3GPP TSG RAN Rel-19 workshop
Taipei, June 15 - 16, 2023

RWS-230291

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Source: ZTE, Sanechips
Agenda: 5

Views on NTN in Rel-19

Overview

- In Rel-17, the basic architecture of NTN has been established to enable this “new direction” for both NR and IoT device with the following essential assumption:
  - ❖ Pre-compensation at UE side to simplify the implementation and spec efforts.
  - ❖ Transparent payload with flexibility to select the Reference point for DL and UL synchronization, which is used to match the different implementation, e.g., co-located gNB & gateway.
  - ❖ Either one or multiple beams per cell can be supported for NR and IoT according to the RAT, scenarios and implementation, etc.
- The initial trial for commercialization usage are also conducted based on the Rel-17 spec [1][2][3];

  [1] https://www.zte.com.cn/china/about/news/20220826C6.html
  [2] https://finance.sina.com.cn/tech/roll/2023-05-16/doc-imytyfac0093812.shtml
  [3] https://www.zte.com.cn/china/about/news/20230119c2.html;
- In Rel-18, additional enhancements are introduced for both NR- and IoT-NTN. However, the progress for certain topic is limited with the risk to be postponed, e.g., mobility enhancement, location verification.
- For Rel-19, the study and potential specified work for NTN should focus on the “essential issue”, which is critical for the deployment of NR-/IoT-NTN and improvement of performance to enable the service.

Essential aspects including performance improvement targeted for the real deployment should be the focus of NTN in Rel-19 instead of “fancy” scenario and functionality .

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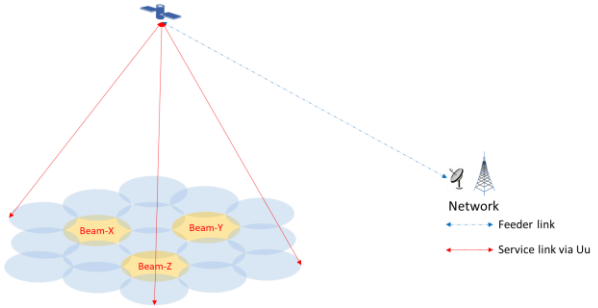
Technical aspect of NR-NTN

- Performance improvement to enable the commercialization of NR-NTN
  - ❖ DL enhancement with systematic analysis based on realistic assumption:
    - As highlighted in the RAN#99 meeting, the DL coverage of NTN system has been impacted by several factor, e.g., power sharing in case of multiple satellite beams and potential ITU regulation
      - ✓ For the power sharing among beam: The realistic assumption of Satellite EIRP density for each beam should be provided, which is determined by the maximum available payload and number of simultaneous beams.
      - ✓ For the PFD (power flux density): Although it may not be "world wide" and "deployment specific", clarification on the limitation are still needed due to the significant impacts on the performance.
    - **To support this feature:** Study phase to identify the bottleneck channel is needed, e.g., from the detection of SSB.



  - ❖ Notification/alert message
    - The intention of this procedure is to directly indicate the "assist information" to the "end user" regarding the "channel quality" or "required action" .
    - The comprehensive study on all potential cases should be considered:
      - Case-1: UE in idle/inactive
        - ➢ Sub-case 1: UE with detected synchronization signal only
        - ➢ Sub-case 2: UE with detection of SSB and failed DL reception of others
      - Case-2: UE with normal transmission in RRC connected state
    - **To support this feature**: Mechanism to enable the corresponding procedure should be defined.

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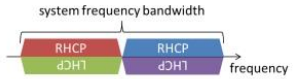
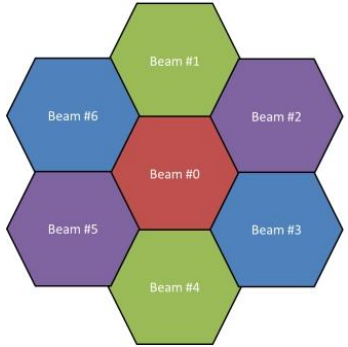
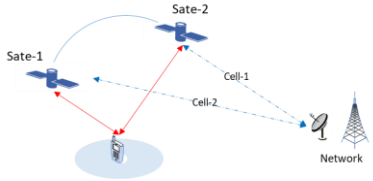
- Polarization indication
  - The mismatch of polarization, e.g., circular at satellite vs linear at UE or Left-Circular vs Right-Circular will lead to significant polarization loss for transmission/reception.
    - The frequency reuse factor, e.g., FRF = 4, is considered as typical way to mitigate the inter-beam interference.
    - In Rel-17, only the cell-level indication is supported in SIB-19:
      - ntn-PolarizationDL-r17 ENUMERATED {rhcp,lhcp,linear}
      - ntn-PolarizationUL-r17 ENUMERATED {rhcp,lhcp,linear}
  - **<u>To support this feature:</u>** The beam level indication of polarization information is needed.



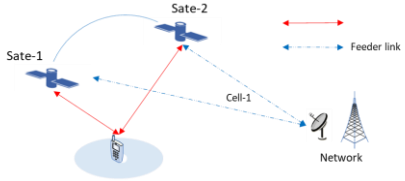


Frequency reuse factor = 4

- Joint transmission from multiple Sates
  - In the Rel-17/18, only the single satellite based transmission is supported by assuming the sparse satellite constellation.
    - Mobility to improve the NTN-NTN handover, e.g., due to the switching of satellite has also been conducted extensively.
  - Considering the LoS condition between satellite-UE, enabling of joint transmission between different satellite will lead to significant performance improvement and following two typical cases can be considered:
    - Case-1: Joint transmission from different cells
    - Case-2: Joint transmission from same cell
  - **<u>To support this feature:</u>**
    - Synchronization mechanism should be considered;
    - Optimization on the scheduling, e.g., based on CA/DC or multiple-TRP



Case-1: Joint transmission for different cells
(Connected to same gateway is prioritized)



Case-2: Joint transmission from same cell
with **same** or **different** CC

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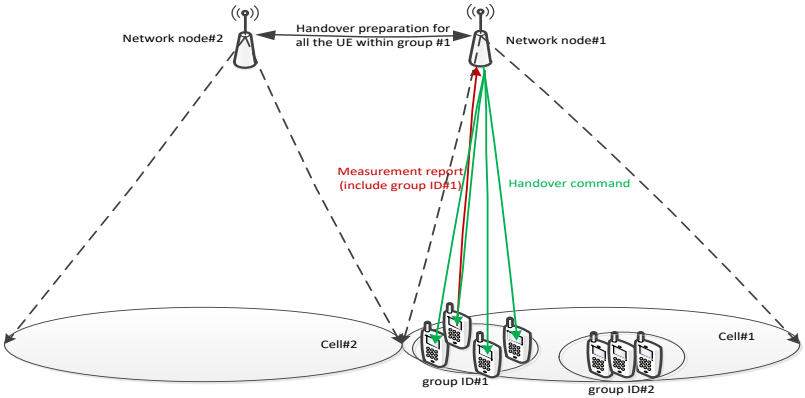
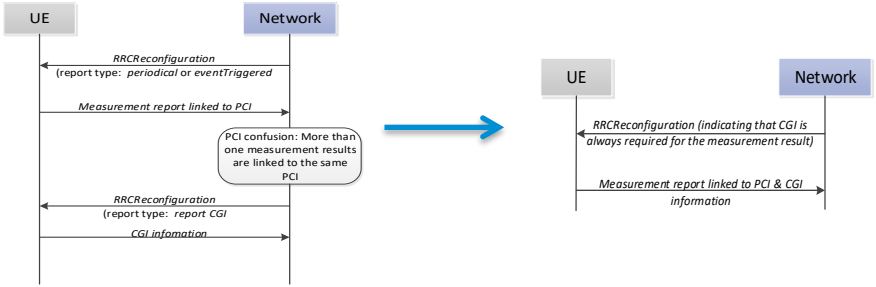
- Reduce signalling overhead in NTN-NTN mobility
  - ❖ HO command based on configuration index
    - Define and provide a list of default configuration to UE and each configuration is associated with a index
    - The index associated with certain default configuration will be provided in HO command.
  - ❖ Group based measurement report and mobility
    - NW categorize multiple UEs into one group and assign group id.
    - Measurement report can be sent from one UE to trigger HO of all the UEs in the same group.
- Address PCI confusion in NTN-TN mobility
  - ❖ CGI always included in the measurement results for NTN cells to avoid PCI confusion.



Group based measurement report and mobility



Address PCI confusion in NTN-TN mobility

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- Cell reselection enhancements
  - ❖ Time and location based cell reselection enhancements
    - o Distance based cell reselection
      - Introduce a distance threshold to help down scope the candidate cells for reselection.
    - o Timing based cell reselection
      - Prioritize neighbour cells with longer valid time, e.g. longer than a threshold.
  - ❖ Prioritize TN over NTN or vice versa
    - o Indicate neighbour cell type (TN or NTN) to UE, e.g.per frequency indication + NTN cell list.
    - o Introduce reselection priority offset/cell speficific offset to prioritize all the frequencies/cells for a certain NW type.
  - ❖ Autonomous search for TN/NTN cells when camping on a NTN/TN cell
    - o An indication is provided from the camped NTN/TN cell to UE to enable autonomous search for TN/NTN cell.
    - o A proximity indication can be sent to the network to indicate that the UE is entering or leaving the proximity of one or more TN/NTN cells which are detected based on autonomous search function.
- **<u>Views on other aspects:</u>**
  - ❖ UE without GNSS: Deprioritized due to the unclear use case, spec effort and non-backward compatible with legacy device for NR-/IoT-NTN.
  - ❖ Regenerative satellite: Deprioritized with more thorough discussion on targeted deployment, architecture and timeline with following thoughts, e.g.,
    - o The benefits is not clear since the end-to-end latency is almost same since the CORE-network is still on the ground.
    - o No improvement on the link budget;
    - o Additional complexity for satellite with higher cost.
  - ❖ Store and forwarding operation: Defined in SA1 for Rel-19, the potential spec impacts highly depend on the assumption for satellite capability, e.g., regenerative (which is coupled with the discussion of re-generation) or transparent payload.

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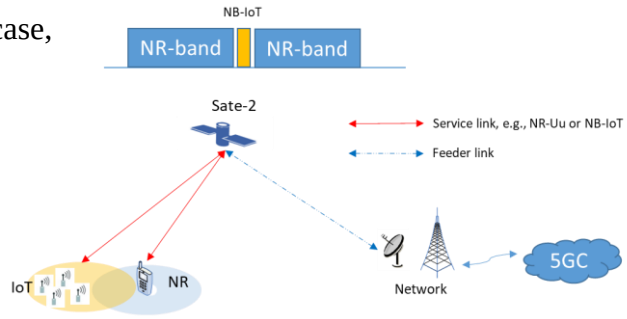
Technical aspect of IoT-NTN

- Support the NB-IoT operation in NR in-band over NTN
  - ❖ This feature is already supported in TN network, can be easily supported NTN case, which is beneficial to enable efficient usage of spectrum & satellite capability.
    - **To support this feature:** RAN4 work is required to specify the corresponding requirements.



Deployment with shared infrastructure

- 5GC supporting IoT-NTN
  - ❖ In Rel-17/18, the IoT with connection to EPC is supported in NTN case.
  - ❖ Considering the flexible network deployment, e.g., shared infrastructure for different RAT over satellite, it's beneficial to enable this feature similar as TN
    - **To support this feature:** RAN2/3 work is required to specify the corresponding enhancement.
- PRACH capacity enhancement (mainly for GEO)
  - ❖ The GEO based IoT service is the promising the direction due to the mature eco-system, e.g., reframing of existing GEO constellation with lower cost, available spectrum mainly for L- and S-band usage.
  - ❖ From coverage perspective, the large beam footprint will provide the seamless coverage over huge region
  - ❖ As analyzed in TR38.821 and TR 36.763, there is potential limitation on the PRACH capacity, also paging capability if large number of UEs (e.g., IoT device) is supported. However, it was concluded that the potential issue of RACH congestion is not to be studied further within Release-17 timeframe.
    - **To support this feature:** Enhancement on the NPRACH for IoT-NTN is required.

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Conclusion

- Based on the analysis before, as for recommendation:
  - ***Proposal-1: For NR-NTN in Rel-19, the following aspects are prioritized to improve the performance to satisfy the commercial deployment***
    - *DL enhancement*
    - *Notification/alert message*
    - *Polarization indication in beam-level*
    - *Joint transmission from multi-sates.*
    - *Reduce signalling overhead in NTN-NTN mobility*
    - *Address PCI confusion in NTN-TN mobility*
    - *Cell reselection enhancements*
  - ***Proposal-2: For IoT-NTN in Rel-19, the following aspects are prioritized:***
    - *Support the NB-IoT operation in NR in-band over NTN*
    - *5GC supporting IoT-NTN*
    - *PRACH capacity enhancement (mainly for GEO)*

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