RAN-R18-WS-eMBB-CATT - Version 0.0.3
RAN

3GPP TSG RAN Rel-18 workshop **RWS-210514**

Electronic Meeting, June 28 - July 2, 2021

Agenda Item: **4.1**

Source: **CATT**

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

Document for: **Report**

1 Introduction

This email discussion summary covers the following documents:

Table 1: List of CATT contributions under AI 4.1

RWS-210400	On further mobility enhancements in Rel-18	CATT
RWS-210401	On multi-radio and multi-connectivity in Rel-18	CATT
RWS-210402	On flexible spectrum usage in Rel-18	CATT
RWS-210403	On uplink MIMO enhancements in Rel-18	CATT
RWS-210404	On SON/MDT in Rel-18	CATT
RWS-210405	On transmission efficiency improvements in Rel-18	CATT

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

2 General comments/questions

2.1 Round 1

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

Table 2: Brief summary of CATT contributions under AI 4.1

Mobility [RWS-210400]	Rel-18 mobility enhancement should focus on the further interruption reduction enhancement, conditional reconfiguration enhancement, and support of LTE and NR interworking in inactive state.
MRMC [RWS-210401]	Enhancements for MRDC, and studies and work towards MRMC.
Flexible frequency usage [RWS-210402]	Enable flexible frequency usage via Serving Cell over Multi-Band (SCoMB)
Uplink MIMO [RWS-210403]	Rel-18 MIMO enhancement focuses on the UL area, including the following topics: UL frequency selective precoding (targeting FR1), Multi-panel joint transmission, Ultra high-density UL MU-MIMO, and Higher order UL MIMO.
SON/MDT [RWS-210404]	Application of SON/MDT mechanism in features introduced in Rel-16/REl-17,e.g. MBS,NPN,MR-DC enhancement and IAB.
Transmission efficiency improvement [RWS-210405]	Motivations and use cases for transmission efficiency improvements, including continuation of Rel-17 UDC, further signaling overhead reduction, and may also studies other use cases such as IOT/MTC, XR, and AI.

Please provide your general comments to these contributions, if any, in the following feedback form.

Feedback Form 1: General comments/questions to all CATT contributions under A.I. 4.1 (Round 1)

2.2 Round 2

Please provide your general comments to contributions listed in section 2.1, if any, in the following feedback form.

Feedback Form 2: General comments/questions to all CATT contributions under A.I. 4.1 (Round 2)

3 Comments/questions to the Tdocs

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

3.1 RWS-210400 Further mobility enhancements

3.1.1 Round 1 comments/questions

Please provide your comments/questions to RWS-210400, if any, in the following feedback form.

Feedback Form 3: Comments/questions to RWS-210400 (Round 1)

1 – MediaTek Inc. **Q1.** Do you see any UE capability issue for DAPS enhancement for DC/CA?
2 – LG Electronics France Q1) Regarding DAPS enhancement for DC/CA, could you explain more what are expected issues if the network provides DAPS configuration with DC/CA? Q2) For LTE and NR interworking in INACTIVE, could you explain more how the UE context can be maintained when core network is changed?
3 – HuaWei Technologies Co. Do you think DAPS with CA/DC would require even stronger UE capability, i.e. supporting 4 legs at the same time? For cross-RAT interworking, are you assuming the same CN node for LTE and NR?
4 – Intel Corporation (UK) Ltd Regarding LTE/NR interworking in INACTIVE state, are you considering: a/ support of common RNA area across LTE and NR? b/ that the UE maintains in INACTIVE when moves to the other RAT?
5 – Apple Hungary Kft. Thanks for the contribution. For IRAT INACTIVE, is the intention that the UE preserves the NR context when it re-selects to LTE and then re-selects back (maybe based on a timer...?) esp for eg on carrier config like CA context.

6 – Lenovo (Beijing) Ltd Thanks for your paper. For LTE and NR interworking, what CN type (EPC or 5GC) of LTE cell is considered? What RRC state when UE is located at B point?
7 – InterDigital Germany GmbH Do you see a single WID for mobility and DCCA enhancements in R18 or separate ones?
8 – Nokia Corporation We share your view that mobility and CA/DC enhancements are important area for Rel-18 enhancements. We also see enhancements needs on similar area as you. E.g. P1 and P2 Regarding P3, where do you see the main changes, if such approach is supported? At the UE side, as the UE will not delete the NR context? What are the expected NW-side impacts of this proposal?
9 – Nokia Corporation **Q1:** Do you foresee a SI spanning multiple WGs and the whole of Rel-18 on both multi-connectivity and FR2 enhancements (as at least multi-connectivity would likely require work from all of RAN1-4)? **Q2:** Are there any specific FR2 problems that should have priority for Rel-18 studies?

3.1.2 Round 1 answers by moderator

Thank you MediaTek, LGE, Huawei, Intel, Apple, Lenovo, InterDigital, Nokia for the comments and questions. Our response can be found in the following.

@MediaTek

Q1: Yes, we also think the UE capability issue needs to be taken into consideration. For DAPS applied with CA, we think the issue may not be very severe. But for DAPS+DC, it may have higher requirement, when UE is communicating with MN, T-SN and S-SN at the same time. But if we only want to keep data transmission continuity on SN, the issue could be less severe. So maybe we could first discuss on the requirement/scenario, before discussing requirement to UE capabilities.

@LGE

Q1: So far the main issue we see is how to ensure the UE capabilities are not exceeded during the handover procedure, and this was mentioned in R16 discussions.

Q2: Here we focus on some cases where UE mobility is within a certain area within which the UE context is kept. For example if UE performs TA update then the benefit of such mechanism is not so obvious.

@Huawei

For Q1 please see our response to MediaTek.

For Q2 Yes the benefit is mainly for the case when CN is the same.

@Intel

Yes, both cases can be considered in our view.

@Apple

Yes, what you mentioned is one possible case. It can also be that RRC resume is performed in other RAT, which we are open to discuss.

@Lenovo

We think at least LTE connected to 5GC should be considered. And we think both inactive and idle can be considered.

@InterDigital

We are open to discuss this aspect in a later stage, when the main motivations and scope become clearer.

@Nokia

Regarding your question on P3, we think the RNA area enhancement may be needed for NW side. If we support UE resume on other RAT, both the UE side and NW side would need some work.

Regarding your question on SI planning, we are open to discuss this aspect in a later stage, when the main motivations and scope become clearer.

Regarding your question on FR2, we think FR2 coverage and mobility are both quite important topics for Rel-18, and this is a general message. Then for FR2 mobility, one of the outstanding requirements is the service continuity when data rate requirement is high. We are open to discuss other motivations as mentioned already by companies.

3.1.3 Round 2 comments/questions

Please provide your further comments/questions to RWS-210400, if any, in the following feedback form.

Feedback Form 4: Comments/questions to RWS-210400 (Round 2)

1 – HuaWei Technologies Co.

Thanks for the answer. Could you please clarify for DAPS with CA/DC, why the issue for CA is not severe? In our understanding this mainly depends on the UL capability, now typically UEs can support two UL but not more, and we think this applies to both CA and DC.

3.1.4 Round 2 answers by moderator

Thanks Huawei for the additional comment/question. Our understanding is that the extra complexity with DAPS+CA may be less compared with DAPS+DC.

3.2 RWS-210401 Multi-radio and multi-connectivity

3.2.1 Round 1 comments/questions

Please provide your comments/questions to RWS-210401, if any, in the following feedback form.

Feedback Form 5: Comments/questions to RWS-210401 (Round 1)

1 – MediaTek Inc.

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

- On **Proposal 1**, is keeping data continuity the main target for introducing multiple SCG? If it is the case, can enabling ”fast” SCG to MCG data switching also keep data continuity when SCG blockage/failure while reusing existing framework of one MCG and one SCG?
- On **Proposal 2**, FR2 failure detection and recovery should be controlled rare by system design, and shortening the timeline may have limited benefit to UE power saving. Is there any specific example that shows the power consumption issue due to failure detection and recovery?

2 – LG Electronics France

Q) Regarding enhancements to FR2 failure detection and recovery, could you share your thought little bit more on what kind of technical enhancements can be considered for this purpose?

3 – Intel Corporation (UK) Ltd

Regarding Proposal 2 on FR2 failure detection enhancements, do you have any views on what direction the enhancements should be going?

4 – Intel Corporation (UK) Ltd

Regarding Proposal 1 on beyond dual connectivity, would this imply a change to the RAN4 basic assumption of UE implementation that number of RF chains does not exceed 2?

5 – Samsung Electronics Co.

Q1) Do you assume more than 2 ULs are always activated and simultaneously transmitted?

Q2) Is there any limitation to the number of connectivities for MR-MC?

Q3) Is the proposal in slide 3 only applied for MR-MC or also applied for MR-DC?

3.2.2 Round 1 answers by moderator

Thank you MediaTek, LGE, Intel, and Samsung for the comments and questions. Our response can be found in the following.

@MediaTek

Q1: Well that may be one possible implementation, but in that way the total data rate is reduced, and MCG may or may not be able to convey the data traffic of the SCG.

Q2: We tend to feel power consumption and failure detection are separate objectives, each with their own motivations.

@LGE & Intel

Regarding your question on FR2 failure detection, currently we are open about the potential solutions, but we think maybe both higher layer and physical layer enhancements could be considered.

@Intel

Regarding your question on beyond dual connectivity, that is open from our perspective. But we understand there is concern on complexity, so we can discuss further on pros and cons. If majority would limit the scope to simpler design (e.g., to allow switching btw the CGs without increasing complexity much), we are ok as well.

@Samsung

Q1: please see our reply to Intel above.

Q2: we are open to discuss. This is highly deployment related so it may be meaningful to collect requirements from operators.

Q3: It is not limited to MRMC, we could discuss for MRDC as well.

3.2.3 Round 2 comments/questions

Please provide your further comments/questions to RWS-210401, if any, in the following feedback form.

Feedback Form 6: Comments/questions to RWS-210401 (Round 2)

1 – Samsung Electronics Co.

Q1) Your motivation of P1 is throughput improvement. In order to achieve it, the number of active DL cell groups should be increased, whereas the number of UL transmissions needs to be limited. Do you have the same understanding?

Q2) Do you assume inter-node interface is non-ideal backhaul as in R17 DC?

3.2.4 Round 2 answers by moderator

Thanks Samsung for the additional comments/questions. Please find our reply below.

Q1) Firstly we agree if the number of active cell groups are increased then in theory the peak data rate is higher. But then we also observed some concerns from companies on increased complexity. So it seems in the next stage we need to take both aspects into account. We are open to discuss on possible middle ground.

Q2) We would like to not add more requirement to backhaul as that is deployment based. It seems useful to

hear more operator opinions on this matter.

3.3 RWS-210402 Flexible spectrum usage

3.3.1 Round 1 comments/questions

Please provide your comments/questions to RWS-210402, if any, in the following feedback form.

Feedback Form 7: Comments/questions to RWS-210402 (Round 1)

1 – ZTE Corporation

For the multiple UL/DL carriers within the same cell, can they be used for transmission (or reception) simultaneously?

Can a TB be transmitted across multiple carriers?

2 – Lenovo (Beijing) Ltd

Thanks for the nice contribution. Several comments from my side for clarification:

(1) Is FR2 carrier included for this proposal?

(2) From a UE's perspective, the aggregated multiple carriers are regarded as multiple BWPs of one serving cell? If the answer is yes, does fast carrier switching be realized as fast BWP switching as legacy BWP framework?

(3) Regarding using a single DCI scheduling PDSCH/PUSCH across multiple carriers, we share same view and would like to extend the scope to FR2/licensed and unlicensed spectrum/two-stage DCI. The detailed address can be checked in https://nwm-trial.etsi.org/#/documents/4609

(4) What are you referring to the resource allocation of PDSCH/PUSCH across multiple carriers? Do you mean a single TB on a single PDSCH/PUSCH is transmitted on multiple carriers instead of a single TB repeated on multiple PDSCHs/PUSCHs on multiple carriers?

(5) Regarding coexistence with legacy UE, if the intention of this proposal is to reduce the overhead like SSB in each carrier, I am afraid there is coexistence issue for legacy UE as some carriers may not have SSBs for initial access.

3 – Intel Corporation (UK) Ltd

With the Serving cell over multi-band proposal, could you explain why, if a multiple carriers are forming a single cell, would fast carrier switching be needed?

4 – Fujitsu Limited

Thanks for the contribution. Several questions for clarification.

1) For Page 3

Q1: Could you please clarify the relation/difference between multiple carriers in a serving cell and the CC1 in the right figure? For example, are you considering a CC as a equivalent of cell in case of CA, and then a CC can include multiple carriers?

2) For Page 4

Q2: Regarding configuration of a serving cell with multiple carriers, do you mean the configuration like normal UL and SUL? For example, the multiple carriers are respectively configured with BWPs, and a BWP is confined within a carrier?

Q3: Regarding PDSCH/PUSCH/TB across multiple carriers, are you considering a PDSCH/PUSCH/TB (with/without repetition?) is mapped on multiple carriers (or multiple BWPs if yes for Q2) and transmitted at the same time?

5 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution. We share the same motivation and also believe significant benefits can be achieved by allowing a serving cell to be configured across multiple carrier and bands. This allows managing and utilizing fragmented bands as a single serving cell, which can reduce the overhead, simplify cell management, and improve UE experience.

6 – China Mobile Com. Corporation

Thank you for the contribution. We also have a similar proposed study, i.e. frequency combination based elastic cell. A small question, what's your consideration on the fast carrier switching among the carriers within a serving cell when they are across multiple frequency bands?

7 – Nokia Corporation

Not clear what is the practical difference over CA with SSB-less SCells (some signal for the UE to maintain sync with would probably still be needed) and multi-carrier scheduling PDCCH. Can you elaborate a bit on how changing the paradigm and making multiple carriers as a property of one cell provides benefits over the existing CA framework.

3.3.2 Round 1 answers by moderator

Thank you ZTE, Lenovo, Intel, Fujitsu, Huawei, CMCC and Nokia for your comments and questions. Please find our answers below.

@ZTE

For Q1, we are open to discuss whether a UE can only receive/transmit on a single carrier at a time or a UE can receive/transmit on multiple carriers within the same cell simultaneously.

For Q2, for transmission/reception across multiple carriers within a cell, we are open to discuss whether a TB can be transmitted across multiple carriers or multiple TBs are transmitted on multiple carriers respectively.

@Lenovo

For Q1, from our perspective, we focused on lower frequency bands, but we are also open to discuss FR2 if use cases are identified.

For Q2, we think there can be different approaches. One approach could be that the aggregated multiple carriers are multiple BWPs of one serving cell as you said. In this case, if a UE can only receive/transmit on a single carrier at a time, then carrier switching can be achieved by BWP switching and the BWP switching delay can be further reduced. Otherwise if a UE can receive/transmit on multiple carriers within the same cell simultaneously, multiple active BWPs can be supported.

For Q3, we are glad to see that we share the similar view. One thing that is not clear to us is that whether you are proposing using a single DCI scheduling PDSCH/PUSCH across multiple carriers or multiple serving cells. We saw the similar question to your contribution and we can continue the discussion.

For Q4, please refer to our reply to ZTE's Q2. We did not think of a single TB repeated on multiple carriers. Do you see any motivation/benefit to support TB repetition across carriers?

For Q5, our thinking is that it depends on the deployment. If a carrier needs to serve legacy UEs, it is true that SSB cannot be omitted for backward compatibility.

@Intel

Now we are open to discuss whether a UE can only receive/transmit on a single carrier at a time or a UE can receive/transmit on multiple carriers within the same cell simultaneously. The fast carrier switching is basically for the former case.

@Fujitsu

For Q1, the idea of SCoMB is that a serving cell can include multiple carriers which are independent component carriers in CA framework. For the figure on P3, there are three serving cells in the CA framework on the left while there is only a single serving cell in SCoMB on the right.

For Q2, we are open to discuss whether there are multiple BWPs with each confined within a carrier or there is a single BWP covering multiple carriers.

For Q3, please refer to our reply to ZTE's Q2.

@CMCC, please refer to our reply to Intel.

@Nokia, compared with CA with SSB-less SCells and multi-carrier scheduling PDCCH, we think SCoMB can simplify cell management given that multiple carriers are aggregated as a single cell. In addition, the SCell activation/deactivation is achieved via MAC-CE in CA and the delay can be reduced by fast carrier switching in SCoMB.

3.3.3 Round 2 comments/questions

Please provide your further comments/questions to RWS-210402, if any, in the following feedback form.

Feedback Form 8: Comments/questions to RWS-210402 (Round 2)

1 – Lenovo (Beijing) Ltd

Thank CATT for the elaboration. Further comments from my side for better understanding your proposal:

(1) Further comments to Q1: Regarding low frequency bands, do you think how many carriers are to be aggregated like a single serving cell? What's the maximum number assumed for standard design?

(2) Further comments to Q2: As you mentioned, if a UE can receive/transmit on multiple carriers within the same cell simultaneously and when multiple active BWPs are supported for the UE, I kind of think your proposed mechanism is quite similar to CA framework. Maybe the difference is same cell ID for the multiple carriers and not all the carriers of the aggregated carriers carry SSB/SIB-1. Right?

(3) Further comments to Q3: My original intention for multi-carrier scheduling is multi-cell scheduling as normal CA, i.e., cell=carrier, as I see this topic is a continuation and enhancement of Rel-17 DSS two-cell joint scheduling. In case of multi-carrier as a single serving cell, I think the main solution for joint scheduling in frequency domain either for the normal CA or the multiple carriers as single serving cell could have no fundamental difference.

(4) Further comments to Q4: Whether to allow a single TB repeated on multiple carriers is dependent on the concrete use case. For URLLC, the single TB repetition on multiple carriers can not only ensure the high reliability but also reduce the latency.

(5) Further comments to Q5: Do you see a scenario where a carrier is not served for legacy UE? Whether should it be within a new band to be specified in Rel-18? On the other hand, a legacy CA-capable UE's performance may be degraded when SSB/SIB1 of some of its supported carriers are omitted. In this sense, whether the backward compatibility should be considered in this proposal?

2 – Nokia Corporation

Ref to the CMCC answer to Nokia question on the benefits over CA

@Nokia, compared with CA with SSB-less SCells and multi-carrier scheduling PDCCH, we think SCoMB can simplify cell management given that multiple carriers are aggregated as a single cell. In addition, the SCell activation/deactivation is achieved via MAC-CE in CA and the delay can be reduced by fast carrier switching in SCoMB.

New question 1: Could you elaborate further how the cell management is simplified? It would appear that each "sub-cell" would need to be provided with all the configuration parameters than one needs to operate a cell. Where do you expect to see the simplifications.

New question 2: If the "sub-cells" are activated and inactivated for power saving purposes, the same delays for activation would seem to apply as with SCell activation as the UE needs to converge on AGC, establish sync, measure a CSI-RS and provide the CSI report on the activated "sub-cell" just as well. If the "sub-cell". Can you elaborate on why the latency is improved and why that latency improvement could not be applied to SCell activation?

3 – ZTE Corporation

Q1: Thanks for the response. If transmitting (or receiving) on multiple carriers simultaneously is allowed to improve throughput in elastic cell, then it seems more like a CA-based solution. We also proposed a flexible association of DL and UL carriers solution in our tdoc RWS-210479 (https://nwm-trial.etsi.org/#/documents/4776), which can serve the same purpose. Do you agree that both your scheme proposed in your tdoc and CA based scheme in our contribution can achieve the same goal?

3.3.4 Round 2 answers by moderator

Thanks Lenovo, Nokia and ZTE for the further comments/questions.

@Lenovo, we are open to discuss the number of carriers to be aggregated in a single serving cell. Regarding the difference from CA, in addition to the differences you mentioned, there are other differences, e.g. activation/deactivation of a carrier, cell/mobility management etc. For the commonality/difference between the joint scheduling in frequency domain for the normal CA and the multiple carriers as single serving cell, details can be discussed further. It seems to us that single TB repetition over multiple carriers is a separate feature. We can discuss later whether to support it under Serving Cell over Multi-Band. Whether there is a carrier which does not serve legacy UE depends on deployment. In addition, there may be new carriers used for NR, e.g. carriers refarmed from LTE. In addition, there can be scattered carriers with bandwidth too narrow to carry SSB or system information as mentioned in RWS-210334. In general, backward compatibility

needs to be considered and the negative impact on performance of legacy UEs needs to be avoided.

@Nokia, we think the cell management of SCell can be omitted, e.g. SCell addition/modification. In addition, the signaling overhead of handover and the RRM measurement can be reduced. We assume sync/QCL assumptions can be inferred across multiple carriers aggregated in the same serving cell so the delay can be reduced compared with SCell activation.

@ZTE, the motivations of Serving Cell over Multi-Band include cell management simplification and fast carrier switching/activation. It is not quite clear to us whether/how flexible association of DL and UL carriers proposed in RWS-210479 can achieve those.

3.4 RWS-210403 Uplink MIMO enhancements

3.4.1 Round 1 comments/questions

Please provide your comments/questions to RWS-210403, if any, in the following feedback form.

Feedback Form 9: Comments/questions to RWS-210403 (Round 1)

1 – China Telecommunications

We also think the emergence of uplink centric (or data-heavy UL) sercives brings challenge to UL capacity, thus enhancement on UL capacity is needed. In our view, higher order UL MIMO (8 transmission laters for UL), DMRS overhead reduction and more orthogonal DMRS ports for UL (e.g. 24) are all benefit to UL capacity. For multi-pannel uplink transmission, we have one comment: In our view, the perfromance of multi-pannel transmisison is related to the position of each pannel, different devices may have different pannel positions, thus under what condition is the enabling of multi-pannel uplink transmission beneficial for uplink performance should be investigated.

2 – Samsung Research America

For UL FS precoding, should it include a new codebook design (e.g. two-stage W1xW2) that can minimize DL signaling (TPMI) overhead, or is it based on reuse of Rel-15 UL CB?

3 – ZTE Corporation

Thanks so much for sharing this contribution. Please find our following comment(s) for clarification.

- Regarding UL frequency selective precoding, we also identify the necessity of this enhancement. From our perspective, we need to study the granularity of indicated precoding in order to balance the performance gain, UE complexity and signaling overhead.
- Regarding STxMP, this issue has been discussed in Rel-16, and as a proponent of this topic, we are fine to further study this point. In general, could you please nicely clarify whether/how to introduce a panel ID for this topic? Also, indicating simultaneous transmission based on DL group based reporting should be considered in our views, since beam correspondence is a mandatory feature and UL beam indication is usually based on DL measurement/reporting.

4 – vivo Communication Technology

1) In which scenario 8 layers UL is viable? Is it codebook based or non-codebook based? In the case of codebook, what antenna structure at UE is envisioned and what type of codebook?

2) On simulation results, is it based on 8Tx codebook? What is system bandwidth and subband size?

5 – Beijing Xiaomi Mobile Software

As for 'joint transmission enabling multiple panels simultaneously', we want to clarify that it is focus on coherent joint transmission or non-coherent joint transmission. We think further discussion on if it is feasible/necessary to enhance the coherent joint transmission is needed.

6 – China Mobile Com. Corporation

Regarding UL frequency selective precoding, for cell edge UEs, the transmission power and bandwidth are usually limited, can you explain how does the frequency selective precoding benefit the cell edge UEs?

Regarding Ultra-high-density UL-MIMO, can you explain the relationship between ultra high density UL-MIMO and the DMRS overhead reduction? Is there any additional assumptions, such as UE is in a low mobility.

7 – Intel Corporation (UK) Ltd

What kind of UE devices can support more than 4 MIMO layer transmission and what is the importance of this enhancement considering the lack of support of 4Tx in UL from RAN4 perspective? Is it an urgent topic considering that RAN4 doesn't yet have support of 4Tx UEs."

8 – MediaTek Inc.

Is Non-CB also considered in the scope of frequency selective precoding?

9 – HuaWei Technologies Co.

We also think it is beneficial for DMRS enhancements for UL in Rel-18, but more urgent for the number of DMRS ports, since more MU transmission requirement for UL industry cases.

10 – Beijing Lenovo Software Ltd.

Q1: For high order UL-MIMO, do you want to enhance CP-OFDM alone, or with DFT-s-OFDM?

Q2: For high density UL-MIMO, do you want to reduce the DMRS overhead without increasing the number of DMRS ports?

Q3: High density UL-MIMO targets higher order MU MIMO, is it the correct understanding?

11 – Ericsson LM

- On UL MIMO, what is the underlying antenna array assumption for the 8 TX codebook for UL?
- Can you elaborate on the DMRS overhead reduction and ultra high density UL MIMO, what enhancement is foreseen? Does ultra-high density UL MIMO include something more than the DMRS overhead reduction?
- Can you clarify the assumptions to achieve the demonstrated gains for UL subband precoding (other than full coherent UE) so we can reproduce these results? Do you also have corresponding results for non-coherent UE?

12 – China Unicom

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

1. For UL frequency selective precoding, whether frequency band, SCS and other factors are considered for precoding scheme□

2. What is the potential solution for multi-panel/TRP?

3.4.2 Round 1 answers by moderator

Thank you for all the comments/questions from companies. Please find our reply below.

@China Telecom: Given different UL panels are likely pointing toward different directions, one possible use case is SDM-based multi-TRP reception where each TRP is used to receive one panel. This is one step over Rel.17 M-TRP reception where only TDM-type multi-panel transmission is possible. This can be considered for both data and control channels. In practice this may also be applicable in S-TRP scenario if the same TRP can be used to receive different UL panels reflected through different propagation paths.

@Samsung: We are open to consider both possibilities, e.g. reusing Rel.15 codebook or a possible new Rel.18 UL codebook to explore UL overhead reduction.

@ZTE: On UL FSP, we share your views that precoding granularity needs to be studied to strike a balance between performance/overhead, along with other design details. On STxMP, whether/how to introduce UL panel ID can be second-level detail that can be discussed in the working group. Agree that it should take into account DL/UL beam correspondence in the evaluation, functionality design and signaling design.

@ vivo/Intel/Ericsson: For >4 layer MIMO, we think there are data-heavy UL traffic in foreseeable applications (e.g. video uploading, XR terminal, drone, security monitoring, IAB nodes, etc.) that warrants >4 layer UL transmission. Scenarios with UL multi-panel UE and/or with distributed receive antennas at the TRP(s) are also possible. Both CB/NCB can be discussed. Antenna structure and codebook structure in our views are next level design details to be finalized in RAN1 working group (e.g. 1-2 meetings).

@vivo: UL frequency-selective precoding assumes Rel.15 4Tx coherent codebook, 100MHz bandwidth, and 4PRB precoding granularity.

@Xiaomi: Both can be considered in our view.

@China Mobile: In our understanding, the allocated bandwidth to cell-edge UE depends on a myriad of system variables including past average throughput, instantaneous channel quality, Tx power budget, etc. Assuming proportional fair scheduling, any boost of instantaneous channel quality (e.g. from precoding gain or other factors) will translate into (1) more allocated bandwidth and/or (2) higher MCS on the allocated bandwidth, which benefit both cell-edge and cell-center UEs. On DMRS overhead reduction, the consideration is that higher UE density leads to higher likelihood of scheduling more UEs at the same time; hence DMRS overhead reduction is relevant.

@MediaTek: In our view it may be simpler to deploy implementation based UL FSP with NCB transmission by exploring channel reciprocity, but we are open to consider this in the scope discussion.

@Huawei: Share the view that high-density MIMO hinges on the actual DMRS overhead (e.g. considering the number of ports and density per-port). If the number of DMRS ports is to be increased, overhead reduction is important to make sure the PDSCH throughput gain is not eroded by extra DMRS overhead.

@Lenovo:

Q1: Our thinking is to consider this for CP-OFDM.

Q2: Yes this is the starting point.

Q3: Not necessarily. Our thinking is that high-density UL-MIMO is mostly for MU-MIMO, and conventional UL Tx dimension (e.g. 1/2/4 SRS ports) should be a starting point.

@Ericsson: For the 1st question, please refer to previous comment to vivo/Intel. For the 2nd question, the main consideration is to reduce the overall DMRS RE overhead across all allocated UEs (given the # paired UE at a certain time instance would increase with high UE density). The actual technical solutions can be working group level details. For the 3rd question, detailed simulation assumptions can be found in a past contribution R1-202816. In brief we assumed 100MHz bandwidth with 30KHz SCS, 4PRB PMI/CQI granularity, 4Tx coherent codebook, SU-MIMO with dynamic rank and MCS adaptation.

@China Unicom: For Q1, please refer to answer to Ericsson (Q3). For Q2, although we think this belongs to working group level details, one possible solution is to build on the existing Rel.17 M-TRP PUCCH/PUSCH enhancement framework, by extending TDM-based multi-panel transmission to SDM-based simultaneous transmission.

3.4.3 Round 2 comments/questions

Please provide your further comments/questions to RWS-210403, if any, in the following feedback form.

Feedback Form 10: Comments/questions to RWS-210403 (Round 2)

1 – Samsung Research America Regarding multi-panel transmission can you please clarify if this is to the same TRP or to different TRPs?
2 – HuaWei Technologies Co. Thanks for the reply, we agree number DMRS ports should be enhanced for both DL and UL, where overhead and backward compatibality should be considered in the design. One more question, with 100MHz bandwidth as assumed in your simulation, then how to deal with the signalling overhead issue in your mind? Since the indication is dynamic, it will be an issue for the overhead as we discussed in RWS-210436.
3 – ZTE Corporation Thank you so much for your reply. Regarding UL MIMO, our preference/discussion can be found in Page 7 8 of our companion contribution RWS-210479. Besides for STxMP, multiple codeword enhancement for UL (also for no more than 4 DL layer) should be considered, if >4 layers are introduced for UL. Some field tests to prove the necessity of introducing multiple codewords for UL can be found in our contribution R1-2104596.

3.4.4 Round 2 answers by moderator

Thanks Samsung, Huawei and ZTE for the further comments/questions. Please find our reply below.

@Samsung:

We think both cases can be considered. Given that panels mounted at the UE are likely pointing different directions, it is likely that their optimal receive points (Rx panels or TRP) are physically non-located, e.g. different TRPs or different RRHs. However the case of single-TRP should not be precluded, e.g. considering multipath and radio signal reflections.

@HW:

We agree the precoding granularity and signaling structure should be an important part of the Rel.18 design. We understand there are also other aspects that may affect DCI overhead (e.g. new UL codebook with dual-stage structure).

@ZTE:

We agree codeword-to-layer mapping is an inherent design details for higher-order SU-MIMO.

3.5 RWS-210404 SON/MDT

3.5.1 Round 1 comments/questions

Please provide your comments/questions to RWS-210404, if any, in the following feedback form.

Feedback Form 11: Comments/questions to RWS-210404 (Round 1)

1 – ZTE Corporation Similar view. However not sure about IAB. For SON of IAB, if the IAB node can be act as a UE and access to the network, the MRO with RLF failure supported can also be covered by current mechanism. So it seems not clear the scope of the enhancement.
2 – Ericsson LM Why current SON/MDT and RLF recovery mechanisms cannot cope with link failures in IAB?
3 – Lenovo Information Technology thanks for the contribution. we share the similiar view with CATT. we think IAB should be included. Besides that SON for NTN mobility may also be considered.

3.5.2 Round 1 answers by moderator

Thanks for the comments from ZTE, Ericsson and Lenovo. Please find our reply as below:

@ZTE @Ericsson Currently, information in UE RLF report includes the last serving cell, re-establish cell, the cell which initiated the last handover procedure and measurements on Uu interface. This information is used for the network to detect whether there is handover too late, handover too early and handover to wrong cell. For IAB deployment scenario, one important aspect which is different from traditional network is topology adaptation. We think at least it deserves further discussion on report of more information from IAB node related to RLF which could help the network implement topology adaptation properly and timely.

@Lenovo As to SON for NTN, we are open for further discussion. If justified, it is OK for us to include this aspect in Rel-18 WI.

3.5.3 Round 2 comments/questions

Please provide your further comments/questions to RWS-210404, if any, in the following feedback form.

Feedback Form 12: Comments/questions to RWS-210404 (Round 2)

1 – ZTE Corporation Thanks for the clarification. We understand the concern for IAB. But in current status, IAB node is deploy in static mode and the connection will be well tested. Then the probability of RLF for IAB node is smaller than normal UE.

3.5.4 Round 2 answers by moderator

Thanks ZTE for the further comments.

In 38.401, there are sessions which are dedicated to intra-CU IAB topology adaptation and RLF recovery, i.e. 8.2.3.1 Intra-CU topology adaptation procedure in SA and 8.2.3.3 Intra-CU Backhaul RLF recovery for IAB-nodes in SA mode. Besides, as far as we know, currently, in RAN2 and RAN3, discussion on IAB migration for inter-CU is also ongoing. With this, we think it is not rare case on the occurrence of RLF for IAB node and optimization on IAB topology adaptation should be considered.

3.6 RWS-210405 Transmission efficiency improvements

3.6.1 Round 1 comments/questions

Please provide your comments/questions to RWS-210405, if any, in the following feedback form.

Feedback Form 13: Comments/questions to RWS-210405 (Round 1)

1 – HuaWei Technologies Co. We share similar view on UDC enhancements. Do you also think some other enhancements can be considered together, e.g. EHC?
2 – Intel Corporation (UK) Ltd Regarding the proposed RACS enhancements, do you consider that there is any dynamic change in capability that needs to be reported?

3.6.2 Round 1 answers by moderator

Thanks Huawei and Intel for the comments/questions. Please find our replies below.

@Huawei: it is a good question. The further enhancements on EHC can also be considered and included. We are open to any enhancements that could bring benefits for improving transmission efficiency. More use cases are welcome.

@Intel: Thanks for your good question. According to previous discussion, our understanding is that there are dynamic capabilities for UTRA-FDD which should be reported to gNB, e.g. START-CS, START-PS etc. In addition, if the network filters are changed (e.g. different gNBs may use different filters which is supported by current specification), the corresponding UE capabilities may also change. And if some devices' capabilities can be turned on/off manually, e.g. 4G is off, 5G SA only is on etc., which may depend on the UE vendor's design, the changed capabilities should be reported. Current mechanism is simple but not efficient, so some enhancement/optimization should be considered.

3.6.3 Round 2 comments/questions

Please provide your further comments/questions to RWS-210405, if any, in the following feedback form.

Feedback Form 14: Comments/questions to RWS-210405 (Round 2)

3.6.4 Round 2 answers by moderator

There are no comments/questions in Round 2 discussion.

4 Summary of the discussions

During email discussions for [RAN-R18-WS-eMBB-CATT], comments and questions to the contributions were received and the detailed comments/questions and the answers from CATT can be found in section 3.

The discussions for each topic are summarized as follows.

RWS-210400 Further mobility enhancements

In RWS-210400, we propose further enhancements on interruption reduction/conditional reconfiguration/ LTE and NR interworking in inactive state in Rel-18. 8 companies provided their comments and questions, and the discussions can be summarized as the following.

On UE capability requirements

During the discussions, some companies seem to have concerns on the UE capability for the DAPS enhancement for DC/CA. We've clarified our position that the capability issue surely needs to be taken into consideration, but it is better to first discuss on the requirements/scenarios. After that, we could go on with potential complexity and specification effort.

On LTE and NR interworking in inactive state

A first question is about the CN type for LTE. In our understanding at least same CN type of NR and LTE should be considered, i.e. at least LTE connected to 5GC should be considered.

Then a second question is on the UE state in LTE. For that we think both inactive and idle can be considered. Then regarding the question on support of common RNA area across LTE and NR, we think it could be taken into consideration.

On the possible impact on NW and UE side, we think the RNA area enhancement may be needed for NW side. If we support UE resume on other RAT, both the UE side and NW side would need some work.

On the scenario of enhancements, we clarify RRC resume performed in other RAT can also be discussed.

On work organization

Some companies asked about whether common or separate WID on mobility and MRDC and the WGs involved. For this we are open to discuss in a later stage, when the main motivations and scope become clearer.

On FR2 aspects

There was also question that whether any specific FR2 problems that should have priority for Rel-18 studies. We think one of the outstanding requirements is the service continuity when data rate requirement is high. We are open to discuss other motivations as mentioned already by companies.

RWS-210401 Multi-radio and multi-connectivity

In RWS-210401, we propose further enhancement on more than dual connectivity and FR2 failure detection and recovery/improved power saving for measurements in higher frequency bands in Rel-18. The discussions can be summarized as the following.

Multi-connectivity

Some companies have concern on the number of the active cell groups. We understand the concern on complexity to support beyond dual connectivity, but we are open to discuss the number of active connectivity for MR-MC. We think this is highly deployment related so it may be meaningful to collect requirements from operators.

On SCG to MCG data switching

There is also question regarding whether 'fast' SCG to MCG data switching could also fulfill the data continuity instead more than 2 SCG. We think it may be one possible way, but in that case the total data rate is reduced. Also, MCG may or may not be able to convey the data traffic of the SCG.

On FR2 failure detection and recovery

We've clarified that we are open about the potential solutions. And, we think maybe both higher layer and physical layer enhancements could be considered. Then we also clarified the proposal may also apply to MR-DC. At last, there was also question on whether fast FR2 failure detection and recovery may have limited benefit to UE power saving. For that we clarified our understanding that power consumption and failure detection are separate objectives, each with their own motivations.

RWS-210402 Flexible spectrum usage

In RWS-210402, we propose to consider Serving Cell over Multi-Band (SCoMB) in Rel-18 to utilize fragmented spectrum resources in different frequency bands more efficiently. 7 companies provided their comments/questions in Round 1 & Round 2 discussions. The following questions were asked by multiple companies and more details can be found in section 3.3.

Difference from/benefit over existing CA framework

Companies asked what the difference is from existing CA framework and what the benefit is. From our perspective, we think the main difference is that the multiple carriers are treated as a single serving cell instead of multiple serving cells as in CA framework. This can help to simplify the cell management. In addition, overhead of common signals can be reduced, the latency of carrier switching can be reduced.

Configuration of a serving cell with multiple carriers

Companies asked whether multiple BWPs are configured for the multiple carriers with each BWP confined within a carrier. While we think this can be a straightforward approach, we are open to other potential solutions, e.g. a BWP with multiple non-contiguous carriers. We think the details can be discussed in a later stage.

Resource allocation of PDSCH/PUSCH across multiple carriers

Companies asked whether a TB can be transmitted across multiple carriers of a same serving cell. From our perspective, we are open to discuss whether a TB is transmitted across multiple carriers or multiple TBs are transmitted on multiple carriers respectively for transmission/reception across multiple carriers within a cell.

Carrier switching

Companies asked why fast carrier switching is needed and how it can be achieved compared with SCell activation. From our perspective, fast carrier switching is for the case when a UE only receives/transmits on a single carrier at a time. Furthermore, we assume sync/QCL assumptions can be inferred across multiple carriers aggregated in the same serving cell so the carrier switching latency can be reduced compared with SCell activation.

RWS-210403 Uplink MIMO enhancements

In RWS-210403, potential enhancements to UL MIMO are proposed. During the discussions, the following questions were received from various companies.

UL frequency-selective precoding

Simulation assumption: A few companies requested details on the simulation assumption. Reference was given to a previous company contribution submitted in RAN1#91e that provided detailed simulation assumptions including antenna structure, codebook, and frequency precoding granularity.

Overhead consideration: A few companies commented that signaling overhead for UL frequency-selective precoding should be considered in this enhancement. CATT concurred with the assessment.

Spatial codebook enhancement: One company inquired whether spatial codebook enhancement with potential new codebook framework (e.g. dual-stage) is part of the Rel.18 enhancement, in order to explore the possibility of signaling overhead reduction. CATT commented that this possibility may be explored due to its overhead reduction potential.

Codebook vs. non-codebook: Several companies seek clarification whether CB and/or NCB are targets of the enhancement. CATT thinks codebook should at least be studied.

Beam management enhancements with multi-panel TX and multi-panel/TRP RX deployment

Application to S-TRP and/or M-TRP scenario: It was asked whether multi-panel joint transmission is toward a single TRP or multiple TRPs. CATT believed both cases are possible in practical deployment, e.g. given that different UL panels are likely pointing to different directions.

UL High-order MIMO

Codeword-to-layer mapping: One company commented that multi-CW transmission should be studied for rank>4. CATT clarified that this is an inherent aspect to be studied when considering rank>4 MIMO.

Application scenarios: Clarification was requested on the application scenarios and type of UEs for higher-order MIMO of >4Tx. CATT clarified that application is targeting non-traditional, low-mobility, high-performance devices such as AR/VR, IAB, medical, industrial, security equipment that are not as stringently battery and form-factor limited.

Waveform: one company asked whether enhancement targets CP-OFDM or DFT-o-OFDM. CATT clarified this is for CP-OFDM.

Ultra-high-density UL enhancement

DMRS overhead reduction: One company commented that they see increasing the number of DMRS ports higher priority than DMRS density reduction. One company asked whether DMRS density reduction should be studied without increasing DMRS port number. CATT clarified that DMRS density reduction and DMRS port increase are two independent features in our understanding; however they are not contradictory to each other.

The following potential enhancement areas are identified based on discussion:

UL frequency-selective precoding

Support codebook-based frequency-selective precoding for 2Tx and 4Tx UL-MIMO, targeting realistic signaling overhead

Multi-panel joint transmission

Support simultaneous transmission from multiple UL panels, including reception at a single TRP and multiple TRPs

UL High-order MIMO

Evaluate the performance benefits, and if justified, specify higher-order MIMO with up to 8 layer spatial multiplexing

Ultra-high-density UL enhancement

Evaluate the performance benefits, and if justified, specify mechanism for DMRS overhead reduction for UL MU-MIMO

RWS-210404 SON/MDT

In RWS-210404, we propose to have a Rel-18 WI on SON/MDT enhancement with more features considered e.g. MBS, NPN, IAB etc.

During the discussion, companies involved in the discussion share the similar view that SON/MDT should be further enhanced in Rel-18.Some companies have questions on whether current mechanism is enough for IAB scenario and further clarification from our side is that topology adaptation may be further optimized based on more information from IAB node. There were also comments that SON for NTN should be considered and we are open to further discussion on this feature.

RWS-210405 Transmission efficiency improvements

RWS-210405 is mainly about to improve/enhance the transmission efficiency for signaling and data in Rel-18. Some companies shared their comments and questions during the email discussions, which are summarized below.

Firstly, there was question on whether the scope include topic such as EHC. We've clarified that it can be taken into account.

Then, there was also question regarding whether signaling enhancement is motivated by any dynamic change in capability report. It has been clarified that such cases include but not limited to dynamic capabilities for UTRA-FDD, as well as two other cases that may see UE capability set changed.

To conclude, we'd clarify that clarified the main use cases for the proposed data and signalling transmission efficiency improvement include

- general use cases where data and signalling compression are beneficial;

- IIoT and MTC use case;

- XR and cloud gaming use cases;

- data and model exchange for AI/ML support;

And, at this early stage, we already identified some possible technical directions, including

- NR UDC can be applied for MR-DC case;

- NR UDC can be applied for RLC-UM in Rel-18 with small adapted adjustment;

- NR UDC can be used as the enhancements for EHC;

- Delta signalling reporting with UE capability ID can be supported in Rel-18 to reduce the signalling overhead and improve the spectrum efficiency.

We are open to discuss other potential technical directions for improving the transmission efficiency for signaling and data in Rel-18.