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RAN

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Source: **MediaTek Inc**

Title: **Summary of email discussion RAN-R18-WS-eMBB-MediaTek**

Document for: **Discussion**

Agenda Item: **4.1**

Work Item / Release: **Rel-18**

Abstract: This contribution provides a summary of the email discussion on RAN-R18-WS–eMBB-MediaTek.

1 Introduction

This document collects Q&A corresponding to contributions listed below.

NOTE: The ”eMBB” classification was self-assigned by the author.

Table 1:

Agenda Item	TDoc	Title	Source
4.1	RWS-210093	[eMBB] MIMO Enhancements	MediaTek Inc.
4.1	RWS-210094	[eMBB] DC/CA Enhancements	MediaTek Inc.
4.1	RWS-210095	[eMBB] XR/CG Enhancements	MediaTek Inc.
4.1	RWS-210097	[eMBB] Sidelink Enhancements - LLeMBB	MediaTek Inc.
4.1	RWS-210100	[eMBB] NTN NR Enhancements	MediaTek Inc.

Each of these contributions includes a motivation and a set of proposed objectives. This email discussion intends to clarify via Q&A the motivation and individual objectives for each of these contributions. It is structured as follows:

- Section 2.1 contains Q&A tables for RWS-210093 for the motivation and each individual objective
- Section 2.2 contains Q&A tables for RWS-210094 for the motivation and each individual objective
- Section 2.3 contains Q&A tables for RWS-210095 for the motivation and each individual objective
- Section 2.4 contains Q&A tables for RWS-210097 for the motivation and each individual objective
- Section 2.5 contains Q&A tables for RWA-210100 for the motivation and each individual objective
- Section 3 provides a summary

2 Email Discussion

2.1 RWS-210093 – MIMO Enhancements

2.1.1 Motivation

Companies are kindly invited to provide their questions to the following motivation:

Motivation:

- Channel State Information (CSI) computation/representation is at the core of MIMO
- Nearly all spectral efficiency enhancement features involve CSI computation
- DL precoding, UL precoding, 8 antennas at the UE, Coherent/non-coherent CoMP, etc.
- Rel-18 will continue advancing MIMO CSI:
- Optimizing overhead and accuracy tradeoff by exploiting sparsity nature of physical channel
- Setting benchmark for future non-parametric solutions such as AI-based CSI representation
- Two Examples
- Time-to-Doppler Compression – exploiting channel correlation in time
- UL frequency dependent precoding and high resolution codebook – borrowing DL ideas for UL use

Feedback Form 1: Round I Questions - Motivation

1 – vivo Communication Technology antenna design at UE depends on numerous implementation issues, how to adapt UL codebook to UE antenna architectures?
2 – Futurewei Technologies Thank you for your nice contribution and proposal on enhancement for high mobility MIMO performance. We also support the work to improve MU-MIMO performance with mobility. In addition, we proposed to work on cooperative MIMO schemes to improve system capacity for XR, FWA and other challenging services. Please take a look at our contribution RWS-210036 (https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_AHs/202 210036.zip) and feel free to comment at: https://nwm-trial.etsi.org/#/documents/4580 .
3 – ITRI Thank you for the good contribution. Could you please clarify whether impact over the gNB side should be further constrained? For example, the number of measurement objectives should be limited or assigned by the gNB?
4 – Beijing Lenovo Software Ltd. Q1: Could your clarify more clear on the concept of ”codebook compression” for UL MIMO? Q2: Do you want to specify different codebooks for different UE antenna architectures? Q3: What’s your intension of overhead reduction in Objective III?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 2: Round I Answers

1. vivo	***A1:*** One possible scheme is, instead of a fixed table based codebook (as in NR/LTE), to use a parametric way to construct precoder set (i.e., a codebook) based on some measurements or UE report.
2. Futurewei	Thank you for your questions. Although we didn’t mention MU-MIMO, but our R-18 MIMO focus is on high resolution CSI, which is well understood to be the key to good MU-MIMO performance. We also agree that cooperative MIMO is one of very few key technologies that can significantly increase the network’s capacity. And again, CSI (and UL sounding as well) is the center piece of this technique.
3. ITRI	We did not understand the question. Please could you explain which objective this question was related to?

4. Lenovo	***A1:*** The intention of codebook compression is to reduce overhead for high-resolution codebook or/and frequency selective precoding. Similar concept of FD compression in DL e-typeII could be a starting point or a reference design. ***A2:*** Instead of a fixed table based codebook, different codebooks can be constructed by a parametric way based on some measurements or UE report. ***A3:*** This part of our focus on high resolution CSI. UE equipped with 8 antennas is most likely a stationary device such as CPE. It is an extreme case of Doppler compression where the Doppler is zero, except for perhaps a small frequency drift. Therefore, downlink high-rank performance can be improved by increasing codebook resolution without increasing CSI feedback overhead if proper compression is used.

Feedback Form 2: Round II Questions

1 – ITRI How to ensure the scope is not too big or small? Is there any further constrain needed? Thank you very much.
2 – Beijing Xiaomi Mobile Software Thanks for your answers. As for "Coherent/non-coherentCoMP", do you mean DL or UL? We think further discussion on if it is feasible/necessary to enhance the coherent CoMP is needed.
3 – vivo Communication Technology thanks for answer on codebook, so there is no codebook is defined in the spec, and exact codebook is derived from few parameters which are specified. What parameters do you have in mind? Because UE antenna implementation may vary from device to device.
4 – Samsung Research America How is the high-res UL codebook parameterized? What are the parameters?
5 – Guangdong OPPO Mobile Telecom. Thanks for the contribution. Regarding enhancements for stationary devices, is there any work in RAN1 to support 8Rx UE? Do you intend to enhance the CSI feedback for the stationary devices?
6 – HuaWei Technologies Co. From the reply, for high resolution CSI , as you mentioned UL SRS and CSI is key to achieve high MU performance, could you provide more details regarding to SRS enhancement in your mind?

MediaTek would like to provide the following answers

To be filled in later

2.1.2 Objective 1

Companies are kindly invited to provide their questions to the following objective:

Objective: CSI enhancement [RAN1, 2, 4]

- Increased CSI feedback resolution with limited overhead (using time-domain i.e. Doppler compression)
- Support for high mobility
- PDSCH/DMRS-based

Feedback Form 3: Round I Questions - Objective 1

1 – Beijing Xiaomi Mobile Software Q1: for 'PDSCH/DMRS-based' in objective I, could you provide more explanation? We are wondering what the meaning of this sub-bullet is.
2 – HuaWei Technologies Co. Thanks for the contribution, similar as Xiaomi comment, what's the detail for "PDSCHbased CSI enhancement", do you mean post sinr feedback or fast olla or any others□
3 – HuaWei Technologies Co. One more question: Could you clarify "sparsity nature of physical channel", the sparsity are for FDD or TDD or both?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 3: Round I Answers

1. Xiaomi	***A1:*** Thank you very much for your question. What we meant is to use DMRS, in addition to CSI-RS, to enhance DL MIMO precoding. Since the same precoding is applied to DMRS and its associated PDSCH, the UE observes from the DMRS the combined effects of the channel and the CSI-RS based precoder. Based on this observation, UE can compute a refined precoder, which we may refer to as DMRS precoder, that can be applied to the CSI-RS precoder to improve performance before the next CSI-RS instance occurs.

2.3.Huawei	***A1:*** Thank you very much for your question. Please refer to our answer to Xiaomi. It's mainly for refinement of PMI. RI and CQI may also be adapted if necessary. ***A2:*** In the past, we've transformed the antenna (spatial) domain to the beam domain and later transformed from the frequency domain to delay-tap domain. The two transformations essentially exploit the "sparsity nature of physical channel," in which there are only a small number of dominant multi-paths in the propagation environment. Going forward, we believe we should exploit a third dimension, which is Doppler domain, to further compress the CSI. And this sparsity property is a physical phenomenon regardless of the duplexing scheme.

Feedback Form 4: Round II Questions

1 – Spreadtrum Communications Thanks for the discussion. For DMRS based CSI feedback, as you explained, UE can compute a refined precoder and the refined precoder is applied to the CSI-RS precoder before the next CSI-RS instance occurs. Is PMI refined by UE or gNB? Is there an association between DMRS and a CSI report?
2 – Samsung Research America How is the high-res UL codebook parameterized? What are the parameters?

MediaTek Inc. would like to provide the following answers to the above questions:

To be filled in later

2.1.3 Objective 2

Companies are kindly invited to provide their questions to the following objective (note no questions were voiced in Round I)

Objective: Beam management [RAN1, 4]

- It is proposed that this topic be fully handled in Mobility Enhancements (see RWS-210105; see RAN-R18-WS-crossFunc-MediaTek).

Feedback Form 5: Round II Questions - Objective 2

1 – Samsung Research America For "RACH-less inter-cell beam switching" do you assume synchronized cells with CP, or unsynchronized cells

2 – ZTE Corporation Thank you so much for your contribution. Regarding reviewing your contribution, L1-centric mobility and BM is to be removed to mobility topics. So, can we assume that you, MediaTek, prefer to handle above issues, in normal mobility WID/SID? Then, based on the last conclusion in this plenary meeting, it seems that Scenario-2 for L1-centric mobility may be handled in Rel-18. One related question: what do you think the RAN1/PHY-related objectives for this Scenario-2?

MediaTek Inc. would like to provide the following answers to the above questions:

To be filled in later

2.1.4 Objective 3

Companies are kindly invited to provide their questions to the following objective:

Objective: Enhancements for stationary devices [RAN1, 4]

- Support for 8Rx UE
- Overhead reduction

Feedback Form 6: Round I Questions - Objective 3

1 – Beijing Xiaomi Mobile Software Q2: for 'overhead reduction' in objective III, we want to clarify what overhead is here, if it is the overhead about beam report, it can be moved to Objective II.
2 – LG Electronics Inc. On the proposal of enhancements for stationary devices, could you explain more on overhead reduction as current spec supports aperiodic RS/reporting as well as periodic RS/reporting with a quite large periodicity?
3 – Apple GmbH Current specification supports 8 Rx or even 12 Rx, we are wondering what specific enhancement is needed for 8Rx device
4 – HuaWei Technologies Co. For enhancement on stationary scenarios, could it be clarified about the overhead reduction? Is this related to DMRS, DCI or CSI-RS?
5 – Qualcomm communications-France Regarding "Support of 8Rx UE" in MIMO enhancements, what type of enhancements are you envisioning from RAN1's specification perspective compared to the existing specification?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 4: Round I Answers

1. Xiaomi	***A1:*** Thank you for your question and suggestion. What we meant by overhead reduction is to reduce the CSI feedback overhead (both report content and frequency) while at the same time explore the full potential of a stationary device equipped with large number of antennas. It's highly related to our Objective I. A stationary device experiences little channel variation in time and therefore can be considered as an extreme case of Doppler compression where the Doppler is zero. Therefore, downlink high-rank performance can be improved by increasing codebook resolution without increasing CSI feedback overhead if proper compression is used.
2. LGE	***A1:*** Please refer to our answer to Xiaomi. The overhead reduction comes from CSI compression exploiting the slow-varying nature of the channel experienced by a stationary device.
3. Apple	***A1:*** Please refer to our answer to Xiaomi. The enhancement is on the higher resolution CSI for 8 RX antennas using compression techniques without increasing feedback overhead.
4. Huawei	***A1:*** Please refer to our answer to Xiaomi. The overhead reduction is on the CSI feedback overhead. CSI-RS transmission overhead can of course be reduced if CSI feedback can fully utilize the slow-varying nature of the channel.
5. Qualcomm	***A1:*** Please refer to our answer to Xiaomi. The enhancement is on the higher resolution and lower feedback overhead of CSI report.

Feedback Form 7: Round II Questions

MediaTek Inc. would like to provide the following answers to the above questions:

To be filled in later

2.1.5 Objective 4

Companies are kindly invited to provide their questions to the following objective:

Objective: Uplink enhancements [RAN1, 4]

- Sub-band precoding
- 4+ layers

Feedback Form 8: Round I Questions - Objective 4

1 – Samsung Research America -(p7) Re high resolution UL codebook, does it imply that codebook designs for different UE antenna architectures are needed? Also, is hi-res similar to Type-II CSI codebook for DL?
2 – Intel Technology India Pvt Ltd How to customize UL codebook to various UE antenna architectures that may substantially differ from UE to UE?
3 – HuaWei Technologies Co. Could you clarify what's the meaning of "codebook compression" for UL frequency selective precoding? Is that DL R16-like codebook for UL?

MediaTek would like to provide the following answers to the above questions:

Table 5: Round I Answers

1. Samsung	***A1:*** Instead of a fixed table based codebook, different codebooks can be constructed by a parametric way based on some measurements or UE report. Considering UE PA efficiency, the constructed codebook should have some properties (e.g., constant modulus entries), in that regards, we don't think Type-II CSI codebook for DL can guarantee that.
2. Intel	***A1:*** One possible scheme is, instead of a fixed table based codebook (as in NR/LTE), to use a parametric way to construct precoder set (i.e., a codebook) based on some measurements or UE report.
3. Huawei	***A1:*** Similar concept of FD compression in DL R16 e-typeII could be a starting point or a reference design.

Feedback Form 9: Round II Questions

MediaTek Inc. would like to provide the following answers to the above questions:

To be filled in later

2.2 RWS-210094 – DC/CA Enhancements

2.2.1 Motivation

Companies are kindly invited to provide their questions to the following motivation:

Motivation:

- Efficient spectrum utilization with robust user experience.
- Address capacity shortage due to Low-latency eMBB (LLeMBB) e.g. XR, CG.

Feedback Form 10: Round I Questions - Motivation

1 – China Telecomunication Corp. [China Telecom] Thanks for the good contribution. We are also interested in further enhancement on MR-DC in Rel-18 and share similar views on the motivation to address capacity shortage or service continuity issues for Low-latency eMBB service.
2 – Ericsson LM For objective 2 it says ”Fast retransmission mechanism for split bearer”. It sounds interesting, can you elaborate on what this could mean more specifically? Does it only apply for UL? For objective 2 it says ”Temporal Reference Signal for PSCell activation”. What scenario does this relate to? For Deactivated SCGs the UE should keep DL sync, so perhaps the bullet is about something else?
3 – vivo Communication Technology Thanks for the contribution. we are supportive of cross-carier HARQ retransmisison and multi-carrier scheduling. On fast DC swtiching (P6), could you explain in more detail about the potential technical enhancements?
4 – Huawei Tech.(UK) Co.. Ltd Thanks for the contribution. We also think that ”DC/CA enhancement” is important to improve capacity for UL latency-bounded traffic with high data rate requirements such as XR, which require more spectrum (e.g., more than 2 bands). If a UE can be configured more UL spectrum and support dynamic switching carrier for initial transmission, retransmission, feedback among the configured spectrum based on the channel condition, traffic condition, D/U configuration, then capacity of UL latency-bounded traffic can be improved.

MediaTek Inc. would like to provide the following answers to the above questions:

Table 6: Round I Answers

General Clarification: **G1**: There will be two main categories in the suggested Rel-18 CA and DC enhancements - CA enhancements to **achieve the efficiency as one joint serving cell**, including cross-carrier HARQ retransmissions (Objective 1) and cross-carrier multi-carrier scheduling with a single DCI (Objective 3). - DC enhancements to **ensure data continuity when SCG block/failure** (Objective 2) **G2:** To realize fast DC switch to ensure data continuity when SCG block/failure, we suggest the following enhancements for both DL and UL in split bearer architecture where PDCP duplication is possible. For DL, early UE indication based on QoS requirement can assist network to duplicate/switch packet to the other leg as soon as necessary (while packet is not always duplicated). For UL, UE is allowed to partially duplicate some packets based on packet delay budget or QoS requirement.	
1. China Telecom	***A1:*** Thanks for the comments. In addition to DC enhancement, we also suggest cross-carrier enhancements that can make CA as efficient as one joint serving cell, which is also related to your spectrum fusing proposals. Further comment(s)/question(s) for identifying common useful CA/DC enhancements is welcomed.
2. Ericsson	***A1:*** Thanks for the question. Please refer to G2 in the above row of "General Clarification", and further comment(s)/question(s) is welcomed. ***A2:*** To accommodate generic PSCell activation, we suggest to consider unknown cell case in additional to known cell case. SSB-like reference signal can be considered to accommodate cell detection and measurement. For deactivated SCGs (known cell case), SSB-like reference signal can be utilized as additional flexibility to R17 temporal RS based on TRS.
3. vivo	***A1:*** Thanks for the question. Please refer to G2 in the above row of "General Clarification", and further comment(s)/question(s) is welcomed.

4. Huawei	***A1:*** Thanks for the comments, and we are aligned in improving the latency-constrained capacity for CA. There are two CA enhancements suggested as described by G1 in the row of "General clarification", and we think they are applicable to both UL and DL CA cases. Regarding your CA enhancement proposals, we see cross-carrier HARQ retransmissions may be necessary to achieve the efficiency as one joint serving cell. Further comment(s)/question(s) for identifying common useful CA/DC enhancements is welcomed.

Feedback Form 11: Round II Questions

MediaTek Inc. would like to provide the following answers to the above questions:

To be filled in after Round I and after Round II

2.2.2 Objective 1

Companies are kindly invited to provide their questions to the following objective:

Objective: Enhancement of latency-constrained capacity for inter-band CA with TDD [RAN1, 2, (4)]

- Cross-carrier HARQ retransmission and cross-carrier HARQ feedback (leftover(s) from R17 eURLLC if any)

Feedback Form 12: Round I Questions- Objective 1

1 – Intel Technology India Pvt Ltd

For cross-carrier HARQ, is it to transmit PDSCH/PUSCH retransmission on a different cell, or the PUCCH carrying HARQ-ACK can be on multiple cells?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 7: Round I Answers

1. Intel	***A1:*** Thanks for the question. Objective 1 is related to transmitting PDSCH/PUSCH retransmission on a different cell. Further question(s)/comment(s) is welcomed.

Feedback Form 13: Round II Questions

1 – ZTE Corporation

Regarding cross-carrier HARQ retransmission, it seems the current Rel-17 discussion of cross-carrier PUCCH transmission under URLLC WI is based on CA framework. Are you proposing to support cross-carrier HARQ retransmission based on legacy CA framework, or based on the framework where one cell consisting multiple carriers as proposed by some other company?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 8: Round II Answers

General Clarification: **G3:** Our proposal is based on existing CA framework and allows HARQ retransmissions to be flexibly transmitted in another component carrier. For inter-band CA cases, this enhancement breaks TDD pattern limit in each component carrier. Moreover, retransmissions over a more reliable carrier can improve the reliability of a less reliable carrier (e.g., NR-U or higher-band carrier of weaker coverage). It notices that resource occupation in the retransmission carrier is manageable since HARQ retransmission probability is low (e.g., 10%) and HARQ RV size is flexible.	
A1: Thanks for the further question. Our proposal is based existing CA framework and more clarification is provided in G3 above. Regarding the proposal of one serving cell of multiple carriers, we see cross-carrier HARQ retransmission is still needed to achieve better efficiency than existing CA framework.	

2.2.3 Objective 2

Companies are kindly invited to provide their questions to the following objective:

Objective: Reduction of data interruption due to SCG blockage or SCG change [RAN2, 1, 4]

- Fast retransmission mechanism for split bearer (i.e. leg 1 to leg 2)
- Temporal Reference Signal for PSCell activation

Feedback Form 14: Round I Questions - Objective 2

1 – Intel Technology India Pvt Ltd

(1) How is the fast DC switching achieved? Is this based on Packet duplication, or who should decide retransmission? (if so, based on what information?) And is this for DL , UL or both?

(2) Can you clarify what the temporal reference signal is for PSCell activation?

2 – Intel Technology India Pvt Ltd

(3) How does temporal RS help reducing data interruption under SCG blockage or change?

3 – Beijing Xiaomi Mobile Software

Thanks for the proposals.

Some questions:

1)P1: For cross-carrier HARQ, in my memory, this was discussed in R10 CA. And it was exluded, because peole think the RLC

can handle the retransimission no matter the retransimission is carried on the original cell . Not sure the benefit of Cross-Carrier HARQ Enhancements.

2)P2:For fast DC switching, how does temporal RS help reducing data interruption? Is that mean we need to introduce new RS for measurement or for downlink sync to reduce the SCG change delay?

4 – China Telecomunication Corp.

[China Telecom] We support the objective to reduce data interruption due to SCG blockage or SCG change. We have a few questions/comments as below.

Q1: Is fast retransmission mechanism only for split bearer? How to handle SCG bearer when SCG blockage/ change occurs?

Q2: Similar question to Intel. How does temporal RS help reducing data interruption under SCG blockage or change?

Besides, in order to guarantee service continuity and low latency, we think fast and dynamic activation/ deactivation among multi SCGs would also be considered.

5 – Nokia Corporation

Q1: What is switched in the ”fast DC switching: Is this about some bearers automatically switching to only using UL/DL from MCG, or something else?

Q2: Why is this switching ”fast”, i.e. what is the defining factor that allows this to happen fast?

Q3: How would the switching be triggered? Would this be done by UE or by NW, and which measurements would it be based on?

Q4: How does the network know that the ”fast DC switching” has occurred?

Q5: Is this only for FR1-FR2 DC or are there other use cases as well?]

6 – Qualcomm CDMA Technologies

1. How is DC switch delay defined (Slide 6)?

2. Can the authors comment on or provide examples of ”fast DC switching” mechanisms that are not currently supported in the standards (Slide 6)?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 9: Round I Answers

General Clarification: **G2:** To realize fast DC switch to ensure data continuity when SCG block/failure, we suggest the following enhancements for both DL and UL in split bearer architecture where PDCP duplication is possible. For DL, early UE indication based on QoS requirement can assist network to duplicate/switch packet to the other leg as soon as necessary (while packet is not always duplicated). For UL, UE is allowed to partially duplicate some packets based on packet delay budget or QoS requirement. **G3**: Considering both unknown cell and known cell cases for generic PSCell activation, SSB-like reference signal can be considered to accommodate cell detection and measurement. For deactivated SCGs (known cell case), SSB-like reference signal can also be utilized as additional flexibility to R17 temporal RS based on TRS. **G4**: Data continuity can be ensured by delivering packet within packet delay budget, and current DC framework with one MCG and one single SCG is sufficient. In case of SCG blockage/change, the following steps can be applied: i. Fast data switching from SCG to MCG to keep data continuity subject to packet delay budget ii. Fast resume or change of SCG by the aid of temporal reference signal iii. Fast data switching from MCG to (new) SCG for data offloading With Objective 2, the data interruption time of steps i or iii can be enhanced with fast DC switch based on split bearer architecture. The data interruption time in step ii can be enhanced by temporal RS. In this way, low-latency eMBB can be accommodated with DC and minimum impacts to networks and UEs.	

1. 2. Intel	***A1:*** Thanks for the question. Please refer to G2 in the row of "General Clarification" for more detailed information. Further question(s)/comment(s) is welcomed. ***A2:*** Thanks for the question. Please refer to G3 in the row of "General Clarification" for more detailed information. Further question(s)/comment(s) is welcomed. ***A3:*** Thanks for the question. Please refer to G4 in the row of "General Clarification", where temporal RS can help reduce the data interruption time of step ii. Further question(s)/comment(s) is welcomed.
3. Xiaomi	***A1:*** Thanks for the question. This question is related to Objective 1. For NR, much tighter packet delay budget, e.g. 10 ms for XR, is the major motivation to utilize cross-carrier HARQ. RLC retransmission schemes has typical delay of several tens of ms and cannot effectively improve the latency-constrained capacity for CA. Further question(s)/comment(s) is welcomed. ***A2:*** Thanks for the question. G4 and G3 in the row of "General Clarification" can provide information to your first part and second part of questions, respectively. In particular, temporal RS can help reduce the data interruption time of step ii, and SSB-like RS can be considered to reduce the delay in change to an unknown SCG. Further question(s)/comment(s) is welcomed.
4. China Telecom	***A1:*** Thanks for the question. Current proposal is based on split bearer, and improvement of SCG bearer can be further investigated. ***A2:*** Thanks for the question. Please refer to G4 in the row of "General Clarification", where temporal RS can help reduce the data interruption time of step ii. The suggested 3-step approach will be sufficient to ensure data continuity under existing DC framework of one SCG. Other enhancement direction(s) can be discussed further, considering network and UE impacts. It is noticed that multiple SCGs will induce additional measurement complexity to UE and additional measurement gaps to network scheduling. Further question(s)/comment(s) is welcomed.

5. Nokia	***A1:*** Thanks for the question. Please refer to G2 in the row of "General Clarification" for more detailed information. Further question(s)/comment(s) is welcomed. ***A2:*** Thanks for the question. Regarding CG/AR/VR application, "fast" can refer to switching delay within 10 ms packet delay budget. ***A3 & A4:*** Thanks for the question. For UL, UE is allowed to trigger the switching based on QoS target. For DL, one example is that UE sends PDCP status report earlier so that network can timely transmit data in the other leg. ***A5:*** Thanks for the question. The mechanism is for general DC that can utilize split bearer architecture.
6. Qualcomm	***A1:*** Thanks for the question. The DC switch delay is the latency data can be transmitted in the other leg after detecting its failure in the original leg. ***A2:*** Thanks for the question. Please first refer to G2 in the above row of "General Clarification" for the targeted fast DC switch. Compared with current standard, UE is not allowed to send early indication for DL data duplication/switch and to partially duplicate some packets for UL. Further question(s)/comment(s) is welcomed.

Feedback Form 15: Round II Questions

1 – ZTE Corporation

Regarding the temporary RS for PSCell activation, the UE may need information indicated by SSB/MIB to activate PSCell. Do you plan to define a new RS to replace SSB to carry the information that was previously carried by SSB/MIB?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 10: Round II Answers

1. ZTE	***A1:*** Thanks for the further question. The fundamental demand on temporal RS for SCG is to accommodate measurement and cell detection. Reusing existing SSB in an aperiodic manner is one possible design. To minimize the resource overhead, keeping only PSS and SSS, as a new RS, is another possible design. In either direction, avoiding impact to legacy UEs needs to be ensured.

2.2.4 Objective 3

Companies are kindly invited to provide their questions to the following objective:

Objective: Full scheduling flexibility for massive carrier aggregation under limited UE blind decoding complexity [RAN1, 4]

- Scalable cross-carrier scheduling with 2-stage control (i.e. all scheduling info for 2nd cell provided in 2nd stage)

Feedback Form 16: Round I Questions - Objective 3

1 – LG Electronics Inc. Thank you for the proposal. **Q**: Regarding 2-stage DCI based multi-CC scheduling, if BD complexity/budget is the motivation, what would be the benefit compared to using multi-TTI scheduling which is currently being designed in Rel-17 52.6 GHz WI?
2 – Intel Technology India Pvt Ltd For cross-carrier scheduling, are there any potential demodulation impacts?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 11: Round I Answers

1. LGE	***A1:*** Thanks for the question. There are two difference from multi-TTI scheduling. The first one is finer scheduling time granularity that is still per-TTI for multi-CC scheduling. The second one is control overhead reduction since SCell control resource for UE-specific scheduling can be saved (there are analytical results in RAN1 R17 study on 1-DCI scheduling 2 CCs). On the other hand, it is possible to combine multi-CC scheduling and multi-TTI scheduling as one R18 CA scheduling enhancement. Further question(s)/comment(s) is welcomed.
3. Intel	***A1:*** Thanks for the question. We think there is no impact to demodulation performance requirements. For control channel performance requirements, there is no impact since legacy PDCCH demodulation and decoding are assumed. There is no impact to data channel performance requirements for analogous reason. But there may be impact to UE processing timeline requirements due to the different control procedure. Further question(s)/comment(s) is welcomed.

Feedback Form 17: Round II Questions

2.3 RWS-210095 – XR/CG Enhancements

2.3.1 Motivation

Companies are kindly invited to provide their questions to the following motivation:

Motivation:

- Optimized support for Low-latency throughput-intensive applications esp. CG, XR

- QoS-related improvements for LLeMBB traffic, with potential impact to the AS: RAN related impact is anticipated as a result of SA activities

- Other radio interface improvements are handled in generic items i.e. DC/CA enhancements (RWS-210094, see above), Mobility Enhancements (RWS-210105, see RAN-R18-WS–crossFunc-MediaTek) and Sidelink Enhancements (RWS-210097, see below)

Feedback Form 18: Round I Questions - Motivation

1 – Spreadtrum Communications We agree that mutual awareness between application and 5GS is benefit for transmission. But how to inform 5GS about the application related info? What information shall be indicated from 5GS to application layer?
2 – HuaWei Technologies Co. Do you mean QoS related enhancements should be a joint discussion among RAN and SA? In our view we also think we should have an E2E mechanism to better support the XR services with multiple data streams and potential multiple QoS flows, and importance of different packets.
3 – Qualcomm Incorporated Please provide example of cross-layer optimization and potential standardization impact. Please provide more info/examples on the Sidelink enhancements for FR2/FR1+FR2 scenarios
4 – LG Electronics Inc. Thanks for the contribution. A question for clarification. Is it correct understanding that from your perspective no dedicated SI/WI for XR is needed for RAN in Rel-18?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 12: Round I Answers

General: *This work will require tight coordination between RAN WGs as well as SA2, SA4*	
1. Spreadtrum	***A1:*** Thanks for the good questions. For "How to inform 5GS about the application related info?" To our information, application like XR/CG may base on RTP/RTCP/webRTC; hence, an interface between these protocols to RAN would need to be designed. For "What information shall be indicated from 5GS to application layer?" Our initial thinking is for application layer to provide information to 5GS. According to our Rel-17 XR study in RAN1, a delay aware scheduler can increase the capacity by 20%, and the scheduling adaptation of different frame types (Ex. I-frame v.s. P-frame) also provide benefits. Therefore, we think the two following information can be useful for 5GS: The consumed delay due to video encoder processing for each packet The frame type or priority level for each packet Also, 5GS can signal information to application about mobility events or predicted mobility events (e.g. handovers or potential handovers), traffic related events (e.g. UP congestion), wireless channel information (e.g. interference, channel degradation, beam blockage, BWP switching, …)
2. Huawei	***A1:*** Thanks for the good questions and comments. For "Do you mean QoS related enhancements should be a joint discussion among RAN and SA?" Yes. For QoS related enhancements, we think RAN1 can first study and conclude on the benefit of RAN awareness of application and application awareness of RAN (Ex. packet dropping, packet prioritization), and then the work can be led by SA4 since QoS requirements are currently under study in SA4. We are also in favor of having a mechanism to better support the XR services with multiple data streams and potential multiple QoS flows, and we also emphasize the importance of packets differentiation.

3. Qualcomm	***A1:*** Thanks for the good questions. For "example of cross-layer optimization and potential standardization impact" According to our Rel-17 XR study in RAN1, a delay aware scheduler can increase the capacity by 20%, and the scheduling adaptation of different frame types (Ex. I-frame v.s. P-frame) also provide benefits. Therefore, we think the following information shall be indicated from application layer to 5GS: The consumed delay due to video encoder processing for each packet The frame type or priority level for each packet To achieve this, the standardization impact would be designing the interface carrying this information from the application layer to 5GS. ***A2:*** For "info/examples on the Sidelink enhancements for FR2/FR1+FR2 scenarios" For tethered glass, 5G connectivity is provided through a tethered device with 5G modem through 5G Sidelink (see AR UE type-3 in TR 26.998). For this use case, the throughput/reliability requirement of 5G NR Sidelink needs to be enhanced to ensure a good user experience. To achieve the low latency 1Gbps Sidelink, we have listed few enhancements in our contribution. Regarding the enhancement for FR1/FR2. We think support of SL-U@5/6/60GHz is needed. Also optimizing SL for FR2 is required as there was no optimization work done on FR2 so far.
4. LGE	***A1:*** Thanks for the good question. For "Is it correct understanding that from your perspective no dedicated SI/WI for XR is needed for RAN in Rel-18?" Our answer is yes. For QoS related enhancements of XR/CG, we think RAN1 can first conclude the benefit of RAN awareness of application and application awareness of RAN first (Ex. packet dropping, packet prioritization) in Rel-17 XR SI, and then the work can be led by SA4 since QoS requirements are currently under study in SA4. For the enhancement of DC-CA/mobility/sidelink, these can be addressed in their dedicated RAN WIs with focus on XR as one of the main applications.

Feedback Form 19: Round II Questions

1 – HuaWei Technologies Co. We understand according to your answer, that we can have RAN and SA work in parallel with coordiantion between SA and RAN, is it consistent with your view?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 13: Round II Answers

1. Huawei	***A1:*** Yes – we share the same view. The work can take place in parallel and in a well coordinated manner between SA and RAN groups.

2.3.2 Objective 1

Companies are kindly invited to provide their questions to the following objective:

Objective: QoS improvements for LLeMBB traffic

- Investigate issues pertaining to data rates fluctuation, jitter, congestion and packet dropping, in coordination with SA2/SA4

- Mutual awareness between application and 5GS through cross-layer optimization, in coordination with SA2/SA4

Feedback Form 20: Round I Questions - Objective 1

1 – Intel Technology India Pvt Ltd Just for clarification, QoS improvements in objective 1 will be used by the MAC scheduler? (for example for improved scheduling with the existing Rel-17 air-interface PHY specification?)
2 – ZTE Corporation Is 'the UE complexity' bullet in slide 5 intended to define UE capability including aspects of CA/DC processing . If not, what's the intention?

Table 14: Round I Answers

1. Intel	***A1:*** We expect impact on QoS flow classification and treatment, and related flow<>bearer mapping at least
2. ZTE	***A1:*** See DC/CA Enhancements Objective III in RWS-210094

MediaTek Inc. would like to provide the following answers to the above questions:

To be filled in after Round I and after Round II

2.4 RWS-210097 – Sidelink Enhancements – LLeMBB

2.4.1 Motivation

Companies are kindly invited to provide their questions to the following motivation:

Motivation:

- Support for Sidelink operation in any spectrum i.e. licensed and unlicensed
- Necessary performance improvements enabling low-latency 1Gbps Sidelink

Feedback Form 21: Round I Questions - Motivation

1 – Classon Consulting FUTUREWEI also supports sidelink MIMO and unlicensed enhancements, see RWS-210039 and https://nwm-trial.etsi.org/#/documents/4714 .
2 – Intel Technology India Pvt Ltd Regarding the objectives for personal area network - (a) Sidelink in unlicensed; (b) Low Latency High Rate Sidelink with scheduling UE: (1) Do you consider any priority between two objectives? Considering the provided use case of personal area network, it seems to require revision of sidelink evaluation methodology. (2) Do you think whether the above two objectives can be worked out without introducing scheduling UE concept?
3 – Guangdong OPPO Mobile Telecom. We agree and support the proposed enhancements for sidelink in R18.
4 – Samsung Electronics Co. Q1: Page 5 'leverageNR-U design for reusing of components/hardware and avoidance of co-existence study of SL-U/WIFI". Do you suggest to avoid co-existance evaluation of SL-U/WIFI ? Considering quite different fundamental design for SL transmission compared with Uu transmission, e.g. SL transmission is more distributed transmission between UEs rather than gNB-UE transmission controlled by gNB, the evaluation based on SL transmission stucture is needed for co-existance with WiFi.

MediaTek Inc. would like to provide the following answers to the above questions:

Table 15: Round I Answers

1. Futurewei	***A1:*** Thank you.

2. Intel	***A1:*** So far, there is no prioritization considered yet. Essentially, objective 1 is to expand the SL for the commercial use cases w/o licensed spectrum and the objective 2 is to enhance SL for the LL eMBB use cases (on the dedicated/licensed spectrum). ***A2:*** UE-scheduling-UEs seems important to secure the better performance, shorter latency and lower power consumption for support of advanced IIoT services. It can be also applied for the relay scenario where the Relay UE can schedule the multiple remote UEs effectively. So far, Mode 1 with network control involves too many signaling exchange and overhead. Mode 2 is more for point-to-point transmission without any centralized coordination/scheduling between UEs for interference/resource management. UE-scheduling-UEs seems promising, similar to BS-scheduling-UEs.
3. Oppo	*Thank you!.*
4. Samsung	***A1:*** If SL-U can reuse NR-U co-existence design/mechanism as much as possible, there may be no/less need for co-existence study between SL-U and WIFI, considering the early comprehensive study for co-existence between NR-U and WIFI. Moreover, the design is to meet the regulatory requirement for co-existence (regardless of the centralized/distributed deployment). If SL-U follows NR-U for co-existence, there should be no problem for co-existence with any other technologies operating on the same unlicensed spectrum. SL transmission structure (like sensing mechanism) can be considered as another domain (or decoding based solution) for co-existence within SL UEs, but it won't impact the co-existence with WIFI/NR-U. Besides, WIFI also supports the distributed mode, i.e., ad-hoc mode. We are also open for the co-existence evaluation if necessary.

Feedback Form 22: Round II Questions

1 – Guangdong OPPO Mobile Telecom. Thanks for the contribution. On CSI enhancement: Is this still limited to SL unicast as in R16 or should CSI reporting enhancement be supported also in SL groupcast?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 16: Round II Answers

1. OPPO	***A1:*** We are primarily looking at unicast use cases but we certainly can discuss further whether to also consider groupcast here.

2.4.2 Objective 1

Companies are kindly invited to provide their questions to the following objective:

Objective: Support for SL-U sub-7GHz, FR2, SL-U Sub-71GHz [RAN1, 4]

- Focus on 5/6GHz unlicensed spectrum leveraging NR-U design
- (Other spectrum: lower priority)

Feedback Form 23: Round I Questions - Objective 1

1 – Classon Consulting FUTUREWEI also supports sidelink MIMO and unlicensed enhancements, see RWS-210039 and https://nwm-trial.etsi.org/#/documents/4714 .
2 – Nokia Denmark Seems MediaTek prioritize SL-U on sub-7GHz band over FR2, which is in line with Nokia position.
3 – Samsung Electronics Co. Q1: Page 5 'leverageNR-U design for reusing of components/hardware and avoidance of co-existence study of SL-U/WIFI". Do you suggest to avoid co-existance evaluation of SL-U/WIFI ? Considering quite different fundamental design for SL transmission compared with Uu transmission, e.g. SL transmission is more distributed transmission between UEs rather than gNB-UE transmission controlled by gNB, the evaluation based on SL transmission stucture is needed for co-existance with WiFi.
4 – CATT Do you consider sidelink unlicensed as a separate WI or do you want to have this topic combined with other sidelink enhancements?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 17: Round I Answers

1. Futurewei	***A1:*** Thank you.
2. Nokia	***A1:*** Yes, this is a correct understanding. Thank you.
3. Samsung	***A1:*** Same as above.
4. CATT	***A1:*** We are open for the discussion. It may also depend on the number of topics for leftover/enhancement than SL-U.

Feedback Form 24: Round II Questions

2.4.3 Objective 2

Companies are kindly invited to provide their questions to the following objective:

Objective: Enable Low-latency 1Gbps Sidelink [RAN1, 2, 4]

- MIMO: a) CSI enhancement (PMI support, CSI reporting) b) >2layers
- CA support: Sidelink + Sidelink incl. licensed + unlicensed
- Reduced latency: mode 2d enhancements (UE scheduling UE) without redesign of PHY structure

Feedback Form 25: Round I Questions - Objective 2

1 – Classon Consulting FUTUREWEI also supports sidelink MIMO and unlicensed enhancements, see RWS-210039 and https://nwm-trial.etsi.org/#/documents/4714 .
2 – Nokia Denmark Question on UE scheduling UE as mode 2 enhancement, why is it related to latency reduction?
3 – Guangdong OPPO Mobile Telecom. On CSI enhancement: Is this still limited to SL unicast as in R16 or should CSI reporting enhancement be supported also in SL groupcast?

MediaTek Inc, would like to provide the following answers to the above questions:

Table 18: Round I Answers

1. Futurewei	***A1:*** Thank you.
2. Nokia	***A1:*** The existing Mode 1 requires a lot of signaling exchange (e.g., SL A/N forwarded via Tx UE to BS) causing the large latency. The existing Mode 2 (only supporting point-to-point scheduling) relies on the distributed sensing and the resource availability, causing uncertainty on the latency. UE-scheduling-UEs with the local centralized scheduler can coordinate the multiple transmissions and manage the interference more effectively, similar to BS-scheduling-UEs. So, the overall latency can be reduced with the improved transmission efficiency and the reduced interference/retransmissions.
3. OPPO	***A1:*** We can focus on the SL unicast case for support of the advanced IIOT services. So far, we have not seen the strong motivation on MIMO enhancement for SL groupcast.

Feedback Form 26: Round II Questions

2.5 RWS-210100 – NTN NR Enhancements

2.5.1 Motivation

Companies are kindly invited to provide their questions to the following motivation:

Motivation:

- Release-17 is the first release for NTN NR with minimum essential functionality for a working NTN NR system

- Release 18 should

- Prioritize the service aspects of NTN NR with minimum additional enhancements to Release-17 NTN NR functionalities as needed: enhancements for VoNR should be studied (due to e.g. UL link budget limitation) and MBS support defined.

- Enable single device availability to cover all NTN bands (half-duplex FDD)

Feedback Form 27: Round I Questions - Motivation

1 – THALES Thanks for triggering the e-mail discussion. We think that NTN related topics should be handled under AI Non-eMBB-driven Functional Evolution
2 – Intel Technology India Pvt Ltd Do you consider any particular scenario for Rel-18 NTN enhancements? (e.g. LEO/MEO/GEO, FR1/FR2, UE type)
3 – ESA Thanks for the vision of NTN in Release 18. Certainly, we consider relevant the introduction of half-duplex FDD support in NTN bands (e.g., it could be very helpful to encompass the issue of FDD UEs in FR2).
4 – THALES Since Rel-17 is defining a minimum set of essential features, shouldn't Rel-18 allow to define enhancements in two directions: performance improvements and new capabilities ? Wrt Half duplex FDD, Can you please clarify what it means ? How it can cover all NTN bands ? Which NTN bands are you refering too ? Do you include FR2 bands like Ka ? What enhancements to VoNR will accomodate UL link budget limitations ?
5 – Inmarsat We support the overall vision and proposed enhancements Can you expand further on which bands the enhancements should cover? In our view further attention should be placed to bands above 10 GHz (e.g. Ku, Ka, Q/V) We also think that the NR NTN air interface should be further optimized to provide efficiency comparable or better than current satellite air interfaces (e.g. DVB-S2x). As such, a number of areas should be addressed, from waveform PAPR to signalling overhead, resistence to pre-distortion and non-linear distortion, phase noise. Can you comment on the point above on performance optimizations?
6 – CATT R17 is a very basic version for NR NTN. Thus, some enhancements may be needed in Rel-18. Would you please clarify which bands are included in "all NTN bands (half-duplex FDD)" ?

MediaTek Inc. would like to provide the following answers to the above questions

Table 19: Round I Answers

1. Thales	***A1:*** Thank you - the classification is largely arbitrary and for a number of items varies between companies. We see NTN NR is enabling mobile broadband over satellite and as such can be seen as enhanced mobile broadband.
2. Intel	**A1:** Scenarios of LEO/MEO/GEO, FR1/FR2, UE type are in scope. For FR1 (PC3) and FR2 (VSAT), and also RedCap assuming HD FDD operations.
3. ESA	***A1:*** HD FDD operations to support RedCap in NTN would be of interest. We'll re-use RedCap work while avoiding BW/antenna restrictions. FDD UEs in FR2 can also be considered. Aspect related to eDRX (e.g. discontinuous coverage) and RRM measurements are also for consideration.
4. Thales	***A1 (general):*** Performance improvement and new capabilities can be complementary for example to support VoNR of Multicast Broadcast Services. This may include protocol and signaling enhancements targeted to introduce new capabilities. ***A2 (HD-FDD:*** Half duplex FDD means UE can transmit on FDD band or receive on FDD band, but not do transmit and receive simultaneously. This removes the need for duplexer RF components and reduce processing requirements which reduce cost of device. HD-FDD is part of RedCap. HD-FDD is different from TDD, because from system viewpoint the frequency bands are FDD using paired spectrum and gNB can transmit and receive simultaneously. Commonalities of solutions to support FR1 and FR2 should be maximized. Ka band seems a good candidate for FR2. ***A3 (VoNR):*** Support of VoNR to minimize packet interruption for GEO due to UL link budget limitations should leverage Rel-17 Coverage enhancements with repetitions and disabling of HARQ, and for LEO (cell/beam switching).

5. Inmarsat	***A1:*** FR1 band (S band) and FR2 (Ka band) ***A2:*** It is very good comment on NR NTN air interface should be further optimized to provide efficiency comparable or better than current satellite air interfaces (e.g. DVB-S2x). Waveform PAPR to signalling overhead, resistence to pre-distortion and non-linear distortion, phase noise are some of the metrics for efficiency, trunking efficiency / MAC flexibility also matter. Cellular NR feasibility consider new types of waveforms each having benefits and drawbacks. A change of waveform would require significant re-design of NR and may not yield the efficiency gains that one may infer looking only at one metric.
6. CATT	***A1:*** Rel-18 enhancements over Rel-17 can be considered in FR1 in S band; FR2 in Ka band. Half-duplex FDD operations in the device can be considered.

Feedback Form 28: Round II Questions

2.5.2 Objective 1

Companies are kindly invited to provide their questions to the following objective:

Objective: Mobility enhancements [RAN2, 1] *[subject to R17 status]*

- Scope depends on whether Release-17 NTN NR can significantly benefit from additional enhancements in some scenarios and use cases

Feedback Form 29: Round I Questions - Objective 1

1 – Intel Technology India Pvt Ltd Do you consider enhancements for features such as BWP switching and beam management under mobility enhancements?
2 – ESA Is it considered to enhance BWP/Beam management in order to support satellite beam-hopping systems? Along with HD-FDD devices, this is very interesting feature. Thank you

3 – THALES What mobnilioty enhancements are you considering ?
4 – Inmarsat Can you expand on the mobility scenarios and enhancements considered? We also have similar comment to ESA. We need a flexible enough framework to support beam hopping and higher FRF.
5 – CATT What's the expected enhancement should be clarified.

MediaTek Inc. would like to provide the following answers to the above questions:

Table 20: Round I Answers

1. Intel	***A1:*** We'll re-use Rel-15 NR and Rel-17 BWP switching and beam management with minor adjustments – e.g. satellite assisted information, signaling enhancements
2. ESA	***A2:*** Very good question. Satellite beam-hopping is used in legacy system. This was not considered in Rel-17 NTN NR. We'll consider potential signaling enhancements to allow this feature. We replied on HD-FDD feature in question in previous section.
3. Thales	***A1:*** same answer as Intel A1
4. Inmarsat	***A1:*** We'll re-use Rel-15 NR and Rel-17 BWP switching and beam management with minor adjustments – e.g. satellite assisted information, signaling enhancements. Satellite beam-hopping is used in legacy system. This was not considered in Rel-17 NTN NR. We'll consider potential signaling enhancements to allow this feature for FR1 and FR2.
5. CATT	***A1:*** same answer as Inmarsat A1

Feedback Form 30: Round II Questions

2.5.3 Objective 2

Companies are kindly invited to provide their questions to the following objective:

Objective: Regenerative architecture [RAN3, 2]

- Support very dense LEO satellite deployment where the number of LEO satellite greatly outnumbers the number of GateWay stations on the ground, and also where it is not possible to locate GateWay stations – i.e. in the middle of vast oceans

Feedback Form 31: Round I Questions - Objective 2

1 – ESA Is it intended for NTN-IoT or NTN-NR ? In addition, this features is strictly related with the introduction of inter-satellite links (ISLs).
2 – THALES What is your prefered architecture option on board : gNB, gNB-DU, else ? and why ?
3 – Inmarsat We agree with ESA comment on ISL. Similar to Thales comment, can you expand on some architecture options?
4 – CATT We also would like to support regenerative architecture. just as Thales mentioned, what's the preferred architecture, full gNB on board, gNB DU on board, or the others?
5 – Nokia France The use case described seems to lead in the direction of supporting ISL, but you use it to motivate regenerative architecture; could you clarify the logic please? Also, could you elaborate on which parts of the gNB you envisage should be on the satellite - i.e. where should the split be?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 21: Round I Answers

1. ESA	***A1:*** Regenerative architecture is intended for NTN NR, where there seems to be a higher justification in Rel-18. Justifications for regenerative payload are dense LEO constellation where number of GateWays cannot match number of satellites, in middle of vast Oceans where GateWays are not possible to be located. . We consider DU on board, the satellite payload can provide inter-satellite links between satellites, and different satellites connected to the same CU on ground. Full gNB on board seems more complexity and cost for the satellite and should have higher justification, the necessity for CU to be on board of the satellite should be justified before this option is further considered. CU/DU split with DU on board for Regenerative architecture can be considered as first priority. The inter-satellite link can be considered to be part of the satellite system. This understanding would be helpful to maximize re-use of Rel-17 NTN NR and minimize impact on RAN1 and RAN2 core specifications.
2. Thales	***A1:*** Same answer as ESA A1
3. Inmarsat	***A1:*** Same answer as ESA A1
4. CATT	***A1:*** Same answer as ESA A1
5. Nokia	***A1:*** Same answer as ESA A1

Feedback Form 32: Round II Questions

2.5.4 Objective 3

Companies are kindly invited to provide their questions to the following objective:

Objective: HD-FDD [RAN1, 2]

- Re-use RedCap work while avoiding BW/antenna restrictions

Feedback Form 33: Round I Questions - Objective 3

1 – Intel Technology India Pvt Ltd

Can you clarify which features from RedCap are of interest for NTN? E.g., is the intention related to eDRX

or relaxed RRM enhancements?
2 – ESA HD-FDD is a very relevant feature.
3 – THALES Can you please elaborate more about what enhancements you consider worth to be addressed to support HD-FDD in the context of NTN ?
4 – Inmarsat We agree but this should be further expanded. We need a framework to support devices that can roam between TN and NTN not only in FR1 but also for FR2 frequencies (above 10 GHz).
5 – HUAWEI TECHNOLOGIES Co. Ltd. Q1: What is motivation to introduce HD-FDD RedCap UE without BW/antenna restrictions for NTN? What is the target use case?
6 – HUAWEI TECHNOLOGIES Co. Ltd. Q2: What enhancements do you foresee are needed to support basic RedCap for NTN?
7 – CATT Similar view with HW, motivation should be clarified.

MediaTek Inc. would like to provide the following answers to the above questions:

Table 22: Round I Answers

1. Intel	***A1:*** HD FDD operations to support RedCap in NTN would be of interest. We'll re-use RedCap work while avoiding BW/antenna restrictions to support FR1 and FR2.Aspect related to eDRX (e.g. discontinuous coverage) and RRM measurements are also for consideration. To support HD FDD operations, potential timing enhancements will be considered. For NTN, simultaneous GNSS and NTN NR operations can be assumed to avoid restriction on use of GNSS as was assumed in Rel-17 NTN IoT.
2. ESA	***A1:*** same answer as Intel A1
3. Thales	***A1:*** same answer as Intel A1

4. Inmarsat	***A1:*** Support devices that can roam between TN and NTN could consider inter-RAT selection mechanisms re-using legacy TN and NTN measurements as much as possible, with minor adjustments as necessary.
5. 6. Huawei	***A1:*** same answer as Intel A1
7. CATT	***A1:*** same answer as Intel A1

Feedback Form 34: Round II Questions

2.5.5 Objective 4

Companies are kindly invited to provide their questions to the following objective:

Objective: VoNR Enh., MBS support [RAN1, 2]

Feedback Form 35: Round I Questions - Objective 4

1 – THALES What enhancements do you foresee to support MBS in NTN may be distinguishing between (quasi) Earth fixed and moving beams ? As per Q about VoNR see feedback in the motivation section
2 – HUAWEI TECHNOLOGIES Co. Ltd. Q1: What enhancements do you foresee are needed to support MBS for NTN?
3 – CATT On support of MBS for NTN, what's the scenario and use cases?

MediaTek Inc. would like to provide the following answers to the above questions:

Table 23: Round I Answers

1. Thales	***A1:*** enhancements to support MBS in NTN with high QoS would include adaptation of Rel-17 MBS enhancements for service continuity, configuration / reconfiguration of semi-persistent schedule with longer satellite RTD and low link budget conditions, packet interruption due to satellite switch / coverage holes. CU/DU split in the context of MBS can also be considered in scope. GEO and LEO scenarios can be considered. L2 feedback and re-Tx at RLC or PDCP layer can be considered. Impact on PHY layer on numerology, waveform should be minimized with potential enhancements considered if justification can be high.
2. Huawei	***A1:*** same answer as Thales A1
3. CATT	***A1:*** same answer as Thales A1

Feedback Form 36: Round II Questions

3 Summary of email discussion

Table 24: Summary of email discussions

MIMO:	MediaTek proposed enhancements related to CSI (e.g. higher resolution, high mobility), FR2 robustness, stationary devices (e.g. CPE) and UL enhancements. Questions asked and answer provided on all of the enhancement areas proposed – mainly requesting more details of the specific techniques. Further discussion required on these proposals and similar proposals from other companies. It would be preferred by MediaTek that beam management mobility aspects are taken as part of a separate “Mobility enhancement” discussion for Rel-18 planning.

DC/CA:	MediaTek proposed (generic) DC/CA enhancements to enable efficient spectrum usage while delivering robust user experience, in particular considering Low Latency eMBB (LLeMBB) services. For DC enhancements: With existing DC framework is utilized, data continuity with SCG change can be ensured by 1) switching from SCG to MCG, 2) changing SCG by aid of temporal RS, and 3) switching from MCG to SCG, subject to total latency within the packet delay budget. - Early UE indication/assistance for leg change helps reduce the delays of steps 1) and 3) - Temporal RS accommodating measurement and cell identification helps reduce the delay of step 2) Multiple companies express interest in extending DC framework to have multiple SCGs for reducing the latency of direct SCG change - Further study on, at least, impacts to UEs and NR specification will be needed. For CA enhancements: There is certain interest to improve CA efficiency toward that of a single serving cell in the aspects of overhead and latency - 1-DCI scheduling multiple carriers (more than 2) helps reduce control resource overhead (as well as UE blind decoding complexity) - Cross-carrier HARQ retransmission helps reduce HARQ latency by breaking per-carrier TDD pattern constraint - The principle of the above cross-carrier enhancements are applicable to the proposals of multi-band serving cell and flexible spectrum fusing that aim for combining multiple carriers as one serving cell

XR/CG:	MediaTek proposed QoS related enhancements and cross-layer optimization between access-stratum protocols and XR/CG application to enable proper treatment of XR/CG traffic throughout the system. (For the enhancements of DC-CA/mobility/sidelink towards XR/CG, these can be addressed in their dedicated RAN WIs with XR as one of the main applications.) The discussion clarified some example optimization that could be had e.g. packet prioritization and packet dropping policies depending on frame type. The discussion also clarified the tight coordination needed between RAN groups and SA groups.
Sidelink:	MediaTek proposed enhancements to enable Low-latency eMBB sidelink operation, and sidelink operation in unlicensed spectrum (Sub-7 as first priority) and FR2. In general, positive feedback was given with a few items for further clarification/discussion: Whether to include the study for co-existence between SL-U and other technologies (e.g., WIFI, NR-U). Our view: no need or minimized study if NR-U design can be reused as much as possible because the previous co-existence study for NR-U can be referred w/ no need of further study for SL-U. How could mode 2d reduce the latency? Our view: mode 2d with well-coordinated and local centralized scheduling can manage the interference, improve the transmission efficiency and reduce the retransmission, according reducing the latency. Whether to have the single/multiple WID for SL? Our view: Open for discussion.

NTN NR:	MediaTek proposed enhancements for NTN NR to better support VoNR, to support MBS and to enable single device availability to cover all NTN bands (using Half-duplex FDD). **Mobility enhancements** Companies are supportive of mobility enhancements and commented to re-use Rel-15 NR and Rel-17 BWP switching and beam management with minor adjustments including potential signaling enhancements. **Regenerative architecture** - Support very dense LEO satellite deployment where the number of LEO satellite greatly outnumbers the number of GateWay stations on the ground, and also where it is not possible to locate GateWay stations – i.e. in the middle of vast oceans Companies are supportive or regenerative architecture and commented CU/DU split with DU on board for Regenerative architecture can be considered as first priority. Full gNB on board seems more complexity and cost for the satellite and should have higher justification, the necessity for CU to be on board of the satellite should be justified before this option is further considered. **HD FDD** - Re-use RedCap work while avoiding BW/antenna restrictions Companies are supportive of HD-FDD and commented to re-use RedCap work while avoiding BW/antenna restrictions to support FR1 and FR2. Aspect related to eDRX (e.g. discontinuous coverage) and RRM measurements are also for consideration. To support HD FDD operations, potential timing enhancements will be considered. For NTN, simultaneous GNSS and NTN NR operations can be assumed to avoid restriction on use of GNSS as was assumed in Rel-17 NTN IoT. **VoNR Enh., MBS support** Companies are supportive and commented enhancements to support MBS in NTN with high QoS would include adaptation of Rel-17 MBS enhancements for service continuity, configuration / re-configuration of semi-persistent schedule with longer satellite RTD and low link budget conditions, packet interruption due to satellite switch / coverage holes. CU/DU split in the context of MBS can also be considered in scope. GEO and LEO scenarios can be considered. L2 feedback and re-Tx at RLC or PDCP layer can be considered. Impact on PHY layer on numerology, waveform should be minimized with potential enhancements considered if justification can be high.