

**3GPP TSG RAN Rel-18 workshop**

**RWS-210610**

**Electronic Meeting, June 28 - July 2, 2021**

**Agenda Item: 4.3**

**Source: CATT**

**Title: Email discussion summary for [RAN-R18-WS-crossFunc-CATT]**

**Document for: Report**

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## **1 Introduction**

This email discussion summary covers the following documents:

RWS-210414 On further positioning enhancements in Rel-18 CATT

RWS-210413 AI/ML for physical layer in Rel-18 CATT

RWS-210412 AI/ML for higher layer in Rel-18 CATT

RWS-210415 On energy saving in Rel-18 CATT

RWS-210416 On duplexing enhancements in Rel-18 CATT

The remainder of this document is organized that general comments/questions and answers by moderator are included in section 2, comments/questions to each contribution and answers by moderator are in section 3. In section 4, the summary is provided.

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## **2 General comments/questions**

### **2.1 Round 1 comments/questions**

The main topics that are discussed in the contributions are summarized in the following table:

**Table 1: Brief summary of CATT contributions under agenda 4.3**

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x-area or new topics	NR positioning [RWS-210414]	<p>Rel-18 should consider the following positioning further enhancements:</p> <ul style="list-style-type: none"> <li>NR positioning with carrier phase and carrier phase difference measurements;</li> <li>NR positioning with aggregated DL/UL resources</li> <li>NR positioning for RedCap UEs</li> <li>Low power high accuracy positioning</li> <li>SL positioning</li> <li>NR positioning for high-speed train scenario</li> <li>AI/ML-based NR positioning</li> </ul>
	AI/ML for physical layer [RWS-210413]	<p>AI for optimizing configurations/-parameters for physical layer can be studied in Rel-18. This is referred to as AI-empowered physical layer. The study focuses on use case identification and evaluation methodology. The study should avoid the case that an AI module is distributed between network and UE.</p>
	AI/ML for higher layer [RWS-210412]	<p>The normative work should base on the Rel-17 SI, with both the aspect of architecture and the aspect of use cases taken into consideration. Cases not completed or sufficiently studied in Rel-17 can continue in Rel-18. Also, pending on SA progress, there may be some work in RAN2/3 scope to support AI over 5G.</p>
	Energy saving [RWS-210415]	<p>Can study both NW and UE side, to figure out the most important use cases and needed enhancements.</p>

	Duplex enhancement [RWS-210416]	For full duplex, feasibility of self-interference cancellation/suppression shall be studied first, taking into account practical effects such as coupling interference and echoes from the environment. Inter-cell/intra-cell cross link interference is also a great challenge to full duplex and shall be investigated carefully.
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Please provide your general comments to these contributions if any, in the following feedback form.

**Feedback Form 1: General comments/questions to all CATT contributions under A.I. 4.3**

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- 2.2 Round 1 answers by moderator
- 2.3 Round 2 comments/questions
- 2.4 Round 2 answers by moderator

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### 3 Questions and comments to the Tdocs

In this section, questions and comments are collected for each of the contributions.

- 3.1 RWS-210414 On further positioning enhancements in Rel-18
  - 3.1.1 Round 1 comments/questions

Please provide your comments to this contribution if any, in the following feedback form.

**Feedback Form 2: Comments or questions to CATT contribution RWS-210414**

<p><b>1 – DanKook University</b></p> <p>1) I agree with the opinion that the carrier phase difference measurement method should be studied in release-18 for further improvement of positioning. CATT also proposed a signal method using out-of-band signing, such as guard-band. Then do you still think both the in-band and out-of-band methods are valid? If you consider changing the existing PRS structure, what method are you considering?</p> <p>2) I agree with the opinion that the motivation between gNBs can be adjusted by using GPS carrier phase signals. However, if it is possible to exchange carrier phase signals between gNBs, we can also consider using it for synchronization between gNBs. what is your opinion on such method?</p>
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## **2 – ZTE Corporation**

- (1) Regarding proposal 1 on carrier phase based positioning, do you think new PRS design is needed, e.g. a very small subcarrier spacing ?
- (2) Regarding proposal 5 for NR positioning for high-speed trains: What kind of enhancement do you expect?

## **3 – Intel Technology India Pvt Ltd**

- (1) Proposal 4: Does LPHAP imply that we need to define a new UE type? What's the difference between this (LPHAP) and RedCap?
- (2) Proposal 5: Is there any gap to support high-speed trains based on R16/17 positioning solutions?

## **4 – China Telecom Corporation Ltd.**

- (1) For proposal 1, we agree that the CPP can be helpful for the NR positioning and can be further studied. The methods already used in GNSS may can't be used directly in NR. For example, the RTK may need the UE sampling for a long time so that the integer ambiguity can be solved. Do you think the CPP methods can be supported in NR by enhancing the existed signals or the new CPP methods need to be proposed for NR positioning?
- (2) For RedCap UE positioning and LPHAP, what scenarios do you think should be studied in high priority and the corresponding accuracy should achieve which level?

## **5 – vivo Mobile Communication Co.**

Thanks for your effort on this. We also view positioning as one of the most import enablers for NR 5.5G. A few detailed questions:

- 1) For carrier aggregation for NR positioning, which WGs are expected to be involved and which WG should start work first?
- 2) For the mentioned low power high accuracy use case, what is the expected power consumption level and positioning accuracy? Would the feasibility with current methods on table should be studied first?
- 3) For the mentioned industrial and sidelink use cases, is unlicensed operation assumed?
- 4) For the potential study on sidelink positioning, is the support of sidelink positioning also assumed for Rel-18? If so, how long is the study expected?
- 5) There are different levels of specification efforts assumed. Does 'should be supported' and "should be studied" mean different priority? does 'should be supported' mean to directly specify?

## **6 – China Mobile Com. Corporation**

Thanks for the contribution, and below please find our comments / questions:

### ***#1 On carrier aggregation for NR positioning***

As discussed during Rel-17 SI, supporting the aggregation significantly increases the implementation complexity to both UE and NW sides. We agree that to attain the theoretical gain of coherent aggregation, we should first study the feasibility to support larger FFT point and to reduce the TAE requirement of the intra-band contiguous CA, and the work seems within the scope of RAN4 WG.

### ***#2 On positioning support for high-speed train***

We would like to understand that, firstly, what would be the use cases to support positioning in high-speed train scenario? In addition, what are the potential enhancements that you have in mind? As far as we know,

in the current high-speed train scenario, all TRPs within a cell transmit the same reference signals / data, which are identical to UEs. In such a case, it seems that the current DL positioning cannot work.

### **#3 On sidelink positioning**

As the study on sidelink positioning in RAN plenary will be finished by the end of RAN#93 meeting, which investigates the positioning use cases and requirements for V2X and public safety, we believe that it is reasonable to further discuss the enhancements in Rel-18. We would like to know your views on the priority of sidelink positioning compared to other potential positioning enhancements? If sidelink positioning is approved to be specified, what would be the priority on:

- use cases (focusing on V2X and public safety that identified in TR38.845, or extending to other commercial use cases such as XR / IoT?)
- scenarios (in /partial /out of coverage?)
- requirements (there are 3 sets of KPIs are identified in TR 38845 for V2X scenarios, do you think we should support all of them or down-select to some of them?)
- band (licensed or unlicensed?)

### **#4 On AI/ML-based positioning**

AI RAN is a critical topic in Rel-18, and many companies are proposing enhancements on AI based PHY layer, in which AI based positioning solutions to increase positioning accuracy especially in NLOS scenarios is a hot issue. In our view, the AI/ML-based positioning can be studied under AI RAN related study item.

### **#5 Others**

In Rel-17, the objective on integrity of RAT-dependent positioning was down-scoped. We think that the integrity is an important metric to ensure the reliability of a positioning system, and it should be defined for RAT-dependent techniques in Rel-18 phase. We would like to know your views on supporting integrity of RAT-dependent positioning.

## **7 – Huawei Tech.(UK) Co.. Ltd**

Q1: What is the special request for high speed train? To what extent is it already covered in the existing topics such as low latency.

## **8 – Sony Europe B.V.**

Q1: There are 8 proposed topics for Rel-18. What would be your priority order?

## **9 – Beijing Xiaomi Mobile Software**

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For sidelink positioning

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Q1: Do you think the commercial and public safety use cases and requirements identified in SA1 Ranging WI(TR22.855/TS22.261) should be taken into account?

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Q2: According to the definition and the KPI requirements of relative positioning and ranging in TS22.261(see below), do you agree that relative positioning and ranging are different, i.e. relative positioning requires to acquire the 2D/3D coordinates(e.g. the horizontal accuracy of relative positioning set requirements on both distance accuracy and angle accuracy) while Ranging requires to acquire only one component of 2D/3D coordinates(either distance or angle) and thereby only set requirements on one component(either distance or angle)?

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relative positioning: relative positioning is to estimate position relatively to other network elements or relatively to other UEs.

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Ranging: refers to the determination of the distance between two UEs and/or the direction of one UE from the other one via direct communication connection.

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For Redcap positioning

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Q3: Do you think is there a need to define new accuracy requirement for RedCap positioning or just reuse the requirement defined for eMBB?

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Q4: Do you think is there a need to have a short study phase to clarify the requirement for RedCap and perform the evaluation to see if there is gap to reach that requirement?

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For carrier phase based NR positioning

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Q5: We would like to understand what is the target error to mitigate. As we know that, there are 4 major kinds of error source for GPS, i.e. clock error, ionized stratum/troposphere error, ephemeris error, multi-path error. For GPS, RTK is mainly to mitigate clock error, ionized stratum/troposphere error, ephemeris. But for NR RAT-dependent positioning, there is no ionized stratum/troposphere error and ephemeris error. For clock error, it can be handled by gNB itself (e.g. by broadcasting clock error, etc.). Besides, the density of GPS RTK reference station is comparable or less than the density of gNB. To introduce carrier phase based NR positioning, what is the consideration for the deployment of reference station (e.g. what density in a cell)?

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For low power high accuracy positioning

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Q6: We would like to understand what would be the RAN impact. And we are wondering whether carrier aggregation can be applied for Low power high accuracy positioning (LPHAP).

## 10 – Spreadtrum Communications

Thanks for the comprehensive contribution. we have some questions:

Q1: Due to possible limited TU, whether we have topic priority consideration?

Q2: For LPHAP, How to achieve low power and high accuracy positioning at the same time?

Q3: For high-speed trains scenario, what specific enhancements do you want to do? We think existing A-GNSS positioning may be enough.

**11 – Samsung Electronics Polska**

What's your view on how to handle multi-path impact in the carrier phase and carrier phase difference based method?

**12 – MediaTek Inc.**

Q1: For High Speed Train, we assume this is only for the high speed aspects. But is it not quite simple already with existing technology to obtain an accurate location for a fast-moving train (or users on the train)? What do you feel is missing?

Q2: For AI/ML based positioning, how would we contain the scope?

**13 – LG Electronics Inc.**

Q1: How much bandwidth is needed for carrier phase or phase difference based positioning?

Q2: For high speed train scenario, the scenario is one of the special deployments for cover different services and the related requirement is mainly designed for performance (e.g. data rates, traffic density, latency and reliability). In terms of positioning, if more details of reason for supporting the scenario is explained, it would be more helpful for us to understand.

Q3: Regarding AI/ML techniques, we think the definitions of adaptability and performance validation are very similar. could you clarify more?

3.1.2 Round 1 answers by moderator

Thank you all for the comments/questions, please find answers below:

**CATT's responses to DanKook University:**

1) In our view, transmitting NR signals specially designed for carrier phase measurement (C-PRS) may be more suitable for providing location service in particular scenarios when cm-accuracy level accuracy is required for all of the time for many UEs, which may need a little more effort in standard. The use of existing DL PRS/UL SRS (w/o change) to provide carrier phase measurements can minimize the impact on the specifications. We could propose to consider C-PRS in a future release if necessary.

2)Yes, we share a similar view that very precise time/frequency synchronization between gNBs can be achieved by supporting the phase-lock of the carrier signals between them. We have actually proposed to study it in 3GPP before. However, some companies consider the time/frequency synchronization between gNBs is an implementation issue and no need to be specified in the standard.

**CATT's responses to ZTE :**

1) Based on our investigation, NR carrier phase measurements can be supported with reference signals transmitted with very small subcarrier spacing as we proposed in Rel-16. However, there may need to have a little more effort in standard. It might be more acceptable for companies to use existing DL PRS/UL SRS (w/o change) can provide carrier phase measurements to minimize the impact on the specifications. We may consider further enhancement in the signals (e.g., C-PRS) in a future release if necessary.

2) High-speed trains positioning, especially under the tunnel, deserves special consideration due to multiple

reasons: a) The simulation evaluation of Rel-16/17 is limited to low-mobility UEs. It is unclear whether there is a need to have a new design of DL PRS/UL SRS to support the high-speed scenarios; b) depending on the deployment scenario, we may need to deal with the gNB antenna distribution structure (e.g., TRP antennas are installed along the train trail, or leaking cable is used); c) other issues caused by high-mobility of the UE (e.g., frequent handover between cells, etc.). In general, we envision it is much more difficult to support precise positioning for high-speed trains, especially under the tunnels, than the scenarios discussed in Rel-16/17.

One advantage of the positioning of trains is that the positioning is, in general, can be considered as 1D in a practical environment.

#### **CATT's responses to Intel:**

For LPHAP, our understanding is to define a new UE type or a new special UE capability. It could be a special UE capability for RedCap UE. At this moment, we consider the positioning of RedCap UEs as the case the UE will only support up to 20MHz BW. For LPHAP, one may consider the UE may support much wider BW for the transmission/reception of DL PRS/UL SRS signals, or support the frequency hopping in a very large BW as some companies also suggested.

We consider high-speed trains positioning, especially under the tunnel, deserves special consideration due to multiple reasons: a) The simulation evaluation of Rel-16/17 is limited to low-mobility UEs. It is unclear whether there is a need to have a new design of DL PRS/UL SRS to support the high-speed scenarios; b) depending on the deployment scenario, we may need to deal with the gNB antenna distribution structure (e.g., TRP antennas are installed along the train trail, all TRP transmits the same DL signals); c) other issues caused by high-mobility of the UE (e.g., frequent handover between cells, etc.). In our view, it is much more difficult to support precise positioning for high-speed trains, especially under the tunnels. To our knowledge, there is no good solution for precise positioning based on cellular signals. The study has a potential impact on the DL PRS/UL SRS design, the PHY and high-layer procedure, etc.

#### **CATT's response to China Telecom:**

1) One of the main issues with GNSS CPP is that the GNSS signals are very weaker. It requires a long period for the receiver to phase-lock the GNSS carrier signals (many seconds or even minutes). NR signals are much stronger. The receiver should be able to provide the carrier phase measurements together with other positioning measurements together. Another fact that has an impact on the time for searching the integer ambiguity is the initial positioning accuracy. For GNSS CPP, there is a need to remove ionosphere and troposphere errors for the resolution of integer ambiguity. NR positioning is not impacted by these errors. Initially, NR CPP needs to use the initial position provided by the existing positioning technique (similar to GNSS CPP). Consider the target R17 is 0.2cm accuracy, the search space of the integer ambiguity is only 2 wavelengths for a carrier frequency of 3GHz.

2) In this moment, our view RedCap UE positioning can be supported with very minimal impact on RAN1/RAN2. The main workload may be in RAN4 due to the impact of smaller BW and 1Rx antenna on the positioning performance. For LPHAP, there can be more impact on RAN1/2. So, we think both of them can proceed in parallel.

#### **CATT's response to VIVO:**

1) For NR carrier aggregation for NR positioning, we assume it should start with RAN1/4 to fully understand the benefits and feasibility.

2) For LPHAP, we assume 3GPP should target very small power consumption with a very long life span (like NB-IOT). Obviously, the power consumption is related to how frequently the positioning information is

needed. We assume the increase of the positioning accuracy depends on the duration and BW for each positioning occasion. We consider frequency hopping in very large BW can be a potential solution as suggested by some companies.

3) We understand using the unlicensed spectrum can have the potential for significant improvement of positioning performance. Positioning with unlicensed spectrum is not considered in Rel16/17, and we assume there are issues that need to be addressed for positioning in unlicensed spectrum. Thus, it might be better to consider the support SL positioning in licensed spectrum first in R18.

4) We are supportive of the study of sidelink positioning in R18. We assume we need at least 2Q for that with reasonable TUs.

5) Yes. We used “‘should be supported’ for the issues that can start with WI phase, and “‘should be studied for the issues that can need further study on the feasibility with SI phase.

### **CATT’s responses to China Mobile:**

#### ***#1 On carrier aggregation for NR positioning***

We share a similar view as CMCC that there is a need to study the feasibility, the potential gain, and the implementation complexity for supporting DL/UL CA. to both UE and NW sides to decide whether to support DL/UL CA positioning.

#### ***#2 On positioning support for high-speed train***

TR 22.889 has defined the use case of FRMCS Positioning Accuracy for trains, where the requirements of positioning accuracy is defined depending on the train’s speed. As CMCC pointed out, “in the current high-speed train scenario, all TRPs within a cell transmit the same reference signals / data, which are identical to UEs. In such a case, it seems that the current DL positioning cannot work”, thus, there is a need to consider the effective approach to deal with the situation in R18.

#### ***#3 On sidelink positioning***

We assume SL positioning will be included in R18.

About the use cases, we assume there is no need to exclude some use cases in R18.

About the scenarios, we don’t have a strong view. It might be easier to start within coverage and out of coverage. Dealing with partial coverage may be more complicated, where we may need to support cooperative positioning.

About KPIs, we consider it may be more practical to support Set 2 for partial/out-of-coverage scenarios. For in-coverage cases, R17 already supports submeter accuracy based on Uu interface alone. With Uu+SL, we may expect better performance.

About licensed or unlicensed, we understand many companies propose to support both licensed or unlicensed bands. Our preference is to start with a licensed band due to R16/17 positioning is not supported in an unlicensed band.

#### ***#4 On AI/ML-based positioning***

For AI/ML-based positioning, in our view it might be better to be included in positioning SI/WI with the

following considerations:

- 1) AI/ML models/algorithms are highly application-specific. For example, the AI/ML models/algorithms for MIMO or channel estimation may not be suitable for positioning;
- 2) Some companies have presented the results of using AI/ML techniques for improving NR positioning performance in Rel-17 ePOS WI.

#### **#5 Others**

Although the integrity of RAT-dependent positioning was missed in our contribution, we share a similar view with CMCC that the integrity of RAT-dependent positioning is an important metric to ensure the reliability of a positioning system, and it should be defined for RAT-dependent techniques in Rel-18 phase.

#### **CATT's responses to Huawei:**

TR 22.889 has defined the use case of FRMCS Positioning Accuracy for trains, where the requirements of positioning accuracy is defined depending on the train's speed. As CMCC pointed out, "in the current high-speed train scenario, all TRPs within a cell transmit the same reference signals / data, which are identical to UEs. In such a case, it seems that the current DL positioning cannot work", thus, there is a need to consider the effective approach to deal with the situation in R18 in our view.

We consider high-speed trains positioning, especially under the tunnel, deserves special consideration due to multiple reasons: a) The simulation evaluation of Rel-16/17 is limited to low-mobility UEs. It is unclear whether there is a need to have a new design of DL PRS/UL SRS to support the high-speed scenarios; b) depending on the deployment scenario, we may need to deal with the gNB antenna distribution structure (e.g., TRP antennas are installed along the train trail, all TRP transmits the same DL signals); c) other issues caused by high-mobility of the UE (e.g., frequent handover between cells, etc.). In our view, it is much more difficult to support precise positioning for high-speed trains, especially under the tunnels. To our knowledge, there is no good solution for precise positioning based on cellular signals. The study has a potential impact on the DL PRS/UL SRS design, the PHY and high-layer procedure, etc.

In addition, it is unclear to us now how much impact the train speed on the accuracy of the multi-RTT. Also, when a train is under a tunnel, RSTD measurement may not work properly, since the UE may only receive the DL signals from one TRP.

#### **CATT's responses to Sony:**

CATT is open to discuss on all these aspects at this early stage. We may consider prioritization after exchanging our views with interested companies.

#### **CATT's responses to Xiaomi:**

For Q1 and Q2, we are still discussing internally if and how the commercial and public safety use cases and requirements identified in SA1 Ranging WI (TR22.855/TS22.261) are taken into account in SL positioning. One issue we like to understand is the difference between the positioning service and the ranging service. In our understanding, if the relative position information (relative coordinates) between two wireless network entities (e.g., UE/TPR) is known, then the ranging information (distance and relative direction) between two entities is also known. On the other hand, if both distance and relative direction are known, the relative position information is also known. If only distance or relative direction is known, then the relative position may not be known. But, we assume adding the support of the ranging service does not necessarily imply adding new PHY measurements. Does Xiaomi have the same understanding?

For Q3, based on the previous experience with eMTC, our view is that at least the accuracy requirement for RedCap devices will be different from eMBB UEs. Due to RedCap UEs may have only 1Rx antenna. The performance requirements may also need to consider the maximum BW is only 20MHz etc. We assume the main workload for RedCap UE positioning is RAN4, if we do not change in the design of DL PRS/UL SRS for positioning.

For Q4, we think there is no need to have a separate study phase, assuming companies share a similar view to support RedCap positioning.

For Q5, for GNSS, the main reason to use carrier phase measurement is not because of the clock error, ionized stratum/troposphere error, ephemeris. These errors can be removed, at least in theory, based on the double differential techniques (regardless of when code-phase measurements are used or carrier phase measurements are used) or through the combination of code/carrier phase measurements obtained from different carrier frequencies. To support carrier phase positioning, these errors need to be removed with differential techniques in order to correctly determine the integer ambiguity in the carrier phase measurement. The basic idea behind the carrier phase positioning is the measurement error of the carrier phase (e.g., the difference between the measured phase and the real phase) is a small fraction of the wavelength, while the measurement error of the code phase is related to code chip length in time (GNSS/CDMA) or limited by the transmission BW (NR/OFDM). For NR CPP, although we may consider there are no iono-/tropo-sphere errors and ideally no ephemeris errors, the gNB clock errors are still there, and has to be removed for cm-level positioning. Thus, differential techniques, similar to GNSS, are still needed to be used in our view. Unlike GNSS, global coverage with the minimum GDOP/PDOP has to be considered during the design of the constellation of GNSS satellites. For NR CPP, the need for the positioning service for a local coverage area should be considered for the DL PRS/UL SRS configuration, including the number of TRPs for transmitting DL PRS.

For Q6: Yes, there is a need to study how to support LPHAP. For example, we assume the common understanding is that to achieve better accuracy, one may use a larger transmission/reception BW. On the other hand, having a larger transmission/reception BW may imply more power consumption for the same transmission/reception. Thus, we assume LPHAP may only support high-accuracy positioning only at the time when it is needed/requested (occasionally and/or at a very long positioning rate).

#### **CATT's responses to Spreadtrum:**

For Q1: CATT is open to discuss on all these aspects at this early stage. We may consider prioritization after exchanging our views with interested companies.

For Q2: Yes, there is a need to study how to support LPHAP. Here, we may assume LPHAP only supports high-accuracy positioning only at the time when it is needed/requested (occasionally and/or at a very long positioning rate).

For Q3: We assume the scenarios when GNSS signals are blocked such as inside a tunnel. It seems no good solution for the moment.

#### **CATT's responses to Samsung:**

We would suggest 3GPP may first consider the use of carrier phase/carrier phase difference measurements for improving positioning performance in LOS environment, and then further investigate how to support the use of carrier phase/carrier phase difference measurements for NLOS environment.

#### **CATT's responses to MediaTek:**

For Q1, our understanding is that it may not be simple to use existing technology to obtain an accurate location

for a fast-moving train, at least 3GPP has not studied the potential issues and corresponding the solutions with practical deployment scenarios. For example, CMCC has pointed out, “in the current high-speed train scenario, all TRPs within a cell transmit the same reference signals / data, which are identical to UEs. In such a case, it seems that the current DL positioning cannot work”. Thus, we think there is a need to have a study on how to meet the requirement defined in TR 22.889 for FRMCS Positioning Accuracy.

For Q2, to contain the scope, we may assume no (or minimum) change on of PHY reference signals and configuration, but focusing on the procedure and measurement reporting for supporting the AI/ML algorithms/models. Based on the evaluation of the effectiveness of candidate AI/ML algorithms/models (including the accuracy, reliability, adaptability, Positioning efficiency, etc.) to decide which candidate AI/ML algorithms/models should be adopted, and specify the necessary changes in the standard to support the adopted AI/ML algorithms/models.

### **CATT’s responses to LG Electronics Inc:**

For Q1: If existing DL PRS and UL SRS are used to obtain the carrier phase or phase difference measurements, there are no extra bandwidth requirements specifically for carrier phase or phase difference-based positioning in our view.

For Q2: TR 22.889 has defined the use case of FRMCS Positioning Accuracy for trains. We assume the accuracy requirements can be met if GNSS signals are available. Thus, we may only consider the scenarios when GNSS signals are not available in our view.

For Q3: We consider both the adaptability and performance validation are related, but have different concepts. In our view, RAN1 may focus on the investigation of the adaptability of different candidate AI/ML techniques, while RAN4/5 may need to come with the requirements or test procedures for validating the adaptability of AI/ML techniques under different environment.

### 3.1.3 Round 2 comments/questions

Please provide your further comments based on the QA in the first round if any.

#### **Feedback Form 3: Feedback Form 3: Comments or questions to CATT contribution RWS-210414**

##### **1 – Huawei Tech.(UK) Co.. Ltd**

Thank you for the reply. We have some additional questions based on the various replies, and your paper:

1. For HST, whilst data should be SFN mode, different RRHs should be treated as different TRPs under the general assumption for positioning. Is there any potential solution for locating the UE using SFN transmission of PRS (without artificial delay)?
2. For RedCap positioning with additional RAN4 requirement, should the current side condition defined per Rx branch?
3. Is there any particular enhancement Intel has in mind that can be further specified in Rel-18 with respect to Uu positioning in unlicensed spectrum, given the Rel-16 capability and Rel-17 LBT exemption discussions?

##### **2 – MediaTek Inc.**

Thanks for your reply on the topic of AI/ML for positioning. Your answer in round 1 suggests that you foresee studying and then standardizing the AI/ML algorithms. Is this a correct reading, and if so, which

group(s) would be responsible?

### **3 – ZTE Corporation**

CATT seems to prefer two SI/WI for SL positioning and other regular positioning respectively. What about positioning for Redcap, is it better to put it under RedCap enhancement? In our view, it is a bit risk to have many SI/Wis which have much related discussion/enhancements. We prefer to put SL(RedCap) positioning discussion either under positioning group or regular SL(RedCap) group.

### **4 – Beijing Xiaomi Mobile Software**

Thank you for the response. Please see our further questions below:

Q1: We also support redcap positioning. Do you think whether power saving should be considered for Redcap positioning since redcap UE (wearable device) usually has a limited battery life?

Q2: For high speed train scenario, whether positioning during mobility should be enhanced?

Q3: We would like to understand how TDOA/RTOA is applied to relative positioning. Do you assume that UE receives PRS from multiple RSU? If so, please justify the scenario and explain the gain compared to RTT+AOA/AOD.

### **5 – LG Electronics Inc.**

Thank you for clarification. We also support SL positioning.

Q1: Considering a train positioning use case in Proposal 5, do you think that some positioning enhancement is needed to support positioning of a train that is equipped with multiple panels?

#### 3.1.4 Round 2 answers by moderator

Thank you all for the valuable comments/questions. Please find our answers below:

#### **CATT's response to Huawei**

For Q1: Thanks for the discussion. We share a similar view that the clean solution is to treat different RRHs as different TRPs. If DL PRS are transmitted in SFN mode, we think we may need to use some additional information, e.g., using Doppler information and RSRP information to keep tracking when the UE is approaching or leaving a particular TRP, or using external aiding information, e.g., installation of the RFID tag along the rail road.

For Q2: Thanks for the discussion. Our understanding is that side conditions are always specified per antenna branch I RAN4 requirements irrespective how many Rx branches the concerning equipment has. Sider condition is a long-term average value and the same value will be applied to all the branches. Different per-branch side condition requirement will be defined for different equipment with different number of Rx branches.

For Q3: Thanks for the question. Not sure the question is to Intel or to us. Anyway, we are glad to provide our views. We think there is a need to discuss Rel-17 LBT exemption for positioning reference signals (PRS/SRS) in order to support the stringent latency requirements of positioning.

#### **CATT's response to MediaTek Inc**

Thanks for further discussion. In our view, RAN1 should be responsible for the evaluation of the effectiveness

of candidate AI/ML algorithms/models (including the accuracy, reliability, adaptability, Positioning efficiency, etc.) and lead the work on the necessary changes in the standard to support the use of the effective AI/ML algorithms/models for positioning. By the way, probably we did not make it clear in our previous response, our proposal was to standardize the procedures, messages, and measurements for supporting the effective AI/ML algorithms/models, but not the AI/ML algorithms.

### **CATT'S response to ZTE**

Thanks for the discussion. Our preference is to include RedCap positioning in R18 positioning enhancements SI/WI. RedCap positioning with SL signals may be considered in a future release or included in SL positioning SI/WI.

### **CATT's response to Xiaomi**

For Q1: Thanks for the discussion. Yes, our preference is to use the existing DL PRS/UL SRS design to support RedCap UEs but we are open to discuss the change of some of the configuration parameters to reduce the power consumptions.

For Q2: Thanks for the discussion. Our thinking is to first evaluate the performance under high-speed and then discuss the potential enhancements if the performance is degraded significantly due to high speed.

For Q3: Thanks for the discussion. In our view, TDOA/RTOA/RTT+AOA/AOD can be used suitable for the cases when RSUs/TPRs/UEs with known coordinates are involved. Otherwise, we may need to use RTT+AOA/AOD for relative positioning.

### **CATT's response to LG**

Thanks for the discussion. Yes, we think there is a need to study how to take the advantage of multiple panels for enhancing the positioning performance, especially for train positioning use case. Multiple antenna panels can be installed with known relative positions in a train and the distances between them can much larger than a V2X positioning.

### **Summary of Round 1 and Round 2 Q&As**

13 companies provided the comments/questions in In Round 1, and 5 companies provided the comments/questions in Round 2 to CATT's proposals for R18 further positioning enhancements.

For positioning based on carrier phase and carrier phase difference measurements, our responses on the key issues are summarized briefly as follows:

Carrier phase measurements can be supported with existing DL PRS/UL SRS in Rel-16. Introducing new reference signals for carrier phase measurements may bring additional advantages.

The time/frequency synchronization errors can be resolved with reference device and double differential techniques as commonly used in GNSS carrier phase positioning

The integer ambiguity can be resolved by taking advantage of R16/R17 positioning with sub-meter accuracy to limit the search space of integer ambiguity to only a few cycles of integers

RAN1 should lead the work, while there may be a small impact on RAN2/3. RAN4 needs to be involved to define the performance requirements of carrier phase measurements.

Carrier phase positioning is most likely used for the case where LOS is dominant. Mitigating the impact of multi-path on carrier phase positioning can be further considered with the consideration of the existing techniques in the area

If existing DL PRS/UL SRS in Rel-16 is used, there is no separate requirement for BW. If new reference signals are introduced for carrier phase measurements, we may need only to use very narrow BWs.

For positioning based on carrier aggregation, our responses on the key issues are summarized briefly as follows:

There is a need to have a feasibility study. RAN4 needs to be involved in the feasibility study.

For positioning for RedCap UEs, our responses on the key issues are summarized briefly as follows:

The accuracy requirement for RedCap devices may be different from eMBB UEs due to reduced capability.

It may be no need to have a separate study phase when existing DL PRS/UL SRS in Rel-16 are used for RedCap positioning.

The side condition for RedCap UEs with multiple Rx branches should be defined in a similar way as eMBB UEs with multiple Rx branches.

RedCap positioning with Uu interface signals can be included in R18 further positioning enhancement SI/WI. If RedCap positioning with SL can either be delayed to future releases or included in SL positioning SI/WI.

We are open to discuss the change of some of the DL PRS/UL SRS configuration parameters to reduce the power consumption.

For Low power high accuracy positioning, our responses on the key issues are summarized briefly as follows:

We consider LPHAP device may be a special type of RedCap UEs or a RedCap UE with a special positioning.

We assume LPHAP targets very small power consumption with a very long life span and support high-positioning accuracy.

We assume low power consumption is achieved by longer sleep time, while high accuracy positioning is achieved through larger bandwidth and more samples of the positioning measurements for each positioning fix. We assume LPHAP devices do not need to support very frequency positioning fixes.

For NR positioning for high-speed trains, our responses on the key issues are summarized briefly as follows:

There is a need to support high-speed train positioning (e.g., TR 22.889). The performance for high-speed scenarios is not investigated so far.

It is a challenge on how to support NR positioning in SFN mode. Further investigation is needed. Using Doppler/RFID tag to keep the track of approaching or leaving a particular RRH/TRP may be a potential solution.

We think there is a need to study how to take the advantage of multiple panels for enhancing the positioning performance.

For Sidelink positioning, our responses on the key issues are summarized briefly as follows:

It might be better to consider the support SL positioning in licensed spectrum first in R18.

In our view, the ranging service can be supported. Ranging information can be obtained from either absolute or relative positioning information.

For AI/ML-based NR positioning, our responses on the key issues are summarized briefly as follows:

Our preference is to include AI/ML-based NR positioning in positioning SI/WI because AI/ML models/algorithms are highly application-specific.

We assume no (or minimum) change on of PHY reference signals and configuration, but focusing on the procedure and measurement reporting for supporting the AI/ML algorithms/models.

We consider RAN1 should lead the work of AI/ML-based NR positioning.

For RAT-dependent positioning integrity, our views are summarized briefly as follows:

Some companies are interested in RAT-dependent positioning integrity. RAT-dependent positioning integrity can be studied to ensure reliability of 5G NR positioning system.

## 3.2 RWS-210413 AI/ML for physical layer in Rel-18

### 3.2.1 Round 1 comments/questions

Please provide your comments to this contribution if any, in the following feedback form.

**Feedback Form 4: Comments or questions to CATT contribution RWS-210413**

**1 – Intel Technology India Pvt Ltd**

For the CSI feedback use-case in slide 7 from the cited paper – Can this formulation be considered in scope

for potential Rel-18 work?

## 2 – CAICT

In page 9, it is proposed that AI model distribute between network and UE should be avoid. Does this mean that AI model should only be deployed at one side?

## 3 – Futurewei Technologies

FUTUREWEI supports the view of performing feasibility study on identified PHY layer use cases that can leverage the strength of AI/ML. We also believe using common evaluation methodology is important. As AI/ML approach is data-driven, we suggest we consider using common datasets for at least testing for identified use cases, which will facilitate the evaluation and benchmark comparison.

For candidate use cases, we believe CSI compression, channel estimation and beam management are valid candidates. For some learning settings that may introduce model distribution between network nodes or between network and UE, they can be further discussed depending on specific use case.

In our contribution, RWS-210038, [https://www.3gpp.org/ftp/TSG\\_RAN/TSG\\_RAN/TSGR\\_AHs/2021\\_06\\_RAN\\_Rel18\\_210038.zip](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_AHs/2021_06_RAN_Rel18_210038.zip), we introduced a few other use cases. Feel free to share your view at: <https://nwm-trial.etsi.org/#/documents/47>

## 4 – Sony Corporation

Thanks for the contribution. We have two questions.

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Does “*The study should avoid the case that an AI module is distributed between network and UE due to its higher complexity and extra burden on air interface*” mean that network doesn’t provide any trained AI model to UE?

-

Considering the CSI compression in page 7, both of network and UE need to have trained AI model. If network doesn’t provide any trained AI model to UE, network and UE should learn AI model individually?

## 5 – DOCOMO Communications Lab.

Thank you for the contribution.

Could you elaborate more on the topic “CSI Compression/prediction @Network Only given in page 7, that is, the “codebook learning”, Will this method give new codebooks based on AI Model interference results instead of the selection of TypeII codebooks which are supported by current specs?

Thanks!

## 6 – Lenovo (Beijing) Ltd

Thanks for the contribution, and we share the same views with you, including the studies on the ‘AI-empowered’ (we termed it as ‘AI/ML-assisted’ in our contribution RWS-210260) and methodology. One question is about the proposal “avoid the case that an AI module is distributed between network and UE”. If an autoencoder is used for CSI compression as illustrated in page 7, the AI module is supposed to be distributed one both sides (i.e., encoder @ UE and decoder @ gNB), right?

**7 – Qualcomm Incorporated**

Is the view that the split inference between network and UE be avoided, is it from the viewpoint of Rel-18 prioritization?

**8 – NEC Corporation**

NEC supports having SI on AI/ML for physical layer.

**9 – Nokia Corporation**

Thank you for the contribution, some questions for clarifications below:

Q1: What concretely is meant by trajectory prediction, the prediction of the path of UE coordinates?

Q2: The Tdoc mentions "Lacking well recognized dataset for training, like ImageNet", which is an interesting and valid point. Are there any more detailed ideas, how such a recognized benchmark dataset would be collected or created (real network data, simulation etc.)?

### 3.2.2 Round 1 answers by moderator

Thank you all for the comments/questions, please find answers below:

**CATT's response to Intel:**

Thanks for the question. The referred CSI feedback use-case involves AI module at both network and UE. If the training of the AI model is split between network and UE, then network and UE need to synchronize the parameters/intermediate results of AI module leading to complex signaling exchange between network and UE. It would be very challenge to finish this kind of study in Rel-18. If the training is performed at one side, and the AI model is provided to the other side, the overhead and complexity seems to be acceptable as long as the AI model does not have to be updated frequently. Of course, the overhead of exchanging the AI model shall be counted as part of the CSI reporting overhead.

**CATT's response to CAICT:**

Thanks for the question. Our first preference is to deploy AI model at one side only. But if AI model is deployed at both sides, we want to avoid that the training procedure is split between network and UE, e.g., exchanging of gradient information between network and UE.

**CATT's response to Futurewei:**

Thanks for the comments. We share the same view that to using common datasets for training/testing identified use cases would be helpful.

**CATT's response to Sony:**

Thanks for the question. Regarding the first question, the distributed AI module here means that the training is split between network and UE. That is, network performs part of the training and sends the intermediate results to UE to complete the training. This is really a complex procedure in our view.

Network provides well trained AI model to UE seems to be acceptable. What we want to avoid is that the training procedure is split between network and UE, e.g., exchanging of gradient information between

network and UE.

**CATT’s response to DOCOMO:**

Thanks for the question. Yes, the output of the AI model is a new codebook which matches the statistics of physical channel better than Type II codebooks.

**CATT’s response to Lenovo:**

Thanks for the question and glad to see that we are aligned on the AI-empowered/assisted physical layer. On the autoencoder/decoder, if the AI model is trained at one side and provided to the other side, the overhead and complexity seems to be acceptable as long as the AI model does not have to be updated frequently. Of course, the overhead of exchanging the AI model shall be counted as part of the CSI reporting overhead. But if the autoencoder/decoder is trained at both sides simultaneously, complicated and resource consuming signaling exchange is needed, e.g., exchanging of gradient information. What we want to avoid is that the training procedure is split between network and UE.

**CATT’s response to Qualcomm:**

Thanks for the question. As explained in previous responses, what we want to avoid is split training between network and UE. Rel-18 could focus on relative simple case, and complicated signaling exchange procedure for split training could be considered in late releases.

**CATT’s response to Nokia:**

Thanks for the question. Regarding Q1, it is the prediction of UE location in future.

Regarding dataset construction, real network data is ideal to have. For example, for certain use case, we can agree on the format of data first, then companies can provide their input as candidate. After validation process, the candidate data could be added to the dataset. If real network data is not feasible due to some reasons, simulation data can be considered. But how to generate the dataset for training and testing from simulation data is to be studied. Construction of a dataset would be a good achievement of this Rel-18 study item if any.

3.2.3 Round 2 comments/questions

Please provide your further comments based on the QA in first round if any.

**Feedback Form 5: Comments or questions to CATT contribution RWS-210413**

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3.2.4 Round 2 answers by moderator

3.3 RWS-210412 AI/ML for higher layer in Rel-18

3.3.1 Round 1 comments/questions

Please provide your comments to this contribution if any, in the following feedback form.

**Feedback Form 6: Comments or questions to CATT contribution RWS-210412**

**1 – ZTE Corporation**

Thanks for the contributions. We agree to focus on the normative work of prioritized AI use cases first. And potential high layer use-case can be studied in Rel-18, such as AI RAN slicing, QoE optimization.

**2 – Futurewei Technologies**

We support the idea that the R17 RAN3 SI should progress further and identified solutions may be turned into WI in R-18. We also share the view that new use cases, such as Coverage and capacity optimization, should be studied.

In addition, as AI/ML approach is data-driven, we also suggest considering using common datasets for at least testing identified use cases, using a common evaluation methodology, as discussed in RWS-210038.

**3 – NEC Corporation**

NEC supports having WI in RAN3 as continuation of the current RAN3 SI and having a new SI as continuation of the current RAN3 SI covering wider scope and use cases.

3.3.2 Round 1 answers by moderator

**CATT's response:**

Thanks to ZTE, Futurewei and NEC for the comments. It is good to know that we share the similar view on Rel-18 work of high layer AI. As to the common datasets raised by Futurewei, we are wondering whether it only applies to physical layer use cases or both high layer and physical layer use cases.

3.3.3 Round 2 comments/questions

Please provide your further comments based on the QA in first round if any.

**Feedback Form 7: Comments or questions to CATT contribution RWS-210412**

3.3.4 Round 2 answers by moderator

3.4 RWS-210415 On energy saving in Rel-18

3.4.1 Round 1 comments/questions

Please provide your comments to this contribution if any, in the following feedback form.

**Feedback Form 8: Comments or questions to CATT contribution RWS-210415**

**1 – MediaTek Inc.**

Thanks for the quality contribution. Below please find our comments:

On **Proposal 1**, we agree that dynamic power saving will be a key enhancement for better system energy efficiency. Since gNB/TRP power saving has impact to UE data activity and power consumption, it is suggested the investigation should take both gNB/TRP and UE into account.

On **Proposal 2**, since the power saving schemes in R15-R17 have extensively optimized single link case and are applicable to XR, REDCAP, CA and DC (R2 SCG suspension). Extension to multi-TRP and multi-panel cases can be further investigated. Regarding power saving enhancement for mobility, is it related to further relaxation of serving-cell RRM measurement?

**2 – Beijing Lenovo Software Ltd.**

Thanks for the contribution.

For UE power saving, if it is associated to MRDC and the mobility enhancement, does it mean the power saving by enhanced RRM measurement or other technique?

**3 – HUAWEI TECHNOLOGIES Co. Ltd.**

Thank you very much for the contribution. Please find one question for clarification as below:

Q1. For adjust the Tx/Rx bandwidth, what kind of granularity for the adjustment in your view, e.g. RB level or BWP level?

3.4.2 Round 1 answers by moderator

Thank you all for the comments. Please find our reply below:

**CATT's response to MediaTek:**

For Q1, We believe that gNB/TRP could achieve the network power saving without impact to the UE data activity and power consumption. For example, gNB could turn off some or all DL RF chains during UE DRX OFF period when there is no DL activity. gNB could also group all UEs in the same DRX cycle during low load period to allow more time in DL RF chain shut down.

For Q2, All power saving techniques from Rel-15, 16, and 17 in time, frequency, and spatial domain, DRX adaptation and PDCCH monitoring reduction could apply to multi-TRP and multi-panel cases since there is no dynamic coordination among multi-TRP Tx.

**CATT's response to Xiaomi:**

The UE power saving for mobility focuses on RRM measurement reduction. The mobility enhancement with multi-TRP techniques in both serving and target cells could reduce the required RRM measurements for mobility management. The UE power saving for MR DC would focus on reducing PDCCH monitoring since not both links have activities at the same time.

**CATT's response to Huawei:**

Since up to 4 BWPs are supported for each cell, the power saving techniques in frequency domain could be simply adjusted based on BWP adaptation in Rel-16 UE power saving study.

### 3.4.3 Round 2 comments/questions

Please provide your further comments based on the QA in first round if any.

**Feedback Form 9: Comments or questions to CATT contribution RWS-210415**

### 3.4.4 Round 2 answers by moderator

## 3.5 RWS-210416 On duplexing enhancements in Rel-18

### 3.5.1 Round 1 comments/questions

Please provide your comments to this contribution if any, in the following feedback form.

**Feedback Form 10: Comments or questions to CATT contribution RWS-2104165**

**1 – LG Electronics Inc.**

Thanks for the contribution. We think the potential work for study of full duplex in page 5 is reasonable. We have one question for our clarification regarding the feasibility of self-interference cancellation/suppression.

Q1) Could you elaborate the practical effects of coupling interference and echoes from the environment?

**2 – Nokia Corporation**

We would see flexible UL/DL studies like gNB-gNB CLI studies for TDD bands more important for deployments in short term. If we should have a SI on FD, then the outlined objectives seem rather reasonable to us. FD, however, may not be practical in short term for practical deployments. Are you considering UE support for FD? Have you studied performance impacts of FD on legacy UEs?

### 3.5.2 Round 1 answers by moderator

Thank you all for the comments. Please find our reply below:

**CATT's response to LGE:**

Thanks for the comments and questions. Echoes refer to reflected signal from the objects close to the transmitter. It would be much stronger than the received signal. As the reflected signal passes a channel unknown to the base station or UE, conventional self-interference cancellation may not work. The coupling interference is caused by the cross talks between Tx chain and Rx chain. This is non-linear and is not easy to cancel.

### **CATT's response to Nokia:**

Thanks for the comments and questions. FD for UE would be much more challenging and would not be feasible in short term in our view. We don't have results on the impacts of FD on legacy UEs by now. It is a good point and should be considered.

#### 3.5.3 Round 2 comments/questions

Please provide your further comments based on the QA in first round if any.

#### **Feedback Form 11: Comments or questions to CATT contribution RWS-210416**

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#### 3.5.4 Round 2 answers by moderator

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## 4 Summary of the discussions

Thanks you all for the comments/questions on the contributions. Summary of the discussions on each contribution is as follow:

### **RWS-210414 On further positioning enhancements in Rel-18**

Based on Q&A discussions, we have the following observations.

**Observation 1:** Many companies are interested in supporting cm-level positioning accuracy with NR carrier phase and carrier phase difference measurements. For supporting NR carrier phase positioning, a number of key issues need to be considered in the SI/WI, including whether it is sufficient to reuse existing DL/UL reference signals for supporting the NR carrier phase positioning, or whether to introduce new reference signals for carrier phase measurements, the methods and solutions for potential challenging issues, including the impact of network time/frequency synchronization errors, multipath mitigation, integer ambiguity resolution, cycle slip detection, the impacts from phase discontinuity in time-domain, etc.

**Observation 2:** Many companies are interested in supporting RedCap positioning. The main discussion is whether we can simply reuse of R17 positioning resolutions for RedCap positioning (the main workload is then in RAN4 for specifying the performance requirements), or there is a need to have further improvements of positioning techniques, signaling and procedures for improving the accuracy, scalability, and reduced UE complexity and/or UE power consumption in RedCap positioning.

**Observation 3:** Many companies are interested in low power high accuracy positioning (LPHAP). The main discussion is what is the mechanism/method that is able to support high-positioning accuracy in one hand,

while having very low power consumption on the other hand. During the SI/WI, there is a need to clear define the target KPIs of LPHAP (accuracy, power consumption, potential battery life, etc.) and study the proper solutions to achieve the target KPIs.

**Observation 4:** Many companies are interested in high-speed train positioning. The discussion focuses on the motivation and the challenges for high-speed train positioning. Due to the special RF environment of high-speed train (e.g., SFN mode, where all TRPs within a cell transmit the same DL reference signals), there is a need during SI/WI to investigate whether existing R16/R17 positioning solutions is good enough to support high-speed train positioning, and if not what kinds of enhancements are needed for supporting high-speed train positioning;

**Observation 5:** Some companies are interested in AI/ML-based NR positioning. For the use of AI/ML techniques to improve NR positioning accuracy, there is a need to study which AI/ML techniques are suitable for NR positioning, and to evaluate the potential benefits of using these AI/ML techniques for NR positioning. It also needs to identify the potential impact on the specification requirements, including the measurement reporting, the signalling, procedures, and the configuration.

**Observation 6:** Many companies are interested in sidelink positioning. It seems most companies consider sidelink positioning should be supported for absolute/relative positioning for in coverage, partial coverage and out of coverage scenarios, and for public safety, V2X and commercial use cases. Many issues, including the target accuracy and latency requirements, evaluation scenarios, sidelink positioning signals, measurements, architecture and solutions (UE assisted/UE based, distributed, cooperative, etc.), resource allocation/coordination, positioning techniques (e.g., SL-RTT, SL-AoA/AOD, sidelink carrier phase positioning), and the spectrum (e.g., ITS, licensed & unlicensed spectrums, FR1, FR2) should be considered in SI/WI.

**Observation 7:** Some companies are interested in RAT-dependent positioning integrity. RAT-dependent positioning integrity can be studied to ensure reliability of 5G NR positioning system.

### **RWS-210413 AI/ML for physical layer in Rel-18**

Two approaches of introducing AI/ML for physical layer are analyzed in the contribution: AI-integrated physical layer and AI-empowered physical layer. An observation is that AI-empowered physical layer is feasible in short term, e.g., Rel-18, Rel-19, while AI-integrated physical layer would be a long-term evolution. An Rel-18 study item should focus on evaluation methodology including construction of dataset. The study should avoid the case that an AI module is distributed between network and UE.

9 companies participate in the discussion and provide valuable insight. Most questions are about the

functionality split between network and UE. We clarified in the response that we would like to avoid splitting the training procedure between network and UE. If the training of the AI model is split between network and UE, then network and UE need to synchronize the parameters/intermediate results of AI module leading to complex signaling exchange between network and UE. It would be very challenge to finish this kind of study in Rel-18. If the training is performed at one side, and the AI model is provided to the other side, the overhead and complexity seems to be acceptable as long as the AI model does not have to be updated frequently. However, how to transfer the model between NG-RAN node and UE need further consideration.

### **RWS-210412 AI/ML for higher layer in Rel-18**

In this contribution, we propose to have a WI which focuses on normative work of the prioritized use cases in Rel-17 and a SI to further discuss the use cases which is not finished in Rel-17. Furthermore, it is proposed to consider how to support AI in 5G pending to the conclusion in SA.

During the discussion, companies share the similar view and no questions is raised. One company proposes to use common datasets and common evaluation methodology for the identified use case. We are open to that and also are not quite sure on whether it applied to both high layer and physical layer use cases. Based on the discussion, our general proposal is to have a Rel-18 high layer AI WI and Rel-18 high layer AI SI as well.

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### **RWS-210415 On energy saving in Rel-18**

In this contribution, we provide our opinions on network energy saving and UE power saving. The general view from our side is to further discuss whether/how to improve network's ability to switch off cell group / cells or adjust the Tx/Rx bandwidth and to consider topics such as XR, Redcap, MRDC, mobility for UE power saving.

During the discussion, there is question on whether network power saving should also investigate the impact to UE and our view is that gNB/TRP could achieve the network power saving without impact to UE data, activity and power consumption. As to another question on UE power saving for mobility, we clarified that it should focus on RRM measurement reduction. For the granularity on adjustment of RX/TX bandwidth, we think it could be adjusted based on BWP adaptation in Rel-16 UE power saving study.

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### **RWS-210416 On duplexing enhancements in Rel-18**

In the contribution, category of full duplex and technology component to enable full duplex are summarized. Based on that, the potential work on duplexing enhancement is outlined:

Identify deployment scenarios/use cases/frequency band for operation of full duplex;

Study the methodology of evaluating full duplex schemes, including at least channel model, performance metric and baseline system configuration;

Study the feasibility of self-interference cancellation/suppression, taking into account practical effects such as coupling interference and echoes from the environment;

Study and identify solutions for inter-cell/intra-cell interference management;

Evaluate the performance gain of full duplex in terms of agreed performance metric over the agreed baseline system;

Two companies participate in the discussion. The practical effects of coupling interference and echoes from the environment to self-interference cancellation was questioned and clarified. The impact of full duplex to legacy UEs was also raised during the discussion. This is a good point and should be considered in future study.