

3GPP TSG-RAN # 102
Edinburgh UK, December 11-15
Agenda Item: 9.1.2.3

RP-233296

EchoStar/Hughes

Priorities for Rel-19 NTN-NR Evolution

ECHOSTAR[®]

Motivation for Rel-19 NTN Evolution

Release 17 - **introduced basic NTN functionality**, focusing on the transparent satellite payload scenario and necessary adaptations to NR to work in a non-terrestrial environment.

Release 18 - **refined the initial NTN release** by improving service continuity between terrestrial and non-terrestrial networks, supporting commercial smartphones and >10GHz deployments.

Release 19 - will increase diversity of supported device types, QoS requirements, and improve network architectures to facilitate deployment and integration of NTN into existing networks.

NTN-NR Rel-19 Priorities

Features	RAN WG
<ol style="list-style-type: none">1. Downlink Coverage Enhancement2. Robust Notification Alert3. Uplink Capacity Enhancement4. Broadcast (cell-broadcast) over NTN5. Other important features	RAN 1,2,3 -led
<ol style="list-style-type: none">6. <i>High Power UE (HPUS) for NTN-NR</i>7. <i>NR channel bandwidth less than 5 MHz</i>	<i>RAN 4 -led</i>

Downlink Coverage Enhancement | RAN 1,2,3

Rationale: Satellite networks (operating in FR1 or above 10 GHz, covering both GSO and NGSO constellations) are typically designed under the assumption of optimized power. The satellite payload may be unable to have all beams active with the « nominal » EIRP density per beam at a given time due to limited power and limited feeder link bandwidth.

Proposal: Downlink coverage enhancements are needed:

- To improve the link margin of selected physical channels to accommodate the EIRP reduction
- To optimize the number of beams that can be activated simultaneously and ensure all UE can be served across the satellite footprint while maximizing overall throughput and ensuring all cells are re-visited

DL coverage enhancements should be considered at both:

- Link level to improve the link margin of selected physical channels
- System level to support an efficient dynamic and flexible power sharing between beams across satellite footprint

Robust Notification Alert | RAN 1, 2,3

Rationale: For incoming calls, users may experience poor reception conditions and thus will miss calls and messages, which can be especially detrimental for public safety or emergency purpose paging messages. These scenarios can occur when UE is placed in pockets, backpacks, or in vehicles, boats, etc., or in conditions where there are clutter losses. In TR 38.811:

- Shadow fading and clutter loss for suburban and rural scenarios can be over 18 dB
- LOS probability showed that at 30 degrees elevation, about 10% of users in rural and 50% in urban scenarios will experience NLOS

Proposal: A robust notification alert feature will address the problem of missed paging messages to UE in low SNR conditions when normal paging fails. The objective is to mitigate additional losses compared to the link margin required in LOS conditions. The feature can also be used for public warning purposes – i.e., emergency broadcast targeting users in NLOS/low SNR.

- Identify the notification message requirement
- Identify and specify possible solutions for the support of a robust notification/alert message and its delivery (including paging procedure impact) over downlink physical channel(s)

Uplink Capacity Enhancement for NTN-NR | RAN 1, 2,3

Rationale: *UL coverage enhancements in Rel-18* include repetitions and DMRS bundling. The use of repetitions by itself has the effect of significantly reducing the system capacity and the individual user throughput. Repetitions also increase UE transmission time, driving higher utilization of UL resources in the time domain, before they can be released to other users. As a result, certain amount of UL capacity will be compromised.

Proposal: The need for uplink capacity and UE throughput enhancements. Specific refinements and their purpose include:

- Support increased system capacity without sacrificing per-UE throughput and coverage performance due to repetitions
- Recover per-UE uplink data rate for handheld UEs that may be lost to repetitions
- An uplink access scheme that can accommodate many UEs in a very wide satellite coverage footprint, with low delay and efficient resource usage

Cell Broadcast over NTN | RAN 1,2,3

Rationale: There is a UN initiative for Satellite Broadcasting for Emergency Alerts. Its's called Early Warning for ALL (EW4all) initiative.

<https://www.un.org/en/climatechange/early-warnings-for-all>.

It is anticipated that some countries will make it mandatory for satellite operators to do cell broadcast for emergency and public warnings.

Cell broadcast is already supported in Rel-17/18 via GSO. However, the provision of broadcast service over NTN needs to address:

- Potential mismatch between the targeted broadcast service area and the NTN radio cell coverage, given that NTN radio cells may be larger than TN radio cells and cross borders (GSO and NGSO)
- Mobility aspects between satellites (NGSO)

Proposal:

- Define enhancements to ensure matching targeted broadcast service area and the NTN radio cell coverage for GSO, given the large coverage
- Define enhancement to ensure service continuity for broadcast over a targeted area (assuming NGSO with quasi-Earth fixed radio cells)

Other important Rel-19 NTN-NR | RAN 1,2,3

Regenerative Payload

To support certain new features, a regenerative payload (5G system functions on board satellite) will be needed. The regenerative payload enhancement should consider support of gNB on board in TS 38.300 and TS 38.401 to define any necessary enhancements related to NG protocol and NG-RAN architecture. This features should support GSO and NGSO and for both with/without Inter Satellite Links are considered.

Enhanced GNSS Operation

Rel-17/18 NR-NTN assumes 100% GNSS service availability. However, the UE may not always receive GNSS which can cause the service availability to be degraded. Therefore, there is a need to increase the robustness of uplink time and frequency synchronization in NTN based access against any circumstances during GNSS temporarily degraded performance. This feature is needed to increase the service availability of user equipment in all 3GPP-based satellite networks covering all bands, orbits and terminal types.

HPUE for NTN-NR | RAN4

Rationale: Larger propagation distance and corresponding higher path loss for direct satellite access creates challenges for UL coverage performance, when UE connect to a SAN in FR1. In Rel-17, PC3 (+23 dBm) handheld UE for satellite access has been standardized as a baseline. However, the required UL performance with the limited link budget for satellite access scenarios can't be guaranteed (e.g., for some public safety and automotive scenarios). Current NTN UE is assumed to have -5.5 dB antenna gain, hence the need for higher TX powers to compensate for these losses for many NR NTN use cases.

Per decision in the RAN#99 plenary, HPUE for NR NTN FDD FR1 band(s) could not be addressed in Rel-18 but can be considered in Rel-19.

Proposal: For Rel-19, support FR1 high power UE for satellite access to improve UL coverage, availability and throughput performance, to meet the market demands associated with fixed wireless, public safety and automotive usage. The objectives are as follows:

- NTN FR1 bands n256, n255, n254 and upcoming Extended L-band for consideration to support PC2 (+26 dBm).
- Same bands as above for consideration to support PC1.5 (+29 dBm) and PC1 (+31 dBm) UE -- not targeted for smartphone.

NR Channel BW less than 5 MHz | RAN4

Rationale: This feature is currently defined for terrestrial networks to address cases where there are spectrum constraints. Satellite deployments in L-Band and S-Band face the same constraints and would benefit from the work done in the Rel-18 WID « NR support for dedicated spectrum less than 5 MHz for FR1>>. The NTN extension should support the 3 MHz NR bandwidth as agreed in the Rel-18 TN WID.

- Facilitate deployment of NR NTN within the existing non-3GPP satellite services
- Lower bandwidth for NR will enable better use of spectrum resource by allowing higher frequency re-use between beams, increasing capacity
- Enable deployment of both NR and standalone NB-IoT/eMTC carriers in the same 5 MHz Bandwidth to enable parallel support of both eMBB and IoT services
- Smaller channel BW helps with link budget
- Allows for optimizing capacity vs demand in each spot beam

Proposal:

- Specify support for channel bandwidth less than 5 MHz for NR NTN FR1 bands
- Specify any additional RF requirements for supporting 3 MHz channel bandwidth in NTN FR1 bands

NR Channel BW less than 5 MHz | RAN4

Rationale: This feature is currently defined for terrestrial networks to address cases where there are spectrum constraints. Satellite deployments in L-Band and S-Band face the same constraints and would benefit from the work done in the Rel-18 WID « NR support for dedicated spectrum less than 5 MHz for FR1>>. The NTN extension should support the 3 MHz NR bandwidth as agreed in the Rel-18 TN WID.

- Facilitate deployment of NR NTN within the existing non-3GPP satellite services
- Lower bandwidth for NR will enable better use of spectrum resource by allowing higher frequency re-use between beams, increasing capacity
- Enable deployment of both NR and standalone NB-IoT/eMTC carriers in the same 5 MHz Bandwidth to enable parallel support of both eMBB and IoT services
- Smaller channel BW helps with link budget
- Allows for optimizing capacity vs demand in each spot beam

Proposal:

- Specify support for channel bandwidth less than 5 MHz for NR NTN FR1 bands
- Specify any additional RF requirements for supporting 3 MHz channel bandwidth in NTN FR1 bands

Proposal for NTN-NR Rel-19 Priorities

TSG RAN to consider for RAN 1,2,3-led at least the following:

- Downlink Coverage Enhancement
- Robust Notification Alert
- Uplink Capacity Enhancement
- Broadcast (including cell-broadcast) over NTN

TSG RAN to consider for RAN 4-led at least the following:

- HPUE for NTN-NR
- NR channel bandwidth less than 5 MHz

Thank You!