

3GPP TSG RAN Rel-18 workshop

RWS-210590

Electronic Meeting, June 28 - July 2, 2021

Agenda Item: 4.2

Source: Qualcomm

Title: Email discussion summary for [RAN-R18-WS-non-eMBB-Qualcomm]

Document for: Discussion

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## 1 Introduction

This document covers the discussion of the tdocs submitted to the "non-eMBB area" by Qualcomm. The complete list of documents can be found in the appendix.

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## 2 On V2X evolution - RWS-21005

### 2.1 Input – Round 1

#### Feedback Form 1: V2X evolution - Round 1

##### 1 – LG Electronics Inc.

Q1: Use of 60 GHz band is illustrated in the figure in the slide for SL CA for V2X. Does this assume using this band as an ITS carrier or an unlicensed carrier?

Q2: About relaying for connection-less traffic, does the term "connection-less" come from the end-to-end traffic perspective? In other words, does this include a scenario where the traffic to be relayed is groupcast or broadcast for which the source UE does not know the exact target UEs, but still the source UE can set up a connection to the relay UE similarly to Rel-17 sidelink relay? Or does this mean a relaying operation that does not use connection setup between relay UE and source/destination UEs?

##### 2 – Huawei Tech.(UK) Co.. Ltd

For "(Pre-)configured mapping from application to carrier", does this mean that carriers will be dedicated to be used for certain applications? Will this mapping be defined in RAN?

##### 3 – Guangdong OPPO Mobile Telecom.

For UE scheduling another UE over SL could be supported as part of inter-UE coordination work in R17 eSL. Do you foresee some enhancement on top of it?

#### **4 – Intel Corporation (UK) Ltd**

Q1: SL CA - figure seems shows SL CA of FR1 and FR2 sidelink carriers and 60GHz carriers. Please clarify whether there is an intention to study/support CA beyond ITS carriers in FR1?

Q2: UE-to-UE relaying is considered for RSU at intersection. Please clarify what is the priority of this specific V2X work, whether L3 option is deemed sufficient and why relaying functionality is limited to RSU only if it is the case?

Q3: Please clarify whether there is an intention to enable UE scheduling in the same resource pools as mode-1 or mode-2 R16 UEs. If so should not we discuss multiplexing of mode-1 and mode-2 UEs first?

Q4: Please clarify priority of the proposed V2X evolution directions for Rel18.

#### **5 – CATT**

For Sidelink UE-to-UE relay evolution, do you consider this as RAN1 lead or RAN2 lead item?

#### **6 – Lenovo (Beijing) Ltd**

Thanks for the nice contribution,

For RSU scenario, whether considers dynamic signaling exchange between RSU and the other UE, and whether considers dynamic signaling exchange OR semi-static signaling exchange between RSU and network?

#### **7 – DOCOMO Communications Lab.**

I see your view on each, but could I ask priorities? If possible, all of SL topics including positioning, unlicensed spectrum, etc. There are many topics on SL proposed from your side, and all might be difficult in Rel-18.

#### **8 – MediaTek Inc.**

Thanks for the contribution. On UE-scheduling-UE, a couple of questions:

- Is the leader UE assumed to have any special characteristics (e.g. in coverage with assistance by BS) or can any UE be selected?
- Slide 3 suggests that the scheduling mechanism would be part of the work—is it envisioned to standardise the actual scheduling behaviour, or is that assumed to be implementation of the leader UE?

#### **9 – Samsung Electronics Co.**

Q1: For carrier aggregation, what kinds of scenarios are QC considering as candidates?

Q2: For SL Positioning, what is your view on SL positioning WI: Part of Rel-18 SL WI, part of Rel-18 Positioning WI, or a separate WI?

Q3: For SL UE2UE Relay, what is your view on UE2UE relay WI? Part of Rel-18 SL work item or a separate WI?

Q4: Since there is no RAN R17 WI to specify UE2UE relay, we wonder the meaning of "SL UE2UE relay evolution". Is the proposal to add SL U2U relay to enhance R17 SL relay WI or something else?

Q5: For UE scheduling another UE over sidelink, regarding the proposed scope "leader selection/reselection, group management", these are not scope of AS layer and it was decided to use upper layer mechanism in R16 NR SL. Then are the proposal to define AS level mechanisms in R18 SL enhancement WI?

## 2.2 Response – Round 1

### **LG Electronics Inc.**

# 1

Q1: Use of 60 GHz band is illustrated in the figure in the slide for SL CA for V2X. Does this assume using this band as an ITS carrier or an unlicensed carrier?

[Answer] The example is assuming use as an unlicensed carrier.

Q2: About relaying for connection-less traffic, does the term "connection-less" come from the end-to-end traffic perspective? In other words, does this include a scenario where the traffic to be relayed is groupcast or broadcast for which the source UE does not know the exact target UEs, but still the source UE can set up a connection to the relay UE similarly to Rel-17 sidelink relay? Or does this mean a relaying operation that does not use connection setup between relay UE and source/destination UEs?

[Answer] The "connection-less" term comes from a V2X perspective. The example is for the V2X traffic using groupcast or broadcast communication mode. This is different from the Rel-17 Sidelink Relay scope for UE-to-UE relay where unicast communication was assumed between the source and target UE (and the relay).

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

# 2

For "(Pre-)configured mapping from application to carrier", does this mean that carriers will be dedicated to be used for certain applications? Will this mapping be defined in RAN?

[Answer] Yes, a given application will be mapped to a set of carriers. The carrier(s) to be used for a particular service type can be determined based on a mapping table in the UE (pre-)configuration. The (pre-)configuration is similar to the V2X configurations that are used even in Rel-16 for the radio resources mapping. SA2 and CT1 will define the NAS layer configuration option, and RAN can define the AS layer configuration option, just like what was done in Rel-16.

### **Guangdong OPPO Mobile Telecom.**

# 3

For UE scheduling another UE over SL could be supported as part of inter-UE coordination work in R17 eSL. Do you foresee some enhancement on top of it?

[Answer] The final scope will depend on the Rel-17 decisions. However, there are enhancements that were not considered in Rel-17 that can be considered for Rel-18. These include scheduling request enhancements.

## **Intel Corporation (UK) Ltd**

# 4

Q1: SL CA - figure seems shows SL CA of FR1 and FR2 sidelink carriers and 60GHz carriers. Please clarify whether there is an intention to study/support CA beyond ITS carriers in FR1?

[Answer] Support of carriers in CA beyond ITS bands in FR1 should be considered for Rel-18.

Q2: UE-to-UE relaying is considered for RSU at intersection. Please clarify what is the priority of this specific V2X work, whether L3 option is deemed sufficient and why relaying functionality is limited to RSU only if it is the case?

[Answer] This work is an optimization to improve the reliability of the broadcast/groupcast transmissions using a relay UE, RSU in the example. RSU is chosen as it can be strategically deployed at intersections and has better LOS to vehicles around the intersection, which may be NLOS to each other. This may be suitable for other use cases as well where higher reliability of groupcast/broadcast transmissions is necessary

This is different from the Rel-17 Sidelink Relay study's UE-to-UE Relay use case. Therefore, the architecture option of L3 or L2 may not apply here, and it depends on the functions considered for the RSU, e.g. data relaying only, or applying network coded retransmissions, etc. It should be reviewed holistically during the study.

Q3: Please clarify whether there is an intention to enable UE scheduling in the same resource pools as mode-1 or mode-2 R16 UEs. If so should not we discuss multiplexing of mode-1 and mode-2 UEs first?

[Answer] We intended for UE-scheduling to operate in the same pool as Mode 1 or Mode 2 Rel-16 (and 17) UEs. For V2X, we view UE scheduling as a Mode 2 enhancement. For other sidelink applications, it would also apply to Mode 1. We're not clear on the necessity of multiplexing mode 1 and mode 2 in the same pool as part of this topic. Could you provide motivation for this?

Q4: Please clarify priority of the proposed V2X evolution directions for Rel18.

[Answer] 5GAA LS RWS-210360 provides a prioritized list of items from automotive community point of view. That list also reflects our preference, e.g. the top 3 are the most important items for V2X in Rel-18: Sidelink Positioning, LTE/NR-V2X Co-Channel Coexistence, and Sidelink Carrier Aggregation.

## **CATT**

# 5

For Sidelink UE-to-UE relay evolution, do you consider this as RAN1 lead or RAN2 lead item?

[Answer] The example of UE-to-UE relay evolution is primarily to enhance the reliability for cars NLOS to each other using relaying and/or network coding at RSU, so it may require a significant effort from RAN1.

## **Lenovo (Beijing) Ltd**

# 6

Thanks for the nice contribution,

For RSU scenario, whether considers dynamic signaling exchange between RSU and the other UE, and whether considers dynamic signaling exchange OR semi-static signaling exchange between RSU and network?

[Answer] When a UE schedules another UE, we consider dynamic scheduling from the RSU (or the scheduler in general) and other UEs. For V2X applications, we don't assume exchanges between the RSU (or scheduler) and the network but this could be the case for other use cases.

## **DOCOMO Communications Lab.**

# 7

I see your view on each, but could I ask priorities? If possible, all of SL topics including positioning, unlicensed spectrum, etc. There are many topics on SL proposed from your side, and all might be difficult in Rel-18.

[Answer] 5GAA LS RWS-210360 provides a prioritized list of items from automotive community point of view. That list also reflects our preference, e.g. the top 3 are the most important items for V2X in Rel-18: Sidelink Positioning, LTE/NR-V2X Co-Channel Coexistence, and Sidelink Carrier Aggregation.

## **MediaTek Inc.**

# 8

Thanks for the contribution. On UE-scheduling-UE, a couple of questions:

- Is the leader UE assumed to have any special characteristics (e.g. in coverage with assistance by BS) or

can any UE be selected?

[Answer]: No special characteristics are assumed. For V2X, we assume that scheduling UE is operating in Mode 2, independent of network coverage. For other applications, it could be operating in coverage under the control of or assistance from the gNB.

- Slide 3 suggests that the scheduling mechanism would be part of the work—is it envisioned to standardise the actual scheduling behaviour, or is that assumed to be implementation of the leader UE?

[Answer]: For V2X applications at least, there could be multiple schedulers in the same resource pool and it is important to specify a general scheduling framework to minimize conflicts between schedulers and conflicts with legacy UEs in the pool.

### **Samsung Electronics Co., Ltd**

# 9

Q1: For carrier aggregation, what kinds of scenarios are QC considering as candidates?

[Answer] We are considering CA for intra-band (e.g. for n47) and inter-band that includes also the FR2 and unlicensed bands. There are different reasons to support different scenarios based on the use cases we cited in the motivation slide.

Q2: For SL Positioning, what is your view on SL positioning WI: Part of Rel-18 SL WI, part of Rel-18 Positioning WI, or a separate WI?

[Answer] Our preference is to have SL positioning separate from the overall Rel-18 SL WI as it requires different study and experts in the work, compared to general Sidelink. Combining SL positioning with the Rel-18 Positioning WI needs further discussion.

Q3: For SL UE2UE Relay, what is your view on UE2UE relay WI? Part of Rel-18 SL work item or a separate WI?

[Answer] This can be decided based on the features approved for SL related work in Rel-18. However, it should be noted that the use case and consideration in this particular proposal is focused on V2X aspects and may be different from the general unicast based UE-to-UE Relay study.

Q4: Since there is no RAN R17 WI to specify UE2UE relay, we wonder the meaning of "SL UE2UE relay evolution". Is the proposal to add SL U2U relay to enhance R17 SL relay WI or something else?

[Answer] The intention here is to suggest that from automotive use case perspective, the Rel-17 U2U relay option (which only focused on unicast traffic) can be expanded to encompass connection-less traffic (broadcast/groupcast traffic). It is for Rel-18 consideration and goes beyond what had been discussed in the previous study.

Q5: For UE scheduling another UE over sidelink, regarding the proposed scope "leader selection/reselection, group management", these are not scope of AS layer and it was decided to use upper layer mechanism in R16 NR SL. Then are the proposal to define AS level mechanisms in R18 SL enhancement WI?

[Answer] No, the selection in this contribution refers to a UE selecting which scheduler to follow, e.g. a vehicle moving from one RSU to another, not which UE is a group leader. This selection requires signaling and procedure to be defined in RAN. This is different from the group management that is outside of AS layer scope.

## 2.3 Input – Round 2

### Feedback Form 2: V2X evolution - Round 2

#### 1 – Huawei Tech.(UK) Co.. Ltd

Thanks for the response. How does the UE indicate (e.g. CIF in SCI), which carrier from the (pre-)configured table for service mapping it is going to transmit on?

#### 2 – Guangdong OPPO Mobile Telecom.

Thank you for the reply. How about the higher layer signalling design to support the hierarchical structure in inter-UE scheduling for groupcast / communication among a group of UEs, e.g. RSU in V2X or a centralized point (AP) in smart home network? Should this be included as part of UE scheduling another UE over SL in R18?

#### 3 – LG Electronics Inc.

Q1: Can you provide your view on so called "licensed-assisted" and "unlicensed standalone" operations? Do you think SL access to unlicensed band in Rel-18 needs to support a case where a licensed carrier is used for some assistance and/or another case where SL access to unlicensed band is done with no assistance from any other carriers?

Q2: In "connection-less" relaying, can you elaborate on the communication between the source UE and relay UE? Do you assume that the source UE sets up a PC5 connection with the relay UE which relays the packets using groupcast or broadcast communication mode? Or no such connection is set up and the relay UE is considered as one of the receivers of groupcast or broadcast transmissions from the source UE?

#### 4 – Intel Corporation (UK) Ltd

Q1: It was clarified that "CA beyond ITS bands in FR1 should be considered for Rel-18". Could you clarify which CA combinations (beyond CA combinations in FR1) should be considered with higher importance according to your view and reasoning behind enabling such combinations (FR1(licensed/unlicensed/ITS) FR2(licensed/unlicensed/ITS))?

Q2: Could you clarify if you are also considering smart repeater type of relaying for V2X at intersections or only decode-and-forward type of relaying with any type of transmission filtering?

Q3: If scheduling functionality is needed, then evolution of mode-1 framework can be considered including multiplexing of mode-2 UEs in the shared resources. Could you please further clarify the definition of UE scheduling you have in mind? Is that the same/similar framework as for gNB scheduling (e.g. scheduling DL/UL transmissions), etc?

Q4: According to 5GAA input power saving aspects have got rank #4. Do you think that R.17 framework of partial sensing/SL-DRX is enough for sidelink power saving? Do you see the need for sidelink wake-up signal support?

## 2.4 Response – Round 2

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

# 1

Thanks for the response. How does the UE indicate (e.g. CIF in SCI), which carrier from the (pre-)configured table for service mapping it is going to transmit on?

[Answer]: This would be part of the discussion and design in the WGs.

### **Guangdong OPPO Mobile Telecom.**

# 2

Thank you for the reply. How about the higher layer signalling design to support the hierarchical structure in inter-UE scheduling for groupcast / communication among a group of UEs, e.g. RSU in V2X or a centralized point (AP) in smart home network? Should this be included as part of UE scheduling another UE over SL in R18?

[Answer]: Such upper layer signaling, i.e. selection and coordination of the UE to provide scheduling, should be discussed in the study.

### **LG Electronics Inc.**

# 3

Q1: Can you provide your view on so called “licensed-assisted” and ”unlicensed standalone” operations? Do you think SL access to unlicensed band in Rel-18 needs to support a case where a licensed carrier is used for some assistance and/or another case where SL access to unlicensed band is done with no assistance from any other carriers?

[Answer] Both options can be studied in Rel-18. The need for such schemes depends on the use case and deployment considerations.

Q2: In “connection-less” relaying, can you elaborate on the communication between the source UE and relay UE? Do you assume that the source UE sets up a PC5 connection with the relay UE which relays the packets using groupcast or broadcast communication mode? Or no such connection is set up and the relay UE is considered as one of the receivers of groupcast or broadcast transmissions from the source UE?

[Answer] There are different potential relaying operations. From V2X perspective, the “connection-less” relaying is referring to the case that the broadcast or groupcast traffic from the vehicle are relayed by the RSU or another designated device, based on some pre-configured or standardized criteria. Depending on use case, there may be some signaling involved in setting up the RSU or the designated device to perform the relay operation. However, this should not require unicast like connection and link establishment.

### **Intel Corporation (UK) Ltd**

# 4

Q1: It was clarified that “CA beyond ITS bands in FR1 should be considered for Rel-18”. Could you clarify which CA combinations (beyond CA combinations in FR1) should be considered with higher importance according to your view and reasoning behind enabling such combinations (FR1(licensed/unlicensed/ITS) FR2(licensed/unlicensed/ITS))?

[Answer] As explained in the contribution RWS-210005, we consider the CA for FR1 ITS bands as necessary for V2X deployment in certain regions due to spectrum fragmentation for example. For V2X, that is the highest priority use case for CA for Rel-18.

Beyond that, any possible mechanisms enabling more spectrum for V2X are important for advanced applications, and that includes CA of licensed and unlicensed bands.

Q2: Could you clarify if you are also considering smart repeater type of relaying for V2X at intersections or only decode-and-forward type of relaying with any type of transmission filtering?

[Answer] Smart repeater type of relaying for V2X can be considered. However, that needs to be used carefully, with proper planning to avoid unintended congestions.

The study should determine at which layer the relay function should be implemented, and whether the traffic content should be used directly in the relay operation.

Q3: If scheduling functionality is needed, then evolution of mode-1 framework can be considered including multiplexing of mode-2 UEs in the shared resources. Could you please further clarify the definition of UE scheduling you have in mind? Is that the same/similar framework as for gNB scheduling (e.g. scheduling DL/UL transmissions), etc?

[Answer] The relation between UE scheduling and multiplexing Mode 1 and Mode 2 in the same pool is unclear. UE scheduling could be viewed as a Mode 2 enhancement, in which case, all UEs in the Mode 2 pool

are Mode 2 UEs, even though only some of them are scheduled by other UEs. There could also be enhancements to Mode 1, but again the UEs will only transmit in the Mode 1 pool when scheduled.

Q4: According to 5GAA input power saving aspects have got rank #4. Do you think that R.17 framework of partial sensing/SL-DRX is enough for sidelink power saving? Do you see the need for sidelink wake-up signal support?

[Answer] Rel-17 power saving/SL-DRX design is still on-going. We will only know if there is anything additional required when the study concludes. Additionally, specifically for wake-up signal, it might be useful for some pedestrian UE use cases, but it is not critical in the V2X application perspective.

Therefore, we agree with 5GAA's ranking.

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### 3 On NR-LTE V2X Co-Channel Coexistence - RWS-210006

#### 3.1 Input – Round 1

##### **Feedback Form 3: NR-LTE V2X Co-channel Coexistence - Round 1**

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

At what granularity can a DSS-like solution allow resource sharing between LTE-V and NR-V - is the intention to overlap resource pools?

###### **2 – Guangdong OPPO Mobile Telecom.**

1. LTE and NR sidelink resource pools are independently (pre-)configured. To facilitate the coexistence on the same channel, separate resource pools can be (pre-)configured in a TDM manner to avoid AGC/PSFCH issue.

2. If LTE/NR V2X resource pools are overlapped, hardware changes are necessary for NR V2X receiver to perform channel estimation and decoding of LTE V2X PSCCH for sensing to avoid collisions.

###### **3 – Intel Corporation (UK) Ltd**

Q1: LTE/NR V2X coexistence. Please clarify whether you also consider asynchronous scenarios when UEs serve as independent synchronization sources or only synchronous scenarios under assumption of known common timing derived from NW/GNSS for both LTE-V2X and NR-V2X?

Q2: Please clarify whether it is assumed that NR-V2X UE is also equipped with LTE-V2X modem or it supports only NR-V2X or both possibilities are considered?

###### **4 – CATT**

If co-channel co-existence here means two RATs use the same resource pool, and since no changes can be made to LTE-V2X UE, what specific changes do you envision for NR-V2X UE?

**5 – MediaTek Inc.**

Thanks for the contribution. We would like to understand if this means that the NR-V2X UE needs to decode LTE-V2X sensing messages. Is there impact to legacy V2X operation under either RAT?

**6 – Samsung Electronics Co.**

Q1: Is it expected that it is impacting existing Rel-16/17 V2X?

Q2: Will this be limited to the case when both systems operate with the same SCS (i.e. 15 kHz) or can NR be operating at 30 kHz?

Q3: What is your view on NR-LTE V2X co-channel coexistence as a part of Rel-18 SL WI or a separate WI?

Q4: What necessary modification to NR V2X is expected for NR-LTE V2X co-channel coexistence?

Q5: Are you considering to allow NR-LTE V2X co-channel coexistence in the same resource pool and NR V2X detects control channel of LTE V2X?

### 3.2 Response – Round 1

**Huawei Tech.(UK) Co.. Ltd**

# 1

At what granularity can a DSS-like solution allow resource sharing between LTE-V and NR-V - is the intention to overlap resource pools?

[Answer] Yes, having overlapping resource pools is an option we have considered. Collisions could be avoided by the Rel-18 UEs sensing LTE V2X SA and avoiding those reserved resources. Other designs could be considered.

**Guangdong OPPO Mobile Telecom.**

# 2

1. LTE and NR sidelink resource pools are independently (pre-)configured. To facilitate the coexistence on the same channel, separate resource pools can be (pre-)configured in a TDM manner to avoid AGC/PSFCH issue.

2. If LTE/NR V2X resource pools are overlapped, hardware changes are necessary for NR V2X receiver to perform channel estimation and decoding of LTE V2X PSCCH for sensing to avoid collisions.

[Answer] Your comments are appreciated. The Rel-18 UE is assumed to also support LTE V2X, e.g. for BSM. We don't expect hardware changes beyond what is required to support NR V2X and LTE V2X separately.

**Intel Corporation (UK) Ltd**

# 3

Q1: LTE/NR V2X coexistence. Please clarify whether you also consider asynchronous scenarios when UEs serve as independent synchronization sources or only synchronous scenarios under assumption of known common timing derived from NW/GNSS for both LTE-V2X and NR-V2X?

[Answer] We considered both scenarios. The same issue of common timing exists for in-device coexistence, and similar solutions could be applied.

Q2: Please clarify whether it is assumed that NR-V2X UE is also equipped with LTE-V2X modem or it supports only NR-V2X or both possibilities are considered?

[Answer] Our initial assumption is that the NR-V2X equipped UE is also equipped with an LTE-V2X modem. Other scenarios can be considered as well.

## **CATT**

# 4

If co-channel co-existence here means two RATs use the same resource pool, and since no changes can be made to LTE-V2X UE, what specific changes do you envision for NR-V2X UE?

[Answer] The Rel-18 UE would also have support for LTE V2X. The change then would be to use LTE V2X SA in NR resource selection.

## **MediaTek Inc.**

# 5

Thanks for the contribution. We would like to understand if this means that the NR-V2X UE needs to decode LTE-V2X sensing messages. Is there impact to legacy V2X operation under either RAT?

[Answer] There is no impact to the LTE-V2X operation. There's no impact on legacy operation for Rel-16 and Rel-17 UEs as the coexistence mechanisms would not be used on NR V2X only clean channels. Co-channel NR-V2X UEs supporting both Rel-18 NR V2X and LTE V2X are already decoding control from both.

## **Samsung Electronics Co., Ltd**

# 6

Q1: Is it expected that it is impacting existing Rel-16/17 V2X?

[Answer] No. There's no impact on legacy operation for Rel-16 and Rel-17 UEs as the coexistence mechanisms would not be used on NR V2X only clean channels.

Q2: Will this be limited to the case when both systems operate with the same SCS (i.e. 15 kHz) or can NR be operating at 30 kHz?

[Answer] We are thinking of the case where both systems are using 15 KHz. We are open to discussions on enabling mixed numerology as well.

Q3: What is your view on NR-LTE V2X co-channel coexistence as a part of Rel-18 SL WI or a separate WI?

[Answer] We are open to both options.

Q4: What necessary modification to NR V2X is expected for NR-LTE V2X co-channel coexistence?

[Answer] The change in Rel-18 would be to use LTE V2X SA in NR resource selection.

Q5: Are you considering to allow NR-LTE V2X co-channel coexistence in the same resource pool and NR V2X detects control channel of LTE V2X?

[Answer] Yes, we are considering having the same or overlapping resource pools. Collisions could be avoided by the Rel-18 UEs sensing LTE V2X SA and avoiding those reserved resources. Other designs could be considered.

### 3.3 Input – Round 2

#### **Feedback Form 4: NR-LTE V2X Co-channel Coexistence - Round 2**

**1 – Huawei Tech.(UK) Co.. Ltd**

Thanks for the response. We assume your answer is based on a UE with both LTE and NR modules, as in Rel-16 in-device coexistence (correct?). If that's correct, which parts of Rel-16 SI proposals for in-device coexistence do you think are most worthwhile revisiting, or is the idea to go in a different direction?

## **2 – Guangdong OPPO Mobile Telecom.**

Thank you for the reply. If relying on LTE-V2X module to perform channel sensing on LTE resource pool, pass on resource allocation information to NR-V2X (like inter-RAT coexistence in R16), and that NR-V2X is to avoid selecting resources that are overlapping with LTE-V2X transmission, it is then expected NR-V2X PHY layer to exclude these resources for both full sensing and partial sensing UEs.

I assume this co-channel coexistence needs a specification solution is only for out-of-coverage mode 2 operation without any operator management, right? Otherwise, if it is in-coverage or within an operator control, LTE and NR resource pool can always be re-configured for changing traffic needs, e.g. LTE-V2X traffic migration to NR.

Furthermore, since C-V2X is still in trial phases and NR-V2X can already support BSM, why not by-pass LTE-V2X and directly use NR-V2X or pre-configured minimum resources for LTE-V?

## **3 – Intel Corporation (UK) Ltd**

Q1: Could you clarify why support of asynchronous LTE-V2X/NR-V2X scenario is considered as an important one and whether you assume inter-RAT synchronization for this case based on NR/LTE-V2X SLSS transmissions?

Q2: Our thinking was that co-channel coexistence work is motivated by flexibility to gradually phase out one of the technologies which means that there may be also UEs that do not support LTE-V2X. In our view it seems reasonable to consider UEs with 1) LTE-V2X only vs UEs with LTE-V2X + NR-V2X and 2) LTE-V2X only vs UEs with NR-V2X only. Could you clarify if you see the need for other (and if so which) scenarios as well?

## **4 – Samsung Electronics Co.**

1. Co-existence of LTE and NR not only requires hardware to support each separately, but also requires a relatively fast communication link between this two. Can you comment on the need for a fast link between NR and LTE hardware.

2. As there are no hardware changes expected for LTE devices operation a same resource pool as NR, does this imply that an LTE transmission gets a higher priority over a colliding NR transmission?

## **3.4 Response – Round 2**

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

# 1

Thanks for the response. We assume your answer is based on a UE with both LTE and NR modules, as in Rel-16 in-device coexistence (correct?). If that's correct, which parts of Rel-16 SI proposals for in-device coexistence do you think are most worthwhile revisiting, or is the idea to go in a different direction?

[Answer] We'd like to minimize changes and maximize reuse as much as possible from the existing in-device coexistence framework for co-channel coexistence. The additions would include using LTE V2X sensing results in the Rel-18 NR resource selection mechanism instead of only doing prioritization as is done in Rel-16 in-device coexistence.

**Guangdong OPPO Mobile Telecom.**

# 2

Thank you for the reply. If relying on LTE-V2X module to perform channel sensing on LTE resource pool, pass on resource allocation information to NR-V2X (like inter-RAT coexistence in R16), and that NR-V2X is to avoid selecting resources that are overlapping with LTE-V2X transmission, it is then expected NR-V2X PHY layer to exclude these resources for both full sensing and partial sensing UEs.

[Answer] The operation is expected to be carried out only by Rel-18 compatible devices. The details should be addressed by the working groups.

I assume this co-channel coexistence needs a specification solution is only for out-of-coverage mode 2 operation without any operator management, right? Otherwise, if it is in-coverage or within an operator control, LTE and NR resource pool can always be re-configured for changing traffic needs, e.g. LTE-V2X traffic migration to NR.

[Answer] For Mode 1 or in-coverage case, the network could assist in handling the resource pool management. However, it does not address all issues, as the network also needs to have a way to understand how to adjust the configuration. This and other issues need to be studied.

Furthermore, since C-V2X is still in trial phases and NR-V2X can already support BSM, why not by-pass LTE-V2X and directly use NR-V2X or pre-configured minimum resources for LTE-V?

[Answer] Please note that it is an incorrect notion that "C-V2X is still in trial phase". There are already commercial launches of LTE-V2X based products, including in China, and other regions. Please refer to the 5GAA announcements and LS for more information.

In some regions, there are regulations designating LTE-V2X for supporting basic safety V2X services, and NR-V2X is to be used to support advanced V2X applications. Please check motivations in RWS-210006 for the reason for supporting co-channel/co-ex operations.

Even if some region may allow the use of NR-V2X for basic safety services, it does not diminish the needs for co-channel/co-ex support in other regions. 3GPP needs to provide the toolbox as requested by the industry forum, 5GAA.

**Intel Corporation (UK) Ltd**

# 3

Q1: Could you clarify why support of asynchronous LTE-V2X/NR-V2X scenario is considered as an important one and whether you assume inter-RAT synchronization for this case based on NR/LTE-V2X SLSS transmissions?

[Answer] We support considering all scenarios and believe that their relative importance will be determined later. We think the existing inter-RAT synchronization mechanism of in-device coexistence could be reused in

the asynchronous scenario but are open to other mechanisms as well.

Q2: Our thinking was that co-channel coexistence work is motivated by flexibility to gradually phase out one of the technologies which means that there may be also UEs that do not support LTE-V2X. In our view it seems reasonable to consider UEs with 1) LTE-V2X only vs UEs with LTE-V2X + NR-V2X and 2) LTE-V2X only vs UEs with NR-V2X only. Could you clarify if you see the need for other (and if so which) scenarios as well?

[Answer] This is a method to expand the spectrum available for NR V2X by using LTE V2X spectrum. We think it's important to be able to decode LTE-V2X SA to avoid interference with LTE-V2X only devices in this case. In our view, Case (1) is a higher priority and we don't see the need for Case (2) in Rel-18. However, it could be considered in a later release.

### **Samsung Electronics Co., Ltd**

# 4

1. Co-existence of LTE and NR not only requires hardware to support each separately, but also requires a relatively fast communication link between this two. Can you comment on the need for a fast link between NR and LTE hardware.

[Answer] This is expected to be within the Rel-18 compatible UE and is an internal UE interaction. We don't anticipate a fast communication between the two modules to be required.

2. As there are no hardware changes expected for LTE devices operation a same resource pool as NR, does this imply that an LTE transmission gets a higher priority over a colliding NR transmission?

[Answer] No change to LTE only device. NR transmission will avoid LTE reserved resources and try to minimize collisions.

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## **4 On 5G & IOT – A UE centric perspective - RWS-210007**

### **4.1 Input – Round 1**

#### **Feedback Form 5: 5G and IOT - Round 1**

**1 – NTT DOCOMO INC.**

Regarding co-existence with legacy UE, we would like to ask followings:

-

BWP and RACH enhancements: What would be the delta from those to be specified in Rel-17 Red-Cap?

-  
Inter-UE priority handling: What scenarios do you assume? Is it the priority handling between Red-Cap UEs and non-RedCap UEs? What is the delta from Rel-16 UL CI?

-  
DSS support: What kind of specification impact is expected to support DSS for RedCap UEs?

-  
Beam management: What kind of specification impact is expected for co-existence with non-RedCap UEs?

## **2 – Classon Consulting**

FUTUREWEI supports studying redcap positioning, but should be in positioning not redcap

## **3 – ZTE Corporation**

Thanks for the proposed RedCap evolution areas. We have following questions to clarify:

-  
For "mobility enhancement", we understand the "stationary deployment" means fixed-location UEs. Based on the discussion in Rel-17, some companies commented even if the RedCap UE is fixed, the cell quality(RSRP/RSRQ) of serving cell may still change, so whether this proposal is to introduce additional relaxation method for fixed-location UEs?

-  
For "Upper-layer enhancements", could you please elaborate more on the enhancements to access, cell re-selection, UP simplifications?

-  
For "Small data transfer (SDT)", we are also interested in supporting small data transmission in idle mode as mentioned in our tdoc RWS-210485. We want to clarify any difference compared with small data enhancement for non-RedCap UEs.

## **4 – Spreadtrum Communications**

Thanks for the nice contribution.

For the Rel-18 proposed RedCap evolution areas, we are also interested in BW reduction, we just want to know when the BW is further reduced to 5MHz, is the scaling factor can still used to enable multiple tiers of products? From our perspective, scaling factor can be used for Rel.17 RedCap UE (Maximum 20MHz BW in FR1) for different use cases.

## **5 – Huawei Tech.(UK) Co.. Ltd**

1. For narrowband positioning, we also consider it is a useful feature for IoT devices. What is the positioning accuracy level you are targeting for RedCap?

For some proposals in your slide 10, we consider those can be largely addressed in Rel-17 unless new issues are identified, so could you explain:

2. For proposals on coexistence with legacy UE, we also think it is important for RedCap commercialization. It would be good to clarify:

(2a) What issues are "BWP and RACH enhancements" to address? And if any, why it can't be solved in R17?

(2b) For inter-UE priority handling, what is the new issue? if any, why it can't be solved in R17?

(2c) For DSS support, isn't it the case that RedCap UE already can work under DSS network? What is the additional needed for "DSS support"?

3. For proposals on power saving techniques, what does the "low-power wake-up radio" beyond WUS and PEI refer to? The former is a receiver radio while the latter two are signals. Is the intention to introduce new wake up signal other than PEI and WUS for RedCap or dedicated wake up radio using WUS and PEI?

For proposals on upper-layer enhancement,

4. Could you clarify what is the meaning of further enhancement to SDT over PUR? Our understanding CG based SDT is somehow an equal concept to PUR in LTE which was already in R17.

5. Could you clarify the purpose of user-plane simplifications: cost reduction or for efficiency improvement, or ...?

## **6 – MediaTek Inc.**

Thank you for sharing your views. We have the following questions:

Q1: What new usecase(s) do you foresee for a UE BW of 5MHz, and do you see sufficient value associated with these usecases when considering the impact such a change would have in reducing the 'scale' of RedCap as highlighted in the document?

Q2: What target RedCap usecase do you consider with regards to multicast? Also, what do you foresee as missing to support multicast in RedCap in R17?

Q3: Could you elaborate some more on UE complexity reductions with respect to access and cell re/selection?

Q4: We have introduced wakeup mechanisms for connected and idle modes in Rel-16 and Rel-17 respectively. Considering these mechanisms, it is expected that link maintenance mechanisms (RRM in Idle, CSI is connected) will dominate UE power consumption. With the suggested wake-up radio, have you considered the associated power consumption impact of these link maintenance activities?

## **7 – VODAFONE Group Plc**

Thanks for the slides. Happy to keep NB-IoT/eMTC platforms stable.

Some questions:

a) except for indoor positioning use cases, why is GNSS not adequate for RedCap?

b) Why would the "study benefits of low-power wake-up radio" be RedCap specific and not also apply to mMTC?

c) Sidelink is a 3GPP platform that does not seem to have yet matured well in the marketplace. What benefits are you seeing from adding it to the emerging RedCap platform?

d) how will adding a 5MHz variant of RedCap help RedCap develop economies of scale?

## **8 – Ericsson LM**

Regarding further reduced UE bandwidth (RWS-210007), we would like to ask what potential UE cost reduction you expect from reduction from 20 MHz to 5 MHz? The estimates from CATT (RWS-210409) and Ericsson (RWS-210313) indicate that according to the established cost evaluation methodology (TR 38.875), there may not be a very significant further cost reduction compared to 20 MHz.

Also, we would like to ask whether your statement (on slide 10) that “support of 30 kHz SCS would have to be further considered” means that you think that it might not be necessary to support 30 kHz SCS?

#### **9 – Intel Corporation (UK) Ltd**

Q1. Considering that low device complexity is the cornerstone of RedCap UEs, could you kindly elaborate on justification for support of inter-UE priority handling for RedCap UEs? Why not rely on gNB scheduling, including resource reservation for RedCap UEs, given that the main benefit of inter-UE prioritization is in terms of user capacity?

Q2. Considering the discussions and outcomes from Rel-17, do you see anything changing in Rel-18 for FR2-related enhancements or DL coverage recovery for RedCap?

Q3. What specific enhancements for DSS support is envisioned for RedCap?

Q4. For MBS-related enhancements, could you kindly elaborate on the specifics as they may only relate to RedCap and not applicable to non-RedCap UEs?

#### **10 – Xiaomi Communications**

[Xiaomi]: Thank you for the contribution. We have the following questions/ comment

(1) For the RedCap positioning, what’s your consideration on the requirement? Define new requirement or reuse existing requirement defined for the non-RedCap?

(2) Xiaomi also has interest on the sidelink RedCap, we think it is helpful to expand more use cases for RedCap

(3) Can you explain more about the BWP and RACH enhancement, inter-UE priority handling for the co-existence with legacy UE.

#### **11 – CATT**

Thanks for the contribution. We have the following comments/questions.

1. Further cost reduction due to reduced BW seems small but lead to market fragmentation and potential impact on initial access. How much cost/complexity reduction is expected by BW reduction smaller than 20MHz based on your evaluation?

2. If the UE BW is reduced to 5MHz, SSB with 30kHz SCS cannot be accommodated within 5MHz BW. Then there will be big spec/implementation impact. Otherwise if 30kHz SCS SSB is not supported, the usefulness in the real deployment is quite limited.

3. By default, RedCap UE supports all non-RedCap UE features except those due to reduced L1 capability. What are the specific identified issues that RedCap UE cannot support MBS, SL, DSS and NRU?

4. Relaxed processing time was dropped in Rel-17 due to marginal cost reduction but significant negative impact to network. What additional justification is found to pursue this in Rel-18?

#### **12 – vivo Communication Technology**

Thanks Qualcomm for the nice paper.

1. Regarding cost reduction, do you think reducing UE RF BW to 5MHz is a must for cost reduction, or we can potentially keep 20MHz RF BW but reduce the baseband capability by TBS/RB restriction, etc for cost reduction. By this way, we would not suffer from many performance degradation issues(frequency diversity, scheduling flexibility, resource fragment) ?

2. as a general question, do you think the enhancement areas listed in P10 should all be included in a single eRedCap WI, or some of them can be split into different items?

### 13 – Apple Poland Sp. z.o.o.

<Apple>

- 1) On 'Narrowband Positioning', what's scope or potential impacts? is it just defining positioning requirement for reduced Rx branches (e.g. 1 Rx) and reduced BW and keeping the same accuracy requirement? (Mainly RAN4 impacts) or some new positioning algorithms? (RAN1 impact). What positioning accuracy performance is in Qualcomm's mind for Redcap device?
- 2) For 'low-power' wake-up radio, it is interested to know some important aspects? e.g. what is the RF sensitivity for WUR detection in Qualcomm mind for Redcap UEs? Should it be a generic design targeting from all devices in IDLE mode?
- 3) SDT is one of Rel-17 WID and it is possible that Rel-17 Redcap UE already supports as part of UE capability. What's the further enhancement proposed here?

### 14 – Samsung Electronics Co.

1. With 10MHz or 5MHz BW, how much additional cost reduction do you expect compared with current RedCap, and simple restriction, e.g. restrict BW for PDSCH or restrict TBS? In the annex A, it seems like SSB/CORESET 0 are expected to be reused, is this correct? However, for PDCCH in CORESET 0, the coverage might have more serious issue compared with 20MHz DL BW. Do you think some coverage recovery is expected?
2. What kind of necessary spec change had been identified to support Pos and/or SL for Redcap?
3. What kind of technique is expected for further power saving for RedCap, e.g., ZP-WUS? why such techniques are specific to RedCap to be discussed in RedCap WI other than general power saving for all type of device?

### 15 – Sony Europe B.V.

Thanks for an interesting set of slides.

We agree that we can leave eMTC / NB-IoT "as is" at the moment. However, we think that eMTC / NB-IoT need to operate over IoT-NTN, where we expect IoT-NTN work items in Rel-17 (essential functionality) and Rel-18 (enhancements).

On redcap evolution (slide 10):

- Bandwidth: The R17 study determined that 20MHz BW was a sweet spot for UE redcap bandwidth capability. What percentage further complexity reduction do you expect with a 5/10MHz UE bandwidth?
- Positioning: Would you consider accuracy enhancements to account for the reduced redcap bandwidth? If not, what accuracy degradation would you consider acceptable?
- Power saving: We are also interesting in low power WUR (as part of the evolution towards zero power communications, as discussed in RWS-210302 and RAN-R18-WS-non-eMBB-SONY). For low power wake-up radio, do you envisage the low power WUR to require a new waveform (other companies suggest OOK waveforms). If so, what performance penalties do you foresee?

## 4.2 Response – Round 1

NTT DOCOMO INC. # 1

Regarding co-existence with legacy UE, we would like to ask followings:

Q1) BWP and RACH enhancements: What would be the delta from those to be specified in Rel-17 RedCap?

**[Answer] Due to further reduction in BW and relaxation of UE processing time capability, BWP configuration and switching mechanism can be re-visited in R18. Besides, BWP enhancement can be studied for RedCap/eRedCap UEs to support NR broadcast/multicast. For RACH enhancement, 2-step/4-step RACH based SDT, low power positioning, RAR multiplexing/differentiation for different UE types, DL coverage enhancement for broadcast PDCCH/PDSCH can be studied in R18.**

Q2) Inter-UE priority handling: What scenarios do you assume? Is it the priority handling between RedCap UEs and non-RedCap UEs? What is the delta from Rel-16 UL CI?

**[Answer] The following scenarios can be further studied for inter-UE priority handling: eMBB UE vs. R17 RedCap UE, eMBB UE vs R18 eRedCap UE, and R17 RedCap UE vs R18 eRedCap UE. UE timeline relaxation for UL CI decoding and partial cancellation of PUSCH/PUCCH repetitions can be a starting point of discussion.**

Q3) DSS support: What kind of specification impact is expected to support DSS for RedCap UEs?

**[Answer] SA deployment on DSS carrier can be discussed for RedCap/eRedCap UEs, based on the discussion at RAN#91e. Rate matching for LTE CRS can be a starting point of discussion.**

Q4) Beam management: What kind of specification impact is expected for co-existence with non-RedCap UEs?

**[Answer] This can include the following for FR2:**

**(a) Optimizations for stationary and rotating UEs, e.g.:**

**Reducing beam overloading and interference**

**Studying ways to reduce beam direction blockage to accommodate other UEs (e.g., in times when beams are preconfigured for RedCap UEs)**

**(b) Optimizations due to reduced BW and reduced resources, e.g.:**

**Mixed RS for P2/P3 (U2/U3) BM procedures to reduce the RS overhead.**

**BFD/BFR procedure optimizations**

**Classon Consulting # 2**

FUTUREWEI supports studying redcap positioning, but should be in positioning not redcap

**[Answer] We are open to study narrow-band positioning in R18 FePOS WI.**

### ZTE Corporation # 3

Q1) For "mobility enhancement", we understand the "stationary deployment" means fixed-location UEs. Based on the discussion in Rel-17, some companies commented even if the RedCap UE is fixed, the cell quality (RSRP/RSRQ) of serving cell may still change, so whether this proposal is to introduce additional relaxation method for fixed-location UEs?

**[Answer] This is mostly related to beam management optimizations for FR2 by reducing beam overloading and interference. Studying ways to reduce beam direction blockage to accommodate other UEs (e.g., in times when beams are preconfigured for RedCap UEs).**

**There is also an additional aspect where the UE's BFD/BFR procedures may be optimized because of the UE's stationary conditions.**

**Also, RRM timing and procedures may be relaxed. Although the channel may be changing as indicated even for stationary UE, but it can be changing at a much slower rate and some optimizations can be done.**

Q2) For "Upper-layer enhancements", could you please elaborate more on the enhancements to access, cell re-selection, UP simplifications?

**[Answer] For access, we are interested in at least the following two areas for study: 1. The impacts of co-existence of R18 eRedCap, R17 RedCap and non-RedCap UEs on initial access procedures such as cell barring, access control, paging, RACH, etc, due to eRedCap UE's further reduced max UE bandwidth and need for coverage enhancement; 2. enhancements to initial access procedures (e.g. RACH) to support high-density deployment of eRedCap UEs.**

**For cell-reselection, similar enhancements to cell reselection procedures for RedCap in R17 can be extended to R18 eRedCap. In addition, additional enhancements can be studied if R18 eRedCap requires coverage enhancement. UP simplifications for R18 eRedCap can adopt those adopted by LTE's eMTC/NB-IoT, as a baseline. We are open to additional enhancements that can reduce UP overhead for eRedCap UEs with low data rate.**

Q3) For "Small data transfer (SDT)", we are also interested in supporting small data transmission in idle mode as mentioned in our tdoc RWS-210485. We want to clarify any difference compared with small data enhancement for non-RedCap UEs.

**[Answer] We are interested in SDT in RRC Idle and contention-based PUR (aka CG-SDT in R17) for the use case of high-density deployment of eRedCap UEs. We are open to other eRedCap-specific enhancements for SDT too.**

### Spreadtrum Communications # 4

Q1) For the Rel-18 proposed RedCap evolution areas, we are also interested in BW reduction, we just want to know when the BW is further reduced to 5MHz, is the scaling factor can still used to enable multiple tiers of products? From our perspective, scaling factor can be used for Rel.17 RedCap UE (Maximum 20MHz BW in FR1) for different use cases.

**[Answer] We don't expect R18 eRedCap devices (max UE BW of 5 MHz) to overlap with LPWA UE capabilities. In fact, we think major evolution of LTE LPWA should stop during the 5G timeframe from**

**R18, and any additional features for NB-IoT/eMTC would have to be very low impact, if any. Overtime, some use cases currently on LPWA will naturally migrate up to RedCap/eRedCap.**

**Huawei Tech.(UK) Co.. Ltd # 5**

Q1) For narrowband positioning, we also consider it is a useful feature for IoT devices. What is the positioning accuracy level you are targeting for RedCap?

**[Answer] The accuracy level achievable by NR RedCap/eRedCap devices depends at least on operational BW of the UE, location (indoor/outdoor), complexity affordable and power saving considerations. For eRedCap devices with max UE BW of 5 MHz, positioning accuracy less than 10 meters (outdoor) would be a good starting point for R18 study. You are welcome to read our paper on NR FePOS RWS-210021 to get more information.**

For some proposals in your slide 10, we consider those can be largely addressed in Rel-17 unless new issues are identified, so could you explain:

Q2) For proposals on coexistence with legacy UE, we also think it is important for RedCap commercialization. It would be good to clarify:

(2a) What issues are "BWP and RACH enhancements" to address? And if any, why it can't be solved in R17?

**[Answer] Our proposal for BWP and RACH enhancements aim to address the leftover issues for R17 RedCap devices. The solutions applicable to R17 RedCap devices can be re-used by R18 eRedCap devices when appropriate, by accounting for BW reduction and processing time capability relaxation. For example, BWP enhancement can be studied for RedCap/eRedCap UEs to support NR broadcast/multicast. For RACH enhancement, 2-step/4-step RACH based SDT, low power positioning, RAR multiplexing/differentiation for different UE types, DL coverage enhancement for broadcast PDCCH/PDSCH can be studied in R18.**

(2b) For inter-UE priority handling, what is the new issue? if any, why it can't be solved in R17?

**[Answer] With the introduction of R17 RedCap and R18 eRedCap devices, co-existence with legacy non-RedCap devices needs to be ensured. Due to the differences in performance requirements, inter-UE priority handling can be leveraged to prioritize the use cases with tighter latency and reliability requirements. UE processing time relaxation and UL cancellation not addressed in R17 RedCap WI can be discussed in R18.**

(2c) For DSS support, isn't it the case that RedCap UE already can work under DSS network? What is the additional needed for "DSS support"?

**[Answer] For R17 RedCap UE, there is no discussion yet for the operation on DSS bands. LTE CRS rate matching can be a starting point of discussion.**

Q3) For proposals on power saving techniques, what does the "low-power wake-up radio" beyond WUS and PEI refer to? The former is a receiver radio while the latter two are signals. Is the intention to introduce new

wake up signal other than PEI and WUS for RedCap or dedicated wake up radio using WUS and PEI?

**[Answer] IDLE mode operation dominates the power consumption especially for IoT devices, so we would like to study more whether there can be meaningful additional power saving by introducing low-power wake-up radio compared to Rel-17 PEI which is being discussed for general UE types.**

For proposals on upper-layer enhancement,

Q4) Could you clarify what is the meaning of further enhancement to SDT over PUR? Our understanding CG based SDT is somehow an equal concept to PUR in LTE which was already in R17.

**[Answer] We are interested in contention-based PUR (aka CG-SDT in R17) for the use case of high-density deployment of eRedCap UEs. And SDT in RRC Idle in general.**

Q5) Could you clarify the purpose of user-plane simplifications: cost reduction or for efficiency improvement, or ...?

**[Answer] Efficiency improvement (e.g. overhead reduction). UP simplifications in LTE's eMTC/NB-IoT can be adopted for R18 eRedCap, as a baseline. Additional simplifications can also be studied for eRedCap UEs with low data rates.**

**MediaTek Inc. # 6**

Thank you for sharing your views. We have the following questions:

Q1: What new usecase(s) do you foresee for a UE BW of 5MHz, and do you see sufficient value associated with these usecases when considering the impact such a change would have in reducing the 'scale' of RedCap as highlighted in the document?

**[Answer] Rel-17 Redcap is targeting high-end IoT devices including industrial wireless sensors, video surveillance and wearables and supporting up to 150 Mbps. But there are other Low to medium end IoT use cases including low-end wearables or tracking devices and Rel-17 Redcap is too heavy for those use cases from cost perspective. Considering not only "scale" but also "Fitness of product to requirements" as described in our Tdoc, new UE types with reduced BW is beneficial to fill the gap between Rel-17 Redcap and LPWA.**

Q2: What target RedCap usecase do you consider with regards to multicast? Also, what do you foresee as missing to support multicast in RedCap in R17?

**[Answer] Use cases for multicast include software update for IoT devices, public safety and etc. Due to BW limitation and reduced number of RX branches, RedCap/eRedCap UE may experience DL coverage losses and co-existence issues with non-RedCap UE, which can be discussed in R18. Also, the power saving enhancements for receiving MBS can be considered for RedCap UEs.**

Q3: Could you elaborate some more on UE complexity reductions with respect to access and cell re/selection?

**[Answer] For access, we are interested in at least the following two areas for study: 1. The impacts of co-existence of R18 eRedCap, R17 RedCap and non-RedCap UEs on initial access procedures such as cell barring, access control, paging, RACH, etc, due to eRedCap UE's further reduced max UE**

**bandwidth and need for coverage enhancement; 2. enhancements to initial access procedures (e.g. RACH) to support high-density deployment of eRedCap UEs..**

**For cell-reselection, similar enhancements to cell reselection procedures for RedCap in R17 need to be extended to R18 eRedCap. In addition, additional enhancements may be needed if R18 eRedCap requires coverage enhancement.**

Q4: We have introduced wakeup mechanisms for connected and idle modes in Rel-16 and Rel-17 respectively. Considering these mechanisms, it is expected that link maintenance mechanisms (RRM in Idle, CSI is connected) will dominate UE power consumption. With the suggested wake-up radio, have you considered the associated power consumption impact of these link maintenance activities?

**[Answer] The power contribution for link maintenance is an important part of power consumption, which could potentially impose different design requirements for wake up receivers . We hope to study more whether there is any room for further improvement of wake-up radio for Idle mode over Rel-17 PEI which is being discussed for general UE types.**

**VODAFONE Group Plc # 7**

Q1) except for indoor positioning use cases, why is GNSS not adequate for RedCap?

**[Answer] Robust & accurate positioning may be the combination of several technologies. For example, GNSS may demonstrate poor performance not only in indoor cases, but also in outdoor street canyon cases. Having robust and optimized terrestrial cellular positioning would be a very useful technology in those cases. In addition, UE power saving can be taken into account when a device has both GNSS and RedCap POS capabilities.**

Q2) Why would the "study benefits of low-power wake-up radio" be RedCap specific and not also apply to mMTC?

**[Answer] Thanks for the question. Could you please clarify if mMTC refers to NB-IoT and LTE eMTC ? Sequence-based WUS has been introduced in LTE R15/16 for NB-IoT and eMTC UEs in idle state. For NR eRedCap UEs, we think it is desirable to study the candidate solutions for LP WUR beyond LTE LPWA, and compare their performance/complexity with the power saving solutions available to R17 RedCap UE.**

c) Sidelink is a 3GPP platform that does not seem to have yet matured well in the marketplace. What benefits are you seeing from adding it to the emerging RedCap platform?

**[Answer] We think the introduction of SL operation is helpful at least for coverage enhancement and UE power saving.**

d) how will adding a 5MHz variant of RedCap help RedCap develop economies of scale?

**[Answer] With max UE BW of 5 MHz, R18 eRedCap devices are expected to fill the gap of UE capabilities between LPWA and R17 RedCap devices. Overtime, we think some use cases on NB-IoT/eMTC can naturally migrate up to RedCap/eRedCap.**

**Ericsson LM # 8**

Regarding further reduced UE bandwidth (RWS-210007), we would like to ask what potential UE cost reduction you expect from reduction from 20 MHz to 5 MHz? The estimates from CATT (RWS-210409) and Ericsson (RWS-210313) indicate that according to the established cost evaluation methodology (TR 38.875), there may not be a very significant further cost reduction compared to 20 MHz.

Also, we would like to ask whether your statement (on slide 10) that “support of 30 kHz SCS would have to be further considered” means that you think that it might not be necessary to support 30 kHz SCS?

**[Answer] Thanks for your question. We’d like to discuss with you the details of cost analysis for BW reduction as well as the extra cost of WUR with energy harvesting functionality. Besides LP-WUR and energy harvesting, we are interested to study the power saving gains of reduced BW and relaxed timeline. Considering the spec impacts of supporting 30 KHz SCS by max UE BW of 5 MHz, we think 15 kHz SCS should be prioritized.**

**Intel Corporation (UK) Ltd # 9**

Q1). Considering that low device complexity is the cornerstone of RedCap UEs, could you kindly elaborate on justification for support of inter-UE priority handling for RedCap UEs? Why not rely on gNB scheduling, including resource reservation for RedCap UEs, given that the main benefit of inter-UE prioritization is in terms of user capacity?

**[Answer] With the introduction of R17 RedCap and R18 eRedCap devices, co-existence with legacy non-RedCap devices needs to be ensured. Due to the differences in performance requirements, inter-UE priority handling can be leveraged to prioritize the use cases with tighter latency and reliability requirements. gNB scheduling alone may not be able to avoid all collision cases, especially for coverage enhancement scenarios. Early termination of long repetitions can improve the SE and save UE’s power. In addition, UE processing time relaxation and UL cancellation not addressed in R17 RedCap WI can be discussed in R18.**

Q2). Considering the discussions and outcomes from Rel-17, do you see anything changing in Rel-18 for FR2-related enhancements or DL coverage recovery for RedCap?

**[Answer] For FR2, this can include the following:**

**(a) Beam management optimizations/simplifications:**

**For stationary and rotating UEs, e.g.:**

## **Reducing beam overloading and interference**

**Studying ways to reduce beam direction blockage to accommodate other UEs (e.g., in times when beams are preconfigured for RedCap UEs)**

**Due to reduced BW and reduced resources, e.g.:**

**Mixed RS for P2/P3 (U2/U3) BM procedures to reduce the RS overhead.**

**BFD/BFR procedure optimizations**

**(b) Power savings techniques**

**(c) UL heavy traffic optimizations**

**(d) BWP hopping (if not adopted in Rel-17), this can be used to:**

**Achieve diversity gains**

**Support larger BW RS for better accuracy for positioning**

**(e) Coverage recovery**

Q3). What specific enhancements for DSS support is envisioned for RedCap?

**[Answer] We think the CRS rate matching can be a starting point for further discussion.**

Q4). For MBS-related enhancements, could you kindly elaborate on the specifics as they may only relate to RedCap and not applicable to non-RedCap UEs?

**[Answer] Due to BW limitation and reduced number of RX branches, RedCap/eRedCap UE may experience DL coverage losses and co-existence issues with non-RedCap UE, which can be discussed in R18. Also, the power saving enhancements for receiving MBS can be considered for RedCap UEs.**

## **Xiaomi Communications # 10**

Q1) For the RedCap positioning, what's your consideration on the requirement? Define new requirement or reuse existing requirement defined for the non-RedCap?

**[Answer] In general, the accuracy level achievable by NR RedCap/eRedCap devices depends at least on operational BW of the UE, location (indoor/outdoor), complexity affordable and power saving considerations. For eRedCap devices with max UE BW of 5 MHz, positioning accuracy less than 10 meters (outdoor) would be a good starting point for R18 study. Further tightening of requirements can be considered during later phases if considered essential.**

**You are welcome to read our paper on NR R18 FePOS RWS-210021 to get more details.**

Q2) Xiaomi also has interest on the sidelink RedCap, we think it is helpful to expand more use cases for RedCap

**[Answer] Agree.**

Q3) Can you explain more about the BWP and RACH enhancement, inter-UE priority handling for the co-existence with legacy UE.

**[Answer] Due to further reduction in BW and relaxation of UE processing time capability, BWP configuration and switching mechanism can be re-visited in R18. Besides, BWP enhancement can be studied for RedCap/eRedCap UEs to support NR broadcast/multicast. For RACH enhancement, 2-step/4-step RACH based SDT, low power positioning, RAR multiplexing/differentiation for different UE types, DL coverage enhancement for broadcast PDCCH/PDSCH can be studied in R18.**

**With the introduction of R17 RedCap and R18 eRedCap devices, co-existence with legacy non-RedCap devices needs to be ensured. Due to the differences in performance requirements, inter-UE priority handling can be leveraged to prioritize the use cases with tighter latency and reliability requirements. UE processing time relaxation and UL cancellation not addressed in R17 RedCap WI can be revisited in R18.**

**CATT # 11**

Q1) Further cost reduction due to reduced BW seems small but lead to market fragmentation and potential impact on initial access. How much cost/complexity reduction is expected by BW reduction smaller than 20MHz based on your evaluation?

**[Answer] The cost reduction highly depends on the device implementation as we saw that the cost reduction gain is diverse between companies during Rel-17 RedCap discussions. We see that there will be cost saving gain for Rel-18 eRedCap UE types if we consider BW reduction down to 5MHz, half duplex, and timeline relaxation together.**

Q2) If the UE BW is reduced to 5MHz, SSB with 30kHz SCS cannot be accommodated within 5MHz BW. Then there will be big spec/implementation impact. Otherwise if 30kHz SCS SSB is not supported, the usefulness in the real deployment is quite limited.

**[Answer] Agree. We think the 15 kHz SCS should be prioritized for R18 eRedCap UE with max BW of 5 MHz.**

Q3) By default, RedCap UE supports all non-RedCap UE features except those due to reduced L1 capability. What are the specific identified issues that RedCap UE cannot support MBS, SL, DSS and NRU?

**[Answer] For R17 RedCap UE with max UE BW of 20 MHz, we think it can support NRU without (significant) spec impacts. For MBS, the BW limitation and reduced number of RX branches may impose co-existence issues with non-RedCap UE. In R17 RedCap WI, there is no discussion for DSS and**

**SL operation. We'd like to discuss the coverage, power saving and co-existence issues in R18 for RedCap/eRedCap.**

Q4) Relaxed processing time was dropped in Rel-17 due to marginal cost reduction but significant negative impact to network. What additional justification is found to pursue this in Rel-18?

**[Answer] Timeline relaxation is beneficial not only from cost saving perspective but also from power consumption perspective. The gain would be even more significant for the low-end eRedCap devices. At the same time, we need to work on how to minimize the network impact as well.**

**vivo Communication Technology # 12**

Q1) Regarding cost reduction, do you think reducing UE RF BW to 5MHz is a must for cost reduction, or we can potentially keep 20MHz RF BW but reduce the baseband capability by TBS/RB restriction, etc for cost reduction. By this way, we would not suffer from many performance degradation issues(frequency diversity, scheduling flexibility, resource fragment) ?

**[Answer] We have an education in LTE phase regarding the BW reduction. In Rel-12, we just considered the reduction of data channel baseband bandwidth only while keeping 20MHz BW for control channels. However, 3GPP eventually introduced eMTC by reducing the BW both in RF and BB in the very next release, which was more successful in the market.**

Q2) as a general question, do you think the enhancement areas listed in P10 should all be included in a single eRedCap WI, or some of them can be split into different items?

**[Answer] It can be further discussed. For positioning and SL support of RedCap/eRedCap UE, we are open to study it in other R18 WIs.**

**Apple Poland Sp. Z.o.o. # 13**

Q1) On 'Narrowband Positioning', what's scope or potential impacts? is it just defining positioning requirement for reduced Rx branches (e.g. 1 Rx) and reduced BW and keeping the same accuracy requirement? (Mainly RAN4 impacts) or some new positioning algorithms? (RAN1 impact). What positioning accuracy performance is in Qualcomm's mind for Redcap device?

**[Answer] In general, the accuracy level achievable by NR RedCap/eRedCap devices depends at least on operational BW of the UE, location (indoor/outdoor), complexity affordable and power saving considerations. For eRedCap devices with max UE BW of 5 MHz, positioning accuracy less than 10 meters (outdoor) would be a good starting point for R18 study. Further tightening of requirements can be considered during later phases if considered essential.**

**Regarding the scope of NB positioning, you are welcome to read our paper on NR R18 FePOS contribution RWS-210021 to get more information.**

Q2) For 'low-power' wake-up radio, it is interested to know some important aspects? e.g. what is the RF sensitivity for WUR detection in Qualcomm mind for Redcap UEs? Should it be a generic design targeting from all devices in IDLE mode?

**[Answer] Whether it should be generic design or not can be further discussed considering many different aspects deployment scenarios, use cases, performance requirements, receiver architecture, signal design, protocol design. We are open for study so it is suggested to study more whether low-power wake-up radio can provide meaningful power saving gain for (e)RedCap devices.**

Q3) SDT is one of Rel-17 WID and it is possible that Rel-17 Redcap UE already supports as part of UE capability. What's the further enhancement proposed here?

**[Answer] We are interested in SDT in RRC Idle and contention-based PUR (aka CG-SDT in R17) for the use case of high-density deployment of eRedCap UEs. We are open to other eRedCap-specific enhancements too.**

**Samsung Electronics Co., Ltd # 14**

Q1) With 10MHz or 5MHz BW, how much additional cost reduction do you expect compared with current RedCap, and simple restriction, e.g. restrict BW for PDSCH or restrict TBS? In the annex A, it seems like SSB/CORESET 0 are expected to be reused, is this correct? However, for PDCCH in CORESET 0, the coverage might have more serious issue compared with 20MHz DL BW. Do you think some coverage recovery is expected?

**[Answer] We see that there will be cost saving gain for Rel-18 eRedCap UE types if we consider BW reduction down to 5MHz, half duplex mode, and timeline relaxation together. If we just consider simple restriction like you mentioned above, it is similar to Rel-12 low-cost MTC . We need to remember that 3GPP eventually introduced eMTC by reducing the BW both in RF and BB in the very next release.**

**For SSB/CORESET0, we need to reuse them as much as possible. And coverage improvements can be also considered as we discussed in our contribution.**

Q2) What kind of necessary spec change had been identified to support Pos and/or SL for Redcap?

**[Answer] Power saving designs for positioning and SL are important for RedCap/eRedCap UEs. For the scope of study and potential spec impacts, please check our RWS contributions for SL/positioning enhancements in RWS-210008 and RWS-210009.**

Q3) . What kind of technique is expected for further power saving for RedCap, e.g., ZP-WUS? why such techniques are specific to RedCap to be discussed in RedCap WI other than general power saving for all type of device?

**[Answer] Wearable and wireless sensors are important use cases of Redcap. In such use cases, idle state power consumption is more dominant, so it is suggested to study more whether low-power wake-up radio provides meaningful power saving gain for (e)RedCap devices.**

**Sony Europe B.V. # 15**

Q1) Bandwidth: The R17 study determined that 20MHz BW was a sweetspot for UE redcap bandwidth capability. What percentage further complexity reduction do you expect with a 5/10MHz UE bandwidth?

**[Answer] The cost reduction by BW reduction highly depends on the device implementation as we saw that the cost reduction gain is diverse between companies during Rel-17 RedCap discussions. We see that there will be substantial cost saving gain for Rel-18 eRedCap UE types if we consider BW reduction down to 5MHz, half duplex, and timeline relaxation together.**

Q2) Positioning: Would you consider accuracy enhancements to account for the reduced redcap bandwidth? If not, what accuracy degradation would you consider acceptable?

**[Answer] We think positioning accuracy improvement can be considered for NB positioning (for example, by frequency hopping). In general, the accuracy level achievable by NR RedCap/eRedCap devices depends at least on operational BW of the UE, location (indoor/outdoor), complexity affordable and power saving considerations. For eRedCap devices with max UE BW of 5 MHz, positioning accuracy less than 10 meters (outdoor) would be a good starting point for R18 study. Further tightening of requirements can be considered during later phases if considered essential.**

Q3) Power saving: We are also interesting in low power WUR (as part of the evolution towards zero power communications, as discussed in RWS-210302 and RAN-R18-WS-non-eMBB-SONY). For low power wake-up radio, do you envisage the low power WUR to require a new waveform (other companies suggest OOK waveforms). If so, what performance penalties do you foresee?

**[Answer] New wave form such as OOK is one of the enablers for low power wake up receivers. However, the introduction of new waveform should be justified by performance/design requirements in the context of Redcap device/use cases.**

## 4.3 Input – Round 2

## Feedback Form 6: 5G and IoT - Round 2

### 1 – vivo Communication Technology

Thanks for your reply. We have following additional questions.

Q1: Regarding further reduced UE RF BW, it is expected that performance degradation will occur in both link level (less frequency diversity) and system level (less frequency selective gain, and more resource fragmentation), we wonder whether and how to compensate these performance degradation, and will the potential solutions increase the UE complexity?

Q2  besides BW reduction, We wonder what is your view on the following potential areas for Rel-18 eRedCap?

- 1  Lower UE power class
- 2  UE Processing time relaxation (data, CSI)
- 3  Reduced number of HARQ processes
- 4  serving cell RRM relaxation for stationary devices
- 5  Coverage recovery

### 2 – Huawei Tech.(UK) Co.. Ltd

Thanks for the reply. Could you highlight the main BWP enhancements you think are needed for RedCap multicast/broadcast?

### 3 – Ericsson LM

In our cost analysis for further reduced UE bandwidth (RWS-210313), we simply followed the established cost evaluation methodology (TR 38.875), and according to our results there was a very small further cost reduction. Do you get different results using the same methodology?

If 15 kHz SCS (FDD) is prioritized, it sounds as if 30 kHz SCS (TDD) will not be supported, meaning that the usefulness of such UEs will be significantly constrained to specific deployments.

### 4 – Intel Corporation (UK) Ltd

- **Q3-follow-up:** *PDSCH rate-matching around CRS is a mandatory feature (w/ capability signaling) and expected to be available in Rel-17 for RedCap UEs. Do you expect any further enhancements necessary, specific to RedCap?*

- **Q4-follow-up:** *For MBS delivery, given it is defined “per service”, if an MBS session can be received by RedCap UEs, it should work for non-RedCap UEs as well. In this regard, the handling can be very similar to SIB delivery, at least for MCCH, etc. Thus, presence of “co-existence issues” is not very clear to us. On power savings related to MBS, would these be specific to RedCap UEs only and not for non-RedCap?*

### 5 – Samsung Electronics Polska

Q1: Do you think RedCap cannot support DSS, i.e., rate matching for LTE CRS, even as optional feature?

Q2: For some other features, e.g., SDT, SL, Pos, what do you expect to do additionally that currently discussed solutions in Rel-17 for general, e.g., eMBB UEs? Why we cannot assume same solutions can also apply for RedCap UE, but need to discuss them in Rel-18?

If some enhancement is needed, do you expect to handle them in Redcap WI or other WI but considering RedCap device?

#### 4.4 Response – Round 2

-

##### **vivo Communication Technology # 1**

Q1) Regarding further reduced UE RF BW, it is expected that performance degradation will occur in both link level (less frequency diversity) and system level (less frequency selective gain, and more resource fragmentation), we wonder whether and how to compensate these performance degradation, and will the potential solutions increase the UE complexity?

**[Answer] For eRedCap UEs with max RF BW of 5 MHz, DL and UL coverage enhancement can be studied in R18 for Uu link. In addition, solutions based on SL could also help with link budget. Even with enhanced solutions, UE complexity increase needs to be avoided.**

Q2) besides BW reduction, We wonder what is your view on the following potential areas for Rel-18 eRedCap?

- 1  Lower UE power class
- 2  UE Processing time relaxation (data, CSI)
- 3  Reduced number of HARQ processes
- 4  serving cell RRM relaxation for stationary devices
- 5  Coverage recovery

**[Answer] As a starting point for further discussion, these objectives look good to us. We think positioning and SL enhancement are also important for eRedCap UEs, and we are open to study them in other R18 WIs.**

**[Linhai, reply to Question 4] we are open to discuss serving cell RRM relaxation for stationary devices.**

##### **Huawei Tech.(UK) Co.. Ltd # 2**

Thanks for the reply. Could you highlight the main BWP enhancements you think are needed for RedCap multicast/broadcast?

**[Answer] In our view, power saving, coverage enhancement and co-existence with legacy UEs can be discussed in R18 for eRedCap UEs.**

##### **Ericsson LM # 3**

In our cost analysis for further reduced UE bandwidth (RWS-210313), we simply followed the established cost evaluation methodology (TR 38.875), and according to our results there was a very small further cost reduction. Do you get different results using the same methodology?

**[Answer] Thanks for your reply. The reason we asked the question is because there are multiple contributions discussing cost reduction, but the results presented look different. We think this needs to be further discussed.**

If 15 kHz SCS (FDD) is prioritized, it sounds as if 30 kHz SCS (TDD) will not be supported, meaning that the usefulness of such UEs will be significantly constrained to specific deployments.

**[Answer] Prioritizing 15KHz SCS does not necessarily mean that 30KHz SCS will not be supported. We are open to study how to efficiently support 30KHz SCS as well.**

#### **Intel Corporation (UK) Ltd # 4**

**Q3-follow-up:** PDSCH rate-matching around CRS is a mandatory feature (w/ capability signaling) and expected to be available in Rel-17 for RedCap UEs. Do you expect any further enhancements necessary, specific to RedCap?

**[Answer] The smaller propagation losses typical of DSS bands is beneficial for the SA deployment of RedCap/eRedCap UEs. For operation on DSS carriers, the rate matching schemes specified for non-RedCap UEs (e.g. MBSFN based vs non-MBSFN based, 15 kHz SCS vs 30 kHz SCS) involves different levels of implementation complexity. In addition, whether or not the CRS from co-located eNB can be used by RedCap/eRedCap UEs for measurements can be further discussed in R18.**

**Q4-follow-up:** For MBS delivery, given it is defined “per service”, if an MBS session can be received by RedCap UEs, it should work for non-RedCap UEs as well. In this regard, the handling can be very similar to SIB delivery, at least for MCCH, etc. Thus, presence of “co-existence issues” is not very clear to us. On power savings related to MBS, would these be specific to RedCap UEs only and not for non-RedCap?

**[Answer] Shall NW always configure the same CFR for different UE types? Probably not. The contents of multicast can include common as well as different information for RedCap and non-RedCap UEs. Besides, the max TBS, max UE BW, LBRM buffer size, and HARQ feedback timeline could be different for RedCap and non-RedCap UEs. How to achieve a better tradeoff among SE, coverage and co-existence can be further studied in R18. Since the R17 MBMS WI and RedCap WI are ongoing, it is premature to conclude which power saving features can or cannot be supported by RedCap/eRedCap UEs. These and other leftover issues of R17 RedCap WI can be discussed in R18.**

#### **Samsung Electronics Polska # 5**

Q1) Do you think RedCap cannot support DSS, i.e., rate matching for LTE CRS, even as optional feature?

**[Answer] Please see our reply to Intel’s Q3-follow-up.**

Q2) For some other features, e.g., SDT, SL, Pos, what do you expect to do additionally that currently discussed solutions in Rel-17 for general, e.g., eMBB UEs? Why we cannot assume same solutions can also apply for RedCap UE, but need to discuss them in Rel-18? If some enhancement is needed, do you expect to handle them in Redcap WI or other WI but considering RedCap device?

**[Answer] For SL and Pos enhancements for RedCap/eRedcap UEs, we are open to discuss them in R18 SL and FEPOS WIs.**

## 5 On Sidelink positioning - RWS-210008

### 5.1 Input – Round 1

#### Feedback Form 7: Sidelink positioning - Round 1

##### 1 – Beijing Xiaomi Mobile Software

1. 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.

2. What bandwidth do you think is required to achieve 10cm distance accuracy & 2 degree angle accuracy?

3. For unlicensed band, what frequency range should be considered (e.g. 60GHz)?

##### 2 – Huawei Tech.(UK) Co.. Ltd

Q1: 0.5 m longitudinal requirement is only applicable to platooning. Why is it required for V2I ?

Q2: The figure on pg 3 in general, is the RSU example for absolute or for relative positioning among vehicles?

##### 3 – Guangdong OPPO Mobile Telecom.

1. Agree that commercial use cases like ranging applications defined in SA1 should be covered.

2. If wide bandwidth is required, SL PRS signal could be possibly transmitted using more than one ITS / licensed carriers (not necessarily always over unlicensed).

##### 4 – Sony Europe B.V.

We also support on the inclusion of sidelink positioning in Rel-18.

1. Would you consider a dedicated SI on sidelink positioning or a study within a WI, such as a study within V2X WI?

2. On introducing SL PRS in unlicensed spectrum, we notice sidelink (for communication) has only utilized in licensed spectrum. Do you have any view whether unlicensed usage should be firstly specified in Sidelink for communication (or at least at the same time)?

#### **5 – Intel Corporation (UK) Ltd**

Q1: It seems the use of unlicensed spectrum for positioning is limited to sidelink only. If it is correct understanding please clarify why Uu (DL and/or UL) based positioning is not considered?

Q2: Is there intention to also support sidelink positioning in FR2 in R18? What is the priority of this work and which spectrum is being considered for FR2?

#### **6 – ROBERT BOSCH GmbH**

Q1: For Unlic. band SL positioning, do you support with data transmission or as a stand alone mode?

Q2: for in-coverage scenario, do you support SL ranging, i.e., independent from Uu positioning ?

#### **7 – CATT**

##### **Comments:**

CATT shares many similar views with Qualcomm on many aspects for Sidelink Positioning.

##### **Questions:**

We have some questions for Slide 5. In the slide, Qualcomm proposed to “study sidelink positioning with PRS being sent on unlicensed spectrum, with coordination information sent on ITS spectrum

- Coordination information can be sent over either LTE V2X or NR V2X to address different regions
- This will allow deployment of V2X positioning without disrupting current V2X deployments in the ITS band

Q1: For the 1st step in V2X positioning in R18, should we first consider the SL positioning in ITS and licensed bands” given that NR positioning is so far not supported in unlicensed spectrum, and the complexity involved in supporting V2X positioning in unlicensed spectrum may be much higher than supporting V2X positioning in licensed spectrum.

Q2: How to support the coordination of unlicensed spectrum over both LTE V2X and NR V2X, given that the channel usages of unlicensed spectrum are dynamically changed?

#### **8 – Lenovo (Beijing) Ltd**

Q1: Why PRS and coordination information are transmitted on different band□

Q2: What’s the coordination information(configuration?measurement results?)?

#### **9 – LG Electronics Inc.**

Q1: Regarding “distributed cooperative positioning” on the last slide, does it mean a relative positioning, or something like position information sharing between UEs for cooperativeness? Please elaborate more the exact meaning of “distributed” and “cooperative” in proposal.

Q2: How much specification impact is expected for unlicensed band based positioning?

**10 – Samsung Electronics Co.**

1. What's your consideration for latency requirement on sidelink only positioning, e.g., V2X?
2. How does V2P positioning compare with other non-RAT (sensor) based ranging (video etc)?

## 5.2 Response – Round 1

### Beijing Xiaomi Mobile Software

# 1

1. 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)?

[Answer] From fundamental positioning technology point of view, there is no major difference between ranging and relative positioning.

The above discussion on the differences seems to be only on how to present the positioning/ranging results. From the SA1 defined use case and requirements for ranging, both distance AND angle are required. Additionally, whether the coordinates are required for relative positioning also depends on definition of the positioning methods.

- 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.

[Answer] Ranging and relative positioning are different ways of presenting the same results. For a set of ranging results, relative position of one UE to the other can be determined given knowledge of the location of one of the UEs.

2. What bandwidth do you think is required to achieve 10cm distance accuracy & 2 degree angle accuracy?

[Answer] This should be exactly what the RAN WG level (e.g. RAN1) study needs to determine in Rel-18 .

3. For unlicensed band, what frequency range should be considered (e.g. 60GHz)?

[Answer] This depends on the use cases. For V2X, the proposed band is U-NII-3. For commercial use, 60GHz may be considered.

**Huawei Tech.(UK) Co.. Ltd**

# 2

Q1: 0.5 m longitudinal requirement is only applicable to platooning. Why is it required for V2I ?

[Answer] V2I applications, for example intersection management, would also require high accuracy.

Q2: The figure on pg 3 in general, is the RSU example for absolute or for relative positioning among vehicles?

[Answer] The RSU example applies to both relative and absolute positioning.

With RSU, relative positioning can be easily converted to absolute positioning when the RSU location is provided. Whether absolute positioning or relative positioning is used depends on the use case.

**Guangdong OPPO Mobile Telecom.**

# 3

1. Agree that commercial use cases like ranging applications defined in SA1 should be covered.
2. If wide bandwidth is required, SL PRS signal could be possibly transmitted using more than one ITS / licensed carriers (not necessarily always over unlicensed).

[Answer] This really depends on the use case. But, the study should cover the use of the unlicensed bands for positioning, as licensed band may not be always available.

**Sony Europe B.V.**

# 4

We also support on the inclusion of sidelink positioning in Rel-18.

1. Would you consider a dedicated SI on sidelink positioning or a study within a WI, such as a study within

V2X WI?

[Answer] Our preference is to have SL positioning separate from the overall Rel-18 SL WI as it requires different study and experts in the work, compared to general Sidelink. Combining SL positioning with the Rel-18 Positioning WI needs further discussion.

2. On introducing SL PRS in unlicensed spectrum, we notice sidelink (for communication) has only utilized in licensed spectrum. Do you have any view whether unlicensed usage should be firstly specified in Sidelink for communication (or at least at the same time)?

[Answer] SL PRS is different from the sidelink communication. Sidelink communication over unlicensed band is NOT a prerequisite for the study on SL PRS over unlicensed spectrum.

### **Intel Corporation (UK) Ltd**

# 5

Q1: It seems the use of unlicensed spectrum for positioning is limited to sidelink only. If it is correct understanding please clarify why Uu (DL and/or UL) based positioning is not considered?

[Answer] We see that the first step in the study is to introduce the basic design for Sidelink positioning to meet the essential needs of the use cases identified, e.g. for all three coverage scenarios (in-coverage, out-of-coverage, partial coverage). For Uu, we are actually also interested in positioning enhancements for Unlicensed spectrum (as shown in the RWS-210021 (In page 8) in the bullet: "Positioning Enhancements for Unlicensed, including FR2x".)

Q2: Is there intention to also support sidelink positioning in FR2 in R18? What is the priority of this work and which spectrum is being considered for FR2?

[Answer] There are potential use cases identified for using FR2 for the Sidelink positioning, especially the commercial use cases. The exact FR spectrum to use can be part of the study in Rel-18.

Our preference is to handle the needs identified in the 5GAA LS first, and then other use cases.

## **ROBERT BOSCH GmbH**

# 6

Q1: For Unlic. band SL positioning, do you support with data transmission or as a stand alone mode?

[Answer] For the initial proposal, it is assuming that the data transmission (if required) will happen using existing Sidelink communication mechanisms. The use of the unlicensed band is mainly for the SL PRS and measurements.

In the future, when the Sidelink communication is expanded to unlicensed band, it can be also used. But, for the study, there should be no limitations on which band this data transmission associated with the positioning is sent.

Q2: for in-coverage scenario, do you support SL ranging, i.e., independent from Uu positioning ?

[Answer] Yes. The SL based positioning should be able to work in all coverage scenarios. We need to have a system that can work regardless of the coverage, and it cannot stop working just because it is in coverage.

## **CATT**

# 7

### **Comments:**

CATT shares many similar views with Qualcomm on many aspects for Sidelink Positioning.

### **Questions:**

We have some questions for Slide 5. In the slide, Qualcomm proposed to “study sidelink positioning with PRS being sent on unlicensed spectrum, with coordination information sent on ITS spectrum

- Coordination information can be sent over either LTE V2X or NR V2X to address different regions
- This will allow deployment of V2X positioning without disrupting current V2X deployments in the ITS band

Q1: For the 1st step in V2X positioning in R18, should we first consider the SL positioning in ITS and licensed bands” given that NR positioning is so far not supported in unlicensed spectrum, and the complexity

involved in supporting V2X positioning in unlicensed spectrum may be much higher than supporting V2X positioning in licensed spectrum.

[Answer] Similar to the answer to previous questions, SL PRS is different from the sidelink communication. Sidelink communication over unlicensed band is NOT a prerequisite for the study on SL PRS over unlicensed spectrum.

Q2: How to support the coordination of unlicensed spectrum over both LTE V2X and NR V2X, given that the channel usages of unlicensed spectrum are dynamically changed?

[Answer] Exactly because the unlicensed spectrum usage are dynamically changed, coordination among the UEs participating in the positioning is required. We are proposing to have such coordination signaling done via LTE V2X or NR V2X transport, e.g. defined as a new V2X application message.

#### **Lenovo (Beijing) Ltd**

# 8

Q1: Why PRS and coordination information are transmitted on different band □

[Answer] This depends on the use case. The proposal here is that the PRS and the coordination information do not have to be always sent in the same band. This will allow the maximum flexibility in deployment, as also discussed in above questions that data communication may not be always possible over the band used for PRS.

Note that for Uu-Positioning, DL-PRS are configured outside of CC-boundaries, but rather inside positioning frequency layers, which can be on a band that is different than the band that carries the PHY communication channels that have the Location Request, Assistance Data, Location Responses, etc.

Q2: What's the coordination information(configuration?measurement results?)?

[Answer] Yes. Configuration and measurement results are examples of coordination information.

#### **LG Electronics Inc.**

# 9

Q1: Regarding “distributed cooperative positioning” on the last slide, does it mean a relative positioning, or something like position information sharing between UEs for cooperativeness? Please elaborate more the exact meaning of “distributed” and “cooperative” in proposal.

[Answer] Thanks for the question. No it doesn't mean relative positioning (this is a separate topic). It is related to position information / measurement sharing amongst UEs, request/response for PRS transmission and measurement reporting between UEs without the need of a centralized entity (i.e., no coordination from an LMF). For example, a UE should be able to discover which other SL-Positioning UEs are in its vicinity, request to start a SL-positioning session, transmit/receive positioning measurements to/from the SL-Positioning peer UEs, perform the positioning calculation.

Q2: How much specification impact is expected for unlicensed band based positioning?

[Answer] Given that the plan is so far to use unlicensed band for PRS only, the relevant specification impact should not be very significant. Some mechanism in the coordination signaling needs to be developed to meet the regulation requirements.

### **Samsung Electronics Co., Ltd**

# 10

1. What's your consideration for latency requirement on sidelink only positioning, e.g., V2X?

[Answer] Sidelink positioning needs to satisfy the latency requirements of the use cases identified in the 5GAA LS and Rel-17 RAN P study.

2. How does V2P positioning compare with other non-RAT (sensor) based ranging (video etc)?

-

[Answer] We don't believe there is a need to compare the different techniques, as they have different assumptions and limitations, , e.g. the lighting conditions, processing power, etc. All these positioning techniques could be complimentary and integrated to achieve higher accuracy and reliability.

## **5.3 Input – Round 2**

## Feedback Form 8: Sidelink Positioning - Round 2

### 1 – Beijing Xiaomi Mobile Software

1. As you clarified that "From the SA1 defined use case and requirements for ranging, both distance AND angle are required". However, it is not the case. there are many use cases in TR22.855 whose KPI requirements only involve distance accuracy (e.g. distance based smart home device control). We agree that the general solution for relative positioning and ranging should be unified. But there might be some sub-option differences, e.g. whether to request distance or angle measurement separately or always together.

### 2 – Huawei Tech.(UK) Co.. Ltd

Thanks for the replies. Some additional questions we would appreciate understanding:

1. How do you propose to use the PHY-layer broadcast nature of LTE-V2X to provide coordination information for SL positioning which is not likely a broadcast technology? We wonder what this means for the overall positioning protocol arrangement.
2. Can you clarify why there is a difference between SL comms and SL positioning in unlicensed spectrum?
3. You refer to positioning with terminology from V2X. Should we assume that it would be standardized to suit sidelink in general, and in particular also public safety?

### 3 – Guangdong OPPO Mobile Telecom.

Thank you for the reply. For SL-PRS transmission, does it need to be integrated as part of existing SL frame/slot structure? Or is the transmission of SL-PRS is suppose to be done independent to the normal SL transmission? I assume they are independent to each other as SL-PRS needs to be transmitted over wideband and normal SL transmission could occupy only a few sub-channels. Therefore, the transmission timing and resource allocation for SL-PRS transmissions would be very different to the normal SL.

### 4 – Intel Corporation (UK) Ltd

Q1: Thanks for clarifying interest on NR Uu positioning in unlicensed spectrum as well. We have two more questions for clarification. 1) Do you consider NR Uu positioning in unlicensed spectrum for V2X use cases and if it is not the case then why? 2) Do you think that NR Uu and PC5 positioning in unlicensed spectrum should be discussed together?

Q2: For R18, do you also consider sidelink positioning in FR2 for V2X use cases or only for commercial use cases? Could you clarify whether there is a need to distinguish applicability of sidelink positioning framework in FR2 on a per use case basis and why?

### 5 – CATT

Thanks for the response to our questions. We have a follow-up question:

Q1: Qualcomm proposes sending the coordination information over either LTE V2X or NR V2X. Does it mean Qualcomm suggest supporting sending the coordination information over LTE V2X, and also supporting sending the coordination information over NR V2X?

## **6 – LG Electronics Inc.**

Thank you for clarification. We also support SL positioning.

Q1: If both FR1 and FR2 are the target band for positioning as summarized in the last slide, I wonder what Qualcomm's view on the panel for positioning is. Do you think a single panel based positioning as in the current specification is sufficient especially in FR2, or multi-panel based positioning also needs to be considered?

## 5.4 Response – Round 2

### **Beijing Xiaomi Mobile Software**

# 1

1. As you clarified that "From the SA1 defined use case and requirements for ranging, both distance AND angle are required". However, it is not the case. there are many use cases in TR22.855 whose KPI requirements only involve distance accuracy (e.g. distance based smart home device control). We agree that the general solution for relative positioning and ranging should be unified. But there might be some sub-option differences, e.g. whether to request distance or angle measurement separately or always together.

[Answer] For Rel-18 study, there first step in our view is to identify and design the baseline operation that is required by all the agreed use cases.

There may be further optimization to simplify certain operation for some sub-cases. Those should be studied when the baseline solution is ready and stable.

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

# 2

Thanks for the replies. Some additional questions we would appreciate understanding:

1. How do you propose to use the PHY-layer broadcast nature of LTE-V2X to provide coordination information for SL positioning which is not likely a broadcast technology? We wonder what this means for the overall positioning protocol arrangement.

[Answer] LTE-V2X is a broadcast technology at PHY layer, but it can also achieve controlled information dissemination at application layer.

For Sidelink Positioning coordination when sent over the LTE-V2X could make use of the upper layer control in determining the intended receivers. It is expected that a new type of V2X application could be developed.

2. Can you clarify why there is a difference between SL comms and SL positioning in unlicensed spectrum?

[Answer] The Sidelink PRS benefits from the bandwidth availability of unlicensed, while potentially being a simple signal, e.g., limited time, known pattern, etc. In contrast, full Sidelink Communication in the unlicensed band would be much more complicated.

3. You refer to positioning with terminology from V2X. Should we assume that it would be standardized to suit sidelink in general, and in particular also public safety?

[Answer] We assume that the Sidelink Positioning study in Rel-18 needs to satisfy the most urgent use cases, i.e. V2X and Public Safety support. This has been demonstrated in the LS from 5GAA.

However, the solution developed for the Sidelink Positioning is not limited to a particular service. It can be used by any service, e.g., commercial sidelink.

### **Guangdong OPPO Mobile Telecom.**

# 3

Thank you for the reply. For SL-PRS transmission, does it need to be integrated as part of existing SL frame/slot structure? Or is the transmission of SL-PRS is suppose to be done independent to the normal SL transmission? I assume they are independent to each other as SL-PRS needs to be transmitted over wideband and normal SL transmission could occupy only a few sub-channels. Therefore, the transmission timing and resource allocation for SL-PRS transmissions would be very different to the normal SL.

[Answer] This needs to be studied in Rel-18. However, we agree with your preliminary analysis above.

### **Intel Corporation (UK) Ltd**

# 4

Q1: Thanks for clarifying interest on NR Uu positioning in unlicensed spectrum as well. We have two more questions for clarification. 1) Do you consider NR Uu positioning in unlicensed spectrum for V2X use cases and if it is not the case then why? 2) Do you think that NR Uu and PC5 positioning in unlicensed spectrum should be discussed together?

[Answer] For 1), and 2), we agree that NR Uu positioning in unlicensed can be considered for V2X, but it should come at a second step, because the most important task for Rel-18 is to develop the solution that can work for all coverage scenarios (in-coverage, partial coverage, and out-of-coverage).

Q2: For R18, do you also consider sidelink positioning in FR2 for V2X use cases or only for commercial use cases? Could you clarify whether there is a need to distinguish applicability of sidelink positioning framework in FR2 on a per use case basis and why?

[Answer] We believe that there are common framework aspects of Sidelink Positioning independent of the bands used. Those parts should be identified and defined first.

For the band dependent aspects, it needs to be discussed in the Rel-18 or in the SID scoping on how to prioritize them. In our view, for the sidelink V2X use case, FR1 support should have high priority comparing to FR2 support.

## **CATT**

# 5

Thanks for the response to our questions. We have a follow-up question:

Q1: Qualcomm proposes sending the coordination information over either LTE V2X or NR V2X. Does it mean Qualcomm suggest supporting sending the coordination information over LTE V2X, and also supporting sending the coordination information over NR V2X?

[Answer] That has to be looked at in the Rel-18 study. Our preference is to support both options, so that we can have flexibility in Sidelink Positioning deployment in different regions, not limited by the LTE or NR V2X's deployment status.

## **LG Electronics Inc.**

# 6

Thank you for clarification. We also support SL positioning.

Q1: If both FR1 and FR2 are the target band for positioning as summarized in the last slide, I wonder what Qualcomm's view on the panel for positioning is. Do you think a single panel based positioning as in the current specification is sufficient especially in FR2, or multi-panel based positioning also needs to be considered?

[Answer] We think this could be investigated as part of the study.

---

# **6 NR Sidelink Evolution & Use Case Expansion for Rel-18 - RWS-210009**

## **6.1 Input – Round 1**

### **Feedback Form 9: Sidelink Evolution - Round 1**

#### **1 – Classon Consulting**

FUTUREWEI also supports sidelink MIMO and FR2 and unlicensed enhancements, see RWS-210039 and

## 2 – CATT

### Comments:

CATT shares many similar views with Qualcomm on the many aspects for Sidelink Positioning.

### Questions:

We have some questions for Slide 5. In the slide, Qualcomm proposed to “study sidelink positioning with PRS being sent on unlicensed spectrum, with coordination information sent on ITS spectrum

- Coordination information can be sent over either LTE V2X or NR V2X to address different regions
- This will allow deployment of V2X positioning without disrupting current V2X deployments in the ITS band

Q1: For the 1st step in V2X positioning in R18, should we first consider the SL positioning in ITS and licensed bands” given that NR positioning is so far not supported in unlicensed spectrum, and the complexity involved in supporting V2X positioning in unlicensed spectrum may be much higher than supporting V2X positioning in licensed spectrum.

Q2: How to support the coordination of unlicensed spectrum over both LTE V2X and NR V2X, given that the channel usages of unlicensed spectrum are dynamically changed?

## 3 – LG Electronics Inc.

Q1: Can you elaborate on Uu/PC5 aggregation in slide 6? What is its difference from the concurrent operation of Uu and PC5?

Q2: Can you elaborate on the use case of ”in-car sidelink for in-vehicle networking” in slide 6? Is it to connect the passenger devices to TCU via sidelink?

## 4 – Huawei Tech.(UK) Co.. Ltd

Q1: On SL assisted scheduling (indication of Tx/Rx resources and UE scheduling another UE), does this intend to support the form of mode 2d that was identified during the Rel-16 SI?

Q2: On page 4, what’s the scenario for Uu/PC5 aggregation & coex enh? Os it for pure sidelink communication, or sidelink relay case?

## 5 – Guangdong OPPO Mobile Telecom.

Q1) For the Uu/PC5 aggregation, is it for U2N relay, so that the aggregation is for the direct path and indirect path from remote UE perspective?

Q2) There are many feature proposals for SL evolution. Which ones are higher priority should be included in R18 from the conclusion slide?

## 6 – Fraunhofer HHI

Q1. Under “Increased data rates and reduced latency”, is the “in-car sidelink for in-vehicle networking use cases” related to the VMR SID being discussed in SA1?

Q2. Does SL extension to unlicensed (e.g. FR2) and multi-beam operation/MIMO enhancements go in parallel? Are there any priorities attached to the proposals on slide 9?

<p><b>7 – Intel Corporation (UK) Ltd</b></p> <p>The wide set of use cases and sidelink evolution directions is discussed and provided in the tdoc for sidelink evolution. So far sidelink support/evolution was mainly driven by vertical (V2X/PS) segments.</p> <p>Q: Is there any view on the most promising/prioritized work direction for 3GPP sidelink evolution in R18 (besides V2X/PS)?</p>
<p><b>8 – InterDigital Communications</b></p> <p>Could you elaborate on SPS optimization and path diversity techniques in slide 9?</p>
<p><b>9 – ROBERT BOSCH GmbH</b></p> <p>Q1: for SL BWP adaptation (for power saving), do you see a need for adaptive SL search space ?</p> <p>Q2: for Industrial IoT, new QoS parameters for CSA (e.g., survival time) is considered. Do you support introducing those critical Functional safety requirements for SL IIoT as well ?</p>
<p><b>10 – CATT</b></p> <p>It seems we posted the comment for SL Positioning incorrectly to this section. Please ignore it.</p>
<p><b>11 – Nokia Denmark</b></p> <p>wouldn't GNSS free operation also increase market uptake as also IoT devices etc with long battery times would be able to use the system.</p>
<p><b>12 – Samsung Electronics Co.</b></p> <p>Q1: In slide 4, there are lots of proposed features for Rel-18+ sidelink. Among those features, which features are expected to prioritize in Rel-18 considering limited TU?</p>
<p><b>13 – vivo Communication Technology</b></p> <p>Would you please elaborate the details of SPS enhancement for SL, and how it could help to improve the reliability, latency &amp; coverage of SL?</p>

## 6.2 Response – Round 1

### Classon Consulting

# 1

FUTUREWEI also supports sidelink MIMO and FR2 and unlicensed enhancements, see RWS-210039 and <https://nwm-trial.etsi.org/#/documents/4714> .

### CATT

# 2

### Comments:

CATT shares many similar views with Qualcomm on the many aspects for Sidelink Positioning.

## Questions:

We have some questions for Slide 5. In the slide, Qualcomm proposed to “study sidelink positioning with PRS being sent on unlicensed spectrum, with coordination information sent on ITS spectrum

- Coordination information can be sent over either LTE V2X or NR V2X to address different regions
- This will allow deployment of V2X positioning without disrupting current V2X deployments in the ITS band

Q1: For the 1st step in V2X positioning in R18, should we first consider the SL positioning in ITS and licensed bands” given that NR positioning is so far not supported in unlicensed spectrum, and the complexity involved in supporting V2X positioning in unlicensed spectrum may be much higher than supporting V2X positioning in licensed spectrum.

[Answer]: It is a possible route to consider SL positioning in ITS/licensed band. However, the bandwidth of ITS is very limited and operators may not want to use their licensed spectrum for SL purpose. We see a stronger use case considering unlicensed channel for SL positioning. However, the PRS design should be shared between licensed and unlicensed, while we need to further consider channel access and PRS validation for unlicensed channel usage. Please also refer to the response to CATT #7 in RWS-210008.

Q2: How to support the coordination of unlicensed spectrum over both LTE V2X and NR V2X, given that the channel usages of unlicensed spectrum are dynamically changed?

[Answer] For this, we are mainly talking about a validation mechanism. The licensed channel in LTE/NR V2X can serve the purpose of setting up the PRS transmission, but the PRS transmission in unlicensed band will subject to LBT and may fail. We will need some kind of validation mechanism for the PRS reception, like we validate the periodic CSI-RS reception in NR-U. Please also see response to CATT #7 in RWS-210008

## LG Electronics Inc.

# 3

Q1: Can you elaborate on Uu/PC5 aggregation in slide 6? What is its difference from the concurrent operation of Uu and PC5?

[Answer] Uu/PC5 aggregation is to support multi-path connection to the device, with coordination by the network which leverage some concepts of the concurrent operation of Uu and PC5.

Q2: Can you elaborate on the use case of ”in-car sidelink for in-vehicle networking” in slide 6? Is it to connect

the passenger devices to TCU via sidelink?

[Answer] Connecting passenger devices to TCU is one use case. We also view in-vehicle network as a method to connect displays and speakers for playing video and audios as another use case.

## **Huawei Tech.(UK) Co., Ltd**

# 4

Q1: On SL assisted scheduling (indication of Tx/Rx resources and UE scheduling another UE), does this intend to support the form of mode 2d that was identified during the Rel-16 SI?

[Answer] This depends on the outcome of Rel. 17; in addition, enhancements such as requesting for scheduling, and SL scheduling with an assistance from the network, such as indicating the resources for reception and indicating a pool of resources from the network to the scheduling UE, can be within the scope of Rel. 18.

Q2: On page 4, what's the scenario for Uu/PC5 aggregation & coex enh? Is it for pure sidelink communication, or sidelink relay case?

[Answer] Coexistence deals with SL and Uu operation on a carrier; the aim is to increase the resource efficiency from the system point of view by providing tools, such as power control and preemption, to better control the allocation of resources to SL and Uu communication. Uu/PC5 aggregation is to support multi-path connection for a device, with coordination by the network which leverages some concepts of the concurrent operation of Uu and PC5.

## **Guangdong OPPO Mobile Telecom.**

# 5

Q1) For the Uu/PC5 aggregation, is it for U2N relay, so that the aggregation is for the direct path and indirect path from remote UE perspective?

[Answer] Yes, this is for multi-path connection support to the device, with one direct connection and other connection over PC5.

Q2) There are many feature proposals for SL evolution. Which ones are higher priority should be included in R18 from the conclusion slide?

[Answer] Besides V2X/PS, in our view, the evolution of SL should target the support of a wider range of use cases such as consumer/wearables at different tiers as well as URLLC/IIOT. The scope of Rel. 18 should include sufficient tools to meet the requirements of such use cases.

## **Fraunhofer HHI**

# 6

Q1. Under “Increased data rates and reduced latency”, is the “in-car sidelink for in-vehicle networking use cases” related to the VMR SID being discussed in SA1?

[Answer] We view in-vehicle networking as a separate topic from VMR. In-vehicle networks are intended for communications within a vehicle, for example to display content from the phone on the vehicle console. We also view in-vehicle network as a method to connect displays and speakers for playing video and audio as another use case.

Q2. Does SL extension to unlicensed (e.g. FR2) and multi-beam operation/MIMO enhancements go in parallel? Are there any priorities attached to the proposals on slide 9?

[Answer] MIMO (and also CSI enhancements) are generic and can be applied to different bands, licensed and unlicensed, to enhance throughput, e.g., for consumer use cases. FR2 extension to 52.6 to 71GHz should be completed in Rel.17. The extension of SL to FR2 (extended) should cover both licensed and unlicensed carriers with a common design. Only channel access mechanism needs to be applied when operating in unlicensed band.

Besides V2X/PS, in our view, the evolution of SL should target the support of a wider range of use cases such as consumer/wearables at different tiers as well as URLLC/IIOT. The scope of Rel. 18 should include sufficient tools to meet the requirements of such use cases.

## **Intel Corporation (UK) Ltd**

# 7

The wide set of use cases and sidelink evolution directions is discussed and provided in the tdoc for sidelink evolution. So far sidelink support/evolution was mainly driven by vertical (V2X/PS) segments.

Q: Is there any view on the most promising/prioritized work direction for 3GPP sidelink evolution in R18 (besides V2X/PS)?

[Answer] Besides V2X/PS, in our view, the evolution of SL should target the support of a wider range of use cases such as consumer/wearables at different tiers as well as URLLC/IIOT. The scope of Rel. 18 should include sufficient tools to meet the requirements of such use cases.

## **InterDigital Communications**

# 8

Could you elaborate on SPS optimization and path diversity techniques in slide 9?

[Answer]: For SPS optimization, we are considering introducing SPS in SL itself to reduce control overhead for relatively deterministic traffic models. For path diversity, we are considering dynamic switching between data transmission from UE to UE directly and tunneled through a gNB, or allow retransmission of the same data through different routes.

## **ROBERT BOSCH GmbH**

# 9

Q1: for SL BWP adaptation (for power saving), do you see a need for adaptive SL search space ?

[Answer] Could you please elaborate on the definition of SL search space?

Q2: for Industrial IoT, new QoS parameters for CSA (e.g., survival time) is considered. Do you support introducing those critical Functional safety requirements for SL IIoT as well ?

[Answer] This certainly can be considered.

## **CATT**

# 10

It seems we posted the comment for SL Positioning incorrectly to this section. Please ignore it.

## **Nokia Denmark**

# 11

wouldn't GNSS free operation also increase market uptake as also IoT devices etc with long battery times would be able to use the system.

[Answer] Could you please elaborate on which aspects of operations you are considering?

## **Samsung Electronics Co., Ltd**

# 12

Q1: In slide 4, there are lots of proposed features for Rel-18+ sidelink. Among those features, which features are expected to prioritize in Rel-18 considering limited TU?

[Answer] This is dependent on the targeted use cases; each use case has a specific set of requirements and calls for different considerations. As an example, consumer use cases (e.g. XR) require features aiming at providing higher data rates and power saving gains, while URLLC/IIOT use cases need those providing

additional latency and reliability gains. In addition, the features for automotive use cases are discussed in our replies to [RWS-210005](#).

## vivo Communication Technology

# 13

Would you please elaborate the details of SPS enhancement for SL, and how it could help to improve the reliability, latency & coverage of SL?

[Answer]: SPS enhancement for SL is about introduce SPS/CG based transmission in SL itself. This helps some more periodic traffic types that we may see in some IIoT scenarios. In this case, the SCI may not be needed, so more resource for data transmission, and less dependency on the reliability of SCI decoding.

## 6.3 Input – Round 2

### Feedback Form 10: NR sidelink Evolution - Round 2

#### 1 – ROBERT BOSCH GmbH

Thanks a lot for your answers. Regarding BWP adaptation, we understand that the UE starts with a small BWP. Then, if the UE is triggered, e.g., receiving an SCI or a wakeup-signal, the UE needs to increase its BWP.

In the first state, this small BWP, do we need to confine transmission to those power saving UEs (form normal UEs) within a limited search space smaller than or equal the small BWP?

#### 2 – LG Electronics Inc.

Q1: For "in-car sidelink for in-vehicle networking," what spectrum and frequency range is considered?

#### 3 – Intel Corporation (UK) Ltd

Q1: Thanks for clarifying that you consider further sidelink evolution (beyond V2X/PS) for consumer/wearables at different tiers as well as URLLC/IIOT. Considering that consumer/wearable segment is also addressed by other wireless technologies, where do you think sidelink can provide a unique advantage? Where do you see more potential for sidelink application in consumer/wearables or URLLC/IIOT scenarios? Do you assume that consumer/wearable and URLLC/IIOT frameworks can have common design components?

#### 4 – Samsung Electronics Co.

1. Can you please comment on the benefit of using in-car SL over using bluetooth or WiFi inside the car.

#### 5 – Philips International B.V.

We fully agree with you in improving reliability, latency and coverage in Rel-18. We would like to share with you our observations regarding coverage.

We are currently working in some Health wearables using LTE-M. We have very recently realized that LTE-M, in practice, does not offer better coverage than LTE and, in some scenarios, even less coverage. The reason why is that CE Mode B is not deployed in the field (several reasons for this, the main one being

that LTE-M uses LTE resources and enabling many repetitions will take too much resources from LTE and make the base stations schedulers quite complex) and a wearable device has a negative antenna gain that cancels the gains of CE Mode A of LTE-M. All this leaves LTE-M even below the coverage offered by LTE. One can argue that you can instead use NB-IoT but NB-IoT does not fulfill the same use cases as LTE-M. Likewise I expect that the coverage of RedCap is limited (although I am not fully up to date with the WI NR Coverage enhancements). We think that supporting LTE-M (and maybe NB-IoT and RedCap) within the Relay ecosystem could greatly improve the coverage. This is not new to 3GPP. During the Rel-16 preparation a SID (RP-180750) along these lines was proposed by several companies but in the end it did not have enough traction. Back then the arguments to promote this SID were different and the lack of coverage of LTE-M was not among them. Considering all this, what is your view on supporting LTE-M (and maybe NB-IoT and RedCap) on Sidelink Relays?

## 6.4 Response – Round 2

### **ROBERT BOSCH GmbH**

# 1

Thanks a lot for your answers. Regarding BWP adaptation, we understand that the UE starts with a small BWP. Then, if the UE is triggered, e.g., receiving an SCI or a wakeup-signal, the UE needs to increase its BWP.

In the first state, this small BWP, do we need to confine transmission to those power saving UEs (form normal UEs) within a limited search space smaller than or equal the small BWP?

[Answer] The operating BW needs to be managed across the peer UEs; if they have a common understanding about the resources that the other UEs are accessible, they can communicate with each other.

### **LG Electronics Inc.**

# 2

Q1: For "in-car sidelink for in-vehicle networking," what spectrum and frequency range is considered?

[Answer] Unlicensed bands in FR1 or FR2.

### **Intel Corporation (UK) Ltd**

# 3

Q1: Thanks for clarifying that you consider further sidelink evolution (beyond V2X/PS) for consumer/wearables at different tiers as well as URLLC/IIOT. Considering that consumer/wearable segment is also addressed by other wireless technologies, where do you think sidelink can provide a unique advantage?

Where do you see more potential for sidelink application in consumer/wearables or URLLC/IIOT scenarios? Do you assume that consumer/wearable and URLLC/IIOT frameworks can have common design components?

[Answer] It is true that there are also other technologies in the area. Sidelink benefits from its better QoS

control, and potential integration with the Uu connection.

**Samsung Electronics Co., Ltd**

# 4

1. Can you please comment on the benefit of using in-car SL over using bluetooth or WiFi inside the car.

[Answer] Sidelink offers better QoS management and higher reliability, which is crucial for in-vehicle communication. We expect the solution to provide scalable throughput/performance/cost to match the device function, removing the need to support different technologies in the same device.

**Philips International B.V.**

# 5

We fully agree with you in improving reliability, latency and coverage in Rel-18. We would like to share with you our observations regarding coverage.

We are currently working in some Health wearables using LTE-M. We have very recently realized that LTE-M, in practice, does not offer better coverage than LTE and, in some scenarios, even less coverage. The reason why is that CE Mode B is not deployed in the field (several reasons for this, the main one being that LTE-M uses LTE resources and enabling many repetitions will take too much resources from LTE and make the base stations schedulers quite complex) and a wearable device has a negative antenna gain that cancels the gains of CE Mode A of LTE-M. All this leaves LTE-M even below the coverage offered by LTE. One can argue that you can instead use NB-IoT but NB-IoT does not fulfill the same use cases as LTE-M. Likewise I expect that the coverage of RedCap is limited (although I am not fully up to date with the WI NR Coverage enhancements). We think that supporting LTE-M (and maybe NB-IoT and RedCap) within the Relay ecosystem could greatly improve the coverage. This is not new to 3GPP. During the Rel-16 preparation a SID (RP-180750) along these lines was proposed by several companies but in the end it did not have enough traction. Back then the arguments to promote this SID were different and the lack of coverage of LTE-M was not among them. Considering all this, what is your view on supporting LTE-M (and maybe NB-IoT and RedCap) on Sidelink Relays?

[Answer] Thanks for sharing the considerations. We agree that it is worth consideration in Rel-18 scope.

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## 7 On XR Improvement for NR - RWS-210010

### 7.1 Input – Round 1

## Feedback Form 11: XR - Round 1

### 1 – CATT

Thanks for sharing the idea of NR enhancement for XR. The proposed schemes of capacity enhancement, traffic awareness at RAN, power saving technique and mobility enhancement with DAPs are quite interesting. However, we believe the aspects of NR enhancements should be discussed and concluded in the working groups first during the XR study before further discussion of the scope of XR work item.

### 2 – Classon Consulting

FUTUREWEI also supports XR capacity enhancements, please see RWS-210036 p8 which shows large capacity gains from cooperative MIMO/interference probing and avoiding. <https://nwm-trial.etsi.org/#/documents/4580>

### 3 – HuaWei Technologies Co.

1) Can you please clarify the difference of the 3 aspects: RAN awareness of traffic information for optimizing lower layer operation, Application awareness at RAN and RAN awareness at application? In our view we think it is useful for the RAN to be aware the multiple data streams association from the application layer, however this needs involvement of CN and it is not the case that RAN has direct interaction with the application layer.

2) There are many aspects listed for XR and some of them are actually not specific to XR, e.g. DAPS enhancements, network coding, which aspects are seen essential for XR from your side?

### 4 – vivo Communication Technology

Thanks for the nice contribution. We support to work on NR enhancements for better support XR services in REL-18. Regarding the proposal, we have following questions:

Q1: Regarding the figure in leftside in page 4, what is the consideration from QC on how gNB identifies the boundary of a file (e.g. video frame)? Since a file from application delivered to RAN is typically in terms of IP packets, gNB would need to identify which frame the IP packets belong to, and also potentially re-order the IP packets belonging to the same frame.

Q2: with delay aware scheduling in gNB, is packets dropping considered when the packets may not be able to transferred within the delay bound?

Q3: Regarding UL & DL alignment, what is the consideration from QC on what kinds of UL transmissions e.g. HARQ-ACK/CSI/SR/configured grant PUSCH/DG PUSCH and how these UL transmissions are aligned with DL transmission?

Q4: Regarding UE assistance info for UL XR traffic, to our understanding, UE reporting assistant information can be beneficial for improvement of capacity and spectrum efficiency by enabling gNB efficient scheduling. Could QC elaborate more on what information will UE report to gNB for power saving purpose?

### 5 – ZTE Corporation

Is mobility/coverage related enhancement, if identified, expected to be in the Rel-18 XR WI?

Is it correct understanding that the optimized scheduler based on file boundary refers to assigning different priority level to the files with different ratio of remaining components to be transmitted, e.g. in case there is only one packet in the file to be transmitted, this packet will be assigned the utmost priority?

Our paper RWS-210469 also discussed the potential benefit of NW coding to XR, and we think this aspect can be evaluated for the remaining budget of the SI.

## 6 – Spreadtrum Communications

Thanks for the good contribution. Considering the redundancy of 80% for network coding, the capacity for XR shall be impacted, how to solve the capacity issue?

## 7 – Guangdong OPPO Mobile Telecom.

Q1: Jitter impacts CDRX, PDCCH detection and SPS/CG configuration, different solutions to tackle jitter will be considered for above different cases, or a unified solution to tackle jitter for all cases. Q2: In our understanding UL and DL alignment can be implemented by reasonable scheduling, what's the spec impact from UL and DL alignment?

## 8 – Samsung Research America

-  
Slide 3: Could you please elaborate on “RAN awareness at application” and “application awareness at RAN”? While “RAN awareness of traffic information for optimizing lower layer operation” in the gNB scheduler is understood, what exactly are you proposing to investigate in the SI in these 2 bullet points? For example, do you see need for new XR related signaling through UE assistance info to the gNB? Or, do you mean to pass down XR stream/type info to the gNB through network interfaces? In particular, are you indicating that the R16 mechanism with UE supporting priority 0 and priority 1 traffic would not be sufficient?

-  
Slide 3: Which specific SPS/CG enhancements are being proposed, e.g. only updated DRX cycles / on-duration counters to improve upon the observed periodicity mismatch with XR traffic, or more ambitious SPS/CG enhancements?

-  
Slide 3: Could you please elaborate on “UL-DL alignment”? To what extent do you see the need for specification changes, e.g. what cannot be handled through the scheduler using the existing R15/R16 baseline? Would be alignment of the UL pose/control stream (250fps) with DL scheduling and DRX on-periods be more critical than UL video (if present)? In particular, did you consider the use of “mini-slot” based scheduling?

## 9 – Nokia Corporation

Thank you for the interesting contribution. 1) Can you elaborate about the RAN awareness at the application? In-band measurements are possible by the application already today for collecting information of the network. 2) Network coding is usually less spectral efficient than HARQ retx. With the large PDB of XR services (10-15ms), it might be more efficient to use HARQ retx than NC. Have you compared in your results NC against HARQ retx?

## 10 – Sony Europe B.V.

On Network coding, what coding you have in mind? E.g. would MAC/RLC outer code be sufficient for low latency XR traffic as mentioned in RWS-210028, or packet dropping may still be used in some cases?

## 11 – Intel Corporation (UK) Ltd

Q1: On delay aware scheduling we have similar observations and believe such information can be helpful to provide to scheduler. PS DPM results: Could you pls. provide some details on the "newly introduced DPM scheme" and the assumptions on the XR traffic used here? any impact to XR capacity observed here?

Q2: - On power consumption related enhancements (e.g. Discontinuous PDCCH Monitoring, C-DRX enhancements or SPS/CG enhancements), could you clarify whether a new study is required (e.g. due to XR specific characteristic) or whether identified solutions e.g. in R16 NR PowSav SI could be re-used  
- Could you clarify the motivation/intention with the proposal on "Tackle jitter enhancements"?

## 12 – Lenovo Information Technology

1) could you please explain what extension DAPS HO means?

2) Application awareness at RAN / RAN awareness at application: could you clarify what kind of information should be aware in RAN or application? for DL, do you mean the XR server should be aware of some RAN information?

3) network coding may have benefits in case of multiple paths transmission. Do you assume that multiple paths transmission are needed for XR?

## 13 – MediaTek Inc.

Thanks for the good contribution. We have some questions below to know more about the enhancements.

-

For enhanced SPS and CG to match XR DL/UL periodicity, dynamic grant should be sufficient for DL (low overhead and high efficiency). UL traffic can also utilize flexible CG type-2. What are the expected additional enhancement and benefit?

-

For Enhanced CDRX to match XR frame rate, DCI-based power saving is able to achieve the best dynamic and fine-granularity power saving. What is expected addition enhancement w.r.t. R17 PDCCH monitoring reduction and benefit, considering very dense UL (Ex. 4ms) in XR assumed in SA4?

-

For jitter handling to achieve power saving, DCI-based power saving is able to achieve the best dynamic and fine-granularity power saving. What is expected addition enhancement w.r.t. R17 PDCCH monitoring reduction and benefit?

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For Alignment of UL and DL transmission, dependency in DL and UL traffics should be first agreed in SA4 and RAN1. Then, it can be evaluated for checking the power saving issue and identify the solution(s). Is it planned to check with SA4 first?

-

For cross-layer enhancement, RAN1 can first conclude the benefit of RAN awareness of application and application awareness of RAN first (Ex. packet dropping, packet prioritization), and then the work can be led by SA4 since QoS requirements are currently under study in SA4. How is it planned to progress the work in SA4 and RAN for RAN awareness of application and application awareness of RAN?

-  
For Network coding to replace PDCP duplication, it is not included in R17 SI (RAN1). Would a study about the achievable gain and involved complexity needed first?  
For UE assistance info for UL XR traffic, UAI is not expected to be frequent (overhead consideration), and how slow UAI can help fast adaptation? Does the UAI information comes from application?

-  
For Extension of DAPS HO, whether this extension of DAPS HO can be used for other use cases other than XR?

#### **14 – Apple Europe Limited**

Can UL/DL alignment be achieved by gNB implementation or specification support is still needed?  
what are the difference between "RAN awareness of traffic information for optimizing lower layer operation" and "Application awareness at RAN"? It seems the latter is broader and subsumes the former?

#### **15 – LG Electronics Inc.**

Thanks for the contribution. We have the following questions.

Q1) In your paper (RWS-210010), you mentioned the application awareness at RAN and RAN awareness at application, in addition to the RAN awareness of traffic information for optimizing lower layer operation. From RAN perspective, do you intend to emphasize different aspects by application awareness at RAN from those by traffic awareness at RAN? If yes, then can you explain the aspects that you see beneficial?

Q2) In the same paper, a large amount of resources is devoted to the network coding compared to the PDCH duplication with some results in FR2. Can you summarize in what XR deployment scenarios you see it is worth considering the network coding? This is neither a URLLC nor eMBB, and, with that understanding, we failed to see the point from that aspect.

Q3) You mentioned in the same paper a newly introduced power saving technique, what you call "Discontinuous PDCCH Monitoring (DPM)" and said it can save UE power up to 50% over baseline (always ON) and up to 35% over Rel-15/16 CDRX. There are discussions in Rel-17 NR PS WI on skipping or reducing PDCCH monitoring. Is it a fundamentally different approach, or your proposed solution in Rel-17 NR PS WI?

#### **16 – Samsung Electronics Co.**

1. What is the need for UE assistance info/RAN awareness for the UL traffic scenarios for XR? What additional is needed relative to a UE supporting priority 0 and priority 1 traffic in Rel-16?
2. What SPS/CG enhancements are needed other than to possibly address a periodicity mismatch?
3. Slide 3: Could you please elaborate on "RAN awareness at application" and "application awareness at RAN"? While "RAN awareness of traffic information for optimizing lower layer operation" in the gNB scheduler is understood, what exactly are you proposing to investigate in the SI in these 2 bullet points? For example, do you see need for new XR related signaling through UE assistance info to the gNB? Or, do you mean to pass down XR stream/type info to the gNB through network interfaces? In particular, are you indicating that the R16 mechanism with UE supporting priority 0 and priority 1 traffic would not be sufficient?
4. Slide 3: Which specific SPS/CG enhancements are being proposed, e.g. only updated DRX cycles / on-duration counters to improve upon the observed periodicity mismatch with XR traffic, or more ambitious SPS/CG enhancements?

5. Slide 3: Could you please elaborate on “UL-DL alignment”? To what extent do you see the need for specification changes, e.g. what cannot be handled through the scheduler using the existing R15/R16 baseline? Would be alignment of the UL pose/control stream (250fps) with DL scheduling and DRX on-periods be more critical than UL video (if present)? In particular, did you consider the use of “mini-slot” based scheduling?

**17 – NTT DOCOMO INC.**

Thanks for the good contribution. Regarding “enhancements to tackle jitter”, independent enhancement for jitter is assumed, or can be included in other enhancement, e.g. CDRX enhancement? Also, regarding “Further enhancements to L1 based signaling”, do you assume the enhancements on Rel-17 search space set group switching and/or PDCCH skipping if needed, or the enhancements on other solution?

## 7.2 Response – Round 1

### CATT # 1

Thanks for sharing the idea of NR enhancement for XR. The proposed schemes of capacity enhancement, traffic awareness at RAN, power saving technique and mobility enhancement with DAPs are quite interesting. However, we believe the aspects of NR enhancements should be discussed and concluded in the working groups first during the XR study before further discussion of the scope of XR work item.

[Reply] Thanks for the comment. Performance evaluation results for enhancement schemes have been submitted in Rel-17 XR study item. Those results will help us discuss Rel-18 work scope.

### Classon Consulting # 2

FUTUREWEI also supports XR capacity enhancements, please see RWS-210036 p8 which shows large capacity gains from cooperative MIMO/interference probing and avoiding.  
<https://nwm-trial.etsi.org/#/documents/4580> .

[Reply] Thanks for sharing your view. We generally agree that variation of inter-cell interference may degrade the XR performance as it can lead to lower MCS selection to meet tight latency requirements. Techniques that tackle this issue can improve the XR performance.

### HuaWei Technologies Co., Ltd # 3

1) Can you please clarify the difference of the 3 aspects: RAN awareness of traffic information for optimizing lower layer operation, Application awareness at RAN and RAN awareness at application? In our view we think it is useful for the RAN to be aware the multiple data streams association from the application layer, however this needs involvement of CN and it is not the case that RAN has direct interaction with the application layer.

2) There are many aspects listed for XR and some of them are actually not specific to XR, e.g. DAPS enhancements, network coding, which aspects are seen essential for XR from your side?

[Reply]

Q1: They are elaborated in the Qualcomm contribution, R1-2104704 submitted for Rel-17 XR SI.

RAN awareness of XR traffic characteristics can be leveraged to trigger beam management and measurement

configuration updates. This could lead to XR performance improvement and reduction in power consumption. For example, in scenarios where the UE's MAC/PHY layers are aware of the UE's positioning/motion information or mobility patterns through application layer information such as XR viewport or pose information, the UE may use this information to request beam or measurement updates from the gNB.

Application awareness at RAN can help gNB improve XR performance. One example is that if XR video frame boundaries are known to gNB scheduler, the information can be used for scheduler metric updates to improve system XR capacity as well as user experience (e.g., IP packets of a video frame close to the latency deadline of the video frame determined by PDB can be given priority, aka delay-aware scheduler) or can be used for UE power saving (e.g., not waking up UE too early taking into account the latency deadline). Your example of RAN awareness of multiple data streams association from the application layer can be another example.

An example of RAN awareness at application is more sophisticated and smarter application rate adaptation at edge server, e.g., taking into account RAN/CN congestion, variation of supportable data rate in RAN, mobility, etc.

Application awareness at RAN and RAN awareness at application are facilitated by tight coordination and communication among RAN, CN, and edge server that may require updates of specifications of RAN and SA.

Q2: We believe those enhancements can help to substantially improve XR performance in terms of user experience, system capacity, power, coverage, and mobility. Yes, in general, NR enhancements techniques are applicable to most of applications, not limited to a certain application. Having said that, we think the enhancements discussed in our paper are highly motivated by the specific set of requirements of XR in terms of latency, reliability, and UE power consumption.

#### **vivo Communication Technology # 4**

Thanks for the nice contribution. We support to work on NR enhancements for better support XR services in REL-18. Regarding the proposal, we have following questions:

Q1: Regarding the figure in leftside in page 4, what is the consideration from QC on how gNB identifies the boundary of a file (e.g. video frame)? Since a file from application delivered to RAN is typically in terms of IP packets, gNB would need to identify which frame the IP packets belong to, and also potentially re-order the IP packets belonging to the same frame.

Q2: with delay aware scheduling in gNB, is packets dropping considered when the packets may not be able to transferred within the delay bound?

Q3: Regarding UL & DL alignment, what is the consideration from QC on what kinds of UL transmissions e.g. HARQ-ACK/CSI/SR/configured grant PUSCH/DG PUSCH and how these UL transmissions are aligned with DL transmission?

Q4: Regarding UE assistance info for UL XR traffic, to our understanding, UE reporting assistant information can be beneficial for improvement of capacity and spectrum efficiency by enabling gNB efficient scheduling. Could QC elaborate more on what information will UE report to gNB for power saving purpose?

[Reply]

Q1: Video boundary detection could be done to some extent by implementation. However, specification

updates of RAN and SA to this end can facilitate it as elaborated in our answer to a Huawei's question.

Q2: We think it is up to gNB/UE implementation. For instance, packets delivered beyond the delay bound could be still useful depending on schemes of video encoding/decoding and display. Qualcomm's evaluation results that are submitted to Rel-17 XR SI assume that those packets beyond the delay bound are dropped from the Tx buffer. This takes into account the fact that Rel-17 RAN1 evaluations do not employ UE admission control and application rate adaptation that would be critical in real networks. Without admission control and application rate adaptation in our simulations, UEs who cannot support a configured XR bitrate, e.g., 45/60 Mbps due to very low geometry tend to behave as full buffer UE and eat up resources that would degrade capacity outcome in our simulations – this could be handled in a smart way in real networks, e.g., by admission control and application bitrate adaptation.

Q3: The alignment can be done by gNB implementation. Some spec enhancements can help, e.g., limited/no HARQ ReTx for the last IP packets associated with a video frame (careful MCS selection would be needed), modifications of CG/SR transmission rules in conjunction with CDRX, etc. We encourage companies to develop techniques to increase UE sleep duration via DL&UL alignment without sacrificing much user experience as well as system capacity.

Q4: Some information that is hard for gNB is get, but easier for UE for uplink, e.g., traffic characteristics such as average interarrival time, UE buffer statistics, etc.

#### **ZTE Corporation # 5**

Is mobility/coverage related enhancement, if identified, expected to be in the Rel-18 XR WI?

Is it correct understanding that the optimized scheduler based on file boundary refers to assigning different priority level to the files with different ratio of remaining components to be transmitted, e.g., in case there is only one packet in the file to be transmitted, this packet will be assigned the utmost priority?

Our paper RWS-210469 also discussed the potential benefit of NW coding to XR, and we think this aspect can be evaluated for the remaining budget of the SI.

[Reply]

Yes, we expect to address mobility and coverage enhancements in Rel-18 that are deemed critical to the XR performance. For instance, coverage enhancement techniques developed in Rel-17 will generally help with XR, too. But, coverage is associated with target data rate as well as latency (e.g., average/target/max HARQ transmissions), and coverage enhancements considering requirements specific to XR can be considered.

As to the second question, yes, it is correct. Please see our answers for Huawei questions, aka delay aware scheduler, and Qualcomm's tdoc, R1-2104704 submitted for Rel-17 XR SI.

Regarding NW coding, good to see that ZTE share the view with Qualcomm. Yes, Qualcomm is planning to submit evaluation results to Rel-17 XR SI, showing the performance improvement by NW coding.

#### **Spreadtrum Communications # 6**

Thanks for the good contribution. Considering the redundancy of 80% for network coding, the capacity for XR shall be impacted, how to solve the capacity issue?

[Reply]

When we evaluate NW coding, of course, overhead shall be considered. For example, 80% redundancy is still smaller than that of PDCP duplication and that redundancy is exploited better by utilizing better coding scheme (e.g. RaptorQ coding) as compared to simple duplication in the case of PDCP duplication. Also note that in comparison to the baseline (based on HARQ) the redundancy of the NW coding can avoid/compensate for HARQ retransmissions, resulting in the smaller delays and smaller packet loss, and hence improved capacity. NW coding is generally beneficial for the case of XR transmission over multiple links (multiple CC's in FR1/FR2), e.g., to tackle the blockage issue. Qualcomm is planning to submit NW coding evaluation results to RAN1 under Rel-17 XR SI.

**Guangdong OPPO Mobile Telecom. # 7**

Q1: Jitter impacts CDRX, PDCCH detection and SPS/CG configuration, different solutions to tackle jitter will be considered for above different cases, or a unified solution to tackle jitter for all cases.

Q2: In our understanding UL and DL alignment can be implemented by reasonable scheduling, what's the spec impact from UL and DL alignment?

[Reply]

Q1: It depends on detailed solutions. For instance, we think it is beneficial to enhance/modify WUS for PDCCH monitoring in conjunction with CDRX, PDCCH skipping (depending on Rel-17 outcome), etc. considering characteristics of XR traffic, where our goal is to minimize unnecessary PDCCH decoding at UE with the aid of WUS, while minimizing the impact on QoS and system capacity. Similarly, we could develop enhancements to SPS/CG to better handle jitter issue, via a same/similar solution or different. We encourage companies to further look into this problem and come up with solutions.

Q2: Please see our answer for vivo's Q3, copied here (The alignment can be done by gNB implementation. Some spec enhancements can help, e.g., limited/no HARQ ReTx for the last IP packets associated with a video frame (careful MCS selection would be needed), modifications of CG/SR transmission rules in conjunction with CDRX. We encourage companies to develop techniques to increase UE sleep duration without sacrificing much user experience as well as system capacity.)

**Samsung Research America # 8**

Slide 3: Could you please elaborate on "RAN awareness at application" and "application awareness at RAN"? While "RAN awareness of traffic information for optimizing lower layer operation" in the gNB scheduler is understood, what exactly are you proposing to investigate in the SI in these 2 bullet points? For example, do you see need for new XR related signaling through UE assistance info to the gNB? Or, do you mean to pass down XR stream/type info to the gNB through network interfaces? In particular, are you indicating that the R16 mechanism with UE supporting priority 0 and priority 1 traffic would not be sufficient?

Slide 3: Which specific SPS/CG enhancements are being proposed, e.g. only updated DRX cycles / on-duration counters to improve upon the observed periodicity mismatch with XR traffic, or more ambitious SPS/CG enhancements?

Slide 3: Could you please elaborate on "UL-DL alignment"? To what extent do you see the need for specification changes, e.g. what cannot be handled through the scheduler using the existing R15/R16 baseline? Would be alignment of the UL pose/control stream (250fps) with DL scheduling and DRX on-periods be more

critical than UL video (if present)? In particular, did you consider the use of “mini-slot” based scheduling?

[Reply]

Q1: Please see our answer for Huawei’s 1<sup>st</sup> question. As described there, we believe spec enhancements for RAN & SA to facilitate such communications/coordination among UE, application server, CN, and RAN are highly beneficial. For example, there can be signaling enhancements between gNB and application server to facilitate gNB awareness of video frame boundaries and rate adaptation at application server by knowing RAN status. Enhancements to beam management and measurement configuration updates can be considered in the context of RAN awareness of XR traffic characteristics as elaborated in our answer for Huawei’s 1st question. We highly encourage companies to further look into this problem as we believe it is highly beneficial for XR performance.

Q2: Both of your examples can be candidate solutions, enhancements to CDRX related operation/procedure, and enhancements to SPS/CG related operation/procedure, possibly in conjunction with HARQ operation.

Q3: Please see our answer for vivo’s Q3, copied here, “The alignment can be done by gNB implementation. Some spec enhancements can help, e.g., limited/no HARQ ReTx for the last IP packets associated with a video frame (careful MCS selection would be needed), modifications of CG/SR transmission rules in conjunction with CDRX. We encourage companies to develop techniques to increase UE sleep duration without sacrificing much user experience as well as system capacity.” We have not considered using mini-slot for this purpose, but are open to such proposals from companies, if any.

#### **Nokia Corporation # 9**

Thank you for the interesting contribution. 1) Can you elaborate about the RAN awareness at the application? In-band measurements are possible by the application already today for collecting information of the network. 2) Network coding is usually less spectral efficient than HARQ retx. With the large PDB of XR services (10-15ms), it might be more efficient to use HARQ retx than NC. Have you compared in your results NC against HARQ retx?

[Reply]

Q1: Yes, it can be done by implementation to some extent. We think spec enhancements for RAN and SA can further facilitate it. Please see our answers for HW’s 1st question and Samsung’s 1<sup>st</sup> question for more details.

Q2: XR traffic characteristics include relatively high data rate, stringent latency bound and reliability requirements. Given these requirements, we have investigated if addition of Network Coding (NC) in the RAN protocol stack provides performance benefits over other existing NR schemes, such as baseline HARQ and PDCP duplication. Redundancy added upfront in case of NC could help XR traffic to fulfil latency and reliability requirements without having to resort to HARQ/RLC retransmissions that would increase the delay of packet reception, especially in cases of blocking. Compared to the PDCP duplication, NC can offer adaptive redundancy, which allows for more efficient operation by adapting to the current traffic load and reliability/latency requirements. Our system simulation performance analysis show that using the NC for XR traffic can provide capacity gain over both baseline and PDCP duplication. We are planning to submit evaluation results to RAN1 under Rel-17 XR SI.

#### **Sony Europe B.V. # 10**

On Network coding, what coding you have in mind? E.g. would MAC/RLC outer code be sufficient for low latency XR traffic as mentioned in RWS-210028, or packet dropping may still be used in some cases?

[Reply]

In our internal analysis we considered RaptorQ coding scheme applied at the RLC layer. Our system simulation performance analysis show that using the NC for XR traffic can provide capacity gain over both baseline HARQ and PDCP duplication. We are open to study of other coding schemes and protocol layers. For more details, please refer to our answers for Spreadtrum's question and Nokia's Q2.

**Intel Corporation (UK) Ltd # 11**

Q1: On delay aware scheduling we have similar observations and believe such information can be helpful to provide to scheduler. PS DPM results: Could you pls. provide some details on the "newly introduced DPM scheme" and the assumptions on the XR traffic used here? any impact to XR capacity observed here?

Q2: - On power consumption related enhancements (e.g. Discontinuous PDCCH Monitoring, C-DRX enhancements or SPS/CG enhancements), could you clarify whether a new study is required (e.g. due to XR specific characteristic) or whether identified solutions e.g. in R16 NR PowSav SI could be re-used

Q3:- Could you clarify the motivation/intention with the proposal on "Tackle jitter enhancements"?

[Reply]

Q1: Good to see that Intel share the view with Qualcomm on delay aware scheduler. Please see our answer for Huawei's 1<sup>st</sup> question for more details. DPM stands for discontinuous PDCCH monitoring that is similar to L1 based power saving schemes that are being discussed in Rel-17 power saving WI such as PDCHC skipping, and SS set switching. The plot uses this term as the outcome of Rel-17 power saving WI is not available yet. In the results on page 4 assume 100Mbps and 60Fps without jitter. Almost no impact to capacity in this case. Once jitter is being considered, then, its power saving gain gets lower than what is shown in the figure.

Q2: We should assume that all power saving techniques defined until Rel-17 are applicable to XR, too. The enhancements listed on page 3 in our paper are additional enhancements on top of Rel-17 spec. Power saving techniques that have been developed and are being developed in Rel-17 do not much consider XR specific requirements and XR traffic characteristics. For instance, a typical XR traffic periodicity is 16.7ms with which the DRX periodicities supported by today's spec does not match. Another example is the jitter issue that has never been considered because jitter would not much matter for eMBB -type of traffic that is generally relatively delay tolerant. We think that better jitter handling in UE power saving context is critical because jitter may substantially decrease the effectiveness of power saving techniques that will be available in Rel-17, in some scenarios/applications.

Q3: As replied above, when packet arrivals are perfectly periodic, power saving techniques assuming periodic nature of Tx/Rx will be much effective, e.g., CDRX with proper parameter setting, or PDCCH skipping that can indicate when UE has to wake up for the next video frame. However, with jitter it is uncertain exactly when the next video frame will arrive, e.g., in DL video stream according to RAN1 traffic model in Rel-17. In this case, the only way that will not lead to excessive delay is to wake up UE earlier than the packet arrival time based on average inter-arrival time, e.g., pull in CDRX on duration cycle or shorter duration of PDCHC skipping which can substantially increase UE power consumption compared to no jitter case. Introduction of a lower power WUS can be highly effective in this case.

**Lenovo Information Technology # 12**

1) could you please explain what extention DAPS HO means?

2) Application awareness at RAN / RAN awareness at application: could you clarify what kind of information should be aware in RAN or application? for DL, do you mean the XR server should be aware of some RAN information?

3) network coding may have benefits in case of multiple paths transmission. Do you assume that multiple paths transmission are needed for XR?

[Reply]

Q1: DAPS HO was mostly developed for FR1 non-Carrier Aggregation (i.e. non-CA) scenarios, therefore, FR1 extensions to CA scenarios and support for FR2 would be beneficial for better XR support. Specific examples of the required extensions include:

Support for beam management and spatial division multiplexing during HO and beam prioritization during collision between source and target cell communication.

Support for Carrier Aggregation or multi-TRP features at HO without the need for explicit carrier activation/deactivation.

Q2: Please refer to our answers for Huawei's 1<sup>st</sup> question and Samsung's 1<sup>st</sup> question.

Q3: Yes, we assume that multiple paths transmissions are needed for XR, for example, CA in FR2 to tackle blocking. Please refer to our answers for other companies' questions on network coding for more details.

**MediaTek Inc. # 13**

Thanks for the good contribution. We have some questions below to know more about the enhancements.

For enhanced SPS and CG to match XR DL/UL periodicity, dynamic grant should be sufficient for DL (low overhead and high efficiency). UL traffic can also utilize flexible CG type-2. What are the expected additional enhancement and benefit?

[Reply]

Those are good candidates. In addition, some enhancements/modifications of procedures/rules with respect to SPS/CG in conjunction with CDRX, PDCCH skipping, HARQ, etc. may be beneficial. Also please refer to our answer for Samsung's Q2.

For Enhanced CDRX to match XR frame rate, DCI-based power saving is able to achieve the best dynamic and fine-granularity power saving. What is expected addition enhancement w.r.t. R17 PDCCH monitoring reduction and benefit, considering very dense UL (Ex. 4ms) in XR assumed in SA4?

[Reply]

Please refer to our answer for Samsung's Q3, copied here: "As replied above, when packet arrivals are perfectly periodic, power saving techniques assuming periodic nature of Tx/Rx will be much effective, e.g., CDRX with proper parameter setting, or PDCCH skipping that can indicate when UE has to wake up for the next video frame. However, with jitter it is uncertain exactly when the next video frame will arrive, e.g., in DL video stream according to RAN1 traffic model in Rel-17. In this case, the only way that will not lead to excessive delay is to wake up UE earlier than the packet arrival time based on average inter-arrival time, e.g.,

pull in CDRX on duration cycle or shorter duration of PDCHC skipping which can substantially increase UE power consumption compared to no jitter case. Introduction of a lower power WUS can be highly effective in this case.”

For jitter handling to achieve power saving, DCI-based power saving is able to achieve the best dynamic and fine-granularity power saving. What is expected addition enhancement w.r.t. R17 PDCCH monitoring reduction and benefit?

[Reply]

Again, when it is not known when the next frame will arrive, especially when the uncertainty (i.e., jitter) is large, DCI based scheme would not be sufficient, e.g., with PDCCH skipping technique, how long will be the skipping duration? As answered above, low power WUS may help much in this case to tackle such uncertainty.

For Alignment of UL and DL transmission, dependency in DL and UL traffics should be first agreed in SA4 and RAN1. Then, it can be evaluated for checking the power saving issue and identify the solution(s). Is it planned to check with SA4 first?

[Reply]

The dependency between DL and UL are out of 3GPP scope since it belongs to application layer. What RAN can do is to enhance specifications to enable DL/UL alignment in a more efficient way. How to use it is up to implementation where application provider may be involved.

For cross-layer enhancement, RAN1 can first conclude the benefit of RAN awareness of application and application awareness of RAN first (Ex. packet dropping, packet prioritization), and then the work can be led by SA4 since QoS requirements are currently under study in SA4. How is it planned to progress the work in SA4 and RAN for RAN awareness of application and application awareness of RAN?

[Reply]

First of all, we would like to clarify that not only SA4 but also SA2 shall be the WGs in addition to RAN WG's of which specifications may need to be updated to support cross-layer enhancements such as RAN awareness at application and application awareness at RAN. RAN and SA WGs can proceed in parallel, for instance, SA2 and/or SA4 may want to refer to RAN1 evaluation results when discussing new study/work item for Rel-18 related to this topic. Some coordination/collaboration can be also done within each company. Within Qualcomm, RAN and SA teams are closely collaborating on this matter.

For Network coding to replace PDCP duplication, it is not included in R17 SI (RAN1). Would a study about the achievable gain and involved complexity needed first?

[Reply]

Yes, Rel-17 RAN1 SI is mainly for evaluation of XR performance. Many companies including Qualcomm have been submitting evaluation results for enhancement techniques. Qualcomm has been and will be submitting evaluation results for enhancement schemes including network coding.

For UE assistance info for UL XR traffic, UAI is not expected to be frequent (overhead consideration), and how slow UAI can help fast adaptation? Does the UAI information comes from application?

[Reply]

Our view is that UAI is not intended to be sent often. UAI information may generally come from upper layers including applications, where some of them could be obtained by implementations.

For Extension of DAPS HO, whether this extension of DAPS HO can be used for other use cases other than XR?

[Reply]

Yes, it can be used for other use cases. Having said that, we believe it is highly motivated by better XR support.

#### **Apple Europe Limited # 14**

Can UL/DL alignment be achieved by gNB implementation or specification support is still needed?

what are the difference between "RAN awareness of traffic information for optimizing lower layer operation" and "Application awareness at RAN"? It seems the latter is broader and subsumes the former?

[Reply]

For first question, please refer to our answer for vivo's Q3, copied here: "The alignment can be done by gNB implementation. Some spec enhancements can help, e.g., limited/no HARQ ReTx for the last IP packets associated with a video frame (careful MCS selection would be needed), modifications of CG/SR transmission rules in conjunction with CDRX, etc. We encourage companies to develop techniques to increase UE sleep duration via DL&UL alignment without sacrificing much user experience as well as system capacity."

For second question, Please refer to our answers for the same questions from Huawei, Samsung, and Nokia.

#### **LG Electronics Inc. # 15**

Thanks for the contribution. We have the following questions.

Q1) In your paper (RWS-210010), you mentioned the application awareness at RAN and RAN awareness at application, in addition to the RAN awareness of traffic information for optimizing lower layer operation. From RAN perspective, do you intend to emphasize different aspects by application awareness at RAN from those by traffic awareness at RAN? If yes, then can you explain the aspects that you see beneficial?

Q2) In the same paper, a large amounts of resources is devoted to the network coding compared to the PDCH duplication with some results in FR2. Can you summarize in what XR deployment scenarios you see it is worth considering the network coding? This is neither a URLLC nor eMBB, and, with that understanding, we failed to see the point from that aspect.

Q3) You mentioned in the same paper a newly introduced power saving technique, what you call "Discontinuous PDCCH Monitoring (DPM)" and said it can save UE power up to 50% over baseline (always ON) and up to 35% over Rel-15/16 CDRX. There are discussions in Rel-17 NR PS WI on skipping or reducing PDCCH monitoring. Is it a fundamentally different approach, or your proposed solution in Rel-17 NR PS WI?

[Reply]

Q1: Please refer to our answers for questions from Huawei, Samsung, and Nokia on the same topic.

Q2: We propose Network coding as an alternative to PDCP duplication and baseline HARQ with application to XR and other traffic types that require relatively high data rate, stringent latency bound and reliability. Our internal system simulation performance analysis show that using the Network coding for XR traffic can provide capacity gain over both baseline HARQ and PDCP duplication by exploiting link diversity, flexible redundancy, and avoiding HARQ retransmissions. Qualcomm is planning to submit evaluation results to Rel-17 XR SI, showing the performance improvement by Network coding.

P3: Please refer to our answers for questions from Intel and MediaTek. As explained there, DPM stands for discontinuous PDCCH monitoring that is similar to L1 based power saving schemes that are being discussed in Rel-17 power saving WI such as PDCHC skipping, and SS set switching. The plot uses this term as the outcome of Rel-17 power saving WI is not available yet.

### **Samsung Electronics Co., Ltd # 16**

1. What is the need for UE assistance info/RAN awareness for the UL traffic scenarios for XR? What additional is needed relative to a UE supporting priority 0 and priority 1 traffic in Rel-16?2. What SPS/CG enhancements are needed other than to possibly address a periodicity mismatch?3. Slide 3: Could you please elaborate on “RAN awareness at application” and “application awareness at RAN”? While “RAN awareness of traffic information for optimizing lower layer operation” in the gNB scheduler is understood, what exactly are you proposing to investigate in the SI in these 2 bullet points? For example, do you see need for new XR related signaling through UE assistance info to the gNB? Or, do you mean to pass down XR stream/type info to the gNB through network interfaces? In particular, are you indicating that the R16 mechanism with UE supporting priority 0 and priority 1 traffic would not be sufficient?

4. Slide 3: Which specific SPS/CG enhancements are being proposed, e.g. only updated DRX cycles / on-duration counters to improve upon the observed periodicity mismatch with XR traffic, or more ambitious SPS/CG enhancements?

5. Slide 3: Could you please elaborate on “UL-DL alignment”? To what extent do you see the need for specification changes, e.g. what cannot be handled through the scheduler using the existing R15/R16 baseline? Would be alignment of the UL pose/control stream (250fps) with DL scheduling and DRX on-periods be more critical than UL video (if present)? In particular, did you consider the use of “mini-slot” based scheduling?

[Reply]

Q1. Some information that is hard for gNB is get, but easier for UE for uplink, e.g., traffic characteristics such as average interarrival time, UE buffer statistics, etc. Having additional knowledge and making resource allocation accordingly will be beneficial for UL-DL alignment, power saving, etc.

Q2. Please check reply in Question 4.

Q3. Same question from Samsung that is addressed above.

Q4. Periodicity mismatch is one problem. There could be other potential enhancements, e.g., MCS/resource adaptation, operation/procedure in conjunction with HARQ and/or CDRX.

Q5. Same question from Samsung that is addressed above..

NTT DOCOMO INC. # 17

Thanks for the good contribution. Regarding "enhancements to tackle jitter", independent enhancement for jitter is assumed, or can be included in other enhancement, e.g. CDRX enhancement? Also, regarding "Further enhancements to L1 based signaling", do you assume the enhancements on Rel-17 search space set group switching and/or PDCCH skipping if needed, or the enhancements on other solution?

[Reply]

Please refer to our answers for the same question from other companies including OPPO and Intel.

## 7.3 Input – Round 2

### Feedback Form 12: XR - Round 2

#### 1 – vivo Communication Technology

Thanks for your reply. We have some additional questions.

Q1: Regarding RAN awareness of XR traffic characteristic, we share the similar view that it is beneficial to improve XR performance. We have some follow-up questions. Could QC elaborate how can UE identify by MAC/PHY layers the application information e.g. XR viewport or pose update from application layer that would request beam or measurement updates? Whether and how can gNB identify the beam or measurement updates requested by UE are corresponding to the XR viewport or pose update from application layer?

Q2: Regarding the packet dropping, from our perspective, we think dropping the packet without meeting the delay bound can be beneficial to improve XR performance. Although the packets exceeding the delay budget could still be useful if they would be delivered, the network resources may be occupied by the transmission late packets thus may decrease the capacity. For example, a video frame from application layer may be transmitted over multiple IP packets. If any of these IP packets is delivered late or is lost, transmitting all these packets may result in a waste of resources, and the other packets may also become obsolete as this video frame may not be reconstructed and displayed any longer. For both DL and UL, there is the similar issue. So, we think there are some specification impacts if dropping for the late packet is considered in RAN. What is QC's view on this aspect?

Besides, we agree that admission control and application bitrate adaptation are needed to ensure the XR bitrate and thus the user experience, especially for the low geometry UE. But such application rate adaptation and admission control may be slow to improve the user experience. Whether a faster way for rate adaptation, such adaptation by RAN, is considered from QC's perspective?

Q3: Regarding the UL&DL alignment, we agree that some spec enhancement will be beneficial. Could you elaborate a bit more on the motivation for limiting the HARQ ReTx for the last IP packets associated with a video frame and how it works?

## 2 – Samsung Electronics Co.

Q1: Have you considered the feasibility of the proposed signaling between application server and gNB or has there been a corresponding study? A UE can currently indicate different traffic types through different SR configurations and BSRs – what else is needed and what XR application motivates it beyond the applications supported in Rel-16?

Q2: In addition to updated DRX cycles / on-duration counters and possibly additional periodicities for SPS/CG, what else do you think is necessary for SPS/CG particularly for XR and, if anything, what would be the corresponding overall benefit given that the gNB can also control DL/UL transmission power based on Rel-16 mechanisms?

Q3: Regarding the “limited/no HARQ ReTx for the last IP packets associated with a video frame (careful MCS selection would be needed), modifications of CG/SR transmission rules in conjunction with CDRX” what are the additional power saving gain and how does it compare to the degraded operation and new dynamic network requirements of having last (large) IP packets with extreme reliability and an inability of a UE to transmit SR?

Q4: What about XR requires mobility enhancements for FR2, or NW coding enhancements, that are specific to XR and not required for URLLC or eMBB? What would be the overall benefit of such enhancements for the quasi-stationary XR applications of Rel-17?

## 3 – MediaTek Inc.

Thanks for the detailed reply.

For the jitter issue, it is unpredictable, but to our understanding NW should be able to know the timing when a new frame arrives from application. Hence, would setting a small PDCCH skipping period from NW when the next frame is close (with jitter ranged considered) be a possible solution?

## 7.4 Response – Round 2

### vivo Communication Technology

# 1

Thanks for your reply. We have some additional questions.

Q1: Regarding RAN awareness of XR traffic characteristic, we share the similar view that it is beneficial to improve XR performance. We have some follow-up questions. Could QC elaborate how can UE identify by MAC/PHY layers the application information e.g. XR viewport or pose update from application layer that would request beam or measurement updates? Whether and how can gNB identify the beam or measurement updates requested by UE are corresponding to the XR viewport or pose update from application layer?

Q2: Regarding the packet dropping, from our perspective, we think dropping the packet without meeting the delay bound can be beneficial to improve XR performance. Although the packets exceeding the delay budget could still be useful if they would be delivered, the network resources may be occupied by the transmission late packets thus may decrease the capacity. For example, a video frame from application layer may be transmitted over multiple IP packets. If any of these IP packets is delivered late or is lost, transmitting all these packets may result in a waste of resources, and the other packets may also become obsolete as this video frame may not be reconstructed and displayed any longer. For both DL and UL, there is the similar issue. So, we think there are some specification impacts if dropping for the late packet is considered in RAN. What is QC's

view on this aspect?

Besides, we agree that admission control and application bitrate adaptation are needed to ensure the XR bit-rate and thus the user experience, especially for the low geometry UE. But such application rate adaptation and admission control may be slow to improve the user experience. Whether a faster way for rate adaptation, such adaptation by RAN, is considered from QC's perspective?

Q3: Regarding the UL&DL alignment, we agree that some spec enhancement will be beneficial. Could you elaborate a bit more on the motivation for limiting the HARQ ReTx for the last IP packets associated with a video frame and how it works?

[Reply]

Q1. UE could monitor certain features associated with the pose info. or viewport application packets at the lower layers. The details of this monitoring would be based on UE implementation considerations. With regards to whether the gNB is aware that the UE's request for beam or measurement updates is based on pose info/viewport, can you let us know why you think gNB needs to know the source information for the UE request?

Q2. We think PDCP discard timer can be used for this purpose. We are open to proposals for further enhancements if justified. On your second question, application layer FEC may help to compensate for slow application layer rate adaptation. We are open to proposals.

Q3: For instance, for uplink transmissions, when gNB is sending a UL grant for the last packet of a video frame, the DCI may indicate a smaller value of ReTx timer for the associated PUSCH (e.g., zero value may indicate no more HARQ reTx for the associated PUSCH) for the purpose of UE power saving (or DL/UL alignment). With this, the UE can more quickly go to sleep after sending the PUSCH.

## **Samsung Electronics Co., Ltd**

# 2

Q1: Have you considered the feasibility of the proposed signaling between application server and gNB or has there been a corresponding study? A UE can currently indicate different traffic types through different SR configurations and BSRs – what else is needed and what XR application motivates it beyond the applications supported in Rel-16?

Q2: In addition to updated DRX cycles / on-duration counters and possibly additional periodicities for SPS/CG, what else do you think is necessary for SPS/CG particularly for XR and, if anything, what would be the corresponding overall benefit given that the gNB can also control DL/UL transmission power based on Rel-16 mechanisms?

Q3: Regarding the “limited/no HARQ ReTx for the last IP packets associated with a video frame (careful MCS selection would be needed), modifications of CG/SR transmission rules in conjunction with CDRX” what are the additional power saving gain and how does it compare to the degraded operation and new dynamic network requirements of having last (large) IP packets with extreme reliability and an inability of a UE to transmit SR?

Q4: What about XR requires mobility enhancements for FR2, or NW coding enhancements, that are specific to XR and not required for URLLC or eMBB? What would be the overall benefit of such enhancements for the quasi-stationary XR applications of Rel-17?

[Reply]

Q1: Here are a few examples. Some companies have shown XR capacity improvement from delay-aware scheduler under Rel-17 XR study item. One example of the delay-aware scheduler is to consider the amount of time until the packet/file transfer deadline (determined by PDB requirement in addition to the traditional proportional fair metric. This needs to know the video frame boundaries, e.g., which packets are 1<sup>st</sup> IP packet and last IP packet of a video frame. Today, such information is not known to gNB and it would be beneficial to define new signaling indicating first and last IP packets of each video frame. Another example is so called UE staggering, where if gNB can indicate to edge server to shift video frame generation time for UE, e.g., shift forward by 1ms for user A, and so forth. It was also shown by some companies in Rel-17 XR SI that UE staggering can help to increase XR capacity. Evaluation methodology for multiple streams, e.g., I-frame vs. P-frame with different PDB/PER requirements are being discussed in RAN1. This is another example of benefit of introducing new signaling, e.g., which IP packets are for I-frame and which IP packet are for P-frame. All of these examples have nothing to do with today's SR/BSR.

Q2: The example given in our above answer for vivo's 3<sup>rd</sup> question can be applied to CG for DL/UL alignment purpose. In addition, it may be beneficial to have more adaptation capabilities in CG to more efficiently handle variable packet sizes for XR in uplink. The bottom line that CG/SPS can be enhanced for the purpose of XR capacity as well as UE power saving, taking into account XR traffic requirements/characteristics such as quasi-periodic, relatively high data rate (e.g., tens of Mbps), variable packet sizes, tight PDB (e.g., 10ms).

Q3: Please refer to our above answer for vivo's 3<sup>rd</sup> question. It is for UE power saving via DL/UL alignment. As studied in Rel-17 XR study item, XR typically has quasi-periodic traffic in both UL and DL. It will be highly beneficial to align DL and UL transmissions and receptions so that UE can stay longer in a sleep state. Along with some enhancements that facilitate DL/UL alignment, we may need to modify/enhance CG/SR related rules/operations. We are open to detailed proposals.

Q4: Network coding related enhancements may not be applicable only to XR and scenarios with mobility. Traffic types in mobile or static environment with requirements of relatively high data rate, stringent latency bound, and reliability could benefit by addition of Network coding in the RAN protocol stack. Adaptive redundancy of Network coding in conjunction with diversity could facilitate efficient fulfilling of latency and reliability requirements (without having to resort to HARQ/RLC retransmissions) without overloading the system.

As indicated earlier, one example scenario where network coding is beneficial is blocking. Again, network coding would not be only beneficial to XR, but it's highly motivated by better XR support.

**MediaTek Inc.**

# 3

Thanks for the detailed reply.

For the jitter issue, it is unpredictable, but to our understanding NW should be able to know the timing when a new frame arrives from application. Hence, would setting a small PDCCH skipping period from NW when the next frame is close (with jitter ranged considered) be a possible solution?

[Reply] Thanks for the follow up. We wonder how NW can know the timing when a new frame arrives from

application. For instance, we assume in RAN1 that the jitter range is [-5 or -4, +4 or +5] ms on top of the average inter-frame arrival rate determined by e.g., 60fps that is the level of uncertainty from the gNB perspective of the timing when a new frame arrives. This implies that even with a PDCCH skipping duration indication in DCI, UE will need to conduct unnecessary PDCCH decoding up to 10ms (if we target no impact to latency loss, eventually capacity loss from UE sleeping). This is a significant portion e.g., for the case of 60fps that determines only “average” inter-arrival time. If we can eliminate such UE’s unnecessary PDCCH decoding, e.g., up to 10ms for every frame arrival interval, e.g., via sequence based low power WUS, a substantial power saving gain may be obtained. If the solution that you are mentioning is that UE monitors discontinuously/sparingly (e.g., every 2ms) from –5ms in the above example, it could still degrade the latency performance (due to sparse monitoring), and eventually XR capacity, for instance, our internal study shows 20% capacity degradation from PDCCH monitoring of every 2ms. We are planning to submit results for RAN1 meetings under Rel-17 XR SI.

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## 8 On NR NTN Evolution - RWS-210011

### 8.1 Input – Round 1

#### Feedback Form 13: NR NTN - Round 1

##### 1 – Asia Pacific Telecom co. Ltd

We share the same view on support of smartphones. However, we wonder whether high-power UEs shall be supported as well.

##### 2 – Spreadtrum Communications

Very instructive contribution. For the Pre-paging alert, we have the following questions

Q 1: What is the difference between the UE receiving DL-only alert and receiving DL-only alert?

Q 2: When UE in a pocket or in backpack, why the UE can receive DL-only alert but not Paging DCI/Paging message?

Q 3: How to trigger the UE to receive DL-only alert? Does UE need to receive DL-only alert periodically?

##### 3 – ESA

We fully support the objective to serve smartphones. The enablers proposed in RWS-210011 are going in this direction. Thank you

##### 4 – MediaTek Inc.

Q1. On protocol simplification for increased link budget for voice, what is the difference and the gains with LTE AMR compare to VoLTE and VoNR for NTN? Is assumption that two different voice codecs need to be supported in the UE – one for TN and one for NTN?

Q2. What is the gap from R17 Coverage Enhancements (assuming up to 32 slot aggregation / repetitions), the justification, need, and use case?

Q3. What enhancements are foreseen beyond the pre-paging alert as defined in Rel-17 Power savings (i.e. likely PDCCH-based where the CRC protection can ensure minimum false alarm)?

## 5 – Inmarsat

We support the objective to support smartphones, but this has a significant dependency on the space segment.

We strongly encourage to focus more on FR2 and VSAT/ESIM use cases. It's clear that Rel 17 will lack significant support for FR2, which is where most of key NTN/satellite use cases and market exist today.

We need a proper framework to handle FR2 and allow broadband UEs such as mounted on any kind of land, air and sea based platforms to roam between satellite and terrestrial networks across multiple frequency bands.

This framework could enable support for high data rate NTN also for quite small platforms such as UAVs. FR2 for NTN has a significant potential.

## 6 – Intel Corporation (UK) Ltd

Q1: Proposed coverage enhancements include the following "For UEs supporting more than one transmit antenna, introduce techniques to enable *full power transmission* in LOS channels with narrowband transmission". Which physical channels/signals are considered for this enhancement?

Q2:- For "Introduce protocol simplifications, targeting overhead reduction for support of low-rate voice support" – could you clarify whether this may be a desirable enhancement for TN in general (e.g. for RedCap) and not only specific to NTN

Q3:- For "pre-paging alert" – could you clarify the intention and how it works e.g. whether it is similar or not to a wake up signal kind of operation?

## 7 – HUAWEI TECHNOLOGIES Co. Ltd.

We share a similar view that Rel-18 NTN should focus on deployment scenarios & use cases that can provide tangible commercial opportunities.

Q1: For the coverage enhancement, what is the target deployment scenario, e.g. orbit, elevation angle, etc, since this would require a study phase to identify the bottleneck as well as the performance gap?

Q2: On the proposal regarding "Pre-paging alert", can you clarify a bit about the target SNR operating point? According to the link budget analysis in Rel-16 SI, it seems that the DL SNR is around 6-7 dB, it is not clear whether there will be an issue for paging.

## 8 – Sony Corporation

Thanks for the contribution. We have three questions.

-

Does Qualcomm envisage a study phase (SI) to all these proposed enhancements?

-

Proposed coverage enhancement solutions are likely to be different for earth-fixed vs earth-moving beams. Should one or the other be prioritized?

-

What kind of simplification of protocol could be for? Layer reduction, function reduction? Do we need to consider backward compatibility?

<p><b>9 – CATT</b></p> <p>Generally, we are fine with the principle "Rel-18 NTN should narrow down deployment scenarios &amp; use cases to maximize the commercial opportunities offered by this technology".</p> <p>Question about Pre-paging alert, in case UE is in the area like basement with bad coverage, how to make alert?</p>
<p><b>10 – Guangdong OPPO Mobile Telecom.</b></p> <p>Pre-paging alert means NW indicates UE an alert to tell user that you need to move to a location with better signal to receive paging?</p>
<p><b>11 – Samsung Electronics Co.</b></p> <p>1) It proposes repetitions and diversity techniques for coverage enh. What should be additional new aspect compared to TN coverage enh?</p> <p>2) For pre-paging alert, what specification impacts are foreseen?</p>
<p><b>12 – Lenovo (Beijing) Ltd</b></p> <p>The NTN proposals from some new perspectives are interesting, and we have the following questions:</p> <p>(1) As some proposals are new and have not been discussed before, do you want to start a new SI for NTN?</p> <p>(2) Are there some consensus or preferences from satellite operators that text and voice are prior to eMBB services in NTN commercial deployment?</p>
<p><b>13 – THALES</b></p> <p>We definitely share the same view on the need for some satellite access to provide direct connectivity to commercial smartphones and hence enhancements should be considered to improve the service performance. However, we recommend that higher-performance UEs be defined to be supported as well.</p>
<p><b>14 – THALES</b></p> <p>What are your views on the need also to define <b>Network based UE location service (LCS)</b> to address some regulated service requirements in terms of accuracy&amp;reliability/trust (e.g. for emergency call) ?</p>

## 8.2 Response – Round 1

APT #1

**[Answer]** Thank you for your support. In our view, higher power class such as PC2 can be considered for handheld devices including smart phones.

Spreadtrum Communications #2

Q1: What is the difference between the UE receiving DL-only alert and receiving DL-only alert?

**[Answer]:** Could you please clarify the question?

Q2: When UE in a pocket or in backpack, why the UE can receive DL-only alert but not Paging DCI/Paging message?

**[Answer]** In NTN, a smart phone needs to be placed/held in an appropriate position and at a favorable location for communications, such as out of the pocket and at a location clear from obstructions. For paging with subsequent UL transmissions such as a PRACH, the subsequent UL transmission is more likely to fail. That is, the UE may have received the paging message, but subsequent response couldn't reach the network. To solve the above problem, a special signal may be needed, which can be more reliable than the paging message, to alert the user to take the phone out of the pocket and move to a better location. The special signal may trigger a DL-only alert at UE for ringing.

Q3: How to trigger the UE to receive DL-only alert? Does UE need to receive DL-only alert periodically?

**[Answer]** Network sends a paging alert if it does not receive the response from the UE within a certain time duration after the paging. After receiving the alert, UE generates a DL-only alert signal internally to trigger ringing or vibration.

ESA #3

**[Answer]** Thank you for the support.

MTK #4

Q1. On protocol simplification for increased link budget for voice, what is the difference and the gains with LTE AMR compare to VoLTE and VoNR for NTN? Is assumption that two different voice codecs need to be supported in the UE – one for TN and one for NTN?

**[Answer]** Per our understanding, UEs currently support multiple voice codecs, and during the negotiation one of them is picked. It is possible that, under some implementations, there would be a need for transcoding at the network (e.g. to connect an NTN UE with a TN UE). Note that competing (proprietary) satellite standards operate in very low codec rate with very efficient protocols (circuit switched), and NR with the current overhead may not be competitive.

If we take as baseline AMR WB 12.65kbps without any protocol improvements, the coverage gain of doing AMR 4.75kbps with the proposed optimizations is around 5dB. Without the protocol optimizations, the gain is reduced since the AS overhead takes around 50% of the payload.

Q2. What is the gap from R17 Coverage Enhancements (assuming up to 32 slot aggregation / repetitions), the justification, need, and use case?

**[Answer]** It is true that we need to take into account the outcome of the R17 coverage enhancement, so we expect to know more details towards the end of the release.

Regarding the proposed enhancements:

- Satellite links have very low diversity due to small bandwidth and single receive antenna at the satellite. We may need to be more aggressive in terms of e.g. support of antenna switching.

- For full power transmission, transparent CDD may not be efficient due to LOS channel, we may need to incorporate other techniques.

The need and use cases we think are pretty clear: due to the reduced antenna gain of smartphones, the satellite link is very noise limited. For sparse constellations, it is very important to be able to support at least some basic services (e.g. text/voice).

Q3. What enhancements are foreseen beyond the pre-paging alert as defined in Rel-17 Power savings (i.e. likely PDCCH-based where the CRC protection can ensure minimum false alarm)?

**[Answer]** Rel-7 pre-paging is used as a wake-up signal for paging and will likely address to a group of UEs. The proposed alert is intended to address certain paging failure such as a paging for MT calls that may likely be caused by subsequent UL transmission. As a result, the alert signal could come after the paging message and is likely addressed to a single UE.

In NTN, a smart phone needs to be placed/held in an appropriate position and at a favorable location for communications, such as out of the pocket and at a location clear from obstructions. For paging with subsequent UL transmissions such as a PRACH, the subsequent UL transmission is more likely to fail. That is, the UE may have received the paging message, but subsequent response couldn't reach the network. The proposed alert is to alert the user via ringing or vibration to take the phone out of the pocket and move to a better location. The special signal may trigger a DL-only alert at UE for ringing.

Inmarsat #5

**[Answer]** Thank you for your support. We believe plenary agreements on NTN Ka and ku bands are a good starting point towards addressing the market involving those bands.

Roaming between TN and NTN networks and across multiple frequency bands has been discussed in RAN2. Depending on the progress of Rel-17, additional enhancements on the subject can be considered in Rel-18.

Intel #6

Q1: Proposed coverage enhancements include the following "For UEs supporting more than one transmit antenna, introduce techniques to enable *full power transmission* in LOS channels with narrowband transmission". Which physical channels/signals are considered for this enhancement?

**[Answer]** Techniques enabling full power transmission are intended for PUSCH/PUCCH.

Q2:- For Introduce protocol simplifications, targeting overhead reduction for support of low-rate voice support” – could you clarify whether this may be a desirable enhancement for TN in general (e.g. for RedCap) and not only specific to NTN

**[Answer]** Although the overall benefit of protocol simplification is more significant in NTN, we are supportive to consider the enhancements also for NR TN.

Q3:- For “pre-paging alert” – could you clarify the intention and how it work e.g. whether it is similar or not to a wake up signal kind of operation?

**[Answer]** In NTN, a smart phone needs to be placed/held in an appropriate position and at a favorable location for communications, such as out of the pocket and at a location clear from obstructions. For paging with subsequent UL transmissions such as a PRACH, the subsequent UL transmission is more likely to fail. That is, the UE may have received the paging message, but subsequent response couldn't reach the network. To solve the above problem, a special signal may be needed, which can be more reliable than the paging message, to alert the user to take the phone out of the pocket and move to a better location. The special signal may trigger a DL-only alert at UE for ringing.

Rel-7 pre-paging is used as a wake-up signal for paging and will likely address to a group of UEs. The proposed alert is intended to address certain paging failure such as a paging for MT calls that may likely be caused by subsequent UL transmission. As a result, the network alert signal could come after the paging message and is likely addressed to a single UE.

Huawei #7

Q1: For the coverage enhancement, what is the target deployment scenario, e.g. orbit, elevation angle, etc, since this would require a study phase to identify the bottleneck as well as the performance gap?

**[Answer]** We don't think another study phase is necessary. It's clear from TR28.821 that there is a large performance gap to support smart phones for scenarios considered in the TR. Coverage enhancements can be considered in a best effort manner and to the point that practically useful data rate can be supported for the identified scenarios in the TR.

Q2: On the proposal regarding ”Pre-paging alert”, can you clarify a bit about the target SNR operating point? According to the link budget analysis in Rel-16 SI, it seems that the DL SNR is around 6 7 dB, it is not clear whether there will be a issue for paging.

**[Answer]** The pre-paging alert is intended to deal certain paging failure such as a paging due to MT calls including failure of an UL transmission in response to the paging message. In NTN, a smart phone needs to be placed/held in an appropriate position and at a favorable location for communications, such as out of the pocket and at a location clear from obstructions. For paging with subsequent UL transmissions such as a PRACH, the subsequent UL transmission is more likely to fail. That is, the UE may have received the paging message, but subsequent response couldn't reach the network. To solve the above problem, a special signal may be needed, which can be more reliable than the paging message, to alert the user to take the phone out of the pocket and move to a better location. The special signal may trigger a DL-only alert at UE for ringing.

Sony #8

**[Answer] Thank you for your comments. Below are our answers:**

We don't think an explicit study phase is necessary for any of the proposals. But we are open to the ideas.

We don't see that the type of satellite footprints, earth-moving vs earth-fixed, have impacts on the specific techniques for coverage enhancement. Could you clarify?

The protocol simplification would be to reduce the overhead introduced by different layers for voice calls. For example, if we are coverage limited, we don't think many of the functionalities of the different layers are needed (e.g. no need to multiplex multiple LCIDs, ROHC can be further simplified, no need to have RLC header since there is no segmentation for the voice bearer). The objective would be to be as close as possible to what competitor satellite standards use (low rate codec + circuit switch, close to zero overhead).

CATT #9

**[Answer]** In our view, smart phone use cases should be at least prioritized. This also means that FR1 should be prioritized.

The pre-paging alert is intended to address certain paging failure such as a paging due to MT calls including failure of an UL transmission in response to the paging message. In NTN, a smart phone needs to be placed/held in an appropriate position and at a favorable location for communications, such as out of the pocket and at a location clear from obstructions. For paging with subsequent UL transmissions such as a PRACH, the subsequent UL transmission is more likely to fail. That is, the UE may have received the paging message, but subsequent response couldn't reach the network. To solve the above problem, a special signal may be needed, which can be more reliable than the paging message, to alert the user to take the phone out of the pocket and move to a better location. The special signal may trigger a DL-only alert at UE for ringing.

Guangdong OPPO Mobile Telecom.

# 10

[Answer] Yes

Samsung Electronics Co., Ltd

# 11

[Answer] 1) We would need to revisit the exact scope when the TN coverage enhancement WID is completed, but we envision techniques related to transmit diversity (antenna switching) and full power transmission (transparent CDD is not a good idea in LOS channels)

2) In lower layers, it should be discussed whether the current paging can be used or not. We expect some

impact in terms of signaling (e.g. above which RSRP/ SINR we should trigger the alert)

Lenovo (Beijing) Ltd

# 12

[Answer]

We don't think that for any new proposal a SI should be started. Most of the proposals are quite small and should go directly to normative phase.

For a low-cost non-dense constellation it will be impossible to support high data rates. We can expect the initial deployments may not be very dense, and thus this may be the main use case.

THALES

# 13

[Answer] Thanks for the comment.

THALES

# 14

[Answer] We are open to considering location enhancements in Rel-18.

## 8.3 Input – Round 2

### Feedback Form 14: NR NTN - Round 2

#### 1 – Spreadtrum Communications

Thank you for your detailed answers.

Our Q1 is that what is the difference between the UE receiving paging alert and receiving paging DCI/message? But in your answer to our Q2 it is mentioned that paging alert can be more reliable than the paging message. Another question is how to ensure the reliable reception of paging alert.

For the answer to our Q2, if the subsequent UL transmission such as a PRACH is to fail, can UE directly a DL-only alert at UE for ringing without receiving paging alert?

#### 2 – Beijing Xiaomi Mobile Software

Thanks for the proposals. For the pre-paging alert, if we have the correct understanding, it seems the

bottleneck is on the UL. As the smart phone may still be able to receive the paging information, while the subsequent UL transmission may not be able to reach the network. Then our questions are:

Q1: Is it a more straightforward way to directly improve the performance of UL transmissions rather than to have pre-paging alert.

Q2: If UE receives the pre-paging alert, does the UE have sufficient information on which locations it should move to.

For the prioritized UE cases in Rel-18, it seems that the text and voice are your first priority. What do you think of other use cases as included in TR 38.821.

### **3 – HUAWEI TECHNOLOGIES Co. Ltd.**

Thanks for the answers. A couple of follow-up questions as below:

Q1: Without knowing the target SNR, it will be difficult to understand how much is actually needed in addition to the Rel-17 coverage enhancement technologies. Our view is that a quick study is required to identify the bottleneck channel and performance gap to fulfill certain services requirements.

Q2: Agree that uplink might be the bottleneck in such a scenario. As an alternative to introduce a "pre-paging alert", it may be simpler to improve the UL coverage?

### **4 – Intel Corporation (UK) Ltd**

Q1: For DL only alert, could you please clarify if the decision on the action (i.e. phone vibration/ringing) should be based only on special DL signal reception or on some other things on top of it (e.g. RSRP value, path loss value)? Is it possible to implement such a feature with the current Rel. 17 spec; if yes, what are the benefits from spec enhancements?

Q2: For the PHY coverage enhancements, do you assume that the scope can be limited to certain enhancements (e.g. increased number of repetitions)?

### **5 – Sony Europe B.V.**

Thank you for answering our Round 1 questions. On the impact of the type of footprint on coverage enhancement, perhaps this will clarify.

What level of coverage enhancement do you envisage for NTN smartphones? How many repetitions would you envisage? Do you not think that as a UE will be covered by an earth-fixed beam for a longer interval than an earth-moving beam, coverage enhancement techniques that depend on many repetitions (depending on answer to first two questions) are more suitable for earth-fixed beam systems?

## **8.4 Response – Round 2**

Spreadtrum #1

[Answer] Thanks for the comments. For the example, it is possible to have UE generate an internal DL-only alert without additional network signaling.

Xiaomi #2

[Answer] Thank you for your comments and questions. Based on the evaluation reported in TR38.821, UL SNR can be less than -10 dB for LOS channels. It is therefore infeasible to support even low-rate voice when the user is at a location without LOS path or when the phone is in the pocket with large body loss. The proposed pre-paging alert is to cover the above cases. Like users of existing satellite phones, NTN smart

phone users will quickly learn to find a place without cover and hold the phone away from body for better signal quality.

We believe Rel-17 should address other use cases reasonably well except regenerative payload. Due to limited time, we propose to prioritize smart phone use cases in Rel-18 to address the biggest market. Additional enhancements for other use cases, if necessary, can be considered in future releases.

Huawei #3

[Answer] We are open to a short study phase to identify the bottleneck channels and performance gaps.

Based on the evaluation reported in TR38.821, UL SNR can be less than -10 dB for LOS channels. It is therefore infeasible to support even low-rate voice when the user is at a location without LOS path or when the phone is in the pocket with large body loss. Like in existing satellite calls, user intervention, such as finding a place without cover and holding the phone away from body for better signal quality, can significantly increase the addressable market.

Intel#4

[Answer] Thank you for your questions. The need of a special DL signal can be further discussed. For instance, a UE, who received a paging for MT call and sent PRACH as a response, may generate an alert to trigger phone ringing after some time without receiving network response. For the problem under consideration, we don't see any solutions with the current Rel. 17 spec.

For coverage enhancements, we would like also to consider mechanisms that enable full power transmission for UEs with two PAs.

Sony #5

[Answer] Thank you for your questions. The number of repetitions required depends on the use cases and the deployment scenarios to be supported. For smart phones, we consider SMS and voice as the two primary use cases in NTN. Take voice for example, suppose a PUSCH carries two 20 ms voice frames, the number of repetitions must be smaller than 40 with 15 kHz SCS. For deployment, a limit on the supported elevation angle, say above  $30^{\circ}$ , could be used to define a feasible link budget target.

In our view, both earth-moving and earth-fixed beams can support the above two use cases under consideration.

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## 9 On NTN IOT for Rel-18 - RWS-210012

### 9.1 Input – Round 1

#### Feedback Form 15: NTN IoT - Round 1

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### **1 – Asia Pacific Telecom co. Ltd**

Support discontinuous coverage enhancement, e.g., for cubesats. Also, we wonder whether to support smaller bandwidth (<5 MHz BW) for cubesats.

### **2 – Spreadtrum Communications**

For Beam-based mobility, our view is that we should first clarify whether the multi-beam per cell in IOT NTN scenario is supported. In order to alleviate the frequent cell handover problem, our view is that IOT NTN should support multi-beam per cell.

In addition, for beam-based mobility in IOT NTN, what is QC's view on whether it is necessary to enhance the existing specification?

### **3 – ESA**

We support your vision on NTN-IoT priorities in Rel.18. We think also that the idea of "Asynchronous UL transmission" (proposed in RWS210011) is very relevant for the IoT use case and it deserves already a study for Rel. 18. Thank you

### **4 – MediaTek Inc.**

We support specify HARQ disabling. We also think shared SI across multiple cells in Rel-18 could be reasonable enhancement.

Reduced-GNSS use to mitigate impact on power consumption with enhancements to initial access and signals and introduction of Closed Loop frequency control expected high impact on RAN1 specifications and workability to support long connection should be justified by the potential gains over simpler mechanisms using RAN1/RAN2 timer-based enhancements or specification of UE behaviour.

What are expected gains and use case of beam-based mobility compare to Rel-17 Cellular IoT enhancements on neighbour cell measurements / triggering and NB-IoT carrier selection based on the coverage level, and associated carrier specific configuration / eMTC CHO?

What are the scope and expected gains compare to Rel-17 NTN IoT enhancements for discontinuous coverage?

### **5 – Sony Europe B.V.**

Slide 3 comment: disabling HARQ is supported already in Rel-13. Aren't these proposals about disabling HARQ feedback, rather than disabling HARQ?

General comment: there are some specific proposals here that cover:

- Power consumption (HARQ disabling in slide 3, GNSS measurement in slide 4, leftovers in slide 6)
- Connection density (desire to increase spectral efficiency in slide 2/6, shared SI in slide 6)
- Latency (throughput issues discussed in slide 3)
- Coverage (slide 4: operation when GNSS is not available, discontinuous coverage in slide 5)

We think it is good to target these "5G mMTC requirements". We are not convinced that the specific approaches (features) are the best ways of meeting these requirements. Since the IoT-NTN SI did not really consider enhancements in terms of power / connection density / latency / coverage, our suggestion is that there could be a short study phase at the start of R18 to decide on which enhancements to pursue.

Further views are contained in RWS-210302 and RAN-R18-WS-non-eMBB-SONY

#### **6 – Inmarsat**

We fully agree with the approach. Beam based mobility is a potentially strong option that today is the de-facto standard in satellite systems. Can you expand on this topic? What enhancements you expect this to require?

We also think some more radical concepts should be considered for UL such as NOMA schemes, to maximise transmission efficiency, power efficiency, and reliability of message delivery.

A UE should be able to wake up, transmit and go back to power saving mode with minimal signalling overhead but without risk of collision (guarantee that message is delivered).

#### **7 – Intel Corporation (UK) Ltd**

Q1: Do you consider to support eMTC / NBIOT over NTN without GNSS for all the cases including LEO, MEO and GEO or for particular scenario?

Q2: For LEO operation without GNSS at the UE, do you expect that frequent PRACH transmission will be required to maintain the TA?

#### **8 – HUAWEI TECHNOLOGIES Co. Ltd.**

Q1: Can you clarify the use cases as well as the market potential of the eMTC/NB-IOT devices without GNSS, since UEs without GNSS are not included in Rel-17. As Rel-17 eNB assumes all IoT NTN devices to have GNSS, can a UE without GNSS capability to get access to a Rel-17 NTN eNB?

Q2: What is the motivation to support shared SI across multiple cells and is this something specific to IoT-NTN?

#### **9 – CATT**

Generally, we are fine with the views on Rel-18 IoT NTN.

I think we should focus on the scope of Rel-17 IoT NTN WI firstly, any leftovers or enhancement to be done in Rel-18 could be further considered. Anyway, we are open to the discussion.

#### **10 – Samsung Electronics Co.**

1) What about the applicability of UE w/o GNSS also to Rel-18 eNTN as well as Rel-18 NTN IoT as proposed?

2) For beam-based mobility, what should be additional new aspect compared to Rel-16 MIMO, Rel-17/Rel-18 MIMO enh?

3) What about the applicability of beam-based mobility also to Rel-18 eNTN as well as Rel-18 NTN IoT as proposed?

#### **11 – Lenovo (Beijing) Ltd**

We are interested in the proposals for IoT NTN and have the following questions:

(1) What does "reduced GNSS use" mean? Does it mean that the availability of GNSS is not continuous or UE can reduce using GNSS proactively e.g. for power saving?

(2) We support enhancements to discontinuous coverage and wonder you considerations on possible core network impacts.

## 9.2 Response – Round 1

### **Asia Pacific Telecom co. Ltd # 1**

Support discontinuous coverage enhancement, e.g., for cubesats. Also, we wonder whether to support smaller bandwidth (<5 MHz BW) for cubesats.

[Answer] Rel-13 eMTC/NB-IoT would by default be supported.

### **Spreadtrum Communications # 2**

For Beam-based mobility, our view is that we should first clarify whether the multi-beam per cell in IOT NTN scenario is supported. In order to alleviate the frequent cell handover problem, our view is that IOT NTN should support multi-beam per cell.

In addition, for beam-based mobility in IOT NTN, what is QC's view on whether it is necessary to enhance the existing specification?

[Answer] Yes, we support multi-beam per cell for NTN-IoT. In that regard, in Release 18, we may need to enable a Ncell with more than one anchor carrier spread across the different beams. In this setting, a cell may be accessed on any of these beams, and L1/L2 based beam-mobility among these can be supported, without the need for frequent handovers. We expect some change in link layer adaptation.

### **ESA # 3**

We support your vision on NTN-IoT priorities in Rel.18. We think also that the idea of "Asynchronous UL transmission" (proposed in RWS210011) is very relevant for the IoT use case and it deserves already a study for Rel. 18. Thank you

[Answer] Thanks for the interesting proposal. However, this may require significant amounts of time for a study/work item.

### **MediaTek Inc. # 4**

We support specify HARQ disabling. We also think shared SI across multiple cells in Rel-18 could be reasonable enhancement.

Reduced-GNSS use to mitigate impact on power consumption with enhancements to initial access and signals and introduction of Closed Loop frequency control expected high impact on RAN1 specifications and workability to support long connection should be justified by the potential gains over simpler mechanisms using RAN1/RAN2 timer-based enhancements or specification of UE behaviour.

What are expected gains and use case of beam-based mobility compare to Rel-17 Cellular IoT enhancements on neighbour cell measurements / triggering and NB-IoT carrier selection based on the coverage level, and associated carrier specific configuration / eMTC CHO?

[Answer] In our understanding, there would be no time for enhancements in Rel-17. Beam based mobility is

to reduce the impact of mostly frequent beam change in RRC\_CONNECTED mode due to LEO moving beams. RRC involvement for beam change within same satellite would be very inefficient.

What are the scope and expected gains compare to Rel-17 NTN IoT enhancements for discontinuous coverage?

[**Answer**] For Rel-17, we may not have any large CN stage 2 change as it is going to freeze in June, i.e., before RAN2 can start work. So SA2 is going to do only necessary alignment work. Without CN being aware of discontinuous coverage, UE may suffer hugely in terms of power e.g., in procedures that involve a lot of NAS and CN signalling. In Rel-18, solutions may be expected to provide the core network with better knowledge of discontinuous coverage conditions, enabling a broader and better set of system solutions.

#### **Sony Europe B.V. # 5**

Slide 3 comment: disabling HARQ is supported already in Rel-13. Aren't these proposals about disabling HARQ feedback, rather than disabling HARQ?

[**Answer**] Thanks for pointing out that. Yes this is for disabling HARQ feedback for DL HARQ process and disabling HARQ retransmission in UL HARQ process.

#### **Inmarsat # 6**

We fully agree with the approach. Beam based mobility is a potentially strong option that today is the de-facto standard in satellite systems. Can you expand on this topic? What enhancements you expect this to require?

[**Answer**] Specially in LEO moving cell, RRC involvement in moving UE from one cell to another is very inefficient in terms of UE power and resource. Switching beam within same satellite may not need any RRC reconfiguration and can be dealt with beam-based mobility. We expect some change in link layer adaptation.

#### **Intel Corporation (UK) Ltd # 7**

Q1: Do you consider to support eMTC / NBIOT over NTN without GNSS for all the cases including LEO, MEO and GEO or for particular scenario?

[**Answer**] The way we see it, GNSS capability impacts the UE's capability to determine its own location (and not that of the satellite). In that regard, we think that a solution that works for UEs with reduced or no GNSS capability should work across all satellite deployments such as LEO, MEO, GEO.

Q2: For LEO operation without GNSS at the UE, do you expect that frequent PRACH transmission will be required to maintain the TA?

[**Answer**] More frequent PRACH transmissions (e.g., once every "validity period" of uplink time/frequency synchronization), followed by closed-loop time/frequency corrections, may be a possible solution to maintain time/frequency sync, without relying on GNSS all the time. In other cases, even the PUSCH transmission may enable the base station to determine time/frequency offsets and send correction commands based on that (such as is done for TA in terrestrial).

We have shown before, that for long connections, such closed-loop based approaches provide significant power savings over always using GNSS. Also, as described in response to the previous question, such a solution may apply to all satellite deployments, and not just LEO.

Also, additionally, if initial access is to be done without GNSS, a new PRACH design may be required.

**HUAWEI TECHNOLOGIES Co. Ltd. # 8**

Q1: Can you clarify the use cases as well as the market potential of the eMTC/NB-IOT devices without GNSS, since UEs without GNSS are not included in Rel-17. As Rel-17 eNB assumes all IoT NTN devices to have GNSS, can a UE without GNSS capability to get access to a Rel-17 NTN eNB?

[**Answer**] We think that for IoT, having a solution that relies less on GNSS fixes is extremely attractive, since the GNSS power-draw overwhelmingly dominates total power consumption, if the solution expressly requires GNSS fixes. In addition to supporting UEs without GNSS capability, a Rel 18 solution along these lines may also significantly benefit the power consumption and complexity of UEs that even have GNSS capabilities, by relaxing the requirements on the frequency of GNSS fixes. Further, this may also benefit UEs that have access to a serving NTN satellite, while not having/not being able to simultaneously access a GNSS satellite.

A UE without GNSS capability cannot access an R17 eNB.

Q2: What is the motivation to support shared SI across multiple cells and is this something specific to IoT-NTN?

[**Answer**] NR already supports Area specific SI and this can be similar in IoT. It is more useful in IoT NTN as reading SIB is power consuming in IoT due to possible frequent cell change specially in LEO moving cell scenario even though UE stays in the same area. RAN2 has already identified the motivation behind.

RAN2#114e agreement: For some IoT UEs it is expected that SI enhancements based on same SI provided in multiple cells can bring power consumption benefits.

**Samsung Electronics Co., Ltd # 10**

1) What about the applicability of UE w/o GNSS also to Rel-18 eNTN as well as Rel-18 NTN IoT as proposed?

[**Answer**] This can be considered for both NR-NTN as well as IoT-NTN.

2) For beam-based mobility, what should be additional new aspect compared to Rel-16 MIMO, Rel-17/Rel-18 MIMO enh?

[**Answer**] For IoT-NTN, it is important to keep in mind that we haven't yet agreed on the notion of an NTN cell that comprises multiple satellite beams; in the absence of this, any "mobility" has to be RRC-based, which can be highly inefficient, especially for earth-moving beam LEO deployments.

Once we agree to define an "NTN cell" as one that is comprised of multiple satellite beams, there are "similarities" with NR's beam-management framework as it currently exists, but there are key differences as well. For example, for the beam-management that is desired for NTN, each satellite beam may typically be at a *different frequency* from the other beam.3) What about the applicability of beam-based mobility also to Rel-18 eNTN as well as Rel-18 NTN IoT as proposed?

[**Answer**] As mentioned above, in addition to support for IoT-NTN, we also support beam-based mobility (including the frequency-shift aspects across beams) for NR-NTN.

**Lenovo (Beijing) Ltd # 11**

We are interested in the proposals for IoT NTN and have the following questions:

(1) What does "reduced GNSS use" mean? Does it mean that the availability of GNSS is not continuous or UE can reduce using GNSS proactively e.g. for power saving?

[Answer] It broadly means that the interval of time during which the UE is "not required to" get a GNSS fix, while still maintaining the performance requirements (e.g., time/frequency offsets within X ppm for uplink transmission), is increased w.r.t Rel 17.

At the extreme end, one can have a UE with no GNSS capability, for which a new PRACH design is potentially required for the purpose of initial synchronization; in connected mode, for such UEs—and even for UEs that have GNSS capability—a solution such as PUSCH/PRACH-driven closed-loop time/frequency corrections may eliminate/significantly reduce the number and frequency of GNSS fixes that may be required to maintain time/frequency synchronization during a long connection, for example.

(2) We support enhancements to discontinuous coverage and wonder you considerations on possible core network impacts.

[Answer] Yes. For Rel-17, we may not have any large CN stage 2 change as it is going to freeze in June, i.e., before RAN2 can start work. So SA2 is going to do only necessary alignment work which, in our understanding, does not include any new change/solution considering discontinuous coverage. In Rel-18, solutions may be expected to provide the core network with better knowledge of discontinuous coverage conditions, enabling a broader and better set of system solutions.

**9.3 Input – Round 2**

**Feedback Form 16: NTN IOT - Round 2**

<p><b>1 – HUAWEI TECHNOLOGIES Co. Ltd.</b></p> <p>Thanks for the answer. A follow up question as below:</p> <p>On the operation without GNSS at all and reduced GNSS usage, do you have any preference to support one or both in Rel-18?</p>
<p><b>2 – Samsung Electronics Co.</b></p> <p>Q1: Regarding discontinuous coverage, could you further elaborate on aspects/solutions related to intermittent backhaul?</p>
<p><b>3 – Intel Corporation (UK) Ltd</b></p> <p>Q1: The GNSS validity period (hence, periodicity of GNSS fix and GNSS power consumption) depends on the UE mobility assumption. While the UL synch validity (i.e. periodicity of PRACH, TA and frequency offset commands) without GNSS depends on both satellite mobility and UE mobility. So, the power consumption analysis depends on many parameters. Could you please provide a reference to the power consumption analysis (GNSS vs. closed-loop based adjustment), if possible? Thanks</p>

#### 4 – NOVAMINT

Thank you for the clarification on the UE without GNSS or reduced GNSS – we believe it is an important topic for IoT device in particular asset monitoring usage and even for asset monitoring – the objective is often to reduce the number of position fixes to reduce battery consumption but it will mean we will have to change some of the features as defined in Release 17 such as UE pre-compensation for UL synchronization in *RRCIDLE* and *RRCCONNECTED* states. What will the changes foreseen in this context compared to release 17 by supporting UE without GNSS?

A second question will be related to new deployment options: It may be very interesting both to improve the service as well as to provide even more cost effective solution to support regenerative payload – what are your views on this and the impact on the overall effort?

#### 5 – Gatehouse Satcom A/S

The RWS-210012 input is well structured, and we do recognize and support your ideas/vision. We also do believe that R-18 shall have enhancements focusing on optimizing power (consumption). I do expect that devices without GNSS are mostly thought for GEO. Do you see a solutions for TN and NTN (dual mode) feasibly, or would this not optimize devices to be LEO or GEO oriented? For LEO the positioning of both satellite and device is important to optimize power/sleep/wake-up as well is necessary for algorithm signal timing and frequency compensations.

## 9.4 Response – Round 2

### HUAWEI TECHNOLOGIES Co. Ltd. # 1

Thanks for the answer. A follow up question as below:

On the operation without GNSS at all and reduced GNSS usage, do you have any preference to support one or both in Rel-18?

**[Answer:]** We think a lot of the solutions that are likely to be developed under this ambit are likely to benefit both UEs without GNSS capability, as well as UEs with GNSS capability that may now be able to operate with much reduced power draws from GNSS, as well as be able to address use cases (such as long connections) that are currently restricted by the stringent GNSS requirements in Rel 17. As such, we are open to solutions that can reduce a IoT UE's dependence on GNSS—both for UEs without GNSS capabilities, as well as those with it.

### Samsung Electronics Co., Ltd # 2

Q1: Regarding discontinuous coverage, could you further elaborate on aspects/solutions related to intermittent backhaul?

**[Answer:]** Intermittent backhaul is a special scenario where UE is in coverage of a regenerative satellite (I.e., UE sees a cell) but the satellite has no backhaul connection to gateway for a certain period of time. We intend to address this use case.

### Intel Corporation (UK) Ltd # 3

Q1: The GNSS validity period (hence, periodicity of GNSS fix and GNSS power consumption) depends on the UE mobility assumption. While the UL synch validity (i.e. periodicity of PRACH, TA and frequency

offset commands) without GNSS depends on both satellite mobility and UE mobility. So, the power consumption analysis depends on many parameters. Could you please provide a reference to the power consumption analysis (GNSS vs. closed-loop based adjustment), if possible? Thanks

**[Answer:]** In Qualcomm's contribution to RAN1#104-bis-e (R1-2103071), we provided some power consumption analyses for different connection types (long vs short connections, e.g.) and the benefits that closed-loop fixes can provide for long connections. Section 3 of the referenced contribution contains the relevant material.

#### **NOVAMINT # 4**

Thank you for the clarification on the UE without GNSS or reduced GNSS – we believe it is an important topic for IoT device in particular asset monitoring usage and even for asset monitoring – the objective is often to reduce the number of position fixes to reduce battery consumption but it will mean we will have to change some of the features as defined in Release 17 such as UE pre-compensation for UL synchronization in *RRCIDLE* and *RRCCONNECTED* states. What will the changes foreseen in this context compared to release 17 by supporting UE without GNSS?

A second question will be related to new deployment options: It may be very interesting both to improve the service as well as to provide even more cost effective solution to support regenerative payload – what are your views on this and the impact on the overall effort?

**[Answer:]** In connected state, we believe that enabling “closed-loop” time/frequency fixes (wherein the base-station detects any drifts in time and/or frequency (relative to the initial uplink synchronization via PRACH) from the PUSCH, or from an ordered PRACH, and sends correction commands to keep the UE synchronized in the uplink) is going to help in reducing/eliminating GNSS fixes. This shouldn't be too big of a change: today, this type of closed loop fix is indeed the norm for timing (referred to as the TA command); we would just need to enable this kind of a fix for frequency correction as well.

In idle mode, if the UE doesn't have GNSS capability, then to acquire initial uplink time/frequency synchronization, a new PRACH design is likely required—one comprising preambles that can enable the base station to determine and correct for large initial offsets in time and frequency offsets. The current PRACH designs may not be suitable for such large initial offsets in time and frequency.

We are open to discussing support for different solutions, such as regenerative payloads. However, inputs from multiple working groups (including SA, CT) may also need to be considered, to evaluate what may be the impacts and ramifications.

#### **Gatehouse Satcom A/S # 5**

The RWS-210012 input is well structured, and we do recognize and support your ideas/vision. We also do believe that R-18 shall have enhancements focusing on optimizing power (consumption). I do expect that devices without GNSS are mostly thought for GEO. Do you see a solutions for TN and NTN (dual mode) feasibly, or would this not optimize devices to be LEO or GEO oriented? For LEO the positioning of both satellite and device is important to optimize power/sleep/wake-up as well is necessary for algorithm signal timing and frequency compensations.

**[Answer:]** We think UEs without GNSS capability may be relevant to both GEO and LEO; since GNSS is only concerned with the UE's own location, the solutions are expected to be applicable across different satellite deployment scenarios.

We think it is too early to know whether there will be single-mode devices or dual-mode devices: this may

become clear(er) as the market for these things pick up.

You are correct that for LEO, satellite location tracking is more critical than for GEO: but this aspect (tracking a satellite's location accurately) is expected to be achieved by Rel 17 solutions itself, with potential "additional SIB-carrying-satellite-ephemeris reading(s)" by UEs in connected mode, if longer connections are supported in the future.

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## 10 On Terrestrial broadcast evolution for Rel-18 - RWS-210013

### 10.1 Input – Round 1

#### Feedback Form 17: Terrestrial Broadcast - Round 1

<p><b>1 – ESA</b></p> <p>Don't you see an NTN component in the MBS evolution ?</p>
<p><b>2 – ESA</b></p> <p>Sorry, I just realized there is a dedicated form.</p>
<p><b>3 – BBC</b></p> <p>BBC agrees that LTE-based 5G Terrestrial Broadcast supports the relevant requirements for dedicated terrestrial broadcast networks as per [TR 36.776, TR 38.913] from a radio perspective.</p>
<p><b>4 – Intel Corporation (UK) Ltd</b></p> <p>What is the motivation to support 5GC for LTE MBMS given that RAN and SA architectures are tightly coupled for both LTE MBSFN and NR MBS?</p>
<p><b>5 – MediaTek Inc.</b></p> <p>It is not clear to us why we need to work on the two tracks for broadcast (LTE and NR) in Rel-18.</p>
<p><b>6 – ZTE Corporation</b></p> <p>Is the market need clear on following scenarios, e.g., UEs with both Terrestrial Broadcast and NR, and deployment of both Terrestrial Broadcast and NR from same or different operators?</p>

### 10.2 Response – Round 1

Thank you for the good questions and comments.

To Intel: Since 5G broadcast was developed in a very late stage of LTE, we think connecting to the 5GC would bring benefits in terms of supporting future features and providing a common core network for delivery of content regardless of it being over NR MBS or 5G broadcast. We expect SA would define a core network component for ROM for MBS, this can be used for 5G broadcast.

To MediaTek: In our view, the target of NR MBS and 5G broadcast is different. NR MBS is targeting cellular operators, cellular deployment (LPLT) and IMT spectrum, and 5G broadcast is targeting broadcasters, HPHT deployment (or MPMT) and broadcast UHF spectrum. We can see the interest from the industry in these two tracks (see e.g. the 5G-MAG contribution).

To ZTE: The use case is to have a single modem receiving 5G broadcast (from a broadcaster) and unicast NR (from an MNO). Reuse of modem capabilities is one of the main selling points of 5G broadcast (vs other competing technologies in the broadcast arena)

## 10.3 Input – Round 2

### Feedback Form 18: Terrestrial Broadcast - Round 2

#### 1 – ZTE Corporation

Thanks for the reply and clarifications. We have below further questions/clarifications:

- As for the 5G broadcast (from a broadcaster), yes, we are aware of the use case. Meanwhile we are also happy to know if there are any clear market need on such use cases.

#### 2 – MediaTek Inc.

Thanks for the reply and clarifications. Meanwhile we see there is a confusion on the terminology used for "LTE based Terrestrial Broadcast". Maybe we can avoid use 5G broadcast to represent "LTE based Terrestrial Broadcast", since NR MBS is also 5G multicast/broadcast .

## 10.4 Response – Round 2

Regarding the market need, in our one of the main targets of 5G broadcast is to support smartphones, which will also support unicast in a concurrent manner. If this is the case, the serving gNB should be informed of the current resources (baseband and RF) being used for receiving the broadcast content, and adjust the resources / configuration for unicast accordingly (this is essentially the "MBMS interest indicator" sent to a NR base station).

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## 11 On Aerial Support in NR - RWS-210014

### 11.1 Input – Round 1

#### Feedback Form 19: Aerial - Round 1

#### 1 – Lenovo Mobile Com. Technology

Thanks for the proposals and we have some clarification questions for further understanding consider following objectives:

1. RRM enhancement: In LTE, multi-cell measurement was introduced and can reduce the measurement overhead to some extent. Do you think it is not enough and some enhancements are still needed especially for mobility purpose?
2. Mobility enhancement: In Rel-17 NTN topic, location-based and timer-based CHO is under specifying.

For UAV topic, we understand NTN CHO mechanism can be served as a baseline solution for further study.  
3. PC5 enhancement: we are wondering what AS layer impact would be if reuse existing NR SL mechanism for UAV remote identification and detect-and-avoid. Both of them seems can be transmitted as a SL data from AS layer perspective?

**2 – LG Electronics Inc.**

Q1: UAV detect and avoid seems similar to the collision avoidance in V2X use cases for which messages like BSM or CAM and the corresponding application protocols were defined outside 3GPP. What specific 3GPP RAN work is expected for UAV use cases?

**3 – Guangdong OPPO Mobile Telecom.**

Q1) For PC5 enhancement support for Drones / UAV, does it require discovery signal over PC5?

Q2) Should SL positioning (esp. ranging) also applied for drones / UAV?

**4 – Intel Corporation (UK) Ltd**

Q1: Do you have some examples for beamforming / beam management enhancements for FR1 required to support UAV?

Q2: Do you consider analog beamforming at the gNB and/or UAV for FR1?

## 11.2 Response – Round 1

Thank you for very good and constructive comments.

Regarding questions on RRM enhancements, we think LTE work can be baseline. For NR, there may be a need to do some adjustments e.g. for beam measurements.

Regarding questions on PC5 enhancements, our intention is to reuse existing V2X solutions as baseline. We share similar understanding that the remote ID and DAA messages may be transmitted as SL data from AS perspective. However, since a proper gap analysis has not been done yet, we cannot conclusively say nothing else would be needed. Hence, we have “introduce enhancement (**if necessary**)”. We think at least there could be some work to support the fact that Aerial UEs needs to also take their height into account, e.g. in calculating 3D distances/zones and accounting for 3D range control in groupcast etc.

Regarding beamforming, we think directional antennas can be considered in FR1 FDD band to reduce UL/DL interferences, e.g., SSB with uptilt beams at gNB side and spatial tx/rx BF at UAV side.

## 11.3 Input – Round 2

### Feedback Form 20: Aerial - Round 2

**1 – Intel Corporation (UK) Ltd**

Q1: Many thanks for your answers. It is still not clear for us which enactments are required for FR1 beamforming /beam management. In our understanding SSB with uptilt beams at the gNB side can be already implemented with Rel. 15 specification. In order to support spatial tx/rx BF at UAV side QCL Type D may be required for FR1. Do you propose to support QCL Type D in FR1 for UAV?

## 11.4 Response – Round 2

Reply to Intel:

For gNB, we think different configurations may be needed for SSBs with downtilt beams and uptilt beams. For example, different tx power for the uptilt beams can be used to control the interference toward sky considering some emission limitation.

For aerial UEs, the QLC Type D and spatial relations could be supported for spatial tx/rx BF in FR1.

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## 12 On Enhancements to NR MBS for Rel-18 - RWS-210015

### 12.1 Input – Round 1

#### Feedback Form 21: MBS - Round 1

##### 1 – ESA

Don't you see an NTN component in the MBS evolution ?

##### 2 – HUAWEI TECHNOLOGIES Co. Ltd.

[Huawei, HiSilicon] Q1: "Monitoring control of group-common PDCCH may be needed, especially for multiple multicast services". Could you share more information about "monitoring control" ? Why it is beneficial to power saving?

Q2: Could you clarify why you think that "Wide Area SFN doesn't improve efficiency in dense deployments" ?

Q3: On the part " Capacity / PHY enhancements: [RAN1]

- RV-level time-interleaving
- HARQ-ACK codebook enhancements for limited reception"

It is not clear the motivation and what are the proposed enhancements, could you share more information about these enhancements?

Comment: The door for PDCP based L2 feedback and retransmission is not closed yet in Rel-17

##### 3 – Guangdong OPPO Mobile Telecom.

Q1.1

Why is it expected to be sufficient to meet the 5G QoS requirement by supporting of L2-feedback based retransmission scheme in addition to Rel-17 PHY HARQ-based retransmission scheme?

Q1.2

What does outer codes exactly mean in details? How to apply outer codes to improve multicast reliability?

Q2.1

How to apply RV-level tim-interleaving to improve capacity?

Q2.2

How to enhance HARQ-ACK codebook, by modifying current codebook Type-1/2 or supporting codebook enh Type-2 and Type-3?

#### **4 – BBC**

BBC supports the evolution of NR MBS under Rel-18 and the topics you propose seem relevant to us as potential enhancements for NR MBS. In particular to the specific topics listed in your contribution, RV-level time-interleaving has been shown to provide significant performance improvements in previous studies.

#### **5 – InterDigital Germany GmbH**

From slide 3, you state: Workaround by L2 PTP/PTM switching is supported in Rel-17, however this may not work with

HARQ NACK-only feedback, why is that the case? and even if that is the case, NACK-only is an optional feature and the network could always configure ACK-NACK HARQ anyway.

#### **6 – Intel Corporation (UK) Ltd**

- 1) Any details regarding “access control” for multicast reception in *RRCINACTIVE*? *So far UE can only transit to RRCINACTIVE from RRCCONNECTED, therefore no need for access control to RRCINACTIVE?*
- 2) Is support of outer codes envisioned to be L1 based? What is the potential benefit for L1 based outer codes over L2 based? Details of RV level time interleaving including gains if any?

#### **7 – Lenovo (Beijing) Ltd**

Thanks for the contribution. We have some comments for clarification:

Q1: Could you clarify why outer code can improve multicast reliability?

Q2: What you mean HARQ-ACK codebook enhancements for limited reception? Could you clarify “limited reception”?

Q3: “L1 feedback by inactive UE” means HARQ-ACK feedback by inactive UE?

#### **8 – MediaTek Inc.**

Thanks for the proposal. Can you clarify the exact power saving techniques for multicast/broadcast monitoring

#### **9 – CATT**

Thanks for the contribution.

A general comment is CATT support NR MBS enh in Rel-18.

Then a few questions for clarification.

1) In your paper this part ‘HARQ-ACK codebook enhancements for limited reception’ was mentioned. So what does ‘limited reception’ mean here?

2) We share MTK’s question on power saving part.

3) Do you have an estimation about the gain from RV-level time-interleaving?

Thanks.

## 10 – ZTE Corporation

Thanks for the contributions, here are our questions to the proposal:

-

For “Specify support of multicast in RRC\_INACTIVE”, how to guarantee the reliability/QoS of multicast in INACTIVE? What’s the potential L1 feedback, e.g., HARQ-ACK or CSI?

-

Could you elaborate a little more on “RV-level time-interleaving” and “HARQ-ACK codebook enhancements for limited reception”, or give some examples? Without any corresponding context, it is not very clear how to interpret them.

-

Does L2 Re-TX mean RLC AM of PTM or PDCP Re-TX, and for RLC AM of PTM, do you think the same complexity issues still applies to the next releases?

As for the outer code, we also think it is beneficial to reliable transmission in mutiple scenarios and there is a similar discussion in our Tdoc RWS-210484 in AI 4.3.

## 11 – Ericsson LM

Thanks for the contribution. Could you please elaborate on the ”CSI feedback enhancement for multicast”?

## 12.2 Response – Round 1

Thank you for very good and constructive comments.

Regarding questions on SFN in general and specifically on Wide Area SFN:

We think Wide Area SFN increases complexity but doesn’t necessarily improve efficiency in dense deployments. (On the other hand, in sparse deployment scenario, Wide Area SFN may need extended CP which increases overhead in addition to increased complexity for inter-CU coordination and LTE MCE-like functionality.) Therefore, we think inter-DU/intra-CU SFN from Rel-17 is sufficient.

Regarding questions on RV-level time-interleaving: The proposal is similar to the one made in R1-2101489, Section 6 (See Fig 4 for simulation results). By doing RV cycling with time interleaving (while keeping a large TBS), we can increase the degree of time diversity without sacrificing the TBS. This allows to achieve higher data rates at the same reliability target, which increases the capacity / peak throughput of the cell.

Regarding HARQ-ACK codebook enh: The objective here is to reduce the HARQ-ACK codebook size for cases when the UE is not capable of simultaneous reception. For example, if the TDRA table has 7 sub-slots, the UE is only capable of receiving 2 PDSCHs, and the UE is receiving 2 multicast services, the type-1 codebook will use 14-bits, which is excessive. Some more technical details were proposed to NTN in Rel-17 (see R1-2104669, Section 4 – around Figure 4)

The UE may be only capable to receive a limited number of PDSCHs in a slot simultaneously. The potential enhancement could be to compress the size for Type-1 HARQ codebook catering to the UE capability.

Regarding questions on multicast L2 reliability:

Since the likelihood of L2 based reliability solution in Rel-17 is low, we think it should be part of Rel-18.

The NACK-only based feedback cannot work with L2 PTM/PTP switching efficiently. In case of NACK only feedback, when multiple UEs send feedback using common PUCCH resources, there is no way for the gNB to know which UE is not able to receive. Then the gNB cannot do PDCP retransmissions efficiently.

We prefer PTM L2 reliability based on RLC AM. The PTM RLC AM is much simpler than L2 PDCP Re-Tx based on PDCP status reports, which requires RLC AM kind of buffer management in PDCP and adds unnecessary complexity with no additional benefits.

Regarding questions on multicast support in RRC\_INACTIVE:

When a UE transits to RRC\_INACTIVE state (i.e., from RRC\_CONNECTED state) due to RAN congestion, the UE can continue to receive low reliability QoS multicast services. If UE wants to get into RRC\_CONNECTED state, UAC mechanism can be used for access control as congestion control mechanism.

For “potential L1 feedback of INACTIVE UEs”, a wrong version was mistakenly submitted by including it. After further consideration, we think it increases complexity and power consumption, so we tend to be negative.

Regarding questions on outer codes for multicast reliability:

Examples of outer code could include block codes, fountain codes etc. Basically, the idea is to transmit redundancy packets using multicast, similar to what is done in LTE eMBMS at service layer, however doing it at lower layer for NR MBS. The UEs which need more redundancy packets to decode the payload need to receive more packets while the UEs already successful in decoding the payload can ignore the redundancy packets. The transmitter may be able to use UE feedback to determine the amount of redundancy to be included in multicast.

Regarding questions on power saving for multicast:

The power saving techniques in Rel-16/17 could be extended for broadcast/multicast reception, such as group-common PDSCCH monitoring on/off, search spacing set switching for unicast/MBS, wake-up signal for MBS, etc..

Regarding questions on CSI feedback enhancement for multicast:

Examples of potential enhancement include group-common aperiodic CSI-RS triggering, beam management/recovery for multicast, and SRS configuration for multicast, etc.

## 12.3 Input – Round 2

### Feedback Form 22: MBS - Round 2

#### 1 – ZTE Corporation

Thanks for the reply and clarifications. We have below further questions/clarifications:

- For RLC AM for PTM, the concern was about both standard and implementation complexity, which could erase the gain from it in real implementation (we do agree that the complexity is not on the UE side). Therefore we doubt if companies will change their views even in later releases. That being said, we are

open to hear more opinions from companies.

- For outer coding, at which layer are you expecting this would happen?

- In the 1st round of Q&A, you mentioned that “search spacing set switching for unicast/MBS” can be applied for power saving. Could you elaborate a bit more on how this can reduce UE power consumption?

## **2 – MediaTek Inc.**

Thanks for the reply and clarifications. For outer coding for multicast reliability, it seems to be different way to handle the transmission reliability from dynamic PTM-PTP switch. According to your reply, one PTM stream is used, where some of the packets are redundant packets, that cater for the need to improve the reliability for some particular UEs. Meanwhile, this PTM transmission may be not quite friendly to other UEs from transmission efficiency perspective.

By the way, is there any strong motivation to move this from service layer to lower layer?

## **3 – HUAWEI TECHNOLOGIES Co. Ltd.**

[Huawei, HiSilicon] Thanks for the answers.

On SFN: in our understanding, NR MBS can be deployed both in small and wide area, and this depends on the operator’s requirements. There is some complexity in UE and NW supporting inter-site SFN, but we do see the benefits of SFN usage, even with Rel-15 numerology/CP. For example 15K SCS/normal CP in small and wide area, and extending CP to 16.7us for 15K SCS would harvest significantly more benefits in our view.

On time interleaving and outer codes: from your explanations, it seems that both time-interleaving and outer codes can benefit from time diversity, but do you think these features are somehow alternative to each other? To us, specifying these features and some other features mentioned by you seem to require a considerable amount of work, bringing limited benefits, so we need to evaluate carefully if they should be in the scope of a Rel-18 WI or not.

## **4 – CATT**

Thanks for the discussions in round 1.

A few follow up.

1) you referred to R1-2101489, where it is proposed to define modified RV definitions. Would that requires changes to channel encoding and de-coding?

2) about outer codes for multicast reliability, would that impact HARQ mechanism such as initial tx, re tx and soft combing?

3) as a comment we are open to further discuss SFN aspects, including scenairos, gains and potentail impact/complexity.

## **12.4 Response – Round 2**

### **Regarding SFN:**

The inter/intra-DU SFN can be considered for Rel-18 MBS. But the benefit/motivation of enabling ECP for MBS only (e.g., ECP for 15kHz not supported for unicast, SIB, etc.) is not clear to us. The impact on UE complexity and gNB synchronization in wide area SFN need to be further studied.

**Regarding time interleaving:**

Both outer code and time interleaving can exploit the benefits of time diversity. The difference is that time interleaving tries to capture the maximum possible amount of time diversity within one transport block, and outer code expands across multiple transport blocks. There is a tradeoff between having very long time interleaving and complexity (e.g. need for large LLR memory), so both should be considered taking these constraints into account.

Regarding the question on changing the RV, this would not require any change in the encoding / decoding chain, just a change on the pointer for the circular buffer. The main objective of this scheme is to “mimic” deep time interleaving by using current HARQ functionality.

**Regarding outer code:**

We think the outer code could be applied in lower layer (e.g., MAC/RLC or PDCP) for MBS, which can improve the reliability, efficiency and reduce the latency compared with that in application layer. More details are included in our contribution RWS-210028.

For the PTM stream, the outer-coded retransmission can improve the spectrum efficiency, compared with respective TB retransmissions. For example, if UE1, UE2 and UE3 wrongly detected TB1, TB2, and TB3 respectively, gNB can transmit outer-coded  $C1=TB1+TB2+TB3$  instead of retransmitting TB1, TB2 and TB3 to the respective UEs.

**Regarding SS set switching:**

The MBS may have variant traffic periodicities. The GC-PDCCH monitoring periodicity is configured in SS set of CFR, the periodicity of GC-PDCCH monitoring can be changed along with the SS set group switching. The SS set group with similar periodicity may include MBS only, unicast only, or MBS and unicast. When the UE monitors GC-PDCCH/PDCCH with larger periodicity, more power saving could be obtained.

**Regarding PTM RLC AM:**

For PTM RLC AM, gNB has to manage its Tx window movement by taking feedback from multiple UEs into account. The same is true even for PDCP based solution. From gNB perspective, whether L2 re-transmissions and window management is implemented at PDCP or RLC, it is same effort and does not need to be specified. In case of PDCP based solution, we need to implement RLC AM type of window management and feedback mechanism to be specified, which adds significant complexity compared to RLC based solution. For PDCP solution, any re-transmission needs to be full PDCP PDU re-transmission, whereas in RLC solution there is no need to re-tx full RLC PDU (i.e. only RLC segment can be re-transmitted) and is more efficient. More detailed info is available in R2-2106008. Therefore, we believe PTM RLC AM solution is simpler and does not add complexity compared to other solutions.

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## 13 On narrowband NR in dedicated Spectrum enabling new 5G verticals - RWS-210017

### 13.1 Input – Round 1

#### Feedback Form 23: Narrowband NR - Round 1

##### 1 – Lenovo (Beijing) Ltd

Thanks for the contribution. We are interested in the scenarios for Railway.

- 1) The narrowband NR scope may have some overlapping with the potential eRedcap WI (Narrowband NR is subset of eRedcap?), so we should wait for the detail scope of eRedcap and clearly focus on what is different for narrowband NR.
- 2) For the scenarios proposed by QC, some of BW are larger than 20RB, some of the BW are smaller than 20RB. From QC's view, no matter which case, we should reuse the PSS/SSS/PBCH design (may puncture some RE even with channel raster update for 3M case?), right?

##### 2 – ESA

Don't you see Narrowband NR also relevant for enabling and improving NTN-smartphones connectivity?  
Thanks.

##### 3 – Huawei Tech.(UK) Co.. Ltd

1. How do you view the relative priority of RWS-210007 vs. this proposal?
2. What are the requirement(s) in terms of data rate, latency, etc, etc. for the targeted use cases, and/or where will they be drawn from?

##### 4 – Intel Corporation (UK) Ltd

- 1) Does the proposal have any RAN4 RF requirement impact?
- 2) The contribution mentions 3.6MHz and 3MHz channel allocations. Is it planned to introduce new RF Channel BWs or reuse 5MHz CBW RF requirements for BS and/or UEs?

##### 5 – vivo Communication Technology

Thanks Qualcomm for the contribution. Some questions from our side.

- 1) For these use cases (e.g. railways), the UE cost and power consumption may not be critical, so it seems also possible to reuse Rel-17 Redcap UE capability as 20MHz BW (similar as in LTE where UE is required to support at minimum 20MHz but network can deploy smaller BW as 1.4/3/5/10MHz), or do you intend to specify new UE type with further reduced BW capability to 3MHz or 5MHz?
2. Do you think coverage recovery solutions needs to be studied as narrow band NR would mean reduced link level performance (e.g. diversity gain), in addition, what is the typical ISD assumption/target for network deployment used for railway communication?

##### 6 – Samsung Electronics Co.

As you already provided some analysis about spec. impacts on BW in your tdoc RWS-210007, current CORESET#0 BW based on 15kHz is 4.32MHz in 24RBs. It is our understanding that even if 15kHz is

used, it is difficult to confine CORESET#0 within 3.6MHz or 3MHz. So, could you elaborate how to address such small BWs <5MHz by using 15kHz only in your proposal?

#### **7 – Sony Europe B.V.**

What are the coverage requirements of narrowband NR compared to Rel-15 NR and GSM?

### 13.2 Response – Round 1

Regarding comments of #1:

1) For Narrowband NR vs. eRedcap, we think they have different use case scenarios with different requirements, as explained in our slide 6. The Narrowband NR is for new vertical use cases in dedicated spectrum, where there are no backward compatible issues, no specific concern on power consumption, cost and complexity, different from eRedCap. In addition, eRedCap is considering BW no less than 5MHz. So, we don't need to wait for the discussion of eRedCap.

2) Yes, we can reuse SSB design with only some punctured RBs on PBCH if needed for 3MHz.

Regarding comment of #2:

For those specific vertical use cases in the dedicated spectrum, it is not intended for cellular smartphones. The Rel-18 Narrowband NR is not relevant for NTN-smartphones connectivity per our understanding.

Regarding comments of #3:

1) For Narrowband NR vs. eRedcap, they are targeting different use case scenarios and market demand. They are both important from our point of view.

2) Those can be part of the discussion of the SI. We think at least the data rate will not be as high as eMBB due to limited BW, and the latency requirement will not be as strict as URLLC for Railways, smart grid and PPDA.

Regarding comments of #4:

We are open for discussion. We strive to have minimal or no RAN4 RF requirement impacts. At least for the case that the BSs for narrowband NR spectrum and adjacent spectrum are co-located, it is possible to reuse the 5MHz CBW RF requirements, in a way similar as reusing 10MHz CBW RF requirement with optional flexible BW between 5MHz and 10MHz supported in Rel-16.

Regarding comments of #5:

1) How to define UE type/capability can be further studied. But we don't think the UE in dedicated narrowband would be categorized as RedCap UE type, due to different requirements as discussed in our slide 6.

2) Our goal is to reuse existing NR techniques with minimum changes. There may be some link budget loss due to punctured RBs to fit into the narrow band. But it can be compensated by simple power boosting and/or existing coverage enhancement schemes. Using FDD sub 1GHz, the coverage is not the main concern and the specific coverage enhancement only for Narrowband NR is not the focus of this study.

Regarding comments of #6:

For CORESET, we may need RB puncturing to fit into 3MHz (16RBs) or 3.6MHz (20RBs). The CCE mapping order is kept same as legacy. The AL may be restricted in some cases.

Regarding comments of #7:

For private network, there is no NR deployment. There is no specific requirement on coverage comparing to Rel-15 NR so far. Some performance loss due to puncturing may be compensated by power boosting or existing coverage enhancement schemes.

### 13.3 Input – Round 2

#### Feedback Form 24: Narrowband NR - Round 2

##### 1 – MediaTek Inc.

Q1: It is often the case that it is difficult to source RF components for bands that are not for mass market devices. We believe that Half Duplex support would help make this easier (Mediatek is making a similar proposal for NR NTN for a similar reason). Have you considered Half Duplex support for NR in Railways/smartgrids/PPDA, and if not, do you think it would be feasible?

Q2: In the case where you have GSM-R and NR both deployed, would these generally be provided by the same operator and use collocated sites? If the answer is yes, there is no mobility and service continuity between NR and GSM defined today. What is the expected deployment and migration plan given this restriction?

Q3: Is this purely a standalone deployment, e.g. not aggregated with other frequency bands from MNOs for example?

Q4: We observe very limited LTE-R demand. What will be the key drivers for using NR when compared to LTE in this scenario, causing you to expect robust demand?

Q5: Is it foreseen that RedCap will be reused to address this market?

##### 2 – Huawei Tech.(UK) Co.. Ltd

Thanks.

Do you expect a dedicated UE for narrowband NR (e.g. supporting only a specific maximum bandwidth of less than 5 MHz), or would this be an additional e.g. capability in a possibly-evolved RedCap, or eMBB UE?

##### 3 – Samsung Electronics Polska

If RB puncturing is considered, we think it may have impacts on performance. So, could you elaborate how to avoid/mitigate the performance impacts? Also, in case that 15kHz only is allowed, we wonder how you can handle SS/PBCH for 3MHz BW because PBCH occupies 20RBs in the current spec.

### 13.4 Response – Round 2

Reply to #1:

Q1: Whether HD is considered can be discussed but may be deprioritized in Rel-18 Narrowband NR, since the UE complexity is not the main concern of dedicated devices.

Q2: Yes, GSM-R and NR would generally be provided by same operator and collocated. The migration from GSM-R to NR is to be progressive so that both technologies should coexist on the same geographical areas. However, a UE should be connected to a single network at a time.

Q3: It is a standalone deployment at least for Rel-18. But we are willing to hear more views from operators' point of view.

Q4: Relative to LTE, NR provides many new capabilities, higher reliability, lower latencies to support many new and important applications.

Q5: We don't think the UE in dedicated narrowband would be categorized as RedCap UE type, due to different requirements as discussed in our slide 6.

Reply to #2:

How to define UE type/capability can be further studied. But we don't think the UE in dedicated narrowband would be categorized as RedCap UE type, due to different requirements as discussed in our slide 6.

Reply to #3:

To fit into 3MHz, 4 RBs at one edge of 20-RB PBCH need to be punctured. The UE will only use the DMRS in the remaining RBs for channel estimation. The performance loss due to the punctured RBs can be compensated by power boosting.

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## 14 NR Smart Repeaters for Rel-18 - RWS-210019

### 14.1 Input – Round 1

#### Feedback Form 25: Smart repeaters - Round 1

##### 1 – KDDI Corporation

Thank you very much for your proposals. We are also interested in smart repeater. In order to understand your proposal more concretely, let us ask you a few questions below.

<Q1>

Are you assuming that the smart repeater does not move, i.e. it is fixed? If it does not move, we imagine that the beam to the gNB is somewhat fixed, and only the beam to the UE is adaptively controlled.

<Q2>

On slide 7, you state that "Smart Repeaters may be the steppingstone towards Reflective Intelligent Surfaces (RIS)". Could you elaborate your intention of this sentence a little more?

## **2 – ZTE Corporation**

Thanks for your proposal. In general, we believe that solution(s) by introducing additional node(s) with simplified protocol is beneficial to improve system performance for both FR1 and FR2. In our contribution (RWS-210465 in AI 4.1), similar motivation is highlighted with the proposed alternative technique called RIS. As shown in our tdoc, the introduction of RIS can be justified by the performance benefits observed from both simulation and field measurement. In our views, this solution can be taken as a promising solution to improve coverage for cell edge and throughput in hotspot by manipulating the propagation. The required cost for the infrastructure is relatively low with high energy efficiency and deployment flexibility compared to other solution(s). For the specification work, we expect some RIS specific enhancements but we have also identified certain aspects with partial similarity as smart repeater, which may be aligned with the following sentence in your contribution: "Smart Repeaters may be the steppingstone towards Reflective Intelligent Surfaces (RIS)". We would appreciate if more clarification on this can be provided from your side.

## **3 – Classon Consulting**

[for FUTUREWEI]

RAN1 study may be needed for the feasibility and performance of the spatial side information proposal.

## **4 – CATT**

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

Q1: How is the side information of TDD configuration used by the smart repeater?

Q2: How does the gNB/repeater get the information of Tx/Rx beam between repeater and UE?

Q3: Does the repeater have to send some reference signal of its own?

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

It seems there are some interests among some companies on smart repeaters. So, we would like to have more understanding on NR Smart Repeaters the following points:

- a) Do we have an assessment on the cost efficiency of smart repeaters, for example how much cost can be reduced for smart repeater compared to a full functional IAB node?
- b) Is there any relationship between smart repeater and RIS (Reconfigurable Intelligent Surface)? Are they complementary or competitive?
- c) What may RAN1 impact?
- d) Do we need a new interface between gNB and repeater?

## **6 – Sumitomo Elec. Industries**

Thank you for the proposal. We believe the enhancement of rel-17 TDD repeater is useful for FR2 coverage compensation.

Regarding WID proposal, we agree that the SI/WI could start from feasibility study to evaluate benefit of taking "side information" into consideration. Regarding integration of IAB and smart repeaters, we have one question. Do you have any thinking about what could be the additional standardization effort to realize such a seamless integration of both IAB and smart repeaters because this point is not clear on the WID proposal page.

## 7 – MediaTek Inc.

Thanks for the good proposals.

We have some questions for further clarification:

- 1) For clarification on def. of ClassA+, does "dynamic TDD" imply no bi-direction A&F and the repeater only A&F (always ON) in either DL or UL direction?
- 2) Page 11 shows benefits for indirect UEs. Do you observe any negative impact on direct UEs?
- 3) What is the assumption on dynamic TDD patterns applied by cells in the evaluation, and what's the reason for the gain from Class A to Class A+? Taking DL for example, if all TDD patterns are aligned in all cells, a smart repeater that doesn't A&F in uplink slots seems to bring no additional gain (compared to Class A) to indirect UEs in DL slots, or do you consider CLI? What do you expect on the gain if we only indicate static TDD pattern to repeater? We are not clear yet on whether repeater needs to further know DL/UL directions on flexible symbols.

## 8 – Intel Corporation (UK) Ltd

- 1) Is spatial Tx/Rx information related to the Repeater Tx/Rx beams? Also, is this information intended for BS-Repeater or for Repeater-UE links?
- 2) In case Repeater implements baseband functions, then it can potentially detect Tx/Rx beams for the BS-Repeater link (i.e. SSB detection) and autonomously adjust Tx/Rx beams. What are the additional benefits of providing network assistance?
- 3) Is it proposed to provide L1 dynamic network assistance for each repeater or for all repeaters in the network?
- 4) What kind of L1/L2/L3 capabilities are needed at the Repeater side? Given the support of selected L1-L2 functionality, what are the cost advantages over IAB?

## 9 – Sony Corporation

Thank you for your proposals on smart repeaters. Here are some questions for clarification:

1. In slide 7 it is mentioned that "smart repeaters may be the steppingstone towards reflective intelligent surfaces (RIS)." Do you envision smart repeaters and RIS sharing any joint 3GPP item (SI/WI)? Or do you see RIS as coming after smart repeaters? Or something else?
2. In slides 9, 10, is the proposed fronthaul link wireless or wired, in-band or out-of-band?
3. Could you please elaborate a bit on the acquisition of channel state information (CSI) to enable UE-specific beamforming? For example, are currently existing mechanisms in Rel-16/17 sufficient to support CSI acquisition, or do you think enhancements are needed?

## 10 – Lenovo (Beijing) Ltd

- Q1: You mentioned time/spatial domain separation for smart repeater. Can you elaborate a bit more on whether frequency domain separation is applicable?
- Q2: We share similar view with other company on RIS. How can RIS be set up based on smart repeater?
- Q3: Regarding the coordination between gNB and smart repeater, do you think any reporting like mechanism from smart repeater is necessary to set suitable beam/TDD pattern?

**11 – NTT DOCOMO INC.**

Q1: we have similar question as CATT that How is the side information of TDD configuration used by the smart repeater?

Q2: what kind of signaling do you have in mind to transmit the control information between gNB and Repeater, e.g. any new interface is needed between gNB and Repeater?

**12 – China Unicom**

Thanks for this contribution.

What is the difference between smart repeater and RIS?

**13 – Samsung Electronics Co.**

Could you elaborate the smart repeater operations in details such as how the side control information is carried to the repeater and how the side control information is used for the repeater?

**14 – Samsung Electronics Co.**

One more question: What is the assumption of impact to RAN4 requirements and conformance testing for RIS implementation based repeater?

**15 – China Telecommunications**

As already discussed in Rel-17, we would also like to consider bandwidth information to be signalled to the repeater with reconfigurable passband bandwidth. The situation is that, when the repeater is deployed, in some cases operator don't know/expect what will the carrier bandwidth become in the future (which is depending on the refarming progress for the 3G/4G).

## 14.2 Response – Round 1

**1 - Response to KDDI:**

Thanks for your feedback and questions!

Answer to Q1: while we do not preclude mobile repeaters, we think it would be better to first focus on fixed repeaters and consider possible enhancements for mobile repeaters as a lower priority. Regarding your point about the beam on the gNB-repeater side, it is fair to assume it is “somewhat” fixed in case the repeater is fixed and has a LOS to the gNB. However, we believe we should (and it seems straightforward to) also support beam adaptation on the gNB-repeater side, at least to address dynamic environments.

Answer to Q2: we believe RIS operation needs protocols and procedures (such as integration, a control interface to the network, etc.) that in essence are like those needed for smart repeaters. Hence, smart repeater protocols (if adopted) can be the baseline/reused for other types of simple assisting nodes such as RIS.

**2- Response to ZTE:**

Thanks for your feedback! We share the same opinion about the necessity of having simpler assisting nodes – including both repeaters and reflecting surfaces – to assist achieving the desired coverage and capacity. Your

interpretation of the above sentence is quite accurate. That is, the protocols and procedures designed for the operation of smart repeaters (or RIS) can be largely leveraged for the other type.

### **3- Response to Classon Consulting [for FUTUREWEI]:**

Thanks for your feedback! We believe the “performance” benefits offered by the availability of spatial side information (i.e., the ability of a repeater to adapt its TX/RX beams) are clear and straightforward. Regarding the “feasibility” aspect, simple control messages (from the network) would suffice to configure the repeater’s beams. Therefore, while it is also nice to have study results for feasibility and performance, we prefer to focus more on the specification objectives in a work item.

### **4 - Response to CATT:**

Thanks for your feedback and questions!

Answer to Q1: given the TDD configuration, the repeater can distinguish between DL and UL slots and set its forwarding direction accordingly. That is, during the DL (UL) slots, the signals should be received from the gNB-side (UE-side) and forwarded towards the UE-side (gNB-side). Without such a knowledge, the repeater may have to be inactive, or forward signals in both directions (if it has such a capability). However, the latter may cause interference and instability issues.

Answer to Q2: This can be further discussed during the WI (if approved). But we believe the simplest solution is to rely on legacy DL/UL measurements at the UE/gNB to probe the effective end-to-end channel quality for various combinations of beams at the gNB, repeater and the UE sides, and select the best combination of TX/RX beams.

Answer to Q3: This can be further discussed during the WI (if approved). But we believe in the simplest solution, the repeater does not need to send its own reference signal. In such a solution, the repeater may only receive and forward (DL/UL reference) signals between gNB and UE.

### **5 - Response to vivo Mobile Communication Co.:**

Thanks for your questions!

Answer to (a): we do not have specific numbers that can be shared. However, compared to a full-functional IAB-node that comprises MT and DU components, a smart repeater has a much more simplified architecture (e.g., a simple MT plus some extra RF components) and hence much less cost.

Answer to (b): we believe RIS and repeaters (and IAB) are all complementary solutions to provide the desired capacity and/or coverage. Each of them has its own benefits and use-cases, and a 5G/6G cellular ecosystem is expected to comprise different types of network and assisting nodes. From the specification point of view, we believe RIS and smart repeaters share similarities and may leverage similar protocols/procedures.

Answer to (c): RAN1 should get involved in design of control procedures/signaling to provide the side information (such as info about repeater’s TX/RX beams, TDD configuration, etc.) required for the operation of smart repeaters.

Answer to (d): we believe we can leverage Uu interface for gNB-repeater connection. New (yet simple) control messages should be defined to allow the gNB to configure the repeater's operation (such as its beams).

## **6 - Response to Sumitomo Elec. Industries:**

Thanks for your feedback and support! Regarding your question about “integration of IAB and smart repeaters”, we believe we should specify an integration procedure for a smart repeater to get into the network and become operational. However, such a procedure is expected to be the same whether a smart repeater connects to a gNB or an IAB-node – like a UE connecting via IAB-node or gNB.

## **7 - Response to MediaTek Inc.:**

Thanks for your feedback and questions!

Answer to question 1: yes, your understanding is correct.

Answer to question 2: we have not observed any negative impact on direct UE's SINR. A potential negative impact would be larger interference on direct UEs, since in the presence of repeaters, there may be more concurrent communications in a vicinity. However, this issue is rectified to some extent due to adopting narrow beams at UEs and repeaters.

Answer to question 3: as in question 1, ClassA+ (with dynamic TDD) here simply means no bidirectional A&F, and only forwarding signals in one of DL or UL directions in each symbol. In that sense, by “dynamic” TDD we meant having full knowledge about DL/UL pattern. The gain comes from not having to operate the repeater in a “bidirectional A&F” mode. Because in such a mode, and to control the local coupling at the repeater to assure stability, the repeater should operate at a lower amplification gain compared to the case of non-bidirectional forwarding.

## **8 - Response to Intel Corporation (UK) Ltd:**

Thanks for your questions!

Answer to 1: the spatial TX/RX information is related to repeater's TX/RX beams on both links.

Answer to 2: correct! But in that case, repeater still needs to properly set its beam on the repeater-UE link. The network can provide the repeater with the relevant configuration.

Answer to 3: these are detailed design options that can/should be further discussed (if the item gets approved).

Answer to 4: in our view, the repeater requires a control interface to the network. This can e.g. be realized using Uu interface – like a [simplified] UE/MT. The repeater should have additional “amplifying and forwarding” component (no L1/L2/L3 functionality), that are much simpler than the DU component of an IAB-node.

## **9 - Response to Sony Corporation:**

Thanks for your feedback and questions!

Answer to question 1: in our view, the protocols/procedures designed for the operation of smart repeaters can be largely (re)used for RIS. However, we believe RIS deserves an SI to mainly focus on channel measurements and modeling discussions. On the other hand, the specification work for smart repeaters is expected to be rather straightforward and light weight. So, separate items (such as a WI for smart repeaters followed by (or in conjunction with) an SI (and then WI) for RIS) may be more practical.

Answer to question 2: the fronthaul link (between the repeater and gNB) is wireless and in-band. Out-of-band fronthaul can also be considered.

Answer to question 3: we believe we can use the legacy procedure to perform end-to-end DL/UL measurements, and assure backward compatibility. The presence of the repeater may be assumed to be a part of an effective end-to-end channel between the gNB and the UE.

## **10 - Response to Lenovo (Beijing) Ltd:**

Thanks for your questions!

Answer to Q1: we are afraid parts of our paper might be misread. In the contribution, we discussed about providing time-domain (i.e. UL/DL configuration) and spatial-domain (i.e. TX/RX beam) “information”, not “separation”. Please let us know if there is still a need for clarification.

Answer to Q2: we believe protocols/procedures required for the operation of a smart repeater (e.g., how the repeater is getting integrated to the system, and the control messages) can be in essence largely used for other types of simple network nodes (such as RIS). Needless to say, details of the RIS and repeater’s configurations will be different, but similar procedures/signaling may be adopted.

Answer to Q3: repeater has two links, one towards the gNB and one towards a UE. For the management of the link between the gNB and the repeater, we may be able to leverage legacy UE procedures. For the management of the link between the UE and the repeater, the simplest repeaters (in our view) do not need to support any new procedures and we may be able to rely on end-to-end measurements performed by the UE or gNB.

## **11 - Response to NTT DOCOMO INC.:**

Thanks for your questions!

Answer to Q1: given the TDD configuration, the repeater can distinguish between DL and UL slots and set its forwarding direction accordingly. That is, during the DL (UL) slots, the signals should be received from the gNB-side (UE-side) and forwarded towards the UE-side (gNB-side). Without such a knowledge, the repeater may have to be inactive, or forward signals in both directions (if it has such a capability). However, the latter may cause interference and instability issues.

Answer to Q2: we believe we can use Uu interface to connect a repeater to the gNB. New, yet simple, (e.g. L1/L2) messages may be needed to provide the control information to the repeater.

## 12 - Response to China Unicom:

Thanks for your feedback and question! We believe China Unicom has a nice paper on RIS (RWS-210390). There are fundamental differences on how an active amplify-forward repeater and a reconfigurable reflector work. However, in our view and in terms of specification, there are similarities on how a RIS or a smart repeater integrates to the system, and receives configurations from the network.

## 13 & 14 - Response to Samsung Electronics Co.:

Thanks for your question!

Answer to the first question: we believe a control interface (e.g. based on Uu interface) should be established between the gNB and the repeater (e.g., the repeater (like an IAB-node) may have a UE/MT component). Over this interface, the gNB can provide the required configurations (e.g., in terms of TX/RX beams, ON-OFF, forwarding direction (DL/UL)) to the repeater. The repeater follows the provided indication to set its configurations accordingly and receive -amplify-forward incoming signals on the indicated resources and using the indicated beams.

Answer to the second question: to be clear, we do not propose RIS implementation-based repeater in our paper. We simply mentioned the specification work to define the required protocols/procedures to enable smart repeater's operation can be leveraged [e.g. in future] for other types of simple network nodes like RIS.

## 15 - Answer to China Telecommunications:

Thanks for your note! Bandwidth-related information is indeed very important and should be considered along with other parameters.

## 14.3 Input – Round 2

### Feedback Form 26: Smart repeaters - Round 2

#### 1 – Sony Corporation

Thank you very much for your answers. We also share your understanding that RIS and smart repeaters should be able to share a common design principle for the control interface toward the gNB. A further question: do you see smart repeaters as being transparent to the UEs, or do you think there could be some advantages of UEs being aware of “in/out of smart repeater coverage”?

#### 2 – MediaTek Inc.

Thanks for your answers. Now we can understand the gain is due to different amplifying gains. Regarding this part in answer 3: “to control the local coupling at the repeater to assure stability, the repeater should operate at a lower amplification gain compared to the case of non-bidirectional forwarding.”, could you please further clarify what the coupling is? Suppose in bidirectional A&F case, we have DL\_in , DL\_out,

UL\_in, and UL\_out at the repeater. Does the coupling mean that UL\_in causes interference to DL\_out (so that we lower the gain in DL direction)? If all TDD patterns are aligned in all cells, UL\_in is zero in DL-slots. So do you mean lowering amplification gain is to handle scenarios with CLI (UL\_in is not zero)?

### **3 – Huawei Technologies France**

Thanks for the contribution.

Q1. Considering the baseband and phased arrays are necessary, how to keep the advantage of low-cost?

Q2. In the simulation, RU on/off shows significant performance gain. Can you explain the reason for the result?

Q3. In mmWave, because the donor node may use different beams or bandwidth, the received power of repeater may be changed, which will impact the gain of the repeater. What's your opinion to the issue?

Q4: Do you think smart repeater&IRS only involve PHY protocol? How about the MAC layer such as scheduling?

### **4 – China Unicom**

Thank you for your reply in round 1. And we also want you to clarify :What's the difference between smart repeater and layer 2 relay?

## **14.4 Response – Round 2**

### **1 – response to Sony Corporation**

Thanks for your further comments! We believe backward-compatibility should be guaranteed so that the legacy UEs can also enjoy better performance offered by the repeaters/RIS. However, we also see your point about potential “advantages” and think they are worth investigating as an optimization for the future UEs.

### **2 – response to MediaTek Inc.**

Thanks for your further comments!

In the case of bidirectional A&F, with simultaneous DL\_in , DL\_out, UL\_in, and UL\_out, we have the following interference components: (i) UL\_out on DL\_in, and (ii) DL\_out on UL\_in. These interference components could be significant, given the interfering signal and the victim signal are associated with two adjacent antenna arrays facing the same direction. For example, in case (i), the “amplified” UL signal sent from a first set of antennas towards the gNB would also be received by a set of adjacent antennas used to receive the DL signal (from the gNB) to be forwarded towards the UE. The received interfering signal would first go thru the amplification chain (used for DL forwarding), and loop through the bidirectional repeater again. This can lead to oscillation and instability, if the amplification levels are not properly set (i.e. they are too high).

Regarding your second question: it does not really matter whether there is any UL signal present or not. If the repeater performs bidirectional forwarding, it would at least pick up noise on its UL\_in RX antennas and send this signal into an amplification loop that may cause the same issue as above.

### 3 – response to Huawei Technologies France

Thanks for your questions!

A1. Baseband is needed only for the “control” (not data) communications to configure the operation of the repeater. A simplified BB processing is one way to reduce the cost. Moreover, compared e.g. to IAB, there is no DU component and the end-to-end data communication is facilitated using only simple HW components (like phased arrays, and power amplifiers).

A2. You are referring to the improvement from class A+ to class A++, that is due to less interference of class A++. It means, by turning off a repeater when it is no needed, we could reduce the overall interference. Please note that none of class A+ or A++ repeaters supports UE-specific beamforming. Hence, they use typically very broad beams to guarantee sufficient spatial coverage. This is the reason they can introduce non-negligible interference to the system.

A3. We may have not understood your question thoroughly, but the idea is that the donor node uses its best beam towards the repeater, when it wants to use the repeater to extend its coverage and serve a UE. There will be anyways natural variations in the channel quality (and rxed power) across time and frequency, which is not any different e.g. for the UEs who are directly connected to a gNB.

A4. We think it is best to keep the repeater/RIS simple, and with minimal capabilities. Hence, scheduling/beam management/etc. can be still centrally implemented at the donor gNB.

### 4 – response to China Unicom

Thanks for your further question! Layer-2 relay implements layer-2 functionalities, such as MAC scheduling. Smart repeaters are simply “analog” (not even digital) repeaters that do minimal processing on the incoming signals – i.e., receive-amplify-forward in the analog domain. Hence, they are much simpler, less costly, and do not incur additional latency for forwarding the signals.

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## 15 IAB - New use cases to enhance RAN topology - RWS-210020

### 15.1 Input – Round 1

#### Feedback Form 27: IAB- Round 1

##### 1 – vivo Mobile Communication Co.

On IAB new use case proposal, one general question, is it a work item or study item? Or a combined SI and

Do we consider high speed mobile IAB node in high speed train?

What may be spec impact for IAB-U, if existing NR-U procedure is not enough?

What’s the relative priority between mobile IAB and IAB-U if we cannot have both?

## **2 – InterDigital Germany GmbH**

For Nomadic IAB, what enhancements are needed to support deployment as we already have an IAB integration procedure even in R16 to get an IAB node up and running. Are we discussing just optimizing the procedure?

For Mobile/Nomadic IAB, is the scenario limited to single hop deployments or for multi-hop cases? (e.g. the moving IAB is an access node multiple hops away from the donor or is a parent to other IAB nodes)

Unlicensed Spectrum: is unlicensed spectrum also proposed to be used in a mobile IAB scenario?

## **3 – Intel Corporation (UK) Ltd**

Q1: What scenarios are included in this direction (one or both of the following)?

– Access in unlicensed and backhaul in licensed (MT in licensed and DU in unlicensed)

– MT connected with licensed and unlicensed parent DUs

Both scenarios need some further work/discussion from RAN1, and further clarification may be needed on whether full-duplex mode will be supported in Rel-18 IAB.

Q2:• How to understand “Autonomous alignment of feature support between migrating IAB-node and RAN.” Does it mean IAB-node fast adopting gNB features (fast update the configuration and notify UE)? What is referred as OAM-based feature?

Q3: For operation in unlicensed band, could you please clarify what is the scenario considered here? 1) access in unlicensed band, while backhaul in licensed band or 2) MT is connected with both licensed and unlicensed parent DU?

Q4:What is the medium access result in unlicensed band? How IAB resource management is affected by it?

Q5:For local services, does it assume the root of IAB-network is a mobile IAB-node, which also has an application layer to provide local services? Or the mobile IAB-network moves within the range of a gNB and consider a multicast or broadcast? Or it considers the CPE/FWA as IAB node, and local services is supported within the home base station.

## **4 – LG Electronics Inc.**

As addressed in your paper, we also think that Rel-18 IAB can support more dynamic mobility and it is important to reduce interruption and interference by mobility. With this in mind, we would like to ask followings for clarification on your proposals.

1. Regarding interference management, what kind of interference management, e.g., CLI enhancement, do you consider?

2. Regarding handover, your paper mentions only node-mobility-aware handover, but reducing interruption by mobility is another key factor to provide stable backhaul performance and now zero-interruption mobility for NR UE, i.e., DAPS, cannot be used for IAB node. What do you think about enhanced DAPS or DC-based interruption reduction for mobility?

## **5 – Lenovo Mobile Com. Technology**

Generally, we are agreed to further discuss mobile IAB and unlicensed spectrum for IAB.

For “Autonomous alignment of feature support between migrating IAB-node and RAN”, what is the “OAM-based feature” and how to autonomously align the feature?

For mobile and nomadic IAB, does the hop count of the topology need to be limited in order to simplify the complexity?

For IAB with NPN, it has been discussed by R16 and some enhancements have been introduced, what the objectives to further discuss in R18.

#### **6 – ZTE Corporation**

Thanks for the contribution. We are interested to the mobile relay scenario. We also submit a paper "RWS-210475 Support of Mobile IAB for 5G Advanced" to address this issue.

For the local services at migrating IAB node, is the local break out service similar to LiPA/SIPTO in LTE, or the local switch defined in 5GC in TS 23.501? Could you please clarify?

#### **7 – NTT DOCOMO INC.**

For NTN-based backhauling in Nomadic IAB-node deployment, do you consider the scenario where IAB node is used as Regenerative Satellite, or the scenario where IAB node (e.g. on the ground) is provided with backhaul link by Transparent satellite in Rel-17 NTN?

#### **8 – Samsung Electronics Co.**

Our general thought is that if IAB on unlicensed band is introduced, the existing NR-U operation can be re-utilized as much as possible. In this sense, we have one question about channel access. Could you elaborate how you can increase opportunity for successful medium access by enhancing IAB resource management?

In addition, we have the following questions:

Q1: Could you please clarify the difference between "in-vehicle IAB-access" and "moving cell site"?

Q2: Should the support for NTN-based backhauling be included in NTN scope?

Q3: Shall we involve HAPS/UAV discussion in IAB scope?

Q4: For autonomous alignment of feature support between migrating IAB node and RAN, is this aiming at skipping OAM configuration to the migrating IAB node?

Q5: For local service at migrating IAB node, the scenario is unclear since the IAB node does not have PDCP/SDAP layer, how to provide the local service?

Q6: Will Rel-18 aim at supporting mesh?

Q7: Is the PCI and RACH collision resulted from reusing those resource by the non-stationary IAB nodes?

#### **9 – Fraunhofer HHI**

Thanks for the interesting contribution. Fraunhofer shares similar views on several topics.

Could the following also be clarified:

#1) Similar to Intel's question, what scenarios does Qualcomm foresee regarding unlicensed/licensed-assisted/licensed mode in the access and backhaul for mobile IAB?

#2) CU sharing is specifically mentioned. Does Qualcomm also foresee the IAB donor node sharing (DU and CU)?

## 15.2 Response – Round 1

### 1 - Response to vivo Mobile Communications Co

Thank you for your questions and feedback. We have read your contribution to the Rel-18 WS, and it seems

we have similar views on Mobile IAB and unlicensed IAB.

**WI vs. SI:** We believe the enhancement of these use cases are sufficiently straight forward to be handled in a WI.

**Mobile IAB in high-speed train:** Support for Uu in high-speed train should be handled in a separate WI since it also applies to UEs. Mobile IAB could transparently leverage this work.

**Spec impact of NR-U:** A baseline solution for IAB network in NR-U with no or minimum spec changes can be that an IAB node follows Rel16/17 resource management framework for resource partition between parent and child links, and IAB-DU/MT follows LBT procedure specified for gNB/UE, respectively, at the assigned resources. This baseline solution may lead to inefficient resource utilization for IAB in NR-U due to uncertainty of LBT results, e.g. an IAB-DU or MT may not be able to access the channel either due to LBT failure within its assigned resources or due to unavailable resources though passing LBT. Better resource utilization can be achieved by further enhancements, which require spec changes for unlicensed channel access procedure, as for instance:

1. Extending COT sharing between co-located MT/DU within an IAB-node and cross parent-child nodes.
2. Optimizing channel sensing by co-located MT and DU at an IAB-node, e.g. separate channel sensing with shared contention window update; dynamic parameter adjustments for channel sensing based on multiplexing capability of the IAB-node.
3. Dynamic adaptation of resource partition between parent and child links based on LBT results.

**Priority Mobile IAB vs. IAB-U:** Mobile IAB is mainly RAN2/3 effort while IAB-U is RAN1 effort. We don't expect these two use cases to compete for TUs.

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## 2 - Response to InterDigital

Thank you for your questions and feedback.

**Enhancements for Nomadic IAB:** Nomadic deployments share many of the enhancements needed for Mobile IAB such as power and interference management (due to suboptimal site selection), PCI/RACH collision avoidance and autonomous alignment of feature support with the local RAN.

**Hop-count for Mobile/Nomadic IAB:** For Mobile IAB, single-hop should be enough (potentially last hop of stationary IAB-network). For Nomadic IAB, multi-hop can be supported since it essentially represents a stationary network.

**Combining Mobile-IAB and IAB-U:** IAB-U and Mobile-IAB represent independent enhancements. They can certainly be used together.

### 3 - Response to Intel Corporation

Thank you for your questions and feedback.

**Scenarios for licensed/unlicensed:** We consider different combinations of licensed and unlicensed bands across access and backhaul links:

1. Both access and backhaul use unlicensed band,
2. Access uses unlicensed, and backhaul uses licensed,
3. Mixed licensed and unlicensed operation for backhaul and access.

**Autonomous alignment of feature support:** The mobile/nomadic IAB-node will certainly support OAM connectivity and use network integration as defined for Rel-16/17 IAB. The issue addressed here refers to the match up of capabilities between IAB-node and RAN. Typically, there is no inter-RAN-node capability reporting, and it is up to the operator to match up RAN nodes via OAM. For IAB, there is some limited capability reporting, which is fine for a stationary deployment. For mobile/nomadic IAB-nodes, this OAM-based match-up between IAB-nodes and RAN is not an option. Alternatives include:

- 1) Define a more extended mandatory feature set for Mobile/Nomadic IAB.
- 2) Extend present capability reporting by IAB-nodes.
- 3) Extend signaling mechanisms that allow IAB-nodes and RAN to mutually converge on features/functionality used.

**Medium access in unlicensed band:** A baseline solution for IAB network in NR-U with no or minimum spec

changes can be that an IAB node follows Rel16/17 resource management framework for resource partition between parent and child links, and IAB-DU/MT follows LBT procedure specified for gNB/UE, respectively, at the assigned resources. This baseline solution may lead to inefficient resource utilization for IAB in NR-U due to uncertainty of LBT results, e.g. an IAB-DU or MT may not be able to access the channel either due to LBT failure within its assigned resources or due to unavailable resources though passing LBT. Better resource utilization can be achieved by further enhancements, which require spec changes for unlicensed channel access procedure, as for instance:

1. Extending COT sharing between co-located MT/DU within an IAB-node and cross parent-child nodes.
2. Optimizing channel sensing by co-located MT and DU at an IAB-node, e.g. separate channel sensing with shared contention window update; dynamic parameter adjustments for channel sensing based on multiplexing capability of the IAB-node.
3. Dynamic adaptation of resource partition between parent and child links based on LBT results.

**Local service at IAB-node:** This means that an application server can be collocated with the IAB-node for in-vehicle access. It is expected that existing architecture options are leveraged. This includes local breakout at the IAB-node (like LIPA in 4G), which implies that a CU-UP and UPF are collocated with the IAB-node to terminate PDCP/SDAP/PDU-session. This also allows in-vehicle UE-to-UE communications using a local route with local switch at the UPF. The CU-CP could remain centralized. It is also perceivable that a full gNB resides in the vehicle, and IAB is used to route Ng-C as “non-F1” traffic via the macro RAN to the CN.

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#### 4 – LG Electronics Inc.

Thank you for your questions and feedback. We have also read your paper on factory IAB. We believe that factory IAB and mobile IAB have various aspects in common.

**Enhancements to interference management:** Presently, CLI framework is based on the assumption that cells are stationary and that the mutual interference does not change due to cell mobility. This assumption is not valid for Mobile IAB. It needs to be discussed how the existing CLI framework can serve these scenarios based on proper configuration, or if enhancements are necessary.

**Zero-interruption mobility for IAB-node:** BH interruption during IAB-node handover is certainly an important aspect. This might be even more critical for factory IAB than in mobile IAB. Enhancing DAPS for BH is certainly one potential option to improve on the interruption time.

## 5. Lenovo Mobile Com. Technology

Thank you for your questions and feedback. We are happy to hear that Lenovo supports mobile IAB and unlicensed IAB.

**Autonomous alignment of feature support:** The mobile/nomadic IAB-node will certainly support OAM connectivity and use network integration as defined for Rel-16/17 IAB. The issue addressed here refers to the match up of capabilities between IAB-node and RAN. Typically, there is no inter-RAN-node capability reporting, and it is up to the operator to match up RAN nodes via OAM. For IAB, there is some limited capability reporting, which is fine for a stationary deployment. For mobile/nomadic IAB-nodes, this OAM-based match-up between IAB-nodes and RAN is not an option. Alternatives include:

- 1) Define a more extended mandatory feature set for Mobile/Nomadic IAB.
- 2) Extend present capability reporting by IAB-nodes.
- 3) Extend signaling mechanisms that allow IAB-nodes and RAN to mutually converge on features/functionality used.

**Hop-count for Mobile/Nomadic IAB:** For Mobile IAB, single-hop should be enough (potentially last hop of stationary IAB-network). For Nomadic IAB, multi-hop can be supported since it essentially represents a stationary network.

**Enhancements for NPN:** We believe that one essential enhancement relates to RAN-sharing where IAB is used by the NPN while CU and CN functionality is provided by a PLMN.

## 6. ZTE Corporation

Thank you for your questions and feedback. We also read your WS submission. It seems we have quite similar views on mobile IAB.

**Local service at IAB-node:** This means that an application server can be collocated with the IAB-node for in-vehicle access. It is expected that existing architecture options are leveraged. This includes local breakout at the IAB-node (like LIPA in 4G), which implies that a CU-UP and UPF are collocated with the IAB-node to terminate PDCP/SDAP/PDU-session. This also allows in-vehicle UE-to-UE communications using a local

route with local switch at the UPF. The CU-CP could remain centralized. It is also perceivable that a full gNB resides in the vehicle, and IAB is used to route Ng-C as “non-F1” traffic via the macro RAN to the CN.

## 7. NTT DOCOMO

Thank you for your questions and feedback.

**NTN-based backhauling:** Two scenarios could be considered:

- 1) NTN is used on the IAB backhaul link. This should be rather straightforward as long as the associated BH latency is acceptable.
- 2) The IAB-node is placed on a regenerative satellite. We believe that this scenario is beyond the scope of Rel-18 Mobile IAB.

## 8. Samsung Electronics

Thank you for your questions and feedback.

**Medium access in unlicensed band:** A baseline solution for IAB network in NR-U with no or minimum spec changes can be that an IAB node follows Rel16/17 resource management framework for resource partition between parent and child links, and IAB-DU/MT follows LBT procedure specified for gNB/UE, respectively, at the assigned resources. This baseline solution may lead to inefficient resource utilization for IAB in NR-U due to uncertainty of LBT results, e.g. an IAB-DU or MT may not be able to access the channel either due to LBT failure within its assigned resources or due to unavailable resources though passing LBT. Better resource utilization can be achieved by further enhancements, which require spec changes for unlicensed channel access procedure, as for instance:

1. Extending COT sharing between co-located MT/DU within an IAB-node and cross parent-child nodes.
2. Optimizing channel sensing by co-located MT and DU at an IAB-node, e.g. separate channel sensing with shared contention window update; dynamic parameter adjustments for channel sensing based on multiplexing capability of the IAB-node.
3. Dynamic adaptation of resource partition between parent and child links based on LBT results.

**Moving cell-site vs. in-vehicle access:** The moving cell-site provides access to outside UEs, e.g., in urban scenarios (without precluding access to inside UEs). The absolute speed of the IAB-node and handover frequency are presumably uncritical. Issues, such as relative speed to UEs, PCI collision, power control, etc. need to be considered. In-vehicle access primarily applies to inside UEs only, e.g., such as in trains. In this scenario, the absolute vehicle speed and BH handover frequency may be high. Also, support for in-vehicle local services may have to be considered.

**NTN-based backhauling:** Two scenarios could be considered:

- 1) NTN is used on the IAB backhaul link. This should be rather straightforward as long as the associated BH latency is acceptable.
- 2) The IAB-node is placed on a regenerative satellite. We believe that this scenario is beyond the scope of Rel-18 Mobile IAB.

**UAV/HAPS:** It is not clear if there is a lot of commercial interest for HAPS, presently. The UAV use case is currently discussed in the context of SL.

**Autonomous alignment of feature support:** The mobile/nomadic IAB-node will certainly support OAM connectivity and use network integration as defined for Rel-16/17 IAB. The issue addressed here refers to the match up of capabilities between IAB-node and RAN. Typically, there is no inter-RAN-node capability reporting, and it is up to the operator to match up RAN nodes via OAM. For IAB, there is some limited capability reporting, which is fine for a stationary deployment. For mobile/nomadic IAB-nodes, this OAM-based match-up between IAB-nodes and RAN is not an option. Alternatives include:

- 1) Define a more extended mandatory feature set for Mobile/Nomadic IAB.
- 2) Extend present capability reporting by IAB-nodes.
- 3) Extend signaling mechanisms that allow IAB-nodes and RAN to mutually converge on features/functionality used.

**Local service at IAB-node:** This means that an application server can be collocated with the IAB-node for in-vehicle access. It is expected that existing architecture options are leveraged. This includes local breakout at the IAB-node (like LIPA in 4G), which implies that a CU-UP and UPF are collocated with the IAB-node to terminate PDCP/SDAP/PDU-session. This also allows in-vehicle UE-to-UE communications using a local route with local switch at the UPF. The CU-CP could remain centralized. It is also perceivable that a full gNB resides in the vehicle, and IAB is used to route Ng-C as “non-F1” traffic via the macro RAN to the CN.

**Mesh-based routing:** Mesh-based routing on BAP layer was proposed in Rel-17 and not adopted. It is not

clear if mesh-based routing on BAP layer is necessary for the new use cases we propose for Rel-18.

**PCI and RACH resource collision:** This related to collisions among Mobile/Nomadic IAB-nodes and/or between Mobile/Nomadic IAB-nodes and stationery IAB-network

## 9. Fraunhofer HHI

Thank you for your questions and feedback. We have read your contribution and it seems that we have very similar views on Mobile IAB, IAB-U and RAN sharing.

**Scenarios for licensed/unlicensed:** We consider different combinations of licensed and unlicensed bands across access and backhaul links:

1. Both access and backhaul use unlicensed band,
2. Access uses unlicensed, and backhaul uses licensed,
3. Mixed licensed and unlicensed operation for backhaul and access.

**RAN sharing scenarios:** Sharing of the entire gNB or only the gNB-DU should be supported. In case RAN uses IAB, gNB sharing does not pose a major problem since this gNB also assumes donor functionality. For gNB-DU-only sharing, each PLMN/NPN holds a separate gNB-CU. This poses a problem for IAB since only one of the gNB-CUs can support donor functionality, while the other gNB-CUs establish traffic bearers without having the means to allocate the corresponding resources at the BH and to ensure the appropriate QoS support on the BH.

## 15.3 Input – Round 2

## Feedback Form 28: IAB - Round 2

### 1 – Huawei Technologies France

Thanks for the contribution.

For the IAB in unlicensed band, do both the MT and DU use unlicensed band? What's the typical scenario?

## 15.4 Response – Round 2

### Huawei Technologies France

Thanks for the contribution.

For the IAB in unlicensed band, do both the MT and DU use unlicensed band? What's the typical scenario?

[Answer] Thank you for your interest. As mentioned in round 1, we consider different combinations of licensed and unlicensed bands across access and backhaul links:

1. Both access and backhaul use unlicensed band,
2. Access uses unlicensed, and backhaul uses licensed,
3. Mixed licensed and unlicensed operation for backhaul and access. Any of these combinations might have significance. Especially unlicensed >60GHz is attractive as backhaul technology. Due to high frequency, multiple hops may have to be necessary, which implies that optimization of parent-child resource coordination should be supported. Another use case is NPN (e.g. IIOT) where access and backhaul may share the same unlicensed band (scenario 1).

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## 16 On NR Positioning Evolution - Perspectives for Release 18 - RWS-210021

### 16.1 Input – Round 1

#### Feedback Form 29: Positioning - Round 1

### 1 – DanKook University

1) Page 4 insists on introducing Phase-Differentiated based techniques for DL-AoD, while Page 6 argues that carrier phase positioning is less attractive. Phase based DL-AoD and carrier phase positioning are eventually the same phase-based measurement technology. Do you mean that phase based measurement should only be used for DL-AoD?

2) Using a carrier wavelength of only a few centimeters may be vulnerable to multipath effects, but using larger wavelengths, such as subcarriers of few meters to hundred meters wavelength, phase measurement

can be relatively robust to multipath effects. Is your comment considered in the case of using such extended length of subcarriers?

3) The reason why the carrier phase should be studied in Rel-18 is that there are various benefits to be gained, such as bandwidth efficiency and synchronization, as well as accrual enhancement.

## 2 – CATT

### Comments:

CATT shares a similar view with Qualcomm on the following aspects, e.g., support of narrowband positioning in R18; study of PRS/SRS Bandwidth Aggregation for improving the accuracy.

About Slide 6 on Carrier phase Positioning, we would like to provide the following comments:

1) **Sensitivity to multipath.** In our view, the issue needs to be address for all positioning approaches that are based on RF signals, especially high-accuracy positioning, including GNSS Carrier phase Positioning. Thus, this should not be used as a reason for not supporting NR Carrier phase Positioning;

2) **Network time/frequency synchronization.** Similar to DL-TDOA and UL-TDOA, the positioning accuracy will be impacted by Network time/frequency synchronization accuracy. Without the full network time/frequency synchronization, we may not be able achieve the target 0.20m accuracy for R17. The common approach to deal with then Network time/frequency synchronization errors, and also other errors, e.g., Tx/Rx timing delay error, is to use differential techniques with reference stations, which are commonly used GNSS positioning. RAN1 has reached the consensus on the benefits of using reference stations for improving positioning performance in RAN1#105e, and an LS was sent to RAN2/3 on the potential impact on the specification to support reference positioning unit.

3) **Implications to RF architectures/antennas /requirements.** In our view, we are not expecting significant change to RF architectures/antennas/requirements for both UE & gNBs. GNSS receiver chip that is able to support carrier phase positioning is very cheap already. Cellular signals are much stronger than GNSS signals. In our view, it would be much easier for UE/gNB to provide Carrier phase measurement from NR signals than GNSS receiver from GNSS signals;

4) **Perform improvement.** It is well known that cm-level accuracy can be achieved for carrier phase positioning, i.e., at least one-order higher accuracy than Rel-17 in LOS environment.

5) **Use Cases.** There are many use cases for cm-level positioning as currently supported by GNSS Carrier phase Positioning (e.g., RWS-210117). The main issue with GNSS Carrier phase Positioning is that it cannot be used when GNSS signals are not available, e.g., indoor, under the tunnel etc.

## 3 – Sony Europe B.V.

1) Generally we also support on the evolution of positioning, e.g. Further Enhanced POS which may include device efficieny in term of power consumption. (See also our contribution RWS-210301)

2) What is the targeted device for narrowband positioning for IoT? For example, is it exclusively for Narrowband NR as described in RWS-210017? Can it be a redcap device?

2) Considering we may have limited TU, what would be QC's prioritization on those proposed items?

## 4 – ZTE Corporation

We have the following comments:

(1) We are also supportive of multiple FL/carriers PRS/SRS reception for the sake of large bandwidth, please see our tdoc RWS-210471;

(2) On page 7 in your slides: Regarding the last bullet, could you please elaborate more on what ‘Asynchronous Location’ is? Further, does ‘SRS to serving gNB only’ mean pathloss RS/spatial relation of SRS should be from the serving gNB?

(3) On page 7 in your slides: Regarding the first bullet for positioning in RRC idle, do you think this should still rely on small data transmission(SDT) in RRC idle ? Actually, we proposed SDT in RRC idle in our tdoc RWS-210485, page 14. We think your proposal for positioning is quite related with our SDT proposal as what we done in Rel-17.

(4) On page 8, what’s the expected spec. impact with joint sidelink&Uu positioning?

#### **5 – Intel Corporation (UK) Ltd**

For asynchronous location without non-serving-cell SRS, is there an intention to specify DL PRS measurement by serving gNB?

#### **6 – Spreadtrum Communications**

Thanks for the well-written contribution. For asynchronous Location without non-serving-cell SRS, we have some questions:

Q1: How to achieve network-sync-robust positioning?

Q2: And is there an intention to specify DL-PRS measurement by serving gNB?

Q3: If question 2 is yes, what is your intention of this measurement? and what metrics are measured?

#### **7 – Ericsson-LG Co.**

We have a couple of questions:

1. For ‘Phase difference DL AoD’ - is the intention to standardize a new multi port DL PRS to allow measurements of phase differences between the signals transmitted from different antenna elements, i.e. from different DL PRS ports?

2. For frequency hopping for RedCap UE reception of DL PRS – is the intention that RedCap UEs should be capable of performing such frequency hopping reception of DL PRS *coherently*.

#### **8 – MediaTek Inc.**

Q1: Please could you elaborate on the gains from LMF in the RAN compared to what is possible today? Assume this would first need to be discussed with SA2?

Q2: How did you arrive at the conclusion that Carrier Phase techniques would be similar performance as for other methods in LOS environments? We understand that your narrowband DL-AoD proposal for narrowband also is a kind of phase measurement, so why do you conclude something different compared to the Carrier Phase proposal?

#### **9 – LG Electronics Inc.**

Q1: What’s the target positioning accuracy of narrow-band positioning for IoT or RedCap devices, compared to wide-band positioning that was proposed for biz competitiveness?

Q2: Regarding DRX-aware positioning, we see trade-off between positioning accuracy and DRX power-saving as mentioned on page 7. In order to enhance positioning accuracy, we may consider ‘UE behavior for transmission/reception of PRS outside of DRS’. But, if UE is allowed transmission/reception of PRS outside of DRS, ‘larger power consumption’ could be an arguing point. If you have any idea to resolve the possible concern, could you explain more for clear understand to introduce DRX-aware positioning

**10 – Samsung Electronics Co.**

1. For "Architecture for low latency positioning", do you consider the RAN local based positioning manner, which has been studied to be feasible before? And do you expect RAN1 impacts on this manner?

**11 – Nokia France**

For location server functionality in RAN, do you see other use cases in addition to low latency?

## 16.2 Response – Round 1

### DanKook University

# 1

1) Page 4 insists on introducing Phase-Differentiated based techniques for DL-AoD, while Page 6 argues that carrier phase positioning is less attractive. Phase based DL-AoD and carrier phase positioning are eventually the same phase-based measurement technology. Do you mean that phase based measurement should only be used for DL-AoD?

[Answer] Thanks for the comment and the discussion. In Page 6 we are referring to Carrier-phase Timing measurements using an RTK-type of solution which requires carrier phase measurements across multiple TRPs and the related synchronization issues/requirements that arise from such type of solutions. Page-4 is proposing solutions for narrowband positioning: with 1<sup>st</sup> item frequency hopping for increased BW (with target timing measurements) and , for DL-AoD, phase-difference measurement from the antennas of a single TRP. Issues related to integer ambiguity, limited network synchronization, absence of highly-accurate positioning reference devices for network synchronization purposes, are going to limit an RTK-type carrier phase positioning vs a phase-difference DL-AoD positioning or vs the current NR Rel-16/17 solutions.

2) Using a carrier wavelength of only a few centimeters may be vulnerable to multipath effects, but using larger wavelengths, such as subcarriers of few meters to hundred meters wavelength, phase measurement can be relatively robust to multipath effects. Is your comment considered in the case of using such extended length of subcarriers?

[Answer] Thanks for the comment and the discussion. Extended length of subcarriers (e.g. meter and above) are not considered in our reply, in the sense that we are considering the available current NR spectrum. For example, even for the n71 (600 MHz) band has a wavelength of 0.5 meter.

3) The reason why the carrier phase should be studied in Rel-18 is that there are various benefits to be gained, such as bandwidth efficiency and synchronization, as well as accrual enhancement.

[Answer] Thanks for the comment and the discussion. As noted in the paper and the replies above, it is not clear to us whether there exist any terrestrial environment or use case where accuracy benefits may be expected over the already defined methods & potential enhancements when the realistic considerations on network synchronization, reference devices, current Freq/time drifts are considered.

### CATT

# 2

### Comments:

CATT shares a similar view with Qualcomm on the following aspects, e.g., support of narrowband positioning in R18; study of PRS/SRS Bandwidth Aggregation for improving the accuracy.

About Slide 6 on Carrier phase Positioning, we would like to provide the following comments:

- 1) **Sensitivity to multipath.** In our view, the issue needs to be address for all positioning approaches that are based on RF signals, especially high-accuracy positioning, including GNSS Carrier phase Positioning. Thus, this should not be used as a reason for not supporting NR Carrier phase Positioning;
- 2) **Network time/frequency synchronization.** Similar to DL-TDOA and UL-TDOA, the positioning accuracy will be impacted by Network time/frequency synchronization accuracy. Without the full network time/frequency synchronization, we may not be able achieve the target 0.20m accuracy for R17. The common approach to deal with then Network time/frequency synchronization errors, and also other errors, e.g., Tx/Rx timing delay error, is to use differential techniques with reference stations, which are commonly used GNSS positioning. RAN1 has reached the consensus on the benefits of using reference stations for improving positioning performance in RAN1#105e, and an LS was sent to RAN2/3 on the potential impact on the specification to support reference positioning unit.
- 3) **Implications to RF architectures/antennas /requirements.** In our view, we are not expecting significant change to RF architectures/antennas/requirements for both UE & gNBs. GNSS receiver chip that is able to support carrier phase positioning is very cheap already. Cellular signals are much stronger than GNSS signals. In our view, it would be much easier for UE/gNB to provide Carrier phase measurement from NR signals than GNSS receiver from GNSS signals;
- 4) **Perform improvement.** It is well known that cm-level accuracy can be achieved for carrier phase positioning, i.e., at least one-order higher accuracy than Rel-17 in LOS environment.
- 5) **Use Cases.** There are many use cases for cm-level positioning as currently supported by GNSS Carrier phase Positioning (e.g., RWS-210117). The main issue with GNSS Carrier phase Positioning is that it cannot be used when GNSS signals are not available, e.g., indoor, under the tunnel etc.

[Answer] Thanks for the comment and the discussion. Please find related comments to this topic in our reply above. Issues related to integer ambiguity, limited network synchronization, absence of highly-accurate positioning reference devices for network synchronization purposes, are going to limit an RTK-type carrier phase positioning vs a phase-difference DL-AoD positioning or vs the current NR Rel-16/17 solutions.

**Sony Europe B.V.**

# 3

- 1) Generally we also support on the evolution of positioning, e.g. Further Enhanced POS which may include device efficiency in term of power consumption. (See also our contribution RWS-210301)

[Answer] Thanks for the note. Indeed it is an important topic.

- 2) What is the targeted device for narrowband positioning for IoT? For example, is it exclusively for Narrowband NR as described in RWS-210017? Can it be a redcap device?

[Answer] Thanks for the comment. No it is not related to the NarrowBand NR described in RWS-210017; It is actually to related to Redcap (and related evolution in NR Rel-18) devices and IoT devices. It is about identifying NR Positioning enhancements in NR Rel-18 to expand further the value of the IoT devices with low Bandwidth & low processing capabilities.

2) Considering we may have limited TU, what would be QC's prioritization on those proposed items?

[Answer] Thanks for the question. We are interested in all the proposals shown in this contribution, but we can highlight some of our higher interest items: Narrowband Positioning, high accuracy/Bandwidth, low power Positioning. Please note that SL-Positioning is also a high interest item but it is in a different contribution/discussion (RWS-210008).

#### **4 – ZTE Corporation**

We have the following comments:

(1) We are also supportive of multiple FL/carriers PRS/SRS reception for the sake of large bandwidth, please see our tdoc RWS-210471

[Answer] Thanks for the comment. Indeed it is an important item that was firstly evaluated in the SI of Rel-17, with promising performance results.

(2) On page 7 in your slides: Regarding the last bullet, could you please elaborate more on what 'Asynchronous Location' is? Further, does 'SRS to serving gNB only' mean pathloss RS/spatial relation of SRS should be from the serving gNB?

[Answer] Thanks for the question. This is one of the techniques within the low-power positioning scope that we envision for a Rel-18 Positioning WI. A summary of an example of the technique is shown below:

UE side Behavior (similar to current specification):

UE transmits SRS towards serving cell

UE measures PRS from serving and neighboring TRPs, reports Rx-Tx for each TRP

gNB side Behavior (Enhancement over current specification):

Serving gNB need to measure PRS from neighboring TRPs

Serving gNB reports the RSTD between the reception of PRS and the reception of the SRS

LMF receives the measurements of the UEs and gNBs, and can perform elliptic-based positioning

Benefits over NR Rel-16/17 approach:

Low-Tx-Power Transmission of SRS (serving cell only SRS)

Network sync robustness (similar to the case of RTT)

No need of dedicated SRS for Positioning for non-serving cell

Elliptic-based Positioning can complement DL-only measurements (RSTD)

(3) On page 7 in your slides: Regarding the first bullet for positioning in RRC idle, do you think this should still rely on small data transmission(SDT) in RRC idle ? Actually, we proposed SDT in RRC idle in our tdoc RWS-210485, page 14. We think your proposal for positioning is quite related with our SDT proposal as what we done in Rel-17.

[Answer] Thanks for the question. Indeed, if SDT in RRC Idle is within the scope of Rel-18, then it could be exploited for Positioning also. We also have a proposal for SDT in RRC Idle for Rel-18 in RWS- 210007.

(4) On page 8, what's the expected spec. impact with joint sidelink&Uu positioning?

[Answer] Thanks for the question. There can be enhancements related to measurements, reference signals being used, high-layer procedures & SL/Uu-joint assistance data enhancements.

## **5 – Intel Corporation (UK) Ltd**

For asynchronous location without non-serving-cell SRS, is there an intention to specify DL PRS measurement by serving gNB?

[Answer] Thanks for the question. Yes our understanding is that this would be required. We provide in the reply above a more detailed example of our thoughts on this scenario.

## **6 – Spreadtrum Communications**

Thanks for the well-written contribution. For asynchronous Location without non-serving-cell SRS, we have some questions:

Q1: How to achieve network-sync-robust positioning?

Q2: And is there an intention to specify DL-PRS measurement by serving gNB?

Q3: If question 2 is yes, what is your intention of this measurement? and what metrics are measured?

[Answer] Thanks for the questions. Yes our understanding is that PRS reception from the serving gNB would be needed. We provide in the reply above a more detailed example of our thoughts on this scenario.

## **7 – Ericsson-LG Co.**

We have a couple of questions:

1. For ‘Phase difference DL AoD’ - is the intention to standardize a new multi port DL PRS to allow measurements of phase differences between the signals transmitted from different antenna elements, i.e. from different DL PRS ports?

[Answer] Thanks for the question. It can be specified either as a PRS resource with multiple resources (e.g. like a multi-port CSI-RS resources for CSI), or as multiple single-port PRS resources within a PRS resource set, where the UE is configured with the necessary information to perform this measurement.

2. For frequency hopping for RedCap UE reception of DL PRS – is the intention that RedCap UEs should be capable of performing such frequency hopping reception of DL PRS *coherently*.

[Answer] Thanks for the question. The short answer is yes, we envision as one of the capabilities to have to receive frequency-hopped PRS such that a better timing resolution is achieved compared to the non-coherent averaging . A typical problem when there is frequency hopping is that there can be phase jumps between the multiple receptions. However, it can be investigated within the scope of the work item what specification enhancements (and corresponding signaling & performance requirements) are needed to enable a UE to perform such coherent PRS reception & frequency hopping. A simple example would be to consider a UE that is doing switching on 2 PRS symbols such that there is overlap in the BW received in both of them. Then, that UE could estimate the phase jump occurring due to the frequency hop and compensate it.

## 8 – MediaTek Inc.

Q1: Please could you elaborate on the gains from LMF in the RAN compared to what is possible today?

Assume this would first need to be discussed with SA2?

[Answer] Thanks for the question. The latency gains have been evaluated in e.g. R2-2010096 (RAN2#112-e) or R3-193587 (RAN3#105). In R2-2010096 we observed:

Observation 1: Location Server functionality in the RAN (e.g., LMC) could reduce the positioning procedure latency significantly. With the given assumptions, the improvements can be:

for UL+DL methods: 40% - 55%;

for UL-only methods: 50% - 61%;

for DL-only methods: 23% - 41%.

In addition, we think RAT-dependent positioning methods (in particular in FR2) can benefit from more ”radio awareness” at a location server, e.g., for beam management, UL/DL PRS coordination, etc. With a location server in the core network additional NRPPa based interaction between a 5GC LMF and NG-RAN elements would be needed, which is less efficient.

Another benefit would be scalability. A centralized location server (possibly one or two per AMF shared over a large number of gNBs) is less suited for supporting a large number of UEs/location requests. A distributed location server functionality (potentially in every gNB) would better scale in case of a large number of UEs need to be supported (e.g., IoT use cases). A distributed location server functionality can also provide better fault tolerance and redundancy. E.g. in case of a LMF failure in the serving gNB, a LMF in a neighbour gNB could be selected.

Other groups (e.g., SA2) would need to be involved, however, since a 5GC LMF and NG-RAN LMF can coexist in a network, we think the item could be RAN2/3 led.

Q2: How did you arrive at the conclusion that Carrier Phase techniques would be similar performance as for other methods in LOS environments? We understand that your narrowband DL-AoD proposal for narrowband also is a kind of phase measurement, so why do you conclude something different compared to the Carrier Phase proposal?

[Answer] Thanks for the question. In short, we consider that there are several technical issues related to integer ambiguity, limited network synchronization, absence of highly-accurate positioning reference devices for network synchronization purposes, which are going to limit significantly an RTK-type carrier phase positioning vs the current Rel-16/17 solutions and the phase-difference DL-AoD proposal.

## **9 – LG Electronics Inc.**

Q1: What's the target positioning accuracy of narrow-band positioning for IoT or RedCap devices, compared to wide-band positioning that was proposed for biz competitiveness?

[Answer] Thanks for the question. It depends on the operational bandwidth of the IoT or Redcap device. However, we can envision devices with 5 MHz bandwidth, and a target of <10m (or better), (or 20 MHz BW devices with similar targets of <3 m as in NR rel-16/17), depending on UE capabilities and potential enhancements that will be specified. For example, performing receive frequency hopping with coherent processing across the PRS hops, could effectively increase the Positioning bandwidth and achieve the performance of a 20 MHz device with just a few hops of 5 MHz each.

Q2: Regarding DRX-aware positioning, we see trade-off between positioning accuracy and DRX powersaving as mentioned on page 7. In order to enhance positioning accuracy, we may consider 'UE behavior for transmission/reception of PRS outside of DRS'. But, if UE is allowed transmission/reception of PRS outside of DRS, 'larger power consumption' could be an arguing point. If you have any idea to resolve the possible concern, could you explain more for clear understand to introduce DRX-aware positioning

[Answer] Thanks for the question. An example of DRX-aware positioning is the following: LMF is provided with the DRX configuration of a specific UE, and adjusts the PRS configuration (e.g. through the on-demand PRS framework that will be specified by the end of Rel-17) to ensure that PRS are within the active time of the UE.

## **10 – Samsung Electronics Co.**

1. For "Architecture for low latency positioning", do you consider the RAN local based positioning manner,

which has been studied to be feasible before? And do you expect RAN1 impacts on this manner?

[Answer] Yes, we consider (at least) some location server functionality in the RAN to be beneficial (see also our response to 8 above). As you noted, it has been studied in SA2, RAN2, RAN3 during Rel-16 already, and there should be no RAN1 impacts. However, RAN1 may exploit the availability of a RAN based location server for e.g., lower layer triggered measurement requests or reports, or triggering of measurement gaps, configured grants, awareness of DRX, etc.

## 11 – Nokia France

For location server functionality in RAN, do you see other use cases in addition to low latency?

[Answer] Please see our responses to 8 and 10 above. In addition to low latency, we consider better "radio awareness" and scalability beneficial.

## 16.3 Input – Round 2

### Feedback Form 30: Positioning - Round 2

#### 1 – ZTE Corporation

(1) Due to the limitation of RedCap UE bandwidth and processing capability, do you think frequency hopping will cause more UE complexity which against the motivation of introducing RedCap UEs? Further, do you think frequency hopping will affect the unicast transmission and scheduling, channel measurement and CSI feedback of Redcap UEs especially if SRS frequency hopping is applied?

(2) Regarding the proposal of asynchronous Location without non-serving-cell SRS, how could we handle the asynchronous issues between the transmission of SRS and PRS from the neighbor cells? In our view, the positioning accuracy of TDOA between reception of SRS and PRS highly depends on whether synchronous can be ensured between SRS and PRS transmission. However, it is hard to ensure SRS and PRS are synchronous since UL transmission involve TA issues which may partially belong to UE implementation.

#### 2 – Guangdong OPPO Mobile Telecom.

Q1: on narrow band positioning, the min BW of PRS is 24 PRBs. That can be used for RedCap UEs. Is that not sufficient for RedCap UE?

Q2: On PRS/SRS bandwidth aggregation: this has been discussed in rel17 SI. The time difference between different subband has critical negative impact on that. And it would increase the UE implementation complexity significantly.

#### 3 – Beijing Xiaomi Mobile Software

Thanks for your answers, please see our further questions below:

Q1: What bandwidth do you think is needed to achieve 10cm distance accuracy and 2 degree angle accuracy?

Q2: As for PRS/SRS Bandwidth Aggregation, we want to know the target maximum bandwidth by aggregation, will it be larger than 100MHz in FR1/ 400MHz in FR2?

Q3: Can PRS/SRS bandwidth aggregation include both licensed band and unlicensed band?

Q4: For ‘RRC Inactive for DL&UL Positioning’, we want to clarify that it means the enhancements based on Rel-17 RRC inactive DL&UL Positioning, or it just want to address any leftover of Rel-17 RRC inactive DL&UL Positioning?

Q5: Is there a need to have a short study phase to clarify the requirement for IoT or RedCap and perform the evaluation to see if there is gap to reach that requirement?

#### **4 – Samsung Electronics Co.**

Q: If RAN local based positioning and also the single cell based positioning is feasible, do you think it’s feasible or attractive to extend the usage of the positioning information for other purpose, e.g., beam management.

#### **5 – CATT**

For carrier-phase positioning, while we share the similar view that issues related to integer ambiguity, limited network synchronization, absence of highly-accurate positioning reference devices for network synchronization purposes need to be resolved for supporting RTK-type carrier phase positioning in NR, we consider many of the existing techniques (e.g., double differential techniques) that have been used in GNSS can be adopted for NR carrier phase positioning. Similar to GNSS carrier phase positioning, we do not expect NR carrier phase positioning is suitable for all RF environments. But, in our view, it is applicable at least for some of the RF environments where LOS signals can be reliably detected. We are wondering what is Qualcomm’s view on this.

#### **6 – LG Electronics Inc.**

Thank you for clarification, we have additional minor concerns for DRX-aware positioning.

Q1: Do you think that bandwidth aggregation also needs to be supported in RRC inactive state? Could you explain the intention of bandwidth aggregation and multiple DRX configurations in terms of DRX-Aware positioning?

## 16.4 Response – Round 2

### **ZTE Corporation**

# 1

(1) Due to the limitation of RedCap UE bandwidth and processing capability, do you think frequency hopping will cause more UE complexity which against the motivation of introducing RedCap UEs? Further, do you think frequency hopping will affect the unicast transmission and scheduling, channel measurement and CSI feedback of Redcap UEs especially if SRS frequency hopping is applied? (2) Regarding the proposal of asynchronous Location without non-serving-cell SRS, how could we handle the asynchronous issues between the transmission of SRS and PRS from the neighbor cells? In our view, the positioning accuracy of TDOA between reception of SRS and PRS highly depends on whether synchronous can be ensured between SRS and PRS transmission. However, it is hard to ensure SRS and PRS are synchronous since UL transmission involve TA issues which may partially belong to UE implementation.

[Answer] Thanks to the additional comment. Overall, we consider accurate & robust positioning the result of combining/enhancing several methods, and not the result of a single-positioning technology. With regards to the timing-based methods, if we stay within (e.g.) 5 MHz BW, we are going to be bandwidth-limited, unless we use hopping to increase the bandwidth. So, enhancements are needed to ensure that time-domain-based methods can play a role to achieve better accuracy. Even though hopping would be an additional feature, we

consider it important for the competitiveness of the eRedcap devices in the positioning arena, and we consider it within the complexity envelope of eRedcap devices. Enhancements in angle-based methods would also be useful, if identified, since these are not limited by the bandwidth as much as the time-domain-based methods.

We don't see how SRS frequency hopping will affect the scheduling; SRS hopping is already supported for SRS-MIMO, and was down scoped for SRS-POS. With regards to PRS hopping, please note that we are talking about receive-based hopping: PRS is still wideband, e.g. 4 symbols, and the UE performs Rx-hopping; therefore there is no need for additional PRS to be transmitted; the legacy/regular PRS are being reused for both the high-end and Redcap devices (for the cases that these coexist on the same band).

With regards to Q2, even for the RTT method that is already specified, it is known that if the UE performs autonomous TA adjustments during the PRS/SRS transmissions & RTT measurements, there can be negative effects on accuracy. This problem is similar to M-RTT and the suggested approach; The suggested approach avoids requiring neighboring cells to measure SRS, (lower Tx power at the UE), by substituting this measurement from the serving gNB measuring the neighboring PRS.

### **Guangdong OPPO Mobile Telecom.**

# 2

Q1: on narrow band positioning, the min BW of PRS is 24 PRBs. That can be used for RedCap UEs. Is that not sufficient for RedCap UE?

Q2: On PRS/SRS bandwidth aggregation: this has been discussed in rel17 SI. The time difference between different subband has critical negative impact on that. And it would increase the UE implementation complexity significantly.

[Answer] Based on our simulations and analysis, since 24 PRBs at 15 KHz or 30 KHz correspond to <5 Mhz and <10 MHz respectively, timing-based methods (RTT, TDOA) would not likely meet a 10m-accuracy target (let alone tighter requirements) in several scenarios of interest. We understand that angle-based methods are not affected as much from bandwidth, but we believe that accurate/robust positioning is the result of having multiple positioning methods/technologies complementing each other. Therefore, if it is evident that one of the methods will be severely limited by the small BW, steps should be taken to study/specify enhancements that could mitigate such limitations (always within the context of low-power, low-complexity, eRedcap constraints). PRS/SRS BW aggregation was discussed in NR Rel17, but it was not concluded that indeed there are feasibility issues. There can be ways to mitigate any timing/phase difference between the aggregated PRS/SRS. For example, if the aggregated PRS are within the same band, having a small overlap between the 2 PFLs will enable the receiver to estimate any phase difference between the PFLs. In the case of intra-band PRS/SRS aggregation, since same PA is used, we believe that the timing/phase differences will be small and increased performance will be achievable over single PFL scenario.

### **Beijing Xiaomi Mobile Software**

# 3

Thanks for your answers, please see our further questions below:

Q1: What bandwidth do you think is needed to achieve 10cm distance accuracy and 2 degree angle accuracy?

Q2: As for PRS/SRS Bandwidth Aggregation, we want to know the target maximum bandwidth by aggregation, will it be larger than 100MHz in FR1/ 400MHz in FR2?

Q3: Can PRS/SRS bandwidth aggregation include both licensed band and unlicensed band?

Q4: For 'RRC Inactive for DL&UL Positioning', we want to clarify that it means the enhancements based on Rel-17 RRC inactive DL&UL Positioning, or it just want to address any leftover of Rel-17 RRC inactive DL&UL Positioning?

Q5: Is there a need to have a short study phase to clarify the requirement for IoT or RedCap and perform the evaluation to see if there is gap to reach that requirement?

[Answer] Q1: Results from the SI's InF/InH scenarios show that 10cm will be within reach using 100 MHz or more bandwidth at least for some scenarios. The angular accuracy doesn't depend strongly to the bandwidth. Even small bandwidth (e.g. 5 MHz) could be used to get relatively good angular accuracy, in some scenarios. Q2: Yes, we envision to support a target max bandwidth of at least 200 MHz in FR2 and 800 MHz in FR2. Further study/analysis may be needed during the WI to decide the maximum aggregated Bandwidth. Q3: Yes, it can be considered if inter-band aggregation is supported. Our understanding though is that intra-band aggregation would be higher priority. Q4: Leftovers of Rel-17 RRC Inactive DL/UL Positioning; as well as RRC Idle Positioning which is not addressed in Rel-17. Q5: We can discuss further if this is needed.

#### **Samsung Electronics Co., Ltd**

# 4 Q: If RAN local based positioning and also the single cell based positioning is feasible, do you think it's feasible or attractive to extend the usage of the positioning information for other purpose, e.g., beam management.

[Answer] Yes, we think it is useful and feasible if LMF in RAN is supported, since RAN can have the location information available about the UE. This type of use case essentially requires to support location service requests from functions internal to the NG-RAN node. For a RAN-LMF the necessary operations would be internal to the NG-RAN and can therefore be handled locally with reduced latency.

#### **CATT**

# 5 For carrier-phase positioning, while we share the similar view that issues related to integer ambiguity, limited network synchronization, absence of highly-accurate positioning reference

devices for network synchronization purposes need to be resolved for supporting RTK-type carrier phase positioning in NR, we consider many of the existing techniques (e.g., double differential techniques) that have been used in GNSS can be adopted for NR carrier phase positioning. Similar to GNSS carrier phase positioning, we do not expect NR carrier phase positioning is suitable for all RF environments. But, in our view, it is applicable at least for some of the RF environments where LOS signals can be reliably detected. We are wondering what is Qualcomm's view on this.

[Answer] Thanks for the comment. RF environment that are mainly LOS, can already achieve 10-20 cm accuracies as it was shown in NR rel-17 SI. The argument that an RTK-type solution will do better than this in practical LOS environments (e.g. 1-cm-type of accuracies), requires that realistic assumptions on integer ambiguity/network sync/accurate reference devices/limitations of UEs/gNB antennas are considered. When these aspects are considered, we think that it is very likely that the theoretical numbers of 1cm-type accuracy will not be reached.

**LG Electronics Inc.**

# 6 Thank you for clarification, we have additional minor concerns for DRX-aware positioning.

Q1: Do you think that bandwidth aggregation also needs to be supported in RRC inactive state? Could you explain the intention of bandwidth aggregation and multiple DRX configurations in terms of DRX-Aware positioning?

[Answer] We are open to consider BW aggregation in the context of multiple DRX configuration, but it may be a second optimization of each separate feature (BW aggregation, DRX-aware positioning). Similarly, considering BW aggregation in RRC inactive may be a second optimization after first addressing each separate feature (BW aggregation and RRC inactive).

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## 17 On RAN slicing enhancements for Rel-18 - RWS-210022

### 17.1 Input – Round 1

#### Feedback Form 31: RAN slicing - Round 1

##### 1 – KDDI Corporation

Thank you very much for the proposal. Let me ask three questions below for the clarifications.

<Q1>

In our understanding, the current RAN3 assumption is that DU is connected to only one CU-CP. Do you expect to change the current assumption to allow DU to be connected to multiple CU-CPs?

<Q2>

From UE's point of view, do you expect that UE connects to only one CU-CP? Or do you expect that UE connects to multiple CU-CPs simultaneously?

<Q3>

We found that there are other multiple CUs proposals relevant to CU resiliency/load balancing. Do you expect that dedicated CUs can be used for those purposes also?

##### 2 – ZTE Corporation

Thanks for your proposal.

We understand the slice specific CU would be beneficial especially for non-eMBB case.

Regarding the common procedures mentioned in the architecture and functional aspects part, what kind of common procedures would be impacted if we have slice specific CU?

### **3 – Nokia**

Q1: What is meant by “slice specific CU”? For example, does it mean that a single gNB can have multiple CU-CPs, and a single DU can have active F1-C connectivity to multiple CU-CPs?

Q2: Slide 2 indicates that slice specific CU(-CP)s are the focus of the document. However, Slide 4 mentions “slice specific CU(-CP/UP)”. Does your proposal envision any enhancements for slice specific CU-UP beyond what can already be supported in R15, e.g. CU-UPs in different security domains?

### **4 – Ericsson LM**

In slide 3, it appears that the “green network (CU+DUs)” can be seen as a SNPN, and the blue network can be seen as PLMN. Is this what you have in mind?

### **5 – Intel Corporation (UK) Ltd**

How does the DU know the slice for selecting slice specific CU?

### **6 – CATT**

Thanks for the contribution. Some questions from our side are as below:

- 1) Could you please clarify the key benefits of the proposal comparing with the legacy solution in which multiple slices could be supported in one CU?
- 2) With this proposal, does it mean that we need to support and specify the case that a gNB-DU is connected to multiple gNB-CUs first?

### **7 – Samsung Electronics Co.**

When a UE has multiple services served by different slices (i.e. different CU functions for different slices), which CU is responsible for the mobility management?

### **8 – LG Electronics UK**

Thanks for the proposal.

Could you clarify the meaning of the dedicated CU for network slicing? In current specification, the operator can already deploy the dedicated NG-RAN functions to support differentiated handling of traffic for different network slices. So, what would be the benefit of the dedicated CU for network slicing?

## 17.2 Response – Round 1

Thank you to all companies that have provided input and questions. Below are the list of all questions in Round 1 and Responses.

### **Questions from KDDI Corporation:**

<Question 1>

In our understanding, the current RAN3 assumption is that DU is connected to only one CU-CP. Do you expect to change the current assumption to allow DU to be connected to multiple CU-CPs?

<Response 1>

The DU is already allowed to connect to multiple CU-CPs for RAN sharing. We are proposing to now allow the , DU to connect to multiple CU-CPs based on slicing as well, i.e., the CU-CP for a specific device could be selected based on slicing information. (How this selection works would be part of the study).

<Question 2>

From UE's point of view, do you expect that UE connects to only one CU-CP? Or do you expect that UE connects to multiple CU-CPs simultaneously?

<Response 2>

Our expectation is UE connects to one CU-CP.

<Question 3>

We found that there are other multiple CUs proposals relevant to CU resiliency/load balancing. Do you expect that dedicated CUs can be used for those purposes also?

<Response 3>

That's a very good point, we'd expect that CU selection mechanisms should consider both factors taking into account slicing information and resiliency/load balancing as a common procedure.

### **Questions from ZTE Corporation:**

<Question 1>

Regarding the common procedures mentioned in the architecture and functional aspects part, what kind of common procedures would be impacted if we have slice specific CU?

<Response 2>

Procedures like service request and connected mode mobility would be impacted by CU selection. Depending on the solutions the information flow in current procedures may be impacted to perform such selection.

### **Questions from Nokia:**

<Question 1>

What is meant by "slice specific CU"? For example, does it mean that a single gNB can have multiple CU-CPs, and a single DU can have active F1-C connectivity to multiple CU-CPs?

<Response 1>

For a single UE, there would be one CU-CP at a given moment, the selection of the CU-CP may take into

account active slices. We don't envision for now multiple CU-CPs serving a same UE simultaneously.

It will be left to the study to determine if a single gNB has multiple CU-CPs or if a gNB is a single CU-CP and a single DU can be part of multiple gNBs (as in PLMN sharing).

We think a single DU will have active F1-C connectivity to multiple CU-CPs which is already the case for PLMN sharing.

<Question 2>

Slide 2 indicates that slice specific CU(-CP)s are the focus of the document. However, Slide 4 mentions "slice specific CU(-CP/UP)". Does your proposal envision any enhancements for slice specific CU-UP beyond what can already be supported in R15, e.g. CU-UPs in different security domains?

<Response 2>

Impacts to CU-CP are our main focus of the study. But when it comes to the details, we did not want to rule out that we might need a gap analysis to see if there would be any impacts for CU-UP.

### **Questions from Ericsson:**

<Question 1>

In slide 3, it appears that the "green network (CU+DUs)" can be seen as a SNPN, and the blue network can be seen as PLMN. Is this what you have in mind?

<Response 1>

No, we did not have in mind that the CU selection criteria would be based on access to PLMN or SNPN, but the figure intends to depict difference network instances dedicated to specific slice(s). The green network intends to depict CU-CP deployments closer to edge.

### **Questions from Intel Corporation:**

<Question 1>

How does the DU know the slice for selecting slice specific CU?

<Response 2>

That would be the core of the study and multiple solutions can be considered. At a very high level though, either the slicing information is provided to the DU, e.g. by the UE, and the DU performs CU-CP selection, or if the DU does not have this information there may be CU-CP reselection (e.g. after receiving slicing information from 5GC).

### **Questions from CATT:**

<Question 1>

Could you please clarify the key benefits of the proposal comparing with the legacy solution in which multiple slices could be supported in one CU?

<Response 1>

One clarification is that the intention is not that a CU-CP supports only one slice.

However, as an example, a RAN deployment may have CU-CP instances that are better equipped to service URLLC and eMBB, in terms of processing capability/speed, functionality and location (e.g. edge), and others meant to only serve eMBB. For UEs that only receive eMBB the CU-CPs for eMBB are selected, and for the UES with active URLLC resources, the CU-CPs better equipped for URLLC+eMBB are selected.

In more general terms, this would allow CU-CP instance that are specialized for certain types of services (which doesn't mean that can only support one specific slice).

<Question 2>

With this proposal, does it mean that we need to support and specify the case that a gNB-DU is connected to multiple gNB-CUs first?

<Response 2>

It is our understanding the a gNB-DU can already connect to multiple gNB-CUs for RAN sharing. This work would extend that use case to slicing as well.

### **Questions from Samsung Electronics Co., Ltd:**

<Question 1>

When a UE has multiple services served by different slices (i.e. different CU functions for different slices), which CU is responsible for the mobility management?

<Response 1>

One clarification we'd like to make is that we do not intend to have multiple CU-CPs serving a same UE simultaneously, but rather one CU-CP is selected based on the slice(s) being active (or being activated) at the moment. This is similar to the current core network concept of a single AMF across multiple slices.

### **Questions from LG Electronics UK:**

<Question 1>

Could you clarify the meaning of the dedicated CU for network slicing? In current specification, the operator can already deploy the dedicated NG-RAN functions to support differentiated handling of traffic for different network slices. So, what would be the benefit of the dedicated CU for network slicing?

<Response 1>

A NW may deploy CU-CP instances that have powerful processing capability and speed, CU-CPs that are closely located (e.g. edge) and specific functionality, that can better serve slices with stringent requirements, and other CU-CP instances that do not require such capabilities for “regular” traffic.

As an example, a RAN deployment may have CU-CP instances that are better equipped to service URLLC and eMBB, in terms of processing capability/speed, functionality and location (e.g. edge), and others meant to only serve eMBB. For UEs that only receive eMBB the CU-CPs for eMBB are selected, and for the UES with active URLLC resources, the CU-CPs better equipped for URLLC+eMBB are selected.

## 17.3 Input – Round 2

### Feedback Form 32: RAN slicing - Round 2

#### 1 – Fujitsu Limited

Thanks for the contribution. We are interested in CU selection / re-selection based on slice information in P4. Details needs be studied but it is helpful to see any responses. Do you mean that DU would select CU like F1-flex mechanism? If this is the case, do you consider to study some new procedure similar to CU-change procedure?

#### 2 – KDDI Corporation

Thanks for the answers. Let me ask one question relevant to <Response1> in round1. Do you expect to reuse the current RAN sharing mechanism specified in TS38.401 section 8.11 Support of Network Sharing with multiple cell-ID broadcast as a baseline? Or do you expect to study something new?

#### 3 – CATT

Thank you for your answers. We acknowledge that the current specification supports the sceanrio that one DU connects with multiple CUs but only for RAN sharing case. Here, it seems the sceanrio is extended. We are open to further discussion on this topic. Besides, as mentioned by Nokia, we think it may also deserve to discuss enhancements on slicing specific CU-UP at the same time.

## 17.4 Response – Round 2

### Fujitsu Limited

# 1

Thanks for the contribution. We are interested in CU selection / re-selection based on slice information in P4. Details needs be studied but it is helpful to see any responses. Do you mean that DU would select CU like F1-flex mechanism? If this is the case, do you consider to study some new procedure similar to CU-change

procedure?

Qualcomm Response #1:

On a high level, there are 2 (not mutually exclusive) modes of CU selection that can be considered:

DU selects CU based on received slice information.

CU reselection (if DU did not receive slice information and selected a CU without taking slice information into account) once slice information is received, e.g. from the 5GC.

We believe both mechanisms asked in your question are in scope of the study.

**KDDI Corporation**

# 2

Thanks for the answers. Let me ask one question relevant to <Response1> in round1. Do you expect to reuse the current RAN sharing mechanism specified in TS38.401 section 8.11 Support of Network Sharing with multiple cell-ID broadcast as a baseline? Or do you expect to study something new?

Qualcomm Response #2:

Many aspects of that section are likely to be reused. However, note that there are some gaps. For instance, in case of Network Sharing the DU knows the PLMN ID right after RRCSetupComplete is received. In some cases, the UE may indeed provide the Requested NSSAI and DU would be able to use this information. However, UE may not provide this information at RRC, and gNB may receive this from 5GC and perform CU reselection at that point.

**CATT**

# 3

Thank you for your answers. We acknowledge that the current specification supports the scenario that one DU connects with multiple CUs but only for RAN sharing case. Here, it seems the scenario is extended. We are open to further discussion on this topic. Besides, as mentioned by Nokia, we think it may also deserve to discuss enhancements on slicing specific CU-UP at the same time.

Qualcomm Response #3:

Correct, the scenario is indeed extended within a same PLMN. Thank you, and we look forward for more discussions on this topic.

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18 On CPE upper layer enhancements for Rel-18 -  
RWS-210030

18.1 Input – Round 1

**Feedback Form 33: CPE - Round 1**

18.2 Response – Round 1

18.3 Input – Round 2

**Feedback Form 34: CPE - Round 2**

18.4 Response – Round 2

**19 On NR for Wireless PLC and Other IIoT Services - RWS-210016**

19.1 Input - Round 1

**Feedback Form 35: Wireless PLC / IIOT - Round 1**

**1 – Guangdong OPPO Mobile Telecom.**

1. Agreed with motivation and use cases raised in this paper.
2. Improving the reliability and latency in SL communication has always been the backbone of developing the SL and enhancement since R16. These enhancement areas although target for V2X, PS and commercial use case, they are equally applicable for IIoT uses. These requirements for IIoT can be also used as inputs for the further SL enhancement WI in R18 and beyond.

**2 – Intel Corporation (UK) Ltd**

- Q1: Do you consider unlicensed spectrum for sidelink IIOT with strict latency and reliability numbers?
- Q2: Do you have any specific PHY/MAC enhancements in mind to support time-sensitive sidelink communication?
- Q3: Do you think sidelink could be enabled in parallel to Uu thus creating further redundant transmission, e.g. at PDCP layer?

**3 – CATT**

- Q1: What exactly do you mean by "Baseline Rel-17 Uu with two-hop communication via gNB (which can utilize higher antenna-count and power available at gNB)" ?
- Q2: What do you consider the UE power consumption aspect of this enhancement ? Since NR- IIoT and NR-V2x are based on different UE power consumption assumptions.

19.2 Response - Round 1

**Guangdong OPPO Mobile Telecom.**

# 1

1: Agreed with motivation and use cases raised in this paper.

2. Improving the reliability and latency in SL communication has always been the backbone of developing the SL and enhancement since R16. These enhancement areas although target for V2X,PS and commercial use case, they are equally applicable for IIoT uses. These requirements for IIoT can be also used as inputs for the further SL enhancement WI in R18 and beyond.

[Answer] Thank you for the positive comments and feedback. We believe that sidelink, together with Uu, can provide a strong framework for meeting the stringent latency and reliability requirements in IIoT . Hence, we agree that SL enhancements in Rel18+ should explicitly take IIoT requirements into consideration.

### **Intel Corporation (UK) Ltd**

# 2

Thank you for the questions, please see below:

Q1: Do you consider unlicensed spectrum for sidelink IIOT with strict latency and reliability numbers?

[Answer] We believe 3GPP should consider both the options: dedicated spectrum where available (e.g., 3.7-3.8GHz in Germany) and unlicensed spectrum.

Q2: Do you have any specific PHY/MAC enhancements in mind to support time-sensitive sidelink communication?

[Answer] Indeed, 3GPP should consider specific sidelink PHY/MAC enhancements to meet the stringent latency and reliability requirements in IIoT: SL CG/DG configuration for both SL transmitter and receiver, direct feedback for faster re-transmission scheduling, SL CSI scheduling and reporting, among others.

Q3: Do you think sidelink could be enabled in parallel to Uu thus creating further redundant transmission, e.g. at PDCP layer?

[Answer] Indeed, based on the factory environment and traffic requirements, 3GPP should consider different architectures of combined SL/Uu communication , including PDCP duplication/switching, HARQ-level fixed/dynamic switching.

### **CATT**

# 3

Thank you for the questions, please see below:

Q1: What exactly do you mean by ” Baseline Rel-17 Uu with two-hop communication via gNB (which can utilize higher antenna-count and power available at gNB)” ?

[Answer] We mean that to study the performance of the proposals incorporating direct communication, e.g.,

over sidelink, between PLC and sensors/actuators (S/A) and comparing with the baseline of Rel.17 two-hop Uu communication, PLC->gNB->S/A, allowing for typical gNB antenna/power configuration, which can be higher than the configuration available for sidelink at PLC and S/As.

Q2: What do you consider the UE power consumption aspect of this enhancement ? Since NR- IIoT and NR-V2x are based on different UE power consumption assumptions.

[Answer] Indeed, the UE power consumption can be different over Uu and sidelink and can be explicitly accounted for. More specifically, the selection between direct communication and 2-hop Uu communication can take into account overall resource usage, in terms of spectrum (RBs) and t power, while meeting the latency and reliability requirements.

### 19.3 Input - Round 2

#### Feedback Form 36: Wireless PLC / IIOT - Round 1

##### 1 – Intel Corporation (UK) Ltd

Further Q: For SL CSI scheduling and reporting, do you mainly consider Mode-1 enhancement enabling CSI for SL available at gNB, or this also targets improved overall CSI framework for both Mode-1 and Mode-2?

### 19.4 Response - Round 2

#### Intel Corporation (UK) Ltd

# 1

Further Q: For SL CSI scheduling and reporting, do you mainly consider Mode-1 enhancement enabling CSI for SL available at gNB, or this also targets improved overall CSI framework for both Mode-1 and Mode-2?

[Answer] 3GPP should consider enhancements on SL CSI scheduling and reporting for both Mode-1 and Mode-2. The former will be particularly needed for the IIoT scenarios with stringent latency/reliability requirements, such as motion control, while the latter can be useful in the IIoT scenarios with relatively relaxed requirements, such as process automation.

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## 20 Appendix: List of documents covered in this contribution

**Table 1: Documents covered in this discussion**

Tdoc	Name
RWS-210005	On V2X evolution
RWS-210006	On NR-LTE V2X Co-Channel Coexistence
RWS-210007	On 5G & IOT – A UE centric perspective

RWS-210008	On Sidelink positioning
RWS-210009	NR Sidelink Evolution & Use Case Expansion for Rel-18
RWS-210010	On XR Improvement for NR
RWS-210011	On NR NTN Evolution
RWS-210012	On NTN IOT for Rel-18
RWS-210013	On Terrestrial broadcast evolution for Rel-18
RWS-210014	On Aerial Support in NR
RWS-210015	On Enhancements to NR MBS for Rel-18
RWS-210017	On Narrowband NR in Dedicated Spectrum enabling new 5G verticals
RWS-210019	NR Smart Repeaters for Rel-18
RWS-210020	Rel-18 IAB - New use cases to enhance RAN topology
RWS-210021	On NR Positioning Evolution - Perspectives for Release 18
RWS-210022	On RAN slicing enhancements for Rel-18
RWS-210030	On CPE upper layer enhancements for Rel-18
RWS-210016	On NR for Wireless PLC and Other IIoT Services