RAN-R18-WS-crossFunc-NTT_DOCOMO - Version 0.0.5
RAN

3GPP TSG RAN Rel-18 workshop **RWS-210634**

Electronic Meeting, June 28 - July 2, 2021

Agenda Item: 4.3

Source: NTT DOCOMO, INC.

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

1 Introduction

This email discussion summary covers the following documents.

- RWS-210271, Study on above 71 GHz frequency range, NTT DOCOMO, INC.

- RWS-210272, Views on XR for Rel-18, NTT DOCOMO, INC.

- RWS-210273, Study on AI/ML for PHY/MAC in Rel-18, NTT DOCOMO, INC.

- RWS-210274, Study on Full duplex for NR, NTT DOCOMO, INC.

- RWS-210327, Motivation of Study on Inter-gNB Coordination, NTT DOCOMO Inc., AT&T, Deutsche Telekom, Verizon, Telecom Italia, Vodafone, KDDI, China Telecom, Dish Networks, SoftBank, Bell Mobility

2 General Q&A

2.1 Round 1

2.1.1 Round 1 General Comments/Questions

Feedback Form 1: Round 1 General Comments/Questions

2.1.2 Answers to General Comments/Questions

No general comments/questions were received in Round 1.

2.2 Round 2

2.2.1 Round 2 General Comments/Questions

Feedback Form 2: Round 2 General Comments/Questions

2.2.2 Answers to General Comments/Questions

No general comments/questions were received in Round 2.

3 Above 71GHz Frequency Range (RWS-210271)

3.1 Round 1

3.1.1 Round 1 Questions on Above 71GHz Frequency Range

Feedback Form 3: Round 1 Questions on Above 71GHz Frequency Range

1 – Samsung Electronics Co.

Q1: Is it the correct understanding that only a SI on the waveform design above 71 GHz is considered in Rel-18?

Q2: As you mentioned, to support >71GHz, several fundamental aspects will be studied (waveform design, numerology, channel and transmitter/receiver RF models), and it can be across multiple release. Do you think what is the order of study for these aspects ?

2 – LG Electronics Inc.

Q) We agree that legacy waveforms (e.g., DFT-s-OFDM) should be taken into account as the starting point, in case new waveform for beyond 71 GHz up to 100 GHz will be studied.

3 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution. Could you explain the meaning of ”Fragmentation for below 71 GHz frequency range should be avoided” on page 3?

Could you clarify which use cases or deployment scenarios you see as most promising above 71 GHz?

4 – Samsung Electronics Polska

Thank you for the contribution. We have few questions:

’Q1: Is it the correct understanding that only a SI on the waveform design above 71 GHz is considered in Rel-18?

Q2: As you mentioned, to support >71GHz, several fundamental aspects will be studied (waveform design, numerology, channel and transmitter/receiver RF models), and it can be across multiple release. Do you think what is the order of study for these aspects ?

5 – Sony Corporation

Thank you for this contribution. Do you think the PAPR of DFT-s-OFDM is not low enough for the spectrum above 71 GHz?

6 – CATT

What priority do you give this item within the Rel-18 time frame? Similarly we also want to hear some of urgent use case for this item from the operator.

3.1.2 Round 1 Answers on Above 71GHz Frequency Range

Feedback Form 4: Round 1 Answers on Above 71GHz Frequency Range

1 – NTT DOCOMO INC.

Thanks everyone for the comments/questions. Please find our answers/clarification below.

General

- One clarification, while we believe study on above 71 GHz would be important for 3GPP, we understand well that it could be not very important (or urgent) one compared to other proposed Rel-18 topics. At first we would like to hear companies' views on when to unlock above 71 GHz for 3GPP. We are ok with having this SI in Rel-18 if and only if there is remaining TU available for this. Also ok with having only limited TUs for this SI.

To Samsung (two comments but seem the same?)

- To Q1: Yes, that is our intention. We do not see strong urgency to finalize the standardization for NR extension beyond 71 GHz, although we are sure it would be important to unlock such higher frequency in the future. Also we assume the study itself is highly likely a long-term one since it may need to consider some fundamental changes, e.g. waveform. Therefore in Rel-18, it would be sufficient to study such fundamental aspects.
- To Q2: From RAN1 perspective, waveform design should be prioritized, but it may need clearer models of channel/transmitter/receiver RF for the studied frequency range. In that sense, waveform design, channel model and transmitter/receiver RF model would be equally important and should be prioritized. Numerology would have a dependency on the exact waveform design adopted for the higher frequency.

To LGE

- Yes, the legacy OFDM-based waveforms should be considered as starting point, and we are open to consider any enhancement to OFDM-based waveforms as well as other waveforms in this study.

To Huawei

- To 1st question: For example, according to the study of beyond 71 GHz, completely different waveform than the existing ones in NR can be introduced (not our strong preference, just an example). In

this case, one could argue that such new waveform should be adopted to 52.6 - 71 GHz as it is also another high frequency range. However, as you know well, Rel-17 will support 52.6 - 71 GHz operation without any new waveform. We do not think it would be good that the potential discussion for beyond 71 GHz in Rel-18 affects the design for NR 52.6 - 71 GHz which will be basically supported after finalizing Rel-17.

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To 2nd question: Use cases promising above 71 GHz would not be crystal clear at this moment from our perspective, while it would be rather clear that above 71 GHz can provide much wider bandwidth resulting in boosting throughputs more, which is attractive for operators. By observing actual benefits and constraints assumed for above 71 GHz operation, we would also like to explore what could be the practical use cases in this band.

To Sony

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That is actually something we need to investigate at the beginning of this potential study in our view. Although we prefer OFDM-based waveform as a starting point, it's not clear for us at this moment whether there is any necessary enhancement on the OFDM based waveform and whether there is any other new waveform candidate working well in the frequency range. It will require study/investigation about channel model and RF model.

To CATT

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We do not see urgent use cases for above 71 GHz at this stage (i.e. 5G) since the use cases themselves are a bit unclear. On the other hand, as above 71 GHz will make larger bandwidth available, operators may be able to provide much better user experiences in some specific use cases, which is attractive for us. To achieve this in the future, we would also like to investigate what could be practical use cases as well as technical study.

Thanks again!

3.2 Round 2

3.2.1 Round 2 Questions on Above 71GHz Frequency Range

Feedback Form 5: Round 2 Questions on Above 71GHz Frequency Range

3.2.2 Round 2 Answers on Above 71GHz Frequency Range

No comments/questions were received in Round 2.

4 XR (RWS-210272)

4.1 Round 1

4.1.1 Round 1 Questions on XR

Feedback Form 6: Round 1 Questions on XR

1 – Spreadtrum Communications

Considering the PDB for XR, how to align the DL and UL transmission timing?

2 – Classon Consulting

[for FUTUREWEI]

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

3 – CATT

Thanks for sharing the idea of NR enhancement for XR. The proposed schemes of capacity enhancement and power saving technique with DL/UL alignment are quite interesting. However, we believe the aspects of NR enhancements should be discussed in the working group first with conclusion in the XR study before further discussion of the scope of XR work item.

4 – Intel Corporation (UK) Ltd

Thank you for the contribution. We also think XR capacity should be increased (based on evaluations in Rel-17) and some RAN2 work on traffic awareness of scheduler may be beneficial to improve XR capacity.

5 – LG Electronics Inc.

Thanks for the contribution.

Q1) In your paper (RWS-210272), it is proposed to consider the mobility in the XR WI scope. More specifically, inter-cell mobility enhancements are proposed and for the details readers are referred to another paper. Then can we assume that your preference is to study the mobility enhancements in the XR SI/WI? If so, can you explain the XR-specific enhancements that can be better handled in XR rather than other mobility enhancement SI/WI?

4.1.2 Round 1 Answers on XR

Feedback Form 7: Round 1 Answers on XR

1 – DOCOMO Communications Lab.

To Spreadtrum,

Thanks for your question. Our intention is to study the DL and UL transmission timing alignment including the feasibility and what is spec impact, and to specify necessary solution if needed. One aspect is that some UL enhancement would be considered so that UL transmission should be performed within on duration. It may relate with CDRX enhancement discussion, and they may be discussed together.

To Classon Consulting,

Thanks for your comments. We see that cooperative MIMO/interference management can help to increase capacity according to your simulation results. In our understanding, the proposed enhancement may be a general method for both eMBB and non-eMBB scenarios. For XR with latency and capacity requirement, we think some enhancements considering XR specific features can be studied, e.g. SPS/CG enhancements.

To CATT,

Thanks for sharing your view. We understand your preference that enhancements area and work item scope should be discussed in the Rel-17 XR SI rather than in the Rel-18 workshops at RAN plenary level. We actually have different view for now that they should be discussed in the Rel-18 workshops considering timeline for Rel-18 package approval. From the initial evaluations submitted at the RAN1#105-e, it seems obvious that at least some enhancements are needed for capacity. Only around 5 UEs can meet the requirements according to the results, while it is expected that more UE need to be accommodated in actual deployment scenario.

To Intel,

Thanks for sharing your views. Yes, we think XR capacity is one important aspects to provide good user experience in actual deployments, and thus some enhancements can be studied, e.g. SPS/CG enhancements. Regarding higher layer enhancements, we are open to study it including traffic awareness scheduler.

To LGE,

Thanks for the question. Our preference is to discuss mobility enhancements in other WIs rather than in XR SI/WI. For example, L1/L2 mobility could be discussed in MIMO WI following to the Rel-17 MIMO discussion.

4.2 Round 2

4.2.1 Round 2 Questions on XR

Feedback Form 8: Round 2 Questions on XR

4.2.2 Round 2 Answers on XR

No comments/questions were received in Round 2.

5 AI/ML for PHY/MAC (RWS-210273)

5.1 Round 1

5.1.1 Round 1 Questions on AI/ML for PHY/MAC

Feedback Form 9: Round 1 Questions on AI/ML for PHY/-MAC

1 – Rakuten Mobile

Thanks for contribution.

We support use of AI/ML in physical layer specially for mitigating interference, mobility management , beam management etc.

2 – Intel Corporation (UK) Ltd

Thank you for the contribution. Please see our questions below:

1. Could you please provide more details on the assumptions for the results in slide 7?
2. Could you please provide more details regarding the usage of grant-free transmissions and feedback content design for deep learning receivers?

3 – LG Electronics Inc.

Thanks for the contribution. In the proposed SI objective, it includes prioritization of use cases. Does this mean prioritization in the middle of study to reduce evaluation burden after the prioritization? Or it is done at the end of the study based on evaluation results of each use case?

4 – Sony Corporation

Thanks for the contribution. We have two questions.

- CSI report enhancement for beam management
  - Why does this aspect require minor specification impact? Is this not require signaling of neural network information?
- Signaling of neural network information

- What kind of information do you assume for neural network information?

5 – Fujitsu Limited

Thanks for the contribution. We have two questions:

1. Do you think AI model/algorithms have the impact on the performance gain in AI use cases?
2. If yes, how to consider avoid discussions on AI/ML models/algorithms in the evaluations of AI gain and comparison the results among companies?

6 – Qualcomm Incorporated

What will be the feedback content of DNN-based receiver? The impact of receiver can be absorbed in CQI reporting.

7 – NEC Corporation

NEC supports having SI on AI/ML enabled radio air interface including PHY and/or MAC layers. We agree that use case prioritization is important to clearly show performance gain.

5.1.2 Round 1 Answers on AI/ML for PHY/MAC

Feedback Form 10: Round 1 Answers on AI/ML for PHY/-MAC

1 – NTT DOCOMO INC.

Thanks everyone for the comments/questions. Please find our answers/clarification below.

To Intel

To Q1: In slide 7, it is assumed that AI estimates the channel based on the type□ CSI codebook PMI from UE. Usually, the channel estimation accuracy deteriorates due to quantization error and frequency domain granularity of CSI report from the limited size of feedback. DNN-based receiver at gNB side could reconstruct the channel better with large granularity than conventional interpolation. After reconstructing the channel, traditional precoding or decoding method is used in our current simulation example. The AI-based precoder design can also be considered.

To Q2: The grant free transmissions w/ enhanced initial access and PUSCH/PDSCH TRx schemes is one of the potential use cases for lean-air interface, i.e. utilizing AI/ML for preamble design and detection in grant-free transmission. Regarding the feedback content design, there are two kinds of considerations as below and we are in favor of the first one to start in Rel-18 since it is easier and more backward compatible.

1. Enhanced Type II: DNN-based receiver at gNB side could reconstruct the channel with larger granularity PMI feedback that may introduce some small modification on specification impact, e.g. larger subband PMI / sparser CSI-RS density.
2. Brand new content: If E2E architecture is assumed(UE involvement in DNN), a more aggressive change in specification would be introduced, e.g. new design of channel feedback regardless of current PMI.

To LGE

We prefer prioritizing use cases based on some factors (e.g., decent amount of specification impact or compatibility with 5G NR) to reduce evaluation burden in study. Of course, it is also necessary to select the use case to work on, after evaluating them in study.

To Sony

To Q1: We realized several companies propose end-to-end CSI report enhancements where AI encoder on UE and AI decoder on BS are performed. We are also supportive of end-to-end CSI report enhancements. However, we think it is better to study CSI report enhancement with AI only on BS instead of end-to-end CSI report enhancements as a first step. In this case, signaling of neural network information could be avoided since AI-based CSI estimation on BS can be transparent to UE.

To Q2: In our context, signaling of neural network information means transferring information about neural networks between gNB and UEs, such as weights of neural networks. Since this requires large specification impacts, we prefer not to introduce it until clarifying the pain and gain.

To Fujitsu

AI model/algorithms impacts the performance gain in our views. We believe that defining common date set for evaluation is the one way to reduce performance gap among companies. However, the observed gain gap between company is inevitable, unless the common AI/ML algorithm is used for the evaluation. But it is our understanding that 3GPP does not need to specify the common AI/ML algorithm, and it can be up to implementation. Therefore, even if there are some performance differences among companies due to details on AI/ML algorithm, 3GPP can discuss the feasibility and performance benefit of the proposed mechanism which have a certain specification impact such as new parameter, configuration and/or reporting.

To Qualcomm

Regarding the feedback content of DNN-based receiver, there are two kinds of considerations as below and we are in favor of the first one to start in Rel-18 since it is easier and more backward compatible.

1. Enhanced Type II: DNN-based receiver at gNB side could reconstruct the channel with larger granularity PMI feedback that may introduce some small modification on specification impact, e.g. larger subband PMI / sparser CSI-RS density.

2. Brand new content: If E2E architecture is assumed(UE involvement in DNN), a more aggressive change in specification would be introduced, e.g. new design of channel feedback regardless of current PMI.

To Rakuten mobile, To NEC

Thanks for the comments and sharing the same view!

Thanks again!

5.2 Round 2

5.2.1 Round 2 Questions on AI/ML for PHY/MAC

Feedback Form 11: Round 2 Questions on AI/ML for PHY/-MAC

1 – ZTE Corporation

On P6, it seems that ML for CSI FB for beam management is deployed in gNB side, and you expect L1-RSRP reporting for SSB and CSI-RS beams to be enhanced. Could you please clarify why and how to enhance L1-RSRP reporting? If developed in UE sides, could you please clarify how to train ML (e.g., DNN) in UE side?

2 – vivo Mobile Communication Co.

Thanks for sharing your views and sharing your evaluation results.

Q1: Regarding ”reduced RS types”, can you elaborate a little bit more?

Q2: Regarding the study item arrangement, do you think identification of use case and evaluation methodology should be conducted in parallel or sequentially? Does the prioritization mean to prioritize after evaluation on each use cases are conducted?

5.2.2 Round 2 Answers on AI/ML for PHY/MAC

Feedback Form 12: Round 2 Answers on AI/ML for PHY/-MAC

1 – NTT DOCOMO INC.

Thanks everyone for the comments/questions. Please find our answers/clarification below.

To ZTE,

Although we are open to deploying AI on gNB or on UE for CSI FB beam measurements, our current main target is ML deployed on gNB for AI-aided beam management. As conventional L1-RSRP/SINR is not optimized for AI-based beam management, L1-RSRP/SINR might need to be enhanced so that gNB can infer the best beam with small overhead.

In our view, one of potential enhancements could be a UE selection rule of reported beam measurements. For example, how UE selects reported beam measurements can be configurable, according to usage of beam measurement values.

To vivo,

Q1: In our view, AI can estimate a variety of channel qualities based on one unified RS type unlike in the current system where many RS types are used according to use cases. Ultimately, we think it is also possible to estimate the channel even without RS, i.e., detect the channel based on received signals w/o or w/ limited RS by utilizing AI/ML. But of course we prefer to have step-by-step approach, i.e., prioritizing use cases/enhancements without big spec impacts in Rel-18 study.

Q2: Since evaluation methodology could depend on use cases, we would like to conduct identification of use cases and evaluation methodology sequentially. Our proposed steps for AI-PHY study are as follows.

- Prioritize some use cases for AI-PHY, considering whether a new feature could be compatible with 5G NR and how much specification effort would be necessary.
- Study and discuss evaluation methodology for prioritized use cases.
- Evaluate performance gains of prioritized use cases.

 Recommend some use cases for WI (if any) based on the evaluated performance gain and the analysis on specification impacts.

Prioritizing before evaluation methodology and performance evaluation is to reduce the burden for evaluation methodology discussion and evaluation campaign. We prefer to finish step in RAN level e.g., during SID scope discussion and leave other steps to WG level SI.

Thanks again!

6 Full Duplex for NR (RWS-210274)

6.1 Round 1

6.1.1 Round 1 Questions on Full Duplex for NR

Feedback Form 13: Round 1 Questions on Full Duplex for NR

1 – vivo Communication Technology

Thanks for DOCOMO's paper on full duplex. we have some questions as below

1. Regarding the option A-2, what is DOCOMO's consideration about its impact to the adjacent channel co-existence issue with different operators?

2. What is your view regarding potential UE hardware impact (i.e. RF) for option A-1 or A-2?

3. What is the frequency band does DOCOMO consider for gNB side full duplex, is it for TDD band only, or also include low band FDD?

2 – Rakuten Mobile

Thanks Docomo for contribution.

We support Sub Band based FD in release 18 & Full Band based FD i.e. OptB-2 in future release.

Q1) How much complexity will UE have from Hardware point of view?

3 – MediaTek Inc.

Thanks for the contribution. Some questions as follows.

Q1: What's the regulation status to enable fullduplex in TDD bands in Japan? Any rationale to also include FDD bands in the study?

Q2: What is the impact of gNB FD support onto NR legacy UEs from R15/16/17 due to UE-UE CLI? How can these terminals be protected from UE-UE CLI? Legacy UEs cannot implement any CLI mitigation techniques or CLI-related measurements.

Q3: What is the impact on legacy gNB because of gNB-gNB CLI?

Q4: Is there any expected RF specification tightening for future R18 Half Duplex UEs (ACLR, ACS, in-band blocking, etc) to operate with a SSFD or SBFD-capable gNB?

Q5: Is there a significant power consumption impact onto FD-capable gNBs?

Q6: Is there any significant difference between FR1 and FR2 to minimise UE-UE CLI and gNB-gNB CLI.

Q7: A huge amount of effort will be needed in RAN4, which is already overloaded. Do you believe the RAN4 effort be prioritised on FR2 over FR1?

4 – LG Electronics Inc.

We are thinking that full duplex operation for unpaired spectrum can provide benefits such as 'adaptation to DL and UL traffic fluctuation' and 'lower latency with increasing UL time resources' as explained in page 1. Furthermore, if more time occasions for UL are provided from full duplex for unpaired spectrum, we may simply think further coverage enhancement can be achieved by more time occasions.

Q1) Do you think what is different point/work scope between coverage enhancement in Rel-17 and coverage enhancement by full duplex?

5 – Intel Corporation (UK) Ltd

Thank you for the contribution. Please see our questions below:

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

2. Do you consider full duplex to be limited to TDD bands only?

6 – Futurewei Technologies

We are supportive of a phased approach for the flexible/full duplex study. The proposed study points by the contribution for Rel-18 seem reasonable for us considering the challenges relating interference cancellation among other implementation challenges;

A suggestion is that the technical challenge part in this contribution can be extended to include aspects such as signal isolation, TRX nonlinearities, cross-operator interference, etc.;

The difficulties of the mentioned final goal of achieving FD Opt B-2 can be elaborated.

Please take a look at our contribution RWS-210036 (https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_AHs/2021_06_1 210036.zip) and feel free to comment at: https://nwm-trial.etsi.org/#/documents/4580

7 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution. In the context of options A-1 and A-2, are you also considering the necessity of RAN study/work on inter-gNB cross-link interference handling?

8 – Samsung Electronics Polska

'- Question for scope in Rel-18, among subband FD what is docomo's priority in terms of, FR1 and FR2, and intra-carrier and inter-carrier, access-link and other use cases (IAB or else) what is highest priority in Rel-18. Also, what is docomo's view on MIMO operation in this area?

- Regarding steps (in slide 4), do you expect step 2 and step 3 in different release ? For exmaple, sub-band based FD (step2) in Rel-19 and spectrum sharing FD (step3) in Rel-20?

9 – Fraunhofer HHI

Thank you very much for the contribution and outline of a phased approach for study and normative work. We would appreciate if you could elaborate to the following aspects:

Q1: Is there any particular reason to exclude FD operation at gNB and UE (B-1/B-2)), in case legacy UEs are served in half duplex mode while new UE may exploit their FD capabilities?

Q2: Do you exclude dynamic changes of the subband allocation for UL and DL on a slot or frame base? option A-1/B-1 may appear rather static

Q3: Can you support a hybrid mode between A-1, A-2,B-1, B-2 in specific combinations? If yes, are there any preferences of particular combinations?

10 – KT Corp.

Happy to see NTT Docomo's mentioning both TDD and FDD for full duplex study. We also believe that this should be taken into account in Rel-18 FDR study.

6.1.2 Round 1 Answers on Full Duplex for NR

Feedback Form 14: Round 1 Answers on Full Duplex for NR

1 – NTT DOCOMO INC.

First of all, thank you very much for your comments, and questions. Please find our answers to your questions.

For vivo Communication Technology

1. We think dynamic TDD may share the same impact/issue, so it should be handled when UL/DL is different at a certain time resource at the adjacent channel with different operators.
2. For A-1 and A-2 (half duplex operation at UE), we expect that impact of UE RF is limited. For A-1 (sub-band based full duplex), appropriate requirements (e.g. guard band between UL/DL) may be considered/studied, and for A-2 (spectrum sharing full duplex), dynamic TDD may share the same impact.
3. Currently, we don't have concrete idea of frequency band. We refer to study both TDD and FDD, bands since they can be potentially considered for full duplex operation in long term aspect. On the other hands, if we consider short term aspect (e.g. considering sub-band based full duplex), TDD bands which have wider bandwidth can be prioritized.

For Rakuten Mobile, Inc

1. For Opt. A (half duplex at UE), we expect that impact of UE RF is limited. For Opt. B (full duplex at UE), UE self-interference should be handled with base band process (e.g. self interference canceler) and if necessary hardware (e.g. antenna and/or RF chain separation for DL/UL isolation).

For MediaTek Inc.

1. Frequency bands are allocated as TDD band or FDD band with regulatory requirement and interference study, and in our understanding TDD(FDD) operation is assumed for the study/requirement for TDD(FDD) band. Therefore MIC may need to consider and study with considering the full duplex operation to enable full duplex in TDD/FDD bands. We think the full duplex is a long term technology, so that we would like to study the possible scenarios/assumptions (e.g. TDD/FDD, FR1/FR2) for the future at this stage.
2. 3. We think that the sub-band based full duplex is a candidate technology for the Rel-18/19 time frame, so that the UE-UE/gNB-gNB CLI can be handled using FDMed operation with requirements (e.g. appropriate guard band between UL and DL frequencies), and they will be studied.
4. For SBFD, we expect that impact of UE RF is limited, and dynamic TDD may share the same impact for SBFD.
5. Currently we have no idea about gNB power consumption.
6. We think this point is one of the study points to fide out the difference.
7. We prefer to study both FR1 and FR2 for long term aspect, on the other hands, we also think that RAN4 workload needs to be taken into account. For example, if we consider short term aspect (e.g. considering SBFD), TDD bands which have wider bandwidth can be prioritized.

For LGE

1. In our understanding, Rel-17 coverage enhancement mainly focused on time domain and DM-RS based solutions, so that increasing UL time resource may maximize the gain of Rel-17 coverage enhancement techniques. Currently DL heavy TDD configuration is widely operated, so that we expect that increasing UL time resource can be realized by full duplex. Thus we believe that the full duplex maximize the gain of Rel-17 coverage enhancement techniques.

For Intel Corporation (UK) Ltd
1. We expect to take a feasibility study in RAN1 with a standard way, for example, RAN1 may study about the performance/gain of full duplex with considering the assumption of the study. And RAN1 may ask to RAN4 (e.g. send LS) whether the assumption of RF related parameters (e.g. guard band between UL and DL for sub-band based full duplex, power imbalance, self-/adjacent channel interference etc.) is reasonable, or RAN4 proposals.
2. We prefer to study both TDD and FDD bands for long term aspect, on the other hands, if we consider short term aspect (e.g. considering sub-band based full duplex), TDD bands which have wider bandwidth can be prioritized

For Futurewei Technologies
Thank you very much for your suggestion. We also realize your suggested aspects and they may be shared with dynamic TDD.

For Huawei Tech. (UK) Co.. Ltd
Yes, study/work on inter-gNB CLI is necessary and we expect that impact of it for Opt. A-1 can be smaller.

For Samsung Electronics Polska
1. In Rel-18 study, we would like to study with widely covering possible scenario/configuration of full duplex. For sub-band based full duplex, TDD bands which have wider bandwidth can be prioritized while we prefer to study both FR1/FR2, inter-/intra carrier, and single/multiple links. MIMO operation is related to antenna configuration, for example if separate antenna is assumed for DL and UL for full duplex operation, smaller number of antenna can be used for MIMO operation, and we need to consider this aspect for performance evaluation.
2. In this moment, we don't have concrete view for which Release is appropriate for step 3, while we expect step 2 can be for Rel-19.

For Fraunhofer HHI
1. It seems that FD at UE seems large impact for current UE design, so that we think FD at gNB may be a realistic approach for short span. On the other hand, we are open to discuss FD at UE with information/views from UE/chipset vendors.
2. We don't intend to exclude dynamic changes. Similar to dynamic TDD, changing frequency resource for DL/UL corresponding to DL/UL traffic is beneficial.
3. Currently we don't have concrete view for hybrid mode. We don't see the use case of hybrid mode, since for example, A-2 covers A-1, so that when A-2 is realized, A-1 can be also configured. Therefore sharing use case or your intention is helpful for our consideration.

For KT Corp.
Thank you very much for your comment.

6.2 Round 2

6.2.1 Round 2 Questions on Full Duplex for NR

Feedback Form 15: Round 2 Questions on Full Duplex for NR

1 – LG Electronics Inc.

Thanks for your kind answer. We are also thinking that full duplex can be a good solution to provide more UL occasion, hence we can expect that Rel-17 CE related solutions (i.e., PUSCH/PUCCH repetition, DMRS bundling, etc.) are well operated. Also, we think the main drawback of operating Rel-17 CE in DL heavy TDD configuration is to increase latency due to PUSCH/PUCCH repetition using multiple slots which are timely longer period. If full duplex is introduced, we can enjoy latency reduction compared with that of Rel-17 CE.

We have one additional question.

Q1) When gNB full duplex and UE half duplex is adopted, we may consider to support legacy UE. If you have in mind any idea to support legacy UE, could you explain how to support that?

6.2.2 Round 2 Answers on Full Duplex for NR

Feedback Form 16: Round 2 Answers on Full Duplex for NR

1 – NTT DOCOMO INC.

To LG Electronics Inc.

Thank you very much for your question. Please find our answer as follows.

1. Yes, we need to consider/study that the enhanced gNB with full duplex operation needs to support both legacy UE and enhanced UE. The resource management may be handled by the NW, e.g. (b) HD+SB-FD as in slide 3 in your document (RWS-210241), DL resource in slot 2-4 may be configured for the legacy UE, and both UL and DL resources in slot 2-4 can be configured for the enhanced UE. On the other hands, UE-UE cross link interference needs to be considered/studied as you summarized (whether Rel-16 CLI may be sufficient, or additional mechanism to handle CLI may be necessary).

7 Inter-gNB Coordination (RWS-210327)

7.1 Round 1

7.1.1 Round 1 Questions on Inter-gNB Coordination

Feedback Form 17: Round 1 Questions on Inter-gNB Coordination

1 – China Telecommunications

To enable inter-gNB/gNB-DU CA and multi-TRP operation could improve the flexibility of operator network deployment and the user throughput with multiple fragmented bands, we support this work. We suggest to start from SI first to evaluate the backhaul latency impact on the performance of inter-gNB/gNB-DU coordination, based on the result we could design the mechanism to support the coordination function.

2 – Spreadtrum Communications

Thanks for the well-written contribution,we have some questions.

How to handle the transmission latency between two gNB/DUs in inter-gNB/gNB-DU carrier aggregation

opration? E.g. considering the impact of DU-DU latency to schduling? What's the possible impact to UE?

3 – ZTE Corporation

Thanks for the contributions. For proposal 3, we think this scenario can be take into account with RAN slicing study in Rel-18 as described in RWS-210022.

4 – CATT

Thanks for the contribution. Some questions from our side:

1)For bullet 1 and bullet 2, although the main impact maybe in RAN3,should it be first discussed in RAN1/RAN2 or RAN3?From our point view, maybe it should be first evaluated and discussed in RAN1/RAN2 on the requirement for backhaul and information which should be coordinated between gNBs/DUs,then RAN3 could further discuss the impact to network interface based the conclusion from RAN1/RAN2.

2) For gNB-CU resilency,is failure of gNB-CU the only scenario?

5 – InterDigital Germany GmbH

For CA cases that are inter-DU with a DU-DU interface or even inter-CU with an Xn interface, are you assuming a no-delay interface or will you propose CA changes to mitigate the extra delays with the interfaces?

6 – Beijing Xiaomi Mobile Software

Thanks for the paper.

It seems the target is to could improve the flexibility of operator network deployment. We want to ask what is the impact to UE? Do we need some enhancement in UU?

7 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution

We do understand that the motivation for inter-gNB/gNB-DU carrier aggregation.is motivated for less RRC signaling compare to DC solution, does our understanding is correct? If not please clarify

Based on assumption above (preference of CA on DC) the inter-gNB/gNB-DU carrier aggregation required intensive traffic to coordinate the scheduler. This traffic required ideal backhaul and heavy CP load. Does the associated costs of this traffic on the network, for CA, when we deployed effort to save energy make sense compare to a share cost with the UE in DC?

Other technical aspect could be difficult like how to guarantee the timing requirements between two gNBs for e.g. HARQ scheduling?

The the inter-gNB/gNB-DU carrier aggregation required the scheduler coordination, how the different scheduler developed by different vendor could be tight coordinated in efficient way? Does the intention here is to "make uniform" the product of vendor at his level?

8 – Samsung Electronics Polska

Thanks for the contributions. We have few questions:
Q1) What is the difference between inter-gNB/gNB-DU CA and inter-gNB/gNB-DU multi-TRP, e.g., aiming scenario (inter-freq., vs, intra-freq.), scheduling, inter-gNB coordination level (semi-static,or dynamic, etc.)?

Q2) Regarding Proposal 3, Is the resiliency of gNB-CU focused on non-RAN-sharing case (i.e., two gNB-CUs belong to the same PLMN)?

Q3) in slide 13, for the failure operation for opton 1&2, the left UE is changed from ”red” to ”green”, which means that the UE can be impacted due to the failure of one CU, while for option 3, the left UE is not impacted. Which impact to UE is expected in option 1 & 2? Why the impact to UE is only applied to option 1 & 2?

7.1.2 Round 1 Answers on Inter-gNB Coordination

Feedback Form 18: Round 1 Answers on Inter-gNB Coordination

1 – DOCOMO Communications Lab.

To China Telecom:
Thanks for your support. We agree that we should start this work from SI and evaluate backhaul latency impact first. Please also see discussion with CATT below.

To Spreadtrum, InterDigital, and Xiaomi (on latency and Uu impact):

Thanks for your questions. Impact and requirements of latency between two gNB/DUs should indeed be studied.

First let me discuss multi-carrier operation.

In our current thinking, one possibility is to assume (near-)ideal backhaul. This would require gNBs/DUs to be in the same or closely-located building(s), but our preference from requirement perspective is this approach. The reason is that it will resolve most of challenges of current architecture as depicted in pp. 4-6, and with this approach we could aim to make the feature transparent to UEs including Rel-15.

Another possibility is to permit gNB/DUs looser coordination with the aid of UE behavior, as indicated by InterDigital. We are open to discuss and study how to realize this (e.g. DC with limited number of simultaneous UL as discussed in triple connectivity contributions, etc), but we should study solutions that minimize the performance impact while addressing as many challenges in the paper as possible.

As for multi-TRP operation, we think the study should be based on R16 multi-TRP feature for non-ideal backhaul, without impacting Uu as compared to the R16 feature. We are also open to discuss R18-architecture-aware Uu enhancements.

As for resiliency of gNB-CU, we think the baseline would be no Uu impact.

To ZTE:

Thanks for pointing this out. Though our primary target is resiliency on gNB-CU failure, yes we see commonality in architecture with RWS-210022. Some of the proponents have similar view, see e.g. RWS-210140. Docomo also think standardized DECOR-like solution would be beneficial to enable different network capability, SLAs (e.g. isolated impact), capacities, etc. among slices.

To CATT:

Thanks for your constructive comments/questions.

1) We think it makes sense to firstly study impact and requirement of latency in RAN1/2 from Uu perspective, and then network latency requirement in RAN3. We would like to continue discussion on how to proceed.

2) Our primary target is gNB-CU failure, but we are open to discuss other promising scenarios with similar architecture/motivation. Please also see the discussion with ZTE above.

To Huawei:

Thanks for your feedback.

(to 1st paragraph)
Firstly let me describe our motivation for inter-gNB/DU multi-carrier operation. Operators have been facing deployment inflexibility with single-node CA from accomodation and cell design perspective. Please see pp. 4-5. Although NR-DC could solve this issue to some extent, we are also seeing some challenges of DC:

- Smaller service coverage due to two ULs
- Need for additional UE capability
- Less flexible resource assignment than CA

Our motivation is to address these issues of single-node CA, and DC.

(to 3rd and 4th paragraph)
As you point out timing requirements/impacts and how to coordinate different gNB/DUs in an interoperable way would be main topics to study. We believe inter-gNB/DU CA would solve the issues above, but it might be challenging especially from inter-operability perspective. That's why we elaborate the issues and requirements in our paper rather than just stressing strong operators' need for inter-gNB CA. We are also open to discuss solutions for (as many as possible of) above issues, which require less inter-operability effort than ideal inter-gNB CA.

(to 2nd paragraph)
As for C-Plane load and energy, the drawbacks pointed out by the question seems valid if viewed from a single gNB perspective. However, if we leave the issues in our paper as it is we will have to deploy more gNB-CUs, DUs, and RRHs in order to provide competitive capacity and user experience by enabling single-node CA, overcoming coverage issue of DC, and so forth, which will cause additional cost on operators' overall deployment.

To Samsung:

Thanks for your questions.

(to Q1) Main difference between multi-carrier operation and multi-TRP operation is the motivation. With multi-carrier operation we aim for wider bandwidth usage, while with multi-TRP operation we aim for path diversity from higher spatial rank etc. Commonly to both operations, we would like more deployment flexibility than today.

(to Q2) Our priority is non-RAN-sharing case, which would be simpler and relevant, but we're open to discuss other promising scenarios with similar architecture/motivation.

(to Q3) In Option 1, before the failover all the UEs are served by CU1. On failover all the UEs are impacted. In Option 2, some of the UEs are served by CU1, while others by CU2. On failure of CU1 UEs served by CU1 are impacted. Option 3 is a hot failover. In Option 3 the UE context of UEs served by CU1 is transferred to CU2, and RRC connection etc. can be taken over by CU2, so that (almost) no service interruption is assumed.

7.2 Round 2

7.2.1 Round 2 Questions on Inter-gNB Coordination

Feedback Form 19: Round 2 Questions on Inter-gNB Coordination

7.2.2 Round 2 Answers on Inter-gNB Coordination

No comments/questions were received in Round 2.