RAN-R18-WS-crossFunc-vivo - Version 0.0.5
RAN

3GPP TSG RAN Rel-18 workshop RWS-210647

Electronic Meeting, June 28 - July 2, 2021

Agenda Item: 4.3

Source: vivo

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

1 Introduction

This NWM document is used to capture the Q&A about the following vivo contributions for Rel-18 cross-functionalities.

Table 1:

RWS-210168	Motivation for new study item on ultra-low power wake up signal in Rel-18	vivo, Spreadtrum communications, Guangdong Genius
RWS-210169	New SID: Study on ultra-low power wake up signal in Rel-18	vivo
RWS-210170	Study on AI/ML based air interface enhancement in Rel-18	vivo
RWS-210171	Support of lower UE power class for Uu and SL in Rel-18	vivo
RWS-210172	Enhanced support for personal IOT networks in Rel-18	vivo
RWS-210173	Further sidelink enhancements in Rel-18	vivo

2 Questions and comments

2.1 General questions and comments

Feedback Form 1: 1st round of general questions and comments

Feedback Form 2: 2nd round of general questions and comments

2.2 Study on ultra-low power wake up signal (RWS-210168, RWS-210169)

The two contributions proposed a new SID to study the ultra-low power wake up signal which allows the device to monitor the signal by a separate receiver component than the main radio receiver, with extremely low power consumption (100x 1000x times power reduction from the existing IDLE mode)

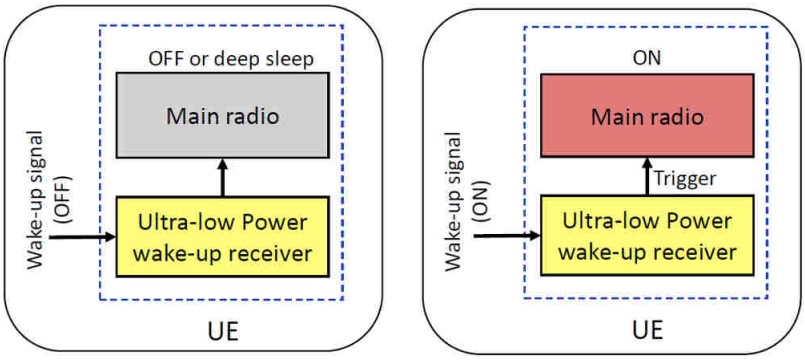

Figure 1:

2.2.1 1st Round-Questions

Feedback Form 3: 1st round of questions and comments to RWS-210168 and RWS-210169

1 – MediaTek Inc.

Thanks for the quality contributions on further UE power saving enhancement with ultra-low-power wake-up. In WIFI, there is design of wake-up-radio (WUR), a.k.a. 802.11ba, that allows both base-station and UE to stay in ultra-low-power states during data inactivity. It is reasonable to investigate whether and how we can also bring the ultra-low-power wake-up to NR.

From R16 and R17 analyses, periodic link maintenance activities, including connected-mode CSI measurements and idle-mode serving-cell RRM measurements, dominate the minimum UE power consumption. Identifying the possible use case/scenario or mechanism that allow relaxation of the link maintenance activities can be the starting point to justify the possible application of a new ultra-low-power wake-up mechanism. Since such case, if existing, doesn't restrict to REDCAP UE, more generic investigation can be considered for developing a universal feature for all NR UE types.

The sensitivity limit of the ultra-low-power wake-up should also be taken into account, and local networking related scenarios looks proper for this technology. Since SL has local networking use case, SL wake-up signaling can also be a good starting point for applying the ultra-low-power wake-up design.

2 – Classon Consulting

[for FUTUREWEI]

Thanks for the very nice paper and descriptions!

Harvesting energy is interesting.

AZP is interesting.

3 – Beijing Lenovo Software Ltd.

Thanks for this interesting paper and the valuable consideration on UE power saving.

This ultra-low power wake-up signal/receiver may have more function compared with the wake-up-signal in NB-IOT for paging enhancement. It may be applied to the UE in idle mode or to the UE with sparse data transmission in inactive mode or connected mode.

4 – CATT

Thanks for the contributions with summary of literature survey on low/ultra-low power and passive receiver for UE wakeup. This is the continuation of CATT's proposal of NR UE power saving in Rel-15. The wide range of receiver sensitivity of low power receiver and passive receiver in the research would create the challenge in the system design to support low power consumption WUS. We would like to clarify the objectives of the proposed study

(1) Should we have design target or requirements for the low/ultra-low power and passive WUS in order to have the study results to meet the target goal?

(2) Most studies of low-power or ultra-low-power receiver sensitivity from literature are based on the experience in a specific carrier frequency. How do we design and evaluate the low-power WUS for NR?

(3) Since the low/ultra-low power WUS receivers from literature are prototype, what is the assumption in the low power WUS study to be used for the NR system design?

5 – SoftBank Corp.

Thanks for the interesting proposals. On ultra-low power wake up signal, can I ask your assumption on the mobility scenario? It seems from your contribution that no mobility is assumed to maximize the benefit of this technology... Please correct me if I misunderstand.

6 – ZTE Corporation

Thanks for the nice paper on further UE power saving enhancement with ultra-low-power wake-up. Further power saving enhancement is beneficial for the battery life of IoT related use cases (industrial wireless sensors, wearables, ...). We are interested in studying the solution of using ultra-low power wake-up. A study item on this is more appropriate.

7 – Xiaomi Communications

[Xiaomi]

Thank you for the good contribution and analysis. It's quite informative. We have the following questions for clarification

(1) It seems additional hardware is required, how about the cost increase for this additional hardware? Considering the IoT devics are sensitive to the cost increase, Maybe the cost analysis can be included into the objective part.

(2) On P10, there is figure showing the transision between AZP and the regular idle mode, do you intend to introduce another new RRC status?

(3) As for the application scenario, is it only for the low-mobility devices?

8 – China Telecom Corporation Ltd.

Thank you very much for the contribution in this paper. Idle mode power saving is critical for UE battery life, the research of ultra-low power mechanism has important application value and development prospect. Do application scenarios support multiple RAT types?(e.g. NR, LTE, etc.), and what is the impact of signal and wake-up procedures design?

9 – Guangdong OPPO Mobile Telecom.

thanks for interesting paper. In general we think AZP signal is attractive to save more power for device. We have few questions for clarification as below:

1, Does the feature target smart phone or Recap/IIoT device or both?

2, Which RRC state does this feature target?

3, Is it correct understanding the only Uu interface is focused in Rel18?

4, In slide 10 of RP-210168, there is switch between regular IDLE mode operation and advanced operation, how would UE and nework alignment between each other?

10 – Asia Pacific Telecom co. Ltd

Thanks for well preparing the great slides and the draft SID on ultra-low power WUS study. We share the similar view that the pros of this new signal is to avoid the latency on the receiving of the legacy wake-up signals, such as PEI, WUS, and/or paging. However, since a new hardware module or RF receiver may be needed for receiving the ultra-low power WUS, we feel curious what kind of UE devices could equip this. The cost of the RF receiver may need to be taken into account for lower-end UEs, e.g., wearable devices, IoT, or Redcap.

On the other hand, we would like to clarify more on the objectives of this new signal:

(1) The ultra-low power WUS can be used for RRC_IDLE, RRC_INACTIVE, and/or RRC_CONNECTED state?

(2) What's the intention of "wake-up" here? Is to ask the UE to monitor the PO or PEI? or any other further UE behaviors?

(3) The ultra-low power WUS can only provide the 1-bit (e.g., wake-up/non-wakeup) information or it could provide more information to the main radio?

(4) How's the detection error rate of the ultra-low power WUS? It seem the paper does not show the reliability of this new signal.

11 – Intel Corporation (UK) Ltd

Q1. Have you consdiered possible coverage and detection performance for WUR if employing envelope detection (for OOK signals), especially considering multi-cellular setup (inter-cell interference)?

Q2. Although the proposal seems to be applicable to "all device types", it is not clear if such operation makes sense for eMBB/URLLC, or even some of IoT traffic, except for latency-tolerant use-cases with very infrequent (mobile terminated) traffic. For such use-cases, do you see significant benefits beyond proper EDRx configurations?

Q2a. Have you considered that, for the main radio to be powered on, achieving sufficient sync for paging reception, there may need to be a significant "warm-up time", implying non-negligible paging delays?

Q2b. Do you see applicability to use cases involving any kind of mobility support?

12 – Apple Italia S.R.L.

Thanks for the interesting paper and the draft SID. Overall we think this is an interesting topic because UE power consumption has become more and more important due to large bandwidth/data rate, various applications and device types. We Some clarification questions:

(1) Is the proposed SI intended for idle/inactive-mode UEs only or for connected UEs also?

(2) We agree with MediaTek that the RRM/CSI measurement/report consumes a lot of power, so this aspect will need to be taken into account.

(3) Is it better to have this independent from RedCap because it can be potentially used by any types of UEs?

13 – Verizon UK Ltd

Thanks for the proposal. We are supportive of sequence based wake up signal even for Rel-17. This obviously is an even more aggressive solution. A few comments:

1) This is a very important feature for device battery life

2) Please provide further clarification on target use cases, e.g. device types, RRC state, mobility state, etc

3) What is the expected latency from the detection of AZP wake up signal to the normal main radio operation?

14 – China Mobile Com. Corporation

Thanks for the contribution! We have some questions need to be clarified.

Question 1: does the ultra-low power wake up signal is UE-specific or UE-group specific?

Question 2: about multiplexing of wake-up signals, it is intra-UE multiplexing or inter-UE multiplexing?
Question 3: about main radio activity procedure, if one UE supports multiple main radios, does the relationship of ultra-low power wake up signal(s) and main radios is one-to-one mapping or one-to-N mapping?

15 – Samsung Electronics Polska

Thank you for the good paper and draft SID. Power saving is very important for NR devices. We have few questions:

1. Can you clarify the use case of Ultra-low power WUS? Is it used when UE is paged in idle /inactive mode or it's used for long DRX cycle in connected mode□

2. Idle mode or inactive mode measurement may also require a lot of UE power. Will this ZP-WUS help on measurement as well?

3. This ZP-WUS seems to require additional hardware. What is the expected the cost and size?

4. What kind of new design is expected for ZP-WUS detection, e.g., new waveform or new sequence?

Besides, we think co-exsitence need to be ensure. And the impact to network might also need to be studied.

16 – Qualcomm Incorporated

1) What device type would be main target for AZP WUR? (e.g., eRedcap, NB-IoT?)
2) Depending on considered main radio (e.g., eMBB vs NB-IoT), the deep sleep current would be different, which could limit overal battery life even with AZP WUR. What is vivo's assumption on sleep current of main radio of interest?
3) In slide 10, the state transition diagram for idle mode is shown. Is this new idle state (AZP) always

necessary to support AZP WUR w/ main receiver?
4) The figure in slide 10 shows that only cell center UEs can use AZP WUR due to sensitivity limitation. This means service would not be uniform within a cell. Does vivo also consider WUS coverage extension to support AZP WUR in cell edge?

17 – Sony Europe B.V.

On RWS-210168

We are also interested in the evolution towards zero power communications and use of energy harvesting, as discussed in RWS-210302 and RAN-R18-WS-non-eMBB-SONY

slide 11, what type of energy harvesting method do you have in mind? Is it harvesting based on ambient energy or wireless power transfer?

On RWS-210169

- We think that items listed as SIs are good.

-

When it comes to network reachability do you consider methods where the range in AZP can reach the same range as in VLP and NR or do you consider AZP has a limited coverage/range?

18 – Huawei Tech.(UK) Co.. Ltd

On page 1, regarding the 'average current @IDLE', is it an average value across deep sleep, RRM measurement and paging reception, or a value only for deep sleep?

The coverage of the AZP-WUS seems to be smaller than that of normal paging message. How the network knows whether a UE to be paged is utilizing AZP-WUR for power saving, or utilizing the main receiver in IDLE mode?

In page 4, is the RF sensitivity of -20dBm for "zero power" valid for all kinds of energy harvesting? Or may it only derive from harvesting energy from received RF signals?

The pages on use cases emphasized wearable devices. Do you think smart phones can also use the AZP-WUR for further power saving?

19 – DOCOMO Communications Lab.

Thanks for the good contribution. We would like to ask following questions:
Q1: Is ultra-low-power wake up applied only for idle mode?
Q2: In page 10, what is the intention of "Network controlled UE behavior"? Could you elaborate it more?
Q3: For AZP receiver and VLPs receiver, a common solution/procedure is applied for both of them, or independent solution/procedure is defined respectively?

2.2.2 1st Round-Answers

Table 2:

Respond to	Answers

MediaTek	Thanks for your comments and questions. We agree to investigate a unified ultra-low-power wake-up mechanism applicable for all UE types rather than restricted to REDCAP UE. Regarding to link maintenance, currently we are considering no measurement at least when UE monitors the ultra-low power wake-up signaling in order to minimize power consumption. SL is one of the potential scenarios of ultra-low-power wake-up mechanism, but it can be also applied to NR, LTE. We think it would be optimal to have a unified ultra-low power wake-up signal design applicable to different main radio technologies. And it is important to study how to ensure the reachability during the SI work.
Futurewei	Thanks for your interest. Ultra-low-power wake-up mechanism is expected to reduce the power consumption 100x-1000x times compared to the current IDLE state power consumption.
Lenovo	Thanks for your comments and questions. This ultra-low power wake-up signal/receiver is mainly proposed for reducing power consumption in idle/inactive state. We are open for connected mode if use cases are clearly identified. Compared to NB-IOT, ultra-low power wake-up signal/receiver is expected to bring lower power consumption by using a simpler receiver structure, e.g., envelop detector, and the advantage compared to eDRX is that NW does not need to wait long time for the next DRX on in order to wake-up UE.
CATT	Thanks for your comments and questions. A1: The design target and requirements may vary for different receiver structure, e.g., hardware design, which can be discussed in the initial stage of SID work. A2: A set of candidate carrier frequency can be considered in the start. For example, we can follow the evaluation assumption used for NR. A3: In our opinion, a simple RF front-end receiver structure including envelop detector, can be used as a reference receiver structure. There is an illustrative example in our t-doc. Other receiver structure are not precluded for studies.

SoftBank	Thanks for your comments and questions. From our view, ultra-low power wake-up is not limited to stationary scenario, low-mobility scenario is also applied. And solutions to mobility scenario can be studied in SID work.
ZTE	Thanks for your comments and questions. We agree that a study item is necessary. Besides IoT, it is important to investigate a unified ultra-low-power wake-up mechanism applicable to all UE types.
Xiaomi	Thanks for your comments and questions. A1: In our opinion, a simple RF front-end receiver structure including envelop detector, can be used. From literature, the size of such receiver based on 65nm CMOS can be designed as small as 1mm * 1mm. The chipset cost can be estimated based on the die size. And it is expected that the cost increase is marginal for such a small die size. We can further discuss the cost in the study item. A2: When UE monitors ultra-low-power wake up signal, the behavior is different with regular state, e.g., no RRM measurement. It will be discussed in the SI whether a new RRC state should be introduced or not. A3: From our view, ultra-low power is not limited to stationary scenario, low-mobility scenario is also applied. And solutions to mobility scenario can be studied in SID work.
China Telecom	Thanks for your comments and questions. As the ultra-low power receiver for receiving wake-up signal can be separated with main radio, it can be versatile to wake up multiple main radio technologies, e.g., NR, LTE, sidelink and so on. And the impact of signal and detailed wake-up procedures can be studied in the SI.

OPPO	Thanks for your comments and questions. A1: We think it would be good to investigate a unified ultra-low-power wake-up mechanism applicable for all UE types rather than restricted to a particular device type. A2: It is mainly target for IDLE/INACTIVE UEs and whether it is applicable for CONNECTED UE is open for discussion if a clear use case is identified. A3: As the ultra-low power receiver for receiving wake-up signal can be separated with main radio, it can be versatile to wake up multiple main radio technologies, e.g., NR, LTE, sidelink. A4: Network and UE alignment is necessary e.g., UE may send a confirmation message to the network once it operates in monitoring ultra-low power wake-up signal.
Asia Pacific Telecom	Thanks for your comments and questions. A1: This ultra-low power wake-up signal/receiver is mainly proposed for reducing power consumption in idle/inactive state. We are open for connected mode if use cases are identified. A2: The ultra-low power wake-up signal/receiver is to trigger UE to return to regular idle mode, after then UE can follow legacy idle behavior, either PO or PEI, depending on the configuration. A3: Both can be considered, more than one bit can be used , i.e., indicating UE grouping like in PEI. A4: It's quite important to evaluate detection error rate of the ultra-low power WUS. Reasonable BLER target rate shall be considered. We see some results in IEEE 802.11ba to show the performance of such OOK detection, e.g., . less than 10% error rate at receiver minimum input level sensitivity -82dBm/-77dBm depending on different data rate. This is an topic requires extensive study in the SI.

Intel	Thanks for your comments and questions. A1: We agree that multi-cellular setup (inter-cell interference) is important, and we believe OOK can work with proper design since the expected data rate for WUS should be very low. The design details can be studied further. A2: For eDRX case, very long PTW cycle is expected to be used to achieve extremely low power consumption, resulting in very high wake-up latency, which is not suitable for services with requirements of both long battery life and low wake-up latency. For example, in fire detection and extinguishment use case, fire shutters shall be closed and fire sprinklers shall be turned on by the actuators within several seconds from the time the fire is detected by sensors, long eDRX cycle cannot meet the delay requirements. Similar requirement exists for wearables. We have give some example use cases in our slides Page 1 and 2. A2a: We agree that there is warm-up time, and about 1-2s is expected, including hardware turning on, synchronization, paging reception and etc. A2b: From our view, ultra-low power is not limited to stationary scenario, low-mobility scenario is also applied. And solutions to mobility scenario can be studied in the SI.
Apple	Thanks for your comments and questions. A1: This ultra-low power wake-up signal/receiver is mainly proposed for reducing power consumption in idle/inactive state. We are open for connected mode if use cases are identified. A2: Regarding to link maintenance, currently we are considering no measurement when UE monitors the ultra-low power wake-up signaling to minimize power consumption. A3: We agree to investigate a unified ultra-low-power wake-up mechanism to all UE types, rather than restricted to REDCAP UE.

Verizon	Thanks for your comments and questions. Device types: We expect to investigate a unified ultra-low-power wake-up mechanism to all UE types RRC state: This ultra-low power wake-up signal/receiver is mainly proposed for reducing power consumption in idle/inactive state. We are open for connected mode if use cases are identified. Mobility state: From our view, ultra-low power is not limited to stationary scenario, low-mobility scenario is also applied. And solutions to mobility scenario can be studied in SID work. The expected latency from the detection of AZP wake up signal to the normal main radio operation is expected in the order of 1 2 seconds
China Mobile	Thanks for your comments and questions. A1: We are not precluding any solution at current stage, both UE-specific and UE-group specific may be considered. A2: The multiplexing of wake-up signals refers to the multiplexing of wake-up signals for different UEs or different UE groups. A3: As the ultra-low power receiver for receiving wake-up signal can be separated with main radio, it can be versatile to wake up multiple systems, e.g., NR, LTE, sidelink.
Samsung	Thanks for your comments and questions. A1: This ultra-low power wake-up signal/receiver is mainly proposed for reducing power consumption in idle/inactive state. We are open for connected mode if use cases are identified. A2: Currently we are considering no legacy measurement when UE monitors ultra-low power wake-up signaling to minimize power consumption. A3: In our opinion, a simple RF front-end receiver structure including envelop detector, can be used. From literature, the size of such receiver based on 65nm CMOS can be designed as small as 1mm * 1mm. Low cost can be achieved by having a small die size. We agree that the cost can be analyzed in the SID work. A4: New waveform or new sequence would be needed for a simpler receiver to reduce power consumption, e.g., OOK signal has been widely used. A5: We agree that co-existence is important, and OOK can work well with proper design, where the design details can be studied later.

Qualcomm Incorporated	Thanks for your comments and questions. A1: We expect to investigate a unified ultra-low-power wake-up mechanism to all UE types A2: Our assumption on main radio deep sleep current is eMBB, e.g., smart phone and smart watch. And from our internal testing, the sleep current is 8.5 mA and 2.0mA for 5G smart phone and 4G smart watch, respectively. A3: At first, when UE monitors ultra-low-power wake up signal, the behavior is different with regular state, e.g., no RRM measurement. At least it is feasible for main receiver to support legacy state operation only. Whether to support a new state by main receiver can be discussed if new functionality is needed. A4: There is a trade-off between power consumption and sensitivity. There would be sensitivity degradation if an extremely low power consumption is targeted. The coverage extension (sensitivity improvement) could be achieved with the cost of higher power consumption
Sony	A1: Our assumption on ambient energy harvesting is taken from RFID, e.g., -20dBm, as shown by some commercial RFID product. A2: There is a trade-off between power consumption and sensitivity. There would be sensitivity degradation if an extremely low power consumption is targeted.
Huawei	A1: The "average current @IDLE" is an average value across deep sleep, RRM measurement and paging reception A2: Network and UE alignment is necessary e.g., via sending confirmation message the network. A3: The RF sensitivity of -20dBm refers to harvesting energy from received RF signals. A4: We think a unified ultra-low-power wake-up mechanism can be designed and applied to all UE types.

2.2.3 2nd Round-Questions

Feedback Form 4: 2nd round questions and comments to Study on ultra-low power wake up signal (RWS-210168, RWS-210169)

1 – Huawei Tech.(UK) Co.. Ltd

Thanks for the reply.

If the wake-up radio is assumed to be applied to multiple RATs as you indicate in other responses, can you share some thoughts on the framework? For example, which bands will be used for the wake-up signal? Will it be like a standalone or in-/guard-band type of arrangement? What would be relevant bandwidth for the wake-up signal?

2 – ZTE Corporation

Thanks for the reply. We want to further clarify, for a non-fixed UE, how to judge the UE is in low mobility scenario and can apply the ultra-low-power wake-up mechanism?

For performance evaluation, when we evaluate the power saving performance of ultra-low-power wake-up mechanism, do you think the impact of multiplexing capacity of wake-up singals should be considered?

3 – Intel Corporation (UK) Ltd

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The feasibility with respect to coverage and in multi-cellular scenarios would be one of the most important considerations to ensure that sufficient power saving gains are still available while maintaining reasonably high operational reliability for the communication system. These considerations are important, especially when the impact from a missed WUS can be very serious, e.g., public safety-related or mission critical use cases as alluded to in your answer A2 in previous round. Overall, it needs to be ascertained that the feature can be used beyond some very specific use-cases. If the applicability is extremely narrow, there may be little motivation to implement such a feature at either UE or network ends, irrespective of spec support.

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For the safety-related use-cases mentioned in context of requiring fast reaction time within several seconds, would it not be counterintuitive to devise a scheme that consumes multiple of these few seconds just to wake the main radio up? For such use-cases, perhaps paging latency should be minimized by following existing methods?

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For mobility support, if the main radio would need to be engaged frequently enough, would there be benefits from a separate radio that relies on no measurements/activities for the main radio for prolonged periods?

4 – DOCOMO Communications Lab.

Thanks for the good contribution. We would like to ask following questions:
Q1: In page 10, what is the intention of ”Network controlled UE behavior”? Could you elaborate it more?
Q2: For AZP receiver and VLPs receiver, a common solution/procedure is applied for both of them, or independent solution/procedure is defined respectively?

5 – China Unicom

Thanks for your contributions and clarification. Ultra-low power wake up signal enhancement is a very interesting topic for UE power saving. It’s expected to investigate a unified ultra-low-power wake-up mechanism to all UE types, thus based on different UE types, such as on smart phone and smart watch,

are there different trade-off mechanisms between power consumption and sensitivity? i.e. smart watches focus on low power consumption, while mobile phones focus on high sensitivity. Is it right?

6 – Samsung Electronics Polska

Q1: Can you clarify more about the use case and functionality of the ZP WUS in idle mode? Does it target a single UE depending whether or not there is traffic per UE? Is the functionality same as the PEI introduced in Rel-17 PS but with much lower detection power?

2.2.4 2nd Round-Answers

Table 3:

Respond to	Answers
Huawei	Thanks for further question. From our view, both in-band and out-band operation for wake-up signal are possible, and for in-band case, the interference may be critical and the coexistence of wake-up signal and legacy signal/channel should be further studied. Considering the required low power consumption for wake-up signal detection, simple design, e.g., OOK signal can be considered, and a narrow bandwidth, e.g., 5MHz or less may be adequate.
ZTE	Thanks for follow-up. In general, ultra-low-power wake-up may not be beneficial for high mobility scenario as measurement may have to be performed frequently, while for low mobility scenario, UE main receiver can be switched off or go sleep, and can be waken up when necessary. The proper low mobility scenario definition and identification can be discussed further in SID phase, e.g., depending on use case (indoor), relying on some measurement to determine whether UE can enter into the ultra-low power wake up signal monitoring mode. Regarding to the multiplexing capacity of wake-up signals, we agree that it should be considered especially designing a narrow band wake-up signal.

Intel	Thanks for your further comments, we agree that the coverage and reliability shall be ensured while pursuing the power saving gain. And the potential requirements may vary across the different deployment scenarios, i.e., from medium reliability to high reliability. Also, the achievable range and reliability by wake-up signal can be studied in the SID phase. Regarding to the scenario applicability, we agree with you it would be better to design a generic feature which can be potentially applicable to various scenarios, as analyzed in our RWS-210169, e.g., 5G phones/wearables, commercial terminals employing sidelink, as well as industry wireless sensors, actuators, asset tracking and so on. For automation system, both low power and wake-up latency are required and wake-up signal is able to prolong the battery life of actuator and reduce latency compared to eDRX. Fire detection is a special case of automation here, and whether the potential requirements can be satisfied or not by wake-up signal can be studied. We believe the several seconds should sufficient for UE to switch on the main radio if waken up. Existing methods for reducing paging latency, e.g., reducing paging cycle, will increase UE power consumption. Ultra-low power receiver can operate in a very low power consumption level while monitoring for potential wake-up indication continuously. This is achieved by a separate receiver which can be studied in Rel-18. In general, ultra-low-power wake-up may not be beneficial for high mobility scenario as measurement may have to be updated frequently, while for scenarios with limited mobility, e.g. indoor case, we think it is worthwhile to study it. In general it would be beneficial to consider wider application scenario as much as possible.

DOCOMO	Thanks for your further comments For Q1, Network controlled UE behavior indicates that the network can control UE work in ultra-low-power wake-up mode or regular mode and switch between them. For Q2, as the power consumption level is different, we believe at least different hardware designs are required for AZP receiver and VLP receiver, and accordingly the structure of wake-up signal may be also different. We can study them in the study item and possibly make a down-selection between the two, or consider both of them for different scenarios with some design commonality.
China Unicom	Thanks for your nice question. While for smart phone, low power consumption and high sensitivity of the wake-up receiver are both important. We agree that there is trade-off between power consumption and sensitivity. And we will target for study these aspects in the study item. For example in our contribution, AZP receiver and VLP receiver are two good examples. While AZP receiver has better power consumption than VLP receiver, and VLP receiver has better receiver sensitivity than AZP receiver.
Samsung	Thanks for your further questions. The functionality of AZP WUS is different from PEI in Rel-17. For AZP WUS, the wake up receiver is used to receive WUS only. The main radio can be switched off or in deep sleep when no data to transmit or receive, while the wake up receiver can always monitor the AZP WUS. The main radio only wakes up when there is an on-demand wake up. There is expected to be no or very relaxed RRM measurements performed when the main radio is off or in deep sleep.

2.3 Study on AI/ML based air interface enhancement (RWS-210170)

Performance studies for various use cases by utilizing AL/ML for air interface performance improvements were shown in the contribution, including CSI feedback, DMRS channel estimation, SRS overhead reduction, CSI-RS overhead reduction, beam management, channel prediction, positioning, etc. The contribution also proposed to a RAN level study item followed by RAN1-led study item for AI/ML based air interface enhancement in Rel-18.

2.3.1 1st Round-Questions

Feedback Form 5: 1st round of questions and comments to RWS-210170

1 – CAICT

Q1: In page 3, if the fast growing of NPU capacity in UE side could be used for both AI model inference and training?

Q2: Even AI model is hard to specify, if some AI model related consensus (maybe use cases related) is necessary in RAN level study?

2 – ZTE Corporation

On P8 and P9: In your simulation and test on DMRS channel estimation, is precoding performed on DMRS? If so, is same or different precoding used for training and inference?

3 – SHARP Corporation

Thank you for the slides with many detailed use cases.

Regarding the use case of CSI-RS overhead reduction, it is shown that AI based CSI-RS compression achieved even better throughtput performance than that with full CSI-RS overhead. It is understandble that approaching performance could be achieved by AI based method, since less CSI-RS ports are used. We are appreciated to see some clarifications:

- The underlying reasons of achieving even better throughput
- Definition of throughput and the intermediate steps from estimation to throughput if possible

4 – LG Electronics France

Q1) RWS-210170 is very impressive to us, covering diverse application of MLs in radio interface. Do you think RAN level study is necessary and efficient enough, compared to RAN WG level study? Instead of having RAN level study, do you think it may be good to have joint WG study phase from scratch?

Q2) Can you elaborate mobility use cases in consideration with AI/ML?

5 – Intel Corporation (UK) Ltd

For use-case-3, could you clarify what is “exchange of NN information” – who is responsible for model training here (NW, UE or both?) as a baseline case.

6 – CATT

Thanks for the contribution, and we have following questions for clarification:

Q1: On page 3, how is the complexity of a AI network calculated?

Q2: On use case 1, if the overhead of exchanging information related to neural network is also considered as part of CSI reporting overhead, can AI based CSI feedback still achieve better performance-overhead tradeoff than Rel-16/17 standardized codebook? Is the AI encoder/decoder common to all UEs in the simulation setup?

Q3: On use case 2, is the neural network for positioning trained for each UE individually, or a single neural network trained for all UEs in the simulation? Is the sync error remains constant during the training phase and testing phase?

Q4: On use case 3, AI module for DMRS channel estimation is a receiver side implementation, but why would neural network related information have to be exchanged between network and UE? How is the neural network trained? Does UE use the real channel, which is unknown to anyone in reality, to train the neural network?

Q5: On use case 4/5, how is the neural network trained? Does gNB use the real channel, which is unknown to anyone, to train the neural network? Why would neural network related information have to be exchanged between network and UE?

Q6: On use case 6, why would neural network related information have to be exchanged between network and UE? During the training phase, UE has to measure all beam pairs. The overall overhead and complexity depends on how often the training is performed.

Q7: On use case 7, channel prediction can be implemented at gNB based on available information, but why would neural network related information have to be exchanged between network and UE?

Q8: On the categorization of positioning use case, it seems that all the inference is carried out at UE side. What is the role of network?

Q9: On the categorization of channel estimation use case, what does it mean by DMRS compression? What is the result of DMRS compression? A new sequence? A new pattern?

Q10: On evaluation methodology, how to generate training data and testing data with channel model in 38.901? What is the difference between generating training data and testing data? How to guarantee that the resulted neural network has good performance in practical?

Q11: Standard impact for different use cases may be very different. Studying these aspects to all use cases (e.g., CSI, beam management, reference signal, positioning) in a single study item would involve a large group of experts and large amount of work. What's vivo's view on how to progress the study?

7 – Sony Corporation

Thanks for the contribution. We have two questions.

- Does "*Exchange of neural network information*" mean that gNB provide the neural network model to UE? Or, other means?

- Do you assume that the algorithm for ML-based advanced positioning is handled in the same way as the ML-algorithm for CSI?

8 – Asia Pacific Telecom co. Ltd

Thanks for the contribution.

We share the same views that supporting AI/ML in 3GPP technologies is an important step to the future.

We also have some questions for clarification.

(1) On page 5, it stated that AI/ML can be applied at either one side or both sides of the communication link. But, in the following examples cases, possible specification impacts all include neural network information exchange between network and UE. Can you elaborate on it? Does it mean that applying AI/ML on both sides will lead to better performance?

(2) On Page 18, the “mobility” use case is mentioned without further information. Can you elaborate on it?

(3) Do you have further views on making progress for supporting AI/ML in 3GPP technologies considering that there are many different models, uses cases, and categories to be studied?

9 – Verizon UK Ltd

Thanks for the interesting proposal. A few questions:

1) The simulation results seems promising. Would be happy to see further network performance improvement by AI/ML.

2) What is the motivation to divide the use cases into 4 categories

3) Do you think it is possible to start WI work in Rel-18?

10 – Lenovo (Beijing) Ltd

Thanks for the quality contribution with a lot of exciting initial evaluation results with AI/ML. It can be clearly observed that AI/ML-based approaches can be better than the traditional methods once being well trained with the data set from the same simulation model. However, as also mentioned in your contribution, in practice, especially for standardization, we have to consider much more issues.

On the proposals, we have the following questions/comments:

Q1: What do you mean ‘Model alignment between companies’? We don’t think it make sense to discuss and conformance AI/ML model construction in 3GPP.

Q2: How do you think to evaluate the ‘generalization performance’?

11 – Apple Hungary Kft.

”exchange of neural network related information between network and UE that facilitate learning and inference” is proposed for many use cases. Would you elaborate more why NN related information exchange is need to facilitate learning, particularly for channel estimation related use cases?

12 – Fujitsu Limited

Thanks for the contribution and efforts on providing so many big gain cases of using AI. We have two question on use case3. The simulation parameters mentioned that ”one AI model for all scenarios” and showed its gain in all simulation scenarios.

1. Have you compared the performance difference of using one AI model vs. using multiple AI models?

2. What is your view on AI model life cycle and update?

13 – China Mobile Com. Corporation

Thanks for the contribution.

1. Example Case7: What is the duration of the predicted channel information?

2. For each use case, whether the AI model can be implement specific or only aligned/recommended AI model(s) can be considered?

14 – MediaTek Inc. Thanks for the contribution. A question for clarification: 1) How to obtain data set (e.g., single UE or multiple UEs) for training and inference? Are the models UE-specific, or cell-specific, or else?
15 – Qualcomm Incorporated For example case 1, there is good gain offered by AI, but 1) what is the SNR range tested/trained and 2) the channel type assumed in simulation and 3) what is the payload of AI and NR specified solution? For example case 5, what is the traditional algorithem? what are the SNR trainted/tested, what channel type(s) is considered.
16 – HUAWEI TECHNOLOGIES Co. Ltd. Thank you very much for the contribution. In general sufficient study on aspects like evaluation methodology, input/output for model training and model inference etc should be done first before we can conclude whether/which use case is beneficial with AL/ML. Align the simulation assumptions is necessary also. Here we have some question for clarification on the assumptions: Q1. For Example Case 1, what is the NR specified solution here? R15 or R16 codebook? Q2. For Example Case 2, are the results UE-based positioning or gNB-based? For third figure, what does the location in ”AI positioning based on location” mean? For the fourth figure, what does the legends mean?
17 – Nokia Corporation Have you considered how to ensure predictable UE behaviour with AI/ML in UE and how to ensure that UE always meets its minimum requirements with AI/ML and UE performance in enhanced in many cases?

2.3.2 1st Round-Answers

Table 4:

Respond to	Answers
CAICT	Re1□Thanks for your question. Yes. The NPU capability at UE side would be useful for both inference and training. Re2: Thanks for your question. Our understanding is yes. Some AI model related consensus are necessary in the coming study for both training and inference, including typical models applicable for each area, high level understanding on how and to what extent the model should be aligned between companies, etc.
ZTE	Re: Thanks for your question. The short answer is no precoding is assumed in the evaluation results. More evaluation results are on the road with precoding assumed.

SHARP	Re1: The results shown in the slides are MMSE estimation rather than throughput. However, we do observe in some cases, there are throughput gains, especially when the SNR is low, and number of antenna ports is large. The reason of throughput performance gains mainly comes from joint processing gains of multiple antenna ports at the transmission side and receiver side. For full port case, all CSI-RS ports are independently estimated which would lead to poor performance at low SNR regain. Re2: Definition of throughput: same as the throughput typically used in link level evaluation. The simulation is conducted by compressing the 32 ports to 16 ports CSI-RS at the transmission side, UE uses an NN model to estimate all the channels on the 32 ports and feedback the corresponding CSI information. The following transmission and reception procedure is similar as typical link level evalution.
LG Electronics	Re1: Thanks for your question. Regarding the arrangement of RAN level study: our initial thinking is to build consensus within 3GPP on the potential applicable use cases and categorization of the use cases that may benefit follow-up WG study. Otherwise if we directly jump into e.g., evaluation methodology discussion without potential use cases in mind, it would be hard to achieve common understanding since evaluation would be different for different cases. Moreover, AI/ML related evaluation is never touched by 3GPP. We may need to have more background information alignment between different companies, e.g., the typical models applicable for each potential area. These would also help the WG to further develop AI/ML evaluation methodology at WG level. Re2: Thanks for your question. For mobility use cases, there are quite a few sub-areas involved. Current evaluation results focused on channel prediction, intra-cell beam management and inter-cell beam management. We also believe AI based handover enhancement would be beneficial for L3 handover, e.g., with prediction of UE movement or signal quality of multiple cells, better handover performance would be achieved.

Intel	Re: Thanks for your question. As illustrated in Page 17(Example#2: Different categories for AL/ML based channel estimation), the model training entity may be different for different categories. For example, for Cat2, the training entity might be UE. For Cat3, the training entity could be network or network and UE since NW has more environment information and channel state information, NW could send some NN information to assist UE for model training. As a baseline case, model training at UE side could be the starting point.

CATT	Re1: Thanks for your question. It could be calculated by API of Keras. Also, it could be easily calculated by ourselves, since one addition or one multiplication is one OP. Calculating all the additions and multiplications, we could have the complexity. Re2: Thanks for your question. It may depend on what exchanging information is and how frequent the exchange of information is needed. For example, the exchanging information might possibly be whether there is LOS or NLOS, the value of speed, or some other low overhead information. Even if the exchanging information includes the parameters of whole AI model, the overhead is still acceptable if frequency of information exchanging for AI model is low. In our current evaluation results, all UEs use the same AI encoder/decoder. All these directions can be studied in the SI phase. Re3: Thanks for your question. A single neural network is trained for all UEs. The sync error distribution is the same for training and inference. Re4: Thanks for your question. As illustrated in Page 17(Example#2: Different categories for AL/ML based channel estimation), the model training entity may be different for different categories. For example, for Cat2, the training entity might be UE. For Cat3, the training entity could be network or network and UE since NW has more environment information and channel state information, NW could send some NN information to assist UE for model training. Currently the NN is trained based the real channel in the evaluation. In real deployment, this can be achieved based on a NN with good generalization performance, or if Cat3 is adopted, this could be achieved based on exchange of NN information between network and UE. Re5: Thanks for your question. As also commented in previous question, the model training entity may be different for different categories. The real channel is used for training in the initial evaluation results. In real deployment, this is always possible since the gNB could always collect the radio environment related information through legacy procedure. In case 5, the receiver may need to know the compression of the transmitter or need to know how to recover full channel with compressed ports through exchange of NN information. Re6: Thanks for your question. The AI model could be just used at one side, or at both sides. For example how would the beam be measured and calculated with fewer samples of CSI-RS for beam management. Such predictive behavior would rely on how the CSI-RS is transmitted from gNB and thus need exchange of information to facilitate corresponding measurement and report. On the comment for training, it needs further study, regarding whether training in UE is needed and how such training would be conducted over air interface

Sony	Re1: Thanks for your question. It has several means. For example, gNB could provide the suggested neural network model to UE, or gNB could provide the channel characteristic information to UE, or gNB could send some gradient information for training. Re2: Thanks for your question. Different AI models are used in positioning and CSI. The AI model may need to be designed separately in different areas.
Asia Pacific Telecom	Re1: Thanks for your question. There might be some misinterpretation. The exchange of NN information does not necessarily mean the AI/ML is performed jointly at two sides. In some cases, AI/ML could be applied at either one side or both sides, and AL/ML on two sides might achieve better performance than AI/ML on one side. Also, for AI/ML on one side, the other could send some information to assist this side, for example, the suggested AI model parameters, or the channel characteristic, or data samples for training. Re2: Thanks for your question. For mobility use cases, there are quite a few sub-areas involved. Current evaluation results focused on channel prediction, intra-cell beam management and inter-cell beam management. We also believe AI based handover enhancement would be beneficial for L3 handover, e.g., with prediction of UE movement or signal quality of multiple cells, better handover performance would be achieved. Re3: Thanks for your question. Indeed, there are quite a lot of potential use cases and NN models on table. To progress the area in 3GPP discussion, our thinking is to discuss based on categorization of use cases, which would facilitate mutual understanding on how AI/ML is applied for each use case and how each use case would impact the system on the high level. Based on aligned understanding on use cases, we can conduct the corresponding evaluation for each area to see how much performance gain can be achieved for each area. NN models may need to be aligned for evaluation/calibration purpose. Such alignment is also based on company input and could of course evolve further during the evaluation procedure. Hopefully with aligned understanding on use cases and performance gains, we may find out the best way to support application of AI/ML in air interface.

Verizon	Re1: Thanks for your comments. Yes, this is one of the most important areas for further improvement of network performance. Re2: Thanks for your question. To progress the area in 3GPP discussion, our thinking is to discuss based on categorization of use cases, which would facilitate mutual understanding on how AI/ML is applied for each use case and how each use case would impact the system on the high level. Different categories mean different impacts on the spec. In Cat 1, there would be no spec impact and the performance gain might not be guaranteed all the time. In Cat 4, the spec may define the exact AI model or the full process of parameters exchanging for AI model, and the performance might the best. With such categorization, we can potentially build the same framework for all the use cases belonging to the same category, which would be beneficial for long term evolution for this area. Re3: Thanks for your question. Our preference is to have a thorough study in this area to satisfy the long-term needs and build a common framework for air interface evolution in the coming a few releases. We may not need to jump into WI in Rel-18.

Lenovo	Re1: Thanks for your question. 'Model alignment between companies' means companies use the same or similar AI model, including hyper-parameters for training. At least for initial calibration purpose, this would be necessary. For performance evaluation of potential areas, it would be better that companies use the similar AI model and hyper-parameters, otherwise it would be difficult to achieve common understanding between different companies and not possible to draw useful conclusions. Such model alignment would of course be based on company input and could continuously evolve. The reported simulation details would be enough as long as the evaluation results could be confirmed by other companies. Re2: Thanks for your question. The generalization performance is a complicated issue and important to address for application of AI/ML in real deployment for various area. Depending on which category we would like to study, the evaluation method of generalization performance would be different. For example, for Cat2 where no explicit exchange of NN is needed, it is necessary to verify the adopted NN is applicable for all kinds of channel models. Thus it is necessary to verify that the training data set is the mixture of different channel conditions and the test data set is based on another channel condition. For Cat3 where explicit exchange of NN related information is possible, the NN may not necessarily be applicable for all kinds of channel models. The generalization performance evaluation could be based on similar large scale parameters with some variation between training set and testing set.
Apple	Re: Thanks for your question. Your question is related to the categories we provided in slides 17 (Example#2: Different categories for AL/ML based channel estimation). For channel estimation, it is possible that inference is typically conducted on one side. For Cat2, the exchange of NN information is not needed, but for Cat3, exchange of NN information would help (e.g.) UE to learn faster to adapt to the local radio environment, and thus exploit to the largest gains provided by AI/ML. Exchanged information related to data samples for training may also be possible, which also needs further study.

Fujitsu	Re1: Thanks for your question. For case3, current evaluation results are based on a single model applied for all UEs. It can be beneficial when considering different AI/ML models applied for different channel models. Re2: Thanks for your question. On the one hand updating of NN more frequently would be beneficial for the link performance. On the other hand, this may involve lager overhead of the exchange information, increased complexity to frequently update the NN parameters, and also potentially increase power consumption at UE side. All these considerations may need to be taken into account to study update of NN through air interface.
China Mobile	Re1: Thanks for your question. Not sure we understand the question. In this case, RS period is 10 slots, and AI model needs to predict the next 9 slots. Re2: Thanks for your question. This is related to the categories we provided in slides 15 18. For Cat1 and Cat2, it is not necessary to always exchange NN information and thus AI model itself may be derived based on network/UE implementation. For Cat3 and Cat4, the exchanged NN would serve the purpose of alignment and recommendation. As shown in slide 18, for majority use cases, it is possible to design as one of Cat1 to Cat4. The performance would be different with different categories.
MediaTek	Re: Thanks for your question. In our current evaluation results, one AI model is used for all UEs and cells in use cases with system level evaluation. UE-specific, or cell-specific AI models may further improve the performance. The training and testing data set is constructed based on 38.901. For system level simulation, the data set includes multiple UEs channel models while for link level evaluation, the data set is constructed based on single UE channel model.
Qualcomm	Re1: For case 1, the channel information is directly generated by SLS and thus there is no specific SNR range target. UMi is assumed in the simulations. The overhead of PMI is 58 bits in the table. Re2: For case 5, The SNR range is 0 30dB, the channel is CDL-C, delay spread 300ns, UE speed 3km/h. Traditional algorithm is based CSI-RS channel estimation per port with noise suppression.

HUAWEI	Re1: The payload size is 58 bits. For such low CSI overhead case, the NR specified solution is only Type I codebook defined in Rel-15. Re2: In case 2, the results could be either UE-based positioning or gNB-based. Current evaluation does not differentiate where such AI module resides. Of course depending on where such AI module resides, the impact over air interface would be different. 'AI positioning based on location' means the output of AI model is the location, 'AI positioning based on delay' means the output of AI model is the delay and traditional method is used based this delay result. In the fourth figure, "based on CIR" means the training and inference is using channel impulse responses as input, "based on first path power" means the training and inference is using power of the first path as input, "based on first path phase difference" means the training and inference is using the phase difference between different antennas as input.
Nokia	Re: thanks for your question. This indeed need some study during the SI phase. From our perspective, the method for different cases could be different to ensure predictable UE behavior and guarantee minimum requirement. For example, For Cat3/4 enhancement with aligned NN models between the two sides (as defined in our side 15), the UE behavior would be predicable as long as the output of NN models (provided by network) is the same as expected. Performance of NN is guaranteed at the network side since the NN is provided by network. For Cat2 enhancement without explicit exchange of NN information (as defined in our side 15), it may be more complicated. One possible way might be to define minimum requirement for a specifically constructed data set which contains a diversified channel models for various channel conditions.

2.3.3 2nd Round-Questions

Feedback Form 6: 2nd round questions and comments to Study on AI/ML based air interface enhancement (RWS-210170)

1 – ZTE Corporation

Thanks for the feedback on our round-1 questions. We are also interested in solving this issue, which is a key point to make AI based RS overhead reduction useful in real world. Let's see what can be done after further study and evaluation. In general, we see similar use cases which has good potential to provide gain

for the current NR network, either to further boost performance/accuracy, or reduce signaling/RS overhead and latency.

We'd like to work together with companies in 3GPP on the use cases which attract wide interest, to investigate the great potential of using AI/ML on NR air interface.

2 – Samsung Electronics Polska

Q1: What is meaning of "genaral performance when constructing verification data set" in page 19 and why is it needed?

Q2: In page 19, what is the model for model alignment in AI evaluation? Do you expect to specify/align AI model for each case?

Q3: In page 12&13, for Case6 beam management, what is the method to pick beam pairs (e.g. 32 out of 256) for measurement? The same beam pair picking methods for both AI and non-AI algorithm?

3 – HUAWEI TECHNOLOGIES Co. Ltd.

Thank you very much for your clarifications for the first round. We have some additional question for clarification as below:

1. For the categorization of use cases, further study might be needed on whether/how to do the categorization. However, if the 4 categories as shown in your paper are followed, do you think that some of them will be prioritized during the potential study or all 4 will be discussed in parallel?

4 – China Unicom

For Areas with AI/ML application at both sides of network and UE, how to transfer the UCI information and other extract features between network and UE? How to guarantee the output from different UE?

2.3.4 2nd Round-Answers

Table 5:

Respond to	Answers
ZTE	Thanks for sharing your views. We fully support such study to have clear understanding on the gains of application of AI/ML over air interface.

Samsung	Thanks for your questions. The answers for each question are listed below. Q1: What is meaning of ”genaral performance when constructing verification data set” in page 19 and why is it needed? A1: Generalization performance should also be considered when constructing verification data set. The intention is to verify whether some specific design of AI/ML models are applicable for various channel conditions and/or gNB/UE implementations. This would help the group to understand the performance of AI/ML in real deployment when the training data set is not statistically aligned with verification data set. Q2: In page 19, what is the model for model alignment in AI evaluation? Do you expect to specify/align AI model for each case? A2: The aligned model would be dependent on use cases. We could start with typical models applied for each case based on companies input. The intention of the SI is to evaluate whether there are performance gains for application of AI/ML over air interface. Such AI/ML model alignment would be needed at least for evaluation purposes. Otherwise, it would not be possible to achieve common understanding on how much gains are possible. Q3: In page 12&13, for Case6 beam management, what is the method to pick beam pairs (e.g. 32 out of 256) for measurement? The same beam pair picking methods for both AI and non-AI algorithm? A3: The beams are picked out uniformly. The same beam pair picking methods is used for AI and non-AI algorithms.

Huawei	Thanks for your questions. Some answers are provided as following. Q1: For the categorization of use cases, further study might be needed on whether/how to do the categorization. However, if the 4 categories as shown in your paper are followed, do you think that some of them will be prioritized during the potential study or all 4 will be discussed in parallel? A1: The intention of the categorization lies in two folds. On the one hand, this is to structure the discussion and align companies understanding for each use case regarding system impact. On the other hand, such categorization is an example that may potentially help the group to find out use cases with similar system impact. It is not our intention to prioritize categories. All 4 can be discussed at least in the initial phase. We are open to hear views from companies.
China Unicom	Thanks for your questions. Our views are provided below Q1: For Areas with AI/ML application at both sides of network and UE, how to transfer the UCI information and other extract features between network and UE? How to guarantee the output from different UE? A1: If I understand the question clear, the intention is to ask UCI feedback for CSI enhancement. The UCI after encoding with AI encoders is still based on PUCCH and PUSCH. The AI encoder at the UE side may need alignment between different UEs through configurations.

2.4 Support of lower UE power class for Uu and SL (RWS-210171)

The contribution proposed to support lower UE power class 5 (20dBm), and power class 6 (14dBm) for devices intended for shorter communication range. The benefits are device cost and higher PA efficiency enabled by CMOS PA.

2.4.1 1st Round-Questions

Feedback Form 7: 1st round of questions and comments to RWS-210171

1 – Intel Corporation (UK) Ltd

1) What are the target RF bands for low power class operation?
2) What is the expected impact on overall performance/coverage if lower power classes are introduced for regular cellular bands?
3) Paper mentions that indoor deployments is one possible use case. Is it planned that low power class

operation will be restricted to indoor use cases?

2 – DOCOMO Communications Lab.

Thank you for contribution. Exactly lower UE power class might be beneficial for SL, e.g. gaming in local area. Then do you assume impact of only power class perspective? Or some other impacts like SL (and/or Uu) power control in RAN1 are assumed?

2.4.2 1st Round-Answers

Table 6:

Respond to	Answers
Intel	Thanks for your questions. A1: We think at least all FR1 bands can be considered A2: We think the lower power class are targeting some specific UE devices which are mainly used in the scenarios where coverage is not an issue, e.g. indoor scenario for Uu case. A3: We are open to consider scenario restriction if needed.
DOCOMO	Thanks for your questions. We agree with you that lower power class is beneficial for short range SL communication. The specification impact could be limited to defining a corresponding power class, as well as the signaling support (e.g., capability reporting or RRC configuration), to make it work. Additional aspects can also be considered if necessary.

2.4.3 2nd Round-Questions

Feedback Form 8: 2nd round questions and comments to Support of lower UE power class for Uu and SL (RWS-210171)

2.4.4 2nd Round-Answers

None

2.5 Enhanced support for personal IOT networks (RWS-210172)

In this contribution, it was proposed to study the efficient operation of personal IOT networks consist of multiple devices, including

1. Service switching at the RAN-level or Core Network level between UEs under the control of the given user while maintaining service continuity

2. Coordinated transmission and reception amongst different devices in seamless and loss less manner considering UE throughput, service reliability, power consumption, etc.

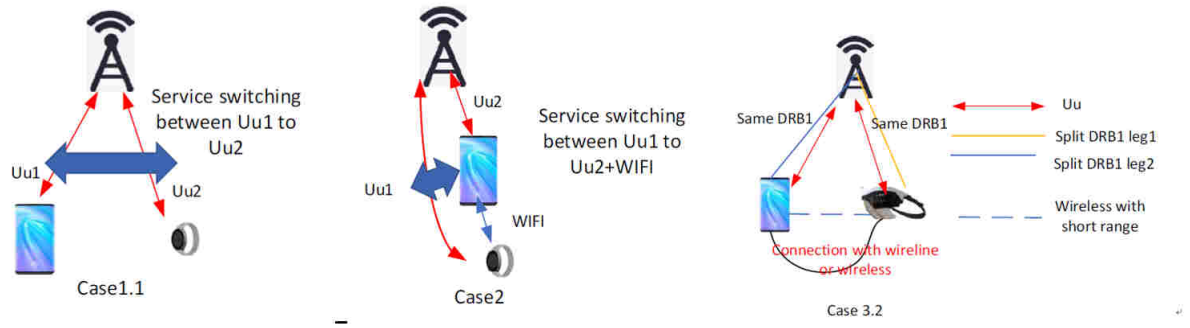

Figure 2:

2.5.1 1st Round-Questions

Feedback Form 9: 1st round of questions and comments to RWS-210172

1 – Beijing Xiaomi Mobile Software

Thanks for the contribution.

We are interested in this use case of negotiation/coordination procedures between multiple UE devices.

Some questions:

1) For the use cases: Case1 is about service switching between UU1 and UU2. Case2 is about service switching between UU1 and UU2+wifi. But I guess for the later, the wifi is not in the 3gpp scope. So impact of both cases to 5G is the same?

2) For case3:

If the interface between the 2 UEs are wireline, is such kind of terminals in the market?

If it is by wireless, are you targeting on sidelink relay or something?

2 – Lenovo (Beijing) Ltd

Case 1:

In case 1, the main target is to avoid the service interruption during switching. e.g. voice call service. However, you proposed the same PDCP in different UEs for less data loss purpose rather than 'zero interruption'. Do you mean the same PDCP in different UEs is proposed for all scenario or less-data-loss only?

How to understand 'same PDCP'? Are the different PDCP in the different UEs associated with the same DRB?

Case2:

When the remote UE accesses gNB via a phone, is this remote UE visible for gNB? If no, the service could be interrupted. If yes, I wonder if this case should be studied in sidelink relay topic.

Case 3:

We agree that could be helpful for power saving. What type of relay do you prefer? reuse the L2/L3 relay protocol stack?

3 – ZTE Corporation

We share similar views on Case 3 that multiple transmissions/receptions from aggregated UEs could be beneficial in terms of UL throughput and service reliability. Regarding the scenarios, we think it can apply to not only personal IOT networks but also other vertical industries, e.g., multiple motion controllers in a product line. What's your view on this?

4 – China Telecom Corporation Ltd.

Thank you very much for the contribution. Let me ask questions below.

As mentioned above, Case2 and Case3 include wireless communication between two UEs, and Case2 mentioned the service switching between Uu1 and Uu2+wifi. Considering the current work in UE sidelink relay, can it be implemented via PC5 interface? What is the priority between Uu+wifi/BT and Uu+PC5?

5 – LG Electronics Inc.

We are generally interested in multiple UE operation but it is not limited to support of personal device use cases but also to cover the industrial use cases. Given that reliability/continuity is a common key factor in multiple UE operation, we would like to ask:

Q1. What does it mean 'same PDCP in different UEs' in case1? Do you consider a synchronized operation of PDCP via some interaction between the UEs?

Q2. What kind of coordination do you assume? Do you consider the failed transmission from a PIOT device is to be recovered by other PIOT device or do you assume a simple switching of end PIOT device?

6 – Spreadtrum Communications

Thanks for the nice contribution,we have some questions.

Case1: we agree that the UPF or gNB can act as the anchor.

Can you explain what's meaning of the same PDCP? The defferent UEs can have same security key for UL?

Case3: In this case, the defferent UEs have same PDCP or different PDCPs?

7 – Apple Portugal

For the interaction/coordination between multiple UEs, the scheme could be RAN based, CN based, or application based solutions.

Q1: For RAN/CN based solution, NW should be able to identify the association amongst multiple UEs and to establish the service/PDU session to the UE group. So how can NW identify the association amongst multiple UEs?

Q2: For the case 3, it assumes that NW transmits the service to multiple UEs in DC model. But in case3 the two UEs are connected via the wireless or wireline link, and additional delay will be introduced between the two CGs' transmission and coordination. The additional delay will degrade the benefit on the throughput. So what's your assumption on the UE-UE link coordination and requirement (latency, throughput requirement)?

8 – Asia Pacific Telecom co. Ltd

Thank you very much for the contribution.

Following are some questions.

Case 1: Can you elaborate more on how does ”same PDCP in different UEs” work? What mobility impacts to support service switching do you have in mind?

Case 2: Are the two options for case 1 also applicable to case 2? The target here is to switch from Uu2 to Uu1 when the relaying through unlicensed band is unreliable. In view of the uncontrollable interference in unlicensed band, what triggering conditions for service switching do you have in mind to ensure no or less data loss during service switching?

Case 3: Can you elaborate more on how does split DRB work? For example, a split DRB is split at which device? For case 3.1, it seems the smart phone is acting as a U2N relay for UL. For discovery of coordinated UEs, is the discovery procedure discussed in sidelink relay WI applicable for this case? If not, what specific aspects do you have in mind that should be discussed here?

9 – HUAWEI TECHNOLOGIES Co. Ltd.

[Huawei, HiSilicon] Some questions. Q1: what’s your preference between RAN-level and CN-level switch (and why)? Q2: Is there any clear use case where App-level switch is not sufficient (and which one)? Q3: what are the possible specification areas that can be affected, i.e. what is the possible specification impact?

10 – China Mobile Com. Corporation

Thanks for your contribution! We are supportive on the motivation of enabling the service switching among different UEs. We have one question: do you think the option 1 in the case 1, where the UPF is the achor of switching cannot garanttee the lossless data during the switching since the different UEs will configured seperate GTP-U Tunnel withe seperate IP address.

11 – Verizon UK Ltd

Thanks for the contribution. A few questions/comments:

1) The use cases mentioned in this contribution are interesting and provide some value for consumer
2) Can you explain what is meant by the same PDCP?
3) How to connect the two UEs in your mind?
4) Synergy with multi-SIM?

12 – TCL Communication Ltd.

All the three types of cases are interesting. Could you please elaborate some specific scenarios aboult case3.1 and 3.2?

13 – Qualcomm Technologies Int

1. In case 3.1 and 3.2, is the smartphone acting as a L2 relay?
2. Does the XR glasses have a simultaneous direct connection with gNB, i.e. multi-path connection to support the split DRB?

14 – China Unicom

Thanks for the contribution and we are interested in PIoT use cases. We have some questions for clarification as the following.

Q1. For under the control of the given user, we assume network (UPF and BS) will take in charge of the service switching and service splitting. Would you please clarify the responsibility of the given UE?

Q2. For UPF as anchor and BS as anchor, how to support seamless and loss less manner of service splitting?

Q3. For case 3.2, the connections between UEs have two type, wireline and wireless. Is that means the candidate solutions will be different for this two type connections?

2.5.2 1st Round-Answers

Table 7:

Respond to	Answers
Xiaomi	Thanks for your comments and questions. A1: Both Case 1 and case 2 focuses on switching. About wifi part, we think that wifi part is transparent from RAN. we do not want to impact wifi protocol . Some wifi signal measurement may be needed by our protocol, anyway details can be further studied. A2: For case 3, such kind of terminals with wireline interface between the 2 UEs are simpler implementation, e.g. there is no specification efforts for the interface. Hence, we think this can be a potential choice. And for wireless interface, sidelink can be a potential alternative between 2 UEs and other technologies are also considered, e.g. wifi, Bluetooth and so on.
Lenovo	Thanks for your comments and questions. For case 1, same PDCP will have different forms. If ideal/wireline interface between 2 UEs exists, only one PDCP entity is needed which is really same PDCP. If non-ideal/wireless interface between 2 UEs exists, there may be some PDCP SN status transfer-/interaction, to maintain service continuity for some services with higher reliability requirements, e.g. RLC AM. We agree that SN synchronization may be not needed for RLC UM services. For case 2, we assume that remote UE is not to be visible for gNB. If the interface between 2 UEs is sidelink, this scenario can be merged into sidelink relay topic. But our case2 is to study other possibility, e.g. wifi or other. For case 3, both L2/L3 relay architectures are possible. However we also see other possibility e.g. wifi or wireline. We can further analysis and evaluate details.

ZTE	Thanks for your comments and questions. We also agree that use cases can include personal IoT networks, vertical industries and other similar scenarios.
China Telecom	Thanks for your comments and questions. About the interface between two UEs, we also think that PC5 interface, wifi and other wireless technologies are possible and need FFS.
LG	Thanks for your comments and questions. A1: same PDCP will have different forms. If ideal/wireline interface between 2 UEs exists, only one PDCP entity is needed which is really same PDCP. If non-ideal/wireless interface between 2 UEs exists, there may be some PDCP SN status transfer/interaction, to maintain service continuity for some services with higher reliability requirements, e.g. RLC AM. A2: detailed mechanisms are up to how often the switching occurs, e.g. semi-static or dynamically. PDCP status reporting trigger and retransmission are potential solutions to recover failure packets.
Spreadtrum	Thanks for your comments and questions. Case 1: same PDCP will have different forms. If ideal/wireline interface between 2 UEs exists, only one PDCP entity and only one key is needed which is really same PDCP. If non-ideal/wireless interface between 2 UEs exists, there may be some PDCP SN status transfer/interaction, to maintain service continuity for some services with higher reliability requirements, e.g. RLC AM. In this case, two separate keys may be needed which is similar with legacy inter-gNB handover and the feasibility of one key needs to consult with SA3. Case 3: we assume that two UEs can have same PDCP entities if connection is wireline.
Apple Portugal	Thanks for your comments and questions. A1: in our understanding, some subscribed and/or dynamic request association are needed to establish the UE group. A2: from the perspective of improving throughput and delay requirements as much as possible, we think that the link quality between two UEs needs to be good enough and sufficient radio resources should be also guaranteed especially for high QoS services if the connection is wireless.

Asia Pacific Telecom	Thanks for your comments and questions. Case 1: same PDCP will have different forms. If ideal/wireline interface between 2 UEs exists, only one PDCP entity is needed which is really same PDCP. If non-ideal/wireless interface between 2 UEs exists, there may be some PDCP SN status transfer/interaction, to maintain service continuity for some services with higher reliability requirements, e.g. RLC AM. Case 2: From our view, case 2 we assume that remote UE is not to be visible for gNB. If the interface between 2 UEs is sidelink, this scenario can be merged into sidelink relay topic. But our case2 is to study other possibility, e.g. wifi or other. Some wifi signal measurement may be needed by our protocol, anyway details can be further studied . Case 3: for a split DRB, anchor PDCP is in UE1 with one RLC leg in UE1 and the other RLC leg in UE2. If the interface between 2 UEs is PC5, it is similar with SL relay architecture and may be merged into SL relay topic. We here want to discuss the leftover possibility except for PC5 interface.
Huawei HiSilicon	Thanks for your comments and questions. A1: RAN-level (gNB as anchor) switching can be seamless and lossless, however CN-level (UPF as anchor) cannot be lossless, since the different UEs will be configured by separated GTP-U Tunnel with the separated IP address. However I agree that RAN-level switch is more RAN2 scope and CN-level switch is more SA2 scope. Both groups Should study it. A2: App-level switch may be simpler but have worse user experiences, e.g. latency, interruption, data loss and so on, we see that voice and gaming have the clear requirement form consumer aspect, we also see some usages in industry aspects . A3: Specification impacts will focus on such as architecture description in stage 2 specifications, in TS38.300 and detailed UE behaviors in stage 3 specifications, e.g., RRC and PDCP specification impact
China mobile	Thanks for your comments and questions. Agree with your observation. UPF-level switching may be just seamless but not really lossless.

Verizon	Thanks for your comments and questions. Same PDCP will have different forms. If ideal/wireline interface between 2 UEs exists, only one PDCP entity is needed which is really same PDCP. If non-ideal/wireless interface between 2 UEs exists, there may be some PDCP SN status transfer/interaction, to maintain service continuity for some services with higher reliability requirements, e.g. RLC AM. The interface between two UEs can be PC5, wifi and so on. Details needs to further analysis and evaluate. There may be some synergy with multi-SIM from number of SIM card and UEs collaboration point of view. however, it is two devices case.
TCL	Thanks for your comments and questions. For case 3.1, a typical example is DL in UE1 and UL in UE2, e.g. in some cases that power of UE1 is limited or for power saving purposes, and Tx consumes more power than Rx. For case 3.2, UL and DL exist in both UEs, e.g. with two UL mode for higher data throughput in coverage restriction case.
Qualcomm	Thanks for your comments and questions. A1: If the interface between two UEs is PC5, case 3 can be similar with SL relay architecture. A2: We assume that one type of XR can connect with gNB directly. Multi-path connection with addition connection can help UE power saving and data throughput increasing in some cases .
China Unicom	Thanks for your comments and questions. A1: We agree it is network (UPF and BS) that take in charge of the service switching and service splitting. And we think that the responsibility of the given UE may include some request/assistance information reporting, performing possible configuration update, triggering status report and retransmission for lossless and so on. A2: For UPF as anchor, we think only seamless can be guaranteed, e.g. association between CN session/-tunnel IDs before switching and after switching. For BS as anchor, lossless may be possible via L2 status report and retransmission to recover failure packets. A3: if the connection between UEs is wireline, specified solution may be not needed, i.e. just left to UE implementation. Only in the connection between UEs is wireless, some interface and procedure need to be specified. Hence the latter is the focus of study.

2.5.3 2nd Round-Questions

Feedback Form 10: 2nd round questions and comments to Enhanced support for personal IOT networks (RWS-210172)

1 – ZTE Corporation

Thanks for the response which is indeed helpful to understand more about the benefits of the use cases. In addition, we have some further clarifications after reviewing the discussion in the first round.

1) Is is a correct understanding that your preferred connection between UEs is wifi, and you think some NR specification impacts are expected for wifi connection?

2) Is there any difference in terms of specification impacts between case 1 and case 2, except for the potential impacts regarding the connections between two UEs in case 2.

2 – China Unicom

Thanks for your detailed response. We have some further clarifications in second round.

1) You mentioned the leading groups of UPF anchor and BS anchor solutions will be different, would you explain the how to organize SA and RAN related work for this topic?

When using another UE to split or switch service for one UE, is there any authentication or safety potential issue?

2.5.4 2nd Round-Answers

Table 8:

Respond to	Answers
ZTE	Thank you for further questions For Q1: We think that connection between UEs can be wifi/buletooth/wireline/sidelink. If it is wifi, we do not want enhance wifi protocol, some measurements/reporting on wifi signaling may be needed on Uu. For Q2: we think that architecture is same for case1 and case2, however some detailed enhancements may be different such as some measurements/reporting on wifi signaling in case2.
China Unicom	Thank you for further questions For Q1, Yes, if UPF anchor is used the leading group is SA2, if BS anchor is used the leading group is RAN2. We suggest both RAN2 and SA2 Study it and identify the potential issues and solutions based on different usage case and requirements. However, we are quite open to discuss how to organize SA and RAN related work for this topic by efficient way. For Q2, Yes, we agree that authentication or safety aspect should be also discussed further.

2.6 Further sidelink enhancements (RWS-210173)

In this contribution, various sidelink enhancements beyond Rel-16/17 were discussed, with following proposals

1. Support of additional spectrum for NR sidelink, such as FR2/2x bands, licensed/unlicensed bands

2. Further power and cost saving for NR sidelink, including PA-less, SL-WUS, power saving beyond sensing reduction.

2.6.1 1st Round-Questions

Feedback Form 11: 1st round of questions and comments to RWS-210173

1 – Classon Consulting

[for FUTUREWEI]

We also support sidelink FR2 and unlicensed enhancements, see RWS-210039 and https://nwm-trial.etsi.org/#/documents/4 . Do you feel that the sidelink enhancements for FR2 should include work on CSI feedback?

2 – LG Electronics Inc.

Q1: In supporting PA-less device in NR sidelink, what specification impact do you envision beyond defining a corresponding power class?

Q2: In the evaluation of PSFCH with and without power control, what is the transmit power of PSFCH when no power control is used? Did you assume the maximum TX power for PSFCH and, if so, can we expect some power saving by configuring P_0 of PSFCH to a smaller value?

3 – HuaWei Technologies Co.

Are the PSFCH enhancements backwards compatible with Rel-16 and scheme 2 of Rel-17 inter-UE coordination?

4 – Asia Pacific Telecom co. Ltd

Thanks for sharing. Please find the following comments from Asia Pacific Telecom (APT):

1) We support that sidelink enhancement on shared band (which may be a licensed band or an unlicensed band) should be considered in Rel-18.

2) We also think that FR2X unlicensed band may be useful in some scenarios. However, it would be appreciated for vivo to share more vivo expectations about 'directional LBT' or 'receiver-assisted LBT'. Moreover, would the proposed LBT protocols replace/affect the existing sensing mechanisms in NR sidelink operation?

Should we consider the mutual impacts between LBT protocols and sensing mechanisms? In addition, there are some proposals (e.g., SL-WUS) in this document. Would these designs be jointly considered with LBT?

3) Should we include the E-UTRA V2X sidelink communication into the R-18 scope for further enhancement?

4) In Figure 1, the home automation network is implemented via many Relay Nodes. However, the description about the Relay Node is absent. Does vivo expect to discuss Rel-18 Relay based on the study

results in R17 SL relay? Could vivo share more expectations about the functionalities of Relay Node in Rel-18?

5) As for the personal IoT scenario and XR scenario. inter-UE coordination on PC5 interface may play an important rule on complexity reduction and power saving. However, we do not how many achievements about inter-UE coordination would be made in Rel-17 since time budget is quite limited. So, we suggest RAN plenary to clarify the goals of inter-UE coordination for NR sidelink communication. Then, we can figure out some baseline objectives should be done in Rel-17 firstly and some identified issues may be addressed in Rel-18.

5 – Fraunhofer HHI

Q1: Based on the candidate spectrums listed in Table 2, which would be your first preference for 3GPP to work on for SL-unlicensed, based on commercial requirements?

6 – Qualcomm Incorporated

What is the most important method of obtaining additional spectrum to prioritize in vivo's view?

7 – Lenovo (Beijing) Ltd

For XR,

1, Besides the throughput and capacity problem, do you think Rel-17 NR sidelink can support delay requirement and reliability requirement of XR use cases?

2, Besides DRX related mechanism, do you consider the other mechanism(s) for XR device power saving?

3, Do you consider the sidelink enhancements for XR in in unlicensed spectrum?

8 – CATT

Q1: What exactly the enhancement related to PA-less device?

Q2: For WUS, do you mean UU-WUS or sidelink WUS? Or both ?

9 – Nokia Denmark

It looks to me ok to have further enhancement on SL power saving at least for the leftover aspects of SL DRX in Rel17.

Question: What standardization impacts are foreseen for support of PA-less SL device? (note: this question may be also due to my personal Ignorant to the issue. At least I cannot figure out standard impact easily).

10 – Guangdong OPPO Mobile Telecom.

Q1: Do you think multi-carrier operation (such as R15-like CA and packet duplication) should be introduced for SL in R18 to further support high data rate applications?

2.6.2 1st Round-Answers

Table 9:

Respond to	Answers

FUTUREWEI	Great to see that we share the same view on FR2 and unlicensed enhancement. And yes, CSI feedback enhancement is considered one feature for enabling FR2 operation (e.g., for beam management).
LGE	Thanks for your good comments and questions. Here are our responses: Q1: We think that defining a corresponding power class, as well as the signaling support (e.g., capability reporting or RRC configuration), would be enough to make the PA-less device work, though any optimization is not precluded. Q2: The PSFCH power control in our simulation follows the R16 mechanism. In the evaluation, since no gNB is operating, the max Tx power is used for PSFCH transmission. Configuring a smaller value of P_0 can reduce the corresponding max Tx power, but the gain may be limited (because it cannot be adaptive to the actual SL pathloss), or may degrade the PSFCH reception performance in some case (as P_0 is configured according to the decoding threshold).
Huawei	Thanks for the good question. We think the backward compatibility for PSFCH enhancement depends on the solution. Some solutions may only impact on the RX UE transmitting PSFCH, thus is fully compatible with Rel-16, while some solutions may require changes to TX UE too, but may not have impact to other UEs, thus still compatible with Rel-16 from system perspective.

APT	Thanks for the comments and question. Good to see we have shared views in many aspects. Here are our responses to the questions: Q2: The 'directional LBT' and 'receiver-assisted LBT' are the candidate solutions currently being discussed in Uu for operating in FR2X. Here we just consider to reuse the solutions defined in Uu. In our view, these LBT-based solutions would likely change the Rel-16/17 sensing mechanism. Q3: Currently we do not see strong motivation to further enhance the LTE sidelink. Q4: SL relay is an important area for home automation network. Our expectation is that Rel-18 would enhance the SL relay based on the Rel-17 leftover (such as U2U relay, etc.) Q5: Yes, inter-UE coordination may be very helpful for power saving. In our view it has not been precluded from Rel-17 work. If it is not achievable based on Rel-17 mechanism, we are fine to consider it in Rel-18.
Fraunhofer	Thanks for the good question. From our perspective, FR2X unlicensed band is our 1s preference, in order to support various P-IoT use cases (such as XR, etc.).
Qualcomm	Thanks for the question. In our view, unlicensed band is the important spectrum to enable the P-IoT market. For AR/VR application, FR2/2X spectrum is probably the best solution to meet the ultra-high data rate requirement.
Lenovo	Thanks for the question. Firstly, we do support SL enhancement in unlicensed spectrum for XR. Regarding the latency and reliability, it depends many factors. For example, in the licensed spectrum with sufficient resources, the Rel-17 NR SL can meet the latency and reliability requirement. But it is not guaranteed in other cases. Regarding the power saving, we think other mechanisms are beneficial for XR device, such as PA-less, SL-WUS, PSFCH enhancement, etc.

CATT	Thanks for the good question. Here are our responses: Q1: At the minimum, we think that defining a corresponding power class, as well as the signaling support (e.g., capability reporting or RRC configuration), would be needed to make the PA-less device work. Additional optimization can also be considered if necessary. Q2: We mean to support sidelink WUS.
Nokia	Thanks for the question. We think at least defining a corresponding power class, as well as the signaling support (e.g., capability reporting or RRC configuration), would be needed to make the PA-less device work. Additional optimization can also be considered if necessary.
OPPO	Thanks for the question. Yes, we think CA is beneficial for NR sidelink to support high data rate application.

2.6.3 2nd Round-Questions

Feedback Form 12: 2nd round questions and comments to Further sidelink enhancements (RWS-210173)

1 – LG Electronics Inc.

Q1: For the PSFCH power control, can you explain how the RX UE transmitting PSFCH calculates the sidelink pathloss from the TX UE, in particular, how the RX UE knows the transmit power?

Q2: If OLPC is applied to PSFCH transmissions, when a UE is requested to transmit multiple PSFCHs to different UEs, PSD of each PSFCH can be different. Do you think such PSD imbalance can be supported by the UE?

2.6.4 2nd Round-Answers

Table 10:

Respond to	Answers
LG	Thanks for further questions. Here are our responses: Q1: In our simulation, the TX UE sends the TX power of PSSCH to the RX UE, so that the RX UE can calculate the SL pathloss, and then derive the TX power for PSFCH transmission. We understand this is one possibility, but may not be the only solution. The detailed solution can be further discussed and designed in WG. Q2: We are open to discuss whether such PSD imbalance can be supported or not in UE, though we prefer to study solutions to avoid such PSD imbalance. For example, the UE can use the same PSD for transmitting multiple PSFCHs even if the corresponding pathloss are different.

2.7 Further Positioning enhancements (RWS-210174)

In this contribution, it is proposed to consider the following areas as positioning enhancements in Rel-18

1. Sidelink positioning

2. Positioning support for NR from 52.6GHz to 71GHz

3. Redcap positioning

4. Rel-17 leftovers, including Aperiodic and semi-persistent PRS, Idle/inactive state positioning enhancements, Positioning with DRX

2.7.1 1st Round-Questions

Feedback Form 13: 1st round of questions and comments to RWS-210174

1 – CATT

Comments:

- We share the similar view that there is a need to support absolute and relative positioning, sidelink assisted/based positioning, and in coverage, out of coverage, and partial coverage scenarios for SL positioning,

- We share the similar view for supporting RedCap positioning.

Questions:

Q1: For XR positioning, does vivo have special methods in mind to support ultra high accuracy and ultra low latency?

2 – ZTE Corporation

(1) On P6, Rel-18 Mid/low-Tier UE enhancement may also consider minimum 5 MHz bandwidth, do you also consider it?

(2) On P7 for the first bullet, how to trigger aperiodic/semi-persistent PRS from neighbor cells by DCI/MAC CE of the serving cell?

3 – Beijing Xiaomi Mobile Software

- Q1: 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)?
  - Relative positioning: relative positioning is to estimate position relatively to other network elements or relatively to other UEs.
  - 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.

-

Q2: For positioning from 52.6GHz to71GHz, we are wondering how to satisfy the ultra-low latency requirement because of LBT mechanism, does it mean to consider the environment without WiFi node surrounding?

-

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

-

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?

4 – Intel Corporation (UK) Ltd

Q1: Please clarify whether you consider unlicensed band for Uu and/or PC5 based positioning in FR1 as well?

Q2: The motivation behind the following note is not fully clear: ”Note: unlicensed band positioning below 52.6GHz may be studied separately”. Please clarify the intention.

Q3: It is not clear if the XR use case requirements can/cannot be met with Rel-17 (or other proposed Rel-18) enhancements already? Do we need more simulation/evaluation work?
Q4: What additional enhancements will be for IDLE mode? To support data transmission/reception in IDLE? Or only measurement in IDLE?
Q5: For DRX, what enhancements are envisoned, e.g. to align PRS/SRS configuration with DRX configuration?

5 – Sony Europe B.V.

In principle we also support sidelink positioning and positioning for RedCap UE (See also RWS-210301)

Q1) On supporting above 52 GHz, would you consider a new waveform for positioning?

Q2) On Ultra-high accuracy for XR, what accuracy and XR’s use cases do you have in mind?

Q3) There are multiple topics being proposed in your contributions (e.g. continuation topics, and Rel-18 new topics (sidelink, >52GHz, and RedCap). What would be your preference in term of the priority order?

6 – Qualcomm Incorporated

Question 1: Could you clarify simulation assumptions for (1) SL (V2X) positioning ? (is that using the 3GPP channel model or assumptions?)

Question 2: With regards to the RedCap UE, are you only considering new performance requirements (i.e. RAN4-centric/only scope), or also RAN1-centric enhancements that can enable such features? If you are considering also RAN1-centric enhancements, can you provide examples of such enhancements?

7 – Huawei Tech.(UK) Co.. Ltd

In 52.6-71GHz there will be more hardware imperfection factors, such as calibration, phase noise that will limit the positioning performance. Why XR is highlighted to motivate the positioning over 50 GHz?

8 – LG Electronics Inc.

Q1: Which positioning method (e.g. TDoA, RTT, AoA/AoD) was used for SL poisoning simulation in Urban and Highway scenario below 6GHz?

Q2: It seems beam alignment between BS and UE is needed for SL positioning above 52.6GHz. Is there any assumption on the UE movement (e.g. speed of UE) in the simulation?

2.7.2 1st Round-Answers

Table 11:

Respond to	Answers
CATT	Re: Thanks for your question. We think positioning from 52.6GHz to 71GHz can be considered as one direction for positioning ultra high accuracy and ultra low latency,since larger bandwidth/SCS and massive antennas/beams can be supported. The detailed solutions may be further studied.
ZTE	Re1: Thanks for your question. We are open to consider smaller BW(such as 5MHz). But performance degradation is expected. We don't expect additional design to improve performance due to 5MHz PRS reception. Re2: Thanks for your question. The detailed triggering scheme can be discussed later. At least for the case when multi-TRP belongs to the same serving cell, it is easy to support triggering of aperiodic/semi-persistent CSI-RS similar as other RS.
Xiaomi	Re1: Thanks for your question. From measurement perspective it seems ranging does not requirement any additional enhancement compared to relative positioning. We are not sure what other enhancements are needed for ranging compared with relative positioning. Re2: Thanks for your question. Coexistence issue for 52.6GHz is much less severe compared to sub-6GHz case due to the inherent channel propagation property of 60GHz. We don't think there would be necessity to discuss the issue of Wifi coexistence at this stage. It can also be observed that such coexistence is never touched in 52.6GHz discussion. Re3: The requirement mentioned is RAN4 performance requirement rather than design target. Re4: We don't think it is necessary. The requirement mentioned is RAN4 performance requirement rather than design target. We don't expect new accuracy requirement defined.

Intel	Thanks for your comments and questions Re1: We are open to consider the unlicensed band in SID. However for sidelink positioning over unlicensed, the basic framework of sidelink over unlicensed should be established first. Re2: Consideration for design of positioning operation over unlicensed band below 52.6G would be dramatically different from above 52.6. We think it is beneficial to put them into separate study. Re3: There are quite many XR cases (online XR gaming including Untethered Immersive, Online Gaming, Immersive Game Spectator Mode, 5G Online Gaming party) which we are expecting at least cm accuracy is needed. We prefer to have a short study phase to evaluate and reach a consensus on the gap we are facing for XR use case. Re4: For idle mode operation, at least measurement should be supported. Re5: For us, aligning PRS/SRS configuration with DRX configuration between different entities for positioning operation is at least needed.
Sony	Thanks for your comments and questions Re1: We believe that the positioning study can be based on the current waveform of Rel-17 >52.6GHz. Re2: In order to ensure user experience for XR, we believe that positioning accuracy of cm-level is required, e.g. online XR gaming including, Untethered Immersive Online Gaming, Immersive Game Spectator Mode, 5G Online Gaming party. Re3: Sidelink positioning and >52.6GHz positioning are of high priority in our mind.
Qualcomm	Thanks for your comments and questions Re1: We use the urban and highway channel model and assumptions in TR37885 for preliminary evaluation. Re2: We do not consider RAN1 specific enhancement for accuracy purpose for Redcap devices.

Huawei	Thanks for your comments and questions According to the TR38808 (Study on supporting NR from 52.6 GHz to 71 GHz), augmented reality (AR)/virtual reality (VR) wearables have been identified as one of potential use cases in the study. For positioning above 52.6GHz with high accuracy requirement, XR positioning can be regarded as a typical use case. Large available bandwidth and massive beams are the major reasons to consider >52.6GHz to satisfy needs of XR. The hardware impairments can of course be taken into account.
LGE	Thanks for your comments and questions Re1: TDOA-based method was used in our simulation for both Urban and highway scenarios. Of course, other methods are not excluded in the follow-up study. Re2: One thing to clarify: current evaluation results for 52.6GHz is based on Uu. For the simulation, UE dropping option A in TR37885 is used for both highway and urban scenarios, that is, speed of 140km/h for highway scenario and 60km/h for urban scenario.

2.7.3 2nd Round-Questions

Feedback Form 14: 2nd round questions and comments to Further Positioning enhancements (RWS-210174)

1 – ZTE Corporation For positioning in idle state, do you think it needs a small data enhancement first, then positioning procedure can reuse the outcome of small data enhancement? What is your view to support integrity of RAT-dependent positioning methods?
2 – Intel Corporation (UK) Ltd Q1: Could you clarify why do you believe that the basic framework of sidelink over unlicensed should be established first, i.e. before NR Uu based positioning support for unlicensed?
3 – LG Electronics Inc. Thank you for clarification. Q1: Regarding high accuracy positioning in 52.6GHz to 71GHz in slide 3, what's vivo's assumption on the panel to be used for positioning? Do you think that a single panel based positioning in the current specification is sufficient, or some positioning enhancement for using multiple panels needs to be considered?

2.7.4 2nd Round-Answers

Table 12:

Respond to	Answers
ZTE	Thanks for your further comments. Regarding positioning in idle state, we think it can be studied in parallel with Rel-18 SDT, just like what we did in Rel-17. Regarding integrity of RAT-dependent positioning methods, we are open to consider it in SID.
Intel	Thanks for your further question. Uu-based enhancement is generally earlier than sidelink-based enhancement, because Uu-based enhancement is more about the design of the basic framework and has a higher priority. Similarly, from the perspective of positioning research, it would be weird to study unlicensed band sidelink positioning earlier than unlicensed band Uu positioning.
LG	Thanks for your further comments. For the first question, the antenna configuration in TR38808 TableA.2-1 is used. For the second question, we are open to consider single panel and multiple panels for positioning enhancement. Regarding potential enhancement for using multiple panels, due to the extremely high positioning accuracy, the positions of multiple panels may need to be distinguished, just like the distributed antenna system in sidelink positioning.

2.8 Views on duplex evolution in Rel-18 (RWS-210175)

In this contribution, it was proposed to only consider the following types for enhanced duplex schemes

Type 1: Quasi Full Duplex @NW + Half Duplex @ UE

Type 2: Full Duplex @NW + Half Duplex @ UE

It was also proposed to consider inter-operator adjacent channel interference issue.

No impact to the UE RF requirement shall be assumed for the study of enhanced duplex scheme in Rel-18.

2.8.1 1st Round-Questions

Feedback Form 15: 1st round of questions and comments to RWS-210175

1 – MediaTek Inc.

Thanks for the contribution. Some questions as follows.

Q1: Regarding potential UE impact, it seems premature to rule out any expected RF specification tightening for future R18 Half Duplex UEs (ACLR, ACS, in-band blocking, etc) to operate with a SFFD or SBFD-capable gNB and mitigate UE-UE CLI. What is your view?

Q2: UE-UE and BS-BS CLI CLI in FD-capable gNBs will impact legacy UEs and gNBs respectively. Do you have a solution in mind to protect legacy UEs and legacy gNB?

2 – Intel Corporation (UK) Ltd

Q1. Given that basic feasibility of FD @ gNB needs to be determined by RAN4 as a first step, what is your view on managing the studies across RAN1 and RAN4? Specifically, under what assumptions should RAN1 proceed with for their study w/o information on isloation and self-, adjacent channel interference effects that would need RAN4 expertise?

Q2. Do you also consider study of ”TDD in FDD bands” or only limited to upaired spectra?

Q3. What is your view on applicability to bands @ lower frequencies vs. higher frequencies (if relying on spatial separation based isolation)?

Q4. With panel-separation/parition, this could impact both DL and UL link performance due to partitioning of antenna panels/elements. Has this been considered in the evaluations for UL as well?

Q5. For XDD, given that this is not exactly same as pure ”FDM” and would require proper filtering, what is your view on need for guard bands between DL and UL within a CC?

3 – Futurewei Technologies

We think the evolution path of advanced duplex schemes part of this contribution is quite clear. We share the view that a step-by-step approach is needed for many of the challenges relating FD to be resolved in the coming releases,

and that any type of full duplex at the UE side may not be considered in Rel-18 time frame, given the large cancellation gap from the target;

The term quasi full duplex (type 1) is introduced as an intermediate step dynamic TDD and full duplex, while we wonder whether it can just be flexible duplex since flexible duplex does not necessarily imply full duplex.

Please take a look at our contribution RWS-210036 (https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_AHs/2021_06_I 210036.zip) and feel free to comment at: https://nwm-trial.etsi.org/#/documents/4580

4 – InterDigital Communications

Thanks for the proposals. We think it would be better to focus on Type 1 in Rel-18 as it is the first release to study full duplex and it will take a long time to have a common evaluation methodology just for Type 1 full duplex. We tend to agree with the evolution path for full duplex described in the second slide.

Q1. for the self-interference cancellation at the gNB, what do you expect as a standards impact? Would it be just gNB implementation with some performance requirement in RAN4 if needed?

5 – Lenovo (Beijing) Ltd Thanks vivo for the contribution. One question regarding type 2 duplex schemes in page 6, where it is proposed to have the possible full duplex for e.g., PUCCH, but not for PUSCH. What is reason to exclude PUSCH in the full duplex operation?
6 – Qualcomm Incorporated On P3, is NW quasi full duplex the FDMed DL and UL in same carrier? Good to clarify the difference from full duplex.

2.8.2 1st Round-Answers

Table 13:

Respond to	Answers
Mediatek	Thanks for your comments and questions A1: From our perspective, in Rel-18 we should have a Full duplex feature with only NW impact. It should be feasible and important to avoid UE RF impact. Enhancements which have UE UE RF impact should be looked at in Rel-19. A2: We do not have any specific solution in mind for legacy UEs, proper scheduling may be needed.
Intel	Thanks for your comments and questions A1: We agree with you that self-interference cancellation feasibility shall be carefully studied, especially in RAN4. Maybe it would make sense to carry out the RAN4 feasibility study first before RAN1 study. A2: We think TDD band should be the main focus. Not sure if FDD band is feasible due to the regulation issues. A3: The applicable frequency band would need to be studied in RAN4. A4: Probably. This might be the shortcoming for the implementation based on antenna isolation, the circulator based solution could be used instead at the gNB sided A5: Probably. There is a tradeoff between resource efficiency (guard band between DL and UL part) and potential additional implementation efforts, e.g. additional filter, which should be studied in RAN4.
Futurewei	Thanks for your comments and questions. In our understanding, in TDD bands, flexible duplex means dynamic TDD, which has been supported already in Rel-15 with enhanced CLI solutions in Rel-16, so it belongs to Type 0 in our view.

InterDigital	Thanks for your comments and questions. We tend to agree with you comment that the spec impact for self-interference cancellation at gNB side maybe limited to RAN4. However, some RAN1 spec impact may also be considered, e.g. how to configure/signal the DL/UL partition in frequency domain to support Type 1.
Lenovo	Thanks for your comments and questions. We do not have an intention to preclude PUSCH in the study, but just provide an possibility to allow PUCCH with low payload (e.g. 1 2bits for SR or HARQ-ACK) to be overlapping with DL since its operating SNR could be much lower than PUSCH.
Qualcomm	Thanks for your comments and questions. In Type 1, the DL and UL at the gNB happen at the same time but orthogonal in frequency, and with a gap in between. While in Type 2, the DL and UL at the gNB can be fully overlapping in both time and frequency domain.

2.8.3 2nd Round-Questions

Feedback Form 16: 2nd round questions and comments to Views on duplex evolution in Rel-18 (RWS-210175)

1 – Samsung Electronics Polska

Page 6: Do you expect new designs for special channels (e.g. PUCCH with 1 or 2 bits as you mentioned) which can work in full duplex mode , or the existing channel structure can already meet the requried SNIR in full duplex mode ? Is it only for UL, or both DL and UL ?

2.8.4 2nd Round-Answers

Table 14:

Respond to	Answers
Samsung	Thanks for your further questions. We are open to consider new design for small payload PUCCH such that it can be more robust to self-interference (low SINR case). Currently we only consider full duplex at the NW side so it seems only UL is relevant?

2.9 Enhanced support for multi-SIM devices (RWS-210176)

In this contribution, it was proposed to consider additional enhancements for multi-SIM devices beyond Rel-17.

1. Specify mechanism for UE to notify Network A of its capability update when it tunes away partial Tx or Rx chains from Network A (for MUSIM purpose) [RAN2]:

2. Specify mechanism to notify the serving network about the information of UEs in one device in case both UEs are served in the same cell [RAN2]:

2.9.1 1st Round-Questions

Feedback Form 17: 1st round of questions and comments to RWS-210176

1 – ZTE Corporation

For the capability update, we want to clarify the relationship between Multi-SIM and eIDC. In LTE, the main intention of IDC is to enable the coexistence of LTE and GPS/ ISM radio within the same device. For Multi-SIM, it seems Multi-SIM with two active USIM can be considered as a special case of IDC with two NR radio within the same device. Therefore, to minimize the complexity on both standardization and implementation, we are wondering whether a common framework&solution can be considered for IDC and Multi-SIM to enable the capability coordination&update in NR.

For the Network awareness of two USIMs (UEs) belonging to one MUSIM device, it seems we only aim to specify the notification mechanism from UE to NW. We want to clarify what's the expected usages of such notification in NW side and whether any change is needed in specs to support such usages?

2 – HuaWei Technologies Co.

Q1: we share the similar views that UE capability coordination/update is useful for Dual TX/Dual RX UE. Which capabilities the UE need to notify NW A of the update?

Q2: For the case that both USIMs are served in the same cell, what are the extra benefits by notifying the NW about this information compared with the UE implementation?

3 – China Telecommunications

Thanks for the contribution. We also think it is necessary to consider enhancements for multi-SIM devices in Rel 18. We quite agree with the proposal 1. For proposal 2, we fully acknowledge the motivation, but we have some questions as follow:

- How to prevent a USIM pretending it is in the same device with another USIM for illegal activities?
- Is there any other enhancements to network or UE in order to realize Unified /common mobility management, paging UEs in one device within the same PO or providing DSDA-like user experience□

-

Don't know how to achieve the optimization in the inter-operator RAN sharing scenario. As the UE ID belongs to different core network.

4 – Samsung R&D Institute UK

Version:1.0 StartHTML:000000215 EndHTML:000023559 StartFragment:000022928 EndFragment:000023455 StartSelection:000022928 EndSelection:000023444 SourceURL:http://kr5.samsung.net/static/mail/mail.html?ref=top

Q1: We think that temporary UE capability coordination/update seems useful for Dual-Tx/Dual-Rx UE. But it varies with UE implementation aspects and use cases. Thus, it would be good to clarify which capabilities to be updated and/or when to be notified as well as what is the expected UE/NW A operations after that?

Q2: Is there any impact on SA groups or RAN3 for NW awareness of one MUSIM device?

2.9.2 1st Round-Answers

Table 15:

Respond to	Answers
ZTE	Thanks for the careful review. From our understanding there are two issues that we need to address: How to resolve MUSIM UE internal interference cause by UE simultaneously connected to two networks. This similar to IDC issue. GPS/ ISM radio does not consume modem resources, but, Multi-SIM UEs share Modem capability When the MUSIM UE uses part of its radio capability in NWB, MUSIM UE radio capability would be impacted in NWA, i.e., the MUSIM UE capability in NWA would be reduced. This capability reduction is an IDC issue and IDC solution may not resolve this. For example, NW can use TDM manner to schedule the two UEs, this can be left to NW implementation. But, if UE is aware that NW would schedule it with a TDM pattern, this would avoid UE blindly decoding PDCCH. NW can correlate the two UEs PO in a same slot, this would avoid UE monitoring PO on two different slot. As a result, UE power consumption would be reduced. To achieve this, RAN have to provide some assistance info to CN for UE ID correlation
Huawei	Thanks for your questions. A2: MIMO capability□DC capability□maximum Tx power capability ,CA capability etc A2: Please see comment to ZTE

China Telecommunications	Thanks for your questions. A1: This can be resolve by NW using MUSIM authentication mechanism. This can be addressed by SA3. A2: We are open to this. A3: In case of RA sharing, different operators USIM are served by the same cell. The gNB can use TDM to schedule these to UEs. Thus, NW may indicate the last N bits of the two UEs S-TMSI for PO overlapping
Samsung	Thanks for your questions. A1: If UE indicate to NW of its MIMO or CA capability change, NW can schedule UE accordingly. A2:Maybe AMF needs to allocate UE with specific S-TMSI

2.9.3 2nd Round-Questions

Feedback Form 18: 2nd round questions and comments to Enhanced support for multi-SIM devices (RWS-210176)

1 – China Telecommunications

Thanks for your information. One question for different operators RAN sharing scenario□we think it is hard to utilize MUSIM authentication mechanism to sovle the security issues if two USIMs belongs to different operators.

2.9.4 2nd Round-Answers

Table 16:

Respond to	Answers
China Telecommunications	We are not sure whether it is possible to utilize MUSIM authentication mechanism to solve the security issues when two USIMs belonging to different operators. And we think both NAS and AS solutions can be considered. Details can be studied by SA3.

2.10 Enhancement for data collection (RWS-210177)

In this contribution, it was proposed to specify the AI enabled data collection in NR for network function optimization purpose.

1. Specify the AI-related capabilities for AI use case support;

2. Specify the input and output of AI function (e.g. model training, model inference) for some use cases, including: energy saving, load balancing, mobility optimization, etc

3. Enhancement of data collection at corresponding node;

4. Specify the inter-node information exchange, including enhancements to NG, Xn, and F1/E1 interfaces.1st round of questions and comments

2.10.1 1st Round-Questions

Feedback Form 19: 1st round of questions and comments to RWS-210177

1 – Samsung Electronics Polska Can you elaborate more on what is AI-related capabilities?
2 – vivo Mobile Communication Co. Where the ML functionality resides depends on NW deployment and on the specific use cases. For instance, the model inference function may be located at RAN node to generate the load prediction. Different nodes may exchange their AI-related capabilities to perform the AI based load balancing.

2.10.2 1st Round-Answers

Table 17:

Respond to	Answers
Samsung	Thanks for your questions. Where the ML functionality resides depends on NW deployment and on the specific use cases. For instance, the model inference function may be located at RAN node to generate the load prediction. Different nodes may exchange their AI-related capabilities to perform the AI based load balancing.

2.10.3 2nd Round-Questions

Feedback Form 20: 2nd round questions and comments to Enhancement for data collection (RWS-210177)

2.10.4 2nd Round-Answers

None

3 Summary

The discussions can be summarized as below

Study on ultra-low power wake up signal (RWS-210168, RWS-210169)

Comments/questions received from 19 companies in 1st round of email discussion, the questions raised on the following points.

1. Ultra-low-power wake up signal

-Design target or requirements

-Waveform and sequence

-Carrier frequency

-Reachability

-Carried information

-Inter-cell interference

2. Ultra-low-power wake up receiver

-Receiver structure

-Cost and size

3. Applicability, including RAT, UE type, RRC states

4. Mobility and RRM measurements

5. Additional RRC states

6. Benefit over eDRX

7. Paging delay

8. Network&UE alignment

Further comments/questions from 6 companies received in 2nd round of email discussion in response to 1st round email discussion

1. Ultra-low-power wake up signal

-Target bands and bandwidth

-Multiplexing capacity

-Reliability

-functionality

Study on AI/ML based air interface enhancement (RWS-210170)

Comments/questions received from 17 companies in NWM discussion, the questions raised on the following points.

1. Implementation of AI/ML at UE side regarding training and inference, complexity etc.

2. Study item arrangement including

-Intention of RAN level study

-How to progress the study considering different models, uses cases, and categories

-Whether all the studies in different areas should be put in the same item

-Rationale to divide into 4 different categories

-When to start the WI work

2.Application details of AI/ML in all the example use cases, including simulation assumption and algorithms:

3. Categorization of different use cases

4. Evaluation methodologies, including

-How to generate training and verification data set

-Whether to model alignment between companies

-How to evaluate generalization performance

5. Whether and How to provide NN related information to the UE, including one or multiple NN models, AI model life cycle and update

6. How to ensure predictable UE behavior and minimum requirements;

Further comments/questions from 4 companies received in 2nd round of NWM discussion in addition to 1st round discussion on data set construction, example use case for beam management, model alignment, how to progress for the study item etc.

Support of lower UE power class for Uu and SL (RWS-210171)

Comments/questions received from 2 companies in 1st round of email discussion, the questions raised on the following points.

-Target frequency band

-Performance impact (coverage, throughput)

-Scenario restriction, e.g. indoor only

-Whether RAN1 impact is required

Enhanced support for personal IOT networks(RWS-210172):

Comments/questions received from 14 companies in 1st round of email discussion, the questions raised on the following points.

-How to link between UE1 and UE2

-What is meaning about same PDCP

-Is it also helpful for industry case

-Should be SA first or RAN first

-How to consider the latency if the data is transferred between UEs.

-What is relation with SL relay

Further comments/questions from 2 companies received in 2nd round of email discussion in response to 1st round email discussion

-Architecture is same for case1 and case2

-how to organize SA and RAN related work for this topic by efficient way.

-If authentication or safety aspect should be also discussed further

Further sidelink enhancement (RWS-210173):

Comments/questions received from 10 companies in 1st round of email discussion, the questions raised on the following points.

-Specification impact for PA-less device

-Clarification on the simulation results for PSFCH power saving

-FR2X resource allocation and CSI feedback enhancement

-PSFCH on PSFCH enhancement

-SL relay

-SL CA

-Prioritization on spectrum

-SL enhancement for XR

-Whether to support LTE V2X enhancement

Further comments/questions from 1 company received in 2nd round of email discussion in response to 1st round email discussion

-Further clarification on OLPC of PSFCH

Further Positioning enhancements (RWS-210174)

Comments/questions received from 8 companies in 1st round of email discussion, the questions raised on the following points.

-Views on priority order of Rel-18 topics

-Clarification on simulation assumption, positioning method used for sidelink/V2X positioning

-Views on relationship between relative positioning and ranging

-Clarification on unlicensed band support for Uu and/or PC5 based positioning

-Views on scope and 5MHz bandwidth support for RedCap positioning

-Clarification on positioning methods, potential requirement and use cases for XR positioning

-Clarification on use case (XR), low latency requirement impacted by LBT, waveform, UE movement simulation assumption for positioning from 52.6GHz to 71GHz

-Views on additional enhancement for idle state positioning

-Views on additional enhancement for positioning impacted by DRX

-Clarification on aperiodic/semi-persistent PRS triggering from serving and neighboring cell

Further comments/questions from 3 companies received in 2nd round of email discussion in response to 1st round email discussion

-Views on relationship between idle state positioning and Rel-18 SDT

-Views on integrity of RAT-dependent positioning methods

-Further clarification on 'basic framework of sidelink over unlicensed should be established first'

-Further clarification panel assumptions and views on multiple panel enhancement for positioning from

52.6GHz to 71GHz

Views on duplex evolution in Rel-18 (RWS-210175)

Comments/questions received from 6 companies in 1st round of email discussion, the questions raised on the following points.

-Most companies agree that step-by-step introduction of full duplex is more practical, e.g. consider NW full duplex as the first step in Rel-18, there are also questions whether UE hardware impact is considered in the first step.

-How to handle CLI (co-channel, adjacent channel) and legacy UEs

-Applicable bands, e.g. TDD or FDD, low frequency or high frequency

-What is the guard band required between DL and UL in XDD

-What would be the spec impact for gNB self-interference cancellation beyond RAN4 requirement.

-Performance impact due to Tx/Rx antenna separation

-Different between Quasi-full duplex and full duplex

-Motivation to support full duplex for a sub-set of channels, e.g. PUCCH

Further comments/questions from 1 company received in 2nd round of email discussion in response to 1st round email discussion

-Further details about enhanced PUCCH design for better full duplex support

Enhanced support for multi-SIM devices (RWS-210176)

Comments/questions received from 4 companies in 1st round of email discussion, the questions raised on the following points.

-Relationship between Multi-SIM and eIDC

-Usages of notification in NW side

-Which capabilities the UE need to notify NW A of the update

-Benefits by notifying the NW compared to the UE implementation

-How to prevent a USIM pretending it is in the same device with another USIM for illegal activities

-Impact on SA groups or RAN3 for NW awareness of one MUSIM device

Further comments/questions from 1 company received in 2nd round of email discussion in response to 1st round email discussion

-MUSIM authentication mechanism to solve the security issues if two USIMs belongs to different operators

Enhancement for data collection (RWS-210177)

Comments/questions received from 1 company in 1st round of email discussion, the questions raised on the following points.

-Clarification on AI-related capabilities to be exchanged

-Further comments/questions from 0 companies received in 2nd round of email discussion in response to 1st round email discussion