3GPP TSG RAN #98-e
E-meeting, December 12th - 16th, 2022
Agenda Item: 9.2.6
Document for: Decision

RP-223163

Discussion on WID for expanded and improved NR positioning

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Background

WID description (RP-222257)

4 Objective

4.1 Objective of SI or Core part WI or Testing part WI

- Study solutions for sidelink positioning considering the following: [RAN1, RAN2]
  - Scenario/requirements
    - Coverage scenarios to cover: in-coverage, partial-coverage and out-of-coverage
    - Requirements: Based on requirements identified in TR38.845 and TS22.261 and TS22.104
    - Use cases: V2X (TR38.845), public safety (TR38.845), commercial (TS22.261), IIOT (TS22.104)
    - Spectrum: ITS, licensed
  - Identify specific target performance requirements to be considered for the evaluation based on existing 3GPP work and inputs from industry forums [RAN1]
  - Define evaluation methodology with which to evaluate SL positioning for the uses cases and coverage scenarios, reusing existing methodologies from sidelink communication and from positioning as much as possible [RAN1].
  - Study and evaluate performance and feasibility of potential solutions for SL positioning, considering relative positioning, ranging and absolute positioning: [RAN1, RAN2]
    - Evaluate bandwidth requirement needed to meet the identified accuracy requirements [RAN1]
    - Study of positioning methods (e.g. TDOA, RTT, AOA/D, etc) including combination of SL positioning measurements with other RAT dependent positioning measurements (e.g. Uu based measurements) [RAN1]
    - Study of sidelink reference signals for positioning purposes from physical layer perspective, including signal design, resource allocation, measurements, associated procedures, etc, reusing existing reference signals, procedures, etc from sidelink communication and from positioning as much as possible [RAN1]
    - Study of positioning architecture and signalling procedures (e.g. configuration, measurement reporting, etc) to enable sidelink positioning covering both UE based and network based positioning [RAN2, including coordination and alignment with RAN3 and SA2 as required]

  Note: When the bandwidth requirements have been determined and the study of sidelink communication in unlicensed spectrum has progressed, it can be reviewed whether unlicensed spectrum can be considered in further work. Checkpoint at RAN#97 to see if sufficient information is available for this review.

- Improved accuracy, integrity, and power efficiency:
  - Study solutions for Integrity for RAT dependent positioning techniques [RAN2, RAN1]:
    - Identify the error sources, [RAN1, RAN2].
    - Study methodologies, procedures, signalling, etc for determination of positioning integrity for both UE-based and UE-assisted positioning [RAN2]
    - Focus on reuse of concepts and principles being developed for RAT-Independent GNSS positioning integrity, where possible.
  - Study solutions for accuracy improvement based on PRS/SRS bandwidth aggregation for intra-band carriers considering e.g. timing errors, phase coherency, frequency errors, power imbalance, etc [RAN4]:
  - Study solutions for accuracy improvement based on NR carrier phase measurements [RAN1, RAN4]
    - Reference signals, physical layer measurements, physical layer procedures to enable positioning based on NR carrier phase measurements for both UE-based and UE-assisted positioning [RAN1]
    - Focus on reuse of existing PRS and SRS, with new reference signals only considered if found necessary
  - Study the requirements on LPHAP as developed by SA1 and evaluate whether existing RAN functionality can support these power consumption and positioning requirements. Based on the evaluation, and, if found beneficial, study potential enhancements to help address any limitations [RAN2, RAN1]
    - Study is limited to a single representative use case (use case 6 as defined TS 22.104). The choice of selected use case can be reviewed at the start of the study.
    - Study is limited to enhancements to RRC_INACTIVE and/or RRC_IDLE state

- Positioning support for RedCap UEs, considering the following:
  - Evaluate positioning performance of existing positioning procedures and measurements with RedCap UEs[RAN1]
  - Based on the evaluation, assess the necessity of enhancements and, if needed, identify enhancements to help address limitations associated with for RedCap UEs [RAN1, RAN2]

Background/Overview

- Workload of current recommended items is too large. Prioritization and/or down-scope of the above recommended items is necessary for the WI scope
  - ‘Positioning of UEs with reduced capabilities’ is essential
    - » Rel-17 supports RedCap UEs with reduced bandwidth/complexity, but there is a positioning performance gap between non-RedCap UEs and RedCap UEs.
    - » In order to achieve NR positioning requirements for not only non-RedCap UEs but also RedCap UEs, Rel-18 should specify the enhancements to remove the performance gap.
  - Especially SL positioning scope is too large
  - ‘PRS/SRS Bandwidth Aggregation’ should be dropped
    - » In Rel-17, RAN1 studied positioning performance of PRS/SRS bandwidth aggregation. In Rel-18, RAN4 studied the feasibility on PRS/SRS bandwidth aggregation and concluded as feasible. However, concrete objectives (especially, RAN1 related objectives) has not been discussed yet.

Proposal: For positioning WI scope, at least,

- ***‘Positioning of UEs with reduced capabilities’ is included in the scope without any modification/reduction from recommendation***
- ***Discuss and endorse scope reduction from recommendation of sidelink positioning***
- ***Drop PRS/SRS Bandwidth Aggregation from Rel-18***

Discussion

Sidelink Positioning

- The following recommendation for the agenda is captured in section 7.3 of TR 38.859:

Performance evaluation results reported as part of the study indicate that, depending on sources, use-cases, scenarios, assumptions, and positioning methods used, the identified target requirements can be satisfied with different values of SL PRS bandwidth choices.

- For FR1 spectrum:
  - For certain sources and combinations of use-cases, scenarios, assumptions, and positioning methods, some target requirements can be satisfied with SL PRS bandwidths of 20 MHz or 40 MHz.
  - For certain sources and other combinations of use-cases, scenarios, assumptions, and positioning methods, some target requirements require SL PRS bandwidth of 100 MHz or may not be satisfied even with SL PRS bandwidth of 100 MHz.
- For FR2 spectrum, based on submitted results from up to two sources:
  - For certain sources and combinations of use-cases, scenarios, assumptions, and positioning methods, some target requirements can be satisfied with SL PRS bandwidth of 200 MHz.
  - For certain sources and combinations of use-cases, scenarios, assumptions, and positioning methods, some of the target requirements may not be satisfied even with SL PRS bandwidth of 400 MHz.

From RAN1's perspective, it is recommended that SL PRS bandwidths of up to 100 MHz are supported by the specifications in FR1 spectrum.

NOTE: The above recommendations are based on the evaluations in licensed and ITS spectra.

Sidelink positioning is recommended for normative work, including:

- Sidelink positioning in-coverage, partial coverage and out-of-coverage scenarios may be supported.
- How to enable the procedures/signaling for supporting SL positioning in in-coverage, partial coverage and out-of-coverage scenarios will be further discussed in normative work.
- Protocols between UE and UE
  - RAN2 will enable the support of SL PRS configuration in normative work based on the progress in RAN1.
  - RAN2 will design protocol and procedures for SL positioning between UEs (SLPP) in normative work.
- Protocols between LMF and UE
  - RAN2 will discuss the details of functionalities of LMF for supporting SL positioning in normative work.
  - RAN2 will discuss the protocol details to support sidelink positioning procedures between UE and LMF in normative work.

Discussion

- Cont’

For the solutions for sidelink positioning,

- The following two operation scenarios are recommended for normative work:
  - Operation Scenario 1: PC5-only-based positioning.
  - Operation Scenario 2: Combination of Uu- and PC5-based positioning.
- RTT-type solution(s) using SL, SL-AoA, and SL-TDOA are recommended for normative work.
  - Both single-sided and double-sided RTT methods, striving to minimize the changes needed on top of the specification support for single-sided RTT, if any, for the introduction of double-sided RTT.
  - For SL-TDOA, DL-TDOA-like operation and UL-TDOA-like operation is recommended for normative work.
- For the support of the above methods the following measurements are recommended for normative work:
  - SL PRS based Rx-Tx measurement
  - SL PRS based RSTD measurement
  - SL PRS based RSRP measurement
  - SL PRS based RSRPP measurement
  - SL PRS based RTOA measurement
  - SL PRS based Azimuth of Arrival (AoA) and SL Zenith of Arrival (ZoA) measurement.
- A new sidelink reference signal (SL PRS) is recommended for normative work.
  - Such a reference signal should use a comb-based frequency domain structure and a pseudorandom-based sequence where the existing sequence of DL-PRS should be used as a starting point.
  - SCI can be used for reserving/indicating one or more SL PRS resources.
- Both a resource allocation Scheme 1 and Scheme 2 is recommended for normative work, where Scheme 1 corresponds to a network-centric operation SL PRS resource allocation and Scheme 2 corresponds to UE autonomous SL PRS resource allocation.
  - For resource allocation mechanism for SL PRS in Scheme 2, a sensing-based resource allocation, or a random resource selection, or both, should be introduced, where the legacy designs for UE autonomous resource allocation are used as a starting point.
- With regards to the SL PRS transmission, both dedicated resource pool and shared resource pool with Rel-16/Rel-17/Rel-18 SL communication are recommended for normative work.
  - For SL Positioning resource (pre-)configuration in a shared resource pool with Rel-16/17/18 sidelink communication, backward compatibility with legacy Rel-16/17 UEs should be ensured.
- With regards to the power control for SL PRS at least Open Loop Power Control (OLPC) is recommended for normative work.
- Unicast, Groupcast (not including many to one) and Broadcast of SL PRS transmission are recommended for normative work.

Discussion

- Although the recommendations from study phase should be included in WI scope, further deprioritization is needed to make workload reasonable:
  - » For spectrum, FR1 unlicensed / FR2 should be deprioritized since discussion on SL communication for them is now on-going
  - » For operation scenario,
    - – All of IC / PC / OoC can be included as for SL communication
    - – PC5-only should be prioritized and Uu/PC5 combination is to be specified if time allows
  - » For positioning method, we should focus on single-sided RTT / SL-AoA / SL-TDOA since double-sided RTT can be achieved by implementation
  - » For resource pool to transmit SL-PRS, it may be better to focus on dedicated resource pool as the initial step and shared pool is to be specified if time allows
  - » For resource allocation scheme, both scheme 1 and scheme 2 would be necessary for commonality with mode 1/mode 2 RA

Proposal: For SL positioning, the following scope is applied

- ***FR1 ITS/licensed spectrum***
- ***In-coverage, partial coverage, out-of-coverage; PC5-only-based positioning (and Uu/PC5 combination if time allows)***
- ***Single-sided RTT, SL-AoA, SL-TDOA***
- ***Dedicated resource pool for SL-PRS (and shared resource pool if time allows)***
- ***Scheme 1 and scheme 2 resource allocation***

Discussion

- Integrity for RAT-Dependent Positioning Techniques
  - The following recommendation for the agenda is captured in section 7.4 of TR 38.859:

Both UE-based and LMF-based integrity for RAT-Dependent Positioning Techniques are recommended for normative work.

  - Analysis
    - » For integrity feature, we think further down-scope is difficult to reduce the workload.

Proposal: For Integrity for RAT-Dependent Positioning Techniques, the following scope is applied

- ***Both UE-based and LMF-based integrity for RAT-Dependent Positioning Techniques***

Discussion

- NR Carrier Phase Positioning (CPP)
  - The following recommendation for the agenda is captured in section 7.6 of TR 38.859:

> If NR CPP is introduced,
> - Existing DL PRS and UL SRS for positioning purpose are recommended as the reference signals to enable positioning based on NR carrier phase measurements for both UE-based and UE-assisted positioning.
> - New measurements are recommended to be introduced for supporting UE-based and UE-assisted NR carrier phase positioning.
> - Multipath mitigation methods for the carrier phase positioning are recommended to be introduced during normative work.

  - Analysis
    - » For NR CPP feature, we think further down-scope is difficult to reduce the workload.

Proposal: For NR CPP, the following scope is applied

- ***Existing DL PRS and UL SRS for positioning purpose as the reference signals to enable positioning based on NR carrier phase measurements for both UE-based and UE-assisted positioning***
- ***New measurements for supporting UE-based and UE-assisted NR carrier phase positioning***
- ***Multipath mitigation methods for the carrier phase positioning***

Discussion

- Low Power High Accuracy Positioning (LPHAP)
  - The following recommendation for the agenda is captured in section 7.7 of TR 38.859:

> The following enhancements for LPHAP are recommended for normative work:
> - For UL and DL+UL positioning for UEs in RRC_INACTIVE state, the enhancements on SRS for positioning in order to avoid frequent RRC connection for SRS (re)configuration is recommended for normative work.
> - Extending DRX cycle beyond 10.24s was studied and found beneficial towards meeting the battery life requirement for LPHAP and is recommended for normative work on Rel-18 positioning enhancements from physical layer's perspective.
> - From physical layer's perspective, DL PRS measurement for UEs in RRC_IDLE state is recommended for the normative work.
>
> Enhancements on simplified DL PRS configuration with 1-symbol PRS can be studied further and if needed, specified during normative phase.
>
> From RAN2's perspective, LPHAP is recommended for normative work, including:
> - Enhancements on SRS configuration
> - SRS positioning validity area for UL positioning in RRC_INACTIVE is recommended for normative work from RAN2's perspective if feasible from RAN1's perspective.
> - SRS configuration request is recommended for normative work from RAN2's perspective.
> - Pre-configuration of multiple SRS configurations (e.g., for multiple SRS positioning validity areas) is feasible from RAN2's perspective and recommended for normative work.
> - Alignment between DRX and PRS is recommended for normative work.
> - DL positioning in RRC_IDLE is recommended for normative work.
> - Skipping paging reception in RRC_INACTIVE is recommended for normative work for achieving LPHAP requirements, if feasible and beneficial from RAN1's perspective.

  - Analysis
    - » Considering the power saving gain, it would be better to include at least DL positioning in RRC_IDLE state in the WID scope.

Proposal: For LPHAP, at least the following is included in WI scope

- ***DL positioning in RRC_IDLE state***

Discussion

- Positioning of UEs with Reduced Capabilities
  - The following recommendation for the agenda is captured in section 7.8 of TR 38.859:

> From RAN1's perspective, for positioning of RedCap UEs, support of PRS frequency hopping and SRS frequency hopping are recommended for normative work.
> - During the normative work, the complexity of the corresponding capabilities for RedCap UEs should be addressed for the introduction of appropriate capabilities for RedCap UEs.

  - Analysis
    - » For Positioning of UEs with Reduced Capabilities, we think further down-scope is difficult to reduce the workload.

Proposal: For Positioning of UEs with Reduced Capabilities, the following scope is applied

- ***PRS frequency hopping and SRS frequency hopping***

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