3GPP TSG RAN Meeting #102 RP-233217
Edinburgh, Scotland, December 11-15, 2023
Agenda Item: 9.1.2.5

Views on Additional RAN2-led topics in Rel-19

- UAV enhancements
- User Plane protocol enhancements
- NR SL Relay enhancement

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UAV enhancements

Background

- During R19 planning WS, several companies proposed to have further work for UAV/UAM in Rel-19 with a WI.
- This document provides our views on the scope for NR UAV/UAM WI in Rel-19.
- Slide 4 provides summary and later slides provide some related details.

UAVs Phase 2 WI: Potential Objectives

- No transmit zone [RAN2/RAN1, SA2 coordination]
  - E.g. Providing NTZ info to the network/UE, measurement reports due to entering/leaving NTZ
- Different aerial flight zones [RAN2/RAN3]
  - Related to new SA1 use cases and requirements
- Mobility enhancement [RAN2/~~RAN3~~/~~RAN1~~]
  - CHO based on height and flight path
  - ~~Inter-RAT HO (e.g., propagate UAV subscription info)~~
  - ~~LTM enh for UAV~~
- ~~FR1 beamforming [RAN1]~~
  - ~~gNB uptilt beam for UAV measurement/reporting (to reduce # of beam meas and reporting)~~
  - ~~UE antenna config selection for UL beamforming (to improve UL interference control)~~
- PC5 enhancement [RAN1]
  - PSCCH DMRS with reduced # of cyclic shifts, PSFCH with reduced # of cyclic shifts
- PRACH enhancement [RAN1]
  - Height-based PRACH config, e.g., with reduced # of cyclic shifts for UAVs to access far-away gNB
- ~~Rel-18 leftover on BRID/DAA over PC5, if any [RAN2/RAN1]~~
  - ~~E.g. PC5-unicast based DAA~~

Note: The yellow-highlighted deletion marks are shown with respect to proposals in RP-231974 (from RAN#101)

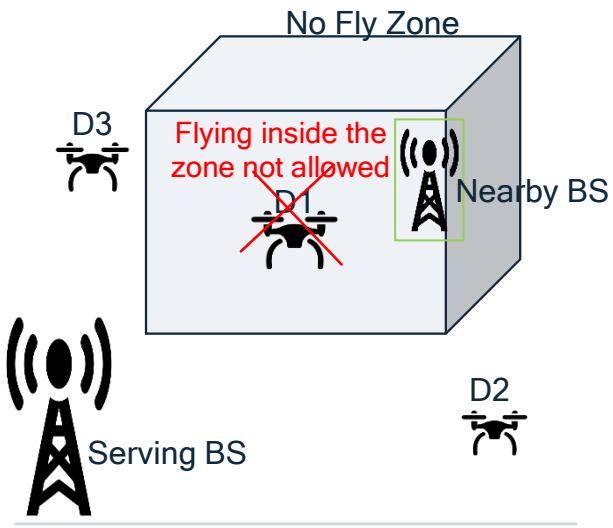
No transmit zone

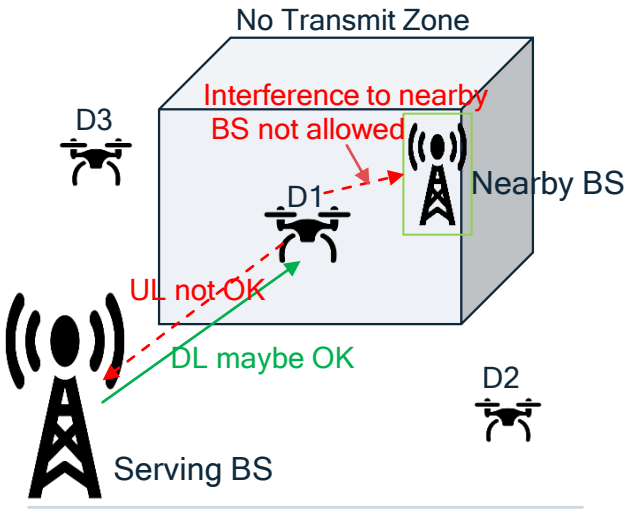
Related to ECC decision 22(07)

- ECC report 348 states there can be no-transmit zones (NTZ) which are imposed to limit the transmissions from drones.
- ECC decision (22)07 on harmonized framework on aerial UE usage in MFCN harmonized bands states “a mechanism is necessary to ensure that aerial UE respect no-transmit zones”.
- RAN sent an LS to SA2 regarding NTZ (see RP-231485). SA2 reply (see RP-231529) indicates further work at system level is needed.
- Latest SA2 SID proposal for Rel-19 includes the following related objective (see S2-2313742)

  - **WT#6:** Study how to support no-transmit zones for UAVs.

- RAN2 should study the impact of this decision, e.g.
  - whether to introduce any mechanisms for signalling of such NTZ, depending on SA2 system level work
  - whether to trigger measurement reports due to moving in/out of such zones
  - whether to switch the uplink transmission to other band/carrier without NTZ restriction when UE is in such zones





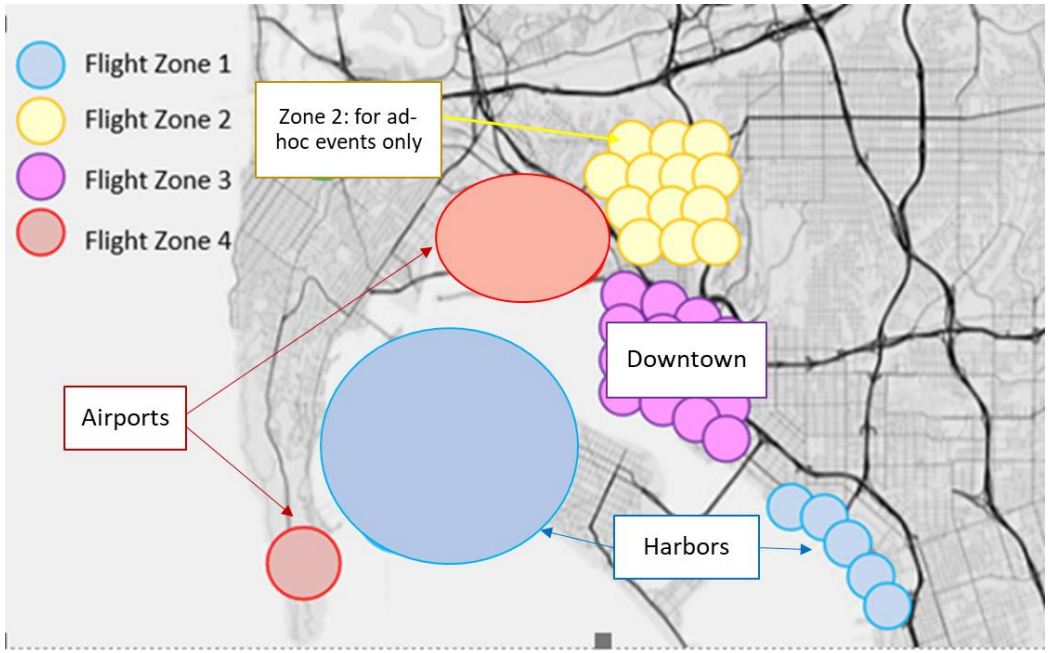
Support of different Aerial Flight Zones

Related to new SA1 use case and requirement

- According to TR 22.843 and SA1-agreed CR to TS 22.125 (see S1-232630), UTM should be able to
  - configure different aerial flight zones where UAV application settings and QoS may be different,
  - provide network and UAV with policy information (including UAV application settings and QoS) to be applied in specific aerial flight zones e.g., based on flight zone type indicated or available to the UAV in a certain geographical location.
- Latest SA2 SID proposal for Rel-19 includes the following related objective (see S2-2313742)

  - **WT#5:** Study whether and how to support aerial flight zones where communication QoS and policy for UAV application (e.g. DAA) may be different.

- RAN3/RAN2 may need to add signaling support to provide network and UAV with means to identify the different flight zone IDs
  - The UAV uses this to identify specific policies on how to use the UAV resources.



Mobility Enhancement

UAV specific minor enhancement

- CHO enhancements
  - Rel-16 NR introduced CHO triggers based on various RRM measurements.
  - Rel-17 NTN introduced distance and time-based CHO.
  - UAV specific CHO can be based on height and UE’s flight path.

PSCCH DMRS and PSFCH Enhancement

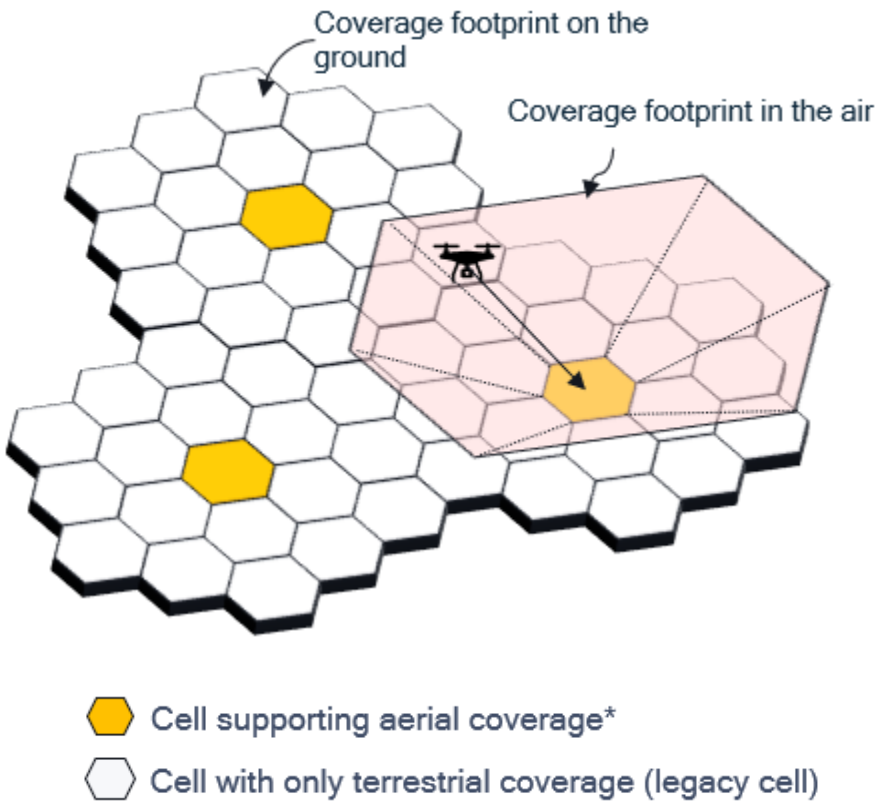
Reduced # of cyclic shifts

- In case of UAV PC5 unicast/broadcast, the propagation delay could be much larger than V2X due to longer distance in case of LOS channel.
- The PSCCH DMRS and PSFCH may not support long distance because of the timing uncertainty resulted from large propagation delay.
  - E.g., for PSCCH with SCS = 30kHz, the max distance is 825m with max propagation delay of N/(4*3) = N/12, where N is the OFDM symbol duration without cyclic prefix and UE randomly selects one of 3 cyclic shifts (CSs) of PSCCH DMRS.
  - E.g., for PSFCH with SCS = 30kHz, PSFCHs with different cyclic shifts cannot be uniquely identified with beyond link distance of 825m with maximum propagation delay of N/12, if $N_{CS}^{PSFCH} = 6$ CS pairs are configured.
- Therefore, to extend the PC5 communication range for UAVs, the cyclic shifts for PSCCH DMRS and PSFCH needs to be restricted, separate from that of terrestrial UEs.

PRACH enhancement

Separate PRACH resource with limited CS

- The current PRACH configuration is mainly for terrestrial UEs without considering the aerial coverage.
- However, the terrestrial and aerial coverage may be very different since the aerial UEs may be connected to a cell far away via side-lobe.
- Moreover, not all cells need to support aerial UEs in some deployments.
- PRACH enhancement for aerial UEs may be needed, e.g. height-based separate random access resource configuration with limited cyclic shifts
  - Otherwise, timing advance pre-compensation (e.g., based on locations) would be needed.



*not all cells need to support aerial UEs

User plane protocol enhancements

Background

- There have been proposals in previous RAN meetings for a Rel-19 Study or Work Item on NR User Plane (UP) enhancements:
  - There was also a more limited proposal on PDCP-level concatenation in Rel-18. This proposal was not agreed since it was deemed that any major changes to NR UP was too late.
- For Rel-19, the proposals from other companies can be classified into two main categories:
  - Introducing new features to NR UP
  - A pre-6G study on UP
- As in Rel-18, we still think major changes to NR UP is too late and chances of such features getting deployment is very low:
  - Considering also the fact that many post-Rel-15 features have not found large acceptance in actual deployments.
- A pre-6G study will also not be productive, given the many unknowns for 6G architecture.

Scope of a possible Rel-19 Study/Work

- As Rel-18 wraps up, the current User Plane implementation has been tested in many deployment scenarios.
- Throughout those deployments, there has been sufficient opportunity to identify gaps and inefficiencies in the current User Plane specs.
- A Rel-19 work on NR UP can be acceptable if it can be limited to fixing these critical issues found in the NR deployments:
  - The changes should be justified based on actual problems discovered in the field.
  - The work should not consume many TUs and only be done within RAN2
  - It can be regarded as a collection of multiple TEIs. A short study phase is feasible to determine the actual problems.
- In the following slides, we discuss some of the issues in current NR deployments in more detail.

Improving User Plane Latency

- With applications that require high data rate, high reliability and low latency (e.g., XR). There is a need to enhance RLC AM mode to perform better for traffic low-latency requirements.
- Currently, existing RLC retransmission mechanisms have a latency-floor related to the time to acquire a STATUS PDU and retransmit NACKed PDUs.
- Proposal 1: **RAN2 to study methods to reduce user plane latency for RLC AM for traffic with low latency requirements.**

Improve UE and gNB window management

- Motivation to introduce enhancements in PDCP/RLC window management.
  - One important motivation is to avoid unnecessary RLC (re)transmissions after PDCP window advances in MR-DC split bearer.
  - The other possible motivation is to enhance data splitting to favor the faster RLC leg.
  - Good alignment between UE and gNB PDCP/RLC window also improves UE memory utilization and power consumption.
  - Aside from DC, CA deployments (e.g., FR1/FR2 may also need to be considered) as the RLC parameters configured for a slower PCell may lead to degraded behavior in the faster SCell, e.g., under-utilization of FR2 due to common RLC parameters across carriers.
- **Proposal 2: RAN2 to study enhancements to UE and gNB PDCP/RLC window management in DC/CA.**
  - **DC can be prioritized for enhancements.**

Summary - User plane protocol enhancements

- SI in Rel-19 should identify specific gaps in current UP design. This SI should evolve to a WI within Rel-19 after gaps have been identified to pursue UP enhancements.
- It is proposed to address the following UP objectives for the Rel-19 UP scope.

- **Proposal 1: RAN2 to study methods to reduce user plane latency for RLC AM for traffic with low latency requirements**
- **Proposal 2: RAN2 to study enhancements to UE and gNB PDCP/RLC window management in DC/CA.**
  - **DC can be prioritized for enhancements.**

NR Sidelink Relay enhancement

Background

- In RAN plenary #101 meeting, Rel-19 RAN2 additional topics were discussed in RP-232627 and the potential SL relay enhancement scope for Rel-19 is proposed as following:

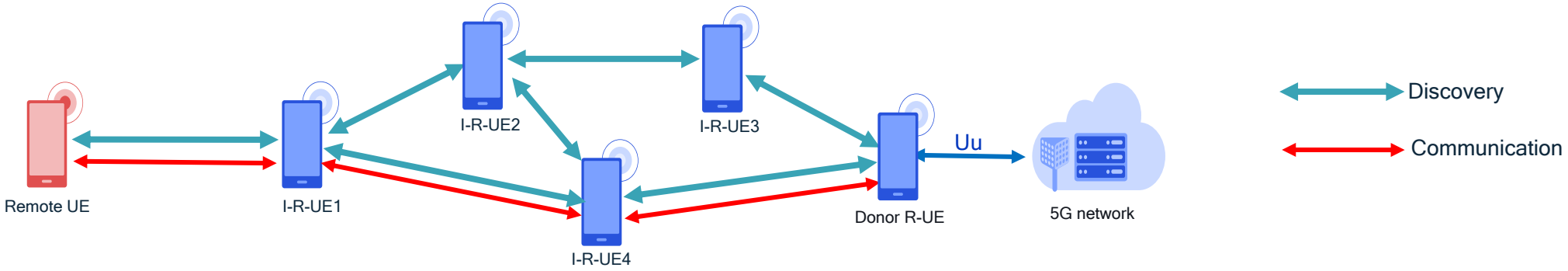
  - There is support from companies for SL relay especially to cover the public safety applications
  - Acceptable objective if it is in Rel-19 package:
    - Support for multi-hop L2 relaying for U2N
    - For further discussion: multi-path enhancements multi indirect paths for a remote UE

Overall views

- As concluded in RAN planery#101, multi-hop U2U relay should NOT be included in Rel-19 scope.
- Multi-hop U2N relay is extension of network coverage, and makes more sense for e.g. public safety service to allow OOC UE more chance to access to network
- Multi-path enhancements (e.g. more than two legs, multi-indirect paths) are further enhancement to improve throughput or reliability on top of Rel-18 multi-path relay, which is additional optimization and not critical requirements to be addressed
- Network coverage extension is more useful and critical than throughput or reliability improvement. Considering limited TUs in Rel-19, we recommend focusing sidelink relay on multi-hop U2N relay.

Views on multi-hop U2N relay

- SA2 alignment work if SA2 approves multi-hop U2N sidelink relay
  - If needed, AS aspects alignment on relay discovery and (re)selection
- Simplify L2 based multi-hop U2N sidelink Relay:
  - Multi-hop U2N Relay design is NOT to be mixed with U2U Relay design
    - Multi-hop U2U Relay design is significantly more complex: both ends are unknown/mobile, and no network assistance can be expected.
    - Currently, multi-hop U2U relay is not in the scope
  - The supported scenario should be restricted to the one where one Intermediate Relay UE only connects to a single Donor Relay UE and a parent Relay UE at a given time, as shown in the following figure.
    - Mesh-based network (e.g. any UE can autonomously connect with any other UE, any multiple Donor Relays) is more complex and requires more study and standards work.
  - No optimization for service continuity during path change, e.g. during relay UE change, hop number change.
    - Procedures should be based on path re-establishment, without bearer level service continuity optimizations.



Proposals - NR Sidelink Relay

- Proposal 1: Specify support for multi-hop U2N sidelink relays.
- Proposal 2: Simplify RAN work on multi-hop U2N sidelink relay
  - Essential AS aspects alignment on relay discovery and (re)selection (assuming SA2 approval of multi-hop U2N relay)
  - Simplify L2 based multi-hop U2N sidelink relay including,
    - Multi-hop U2N relay architecture without relying on multi-hop U2U relay support.
    - Support the scenario where one Intermediate Relay UE only connects to a single Donor Relay UE and a parent Relay UE at a given time.
    - No optimization for service continuity during path change, e.g. during relay UE change, hop number change.
- Observation: multi-hop U2U sidelink relay
  - Support could be added on top of multi-hop U2N sidelink relay design in the future if deemed necessary, e.g. extending the End UE discovery, and UE based bearer configurations, etc.

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