

## **RAN-R18-WS-non-eMBB-Apple - Version 0.0.8**

### **RAN**

#### **3GPP TSG RAN Rel-18 workshop RWS-210552**

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

Agenda Item: 4.2

Source: Apple Inc.

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

Document for: Report

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## **1 Introduction**

This document is created to provide Q&A regarding the Apple contributions for the thread [RAN-R18-WS-non-eMBB-Apple], which covers the following Apple contributions:

1. RWS-210495, “Sidelink relay enhancements in R18”
2. RWS-210496, “Discussion on Sidelink Positioning”
3. RWS-210500, “Considerations on NR enhancements for XR”
4. RWS-210501, “NR NTN Enhancement in Rel-18”
5. RWS-210502, “NR Sidelink Further Enhancement in Rel-18”
6. RWS-210503, “On unlicensed band enhancement”
7. RWS-210504, “Views on Redcap Enhancements for Rel-18”

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## **2 Q&A**

For companies who have general comments and questions regarding Apple contributions for the non-eMBB related Rel-18 work, please use the feedback form below

## Feedback Form 1:

### 2.1 Comments/Questions to RWS-210495 on Sidelink Relay

In the contribution RWS-210495, “Sidelink relay enhancements in R18”, we provided several proposals for the sidelink relay enhancement in Rel-18 in RAN2, the proposals are listed as below for easy reference

Recommend the following objectives to Rel-18 WI on Sidelink Relay Enhancements:

1. Objective 1: Specify common part for both L2 and L3 U2U relay
  - U2U relay discovery
  - U2U relay (re)selection
2. Objective 2: Specify Layer 2 specific UE-to-UE relay work
  - Data forwarding in User plane, e.g., PC5 adaptation layer header.
  - CP Procedures: service continuity & mobility support.
3. Objective 3: Leftovers of R17 U2N relay work can also be considered.
  - e.g., Inter-gNB mobility for U2N relay

#### 2.1.1 Round 1 Comments/Questions (LOCKED)

For round 1, please provide your comments and questions regarding RWS-210495 on sidelink relay enhancement in RAN2 in the feedback form below

## Feedback Form 2:

### 1 – CATT

In general we support SL relaying enhancement in R18 (as stated already in our paper RWS-210407). Then a few questions for clarification

- 1) for U2N part as proposed in your paper, do you also consider indirect/indirect path switching?
- 2) for CP procedures, besides service continuity & mobility support, do you also consider aspects such as connect. establishment, RLF handling, etc?

#### 2.1.2 Round 1 Response from Apple

### Response to CATT

Q1. for U2N part as proposed in your paper, do you also consider indirect/indirect path switching?

A1: Yes, we are OK to finish the indirect-indirect path switching in R18 as part of R17 leftovers. If there is a need to rank the remaining mobility issues to be included in R18 for L2 U2N relay, we rank inter-gNB > indirect/indirect > group mobility.

Q2. for CP procedures, besides service continuity & mobility support, do you also consider aspects such as connect. establishment, RLF handling, etc?

A2: Yes, we support to include any essential procedures to ensure L2 U2U relay work are in object 2, including RLF handling and end-to-end connection establishment procedures.

### 2.1.3 Round 2 Comments/Question (LOCKED)

For round 2, please provide your further comments and questions regarding RWS-210495 on sidelink relay enhancement in the feedback form below

#### **Feedback Form 3:**

##### **1 – HuaWei Technologies Co.**

In Rel-17 we have not yet supported U2U and we think it may be possible to have a fundamental U2U function for Rel-18, and do you think we can start from single hop on U2U?

### 2.1.4 Round 2 Response from Apple

#### **Response to Huawei:**

Q: In Rel-17 we have not yet supported U2U and we think it may be possible to have a fundamental U2U function for Rel-18, and do you think we can start from single hop on U2U?

A: Yes, we think the work on U2U relay need start from single-hop.

## 2.2 Comments/Questions to RWS-210496 on Sidelink Positioning

In the contribution RWS-210496, “Discussion on Sidelink Positioning”, we provided several proposals for the sidelink based positioning, the proposals are listed as below for easy reference

Recommend the following objectives to Rel-18 WI on Sidelink positioning:

1. Objective 1: Relative positioning/ranging over sidelink

- Sidelink positioning reference signals and measurements

- Configurations to support both in-coverage and out-of-coverage scenarios

- Algorithms to estimate distance and angle
- UE-based methods and procedures for sidelink positioning

2. Objective 2: Hybrid Positioning (PC5 + Uu Combined)

- Messages/signaling protocol enhancements (e.g. LPP) to enable hybrid positioning
- Both UE-based and UE-assisted methods are supported.

2.2.1 Round 1 Comments/Questions (LOCKED)

For round 1, please provide your comments and questions regarding RWS-210496 on sidelink positioning in the feedback form below

**Feedback Form 4:**

<p><b>1 – Intel Corporation (UK) Ltd</b></p> <p>&lt;Intel&gt;</p> <p>Q1. As for hybrid positioning, can it be assumed that hybrid positioning reference signals (PRS/SRS) over both Uu and SL need to be defined? Are there any additional impact of supporting this hybrid positioning solution?</p>
<p><b>2 – CATT</b></p> <p>In general, CATT shares the similar view with Apple on the issues that need to be considered for SL positioning.</p> <p>Q1: In Page 9, “Algorithms to estimate distance and angle” is included in Objective 1. Any special reason to include it? Positioning algorithms are normally implementation dependent and not defined in the standard.</p>
<p><b>3 – Beijing Xiaomi Mobile Software</b></p> <p>1. Do you think the commercial and public safety use cases and requirements identified in SA1 Ranging WI(TR22.855/TS22.261) should be taken into account?</p> <p>2. 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)?</p> <ul style="list-style-type: none"> <li>- relative positioning: relative positioning is to estimate position relatively to other network elements or relatively to other UEs.</li> <li>- 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.</li> </ul>

3. Do you think unlicensed band should be considered? If so, what frequency range is considered(e.g. 60GHz)?
4. What bandwidth do you think is needed to achieve 10cm distance accuracy and 2 degree angle accuracy?
5. For in coverage case, do you think UE based SL-positioning should also be supported?
6. Do you think power consumption and Redcap UE should be taken into account?

#### **4 – Motorola Mobility Germany GmbH**

[Lenovo, Motorola Mobility]:

Thank you for your contribution.

Q1: Given the complementary benefits of Uu and SL positioning and the amount of WG-level work required for SL Positioning, do you envision that a separate study for SL positioning should be pursued in Rel-18?

Q2: Do you also think that there is a joint (in the same potential Rel-18 SL Positioning study) or separate (continuing the general Positioning work) opportunity in Rel-18 to exploit the synergies of both Uu and SL positioning for improving the overall absolute and relative location estimation performance?

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

Usually algorithms to estimate distance and angle is up to UE, what is expected to be specified by this bullet?

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

Does it mean that SL positioning should not consider locating a UE via **multiple** UEs by saying "Calculating the relative distance is sufficient in many applications."?

#### **7 – Sony Europe B.V.**

Thanks for the contribution, in principle, we also support sidelink positioning as indicated in our contribution RWS-210301.

It seems partial coverage scenario is not shown/considered. Is that your intention?

#### **8 – InterDigital Communications**

"algorithms to estimate distance and angle", are they based on Rel. 16/17 positioning methods such as timing/angle based positioning? Do you support sidelink positioning for partial coverage?

#### **9 – Nokia Denmark**

QUESTION: is the actual target of objective 2 hybrid positioning to support also partial coverage with P2?

### 2.2.2 Round 1 Response from Apple

#### **Response to Intel**

Q: As for hybrid positioning, can it be assumed that hybrid positioning reference signals (PRS/SRS) over both Uu and SL need to be defined? Are there any additional impact of supporting this hybrid positioning solution?

A: For reference signals in Uu, we prefer to leverage existing signal rather than defining new PRS/SRS. For

SL, new reference signals are expected to be introduced. The hybrid (combined) solutions will have additional impact on both NW and UE side, especially for power consumption and overhead aspects, but we can focus on the key enablers first in R18.

### **Response to CATT**

Q: In Page 9, “Algorithms to estimate distance and angle” is included in Objective 1. Any special reason to include it? Positioning algorithms are normally implementation dependent and not defined in the standard.

A: For algorithms, what we mean is the mathematic methods underneath the SL positioning technology. The algorithm does not need to be exactly specified, but has to be commonly understood so that the measurements and signaling can be built on the top of this understanding and the constraints of the algorithms are also addressed by WGs. I think at least some of those understandings are to be studied and captured.

### **Response to Beijing Xiaomi Mobile Software**

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

A1: We are open to extend the positioning use case to commercial case so that some SA1 requirements for range can also be taken into account in this RAN work.

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

- 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.

A2: We do not think those two are drastically different. The angle component is quite important in both relative positioning and ranging. A ranging solution only provide angle or only provide distance is less useful.

Q3: Do you think unlicensed band should be considered? If so, what frequency range is considered(e.g. 60GHz)?

A3: We are open to consider unlicensed band, but this also depends on the discussion outcome of potential work on SL in Unlicensed.

Q4: What bandwidth do you think is needed to achieve 10cm distance accuracy and 2 degree angle accuracy?

A4: So far, the stringent set of requirements in TR 38.845 is targeted for sub-meter. So, we have not focus on 10cm accuracy yet. But we are open to discuss this accuracy requirement further with other companies.

Q5: For in coverage case, do you think UE based SL-positioning should also be supported?

A5: Yes

Q6: Do you think power consumption and Redcap UE should be taken into account?

A6: We would prefer this to be discussed under RedCap enhancement in R18, rather than under positioning topic.

#### **Response to Lenovo, Motorola Mobility**

Q1: Given the complementary benefits of Uu and SL positioning and the amount of WG-level work required for SL Positioning, do you envision that a separate study for SL positioning should be pursued in Rel-18?

A1: We are open to have a SI for SL positioning, or SI phase in WI for R18.

Q2: Do you also think that there is a joint (in the same potential Rel-18 SL Positioning study) or separate (continuing the general Positioning work) opportunity in Rel-18 to exploit the synergies of both Uu and SL positioning for improving the overall absolute and relative location estimation performance?

A2: We prefer to have a single positioning WI for R18 and sidelink positioning shall be the primary objective and other general enhancements which are not related to SL positioning can be put as second priority.

#### **Response to Guangdong OPPO Mobile Telecom.**

Q: Usually algorithms to estimate distance and angle is up to UE, what is expected to be specified by this bullet?

A: Please see our response to CATT.

#### **Response to Huawei**

Q: Does it mean that SL positioning should not consider locating a UE via multiple UEs by saying "Calculating the relative distance is sufficient in many applications."?

A: We think relative positioning can be an independent objective rather than being treated as an inter-mediate goal for absolute positioning. If applications request for relative positioning, then UE and NW shall just provide relative positioning and not necessarily to locate UE's absolute coordinates.

### **Response to Sony**

Q: It seems partial coverage scenario is not shown/considered. Is that your intention?

A: No, we also support partial coverage scenarios and both IC and OOC techniques can be considered in PC case.

### **Response to InterDigital Communications**

Q: "algorithms to estimate distance and angle", are they based on Rel. 16/17 positioning methods such as timing/angle based positioning? Do you support sidelink positioning for partial coverage?

A: Not necessarily reusing R16/R17 techniques. We support to consider new techniques, but tend to agree the measurements available in SL interface are also either timing-based or RSRP-based.

For partial coverage question, Yes, see above. We support PC (partial coverage) case.

### **Response to Nokia**

Q: is the actual target of objective 2 hybrid positioning to support also partial coverage with P2?

A: Yes, as mentioned above, we support PC case.

### **2.2.3 Round 2 Comments/Question (LOCKED)**

For round 2, please provide your further comments and questions regarding RWS-210496 on sidelink positioning in the feedback form below

## Feedback Form 5:

### 1 – ZTE Corporation

Do you think some new positioning algorithms other than Rel-16/17 algorithms including TDOA/AOA/AOD/RTT are needed for SL relative positioning? If yes, what kind of algorithms in your mind?

#### 2.2.4 Round 2 Response from Apple

##### Response to ZTE

Q: Do you think some new positioning algorithms other than Rel-16/17 algorithms including TDOA/AOA/AOD/RTT are needed for SL relative positioning? If yes, what kind of algorithms in your mind?

A: We prefer to reuse the existing procedures to Uu positioning for SL positioning, but we are open to consider new techniques if they are justified/needed.

#### 2.3 Comments/Questions to RWS-210500 on XR

In the contribution RWS-210500, “Considerations on NR enhancements for XR”, we provided several proposals for the XR related work, the proposals are listed as below for easy reference

1. Proposal 1: Rel-18 NR enhancements for XR should be motivated by XR services’ traffic characteristics, especially the multiple data flow aspects.
2. Proposal 2: Rel-18 XR WID should specify the mechanism to adapt UE processing of data channel, control channel, CSI feedback to XR traffic flows:
  - Specify enhancements in SPS/configured grant/DRX configurations to adopt to non-integer periodicity of XR traffic.
  - Evaluate and specify control signaling enhancements to adapt to time-varying packet size for XR traffic.
  - Specify CSI enhancements for faithful CSI measurements.
  - Support CSI/HARQ feedback enhancements to achieve efficient transmission and satisfy stringent latency requirement.
3. Proposal 3: Study, identify and specify if needed, suitable protocol enhancements to efficiently enable the support of XR traffic characteristics based on Rel-17 studies in RAN1 and SA4.
4. Proposal 4: Specify enhancements to configure and enable UE scheduling assistance information
  - Study, identify and specify if needed, the set of QoS parameters for XR including how to signal them and how to optimize the system for bursty traffic characteristics exposed by XR (in interaction with SA2)
  - Identify and specify enhancements for end-to-end scheduling adjustments (in interaction with SA4)

5. Proposal 5: Investigate and specify handling of different latency budgets for different data flows in the same PDSCH/PUSCH.

### 2.3.1 Round 1 Comments/Questions (LOCKED)

For round 1, please provide your comments and questions regarding RWS-210500 on XR enhancement in Rel-18 in the feedback form below

#### Feedback Form 6:

<p><b>1 – Spreadtrum Communications</b></p> <p>What is the function of new enhanced protocol in proposal 3? The clock for TSN?</p>
<p><b>2 – CATT</b></p> <p>Thanks for sharing the idea of NR enhancement for XR. The proposals of NR control/data/feedback adapting to XR traffic, protocol enhancement, UE assistance to scheduling, and handling of traffic with delay budget are quite interesting. However, we believe the aspects of NR enhancements should be discussed in the working groups first with conclusion in the XR study before further discussion of the scope of XR work item.</p>
<p><b>3 – Classon Consulting</b></p> <p>[for FUTUREWEI]</p> <p>Thank you for the nice paper. We agree that better performance under interference conditions is a must for XR, and support CSI enhancements. We also support cooperative MIMO/interference probing and avoiding for higher capacity, as can be seen in RWS-210036 p8 which shows large capacity gains from interference probing/pre-scheduling. <a href="https://nwm-trial.etsi.org/#/documents/4580">https://nwm-trial.etsi.org/#/documents/4580</a> .</p>
<p><b>4 – HuaWei Technologies Co.</b></p> <p>Q1. We have similar proposal and also see some value on NR enhancements to deal with multiple data streams aspects for XR. Do you have any specific consideration on what kind of enhancements can be done in RAN? In addition, since the multiple data streams in XR may have different QoS requirements, we share your view that the QoS mechanism may need to be enhanced with SA2/SA4 cooperation to ensure in the end we have a workable E2E mechanism.</p> <p>Q2. Can you please clarify What kind of protocol enhancements in RAN2 is required?</p>
<p><b>5 – NTT DOCOMO INC.</b></p> <p>Thank you for interesting proposals.</p> <p>For the second bullet about control signaling enhancement in Proposal 2, as described in section 2.2.3 (PDCCH monitoring) in RWS-210500, could you clarify the relationship between the PDSCH and the embeded control signaling? Is control signaling always expected in PDSCH?</p>

**6 – LG Electronics Inc.**

Regarding potential protocol enhancements, it is not clear what kind of enhancements you expect to support XR traffic. Could you elaborate more on "treatment and preparation of SDUs for proper staggering of data in the L2 stack and MAC"?

**7 – ZTE Corporation**

1)For light-weighted control signaling embedded in the PDSCH reception occasions, how does the UE decide the PDSCH reception occasions? What kind of information should be carried by the DCI which is embedded in the PDSCH?

2)Which information can be used to indicate how much redundancy is needed further for the UE to decode the transport block?

3)How to control the reporting of UE assistance information. For example, in cases where the traffic patterns change too frequently, will the UE also report the assistance information to gNB too frequently? how to avoid this issue?

**8 – MediaTek Inc.**

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

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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?

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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?

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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?

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For enhancement to support multiple data flows in a XR service, since NR can already accommodate multiple QoS flows, what additional enhancement(s) and benefit are expected? Is this equivalent to define new 5QIs?

-

For protocol enhancements, what are the major motivation and target(s)?

2.3.2 Round 1 Response from Apple

**Response to Spreadtrum**

Q: What is the function of new enhanced protocol in proposal 3? The clock for TSN?

A: Thanks for the question. SA4/RAN1 are having discussions relevant to XR traffic characteristics, for example, SA4 has produced traffic models with multiple flows for both uplink and downlink. RAN1 may generate the physical layer support for them, RAN2 needs to have corresponding design as well to provide a complete solution.

We did not have TSN and/or clock synchronization in mind here. Rather, the enhancements should focus on enabling the support of XR in Rel-18. We would like to first evaluate potential enhancements with a holistic view from end-to-end. Details are still FFS.

### **Response to CATT**

Q: Thanks for sharing the idea of NR enhancement for XR. The proposals of NR control/data/feedback adapting to XR traffic, protocol enhancement, UE assistance to scheduling, and handling of traffic with delay budget are quite interesting. However, we believe the aspects of NR enhancements should be discussed in the working groups first with conclusion in the XR study before further discussion of the scope of XR work item.

A: Thanks for your comment. We appreciate you find our discussion interesting. The timeline for XR study/normative work can be and should be discussed.

### **Response to FUTUREWEI**

Q: Thank you for the nice paper. We agree that better performance under interference conditions is a must for XR, and support CSI enhancements. We also support cooperative MIMO/interference probing and avoiding for higher capacity, as can be seen in RWS-210036 p8 which shows large capacity gains from interference probing/pre-scheduling. <https://nwm-trial.etsi.org/#/documents/4580> .

A: Thanks for your comment. In our view, CSI enhancements for XR has several aspects: 1) faithful interference representation which facilitates gNB's scheduling, which requires the interference measurement resource to collocate with actual XR traffic at the desired UE, 2) for HARQ retransmission, given short latency budget for some data flows, CSI enhancements can be used to ensure the retransmission which may well be the last chance left, is successful. The CSI reporting should be actionable by gNB and testable for the UE, 3) to save UE power, the CSI reporting should also be aligned with the XR traffic.

We see CSI enhancements as an important topic for XR, some of them may be best handled in the XR WI, some by the MIMO WI. Of course, irrespective of where the enhancement is made, performance gain/UE power gain/etc should be demonstrated.

### **Response to Huawei**

Q1. We have similar proposal and also see some value on NR enhancements to deal with multiple data streams aspects for XR. Do you have any specific consideration on what kind of enhancements can be done in RAN? In addition, since the multiple data streams in XR may have different QoS requirements, we share your view that the QoS mechanism may need to be enhanced with SA2/SA4 cooperation to ensure in the end we have a workable E2E mechanism.

A1: Thanks for your questions and comments. For multiple data flows, if they have different traffic

characteristics (reliability, latency, periodicity, throughput, etc), MCS level selection, periodicity can be individually configured for them. As we discussed in our paper, periodicity mismatch needs to be fixed to allow better SPS/CG support. If there is a single data flow (main flow) in DL (or UL), and a small data flow (aux flow) which mainly carries higher-layer acknowledgement packets in another direction, matching CDRX periodicity with that with the main flow should be enough for CDRX enhancement. However, with multiple dataflows, such a fix to CDRX may not be sufficient. Assume there is a work item on XR, then how to coordinate with SA2/SA4 will be quite important.

Q2. Can you please clarify What kind of protocol enhancements in RAN2 is required?

A2: An initial evaluation of RAN2 capabilities and constraints should be part of XR studies to identify suitable enhancements, if any. Accurate traffic identification, scheduling of data at required granularities are important areas in our view considering packet sizes for XR and gaming and investigate the impact on performance.

In the best scenario, network capacity can be boosted so latency budget can be met and network does not need to resort to discarding backlogged packets. However, as seen from initial evaluations, the network capacity can be rather limited, because of the stringent requirements for XR. Given the SA2/SA4 requirements are even more stringent than the evaluation methodology agreed in RAN1, how to enlarge the number of UEs engaged in XR service is key. It may happen to serve every packet from every flow all the time may be challenging. With traffic related information available at gNB, it can be expected for majority of the time, gNB makes correct decision in discarding/transmitting a packet even before the transmission starts. However, how to handle packet retransmission can be also very important, for the rest of cases. For example, in downlink, staggering data according to delay budgets, e.g., the SDUs of critical importance are placed towards the beginning of the MAC PDU. And MAC SDUs with less importance which are placed after those SDUs of critical importance can be omitted in retransmission by gNB.

### **Response to NTT DOCOMO**

Q: Thank you for interesting proposals. For the second bullet about control signaling enhancement in Proposal 2, as described in section 2.2.3 (PDCCH monitoring) in RWS-210500, could you clarify the relationship between the PDSCH and the embedded control signaling? Is control signaling always expected in PDSCH?

A: If the PDSCH is scheduled by dynamic grant, such embedded control signaling is not needed. One consideration on the embedded control signaling is to achieve flexibility in gNB scheduling without involving the full suite of complexities associated with PDCCH monitoring. Then with multiple data flows, assumed each configured with a separate SPS configuration, the embedded control signaling follows each configuration. If a SPS configuration is de-activated, then the UE does not need to attempt to detect the embedded control signaling.

### **Response to LG Electronics**

Q: Regarding potential protocol enhancements, it is not clear what kind of enhancements you expect to support XR traffic. Could you elaborate more on "treatment and preparation of SDUs for proper staggering of data in the L2 stack and MAC"?

A: In the best scenario, network capacity can be boosted so latency budget can be met and network does not

need to resort to discarding backlogged packets. However, as seen from initial evaluations, the network capacity can be rather limited, because of the stringent requirements for XR. Given the SA2/SA4 requirements are even more stringent than the evaluation methodology agreed in RAN1, how to enlarge the number of UEs engaged in XR service is key. It may happen to serve every packet from every flow all the time may be challenging. With traffic related information available at gNB, it can be expected for majority of the time, gNB makes correct decision in discarding/transmitting a packet even before the transmission starts. However, how to handle packet retransmission can be also very important for the rest of cases. For example, for downlink, staggering data according to delay budgets, e.g., the SDUs of critical importance are placed towards the beginning of the MAC PDU. And MAC SDUs with less importance which are placed after those SDUs of critical importance can be omitted in retransmission by gNB.

### **Response to ZTE**

Q1: For light-weighted control signaling embedded in the PDSCH reception occasions, how does the UE decide the PDSCH reception occasions? What kind of information should be carried by the DCI which is embedded in the PDSCH?

A1: If the PDSCH is scheduled by dynamic grant, such embedded control signaling is not needed. One consideration on the embedded control signaling is to achieve flexibility in gNB scheduling without involving the full suite of complexities associated with PDCCH monitoring. Then with multiple data flows, assumed each configured with a separate SPS configuration, the embedded control signaling follows each configuration. If a SPS configuration is de-activated, then the UE does not need to attempt to detect the embedded control signaling. Essentially the embedded control signaling accompanies SPS transmission occasions. The embedded control signaling should contain minimum information e.g., the number of transport blocks for one or more available occasions, so the UE detection complexity is not as onerous as that with PDCCH.

Q2: Which information can be used to indicate how much redundancy is needed further for the UE to decode the transport block?

A2: Essentially some kind of soft HARQ-ACK is needed. The redundancy copies (e.g., at redundancy version 0) can be used. The UE may require retransmission with RV0 for 3 times for example, which is both actionable by gNB and testable for the UE. By the way, the testability issue is not well discussed in Rel-17 URLLC.

Q3: How to control the reporting of UE assistance information. For example, in cases where the traffic patterns change too frequently, will the UE also report the assistance information to gNB too frequently? How to avoid this issue?

A3: Perhaps you have some mechanism to control the feedback frequency in mind. It seems one option is that the network configures a prohibit timer to prevent UEs from sending frequent updates. But different solutions can be discussed as part of the XR work of course.

### **Response to MediaTek**

Q0: Thanks for the good contribution. We have some questions below to know more about the enhancements.

Q1: 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?

A1: dynamic grant is the best choice for DL from network capacity's perspective: the gNB can choose the suitable MCS/resource allocation/etc according to the current traffic need. However, that comes with a price for both UE power consumption due to PCCH monitoring and PDCCH overhead. Hence SPS should still be considered. Then the non-integer periodicity issue (some companies call it tempo mismatch) should be addressed for both SPS/CG.

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?

A2: Note for pose/control, even though it is periodicity is small, the reliability requirement is relaxed, it may be handled by configured grant in some cases. We would like to investigate how to avoid frequent PDCCH monitoring.

Q3: 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?

A3: Following the Rel-17 study outcome, RAN should ensure XR traffic characteristics can be supported and further identify whether any updates to QoS parameters, including solutions for cross-layer control, are potentially needed. Since XR requires a holistic view from end-to-end, we think there is a need to liaise with SA2 and SA4 after perhaps an initial evaluation phase in RAN1/RAN2. What exactly RAN awareness and application awareness mean should be identified.

Q4: For enhancement to support multiple data flows in a XR service, since NR can already accommodate multiple QoS flows, what additional enhancement(s) and benefit are expected? Is this equivalent to define new 5QIs?

A4: Defining new 5QIs is necessary, for various XR services. However, how to achieve them is key. If different QoS flows are always carried with different physical channels, gNB can tailor their transmission strategies accordingly, e.g., with multiple PDSCHs within the same slot. However, this may not be realistic from network capacity point of view, and also it may not be desirable from UE power consumption point of view. When different QoS flows are carried with different physical channels, essentially TDM is used to serve different flows. In that case the reception time for PDSCHs (transmission time for PUSCHs for UL) can be long, which translates UE power consumption. Hence there is a need to tackle the situation where a PDSCH/PUSCH carries data with multiple flows.

Q5: For protocol enhancements, what are the major motivation and target(s)?

A5: please refer to our answer in A3.

### 2.3.3 Round 2 Comments/Question (LOCKED)

For round 2, please provide your further comments and questions regarding RWS-210500 on XR enhancement in Rel-18 in the feedback form below

#### **Feedback Form 7:**

##### **1 – Fujitsu Limited**

Thank you for the contribution and answers.

We are interested in the protocol enhancement and MAC PDU which is explained about. We have proposal in RWS-210288, where L2 structure that have 4 legs associated with one PDCP entity is shown. In this architecture, PDCP PDU can be distributed depending on the importance (e.g. latency budget). Do you have any concrete L2 structure in mind? The background of question is to ask you standardization impact. The explained MAC PDU placement (e.g. at the head of data buffer) seems to be an implementation technique.

##### **2 – NTT DOCOMO INC.**

Thank you very much for your reply. Based on you reply, we have some further questions:

Q1: According to your reply, we understand the DCI is only embedded in SPS PDSCHs. Then do you assume the DCI is always expected in SPS PDSCHs or only exist sometimes?

Q2: As you describe by "The embedded control signaling should contain minimum information e.g., the number of transport blocks for one or more available occasions, so the UE detection complexity is not as onerous as that with PDCCH", do you mean that special DCI fields are designed other than current existing DCI formats? What's the criteria in your mind to design the minimum information to be included?

Q3: Do you assume any impact on current PDCCH monitoring configuration or behavior?

##### **3 – Nokia Corporation**

Thank you for your interesting proposal. Could you please elaborate what kind of specific CSI enhancements you would like to study/specify for the XR?

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

Thanks for the contribution. We agree that UE scheduling assistance information is helpful. What kind of information does Apple have in mind for UE scheduling assistance information? Moreover, could Apple elaborate more what does end-to-end scheduling adjustments refer to?

##### **5 – MediaTek Inc.**

Thanks for the detailed reply.

For Enhanced CDRX to match XR frame rate, if we align pose/control with DL frame (16.7ms), it may violate the current assumption in SA4 (4ms periodic control for UL with PDB=10ms). Would this be confirmed with SA4?

### 2.3.4 Round 2 Response from Apple

#### **Response to Fujitsu**

Q: Thank you for the contribution and answers. We are interested in the protocol enhancement and MAC PDU which is explained about. We have proposal in RWS-210288, where L2 structure that have 4 legs associated with one PDCP entity is shown. In this architecture, PDCP PDU can be distributed depending on the importance (e.g. latency budget). Do you have any concrete L2 structure in mind? The background of question is to ask you standardization impact. The explained MAC PDU placement (e.g. at the head of data buffer) seems to be an implementation technique.

A: If MAC SDU placement can be well aligned with PDSCH transmission, then that may be an implementation issue. Perhaps you have something similar to *CCTrCH* in UMTS in mind? With that, multiple MAC PDUs (transport blocks) can be transmitted over the same PDSCH, and different MCS levels can be chosen for those MAC PDUs. However, how to handle PDSCH retransmission with different MAC SDUs even with a single MAC PDU may involve RAN1 and RAN2 specification support.

### **Response to NTT DOCOMO**

Q1: According to your reply, we understand the DCI is only embedded in SPS PDSCHs. Then do you assume the DCI is always expected in SPS PDSCHs or only exist sometimes?

A1: it would be more accurate to refer to that as embedded signaling than “DCI”. The embedded signaling can be absent at some occasions.

Q2: As you describe by ”The embedded control signaling should contain minimum information e.g., the number of transport blocks for one or more available occasions, so the UE detection complexity is not as onerous as that with PDCCH”, do you mean that special DCI fields are designed other than current existing DCI formats? What’s the criteria in your mind to design the minimum information to be included?

A2: Using the PDCCH design with a fewer number of candidates for blind detection is one option. It seems introducing special fields in a DCI won’t address the blind detection complexity issue. We would also like to hear your view on that. The minimum information can include the adaptation of resource for data transmission, including time, frequency, etc.

Q3: Do you assume any impact on current PDCCH monitoring configuration or behavior?

A3: Depending the design embedded signaling design details, current PDCCH monitoring configuration/behavior may be modified or a new configuration/behavior for the embedded signaling can be introduced.

### **Response to Nokia**

Q: Thank you for your interesting proposal. Could you please elaborate what kind of specific CSI enhancements you would like to study/specify for the XR?

A: In our view, CSI enhancements for XR has several aspects: 1) faithful interference representation which facilitates gNB’s scheduling, which requires the interference measurement resource to collocate with actual

XR traffic at the desired UE, 2) for HARQ retransmission, given short latency budget for some data flows, CSI enhancements can be used to ensure the retransmission which may well be the last chance left, is successful. The CSI reporting should be actionable by gNB and testable for the UE, 3) to save UE power, the CSI reporting should also be aligned with the XR traffic.

### **Response to vivo**

Q: Thanks for the contribution. We agree that UE scheduling assistance information is helpful. What kind of information does Apple have in mind for UE scheduling assistance information? Moreover, could Apple elaborate more what does end-to-end scheduling adjustments refer to?

A: As we explained in our contribution, adjustments may be based on codec rates and application layer parameters, for example, to optimize an XR session between two UEs or between a UE and an XR application server. Scenarios with XR traffic between UEs served by different network operators or even between different countries require special consideration as well.

### **Response to MediaTek**

Q: For Enhanced CDRX to match XR frame rate, if we align pose/control with DL frame (16.7ms), it may violate the current assumption in SA4 (4ms periodic control for UL with PDB=10ms). Would this be confirmed with SA4?

A: SA4 provides requirements/recommendations on the XR traffic, we certainly should respect them; multiple data flows is a key part of them. That is also the reason we (Apple) have follow the SA4 LS to RAN1 closely. The alignment of pose/control arrivals with video frames as suggested by you exactly reveals the limit on enhanced CDRX: for multiple data flows, configuring CDRX to suite either one won't work well.

## **2.4 Comments/Questions to RWS-210501 on NTN**

In the contribution RWS-210501, "NR NTN Enhancement in Rel-18", we provided several proposals for the NR NTN enhancement in Rel-18, the proposals are listed as below for easy reference

### **1. Objective 1: Enhancement for non-GNSS operation**

- Uplink synchronization in RRC idle mode
- RACH enhancement
- Uplink synchronization in RRC connected mode
- Time and frequency maintenance enhancement

### **2. Objective 2: enhancement for regenerative satellite**

- TN-NTN handover
- Satellite mobility will cause additional handover synchronization with TN gNB
- Uplink time and frequency synchronization
- Timing relationship

### 3. Objective 3: enhancement for Beam management

- Beam-specific BWP framework
- Association between beam and BWP
- Joint uplink/downlink beam switching or control/data beam switching
- Beam measurement enhancement
- Advanced beam switching schemes
- Predictable beam switching (e.g., timer based)
- Group-based beam switching

#### 2.4.1 Round 1 Comments/Questions (LOCKED)

For round 1, please provide your comments and questions regarding RWS-210501 on NTN enhancement in Rel-18 in the feedback form below

#### **Feedback Form 8:**

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

We share the same view that regenerative payload and non-GNSS UEs shall be supported. However, considering the current progress, we wonder whether UE with GNSS but without UL timing/freq. pre-compensation shall be supported first.

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

<Intel>

Q1: Enabling NR NTN without GNSS at the UE will lead to decreased system performance due to larger PRACH reception window (especially for GEO) and frequent PRACH transmission (especially for LEO). Do you expect that significant part of connections will correspond to UEs without GNSS?

Q2: For LEO operation without GNSS at the UE, do you expect that frequent PRACH transmission will be required to maintain the TA?

### 3 – THALES

As per regenerative satellite, what architecture do you recommend to address in priority and why (gNB, gNB-DU, else on board) ?

### 4 – Lenovo (Beijing) Ltd

Q1: From our perspective, uplink time/frequency synchronization for regenerative payload is same T/F synchronization between UE and satellite in transparent payload, and it has already been supported in R17 by setting the reference point at satellite. So do you expect any additional spec impact?

Q2: For beam measurement enhancement, do you expect it is applicable for L1-RSRP reporting, L1-SINR reporting or as well other CSI reporting?

### 5 – Spreadtrum Communications

Thanks for the nice contribution. We have the following questions.

For non-GNSS operation, do you consider UE using NTN specific position mechanism for time-frequency synchronization pre-compensation? With NTN specific position mechanism, does uplink time/frequency synchronization enhancement in R17 need further enhancement?

For regenerative payload, the uplink time and frequency synchronization enhancement in R17 may be completely reusable. What are Apple's specific considerations for enhancements on uplink time and frequency synchronization in the scenario of regenerative payload?

### 6 – CATT

We're pretty much aligned on the scope of Rel-18.

Just one question on TN-NTN coordination: What do you think of the DC operation between TN and NTN, between LEO and GEO?

### 7 – Sony Corporation

Thanks for the contribution. We have a question.

-

For regenerative satellite

o

What is the enhancement point to uplink time and frequency synchronization compared to transparent payload?

### 8 – Guangdong OPPO Mobile Telecom.

Q1: Is it a common case that UE can receive NTN signals but cannot receive GNSS signals?

Q2: RACH enhancement means to use separate RACH recourse for the UE without GNSS capability?

### 9 – LG Electronics France

We agree to support regenerative payload. We think that signaling delay can be reduced via ISL between the satellites.

**10 – Samsung Electronics Co.**

Q1: Page 3 - For a UE with no GNSS capability, do you think enhancement to mobility aspects should be also considered?

**11 – Nokia France**

For regenerative architecture, you mention that reduced latency can be achieved if the gNB is located at satellite; do you expect to see much reduction in overall application layer latency? (since the backhaul anyway is still needed to earth).

## 2.4.2 Round 1 Response from Apple

### Response to Asia Pacific Telecom

Q: We share the same view that regenerative payload and non-GNSS UEs shall be supported. However, considering the current progress, we wonder whether UE with GNSS but without UL timing/freq. pre-compensation shall be supported first.

A: Thank you for sharing your views and great to know we share the same view on regenerative payload and non-GNSS UEs. Regarding the case UE with GNSS but without UL timing/frequency pre-compensation, we guess you mention UE with GNSS capability, but does not receive GNSS signal. If so, we agree this scenario should be considered, because UE may have GNSS signal blocked, UE may not receive GNSS very frequently for the purpose of power saving.

### Response to Intel

Q1: Enabling NR NTN without GNSS at the UE will lead to decreased system performance due to larger PRACH reception window (especially for GEO) and frequent PRACH transmission (especially for LEO). Do you expect that significant part of connections will correspond to UEs without GNSS?

A1: Thank you for your questions. For Q1, we think at least the case where UE has GNSS capability but does not always receive GNSS signals could be considered. This could be due to the GNSS signal blockage, UE does not receive GNSS signal for power saving purpose, etc. The first/simple thing to consider is that UE misses GNSS signal in RRC connected mode, where the system impact is small. If UE misses GNSS signal before initial access, the solutions may depend on whether UE totally misses GNSS signal or UE only gets inaccurate GNSS signal. The solution to the latter case may be simple, e.g., by enhancing preamble signals. The solution to the former case may have large impact on the system.

Q2: For LEO operation without GNSS at the UE, do you expect that frequent PRACH transmission will be required to maintain the TA?

A2: We think your mentioned approach could be a candidate solution and we are also open to other solutions.

### Response to Thales

Q: As per regenerative satellite, what architecture do you recommend to address in priority and why (gNB, gNB-DU, else on board)?

A: Thank you for your question. We think gNB-DU could be considered first, as this case is the first step forward in both deployment and solution viewpoint.

### **Response to Lenovo**

Q1: From our perspective, uplink time/frequency synchronization for regenerative payload is same T/F synchronization between UE and satellite in transparent payload, and it has already been supported in R17 by setting the reference point at satellite. So do you expect any additional spec impact?

A1: Thank you very much for your questions. For Q1, we agree with you that the main framework of T/F synchronization to support regenerative payload is probably covered in transparent payload. However, we propose to consider regenerative payload is to re-evaluate and ensure whether the T/F synchronization designed for transparent payload can support regenerative payload case. Furthermore, we can consider some optimization design particularly for regenerative payload.

Q2: For beam measurement enhancement, do you expect it is applicable for L1-RSRP reporting, L1-SINR reporting or as well other CSI reporting?

A2: We think it is possible for L1-RSRP reporting.

### **Response to Spreadtrum**

Q1: Thanks for the nice contribution. We have the following questions.

For non-GNSS operation, do you consider UE using NTN specific position mechanism for time-frequency synchronization pre-compensation? With NTN specific position mechanism, does uplink time/frequency synchronization enhancement in R17 need further enhancement?

A1: Thank you very much for your questions. For Q1, we think it could be a nice potential solution to consider using NTN specific position mechanism for time-frequency synchronization pre-compensation in non-GNSS operation. More evaluation of this potential solution is needed before we could justify whether further enhancement is needed on top of the R17 design.

Q2: For regenerative payload, the uplink time and frequency synchronization enhancement in R17 may be completely reusable. What are Apple's specific considerations for enhancements on uplink time and frequency synchronization in the scenario of regenerative payload?

A2: We agree with you that the main framework of T/F synchronization to support regenerative payload is probably covered in transparent payload. However, we propose to consider regenerative payload is to re-evaluate and ensure whether the T/F synchronization designed for transparent payload can support

regenerative payload case. Furthermore, we can consider some optimization design particularly for regenerative payload.

### **Response to CATT**

Q: We're pretty much aligned on the scope of Rel-18.

Just one question on TN-NTN coordination: What do you think of the DC operation between TN and NTN, between LEO and GEO?

A: Thank you very much for sharing your views and glad to know we have quite aligned views. Regarding your question, we think the DC operation between TN and NTN, between LEO and GEO, could be considered.

### **Response to Sony**

Q: Thanks for the contribution. We have a question. For regenerative satellite

What is the enhancement point to uplink time and frequency synchronization compared to transparent payload?

A: Thank you very much for the question. we agree with you that the main framework of T/F synchronization to support regenerative payload is probably covered in transparent payload. However, we propose to consider regenerative payload is to re-evaluate and ensure whether the T/F synchronization designed for transparent payload can support regenerative payload case. Furthermore, we can consider some optimization design particularly for regenerative payload.

### **Response to OPPO**

Q1: Is it a common case that UE can receive NTN signals but cannot receive GNSS signals?

A1: Thank you very much for the questions. For Q1, we think it is possible that a UE receive NTN signals but not GNSS signals. This could be due to GNSS signal blockage, since some GNSS signal may come from some direction which may be blocked. This is also possible UE does not receive GNSS signals for power saving purpose.

Q2: RACH enhancement means to use separate RACH resource for the UE without GNSS capability?

A2: For Q2, using separate RACH resource for UE without GNSS capability could be one potential solution. We are open to other solutions as well.

### **Response to LG**

Q: We agree to support regenerative payload. We think that signaling delay can be reduced via ISL between the satellites.

A: Thank you very much for sharing your views and glad to know we share the similar view on this point.

### **Response to Samsung**

Q: Page 3 - For a UE with no GNSS capability, do you think enhancement to mobility aspects should be also considered?

A: Thank you very much for your question. We think the mobility enhancement could be considered in UE without GNSS. For example, more information may need to be delivered to UE during its handover procedure in case UE does not have GNSS signal.

### **Response to Nokia**

Q: For regenerative architecture, you mention that reduced latency can be achieved if the gNB is located at satellite; do you expect to see much reduction in overall application layer latency? (since the backhaul anyway is still needed to earth).

A: Thank you very much for your question. I think the latency reduction at layer 1 (e.g., HARQ retransmission latency reduction) could affect the higher layer latency. As per the quantity of latency reduction in overall application layer, more evaluation is needed for justification. On the other hand, the latency may be reduced if two communicating UEs are both connected via NTN.

### 2.4.3 Round 2 Comments/Question (LOCKED)

For round 2, please provide your further comments and questions regarding RWS-210501 on NTN enhancement in Rel-18 in the feedback form below

#### **Feedback Form 9:**

##### **1 – ZTE Corporation**

Thanks for your contribution and replies. Except for the items listed in your contribution, it seems that the UL enhancement to enable the direct connection between smart UE and satellite for different service, e.g., VoNR, is also highlighted by companies for this topic. As the UE vendor, any views on this direction and do you think that it's needed to introduce the lower antenna gain for smart phone (e.g., negative value) for the link budget evaluation

Based on the question and comments we received, more specifically, we would also like to get companies' opinion on the following two questions. It is appreciated that companies can share their views

Q1: Do you agree there exist scenarios where UE does not receive GNSS signals in NTN? If so, do you think solutions are needed to address this issue?

Q2: Do you agree there is a need to re-evaluate the applicability of R17 NTN for regenerative payload,

including some potential optimization design?

### **Feedback Form 10:**

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#### 2.4.4 Round 2 Response from Apple

##### **Response to ZTE**

Q: Thanks for your contribution and replies. Except for the items listed in your contribution, it seems that the UL enhancement to enable the direct connection between smart UE and satellite for different service, e.g., VoNR, is also highlighted by companies for this topic. As the UE vendor, any views on this direction and do you think that it's needed to introduce the lower antenna gain for smart phone (e.g., negative value) for the link budget evaluation□

A: We think the topic of UL enhancement in NTN could be considered in Rel-18. This could be caused by the lower antenna gain of smart phones.

#### 2.5 Comments/Questions to RWS-210502 on further enhanced sidelink

In the contribution RWS-210502, "NR Sidelink Further Enhancement in Rel-18", we provided several proposals for the NR sidelink further enhancement in Rel-18, the proposals are listed as below for easy reference

##### 1. Objectives 1: Sidelink coverage enhancement

- Long PSFCH format
- Shorter S-SSB periodicity
- Sidelink slot aggregation, including PSCCH/PSSCH and PSFCH

##### 2. Objectives 2: Sidelink Multi-Carrier operation support

- Multiplexing of different services on different carriers
- S-SSB transmissions over multiple carriers
- Carrier and resource selection procedure on multiple carriers
- Packet duplication at PDCP layer

## 2.5.1 Round 1 Comments/Questions (LOCKED)

For round 1, please provide your comments and questions regarding RWS-210502 on further enhanced sidelink in Rel-18 in the feedback form below

### Feedback Form 11:

#### 1 – vivo Communication Technology

Thanks very much for the contributions. We are also interested in the proposed use cases. Here are some questions:

-

What is the target spectrum for the SL coverage enhancement for these use cases, e.g., licensed or unlicensed band, or both?

-

Regarding the enhancement of PSFCH, what is the reason to consider long PSFCH format, instead of PSFCH repetition, especially considering one symbol repetition is already supported from Rel-16 (for AGC)?

-

From sidelink coverage enhancement perspective, what is the relation of this proposal to sidelink U2U relay?

#### 2 – ZTE Corporation

1) For the coverage enhancement, is there a desired coverage target for the sidelink enhancement from Apple's perspective? E.g. 2km, 10km or more?

2) We support the idea of slot aggregation to increase the coverage of data channel. However, it is not clear about the enhancement to PSFCH/SSB. What is the potential gap between the R16/17 coverage of PSFCH/S-SSB and desired coverage target?

3) We think the support of multi-carrier operation is important for NR sidelink. With regard to the "multiplexing of difference services on different carriers", does it mean that each services is associated with a list of carriers and the scheduling of the data packet from a certain service should be restricted to the associated carriers as defined in LTE? Is there anything different in NR sidelink?

#### 3 – LG Electronics Inc.

Q1: Can you elaborate on how the resource selection procedure will be affected by the introduction of multiple sidelink carriers?

#### 4 – Guangdong OPPO Mobile Telecom.

Long PSFCH format and slot aggregation for SL seem to be some of the popular topics for enhancement for R18.

On CA, is there any particular reason S-SSB should be transmitted over multiple carriers as it tends to increase the HD restriction and limit on resource selection? Could a UE receive S-SSB on one carrier and use its timing for SL reception on other carriers in CA?

**5 – Huawei Tech.(UK) Co.. Ltd**

Does the proposed long PSFCH format of Rel-18 intend to co-exist with Rel-16/17 with short PSFCH format in the same RP?

**6 – CATT**

Do you also consider UE relay for coverage enhancement?

**7 – Nokia Denmark**

Related to regenerative satellite operation - is the expectancy that the latency on the application layer would be reduced? After all, the satellite would still need to have backhaul to earth surface to be able to see

2.5.2 Round 1 Response from Apple

**Response to vivo**

Q1: What is the target spectrum for the SL coverage enhancement for these use cases, e.g., licensed or unlicensed band, or both?

A1: Thank you for your interest in this use case and very nice questions. Regarding Q1, we may need to check which spectrum fits for SL coverage enhancement, either licensed or unlicensed. In general, lower frequency band is preferred due to its better propagation property.

Q2: Regarding the enhancement of PSFCH, what is the reason to consider long PSFCH format, instead of PSFCH repetition, especially considering one symbol repetition is already supported from Rel-16 (for AGC)?

A2: Regarding Q2, we think the long PSFCH generally has better coverage performance than short PSFCH. It could be slot-length PSFCH, which is better than 2-symbol short PSFCH.

Q3: From sidelink coverage enhancement perspective, what is the relation of this proposal to sidelink U2U relay?

A3: Regarding Q3, we think sidelink U2U relay is an alternative way to enhance sidelink coverage. However, it is based on the assumption that a relay UE is in-between two communicating UEs. If this situation is not satisfied, then we have to rely on sidelink physical layer enhancement. That is the motivation of this proposal.

**Response to ZTE**

Q1: For the coverage enhancement, is there a desired coverage target for the sidelink enhancement from Apple's perspective? E.g. 2km, 10km or more?

A1: Thank you for your questions. For Q1, we are considering more than 1 km in NLOS. For LOS, the coverage could be even larger. The detailed distance could be further evaluated.

Q2: We support the idea of slot aggregation to increase the coverage of data channel. However, it is not

clear about the enhancement to PSFCH/SSB. What is the potential gap between the R16/17 coverage of PSFCH/S-SSB and desired coverage target?

A2: For Q2, we could consider slot aggregation of short PSFCH. Unlike Uu link, current SL only supports short PSFCH, whose coverage needs to be enhanced. Similarly, the longer periodicity of S-SSB may leave the gap for coverage.

Q3: We think the support of multi-carrier operation is important for NR sidelink. With regard to the “multiplexing of different services on different carriers”, does it mean that each service is associated with a list of carriers and the scheduling of the data packet from a certain service should be restricted to the associated carriers as defined in LTE? Is there anything different in NR sidelink?

A3: For Q3, it is a possible solution to associate each service with a SL carrier, like LTE sidelink. However, we are open to further optimize the design to have more flexibility in the association.

#### **Response to LG:**

Q: Can you elaborate on how the resource selection procedure will be affected by the introduction of multiple sidelink carriers?

A: Thank you for your question. Overall, we think the resource selection procedure over multiple sidelink carriers could use LTE V2X as a starting point. However, NR V2X introduces additional resource selection schemes (e.g., resource re-evaluation and pre-emption). These aspects could be further examined in the contents of multiple sidelink carriers. The feedback transmissions in multiple sidelink carriers should be considered as well.

#### **Response to OPPO:**

Q1: Long PSFCH format and slot aggregation for SL seem to be some of the popular topics for enhancement for R18.

A1: Thank you very much for your comments. It is great to consider long PSFCH format and slot aggregation for SL as a solution of sidelink coverage enhancement.

Q2: On CA, is there any particular reason S-SSB should be transmitted over multiple carriers as it tends to increase the HD restriction and limit on resource selection? Could a UE receive S-SSB on one carrier and use its timing for SL reception on other carriers in CA?

A2: For your question, yes, it is possible that S-SSB is transmitted on one carrier, which is used for SL reception on other carriers in CA. In LTE V2X, the SLSS can be transmitted on selected synchronization carrier or all carriers from Set-B. We may re-evaluate this approach to see if the similar design applies to NR V2X.

#### **Response to Huawei**

Q: Does the proposed long PSFCH format of Rel-18 intend to co-exist with Rel-16/17 with short PSFCH format in the same RP?

A: Thank you very much for your question. We hope that the long PSFCH format could coexist with Rel-16/17 short PSFCH format in the same resource pool. This provides flexibility for UEs using this resource pool. A far-away UE could use long PSFCH format, while a legacy UE could use short PSFCH format. On the other hand, based on resource pool configuration, we could support only long PSFCH format in a resource pool.

### **Response to CATT**

Q: Do you also consider UE relay for coverage enhancement?

A: Thank you very much the question. Yes, we consider UE relay for sidelink coverage enhancement as an alternative solution. The relay UE-based solution is based on the assumption that a relay UE is in-between two UEs. If there is no such relay UE, then the sidelink coverage enhancement (e.g. via physical layer enhancement) is necessary.

### **Response to Nokia**

Q: Related to regenerative satellite operation - is the expectancy that the latency on the application layer would be reduced? After all, the satellite would still need to have backhaul to earth surface to be able to see

A: Thank you very much for the question. This question seems on NTN, please check our answer to this question in NTN section.

### 2.5.3 Round 2 Comments/Question (LOCKED)

For round 2, please provide your further comments and questions regarding RWS-210502 on further enhanced sidelink in Rel-18 in the feedback form below

#### **Feedback Form 12:**

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

Thanks for the response. Some followup -

Q1: How would resource collision be avoided for the different Releases of PSFCH?

Q2: Given the challenges in Rel-16 relating to non-configuration of HARQ in a RP when the TB requires it, does this Rel-18 proposal imply some resource pools with only long-format PSFCH that are only for Rel-18 UEs?

##### **2 – Samsung Electronics Co.**

Which SL channel or signal limits the coverage of the SL interface? Please comment on the benefit of transmitting S-SSB over multiple carriers as this leads to more overhead.

### 3 – ZTE Corporation

Could you elaborate on the necessity of further optimization design to have more flexibility in the association to support the multiplexing of different services on different carriers?

### 4 – MediaTek Inc.

Thanks for the quality contribution and response. Below please find our comment and question:

-

In our view, enhancing SL physical-layer performance and capacity is important topic for R18 to expand the possible applications, including consumcial use cases.

-

Regarding coverage enhancement, we see CP length is one critical factor dominating SL coverage since there is no TA mechanism in SL. Do you consider to change/extend CP length for SL coverage enhancement?

Based on the feedback we received, there are multiple questions regarding the sidelink coverage enhancement. From our perspective, we believe that sidelink coverage enhancement is one of the most important topics especially for the purpose of enabling sidelink deployment in usage scenarios beyond V2X. It is highly appreciated if we can get more feedback regarding the following question.

Q: Do you agree that sidelink coverage needs to be enhanced? If so, which aspects do you expect to enhance?

### Feedback Form 13:

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#### 2.5.4 Round 2 Response from Apple

##### Response to Huawei

Q1: How would resource collision be avoided for the different Releases of PSFCH?

A1: We think a Rel-18 UE could support either long PSFCH format or short PSFCH format and a Rel-17/16 UE only needs to support short PSFCH format. The long PSFCH resources could be allocated different from short PSFCH resources, e.g., in frequency domain. The association (or resource mapping) between PSSCH resources and long PSFCH resources could be configured to avoid the resource collision of PSFCH.

Q2: Given the challenges in Rel-16 relating to non-configuration of HARQ in a RP when the TB requires it, does this Rel-18 proposal imply some resource pools with only long-format PSFCH that are only for Rel-18 UEs?

A2: It is possible that Rel-16/17 UEs could still use this resource pool, treating the resource pool as no PSFCH resource is configured.

##### Response to Samsung

Q: Which SL channel or signal limits the coverage of the SL interface? Please comment on the benefit of

transmitting S-SSB over multiple carriers as this leads to more overhead.

A: Thank you for your questions. In our understanding, at least PSFCH limits the sidelink coverage. Other channels, e.g., PSCCH or PSSCH, may also need to be examined depending on the usage scenario. Regarding the S-SSB transmissions, we think it is possible that S-SSB could be transmitted on one carrier. In LTE V2X, the SLSS can be transmitted on selected synchronization carrier or all carriers from Set-B. We may re-evaluate this approach to see if the similar design applies to NR V2X.

### **Response to ZTE:**

Q: Could you elaborate on the necessity of further optimization design to have more flexibility in the association to support the multiplexing of different services on different carriers?

A: Thank you very much for your question. The association between different services on different sidelink carriers may have flexibility, e.g., based on the channel busy ratio (BSR). If one carrier turns out to be busy, the high reliable and low latency traffic could be associated with another carrier.

### **Response to MediaTek:**

Q: Thanks for the quality contribution and response. Below please find our comment and question:

In our view, enhancing SL physical-layer performance and capacity is important topic for R18 to expand the possible applications, including consumcial use cases.

Regarding coverage enhancement, we see CP length is one critical factor dominating SL coverage since there is no TA mechanism in SL. Do you consider to change/extend CP length for SL coverage enhancement?

A: Thank you very much for sharing your views on sidelink coverage enhancement. We agree with you that the CP length may limit the SL coverage since no TA mechanism is used in SL. In this sense, we are open to consider the option of extend CP length for SL coverage enhancement.

## **2.6 Comments/Questions to RWS-210503 on unlicensed operation enhancement**

In the contribution RWS-210503, “On unlicensed band enhancement”, we provided several proposals for the NR unlicensed operation enhancement in Rel-18, the proposals are listed as below for easy reference

1. Proposal 1: Enable sidelink in unlicensed band for NCIS use cases.
2. Proposal 2: Support mTRP enhancement in unlicensed band
3. Proposal 3: Support DL coverage enhancement in unlicensed band
4. Proposal 4: Relax the restriction on the gNB not transmitting unicast data to other UEs within a UE-initiated COT.

## 2.6.1 Round 1 Comments/Questions (LOCKED)

For round 1, please provide your comments and questions regarding RWS-210503 on unlicensed operation enhancement in Rel-18 in the feedback form below

### Feedback Form 14:

#### 1 – Samsung Electronics Co.

Q1: For mTRP enhancement in unlicensed band, the backhaul is considered to be licensed or unlicensed?

Q2: Could you further elaborate more on the potential enhancement for over the air coordination?

Q3: One general question, what do you think of having one SI/WI for unlicensed operation covering various scenarios, e.g. SL, IAB, IoT, eMBB, etc, or be part of corresponding verticals ?

#### 2 – Guangdong OPPO Mobile Telecom.

OPPO is also supportive of enabling SL operation in unlicensed bands.

#### 3 – Samsung Electronics Co.

Q1: For mTRP enhancement in unlicensed band, the backhaul is considered to be licensed or unlicensed?

Q2: Could you further elaborate more on the potential enhancement for over the air coordination?

Q3: One general question, what do you think of having one SI/WI for unlicensed operation covering various scenarios, e.g. SL, IAB, IoT, eMBB, etc, or be part of corresponding verticals ?

## 2.6.2 Round 1 Response from Apple

### Response to Samsung

Q1: For mTRP enhancement in unlicensed band, the backhaul is considered to be licensed or unlicensed?

A1: Backhaul links include both ideal backhaul and non-ideal backhaul, wired and wireless. For wireless, both licensed and unlicensed can be considered.

Q2: Could you further elaborate more on the potential enhancement for over the air coordination?

A2: The discussion in 802.11be and conclusion captured in “IEEE 802.11-19/1262r23, “Specification framework for TGbe”, are typical example of over the air coordination. High level idea is COT owner send over the air signaling to announce the COT sharing schedule to different TRPs/APs, then the shared AP/TRP can start transmission with the shared COT without CCA procedure success.

Q3: One general question, what do you think of having one SI/WI for unlicensed operation covering various scenarios, e.g. SL, IAB, IoT, eMBB, etc, or be part of corresponding verticals ?

A3: Yes, we are thinking of one SI/WI for unlicensed operation, including 5/6GHz band and 60GHz band, also SL, IAB, IoT and eMBB etc, instead of spreading unlicensed components into multiple WIs.

## **Response to OPPO**

Q: OPPO is also supportive of enabling SL operation in unlicensed bands.

A: Thanks for the comments. We support SL in unlicensed band including both 5/6GHz band and 60GHz band, where 5/6GHz band has higher priority.

### 2.6.3 Round 2 Comments/Question (LOCKED)

For round 2, please provide your further comments and questions regarding RWS-210503 on unlicensed operation enhancement in Rel-18 in the feedback form below

#### **Feedback Form 15:**

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

Thank you for the contribution.

In section 2.2, the spatial reuse across mTRP/gNB is important to make full use of frequency resources. In LTE LAA and NRU SI, the benefit had been discussed and acknowledged. However, it is not specified explicitly because companies thought it can be achieved by implementation. Could you clarify the extra benefit if it is standardized?

In section 2.4, the mechanism for gNB sharing UE acquired COT to other UE had been discussed in Rel-16. It may not comply with ETSI BRAN HS as the COT sharing only occurs between initiating device and responding device. Maybe the HS would need to be updated at first before normative work in 3GPP?

### 2.6.4 Round 2 Response from Apple

#### **Response to Huawei**

Q1: In section 2.2, the spatial reuse across mTRP/gNB is important to make full use of frequency resources. In LTE LAA and NRU SI, the benefit had been discussed and acknowledged. However, it is not specified explicitly because companies thought it can be achieved by implementation. Could you clarify the extra benefit if it is standardized?

A1: In LTE LAA and NR-U, each TRP perform CCA independently. Due to different interference condition and independent CCA process, each TRP can get the COT at different time. CoMP transmission is by implementation and depends on the CCA status. This is aligned with 802.11n/ac/ax CCA procedure as well. In the proposed WI here, we propose to allow owner TRP to share the COT with other TRPs, so other TRPs can start mTRP transmission without CCA success. Better mTRP performance can be achieved instead of operating mTPR with fully a-synchronized COT. This also align to the new framework agreed in 802.11be, which is expected to be standardized by Q3 2022.

Q2: In section 2.4, the mechanism for gNB sharing UE acquired COT to other UE had been discussed in Rel-16. It may not comply with ETSI BRAN HS as the COT sharing only occurs between initiating device and responding device. Maybe the HS would need to be updated at first before normative work in 3GPP?

A2: The proposal here is to allow gNB to transmit unicast PDSCH to other UEs, when sharing UE acquired

COT. We do not propose that gNB further share the UE acquired COT to other UE for PUSCH transmission. Section 4.2.7.3.2.7 of HS did not explicitly specify the limitation of responding device transmission. LTE eLAA and NR-U sharing rule takes 802.11n/ac/ax reverse direction protocol as reference and defined similar rules. In current 802.11be discussion, further extension of 802.11ax COT sharing is under discussion. The proposal here is if 802.11be agrees to relax the sharing rule, similar thing can be done in 3GPP.

## 2.7 Comments/Questions to RWS-210504 on Redcap enhancement

In the contribution RWS-210504, “Views on Redcap Enhancements for Rel-18”, we provided several proposals for the NR Redcap enhancement in Rel-18, the proposals are listed as below for easy reference

### 1. Improve the power efficiency for Redcap UEs

- Consider low-power wake-up radio and related signaling/protocol design for RRC Idle Redcap devices.

### 2. New Use Cases with High-End Redcap

- Flexible Bandwidth larger than the max. BW supported in Rel-17.

### 3. Rel-17 leftovers (PDSCH/PUSCH/CSI processing timeline relaxation).

#### 2.7.1 Round 1 Comments/Questions (LOCKED)

For round 1, please provide your comments and questions regarding RWS-210504 on Redcap enhancement in Rel-18 in the feedback form below

#### Feedback Form 16:

##### 1 – Intel Corporation (UK) Ltd

<Intel>

Q1. Considering discussions during Rel-17, could you elaborate on possibly meaningful outcome from consideration of larger than 20 MHz BW support for RedCap (if “flexible BW” alludes to support of larger max UE BWs)?

Q2. What are particular use-cases (latency, form-factor considerations for separate WUR in addition to a main radio, etc.) being considered for separate WUR? While it is true that the battery lifetime targets listed from R17 were not evaluated, achievable battery lifetime depends on particular traffic assumptions, and is it clear that Rel-17 RedCap cannot satisfy battery lifetime targets even for very infrequent traffic profile?

##### 2 – Qualcomm Incorporated

1) In terms of flexible BW, do you think R18 eRedCap UE could support max UE BW lower than 20 MHz ?

2) Could you clarify if the flexible BW refers to RF, BB, or both RF and BB ?

3) which use cases require an eRedCap UE to support wider than 20 MHz and relaxed processing time

capability ?

4) Could "flexible BW" be treated as a distinctive UE feature ?

### 3 – LG Electronics Inc.

Q1) For the wake-up radio in RRC\_IDLE RedCap UEs, do you have in mind kind of a sequence-based WUS as in LTE MTC and NB-IoT rather than a DCI-based solution?

Q2) With the introduction of power saving techniques for idle mode in Rel-17, e.g., PEI, eDRX, we expect significant power saving for devices requiring long battery life. Do you think further power saving enhancement is still needed? Please share if you have any target for performance enhancements or analysis results to back up your proposal, if you have any.

### 4 – Samsung Electronics Co.

1. InPage 6 - Is the proposal of flexible bandwidth for FR1/FR2? And for connected mode?

2. 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?

### 5 – Sony Europe B.V.

Does the low power wake-up radio use the NR waveform or some other waveform (we have seen other proposals to use an OOK waveform). What power consumption and sensitivity would you be targeting for a low power wake-up radio?

## 2.7.2 Round 1 Response from Apple

### Response to Intel

Q1: Considering discussions during Rel-17, could you elaborate on possibly meaningful outcome from consideration of larger than 20 MHz BW support for RedCap (if "flexible BW" alludes to support of larger max UE BWs)?

A1: We acknowledged that support of wider BW than 20MHz was discussed in Rel-17 but not agreed. On the other hand, companies may change position release by release, which happened frequently in 3GPP, e.g., due to new important emerging use cases. Especially here, XR is one of important use cases targeted by Rel-18, which requires both lower code rate for reliability and relatively high data rate to fulfill the latency requirement. Support of BW wider than 20MHz makes it possible to unlock XR application for wearable devices. On the other hand, 'flexible BW' here intends to study the feasibility of a set of BWs options for Redcap including both increased and decreased BW compared to 20MHz, instead of single BW per FR, to meet different Low/Med/High-tiers market requirements with minimized cost/complexity.

Q2: What are particular use-cases (latency, form-factor considerations for separate WUR in addition to a main radio, etc.) being considered for separate WUR? While it is true that the battery lifetime targets listed from R17 were not evaluated, achievable battery lifetime depends on particular traffic assumptions, and is it clear that Rel-17 RedCap cannot satisfy battery lifetime targets even for very infrequent traffic profile?

A2: On 'Latency', our view is on the scale of several tens ms, e.g., larger than 10ms. In Rel-16 power consumption model, the transition period for 'deep sleep' was assumed to be 20ms and one-way latency would be 10ms. For WUR here, compared to 'deep sleep' state, more components may be turned off to further reduce power at UE side. Regarding the 'form-factor' consideration, it has some dependency which device

type WUR targets to. For example, if it targets for non-Redcap UEs as well, form-factor is in normal size. However, if it targets for Redcap device, small form factor should be carefully modeled for WUR design. One thing should be clarified that a separate or integrated WUR/main radio should be left for implementation. Regarding the 'Battery lifetime', we agree traffic profile is one dominant factor. However, we also believe that even for every infrequent traffic profile, it is challenging to achieve Rel-17 battery life target of '1-2 weeks' for wearable even in IDLE mode with long DRX cycle due to paging monitoring.

### **Response to Qualcomm**

Q1: In terms of flexible BW, do you think R18 eRedCap UE could support max UE BW lower than 20 MHz?

A1: Yes, 'flexible BW' here intended to cover both 'increased' and 'decreased' max UE BW compared to Rel-17 Redcap device (e.g., 20MHz for all Redcap devices in FR1) to minimize the cost of different IoT tiers with considering the practical economies of scale. On the other hand, support of smaller max BW should be carefully justified based on the study of cost reduction gain vs. specification impacts.

Q2: Could you clarify if the flexible BW refers to RF, BB, or both RF and BB?

A2: Flexible BW here refers to both RF and BB.

Q3: which use cases require an eRedCap UE to support wider than 20 MHz and relaxed processing time capability?

A3: Our view is that these two features are NOT necessarily coupled together for a given UE. As elaborated earlier, an eRedcap device may support wider BW to support some applications (e.g., XR service) on wearable. While relaxed processing time capability maybe supported by Redcap UEs support less time-sensitive traffic only. These features can be independent Redcap UE capabilities.

Q4: Could "flexible BW" be treated as a distinctive UE feature?

A4: Yes, we are open to consider how to implement this feature including as part of UE capability/feature report.

### **Response to LGe**

Q1: For the wake-up radio in RRC\_IDLE RedCap UEs, do you have in mind kind of a sequence-based WUS as in LTE MTC and NB-IoT rather than a DCI-based solution?

A1: Paging early indication (PEI) is currently being discussed in Rel-17. Whether it is sequence-based (e.g., like WUS in LTE NB-IoT) or DCI-based is still being debated. For the wake-up radio proposal for R18, it would be justifiable only if it can provide meaningful power saving gain compared to R17 PEI, which needs to be studied. Detailed solution, including the feasibility, should be part of study and determined based on the target use case, performance requirement e.g., RF sensitivity, complexity/cost, and power consumption considerations.

Q2: With the introduction of power saving techniques for idle mode in Rel-17, e.g., PEI, eDRX, we expect significant power saving for devices requiring long battery life. Do you think further power saving enhancement is still needed? Please share if you have any target for performance enhancements or analysis results to back up your proposal, if you have any.

A2: We agree Rel-17 PS solutions can reduce the power consumption. On the other hand, eDRX is not typical configuration for wearable device. We agreed the analysis results in RWS-210168 that the target of '1 or 2

weeks' battery life are challenging to meet even assuming IDLE only with DRX configuration e.g., due to paging monitoring. Rel-17 PEI provides some power saving gain, but it is still not sufficient to achieve the target battery life.

### **Response to Samsung**

Q1: In Page 6 - Is the proposal of flexible bandwidth for FR1/FR2? And for connected mode?

A1: 'Flexible BW' mainly motivates to minimize the cost for different IoT tiers. Currently, this is at least well motivated for FR1. We are open to consider FR2 as well. Regarding 'connected mode', 'Flexible BW' intends to reduce cost of device regardless of RRC states.

Q2: 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?

A2: The techniques can be part of study. ZP-WUS may be more challenging to achieve the performance requirements for cellular communication and have relatively larger impact on design, and we may start from something in middle. Regarding separate SI or Redcap enhancement, although we put it in Redcap enhancement document, the design may be generically applicable for all devices type.

### **Response to Sony**

Q: Does the low power wake-up radio use the NR waveform or some other waveform (we have seen other proposals to use an OOK waveform). What power consumption and sensitivity would you be targeting for a low power wake-up radio?

A: We do not have preferred waveform at this moment. Waveform would be one of important design perspective based on use cases, complexity/cost, power consumption, and key performance target (e.g., RF sensitivity). Main motivation to introduce low-power WUR is to avoid constantly waking up BB modem. Therefore, we do not think it is necessary to reuse the existing NR waveform. Regarding the sensitivity target, ideally it could reach comparable existing cell coverage.

### **2.7.3 Round 2 Comments/Question (LOCKED)**

For round 2, please provide your further comments and questions regarding RWS-210504 on Redcap enhancement in Rel-18 in the feedback form below

#### **Feedback Form 17:**

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

Thanks for the contribution. In addition to the enhancements mentioned in in the contribution, we wonder what is your view on the following potential areas for Rel-18 eRedCap?

- 1) Peak data rate reduction (by reduced BW, or TBS/RB restriction)
- 2) Lower UE power class
- 3) reduced number of HARQ processes
- 4) serving cell RRM relaxation
- 5) coverage recovery

## 2 – Spreadtrum Communications

Thanks for nice contribution.

Q1: In slide 4, what kind of relaxed processing capabilities do you propose for Rel-18 RedCap? And are those relaxed processing capabilities correlated with specific use cases or services?

Q2: For flexible bandwidth, whether you consider for unlicensed band?

## 3 – QUALCOMM JAPAN LLC.

Qualcomm

Thanks much for your clarifications/replies in the first round discussion. We have a few follow-up questions.

Q1) In addition to N1/N2 relaxation for R18 eRedCap UE, what is your view on CSI computation delay requirements ( $Z/Z'$ ) ?

Q2) If a R18 eRedCap UE supports flexible BW and N1/N2 relaxation (e.g . doubling of N1/N2 of UE processing time capability #1), does it require a pair of separately configured DL/UL BWP during (and after ) initial access ? Do you plan to study the co-existence of different UE types (eMBB, R17 RedCap, R18 eRedCap)?

## 4 – Sony Europe B.V.

Thanks for your detailed responses to company questions. In your response to LGE, you state “eDRX is not typical configuration for wearable device. We agreed the analysis results in RWS-210168 that the target of ‘1 or 2 weeks’ battery life are challenging to meet even assuming IDLE only with DRX configuration e.g., due to paging monitoring. Rel-17 PEI provides some power saving gain, but it is still not sufficient to achieve the target battery life”.

Our thinking is that for a wearable device, there needs to be a reasonably low latency for communicating in the DL. Achieving a long battery lifetime through long DRX cycles is hence not desirable from the user experience perspective. The way to achieve both low latency and low power consumption is hence to use a low power WUR in conjunction with a frequent DRX cycle. This allows for frequent paging opportunities with a low amount of energy being used per paging opportunity, allowing for both low latency and long battery lifetime. Would this thinking be consistent with your answer to LGE?

### 2.7.4 Round 2 Response from Apple

#### **Response to vivo:**

Q1: Thanks for the contribution. In addition to the enhancements mentioned in in the contribution, we wonder what is your view on the following potential areas for Rel-18 eRedCap?

- 1) Peak data rate reduction (by reduced BW, or TBS/RB restriction)
- 2) Lower UE power class
- 3) reduced number of HARQ processes

4) serving cell RRM relaxation

5) coverage recovery

A1: We support to study the area #3 and area #4 for potential enhancement. On area #1, as we replied to Qualcomm in the first round, the tradeoff between cost reduction and specification impact should be carefully studied. On area #5, we generally support to further enhance the coverage since lower antenna efficiency due to smaller form factor for wearable is not well modeled in Rel-17 Redcap WI. Target use cases may need to be first clarified to understand the scope of this direction.

### **Response to Spreadtrum**

Q1: In slide 4, what kind of relaxed processing capabilities do you propose for Rel-18 RedCap? And are those relaxed processing capabilities correlated with specific use cases or services?

A1: As briefly described in bracket of slide #4, we are mainly thinking PDSCH/PUSCH/CSI processing time relaxation. In general, the relaxed processing time should be reported as part of Redcap device capability and maybe not necessarily limit them to certain use cases. On the hand, as relaxed processing maturely increases the turn-around latency, they are more suitable for non-URLLC service type.

Q2: For flexible bandwidth, whether you consider for unlicensed band?

A2: Yes, it targets both licensed and unlicensed band. We did not observe special obstacle to support it for unlicensed.

### **Response to Qualcomm**

Q1) In addition to N1/N2 relaxation for R18 eRedCap UE, what is your view on CSI computation delay requirements ( $Z/Z'$ )?

A1: We think these should be considered together such that the UE power consumption and cost can be practically reduced.

Q2) If a R18 eRedCap UE supports flexible BW and N1/N2 relaxation (e.g. doubling of N1/N2 of UE processing time capability #1), does it require a pair of separately configured DL/UL BWP during (and after) initial access? Do you plan to study the co-existence of different UE types (eMBB, R17 RedCap, R18 eRedCap)?

A2: First, we believe relaxed N1/N2 values would NOT necessitate separate DL/UL BWP during initial access procedure. Instead, the only impact is to early identify this kind of UE to facilitate the Msg3/Ms4 scheduling. Regarding the potential impact caused by 'flexible BW', it seems larger BW can share the DL/UL BWP for Rel-17 Redcap UE as it is upbound by 20MHz in FR1 as one example. On the other hand, introducing a smaller BW e.g., 10MHz, a separate initial DL/UL BWP maybe needed as discussed in Rel-17, which can be shared with Rel-17 Redcap UE. Therefore, from system perspective, only two sets of initial BWPs are needed,

one for non-Redcap UEs and the other for Rel-17/18 Redcap UEs. Co-existence with non-Recap and Rel-17 Redcap UEs should be part of study even we did not observe any problem as briefly explained.

### **Response to Sony**

Q: Thanks for your detailed responses to company questions. In your response to LGE, you state “eDRX is not typical configuration for wearable device. We agreed the analysis results in RWS-210168 that the target of ‘1 or 2 weeks’ battery life are challenging to meet even assuming IDLE only with DRX configuration e.g., due to paging monitoring. Rel-17 PEI provides some power saving gain, but it is still not sufficient to achieve the target battery life”.

Our thinking is that for a wearable device, there needs to be a reasonably low latency for communicating in the DL. Achieving a long battery lifetime through long DRX cycles is hence not desirable from the user experience perspective. The way to achieve both low latency and low power consumption is hence to use a low power WUR in conjunction with a frequent DRX cycle. This allows for frequent paging opportunities with a low amount of energy being used per paging opportunity, allowing for both low latency and long battery lifetime. Would this thinking be consistent with your answer to LGE?

A: We share the view that long DRX cycle is NOT attractive for wearable due to relatively large latency. Low-power WUR with a short WUR-DRX cycle is definitely a technique that we are open to study further, which can potentially achieve both lower latency and longer battery life. We agree this can be part of the study. Careful study is needed on the tradeoff between the power consumption and latency (including the time to wake up the main radio).

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## **3 Summary**

In [RAN-R18-WS-non-eMBB-Apple], two rounds of Q&A were carried out regarding the following 7 Apple contributions related to the non-eMIMO work for Rel-18 NR. The high level Q&A are summarized below for each contribution.

### **RWS-210495, “Sidelink relay enhancements in R18**

This contribution provides several proposals for the sidelink relay enhancement in Rel-18 focusing on the RAN2 related work. Total 3 questions/comments were raised from 2 different companies, Apple provided the corresponding response. Most of the questions and comments were focused on (1) U2U relay support (2) U2N relay enhancement

### **RWS-210496, “Discussion on Sidelink Positioning**

This contribution provides several proposals for the sidelink positioning

in Rel-18. Total 16 questions/comments were raised from 10 different companies, Apple provided the corresponding response. Most of the questions and comments were focused on (1) sidelink positioning in unlicensed band (2) interaction between Uu and sidelink based positioning (3) sidelink positioning for partial coverage scenario

### **RWS-210500, “Considerations on NR enhancements for XR**

This contribution provides several proposals for the XR enhancement in Rel-18. Total 22 questions/comments were raised from 11 different companies, Apple provided the corresponding response. Most of the questions and comments were focused on (1) CSI enhancement (2) enhancements to deal with multiple data streams potentially with special periodicity

### **RWS-210501, “NR NTN Enhancement in Rel-18**

This contribution provides several proposals for the NTN enhancement in Rel-18. Total 16 questions/comments were raised from 12 different companies, Apple provided the corresponding response. Most of the questions and comments were focused on (1) support/enhancement of regenerative satellite (2) support/enhancement of non-GNSS UE

### **RWS-210502, “NR Sidelink Further Enhancement in Rel-18**

This contribution provides several proposals for the NR sidelink further enhancement in Rel-18. Total 17 questions/comments were raised from 8 different companies, Apple provided the corresponding response. Most of the questions and comments were focused on (1) sidelink coverage enhancement (2) support of multi-carrier sidelink

### **RWS-210503, “On unlicensed band enhancement**

This contribution provides several proposals for the NR-U enhancement in Rel-18. Total 6 questions/comments were raised from 3 different companies, Apple provided the corresponding response. Most of the questions and comments were focused on (1) sidelink operation in unlicensed band (2) mTRP operation in unlicensed band

### **RWS-210504, “Views on Redcap Enhancements for Rel-18**

This contribution provides several proposals for the NR RedCap enhancement in Rel-18. Total 17 questions/comments were raised from 7 different companies, Apple provided the corresponding response. Most of the questions and comments were focused on (1) More flexible BW for RedCap device (2) further power saving for RedCap devices including wake-up radio (3) relaxed processing capability