3GPP TSG RAN Rel-18 workshop
Electronic Meeting, June 28 - July 2, 2021
Agenda Item: 4.2

RWS-210011

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On NR NTN Evolution

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NTN Rel-17 status

- On-track to provide support for target use cases
- General deployment scenario
  - Both LEO and GEO
  - Both FR1 and FR2
  - Both bent-pipe and regenerative
  - Both Earth fixed and moving beams
- Key Rel-17 design components
  - Key assumption: GPS-based frequency and time pre-compensation by the UE both in DL and UL
    - Initial access and connected mode time/frequency tracking only needs to target the range of residual errors
  - Mix of HARQ-based and HARQ-less modes
  - Add DL-UL time offset signaling
  - Up to 32-slot PUSCH repetition with time coherence within hops
  - Support satellite beam-based mobility with frequency reuse
  - Support frequent and possibly pre-scheduled handovers
  - Necessary higher layer changes

NTN Rel-18 objectives at high level

- Rel-18 NTN should narrow down deployment scenarios & use cases to maximize the commercial opportunities offered by this technology

- Prioritize use cases that can be uniquely delivered & economically served by NTN
  - First priority is text and voice (e.g. emergency communication anywhere on earth)
  - Second priority is eMBB data

- Proposal: focus only on direct access by smartphones
  - Accommodating smartphone form factor is a must
    - → no external antenna
    - Possibly reuse antennas or other components used for terrestrial bands
  - Co-existence with other, services provided by the same NTN system should be also considered (eg CPE)

- Proposal: prioritize features that maintain commonality with terrestrial in modem implementation
  - Essential to facilitate commercial uptake of 3GPP work
  - First priority: features not requiring changes to initial access, waveforms eg coverage enhancements and protocol simplifications to improve link budget

- Rel-18 Prioritized scenarios:
  - LEO
  - FR1
  - Both bent-pipe and regenerative

NTN Spectrum aspects

- Views on NTN operating bands
- NTN bands can be divided into two categories
  - **NTN Band Category 1:** Bands that fall inside existing frequency ranges
    - For example, L bands in FR1, those Ka bands that fall in FR2
  - **NTN Band Category 2:** Bands that fall outside of existing frequency ranges
    - For example, Ku band in between FR1 and FR2
- Proposal for NTN Band Category 1:
  - Continue to follow the existing procedure
    - Define an example band for RAN4 requirements (potentially one band in FR1 and one band in FR2)
    - Later on, add bands as needed, in a release-independent manner
  - **It is expected that NTN bands and Terrestrial bands are defined independent of each other, possibly in separate TS**
- Proposal for NTN Band Category 2:
  - As a short cut, may decide to apply FR1 or FR2 definitions for these bands (potentially different choice for different bands)
  - In case such step is taken for NTN bands:
    - **Such categorization should not redefine or extend the existing frequency ranges**
    - **Such categorization should not automatically apply to future terrestrial bands defined in this frequency region**

Summary of detailed NTN Rel-18 objectives

- Proposed for Rel-18

Proposal	What are the benefits?
Further coverage enhancements	Universal direct access to NTN
Protocol simplification	Increased link budget for voice
Pre-paging alert	Allows transitioning from insufficient link budget scenario to sufficient link budget scenario

- To be considered for future releases

Proposal	What are the benefits?
Asynchronous UL transmission	Signaling overhead reduction, UE power saving, improvement in system capacity
Operation without GNSS, NTN-enhanced/based positioning	NTN access where GNSS operation is not possible, enables positioning for UE without GNSS and out of terrestrial coverage, improved positioning accuracy, reduced time to GNSS fix
DL PAPR reduction	Improved PA efficiency and link budget
Air-to-ground communications	A reuse of the same building blocks to enable a different use case - seamless broadband passenger communication for commercial aviation verticals

Detailed Rel-18 objectives: Coverage enhancement for smartphone

- **Scenario description**
  - Although some of the enhancements introduced in Rel-17 coverage enhancements are applicable to NTN, there is still a coverage gap with respect to terrestrial networks in some cases
  - The study for coverage enhancement is not valid for NTN due to the difference in assumptions (channel model, number of antennas, etc.)
  - We should make sure that basic functionality is supported by a smartphone form factor for NTN in all scenarios. In particular, the following should be supported
    - Low-rate data (e.g. text / instant messaging)
    - Voice (consider non-HD voice for extreme coverage conditions)
- **Proposed enhancement**
  - Introduce NTN-specific enhancements to uplink physical channels / signals to meet the link budget requirements
    - Consider repetitions and diversity techniques for all channels
  - For UEs supporting more than one transmit antenna, introduce techniques to enable *full power transmission* in LOS channels with narrowband transmission
    - In this case, transparent CDD is not efficient
- **Benefits**
  - Access to services anywhere in the world with your smartphone

Detailed Rel-18 objectives: Coverage enhancement for smartphone - Motivation

- Uplink link budget analysis (smartphone form factor)

Orbit Alt. (km)	Sat Antenna Gain (dBi)	G/T (dB/K)	UE Power (dBm)	UE antenna gain (dBi)	Shadowing Margin (dB)	Polarization loss (dB)	Signal BW (kHz)	Channel Condition
1200 & 600	24	-4.9	23	-5	3	3 (1Tx ant)	180	Clear sky and LOS

Elevation Angle (Deg)	10	20	30	40	50	60	70	80	90
SNR (dB) @1200 km	-17.4	-15.3	-13.5	-12.1	-11.0	-10.1	-9.6	-9.2	-9.1
SNR (dB) @600 km	-13.2	-10.4	-8.2	-6.4	-5.1	-4.2	-3.6	-3.2	-3.1

Detailed Rel-18 objectives: Protocol simplification

- **Scenario description**
  - In coverage limited scenarios, the overhead introduced by different protocol layers is comparable to the data rate required for voice
  - For example, for a narrowband voice codec (AMR 4.75kbps), the protocol overhead is around 40%
  - Competing proprietary standards have very efficient support of voice (e.g. circuit-switched). NR should be competitive in this space
  - Packet aggregation would increase the delay significantly (40ms delay for each packet that is aggregated)

- **Proposed enhancement**
  - Introduce protocol simplifications, targeting overhead reduction for support of low-rate voice support

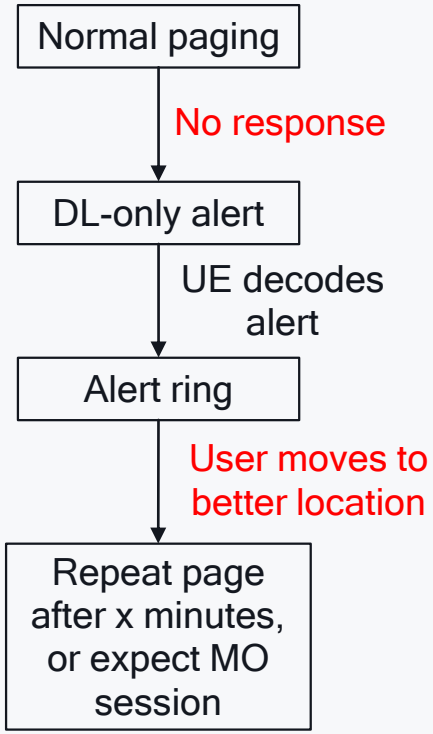
- **Benefits**
  - Increased link budget for voice

Summary of overhead
(one packet every 20 ms)

Layer	Overhead
MAC (2B)	0.8 kbps
RLC (1B)	0.4 kbps
PDCP (2B)	0.8 kbps
ROHC (3B)	1.2 kbps
Total	3.2 kbps

Detailed Rel-18 objectives: Pre-paging alert

- **Scenario description**
  - Even with Rel-17 coverage enhancements, the link budget, especially the UL link budget has thin margins
  - For MO calls/sessions, the user is expected to move into a preferred location and to attempt to minimize blockage
  - The above doesn't work for MT calls/sessions
  - → Paging will not go through if the smartphone is in a pocket or in backpack
- **Proposed enhancement**
  - Introduce a 'pre-paging' alert
  - Try to reuse Rel-17 power saving enhancement, if applicable
  - Needs sufficient repetition level
    - Although the paging failure is most likely due to insufficient UL link budget
    - Need to provide close to zero false alarm to avoid annoyance factor
- **Benefits**
  - Allows transitioning from insufficient link budget scenario to sufficient link budget scenario
  - Enable delivery of emergency paging



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