cell reselection priority configuration, is taken as a baseline for NTN. However, at RAN2#112 further decisions have been made: the information concerning when a cell is going to stop serving the area and information about new upcoming cell can be further considered. However, the exact form and its use in cell reselection process is FFS. Here we attempt to discuss more details of this information, also considering that this has been already partially done in [8] and in the e-mail discussion preceding RAN2#112.

In [8] there were different views expressed how this additional information can be expressed:

* A list of neighbour cells, provided in the system information
* Ephemeris and resulting calculations done by the UE (i.e. no additional separate information provided/broadcasted)
* Separate broadcasting of time left in the camped/serving cell or time until a new cell becomes available

If any other means were considered and are missing in the list above, please indicate in the table below, for Question 8. Companies are kindly asked to first answer if this additional information on ’when a cell is going to stop serving the area and information about new upcoming cell’ should be a mandatory part of the cell reselection for NTN. Current agreement states this information ‘can be further considered’, which does not seem to be binding in any way.

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| **Question 8: Should the additional information on when a cell is going to stop serving the area and information about new upcoming cell become a mandatory part of the cell reselection in NR? Please motivate the answer, especially if you think legacy reselection is not sufficient (please state why).**  |
| **Company** | **Yes/No** | **Motivation** |
| APT | No | The dwell time is good to have, but not essential to us. |
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In case you have answered ‘Yes’ to Question 8 (or have other insights in this area), please provide further details in what form is this information provided and how it is employed in the NTN cell reselection procedure. Please describe how the potential solution differs between Earth-moving and Earth-fixed scenario.

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| **Question 9: In what form and how is this additional information employed in NTN’s cell reselection process? Please underline the differences between Earth-moving and Earth-fixed scenario.** |
| **Company** | **Answer** |
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Somewhat different aspect, still related to cell reselection in NTN, was discussed in [1], namely the number of reselection priorities. It was observed that up to 40 different priorities can be provided, thanks to the existence of up to 8 different values of *cellReselectionPriority* and up to 5 different values of *cellReselectionSubPriority*. Companies are invited to comment whether such reselection means are sufficient.

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| **Question 10: Is the existing NR cell reselection prioritization, in terms of the number of different priorities that maybe configured, sufficient for NTN?**  |
| **Company** | **Yes/No** | **Motivation** |
| APT | Yes | The reselection means based on RSRP/RSRQ measurement shall be the baseline. |
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# 6 Conclusions

Based on the views expressed in the previous sections, we propose the following:

# 7 List of referenced documents

[1] R2-2009774 *IDLE mode aspects for Non-Terrestrial Networks (NTN)*  Nokia, Nokia Shanghai Bell, 3GPP TSG-RAN WG2 Meeting #112 Electronic Elbonia, 2 – 13 November 2020

[2] R2-2009454 *Cell selection and reselection enhancements* Qualcomm Incorporated, 3GPP TSG-RAN WG2 Meeting #112 Electronic Elbonia, 2 – 13 November 2020

[3] R2-2009597 *Control Plane for Idle mode UE*  Xiaomi, 3GPP TSG-RAN WG2 Meeting #112 Electronic Elbonia, 2 – 13 November 2020

[4] R2-2010578 *Idle mode issues in NR NTN*  LG Electronics Inc, 3GPP TSG-RAN WG2 Meeting #112 Electronic Elbonia, 2 – 13 November 2020

[5] R2-2010453 *Satellite ephemeris in NTN*  InterDigital, 3GPP TSG-RAN WG2 Meeting #112 Electronic Elbonia, 2 – 13 November 2020

[6] R2-2008837 *Remaining Issues of IDLE and Inactive Mode for NTN* CATT, 3GPP TSG-RAN WG2 Meeting #112 Electronic Elbonia, 2 – 13 November 2020

[7] R2-2009255 *Idle mode procedures in NR NTN* Thales, 3GPP TSG-RAN WG2 Meeting #112 Electronic Elbonia, 2 – 13 November 2020

[8] R2-2010765 *[AT112-e][104][NTN] Misc CP issues (Ericsson)* Ericsson, 3GPP TSG-RAN WG2 Meeting #112 Electronic Elbonia, 2 – 13 November 2020

# Contact information

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