

Email discussion summary for [RAN-R18-WS-eMBB-China_Telecom] - Version 0.0.5
RAN

3GPP TSG RAN Rel-18 workshop

RWS-210517

E-Meeting, June 28 - July 2, 2021

Agenda Item: 4.1

Source: Moderator (China Telecom)

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

Document for: Discussion

1 Introduction

This contribution is a summary of email discussion on proposals [1-5] for eMBB evolution.

2 Email discussion

2.1 General comments

Companies are invited to provide general comments on contributions [1-5].

Feedback Form 1:

1 – Spreadtrum Communications

Regarding the eMBB enhancements, we share a similar view that Mobility and UL improvement can be studied with high priority.

Besides, from Spreadtrum's view, the eMBB enhancements for R18 also include MIMO, and flexible/full Duplex.

2.2 Multi Radio Multi Connectivity ([1])

2.2.1 1st round: Questions and comments

Companies are invited to provide questions and comments on the following contribution.

RWS-210143, "Multi Radio Multi Connectivity for Rel-18".

Feedback Form 2:

1 – KDDI Corporation

Thanks for the proposals, let me ask questions below.

<Q1>

With regard to slide 4 “Motivation for Multi-layer deployment”, could you share your expectation on how many uplink transmissions UE can have with this multi connectivity feature? Do you want to have more than three uplinks?

<Q2>

With regard to slide 5 “NR-WLAN aggregation”, could you elaborate your motivation? At least to us it seems that using NR-U for unlicensed band seems to be more straight forward rather than using Wi-Fi, it seems that NR-U is much easier to be aggregated with NR. Do you see some benefit to use Wi-Fi technology instead of using NR-U?

2 – Spreadtrum Communications

We are interested in further enhancement on MR-MC in R18. And we have one question for clarification and one comment.

Q1: For the scope of fast and dynamic SCell/SCG activation for groups management, whether physical signaling is involved or not? If yes, it will have RAN1 impact, is that correct understanding?

Comment 1: For multi-RAT integration including NR-LTE-WLAN aggregation, we have a little concern on the workload within one SI/WI, but we open to discuss this at a late stage.

3 – Apple Hungary Kft.

[Apple] We agree on the usefulness of this in terms of use cases, and we think configuration of multi-CG but activation of one SCG with an MCG is a reasonable/practical Rel-18 objective. Similar to KDDI, we also have concern on the number of ULs (or active SCGs) would mean big impact to RAN2, and faster switching between multiple configured SCGs (with UE feedback) would be more practical.

4 – SoftBank Corp.

Thank you very much for your proposals. Regarding (UL) coverage enhancements in page 3 and 6, we are wondering if enhancement on PUSCH repetition type B helps to achieve additional coverage gain of several dB (on top of PUSCH repetition type A) . Your clarification is appreciated. Thanks.

5 – MediaTek Inc.

Thanks for the quality contribution. Please find our questions/comments below:

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On **Proposal 1**, what is the targeted number of active legs?

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Note: There is certain complexity impact to UE if supporting ≥ 3 active legs

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On **Proposal 2**, can we leverage LTE-WIFI interworking study and specification? Alternatively, can utilizing NR-U also serve the purpose?

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On **Proposals 3 and 4**, is keeping data continuity the main target? If it is the case, enabling "fast" SCG to MCG data switching can also keep data continuity when SCG blockage/failure while reusing existing framework of one MCG and one SCG.

6 – Beijing Xiaomi Mobile Software

Thanks for the proposal.

We are interested in this multi connectivity feature. We have some questions:

- 1) For the 3-connectivities, do you want to have more than three uplinks for UE uplink transmissions or the UE selectively use 2 of them?
- 2) Page 6: Multi-RAT integration, do you mean that UE can use 2 SNs and can one of them be WLAN AP?

7 – China Unicom

Thanks for this contribution. Supporting the configuration of multi-SCGs is very useful in multi-layer deployment scenario. Our comments are below.

Q1: what is the maximum uplinks to be considered in R18 as well as taking into account of UE implementation complexity?

Q2: For slides 9, "fast and dynamic SCell/ SCG activation and deactivation with selective (UL) activation" is in the scope, what is the mechanism of UE selective activate the SCell/SCG?

8 – CATT

In generale we support studies toward this direction due to the benefits mentioned by the paper.

Then we also agree with some other companies that it is useful to clarify some aspects, e.g., what is the number of simultaneously active 'legs'.

9 – Ericsson LM

Is this for a scenario where the SNs (e.g. in a pico-layer) are using different or same frequencies? We are asking because in DC today the MN and SN are on different frequencies.

10 – HuaWei Technologies Co.

Do you think the fast and dynamic mechanism for multiple layers include multiple carriers cases, i.e. not only for MR-DC case? We have similar proposal in RWS-210449 and we think such principle can be applicable for more wider cases.

Do you think there could be limitation on the supported number of SNs?

11 – Lenovo Mobile Com. Technology

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How many SCGs are expected to be activated per time? There will be big impact to UE capability when more than 2 links are activated per time.

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For dynamic activation/deactivation of SCG among multiple SCGs. We suppose RAN should aim at a solution with less latency compare to legacy SN change or conditional SN change.

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Regarding, NR-WLAN, we wonder if there is strong motivation at this stage, otherwise it could be safer to focus on multiple SN support first.

12 – Qualcomm CDMA Technologies

1. How is switched bearer in NR-WLAN aggregation scenario defined and when does "switching" take place (Slide 8)?
2. What are the functions of the Adaptation protocol (Slide 8)?

13 – Samsung Electronics Co.

- Q1) Could you clarify the meaning of 'selective UL activation'? Is it similar to UL switching in Samsung's proposal RWS-210183?
- Q2) Is there any limitation to the number of connectivities for MR-MC?
- Q3) Does the LTE-NR-WLAN aggregation require the support LTE/NR-WLAN DC first, which is not currently supported in NR?"
- Q4) What would be additional RAN impact for NR-WLAN aggregation in addition to MR-DC/MC?

14 – ZTE Corporation

Thanks for the contribution. We are also interested in the direction of MR-MC with selective activation. We have three questions:

- Q1:** According to this contribution, it seems most of the objectives are only related to RAN2/RAN3/RAN4. Do you see any RAN1 spec impact for these potential objectives, e.g., "fast and dynamic SCell/ SCG activation and deactivation with selective (UL) activation"?
- Q2:** Can you elaborate more about "UE capability management to support MR-MC" in slide 9?
- Q3:** Do you propose to support 2 activated SN simultaneously (i.e., 3 RF chain)? If yes, then maybe RAN1 also needs to be involved, e.g., PHR.

15 – Nokia Corporation

- Q1:** The scope is very wide so is this assumed to be a SI first? Or are there some priority topics that would take precedence over others?
- Q2:** Is the intent with N3IWF could be used together with MR-MC as one of the involved RATs, i.e. there would be something similar as done for LTE in LWA/LWIP?

2.2.2 1st round: Response to companies' feedback

Questions about Multi-layer deployment (e.g. multi-SN connectivity)

Q1: how many simultaneous UL transmissions or active CGs/ legs UE can have with this multi connectivity feature?

(@KDDI, Apple, MTK, xiaomi, CUC, CATT, Huawei, LENOVO, Samsung)

A1: Considering the UE implementation complexity and RF capability limitation, having **at most 2 simultaneous UL transmissions** would be more feasible in Rel-18. We propose to focus on at most 2 active UL in the first phase. But we can have more than one SCG configured (at least 2 SCG configured), and activate/ deactivate an SCG among the configured SCGs dynamically based on certain criterions such as the service requirements or radio link quality, and so on. Further extension to 3 legs in the DL could also be considered.

Q2: Any RAN1 spec impact for these potential objectives, e.g., fast and dynamic SCell/ SCG activation and deactivation, PHR?

(@ Spreadtrum, ZTE)

A2: Maybe yes. In our opinion, L1/L2/RRC signalling could all be considered for fast SCell/SCG activation and deactivation. If L1 signalling is used, then RAN1 spec impact will be expected. Meanwhile, in order to support MR-MC, UL power control or PHR would need further discussion or enhancement, which may also involve some RAN1 work. In general, the objectives of MR-MC are mainly related to RAN2/RAN3/RAN4.

Q3: Is keeping data continuity the main target? If it is the case, enabling "fast" SCG to MCG data switching can also keep data continuity when SCG blockage/failure while reusing existing framework of one MCG and one SCG.

□@MTK□

A3: Data continuity is one of the main targets as well as **higher bandwidth and capacity**. For new applications and services, such as AR/XR, HD live video, require not only service continuity and lower latency, but also higher bandwidth and capacity. "Fast" SCG to MCG data switching (maybe 2 legs into 1 leg?) might not be enough to meet the high bandwidth and capacity requirements. However, we are also open to fast" SCG to MCG data switching mechanism.

Q4: what is the mechanism of UL selective activate the SCell/SCG?

(@CUC [Maybe "UE selective activate" in Q2 from CUC is a typo of "UL selective activate"?], Samsung)

A3: The efficient activation/de-activation mechanism for one SCG discussed in Rel-17 can be the baseline. Since simultaneous UL transmission would be the main obstacle or bottleneck for MR-MC, we propose to further enhance activation/de-activation SCG mechanism for multi SCG scenario, and can also consider other UL selective activate mechanism, such as dynamic UL switching between different SCGs.

Q5: Is this for a scenario where the SNs (e.g. in a pico-layer) are using different or same frequencies?

(@Ericsson)

A5: We think both different and same frequencies scenarios for multi SNs can be considered in Rel-18.

Q6: Do you think the fast and dynamic mechanism for multiple layers include multiple carriers cases, i.e. not only for MR-DC case?

(@Huawei)

A6: Yes. We are also interested in the fast and dynamic mechanism for multiple carriers cases in Huawei's contribution. The details might be a bit different, but could be further discussed.

Q7: Can you elaborate more about "UE capability management to support MR-MC" in slide 9?

(@ZTE)

A7: As mentioned by many companies in the first round discussion, UE implementation complexity and RF capability limitation are the major concerns for MR-MC. Based on the current UE capability configuration framework, the maximum simultaneous UL transmission bands equal to the configured bands, which might need further enhancement to support more dynamic UL or SCG activation. For example, the network can configure more SCells or SCGs, but only active SCell or SCG are related to UE capability coordination.

Questions about Multi-RAT integration

Q8: motivation for NR-WLAN aggregation □ Can utilizing NR-U also serve the purpose?

□ **@KDDI, MTK, LENOVO** □

A8: The **main motivation for NR-WLAN aggregation** is to better use WLAN networks to increase hotspot throughput and provide supplementary coverage for weak coverage areas. With the development of Wi-Fi 6 (i.e. IEEE 802.11.ax), WLAN is still expected to be widely deployed by operators/vertical industry enterprise. Besides that non-3GPP access to 5GC (N3IWF) is already enabled in NR at the core network level, NR-WLAN aggregation at RAN level can achieve common radio resource control and management, and can be further considered and studied.

Compared with NR-U, WLAN industry chain is more mature and has a large number of commercial terminals or equipment, which have lower cost and are easier to deploy. From technical point of view, NR-WLAN aggregation and NR-U are not contradictory, and can be complementary with each other. From this aspect, we think NR-WLAN aggregation is useful and meaningful.

Q9: Multi-RAT integration, do you mean that UE can use 2 SNs and can one of them be WLAN AP? Does the LTE-NR-WLAN aggregation require the support LTE/NR-WLAN DC first, which is not currently supported in NR?

(@xiaomi, Samsung)

A9: Yes. For multi-RAT integration, we think WLAN AP can be used as one of the SNs. However, we can first consider multi-SN connectivity and NR-WLAN aggregation respectively, then further discuss the scenario of WLAN AP as one of the SNs or LTE-NR-WLAN aggregation.

Q10: What would be additional RAN impact for NR-WLAN aggregation in addition to MR-DC/MC?

(@Samsung)

A10: In our opinion, the potential RAN impact for NR-WLAN aggregation may involve air/network interface, UP and CP protocol, the traffic steering, switching, aggregation, splitting, retransmission and duplication aspects. We can use the architecture and framework of LWA as a baseline to further discuss enhancement or details for NR-WLAN aggregation.

Q11: How is switched bearer in NR-WLAN aggregation scenario defined and when does "switching" take place (Slide 8)? What are the functions of the Adaptation protocol (Slide 8)?

(@QC)

A11: Basically, we think the framework of LWA can be the baseline for NR-WLAN aggregation. Similar definition and mechanism can be used for traffic switching of NR-WLAN aggregation. The adaptation protocol could have similar functions as LWAAP entity of LWA. Further details or enhancements can be discussed later.

Q12: The scope is very wide so is this assumed to be a SI first? Or are there some priority topics that would take precedence over others?

□@Nokia, Spreadtrum□ A13: We think we can consider multi-SN connectivity and NR-WLAN aggregation respectively. Based on the first round discussion, multi-SN connectivity seems to have a higher priority, since more companies are interested in this topic.

Q13: Is the intent with N3IWF could be used together with MR-MC as one of the involved RATs, i.e. there would be something similar as done for LTE in LWA/LWIP?

□@Nokia□

A13: In our opinion, compared with non-3GPP access to 5GC (N3IWF) at NR core network level, NR-WLAN aggregation at RAN level can achieve common radio resource control and management, and can be further considered and studied.

Others

Softbank's question seems related to UL enhancement. You can find the response in section 2.4. (@Softbank)

2.2.3 1st round: Moderator's summary

14 companies participated in the first round discussion on Multi Radio Multi Connectivity. 12 companies focus on or are more interested in multi SN connectivity scenario. 6 companies have concerns or questions on multi-RAT integration (NR-WLAN aggregation).

Based on the received comments and questions from companies, we summarized them into the following issues and make corresponding clarifications:

Multi-layer deployment (e.g. Multi-SN connectivity):

- (1) **Scenarios and use cases:** 8 companies support or are interested in multi SN connectivity scenario to be further discussed in Rel-18.
- (2) **How many simultaneous UL transmissions or active CGs/ legs UE can have:** 9 companies raise similar questions on the number of simultaneous UL transmissions or active CGs/ legs for UE. As our response above, we think having **at most 2 simultaneous UL transmissions** would be more feasible in Rel-18.
- (3) **Fast and dynamic SCell/ SCG activation and deactivation:** 8 companies are interested in this or think it is reasonable/practical for Rel-18 objective.
- (4) **Others:** Related issues such as "fast" SCG to MCG data switching, L1 signalling, dynamic UL switching, PHR and UE capability management are also raised by companies, and can be further discussed or studied.

Multi-RAT Integration:

- (1) **Scope:** 3 companies have concerns on the scope for Multi-RAT Integration, and suggest have some high priority topics. From our point of view, we are willing to consider the priority based on the discussion and companies' views.
- (2) **Motivation for NR-WLAN aggregation:** 3 companies wonders to know the motivation for NR-WLAN aggregation. We clarify that the main motivation is to better use WLAN networks deployed by operators/vertical industry enterprise to increase throughput and provide supplementary.
- (3) **Scenario:** 2 companies raised questions on the detail deploy scenarios. We think we can first consider NR-WLAN aggregation, then further discuss the scenario of WLAN AP as one of the SNs or LTE-NR-WLAN aggregation.
- (4) **Others:** 2 companies raised questions on the overall RAN impact or mechanism for NR-WLAN aggregation. We think we can use the framework of LWA as a baseline, and further discussion or enhancement would be needed.

2.2.4 2nd round: Questions and comments

Companies are invited to provide questions and comments to the follows:

- 1. Any further questions and comments to moderator's response and summary for 1st round in section 2.2.2 and 2.2.3**

Feedback Form 3: Any further questions and comments to moderator's response and summary for 1st round in section 2.2.2 and 2.2.3

1 – ZTE Corporation

Thanks for the clarification on "UE capability management to support MR-MC". We also have some interests on this aspect, and we have similar proposal in RWS-210464 (i.e. Dynamic UE capability sharing).

2 – Spreadtrum Communications

Thank you for your response. We have a clearer picture of your motivation and scope. And we have a further question for clarification:

For Q1 of multi-layer deployment, is the fast SCG activation supplied to inactive or idle UE, e.g. based on early measurement results?

3 – China Unicom

Thanks for your contributions and clarification.

For Multi-layer deployment (e.g. Multi-SN connectivity), what is the preference/priority of the potential objective of MR-MC?

4 – CATT

Thanks for the response to CATT question in round 1. We tend to think your assumption on # of legs reasonable, considering the potential complexity.

Then we believe at this stage it would be very useful to align companies understanding on the motivation and use case for multiple connectivity. In our current understanding we the benefits are two: a) capability with better resource efficiency, and b) robustness, and signaling reduction for mobility/reconfiguration

Perhaps not a topic at this stage, but later we could further discuss on the organization of work in mobility topics and mrdc/mrnc topics.

5 – Beijing Xiaomi Mobile Software

Thanks for the response!

One question for clarification:

For A3: UL selective activate mechanism, will the UE perform this or the network gives UE indications for the selection?

6 – Samsung Electronics Co.

Do you consider three DL receptions and at most two UL transmissions at a time?

7 – HuaWei Technologies Co.

Thanks for the clarifications. Just a question for clarification that "activate/deactivate an SCG among configured SCGs dynamically based on certain criterion". Do you think it is either NW triggered or UE triggered dynamic switch?

In addition what is the meaning of retransmission in the following objective "2. Specify the traffic steering, switching, aggregation, splitting, retransmission and duplication aspects for Multi Radio Multi Connectivity, including [RAN2, RAN3]"?

8 – Lenovo Mobile Com. Technology

Thanks for clarifying, we also believe it’s practical to support only 2 active UL in Rel18.

Whether L1/L2/L3 based solution shall be supported and whether it’s initiated by NW or UE can be further discussed in R18. Do you plan to have a dedicated SI or WI for MRMC, or merge with Mobility? We are open though.

9 – MediaTek Inc.

Thanks for the response and clarification. Below please find our further comment/questions:

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Having 3 active DL legs while only 2 active UL legs is a bit confusing since there is no UL for one active DL leg to transmit ACK/NACK. If it is the case, can we effectively leverage the 3rd DL leg that may not be able to enable HARQ?

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Can adding more DL-only SCell in MCG/SCG be more effective to boost the data capacity given that there will be no UL ACK/NACK issue.

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While the reason of RAN-level integration between NR and WIFI is understood, existing phone implementation with aggressive dual connections to both NR and WIFI can already be used to leverage WIFI whenever available. Although some duplication in dual NR and WIFI connections can be argued, the efficiency may not be a big issue in an unlicensed spectrum.

2. Any further questions and comments to proposal RWS-210143

Feedback Form 4: Any further questions and comments to proposal RWS-210143

2.2.5 2nd round: Response to companies’ feedback

@ ZTE Corporation

Thanks for your comments. Generally, we share a similar view that dynamic UE capability sharing is one potential solution for enabling MR-MC in Rel-18. For the details, we can further discuss in the study phase.

@ Spreadtrum Communications

Q1: For Q1 of multi-layer deployment, is the fast SCG activation supplied to inactive or idle UE, e.g. based on early measurement results?

A1: Thanks for your question. From our point of view, fast SCG activation is mainly applied to Connected UE. But we are open to further enhancement on inactive or idle UE, including enhancement on EMR for FR2.

@ China Unicom

Q2: For Multi-layer deployment (e.g. Multi-SN connectivity), what is the preference/priority of the potential objective of MR-MC?

A2: Thanks for your question. Based on the Round1 and Round2 discussion, we think the higher priority objective of MR-MC would be “fast SCell/SCG activation and deactivation” and “dynamic UL switching between different SCGs”. Besides, bearer management and UE capability management could also be considered for further discussion.

@ CATT

Thanks for your comment. We share the same view as CATT on the motivation and use case for multi-connectivity. For the coordination with other topics, we prefer to study separately with mobility topic, and maybe jointly with MR-DC enhancement. And we are also open to further discussion.

@ Beijing Xiaomi Mobile Software

Q3: UL selective activate mechanism, will the UE perform this or the network gives UE indications for the selection?

A3: Thanks for your question. Basically, we think the UE can perform UL selective activation based on certain criteria configured by the network. And we are also open to other potential solutions in this stage.

@ Samsung Electronics Co., Ltd

Q4: Do you consider three DL receptions and at most two UL transmissions at a time?

A4: Thanks for your question. Yes. We think having at most 2 simultaneous UL transmissions would be more feasible in Rel-18 due to the UE implementation complexity and RF capability limitation for the UL. Further extension to 3 DL reception could also be considered based on the UE capability in Rel-18.

@ HuaWei Technologies Co., Ltd

Q5: Just a question for clarification that ”activate/deactivate an SCG among configured SCGs dynamically based on certain criterion”. Do you think it is either NW triggered or UE triggered dynamic switch? A5: Thanks for your question. Basically, we think the UE can perform UL selective activation based on certain criteria configured by the network. And we are also open to other potential solutions in this stage.

Q6: In addition what is the meaning of retransmission in the following objective ”2. Specify the traffic steering, switching, aggregation, splitting, retransmission and duplication aspects for Multi Radio Multi Connectivity, including [RAN2, RAN3]”?

A6: The intension of this objective is to identify and specify potential changes of radio resource management when multi-SN and NR-WLAN is considered. The retransmission aspects for MR-MC may involve RLC and

PDCP retransmission of new bearer types, such as split bearer between 2 SNs or between NR gNB and WLAN AP.

@ Lenovo Mobile Com. Technology

Thanks for your comment. We also think the details for fast SCG activation and deactivation can be further discussed in R18. And we prefer to have a dedicated WI for MR-MC, since the motivation and scenarios of MR-MC are not only related to mobility issues but also capacity issues.

2.2.6 2nd round: Moderator's summary

8 companies participate in the second round discussion on Multi Radio Multi Connectivity. All of the participating companies focus on or are more interested in multi SN connectivity scenario.

Based on the received comments and questions from companies, we summarized them into the following issues and make corresponding clarifications:

(1) **Priority of objectives of multi-SN connectivity:** 1 company wonders further priority of multi-SN connectivity objectives. We suggest prioritize “fast SCG activation and deactivation” and “UL selective activation/ switching” for Rel-18 MR-MC discussion.

(2) **Trigger of UL selective activation:** 2 companies raise the question that who triggers UL selective activation. We think UE can perform UL selective activation based on certain criteria configured by the network. Other potential solution also can be further discussed in Rel-18.

(3) **3 DL receptions and at most 2 UL transmissions at a time:** 1 company wants to confirm whether 3 DL receptions and at most 2 UL transmissions at a time can be considered. We tend to support this scenario in order to further increase DL capacity and bandwidth in Rel-18.

(4) **Others detail objectives of MR-MC:** 3 companies raise other issues including fast activation for inactive or idle UE, dynamic UE capability sharing and details of retransmission for MR-MC. We are open and pleased to further discuss these issues in Rel-18.

(5) **Organization of work in Mobility topics and MR-DC/MR-MC topics:** 2 companies suggest further discuss on the organization of work in Mobility topics and MR-DC/ MR-MC topics. In our opinion, consider the work load to have a huge scope including many topics, we prefer to have dedicated WI for MR-MC, since the motivation and scenarios of MR-MC are not only related to mobility issues but also capacity issues.

2.3 Flexible Spectrum Fusing ([2])

2.3.1 1st round: Questions and comments

Companies are invited to provide questions and comments on the following contribution.

RWS-210147, “Flexible Spectrum Fusing for Rel-18”.

Feedback Form 5:

1 – Spreadtrum Communications

We have one question and one comment for flexible spectrum fusing:

Q1: Is flexible spectrum supplied to idle UE or connected UE, or both?

Comment 1: Regarding discontinuous frequency in multiple bands, the impact to UE RF and gNB RF should be studied.

2 – ZTE Corporation

Regarding the second framework, i.e., single cell with multiple downlink and multiple uplink carriers, can the multiple downlink carriers (or uplink carriers) been used for reception (or transmission) simultaneously?

Two schemes are listed in the objective, i.e., multiple cells of CA and single cell scheme, could you clarify a little bit the detailed relationship of these two schemes, e.g., are they mutually exclusive?

3 – China Mobile Com. Corporation

[CMCC] we have a few questions for Flexible Spectrum Fusing.

Q1 Does the enhancement for Flexible Spectrum Fusing focus on connected mode, or both idle/inactive and connected mode?

Q2: For objective 4), what the consideration of limiting multiple bandwidths to be the same duplex mode?

Q3: For objective 5), Combine PDCCHs from multi-carriers and allocate in one of carriers, we guess the "allocate in one of carriers" means PDCCH is transmitted only in one carrier but the allocated frequency is among all the carriers, is this intended for single cell framework only?

4 – CATT

We support the motivation and we have similar proposal in RWS- 210402.

We would like to understand more about flexible spectrum fusing with multiple cells of CA. As stated in the contribution, the idea of flexible spectrum fusing is to integrate the bandwidths from different carriers to one virtualized bandwidth, which in our view should be a single carrier. So we are wondering how to achieve flexible spectrum fusing with CA and what would be the difference/benefit from/over the existing CA in NR.

For "Combine PDCCHs from multi-carriers and allocate in one of carriers", we would like to clarify that whether a PDCCH can schedule PDSCH/PUSCH across multiple bandwidths.

5 – MediaTek Inc.

Thanks for the quality contribution. In general, spectrum fusing is the ultimate version of cross-carrier enhancements. **We are supportive to cross-carrier enhancements, which can be part of further CA/DC enhancements in Rel-18.** Below please find our comments/questions:

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For control channels, RAN1 agrees to specify dynamic PUCCH carrier switch in R17 URLLC agenda and SCell scheduling PCell (both restricted in FR1) in R17 DSS agenda. We expect the flexibility on PUCCH/PDCCH location should be sufficient with R17.

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To reduce the DL control overhead, we are supportive to investigate 1-DCI scheduling multiple carriers, where the number of carriers should be larger than 2 for more effective overhead reduction in future CA of massive carriers. **In addition to control resource overhead reduction, 1-DCI scheduling multiple carriers can also resolve the fundamental conflict between full CA scheduling flexibility by network and limited total blind decoding complexity by UE, as highlighted in our contribution (RWS-210094).**

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Even with the scheduling flexibility enhanced for new transmissions, HARQ retransmission(s) is still limited in the same carrier as new transmission. Therefore, full flexible CA scheduling cannot be complete without enabling cross-carrier HARQ retransmissions. In this regard, should we also include cross-carrier HARQ retransmissions as part of Rel-18 CA enhancements?

6 – Intel Corporation (UK) Ltd

- 1) Can you explain why you propose to restrict the multiple bands for fusing to have the same duplex?
- 2) Typically UEs have more limited UL capabilities than DL. Is it expected that there may be different number of bands/carriers for DL and UL operation? Is it planned that UE should be capable to do UL switching within the combined virtualized large bandwidth?
- 3) Is it expected that there will be UE RF impact? If so, further details would be appreciated.

7 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution. We agree this is a promising direction for Rel-18, which we also identified in RWS-210441.

For the scope, does "Limit multiple bands for fusing to be neighboring bands" also allow flexible spectrum fusing across e.g. only 700 and 900 MHz (i.e. skipping 800 MHz)?

On page 5, for multi cells of CA where PDCCH for all cells is in just one DL carrier (shared by multiple cells), does it require changing the serving cell definition in the specifications?

8 – Qualcomm Incorporated

Q1: Is it correct understanding that the target is to enable aggregating narrowband carrier(s) that cannot accommodate broadcast/SSB together with an anchor carrier that accommodates broadcast/SSB? Is it intended to enable this for narrowband carrier(s)/band(s) that cannot accommodate SSB/OSI/paging? If so, what bandwidth is such narrowband carrier(s) supposed to have? If not, does not this cause "unbalanced cell load" across carrier(s)/band(s), which may result in performance loss?

Q2: Could you please elaborate what the following on page 5 of RWS-210147 mean: "Flexible uplink and downlink carrier linkage (FDD and TDD)"?

9 – 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, right?

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

(4) 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.

10 – 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.

11 – China Unicom

Thanks for the contribution, the following questions are listed for clarification:

Q1: What is the difference between flexible spectrum fusing and DSS on combining PDCCHs for multi-carriers?

Q2: What is the detail on simplifying SSB designation?

12 – Beijing Xiaomi Mobile Software

Thanks for the contribution and we have some comments:

1 We agree that SSB can be allocate in one of the bands, however, we do not think we should limited it to only in one.

2 For the impact to the UE Tx chain architecture, we think option1 should be avoid as much as possible and other options can be FFS.

2.3.2 1st round: Response to companies' feedback

1. Relation with other works like CA/DC and DSS.

@ MTK, China Unicom

We don't think that parts of objectives are related to CA/DC enhancement in Rel-18. Because considering the specific scenarios for neighbor bands, there are other improvements such as CA cell optimization, SSB simplification; we still prefer to set an independent work to focus on the clear request and enhancement for the scenario of neighbor bands.

The difference from DSS in flexible spectrum fusing including support for single DCI scheduling multiple more than two carriers, and one DL carrier mapping two UL carriers, i.e. one DL carrier could be shared by multiple cells.

2. Scenarios

@ Huawei, Qualcomm, Lenovo

All the subsets of 700/800/900 are intended to include in the scope which is similar to the fallback rules of CA, so the case of 700 and 900MHz is under the scope of our interested scenarios.

The narrowband which cannot accommodate SSB is considered in the scope, but not limited to the “narrowband”. It could be extended to include the scenario that SSB occupies a considerable space of the narrowband, which will cause the spectrum efficiency degradation.

No, FR2 is not proposed

3. Frameworks for multi-cell CA and single cell

3.1 General - common for multi-cell CA and single cell

@ZTE, CMCC

We just listed the potential frameworks for flexible spectrum fusing from numbers of cells point, and also open to discuss if they could be merged to one solution.

Regarding “Combine PDCCHs from multi-carriers and allocate in one of carriers”, that is intended for both single cell and multi-cell CA.

3.2 Comments/Questions specially for multi-cell CA

@ CATT, Huawei, Qualcomm

As described in the objectives, it could be achieved by uplink and downlink carrier linkage which is similar to active multiple BWPs for single cell. The benefit over existing CA is similar to for single cell, saving the cost of SSB resource, PDCCH DCI resource, etc.

It has no impact to the serving cell definition, but may require to study the coexistence interference between carriers, as one DL carrier is mapped to different UL carrier.

“Flexible uplink and downlink carrier linkage (FDD and TDD)” means that the downlink carrier and uplink carrier could be flexibly mapped. E.g. 3.5 DL mapping 800UL

So the PDCCH in the downlink carrier could schedule the mapped uplink carrier, which belongs to the concept of cross-carrier scheduling.

3.3 Comments/Questions specially for single cell

@Nokia,

One of the benefits is to simplify HARQ retransmission, for existing CA framework, cross-carrier HARQ needs to be defined to enable flexible cross carrier scheduling. Further, it could be considered if SCell addition and activation could be avoid when as a property of one cell, which will benefit the bursty traffic service.

4. Questions/comments for specific objectives

4.1 Applying to connected mode, or both idle/inactive and connected mode

@ Spreadtrum Communications, CMCC

The flexible spectrum fusing applies to both idle and connected UE.

4.2 Single DCI scheduling PDSCH/PUSCH

@CATT, Lenovo

It is intended to introduce such kind of function to enable one PDCCH schedules multiple bandwidths across multiple carriers.

We are willing to extend the scope to a large extent as mentioned in your document to use a single DCI to schedule more than 2 carriers.

4.3 SSB simplifying

@China Unicom, Xiaomi

The simplifying SSB is to limit SSB and other system information transmission in one of carriers. Based on SSB and SIB, UE can choose any one of UL carriers for initial access.

We are open to discuss for the SSB allocation on the numbers of the carriers.

4.4 Number of BWPs for one serving cell

@Lenovo,

Yes, right, from UE's perspective, the aggregated multiple carriers are regarded as multiple BWPs of one serving cell.

5. RF impact

5.1 Impact to UE and BS RF

@ Spreadtrum Communications, Intel,

There indeed will be implementation impact to UE RF and gNB RF, especially for UE Tx chains. But for spec

impact we preliminary think only UE RF needs to be specified.

5.2 Restricting to same duplex

@CMCC, Intel

One reason is the multiple bandwidths could share the same tx chains for same duplex mode. Otherwise it will mandate at least two tx chains for neighbor bands or switching between two different duplex mode.

5.3 Number of tx chains for UE architecture

@ZTE, Intel, Xiaomi

If simultaneous transmission allowed for multi carriers will depend on UE capability, for high end UE, more than two tx(rx) for sub-1GHz will facilitate the simultaneously transmission (or reception)

Yes, there may be more UL carriers/bands than DL carriers/bands. For UL switching that depends on UE architecture, maybe the neighbor bands could share the same RF chain.

We understand that option1 to enable 2 Tx for low frequency may be challenging. That could be further discussed in RAN4 for the UE architecture.

6. Backward compatibility

@Lenovo

To our understanding, the commercial UE are designed to support most of mainstream bands, which will facilitate to roam across world operators. Also from operator point, they could choose their “popular” band to be the anchor frequency for UE accessing.

7. Others if companies have additional comments

None

2.3.3 1st round: Moderator’s summary

12 companies participated in the 1st round email discussion and following issues have been discussed.

1. Relation with other works like CA/DC and DSS.

- 2. Scenarios
 - 3. Frameworks for multi-cell CA and single cell
 - 3.1 General - common for multi-cell CA and single cell
 - 3.2 Comments/Questions specially for multi-cell CA
 - 3.3 Comments/Questions specially for single cell
 - 4. Questions/comments for specific objectives
 - 4.1 Applying to connected mode, or both idle/inactive and connected mode
 - 4.2 Single DCI scheduling PDSCH/PUSCH
 - 4.3 SSB simplifying
 - 4.4 Number of BWPs for one serving cell
 - 5. RF impact
 - 5.1 Impact to UE and BS RF
 - 5.2 Restricting to same duplex
 - 5.3 Number of tx chains for UE architecture
 - 6. Backward compatibility
 - 7. Others if companies have additional comments
- 2.3.4 2nd round: Questions and comments

Companies are invited to provide questions and comments to the follows:

- 1. Any further questions and comments to moderator's response and summary for 1st round in section 2.3.2 and 2.3.3**

Feedback Form 6: Any further questions and comments to moderator's response and summary for 1st round in section 2.3.2 and 2.3.3

1 – Lenovo (Beijing) Ltd

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

- (1) Further comments to Q1: If we focus on 700/800/900MHz, 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: From a UE's perspective, in order to fully use the aggregated multiple carriers, the UE should support multiple active BWPs of one serving cell, right?

(3) Further comments to Q4: So a legacy CA-capable UE's performance may be degraded when SSB/SIB1 of some of its supported carriers are omitted. From the operator's point of view, do you see whether the performance degradation of legacy CA-capable UEs is allowed?

2 – Beijing Xiaomi Mobile Software

Thanks China Telecom for further discussion, we have a further question on relation with CA. If such multi-band framework is defined in rel_18, is the CA capability of UE on these bands required simultaneously? Maybe, from the UE complexity of view, we might require only one of them.

3 – QUALCOMM JAPAN LLC.

We think it is premature to discuss “down-select frameworks” and “specific objectives”. Further discussion is necessary to understand the proposal.

In addition we would like to know what the difference between the spectrum aggregation enhancements being proposed in RWS-RWS-210147 and RWS-210149 is? In your response, you note that RWS-210147 focuses on single cell enhancements, while RWS-210149 focuses on CA/DC scenarios. Could you elaborate some details on this?

4 – China Unicom

Thanks for the contribution and response. For the scope of single cell with multiple downlink and multiple uplink carriers, are different UE types considered, such as RedCap and eMBB?

Based on the 1st round discussion, we summarized the topic to three sub-topics for 2nd discussion, which includes 1) Frameworks for multi-cell CA and single cell, 2) Questions/comments for specific objectives(RAN1, RAN2), 3)RF impact.

More specifically, companies are invited to provide questions and comments to the follows:

1. Whether to down-select frameworks for multi-cell CA and single cell?

-Option1: Only based on multi-cell CA. For multi-cell CA, flexible uplink and downlink carrier linkage (FDD and TDD), one downlink physical carrier can be shared by multiple cells

-Option2: Only based on single cell. For single cell multiple bandwidths can be mapped into single cell

-Option3: Both

Please firstly indicate the **serial number and specific issue** when posting the comment in below feedback form.

Feedback Form 7: Whether to down-select frameworks for multi-cell CA and single cell

1 – Spreadtrum Communications

Thanks for your detailed response for 1st round.

For the target scenario, in our understanding, both multi-cell CA and single cell could achieve the same functionality, such as overhead reduction, flexible DL/UL carrier/frequency block association, more aggregated bandwidth and so on. So, one of multi-cell CA and single cell seems to be enough. At current stage, we have no strong preference, slightly prefer option1 for the reason of relatively small specification workload.

Do you have compared the two frameworks? Which framework is high priority in your mind, especially if considering down-selection may be needed for the current scope seems to be large, and if there is no essential difference at use cases/scenarios/functionality between the two frameworks.

2 – ZTE Corporation

Overall, we think it is too premature to discuss these detailed options. All the options can be further studies and analyzed.

We also proposed flexible DL&UL carrier association (Option 1) in our tdoc RWS-210479 (<https://nwm-trial.etsi.org/#/documents/4776>). Currently, our understanding is that, both Option1 and Option2 can serve the same or similar purpose. More study can be carried out before selecting the above options, and the study should take spec impacts and implementation impacts into account.

3 – QUALCOMM JAPAN LLC.

So far, we still do not fully understand the “flexible spectrum fusing”. Also, we do not fully understand what “framework for multi-cell CA” and “single cell” mean. The motivation, benefit, and feasibility should also be justified. Therefore, we consider discussing the options is not appropriate for now. Further clarifications are necessary.

2. Questions/comments for specific objectives (RAN1, RAN2)

2.1 Scenarios-focus on 700/800/900, 1.8G/2.1G, etc. and their subsets

2.2 Applying to both idle/inactive and connected mode

2.3 Single DCI scheduling PDSCH/PUSCH

-enable one PDCCH schedules multiple bandwidths across multiple carriers.

-extend to use a single DCI to schedule more than 2 carriers.

2.4 SSB simplifying

-Option1: Restrict SSB in only one carrier

-Option2: SSB could be allocated in more than one carrier

Please firstly indicate the serial number and specific issue when posting the comment in below feedback form.

Feedback Form 8: Comments for specific objectives (RAN1, RAN2)

1 – Spreadtrum Communications

2.2: We guess 2.2 applied for single cell, not multi-cell CA, right? CA is configured only in connected state.

2.3: For sing cell framework, if supporting a single DCI to schedule multiple TBs/PDSCHs across more than 2 carriers, does the principle of in-order HARQ operation in Rel-15/16/17 be followed? Otherwise, it would bring additional UE complexity.

2.4: We prefer UE could see SSB in only one carrier like Rel-15 where SSB is seen only in BWPs overlapping with SSB. Whether SSB exists in another carrier other than intial accessed carrier depends on gNB's implementation.

2 – ZTE Corporation

Overall, we think it is too premature to discuss these detailed options. All the options can be further studies and analyzed.

3 – QUALCOMM JAPAN LLC.

Regarding 2.2 and 2.4:

As we have commented, on the carrier(s)/band(s) with sufficient bandwidth for SSB/SIB/paging (e.g., 5MHz, 10MHz), if they are not transmitted, the carrier(s)/band(s) becomes inaccessible by legacy UEs. While the overhead reduction of SSB/SIB/paging could be a potential gain, we are wondering if this could offer actual performance improvement given the load across carrier(s)/band(s) would be unbalanced.

If the “flexible uplink-downlink carrier linkage” is combined with the proposal “some of DL carriers do not transmit SSB/SIB/paging”, the initial/random access for legacy UEs is restrictive as mentioned earlier. If each DL carrier still transmits SSB/SIB/paging, the benefit of flexible UL carrier selection for initial/random access would not be clear; rather, UEs receiving SSB/SIB/paging on different DL carriers may proceed initial/random-access on the same UL carrier – there should be means for the network to distinguish which DL carrier is associated with the UL carrier used where the initial/random-access is carried out.

3. RF impact

3.1 Impact to UE and BS RF

-Option1: impact to both UE and BS RF

-Option2: impact to only UE RF

3.2 Whether to restrict bands to same duplex

-Option1: restrict bands to same duplex (sharing Tx chain if feasible)

-Option2: not restrict bands to same duplex

3.3 Number of tx chains for UE architecture

-Option1: keep/Increase number of Tx chains by at least two to enable low frequency bands concurrent transmission

-Option2: Share the same Tx chain for neighboring bands in low frequency such as sub-1GHz

-Option3: No concurrent transmission, restrict the uplink transmission within single band

Please firstly indicate the serial number and specific issue when posting the comment in below feedback form.

Feedback Form 9: Comments to RF impact

1 – China Telecom Corporation Ltd.

Regarding 3.3 Number of tx chains for UE architecture□some options are missing, so the update is shown below

3.3 Number of tx chains for UE architecture

-Option1: keep/Increase number of Tx chains by at least two to enable low frequency bands concurrent transmission

-Option2: Share the same Tx chain for neighboring bands in low frequency such as sub-1GHz

-Option3: No concurrent transmission, restrict the uplink transmission within single band

Please use this update as baseline for further discussion, sorry for the inconvenience.

2 – ZTE Corporation

Overall, we think it is too premature to discuss these detailed options. All the options can be further studies and analyzed.

3 – QUALCOMM JAPAN LLC.

Regarding overall “3 RF impact”:

For any possible linkage, REFSENS, MSD and other requirements still need to be derived and specified per pairing. Once it is done, how is the pairing really different from simply defining it as an FDD band? Also, in such pairings, the possible DL BW and UL BW combinations and frequency offsets would still need to be defined, which again would make it not much different from simply defining it as an FDD band.

2.3.5 2nd round: Response to companies’ feedback

Below we copy the comments for convenience of review and give our response in line with the comments.

1. Any further questions and comments to moderator’s response and summary for 1st round in section

2.3.2 and 2.3.3

@Lenovo

(1) Further comments to Q1: If we focus on 700/800/900MHz, how many carriers are to be aggregated like a single serving cell? What's the maximum number assumed for standard design?

[CTC]: Maximum three carriers are assumed to be combined according to our scenario.

(2) Further comments to Q2: From a UE's perspective, in order to fully use the aggregated multiple carriers, the UE should support multiple active BWPs of one serving cell, right?

[CTC]: Yes, one active BWP per carrier, i.e. multiple active BWPs of one serving cell for framework of single cell.

(3) Further comments to Q4: So a legacy CA-capable UE's performance may be degraded when SSB/SIB1 of some of its supported carriers are omitted. From the operator's point of view, do you see whether the performance degradation of legacy CA-capable UEs is allowed?

[CTC]: We surely don't expect performance degradation of legacy CA UE. Regarding the FDD narrow band scenario, because they are FDD refarming band, there will be no NR legacy CA UE for these bands. Even assuming it did exist, the operator could decide whether to add additional SSB in the certain of bands. So that will depend on operator's deployment, but for us, we think no backward compatibility issue.

@Xiaomi

[Xiaomi]: If such multiband framework is defined in rel_18, is the CA capability of UE on these bands required simultaneously? Maybe, from the UE complexity of view, we might require only one of them.

[CTC]: We have requested 2UL CA in Rel-17 for 700/800/900 carrier aggregation in RAN4, which could be a starting point to discuss the UE RF for supporting simultaneous transmission.

@Qualcomm

[Qualcomm]: We think it is premature to discuss "down-select frameworks" and "specific objectives". Further discussion is necessary to understand the proposal.

In addition we would like to know what the difference between the spectrum aggregation enhancements being proposed in RWS-210147 and RWS-210149 is? In your response, you note that RWS-210147 focuses on single cell enhancements, while RWS-210149 focuses on CA/DC scenarios. Could you elaborate some details on this?

[CTC]: We are fine to further discuss the proposal. Based on the first round discussion we see some different views on the frameworks and also some specific comments to the objectives, that's why we propose to focus on down-selecting frameworks and specific objectives to make the discussion more efficiency, otherwise we

may still be held on the status of 1st round discussion. Since company has concern with this proposal, we are fine to further discuss.

Regarding the scope of RWS-210147 and RWS-210149, 147 will focus on both CA and single cell, 149 will only cover CA/DC scenarios. However, the CA scenarios for 147 and 149 are different. 147 will focus on neighbor bands which mostly are FDD low frequencies and 149 will focus on bands which suffer from coverage issues. 147's CA enhancement includes single SSB allocation, but 149 does not have.

@China Unicom

[China Unicom]: Thanks for the contribution and response. For the scope of single cell with multiple downlink and multiple uplink carriers, are different UE types considered, such as RedCap and eMBB?

[China Telecom]: We tend to focus on eMBB as the scope is to enhance NR efficiency and flexibility.

More specifically, companies are invited to provide questions and comments to the follows:

1. Whether to down-select frameworks for multi-cell CA and single cell?

-Option1: Only based on multi-cell CA. For multi-cell CA, flexible uplink and downlink carrier linkage (FDD and TDD), one downlink physical carrier can be shared by multiple cells

-Option2: Only based on single cell. For single cell multiple bandwidths can be mapped into single cell

-Option3: Both

@ Spreadtrum Communications

[Spreadtrum Communications]: For the target scenario, in our understanding, both multi-cell CA and single cell could achieve the same functionality, such as overhead reduction, flexible DL/UL carrier/frequency block association, more aggregated bandwidth and so on. So, one of multi-cell CA and single cell seems to be enough. At current stage, we have no strong preference, slightly prefer option1 for the reason of relatively small specification workload.

Do you have compared the two frameworks? Which framework is high priority in your mind, especially if considering down-selection may be needed for the current scope seems to be large, and if there is no essential difference at use cases/scenarios/functionality between the two frameworks

[CTC]: We share the same understanding with you for both multi-cell CA and single cell could achieve the same functionality. Thanks for the view on these two options. Unfortunately, by now, we have not compared these two frameworks gains, so that's why we propose to hear more preference on these two options. Let's continue to discuss these two frameworks further.

@ZTE, Qualcomm

[ZTE]: Overall, we think it is too premature to discuss these detailed options. All the options can be further studies and analyzed.

We also proposed flexible DL&UL carrier association (Option 1) in our tdoc RWS-210479 (<https://nwm-trial.etsi.org/#/documents/4776>). Currently, our understanding is that, both Option1 and Option2 can serve the same or similar purpose. More study can be carried out before selecting the above options, and the study should take spec impacts and implementation impacts into account.

[Qualcomm]: So far, we still do not fully understand the “flexible spectrum fusing”. Also, we do not fully understand what “framework for multi-cell CA” and “single cell” mean. The motivation, benefit, and feasibility should also be justified. Therefore, we consider discussing the options is not appropriate for now. Further clarifications are necessary.

[CTC]: Fine, let’s continue to discuss these two frameworks further.

2. Questions/comments for specific objectives (RAN1, RAN2)

2.1 Scenarios-focus on 700/800/900, 1.8G/2.1G, etc. and their subsets

2.2 Applying to both idle/inactive and connected mode

2.3 Single DCI scheduling PDSCH/PUSCH

-enable one PDCCH schedules multiple bandwidths across multiple carriers.

-extend to use a single DCI to schedule more than 2 carriers.

2.4 SSB simplifying

-Option1: Restrict SSB in only one carrier

-Option2: SSB could be allocated in more than one carrier

@ Spreadtrum Communications

[Spreadtrum Communications]:

2.2: We guess 2.2 applied for single cell, not multi-cell CA, right? CA is configured only in connected state.

2.3: For sing cell framework, if supporting a single DCI to schedule multiple TBs/PDSCHs across more than 2 carriers, does the principle of in-order HARQ operation in Rel-15/16/17 be followed? Otherwise, it would bring additional UE complexity.

2.4: We prefer UE could see SSB in only one carrier like Rel-15 where SSB is seen only in BWPs overlapping with SSB. Whether SSB exists in another carrier other than intial accessed carrier depends on gNB’s

implementation.

[CTC]: Thanks for the comments for the specific issue.

2.2 Yes, by preliminary thinking, multi-cell CA will not change the baseline structure, so only applicable in connected state.

2.3 Yes, the principle will be kept for sake of simplifying modification to the spec.

2.4 Yes, we also prefer one SSB in only one carrier, otherwise the benefit will be degraded.

@ZTE

[ZTE]: Overall, we think it is too premature to discuss these detailed options. All the options can be further studies and analyzed.

[CTC]: We are fine to further discuss

@Qualcomm

[Qualcomm]: Regarding 2.2 and 2.4:

As we have commented, on the carrier(s)/band(s) with sufficient bandwidth for SSB/SIB/paging (e.g., 5MHz, 10MHz), if they are not transmitted, the carrier(s)/band(s) becomes inaccessible by legacy UEs. While the overhead reduction of SSB/SIB/paging could be a potential gain, we are wondering if this could offer actual performance improvement given the load across carrier(s)/band(s) would be unbalanced.

[CTC]: Regarding the legacy UEs, we surely don't expect performance degradation of legacy CA UE. Regarding the FDD narrow band scenario, because they are FDD refarming band, there will be no NR legacy CA UE for these bands. Even assuming it did exist, the operator could decide whether to add additional SSB in the certain of bands. So that will depend on operator's deployment, but for us, we think no backward compatibility issue.

Regarding load unbalanced, we think it may be a trade-off with SSB overhead saving, so that could be decided by network deployment implementation, according to the actual network load for different areas.

[Qualcomm]: If the "flexible uplink-downlink carrier linkage" is combined with the proposal "some of DL carriers do not transmit SSB/SIB/paging", the initial/random access for legacy UEs is restrictive as mentioned earlier. If each DL carrier still transmits SSB/SIB/paging, the benefit of flexible UL carrier selection for initial/random access would not be clear; rather, UEs receiving SSB/SIB/paging on different DL carriers may proceed initial/random-access on the same UL carrier – there should be means for the network to distinguish which DL carrier is associated with the UL carrier used where the initial/random-access is carried out.

[CTC]: Regarding the network to distinguish DL carrier associating with UL carrier, we think now the

network has supported this function, in the SIB network configure two DL carrier and one UL carrier, UE can acquire the access information from both DL carrier and then access from the indicated one UL carrier. After UE connecting, network could configure the DL carrier BWP which will indicate UL based on UE DL/UL carrier capability reporting.

3. RF impact

3.1 Impact to UE and BS RF

-Option1: impact to both UE and BS RF

-Option2: impact to only UE RF

3.2 Whether to restrict bands to same duplex

-Option1: restrict bands to same duplex (sharing Tx chain if feasible)

-Option2: not restrict bands to same duplex

3.3 Number of tx chains for UE architecture

-Option1: keep/Increase number of Tx chains by at least two to enable low frequency bands

@ZTE

[ZTE]: Overall, we think it is too premature to discuss these detailed options. All the options can be further studies and analyzed.

[CTC]: We are fine to further discuss

@Qualcomm

[Qualcomm]: For any possible linkage, REFSENS, MSD and other requirements still need to be derived and specified per pairing. Once it is done, how is the pairing really different from simply defining it as an FDD band? Also, in such pairings, the possible DL BW and UL BW combinations and frequency offsets would still need to be defined, which again would make it not much different from simply defining it as an FDD band.

[CTC]: We would like to minimize the requirement impact due to band pairing, e.g. CA requirements could be reused for the pairing bands to by trying to reuse the same RF architecture. Regarding DL BW and UL BW frequency offsets, that may be need to be defined and could be further discussed for spec impact.

2.3.6 2nd round: Moderator's summary

On the 2nd round, there are 6 companies participating in the discussion and raising some very valuable comments to this topic. The comments/questions reach the following aspects as we categorized on 1st round

summary, which we think could be highlighted for further discussion.

1. Whether to down-select frameworks for multi-cell CA and single cell

2.1 Scenarios-focus on 700/800/900, 1.8G/2.1G, etc. and their subsets

2.2 Applying to both idle/inactive and connected mode

2.3 Single DCI scheduling PDSCH/PUSCH

2.4 SSB simplifying

3. RF impact

3.3 Number of tx chains for UE architecture

4 Backward compatibility

Also, company had concern to the benefit and feasibility of this work, we gave the detailed response to the specific concern regarding benefit and feasibility. We think that could be further discussed based on the detailed issue which may be well continued in email round-trip discussion.

2.4 Uplink enhancements ([3])

2.4.1 1st round: Questions and comments

Companies are invited to provide questions and comments on the following contribution.

RWS-210149, “NR uplink enhancements for Rel-18”.

Feedback Form 10:

1 – Xiaomi Communications

Coverage enhancement and capacity enhancement are different issues. In certain scenario, the targets of the two issues are often mutually exclusive. Which one is the main objective of the topic? We concern the impact on UE complexity due to 1024 QAM and more transmission layers introduced for UL.

2 – Spreadtrum Communications

We are quite interested in UL enhancements, and open to discuss the its scope at a late stage. Meanwhile, there is a question for clarification as below.

1. In case there are less DL carriers than UL carriers, will PDCCH capacity be a potential issue? If yes, how to solve it?

3 – LG Electronics Inc.

We are interested in UL enhancements although appropriate WI could be different for each topic. Please find some questions on RWS-210149 below:

Q1) Regarding the proposed DMRS enhancement, is there any specific reason to pick 24 DMRS ports? Is this for type-1 or type-2 DMRS?

Q2) Could you explain operation scenario(s) considered for the UE cooperation proposed in the last bullet?

Q3) For coverage enhancement, what kind of packet aggregation, e.g., PDCP or application layer, do you have in mind?

Q4) For RACH enhancement, do you consider simultaneous multiple RA procedure in MAC, which has been dropped in the beginning of NR due to complexity?

Q5) Regarding flexible spectrum allocation under capacity enhancement,

- do you consider UL heavy CA with UL only serving cell?

- do you consider flexible change of pairing DL/UL carriers for a serving cell?

4 – Apple Computer Trading Co. Ltd

Thanks for the nice contribution. We have several questions for clarification on UL capacity enhancements.

1. Support 8 transmission layers in UL and 24 DMRS ports, this seems overlapping with MIMO enhancement discussion.

2. Flexible spectrum allocation, is there any restrictions from regulatory perspective on flexible UL and DL carrier pairing?

5 – ZTE Corporation

In general, we share similar view that UL enhancements for higher uplink capacity are desirable.

One clarification from our side: For ‘FDSS with or without spectrum extension’ and ‘tone reservation’, what would be the RAN1 impacts on these two aspects?

6 – LG Electronics Inc.

Sorry that I missed one more question in the previous post:

Q6) For coverage enhancement, it seems RAN1-led items are the topics which were studied in Rel-17 SI, but were not included in Rel-17 WID. Do you think further work for coverage enhancement is required in Rel-18?

7 – vivo Communication Technology

1) What is the scenario/use case for supporting 8 layers in UL?

2) Different channels/signals have different coverage, from system perspective a balanced coverage among the channels/signals is desired. What is the baseline for further coverage enhancement? Should we re-evaluate to identify the bottleneck channel after Rel-17 coverage enhancement?

8 – Guangdong OPPO Mobile Telecom.

Thanks for the contribution. We share the general view that UL should be enhanced, e.g. support more UL layers for some type of UE (e.g., CPE). We also have some questions for the specific topics as below:

Q1: What’s the typical scenarios for 24 UL DMRS ports? In practical deployment, it is very difficult for gNB to schedule multiple UEs for a larger number of MIMO layers.

Q2: 1024 QAM for UL seems too aggressive from the perspective of UE implementation.

9 – Intel Corporation (UK) Ltd

Q1: There were extensive studies for PUSCH repetition type B enhancement and sequence based PUCCH during CovEnh SI phase but there was no consensus to support this. Can you please clarify the motivation to reopen the discussion?

Q2: Transmit waveform design typically involves substantial standardization effort. There were not sufficient discussions during CovEnh SI phase. Do you expect additional study for this objective?

10 – Intel Corporation (UK) Ltd

Sorry, I hit post before providing all our questions. Here are the remaining Intel questions.

Q3: For UL 1024QAM - is it planned for FR1?

Q4: For 8 UL MIMO layers - currently RAN4 supports up to 2 Tx and 4Tx is not supported. Is it feasible from implementation perspective to consider 8TX?

Q5: For UL waveform with reduced MPR, how does this work correspond to the ongoing work on $\pi/2$ BPSK improvements and will $\pi/2$ BPSK provide better coverage comparing to "improved" QPSK? Also, what are the target UE power classes?

11 – SHARP Corporation

In slide 7, what do you mean by "more UL carriers than DL carriers"? Does it mean SUL-like multiple carriers in a cell, or configuring SCells with only uplink carriers?

12 – CATT

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

1) For higher layer compression, do you think UDC can be used as a solution?

2) What kind of scenario are you targeting for DMRS overhead reduction?

3) for more UL carriers than DL carriers, do you intend to support a single DCI to schedule PUSCHs on multiple UL carriers?

13 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution. We also think that UL capacity enhancements should be a key direction for Rel-18.

Regarding the UL capacity enhancements and the proposal to have more UL carriers than DL carriers, we think in practice this should be achieved with a reasonable UE complexity with e.g. maximum 2Tx or 3Tx, which will require enhancements of UL Tx switching. Or do you think that full UL CA is a requirements to achieve the target?

What is your intent for 24 DMRS ports for UL with overhead reduction? Is the target to keep the total UL DMRS overhead the same but increase the number of ports?

14 – Samsung Electronics Co.

Q1. Can you elaborate more on enabling UE cooperation?

Q2. For the proposal on flexible spectrum allocation, is it for FR1/2? Any specific target scenario? What type of enhancements are envisioned/proposed?

15 – China Unicom

Thanks for the contribution, the following questions are listed for clarification:

1. What is the potential solution for UE cooperation to improve capacity?
2. In addition to DMRS overhead reduction, how to further reduce the overhead of signals?

16 – Motorola Mobility España SA

Thanks for the contribution. Could you please elaborate a bit more on the following questions:

1. Can all the UL and DL carriers be activated when in the case of more UL carriers than DL carriers?
2. Which node will control the association between DL and UL carriers?

2.4.2 1st round: Response to companies' feedback

(1) General comments & questions:

(1.1) Relation between coverage enhancement and capacity enhancement

@ Xiaomi

For the relation between coverage enhancement and capacity enhancement, in our view, both coverage and capacity enhancement are included in UL enhancement, they both are main objectives but focus on different scenarios. For coverage enhancement, it mainly focuses on cell-edge UEs and aims at improving their coverage performance. For capacity enhancement, it mainly focuses on UEs who have relatively good channel condition and have high uplink data rate requirements. Considering the emergence of uplink centric services e.g. HD video surveillance, XR, the challenge on uplink capacity becomes severe.

(1.2) Necessity of coverage enhancement

@LG @vivo

For coverage enhancement, we want to make some clarifications and answer companies' question as follows:

1) Is further work for coverage enhancement required in Rel-18?

From operator's perspective, we think further work for coverage enhancement is desired in Rel-18. In Rel-17 SI phase on NR coverage enhancement, at least 10 coverage enhancement solutions are proposed and studied for PUSCH; 4 coverage enhancement solutions are proposed and studied for PUCCH. Due to some reasons, not all of the solutions with companies' interested solution are include in Rel-17 WI on coverage enhancement. Based on the performance gap between baseline and target performance for each bottleneck channel, there're still several dB gap. Coverage is a critical factor for operators, since the gap exists, we think further enhancement is needed. Moreover, we don't preclude other solutions which were not studied in Rel-17 SI phase.

2) Do we need re-evaluate to identify the bottleneck channel after Rel-17 coverage enhancement?

We think there is no need to re-evaluate. In the Rel-17 SI phase on coverage enhancement, the bottleneck channels are identified for each scenario and the performance gap is already obtained. For example, for urban

4GHz TDD, the MIL gap between the worst channel (eMBB) and the second worst channel (Broadcast PDCCH) is larger than 9dB, In terms of MPL, the gap is larger than 7dB. When compare the potential gain of the solutions in Rel-17 WI on coverage enhancement, it can be found that remaining gap still exists. Here, we don't mean to completely make up the remaining gap but to minimize the gap.

(2) Coverage related comments & questions:

(2.1) PUSCH repetition type B

@ Intel @softbank

For PUSCH repetition type B enhancement, we think it is beneficial for PUSCH coverage, where special slot can be used. Companies' simulation results summarized in TR 38.830 also shows that performance gain can be obtained by PUSCH repetition type B enhancement.

(2.2) Sequence based PUCCH

@Intel

For sequence based PUCCH, we think it is beneficial for PUCCH coverage. Companies' simulation results summarized in TR 38.830 also shows that performances gain can be obtained by sequence based PUCCH.

(2.3) PRACH enhancement

@LG

For PRACH enhancement, we mainly consider multiple PRACH transmission with same/different beams which was studied in Rel-17 SI phase on NR coverage enhancement.

(2.4) Higher layer compression

@LG @CATT

For higher layer compression, we want to make some clarifications and answer companies' question as follows:

1) Packet aggregation on which layer?

Currently, we think packet aggregation in PDCP and application layer can be both considered as long as it is beneficial to coverage. We are open to discuss it.

2) Views on UDC

In fact, UDC is a solution for higher layer compression, but we think it is ongoing in Rel-17. Whether to include it in the scope of Rel-18 UL enhancement depends on its progress after Rel-17. Currently, we think packet aggregation in PDCP and application layer can be considered, but other solutions are not precluded.

(2.5) UE transmit waveform design to reduce MPR

@ZTE @Intel

For UE transmit waveform design to reduce MPR, we want to make some clarifications and answer companies' question as follows:

1) RAN1 impacts

Based on TR 38.830, potential specification impacts of tone reservation, FDSS with and without spectral extension for QPSK include: related signaling, design for spectral extension, RF requirements. As for RAN1 impact, it depends on the specific scheme and need further discussion.

2) Do we need additional study for this solution?

If necessary, we can add a SI phase on this solution in corresponding Rel-18 WI.

3) Views on the relation with $\pi/2$ BPSK?

We understand that $\pi/2$ BPSK improvement is ongoing, but we think FDSS with and without spectral extension for QPSK is beneficial for coverage as well. For the target power class, we think at least PC2 and PC3 can be considered.

(3) Capacity related comments & questions:

(3.1) Flexible spectrum association

@Spreadtrum @LG @Sharp @CATT @HW @Samsung @Motorola @Apple

For flexible spectrum association, we want to make some clarifications and answer companies' question as follows:

1) The intention for enabling flexible spectrum allocation

With the emergence of uplink centric services such as HD video surveillance, XR, machine vision and etc., enhancement on uplink capacity is needed. In the current specification, UL carrier cannot be separately configured for either TDD or FDD spectrum, which is not good for UL heavy scenarios. Thus, we think the flexible spectrum allocation can improve the situation and is beneficial for UL capacity. We think at least two aspects can be considered for enabling flexible spectrum allocation, the first is more UL carriers than DL carriers can be configured, second is flexible association of DL and UL carriers. We will make some clarification on these two aspects separately in the following part. Note that, we mainly consider the enhancement on CA frame work and both FR1 and FR2 can be considered, the single cell based enhancement is covered by another contribution from us on flexible spectrum fusing (RWS-210147).

2) Clarification on “More UL carriers than DL carriers”

Currently, configuration of more UL carriers than DL carriers is already supported for SUL. We mainly consider the enhancement on CA frame work here. The main purpose on configuration of “more UL carriers than DL carriers” is for uplink centric scenario, e.g. HD video surveillance, XR, machine vision and etc. In current CA frame work, only downlink carrier can be separately configured. To support the capacity requirement of uplink centric services, we think separate uplink carrier configuration is needed. For example, configure 1 DL carrier and 2 UL carrier, one of the UL carriers is separately configured as a Scell. When “More UL carriers than DL carriers” is configured, whether all the UL and DL carriers be activated depends on the UE capability.

As for PDCCH capacity, in our view, whether PDCCH capacity would be an issue depends on the specific scenario. For uplink centric scenario, the capacity requirement on downlink transmission is not that high. Thus, we think the PDCCH capacity would not be an issue for these scenarios. However, if necessary, PDCCH enhancement can be considered, e.g. one PDCCH schedules multiple UL carriers.

3) Clarification on “Flexible association of DL and UL carriers”

The intention is to enable flexible paring of downlink and uplink carrier and the paring of DL and UL carriers is controlled by gNB. For example, for cell-edge UE, 3.5G DL + 800MHz UL can be considered to improve the UL performance. From our point of view, what we considere is the existing spectrum, it is just re-combination of DL and UL carrier, thus there is no restriction from regulatory perspective on flexible association of DL and UL carriers.

(3.2) Support more DMRS ports for UL

@LG @OPPO

For supporting 24 DMRS ports for UL, we want to make some clarifications and answer companies’ question as follows:

1) Why pick “24”? Is this for DMRS type 1 or type 2?

The intention actually is to support more than 12 orthogonal DMRS ports for UL, “24” here is just an example. As for DMRS type 1 and type 2, we think enhancement on DMRS type 2 should be considered with higher priority since the intention of DMRS type 2 is for the scenario with higher capacity requirement. But we don’t preclude the enhancement on DMRS type 1, we are open to discuss it if companies have interest.

2) The scenario/use case for supporting 24 DMRS ports for UL?

In our view, for the scenarios with dense UE and large UL capacity requirement such as IIoT, machine vision in factory (as mentioned by companies), and HD video surveillance, more orthogonal DMRS ports is beneficial for improving the uplink capacity. The maximum number of orthogonal DMRS ports is not limited to 24, we just take 24 as an example.

(3.3) DMRS overhead reduction

@CATT @HW @China Unicom

For DMRS overhead reduction, we want to make some clarifications and answer companies' question as follows:

For uplink centric services such as HD video surveillance, one of its features is the channel between the UE and gNB is basically stable since there is no mobility. DMRS density for each port can be reduced. In addition, DMRS sharing across some uplink slots can also be considered, where in some slots no uplink DMRS is transmitted.

(3.4) Support more transmission layers for UL

@ Apple @vivo @Intel

For supporting eight transmission layers for UL, we want to make some clarifications and answer companies' question as follows:

1) The overlapping with MIMO enhancement.

We have noticed that this issue is included in some MIMO enhancement discussion. Meantime, we think it also belongs to the scope of uplink enhancement. How to deal with the overlapping may need further discussion.

2) The scenario/use case for supporting 8 layers in UL

8 transmission layers in UL is beneficial for the scenarios with low mobility, good channel quality and high capacity requirement, such as: □ HD video surveillance, where the surveillance is generally deployed at a higher position and the possibility of LoS is higher; □ Indoor XR, machine vision, where the channel between the UE and gNB is generally stable.

3) Is it feasible from implementation perspective to consider 8TX

As mentioned by some companies, currently RAN4 supports up to 2 Tx and 4Tx is not supported. In our view, the study in RAN 4 is always later than that in RAN1 and RAN2. We don't expect that all UE should support 8 Tx, we can focus on some UE such as laptop, CPE etc., at this stage.

(3.5) Support 1024 QAM for UL

@Xiaomi @OPPO @Intel

For supporting 1024 QAM for UL, we want to make some clarifications and answer companies' question as follows:

1) Companies' concern the impact on UE complexity

We don't expect that all UEs should support 1024 QAM for UL, maybe some high-end UE can support this at this stage.

2) FR1 or FR2?

In our view, it is planned for FR1, but we don't preclude FR2 if companies have interest.

(3.6) UE cooperation

@LG @Samsung @China Unicom

For enabling UE cooperation, we want to make some clarifications and answer companies' question as follows:

In our view, UE cooperation can be considered at least under following scenario: one user has multiple kinds of devices, e.g. cell-phone, ipad and etc. These devices may have different RF capabilities. To improve uplink performance, these devices can cooperatively transmit data to the network, which means they can share capabilities and help with each other in uplink transmission. We are open to discuss if the devices can belong to different users.

2.4.3 1st round: Moderator's summary

In the first round discussion, 15 companies participated in the discussion on UL enhancements. Based on the received comments and questions from companies, we summarized them into the following issues and make corresponding clarifications:

(1) General issues

(1.1) Relation between coverage enhancement and capacity enhancement

(1.2) Necessity of coverage enhancement in Rel-18

(2) Coverage related candidadates

(2.1) PUSCH repetition type B

(2.2) Sequence based PUCCH

(2.3) PRACH enhancement

(2.4) Higher layer compression

(2.5) UE transmit waveform design to reduce MPR

(3) Capacity related candidadates

(3.1) Flexible spectrum association

(3.2) Support more DMRS ports for UL

(3.3) DMRS overhead reduction

(3.4) Support more transmission layers for UL

(3.5) Support 1024 QAM for UL

(3.6) UE cooperation

2.4.4 2nd round: Questions and comments

Companies are invited to provide questions and comments to the follows:

1. Any further questions and comments to moderator's response and summary for 1st round in section 2.4.2 and 2.4.3

Feedback Form 11: Any further questions and comments to moderator's response and summary for 1st round in section 2.4.2 and 2.4.3

1 – Spreadtrum Communications

Thank you for your response. According to more UL carriers than DL carriers, if only a UL carrier configured as Scell without DL carrier, there would be some issues need discussion, such as this UL only cell cannot be a standalone Cell, since UE cannot access in this cell. In additional, all procedure related with measurements/reports/power control would be studied.

Besides, as you mentioned, 24 is just an example and type 2 DMRS is your focus. Currently, the overhead of type 2 DMRS is 4-RE per port. Our question is, do you want to maintain the same per port overhead as in Rel-15/16? or same total overhead for all DMRS ports?How about its backward compatibility? Thanks!

2 – Xiaomi Communications

Thanks for the contribution and response. We think supporting 8 transmission layers in UL and 24 DMRS ports in MIMO enhancement is better. Maybe it is a big challenge to introduce 1024 QAM for UL from the perspective of UE implementation.

3 – ZTE Corporation

Thanks for the response and further summary.

We agree with moderator's clarifications regarding flexible association of DL and UL carrier. There are two restrictions of current CA framework that limiting UL coverage/capacity: 1) the DL and UL physical carrier of the same cell is limited to the same band, 2) one DL physical carrier cannot be shared by multiple cells.

For the first restriction, as the example mentioned by moderator, it will limit the configuration of 3.5G DL + 800MHz UL which is beneficial for UL coverage. Due to the second restriction, gNB can only configure multiple cells each with one DL carrier and one UL carrier for UL-heavy scenario, where using multiple DL carriers is actually not needed in such scenario. Therefore, we think further enhancements to current CA framework with minimized spec impacts to remove above restrictions could be a promising way for UL improvement.

4 – LG Electronics Inc.

Thanks for clarifying the scenario for UE cooperation. It seems that it is mainly for transmitting UL data from multiple devices belonging to a same user. For this, we see some high layer impacts but could you further explain what would be RAN1 impact for supporting this?

5 – Guangdong OPPO Mobile Telecom.

Thanks for the reply. Here are some further comments

1. Regarding to "More UL carriers than DL carriers", the benefits are not clear. If the main motivation is to boost the UL data rate, isn't it a better deployment where more slots are configured for UL and multiple DL CCs are activated for UE? This configuration seems to achieve the same purpose. Moreover, it can be supported by more types of UEs
2. Regarding the UE cooperation, we have the similar question as LGE. It seems more related to high-layer design, rather than to PHY design.

2. From your perspective, which scheme(s) can be considered in Rel-18 for UL coverage enhancement, e.g., :

- A1-1. PUSCH repetition type B enhancement
- A1-2. Mechanism to support sub-PRB transmission with multi-slot aggregation
- A1-3 Mechanism to support higher layer compression, e.g. packet aggregation
- A2. Sequence based PUCCH with UCI payload up to 11 bits
- A3. PRACH enhancement for FR2
- A4. UE transmit waveform design to reduce MPR
- A5. Others

Feedback Form 12: From your perspective, which scheme(s) can be considered in Rel-18 for UL coverage enhancement

1 – ZTE Corporation

Based on the evaluation results in Rel-17 CE SI, sequence based PUCCH with UCI payload up to 11 bits could provide clear performance gain and therefore could be further studied. For PRACH enhancements, we think it may no need to limit to FR2 if enhancements are to be considered.

3. From your perspective, which scheme(s) can be considered in Rel-18 for UL capacity enhancement, e.g., :

- B1. Mechanism to support 8 transmission layers for UL
- B2. 1024 QAM for UL
- B3-1. More than 12 orthogonal DMRS ports for UL
- B3-2. DMRS overhead reduction
- B4. Mechanism to enable flexible spectrum allocation, e.g. More UL carriers than DL carriers , flexible association of DL and UL carriers

B5. UE cooperation

B6. Others

Feedback Form 13: From your perspective, which scheme(s) can be considered in Rel-18 for UL capacity enhancement

1 – Spreadtrum Communications

We support B5 and open for the other solutions.

2 – ZTE Corporation

We are in general agree that all above enhancements could be considered as potential solutions for UL capacity improvement.

4. Any further questions and comments to proposal RWS-210149

Feedback Form 14: Any further questions and comments to proposal RWS-210149

2.4.5 2nd round: Response to companies' feedback

(1) Flexible spectrum association related comments & questions

@ Spreadtrum @OPPO

For “More UL carriers than DL carriers”, we think the linkage between multiple UL carrier and one DL carrier can be established, e.g. one PDCCH schedule one UL carrier utilizing a switch mechanism or one PDCCH schedule multiple UL carrier.

In practical macro network, the frame structure is fixed, i.e. the number of UL slots is fixed. Even for some scenarios where dynamic TDD is applied, the maximum number of UL slots is limited, which may not satisfy the requirement of uplink centric service. Thus, we think the configuration of “More UL carriers than DL carriers” is more beneficial for UL capacity.

(2) More DMRS ports for UL related comments & questions

@ Spreadtrum

For “24 DMRS ports for UL”, at least maintain the same REs per port can be considered. Whether to further reduce the DMRS overhead per port, we think it can be further discussed.

(3) 1024 QAM for UL related comments & questions

@Xiaomi

As we clarified in the 1st round, we don't expect that all UEs should support 1024 QAM for UL, maybe some high-end UE can support this at the first stage.

(4) UE cooperation related comments & questions

@LG @OPPO

The spec impact depends on the specific solutions. We share the similar view that it is more related to high-layer design, e.g. RAN2, RAN4, but we don't preclude RAN1 impact. We think this needs more study and discussion. Moreover, we think current side link mechanism can be re-used as much as possible.

2.4.6 2nd round: Moderator's summary

In the 2nd round discussion, 5 companies participated in the discussion on UL enhancements. Based on the received comments and questions from companies, we summarized them into the following issues and make corresponding clarifications:

(1) Flexible spectrum association related comments & questions

(2) More DMRS ports for UL related comments & questions

(3) 1024 QAM for UL related comments & questions

(4) UE cooperation related comments & questions

2.5 Mobility enhancement ([4])

2.5.1 1st round: Questions and comments

Companies are invited to provide questions and comments on the following contribution.

RWS-210151, "Further enhancement on NR mobility for Rel-18".

Feedback Form 15:

1 – Spreadtrum Communications

We are open to discuss mobility enhancements in Rel-18. one clarification for fast failure recovery, what is the new features comparing to the current fast failure recovery?

2 – DOCOMO Communications Lab.

Thank you for the proposal. We think we share the same motivation in a number of areas such as data

interruption reduction in FR2, and fast failure detection and recovery.

Regarding multiple SCG configuration with a single active PSCell in Page 7, we think this might be related to past discussions like in R2-1910265, but not sure how it realizes 0ms interruption. What do you think would be a key technology to realize 0ms interruption even with a single active PSCell?

3 – Apple Hungary Kft.

[Apple] We have similar views in terms of improving mobility and FR2 specific mobility as well as enhancements towards 0ms, and failure prevention/recovery. We support this direction.

4 – ZTE Corporation

We want to clarify the definition of interruption time for PSCell change. In Rel-16 WI NR mobility enhancement, the mobility interruption time is defined as "the shortest time duration supported by the system during which a user terminal is not able to exchange user plane packets with any base station during transitions". Based on such definition, it seems there will be no interruption time for PSCell change, at least for the split bearer.

5 – Lenovo (Beijing) Ltd

[Lenovo] We have the same view to support higher mobility performance in current handover procedures and reduce data interruption for mobility procedures in MR-DC scenario in Rel-18 (our paper RWS-210283 has the similar proposals). For early data forwarding enhancement to reduce the cache pressure, we have the doubt that whether existing HO cancel mechanism can work well. For data acquisition procedures to retrieve the UE context, we are not sure about the frequency of high traffic load in the source node.

6 – Beijing Xiaomi Mobile Software

In FR2, cell radius is small and dense deployment is expected. The radio channel quality changes rapidly. Mobility performance in FR2 is not as good as in FR1. Mobility enhancement is needed to handle the mobility in FR2. However, UE power consumption may not be directly related to mobility. We may need to evaluate power consumption in mobility and avoid sacrifice mobility performance to save power.

7 – Guangdong OPPO Mobile Telecom.

Thanks for the contribution. We are supportive of mobility enhancement in R17. Some questions from our side

Q1: The objectives are quite vague. Would you like to elaborate a bit more on the specific enhancements in mind?

Q2: Regarding UE power consumption, we are not sure whether it should be included here or in other WI.

8 – CATT

In general we support mobility enhancement, especially for the cases with small cell size in FR2 and relatively high moving speed.

Then

1) for P10, we are not sure what is the main focus of power saving discussions here, i.e., there are many other power saving proposals from companies. maybe it would be good to clarify the difference here.

2) for P 11, on 'ensure 0ms interruption for PScell change procedure', does this relate to DAPS+CA, or DAPS+MRDC?

9 – LG Electronics France

Q1) For enhancement to ensure high reliability and 0ms interruption during the HO procedure, do you have other solutions if the CHO+DAPS option is excluded?

Q2) For NG-based handover enhancement, could you explain more how X2 based handover can be avoided in certain cases?

Q3) For enhancement to ensure 0ms interruption for PSCell change procedure, do you have other solutions if the DAPS mechanism with SCG is excluded?

10 – HuaWei Technologies Co.

We share similar view on inter-MN handover enhancements, see RWS-210449. There are various aspects proposed, do you have any priority on these proposals?

11 – Ericsson LM

Slide "Motivation 5/8" says "no transition from EN-DC to DC" and also says "Support inter-RAT PSCell Change". These seem to point at different scenarios? EN-DC->DC would be a handover, while "inter-RAT PSCell change" seem to be EN-DC -> LTE-DC or NE-DC -> NR-DC? Some clarification may be needed.

Slide "Motivation 7/8" mentions "Early data forwarding enhancement". Some clarification may be needed. Already today the source can forward data to the target early. And the target can discard data which the source already sent based on a PDCP status report. But perhaps something else is considered here?

12 – Intel Corporation (UK) Ltd

Q1/ Do you have any view on the solution direction for optimized data forwarding for failure case?

Q2/ Do you have any view on the solution direction for reduced UE power consumption, or network signaling, or fast failure detection and recovery?

13 – Nokia Corporation

Q1: Robustness of NG-based handover implies the support of CHO via NG interface? Or is something else proposed here?

Q2: For high reliability and 0 ms interruption during HO procedure, do you mean DAPS in combination with CHO is to be supported? Or other means are considered?

Q3: DAPS for PSCell change requires three active links (PCell+S-PSCell+T-PSCell) - How can this be made more feasible for UEs?

Q4: What kind of enhancements are foreseen to reduce the UE power consumption?

Q5: Is RACH-less HO intended for both FR1 and FR2?

Q6: For inter-RAT SN change, PCell change may also be required (e.g. EN-DC to NR-DC), which means a full inter-RAT HO. How would the data interruption be reduced in such a case, especially if CN also changes (e.g. EN-DC uses EPC, NR-DC uses 5GC)?

2.5.2 1st round: Response to companies' feedback

Thanks for all the inputs, based on the received questions/comments, we've compiled the responses as below:

1. The potential solutions to reduce data interruption for FR2

@Nokia

Regarding to reduce data interruption in FR2, we propose to support RACH-less handover which is introduced in LTE but not supported in NR in FR2 to reduce the data interruption during handover procedure, and since the DAPS HO is already supported in FR1, then we think the RACH-less handover is not necessary to be introduced in the FR1. In addition, the RACH-less HO is only a potential solution, other solutions such as MBB HO or multiple candidate target cell configuration with single active cell connection can be considered in R18.

2. The potential solutions to support high reliability and 0ms interruption

@LG @Nokia

In order to support high reliability and 0ms interruption during mobility procedures, we think the best solution is to support coexistence of CHO and DAPS, and it has limited impact on the specifications.

3. Clarification on the NG-based handover enhancement

@LG @Nokia

Regarding to enhance the robustness of NG-based handover, we think the best solution is to support NG-based CHO. Considering that there is not always an Xn interface between the base stations, such as in high speed train scenario, neighboring base stations may belong to different provinces and use NG interface to connect, in such scenarios, support CHO over NG interface to improve mobility robustness is worth to study. In addition, both intra-system and inter-system NG-based CHO should be studied in R18.

4. The potential solutions for fast failure detection and recovery

@Spreadtrum @Intel

Regarding to support fast failure detection and recovery, the current RLF declaration is based on DRX and since the radio conditions change rapidly in FR2, there will be few seconds before RLF is declared, so optimizations to reduce the failure detection time should be studied especially for FR2. Besides, similar as fast MCG Failure recovery in Rel-16, the faster failure recovery for PCell through SCell in FR2 should also be considered.

5. The potential solutions to reduce data interruption in SN for PScell change procedure

@DOCOMO @ZTE @CATT @LG @Nokia

Regarding to support 0ms PScell change procedure, we propose to study the solutions to reduce data transmission interruption time in SN when PScell change occurs, but take ZTE's replay as a reference, the feature may should be updated as "Reduce data interruption in SN for PScell change procedure", since there is always a connection between MN and UE.

One possible way to realize 0ms interruption in SN is to support DAPS-like PScell change, which requires UE to continue the user data transmission from source SN until successful random access to the target SN, in this approach, the UE needs to support 3 legs as the same time. Considering the UE complexity, we can restrict the maximum number of the active serving cells in source SN and target SN, but in this way, the data transmission interruption time in SN can be reduced but cannot be realized as 0ms, this is a tradeoff between system performance and UE complexity.

6. The potential solutions for data forwarding optimization

@Lenovo @Ericsson @Intel

For early data forwarding enhancement to reduce the cache pressure, we notice that the source node may not exactly know the resource status of the (candidate) target node, once early data forwarding is performed and source node doesn't update PDCP SN Status in time, the data cached on the (candidate) target node may be discarded, which may result in data loss. One possible approach is to support the (candidate) target node uses Xn signaling to request the latest PDCP SN Status from source node.

For data acquisition procedures, this approach is mainly used for handover failure cases. In normal HO procedure, the source stops data transmission towards the UE and forwards the data to the target when handover is executed, the target should buffer the user data until the UE connects. Considering the resource pressure, most source node may drop the user data if it has already forwarded to the target node. Once the HO failed before UE set up connection to the target cell, it will report the source cell as the last serving cell, then the re-establishment node (not the original target node) will request context from the source node, which has already forwarded data to the original target and dropped the user data. In such situation, data acquisition approach should be studied to avoid user data loss. One possible solution is to support the re-establishment node uses new or existing Xn signaling to fetch the data in the original target node, the target cell ID can be reported by the UE.

7. The potential solutions to reduce UE power consumption and network signaling

@Xiaomi @OPPO @Intel @Nokia @CATT

Regarding to reduce UE power consumption and network signaling, we intend to improve user mobility performance while avoiding causing excessive UE power consumption and signaling overhead. Considering that the UE performs more frequent measurement and report for handover or PScell change procedures in FR2, which will increase UE power consumption and network signaling, so solutions to reduce UE power consumption and network signaling overhead should be studied, one possible solution is to allow the network to pre-configure multiple candidate nodes for the UE, and support the UE to directly switch between the nodes based on the reference signal measurement without reporting the measurement report to the network. In addition to the above approach, the L1/L2 based mobility and UL signal based handover can be considered as potential solutions here, which can be further enhanced in R18.

8. Clarification on the inter-RAT PScell Change

@Ericsson @Nokia

Regarding to inter-RAT PScell change, we notice there is a note in TS37.340 10.1.5 which indicate that “*inter-RAT SN change procedure with single RRC reconfiguration is not supported in this version of the protocol (i.e. no transition from EN-DC to DC)*”, and we want to clarify that this restriction is only limited to EN-DC to LTE DC, NR-DC to NE-DC and vice versa. Considering in NSA deployment, the coverage of NR cell and E-UTRAN cell may not continuous, when the UE is enjoying a clouding gaming while moving, it may move out of the NR SN coverage area and the single E-UTRAN MN connection is unable to provide high data rate service for UE, in such situation, the network may need to configure the UE from NR SN to E-UTRAN SN, therefore, direct inter-RAT SN change should be supported to reduce the PScell change interruption.

9. The priority of the features in our scope

@Huawei

We consider the priorities for R18 work to be as follows (listed in priority order):

- Reduce data interruption in FR2 (such as RACH-less HO, etc...)
- Reduce data interruption for inter-MN handover (such as support coexistence of DAPS and DC);
- Ensure high reliability and 0ms interruption during HO (such as support coexistence of DAPS and CHO);
- Reduce data interruption in SN for PScell change procedure (such as DAPS-like PScell change, multiple SCG configuration with single active PScell, etc...)
- Fast failure detection and recovery (especially for FR2)
- NG-based handover enhancement (such as support intra-system and inter-system NG-based CHO)
- Reduce UE power consumption or network signaling □such as multiple pre-configured candidate cell, UL signaling based handover and L1/L2 based mobility enhancement, etc... □
- Support inter-RAT PScell Change (EN-DC to LTE DC, NR-DC to NE-DC and vice versa)
- Optimize data forwarding procedure

2.5.3 1st round: Moderator’s summary

In the first round NWM discussion, a total of 13 companies participated in the discussion, and eight of them (Spreadtrum, DOCOMO, Apple, Lenovo, Xiaomi, OPPO, CATT, Huawei) show their interest in further mobility enhancement in R18. Based on the received questions and comments, we have further clarified the following issues:

- The potential solutions to reduce data interruption for FR2 (such as RACH-less HO, etc...);
- The potential solutions to support high reliability and 0ms interruption (such as support coexistence of DAPS and CHO);
- Clarification on the NG-based handover enhancement (such as support intra-system and inter-system NG-based CHO);

- The potential solutions for fast failure detection and recovery (such as reduce the failure detection time especially for FR2);
- The potential solutions to reduce data interruption in SN for PScell change procedure (such as DAPS-like PScell change, multiple SCG configuration with single active PScell, etc...);
- The potential solutions for data forwarding optimization (see response to Q6);
- The potential solutions to reduce UE power consumption and network signaling (such as multiple pre-configured candidate cell, UL signaling based handover and L1/L2 based mobility enhancement, etc...);
- Clarification on the inter-RAT PScell Change (EN-DC to LTE DC, NR-DC to NE-DC and vice versa);
- The priority of the features in our scope (see response to Q9);

The statistics of companies' views are as below:

- 4 companies (Apple, Xiaomi, CATT, Lenovo) show their interest in FR2 mobility enhancement (such as reduce data interruption in FR2);
- 2 companies (DOCOMO, Apple) show their interest in fast failure detection and recovery;
- 1 company(Huawei) show its interest in inter-MN handover enhancement;
- 1 company share similar view to support higher mobility performance in current handover procedures, such as DAPS supporting DC/CA and coexistence of CHO and DAPS (Lenovo [RWS-210283]);

Based on the inputs from companies, moderator propose to change current “*Ensure 0ms interruption for PScell change procedure*” in our scope into “*Reduce data interruption in SN for PScell change procedure*”, which is more precise. And FR2 mobility enhancement can be considered as high priority in the next phase discussion, detailed features/solutions and corresponding applicable scenes can be further discussed in the next phase.

2.5.4 2nd round: Questions and comments

Companies are invited to provide questions and comments to the follows:

1. Any further questions and comments to moderator’s response and summary for 1st round in section 2.5.2 and 2.5.3

Feedback Form 16: Any further questions and comments to moderator’s response and summary for 1st round in section 2.5.2 and 2.5.3

1 – Beijing Xiaomi Mobile Software

It seems the proposed power saving solution is more beneficial to save signaling. Signaling reduction could be considered with higher priority instead of power saving.

2 – ZTE Corporation

We see urgent need to improve the robustness and interruption time for FR2 mobility, thus we think a), i) and

h) should be considered as high priority issue for Rel-18. For e), we also see some benefit in this for FR2, but the "multiple SCG configuration with single active PScell" seems overlapping with the enhancement proposed in "Multi Radio Multi Connectivity" in section 2.2.

For c) and f), we also see some use cases and support these features. In addition, for c) "intra-system and inter-system NG-based CHO", considering some changes may be required in SA2, SA2 should be involved as well to confirm the feasibility.

For the other features, we are also open to discuss these proposals, but the complexity should be taken into account to ensure the feature can be implemented and deployed in the market.

3 – Spreadtrum Communications

Thanks for your detailed response.

We wonder whether the Scell needs to be worked as a Pcell in the process of fast failure recovery, and whether there are any foreseeable difficulties.

4 – CATT

Thanks for your nice summary. Regarding your response on power saving aspects we agree that mobility work could take this aspect into further consideration, as many other topics do. Let's continue with detailed discussions.

5 – Guangdong OPPO Mobile Telecom.

Thanks for the reply. Please find our further question as below

1. Regarding the 2nd objective, what (EN-DC, NR-DC, NE-DC, ...) are expected to be included for MRDC scenarios in your mind? It is Rel-18 now. Do we still need to further optimize EN-DC when SA is gradually trending worldwide?

6 – HuaWei Technologies Co.

Thanks for the reply. Can you please clarify whether you have any preference on the reduction of data interruption in FR2? We understand dynamic switch of cells via L1/L2 signaling is one candidate?

2. From your perspective, which scheme(s)/feature(s) can be considered in Rel-18 for mobility enhancement, e.g.,

- a) Reduce data interruption in FR2 (such as RACH-less HO, etc...);
- b) Ensure high reliability and 0ms interruption during HO (such as support coexistence of DAPS and CHO);
- c) Enhance robustness of NG-based Handover (such as support intra-system and inter-system NG-based CHO);
- d) Reduce data interruption for inter-MN handover (such as support coexistence of DAPS and DC);
- e) Reduce data interruption in SN for PScell change procedure (such as DAPS-like PScell change, multiple SCG configuration with single active PScell, etc...);
- f) Support inter-RAT PScell Change (EN-DC to LTE DC, NR-DC to NE-DC and vice versa);
- g) Optimize data forwarding procedure (such as early data forwarding enhancement to reduce the cache pressure or data acquisition procedures);

- h) Reduce UE power consumption or network signaling (such as multiple pre-configured candidate cell, UL signaling based handover and L1/L2 based mobility enhancement, etc...);
- i) Fast failure detection and recovery (especially for FR2);
- j) Others (such as coexistence of CHO and CPAC, etc...);

Feedback Form 17: From your perspective, which scheme(s)/feature(s) can be considered in Rel-18 for mobility enhancement

<p>1 – Beijing Xiaomi Mobile Software</p> <p>We support mobility enhancement. However, the enhancement shall consider UE complexity. We don't prefer enhancement which requires more than 2 active links, for example DAPS PSCell change.</p>
<p>2 – CATT</p> <p>Thanks for the summary and further question. We think at least a/b/d/e could be discussed. Then as a general comment the list seems to be quite long and maybe we could first align companies views on main gap/motivation for mobility enh in r18, then go to technical solutions a bit later.</p>
<p>3 – Lenovo (Beijing) Ltd</p> <p>Thank you for the summary and 2nd round discussion. From our point of view, at least a/b/d/e/j (coexistence of CHO and CPAC) should be considered in Rel-18, and we are also open to discuss other proposals.</p>

3. Any further questions and comments to proposal RWS-210151

Feedback Form 18: Any further questions and comments to proposal RWS-210151

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2.5.5 2nd round: Response to companies' feedback

1. Beijing Xiaomi Mobile Software

1

It seems the proposed power saving solution is more beneficial to save signaling. Signaling reduction could be considered with higher priority instead of power saving.

2

We support mobility enhancement. However, the enhancement shall consider UE complexity. We don't prefer enhancement which requires more than 2 active links, for example DAPS PSCell change.

China Telecom feedback:

Thanks for your support on mobility enhancement, we also think signaling reduction is important and we will consider it in mobility procedures for further study. And for your concern on UE complexity, we think we can

further study the solutions for UE with limited capabilities (i.e. the UE cannot support more than 2 active links), such as multiple pre-configured candidate SN (≥ 2) with single active SN, or TDM based mechanism to enable DAPS PScell change (coordination between source SN and target SN may be need here).

2.ZTE Corporation

We see urgent need to improve the robustness and interruption time for FR2 mobility, thus we think a), i) and h) should be considered as high priority issue for Rel-18. For e), we also see some benefit in this for FR2, but the "multiple SCG configuration with single active PScell" seems overlapping with the enhancement proposed in "Multi Radio Multi Connectivity" in section 2.2.

For c) and f), we also see some use cases and support these features. In addition, for c) "intra-system and inter-system NG-based CHO", considering some changes may be required in SA2, SA2 should be involved as well to confirm the feasibility.

For the other features, we are also open to discuss these proposals, but the complexity should be taken into account to ensure the feature can be implemented and deployed in the market.

China Telecom feedback:

Thanks for the comments, we also think a) i) h) are worth to be studied in R18, and for e), we want to clarify that the solution used here is intent to reduce the data interruption in SN for PScell change procedures, the trigger conditions may be mainly based on the radio link status, for "Multi Radio Multi Connectivity" in section 2.2, it is mainly used in SN addition scenarios, the trigger condition can also be based on the RAT type or service type.

For c), we think it is meaningful to enhance robustness for NG-based Handover, maybe we can start discussion in RAN3 and coordinate with SA2 regarding the signaling and procedures if needed. Furthermore, we are happy to discuss the detailed solution in the further and take the complexity into consideration.

3.Spreadtrum Communications

Thanks for your detailed response.

We wonder whether the Scell needs to be worked as a Pcell in the process of fast failure recovery, and whether there are any foreseeable difficulties.

China Telecom feedback:

Thanks for the comments, our intention is to introduce similar MCG fast failure recovery approach (which was already supported in R16) in CA case, the UE can send failure information through SCell to the network when PCell failure is detected, then the network can send RRC reconfiguration message to UE through SCell, in this way, UE does not need to perform RRC reestablishment procedure, and the Pcell failure recovery time can be reduced to a certain degree. In general, we think we can further discuss the detailed signaling procedures and avoid introducing too complex approaches.

4. CATT

1

Thanks for your nice summary. Regarding your response on power saving aspects we agree that mobility work could take this aspect into further consideration, as many other topics do. Let's continue with detailed discussions.

2

Thanks for the summary and further question. We think at least a/b/d/e could be discussed. Then as a general comment the list seems to be quite long and maybe we could first align companies views on main gap/motivation for mobility enh in r18, then go to technical solutions a bit later.

China Telecom feedback:

Thanks for your support on a/b/d/e, we also think they are worth to be studied in Rel-18. Furthermore, we share similar views as your comments that companies need to align the general features/aspects to be studied for mobility enhancement in R18, and we will further refine our scope to accommodate the requirements from companies.

5. Guangdong OPPO Mobile Telecom.

Thanks for the reply. Please find our further question as below

Regarding the 2nd objective, what (EN-DC, NR-DC, NE-DC, ...) are expected to be included for MRDC scenarios in your mind? It is Rel-18 now. Do we still need to further optimize EN-DC when SA is gradually trending worldwide?

China Telecom feedback:

Thanks for your comments, we think that NR deployment would coexist with LTE widely for a long period of time, so for the enhancement approach on the mobility procedure, all MRDC scenarios should be considered at this stage.

6. HuaWei Technologies Co.

Thanks for the reply. Can you please clarify whether you have any preference on the reduction of data interruption in FR2? We understand dynamic switch of cells via L1/L2 signaling is one candidate?

China Telecom feedback:

We notice that the *dynamic switch approach* is proposed in your paper [RWS-210449], we think we share similar views on the solution, the *dynamic switch approach* is one of the potential solutions for data interruption reduction for FR2, and the detailed signaling procedure can be discussed in the further. In addition, we are open to discuss other potential solutions such as RACH-less HO, MBB HO, etc.

7.Lenovo (Beijing) Ltd

Thank you for the summary and 2nd round discussion. From our point of view, at least a/b/d/e/j (coexistence of CHO and CPAC) should be considered in Rel-18, and we are also open to discuss other proposals.

China Telecom feedback:

Thanks for your support on a/b/d/e/j (coexistence of CHO and CPAC), we also think they are worth to be studied in Rel-18, for others aspects/features proposed in our slides we are happy to discuss the motivation and detailed solutions in the further work.

2.5.6 2nd round: Moderator's summary

In the second round NWM discussion, a total of 7 companies participated in the discussion, the statistics of companies' views are as below:

- 3 companies (ZTE, CATT, Lenovo) show their interest in reduce data interruption in FR2;
- 2 companies (CATT, Lenovo) show their interest in following aspects:
 - * Ensure high reliability and 0ms interruption during HO;
 - * Reduce data interruption for inter-MN handover;
 - * Reduce data interruption in SN for PScell change procedure;
- 1 company (ZTE) shows its interested in Fast failure detection and recovery (especially for FR2);
- 1 company (Lenovo) shows its interested in supporting consistence of CHO and CPAC;
- 3 companies (Xiaomi, ZTE, CATT) think the UE complexity or network signaling should be taken into account when further discuss the approaches;

In addition, we further clarified our views on the fast failure recovery, dynamic switch approach, and our consideration on the MRDC enhancement scenarios.

2.6 Multi-Sim ([5])

2.6.1 1st round: Questions and comments

Companies are invited to provide questions and comments on the following contribution.

RWS-210299, "Discussion on Multi-SIM devices enhancement in Rel-18".

Feedback Form 19:

1 – Apple Hungary Kft.

[Apple] We fully acknowledge the limitations with the Rel-17 multi-SIM and the improvement that can

be made and agree to the proposals as the right direction for multi-SIM for Rel-18.

2 – CATT

For “Key issue2” in P9 and “Key issue3” in P10, it seems pure UE implementation, what needs to be specified? furthermore, DSDA type UEs have already been in the market for a long time at least since LTE era, so the uplink transmitting power issue and interference control issue at UE side should not a new issue. If it worked well in LTE, why this issue has to be addressed and specified in NR?

3 – ZTE Corporation

Thanks for the proposal.

(1) For the capability update, we want to clarify the relationship between Multi-SIM and eIDC. In LTE, the main intention of IDC is to enable the coexistence of LTE and GPS/ ISM radio within the same device. For Multi-SIM, it seems Multi-SIM with two active USIM can be considered as a special case of IDC with two NR radio within the same device. Therefore, to minimize the complexity on both standardization and implementation, we are wondering whether a common framework & solution can be considered for IDC and Multi-SIM to enable the capability coordination & update in NR.

(2) For UE request Network A to release SCG or deactivate Scell, we understand this can be achieved by UE assistance information with the maxCC-Preference included. Do you intend to introduce a specific procedure for the multi-SIM case?

4 – HuaWei Technologies Co.

Q1: we share the similar views that UE capability coordination/update is useful for Dual TX/Dual RX UE. But we are wondering what need to be specified for UL power sharing and interference control between two USIMs? The current UE implementation already support them.

5 – Qualcomm CDMA Technologies

Q1: For IDC, wouldn't it be better to have a more general solution (possibly in a separate WI) to cover all other interference scenarios but not just MUSIM?

Q2: For UE requesting to release SCells/SCG, is the intention just to add MUSIM as another cause for transmission of already specified UAI message?

Q3: As an operator, are you interested in any intra-PLM (two USIMs from the same operator) optimizations?

6 – Nokia Corporation

Q1: Which capabilities would UE be allowed update and how would this be controlled by the network?

Q2: RAN2 is already discussing SCG deactivation in Rel-17, so what would be the additional part needed for MUSIM SCG deactivation?

Q3: Is the basic assumption from Rel-17 that networks need to coordinate with each other still valid for these cases?

7 – vivo Mobile Communication Co.

Thanks for the contribuion, we agree that Two TX/RX should be discussed in R18 . We also think that same operator should be enhanced further based R17 discussion. however could you clarify what should be enhanced for UL power sharing and interference control for Multi-SIM?

8 – Spreadtrum Communications

Thanks for the proposal.

Generally, we are fine to consider dual Tx/dual Rx in Release 18, including, e.g. capability update notification, and transmitting power impacts. but we suggest to consider that, DSDA type UEs have already been in the market for a long time, as CATT mentioned.

9 – Samsung R&D Institute UK

Q: For Key issues 2 and 3, would you clarify what specification efforts are needed?

10 – Samsung R&D Institute UK

Q: For Key issues 2 and 3, would you clarify what specification efforts are needed?

2.6.2 1st round: Response to companies' feedback

Some questions related to enhancement on dual Tx/dual Rx multi-SIM device can be summarized into four categories and a new topic related to intra-PLMN optimization is also mentioned.

1. Capabilities coordination for multi-sim purpose

Q1: Which capabilities would UE allowed update and how would this be controlled by the network?

CT response: As far as we can see, the capabilities like *maxNumberMIMO-LayersCB-PUSCH*, *maxNumberMIMO-LayersPDSCH*, supported CA/DC combinations, *supportedSRS-TxPortSwitch* and *maxNumberSRS-Ports-PerResource* will be impacted and need to be updated. Other capabilities related to DAPS and SUL may also be impacted which we can further discuss during the WI if possible. From our point of view, which kind of information can be reported is always configured by network as what we have done for power saving.

Q2: Whether a common framework & solution can be considered for IDC and Multi-SIM to enable the capability coordination & update in NR.

CT response: We also think that a common framework is enough to solve IDC problem and enable the capability coordination. However, different trigger and cause value should be considered.

2 SCG/Scell release for multi-sim purpose

Q1: Whether existing UAI scheme can be reused for this scenario Anything additional need to be considered

CT response: The existing UAI scheme may take as a candidate solution. However the following aspects need to be considered:

- a) The network need to know the request from UE is for multi-SIM purpose as it may take different action for different purpose
- b) It is helpful that UE can indicate the specific SCells which are impacted not just the number of CCs supported.
- c) The SCG can be deactivated instead of being released for some cases, which can reduce the SCG recovery delay.

Q2: Whether SCG deactivation procedure in Rel-17 can be reused for this scenario□ Anything additional need to be considered□

CT response: As the UE initiated SCG deactivation procedure in Rel-17 is still under discussion. If it is supported, we may take it as a reference. However, we think an unified solutions for SCG/SCell deactivate/release and capabilities coordinate should be considered.

3□ Uplink power sharing between different USIMs

Q1: Why this issue has to be addressed and specified in NR

CT response: The total uplink transmitting power is restrained by SAR and RF structure. If the uplink transmitting power is dynamically shared by two USIMs, when dual Tx/ dual Rx UE are in RRC connected status in both USIMs and transmitting simultaneously with two networks, the available transmitting power may not fulfill the required transmitting power in both USIMs. Therefore, the UE has to reduce transmitting power in one USIM or even drop connection in some extreme case. The UE behavior should be predictable to network to avoid inaccurate estimate of the link status. When the UE drop connection because out of power it will be helpful that network know the reason.

Q2: What specification efforts are needed?

CT response: When the required transmitting powers in both USIMs exceed the maximum power UE can afford, a mechanism can be defined to adjust configured output power between two USIMs which should be synchronized with the network. And when UE decide to drop the connection of one USIM for out of power, the reason should be indicated to associate network.

4□ Interference between different USIMs

Q1 : Why this issue has to be addressed and specified in NR

CT response: During LTE era, most devices only support transmission on 1TX chain at one time. Multi-USIM UE supporting dual Tx /dual Rx is not popular. Situation changed in 5G era, as the type of device supporting simultaneous transmission on 2TX chains becomes the majority. Due to the introduction of new bands running

on high frequencies and concurrent low bands between different operators, there are new carrier combinations including high frequency & high frequency, high frequency and low frequency, low frequency and low frequency.(high frequency, such as n77,n78,n79 and low frequency, such as n28,n5,n8) and more complicated interference including harmonic, harmonic mixing, cross band isolation, inter-modulation, counter inter-modulation, which needs to be specified for the scenario that both USIMs in connection status.

Q2: What specification efforts are needed?

CT response: For RF TX specify total max transmission power, delta_TIB, MPR, AMPR, SEM, ASEM, ACLR, etc. Especially under the total max transmission power higher than 26dBm.

For RF RX, specify delta_RIB, MSD caused by IMD issue, harmonic interference, harmonic mixing interference, cross band isolation interference etc. for new band combinations introduced by Multi-USIMs .

For interference UE cannot solved by itself, a solution as NR IDC mechanism can be introduced.

5. New topics

In additional, two companies mentioned the consideration on intra-PLMN (two USIMs from the same operator) optimizations.

CT response: We fully acknowledge the motivation of this optimization and we are welcome to discuss this topic. We have some question on the optimization listed below, which may need further discussion.

a) Security issues should be considered such as a USIM pretending it is in the same device with another USIM for illegal activities.

6. General questions

Q1: Whether networks need to coordinate with each other

CT response: As we known, coordination between different networks is not considered in rel 17. For intra-PLMN cases, if optimization is supported, the network coordination with two USIMs is needed.

2.6.3 1st round: Moderator's summary

There are 9 companies participate in the discussion. According to the first round discussion, it seems all participants agree that dual Tx/dual Rx multi-SIM device should be considered in Release 18. There are some detailed questions on how to realize capabilities coordination and SCG/SCell deactivation. More concerns are on the necessity of enhancement on uplink power sharing and interference control. Two companies mentioned the consideration on intra-PLMN (two USIMs from the same operator) optimizations. A general question about the network coordination is raised.

2.6.4 2nd round: Questions and comments

Companies are invited to provide comments to the follows:

1. Capabilities coordination for multi-sim purpose

For Tx chains or Rx chains sharing between two UEs and UE have to tune away partial of Tx/ Rx chains for activities in another USIM, the UE capabilities such as supported MIMO layers, CA/DC combinations and SRS transmitting may be impacted.

Q1.1: Do you think capabilities coordination for multi-SIM purpose is needed for dual Tx/dual Rx multi-SIM device in Rel 18?

Q1.2: If the answer is Yes for Q1.1, do you think capabilities like supported MIMO layers, CA/DC combinations and SRS transmitting related capabilities should be considered And what else should be considered?

Feedback Form 20:

<p>1 – Qualcomm CDMA Technologies</p> <p>The response to Q1.1 is "Yes", assuming that this is not a coordination on the NW side but based on UE signaling of reduced capability due to sharing of resources between the two USIMs.</p> <p>For Q2.2, yes, at least RF and baseband related capabilities and features will need to be considered. In general, any capability which is band of BC dependent is a potential candidate.</p>
<p>2 – CATT</p> <p>Q1.1:Yes</p> <p>Q1.2:Yes</p>
<p>3 – vivo Mobile Communication Co.</p> <p>For Q1.1, Yes, the issue needs to be handled in R18. UE has been found tuning away partial of Tx/ Rx chains for MUSIM purpose in practical network, it causes radio resource wasting and network performance declining.</p> <p>For Q1.2 At least the above listed capabilities should be considered.</p>

2. SCG/Scell release for multi-sim purpose

There are two companies think existing scheme such as UAI and potential Rel 17 UE initiated SCG deactivated procedure can be reused for multi-SIM purpose. The moderator thinks there are some additional specification works as the trigger and the expected network reaction are different. Also the UE may request to release or deactivate specific SCells which is not considered in other WIs.

Q2: Do you think SCG/Scell release/deactivated for multi-sim purpose should be considered for dual

Tx/dual Rx multi-SIM device in Rel 18?

Feedback Form 21:

1 – Qualcomm CDMA Technologies This is definitely needed. The current UAI framework does not allow signaling such request per band or per BC, which should be supported for MUSIM case.
2 – CATT Q2:Yes
3 – vivo Mobile Communication Co. Generally speaking, new mechanism should be avoided if an issue can be handled with existing solutions. But if additional benefit is observed for the network to know the trigger of a UE initiated SCG/Scell release procedure (e.g. network admits SCG/Scell release triggered by MUSIM purpose with high probability than other purpose)

3. Uplink power sharing between different USIMs

Some companies think devices have already supported UL power sharing and interference control by UE implementation and are wondering what any specification work needed. However, as we know the majority of multi-sim devices are single Tx/single RX or single Tx/dual RX in LTE era. The issues of uplink power sharing and interference caused by simultaneous transmitting to different network are new challenges to us.

Q3.1: Do you think issues related to Uplink power sharing between different USIMs do exist for dual Tx/dual Rx multi-SIM device?

Feedback Form 22:

1 – Qualcomm CDMA Technologies It can exist due to emission and SAR requirements but they can be handled by the UE implementation.
2 – CATT Yes
3 – CATT Not sure for the spec effort mentioned by moderator in 1st round.Regarding “a mechanism can be defined to adjust configured output power between two USIMs which should be synchronized with the network.”.it seems adjusting output power between USIMs by UE implementation is sufficient, why it has to be synchronized with the network? Regarding “when UE decide to drop the connection of one USIM for out of power, the reason should be indicated to associate network.”, we understand the key point here is to request leaving connected state in

one network. For this purpose, it seems “network switching while leaving RRC_Connected state in NW A” which is supported in R17 is sufficient.

4 – vivo Mobile Communication Co.

Yes, we think it is a new challenge. However, we would like to consider further how to handle this issue.

Q3.2: As we mentioned in the first round Q&A. The UE may reduce or restriction the uplink power of one network if the required transmitting powers in both USIMs exceed the maximum power UE can afford. **Do you think it is needed to specify any mechanism to inform network of the UE behavior in uplink power restriction/reduction for multi-SIM purpose?**

Feedback Form 23:

1 – Qualcomm CDMA Technologies

Some enhancements due to IDC can be considered. However, uplink tx power is dynamic and the UE should not have any specific static or dynamic partitioning between the two USIMs.

2 – CATT

Not sure for the spec effort mentioned by moderator in 1st round.Regarding “a mechanism can be defined to adjust configured output power between two USIMs which should be synchronized with the network.”.it seems adjusting output power between USIMs by UE implementation is sufficient, why it has to be synchronized with the network?

Regarding “when UE decide to drop the connection of one USIM for out of power, the reason should be indicated to associate network.”, we understand the key point here is to request leaving connected state in one network. For this purpose, it seems “network switching while leaving RRC_Connected state in NW A” which is supported in R17 is sufficient.

3 – vivo Mobile Communication Co.

Yes, we think it is a new challenge. However, we would like to consider further how to handle this issue.

Q3.3: As for EN-DC, the spec defines a scheme on how to adjust the transmitting power. **Do you think it is needed to specify a scheme for DSDA operation?**

Feedback Form 24:

1 – Qualcomm CDMA Technologies

No, we shouldn't create any cross-dependency between power control between the two USIMs.

2 – CATT

No,see answer to Q3.2

3 – vivo Mobile Communication Co.

Yes, we think it is a new challenge. However, we would like to consider further how to handle this issue.

4. Interference between different USIMs

Due to new band combinations introduced by different USIMs combination, the interference issues are more completed for dual Tx/ dual Rx multi-SIM UEs. In addition the total transmitting power of dual Tx/ dual Rx UE may increase and have some impact on RF performance.

Q4.1: Do you think new TX RF or Rx RF requirements should be specified?

Feedback Form 25:

1 – Qualcomm CDMA Technologies

No, this will be very complicated for RAN4 and not necessary. Here, we are assuming that the two USIMs have separate PHYs. If a shared PHY is specified as part of intra-PLMN optimization, then there won't be any problem either.

2 – CATT

Yes

3 – vivo Mobile Communication Co.

We have discussed this issues during R17 multi-SIM WID setting up, however We would like to consider further how to handle this issue.

Q4.2: Do you think IDC scheme should be enhanced for multi-USIM purpose?

Feedback Form 26:

1 – Qualcomm CDMA Technologies

Yes, IDC problems due to MUSIM can be considered.

2 – CATT

Yes

3 – vivo Mobile Communication Co.

We have discussed this issues during R17 multi-SIM WID setting up, however We would like to consider further how to handle this issue.

Q4.3: There is one company mentioned that IDC issue and capabilities coordinate can be considered together with a common framework. Do you agree with it?

Feedback Form 27:

1 – Qualcomm CDMA Technologies

It is not clear capability coordination by itself can solve all potential IDC issues.

2 – vivo Mobile Communication Co.

We have discussed this issues during R17 multi-SIM WID setting up, however We would like to consider further how to handle this issue.

5. New topics

During the first round Q&A, two companies mentioned the consideration on intra-PLMN (two USIMs from the same operator) optimizations.

Q5.1: Do you support optimization on intra-PLMN (two USIMs from the same operator) for multi-USIM devices?

Feedback Form 28:

1 – Qualcomm CDMA Technologies

Our understanding is that a significant portion of MUSIM devices in the market have subscriptions to the same operator. So we are interested in leveraging the co-existence in the same device to improve performance and UE power. Some of such enhancements can be done as UE implementation but NW awareness and control can provide more benefits.

2 – vivo Mobile Communication Co.

Yes, a lot of MUSIM using the SIMs from one operator. We expect benefit can be obtained with small specification effort.

And also, for RAN sharing case.

Q5.2: What kind of optimization do you think is necessary if the network awareness two USIMs belong to the same devices?

Feedback Form 29:

1 – Qualcomm CDMA Technologies

This can simply be NW awareness of the co-existence of two USIMs in the same device (e.g. UE signaling the C-RNTI of the other USIM). Then, NW implementation can adjust RRM and mobility, for example triggering HO simultaneously. We are also open to further optimizations, e.g. sharing same PHY and

MAC between two USIMs, which can provide even better performance.

2 – vivo Mobile Communication Co.

Allocate the same Paging occasion for two UEs in one device. Allow DSDA like performance with one 1tx/1rx.

Q5.3: We think Security issues should be considered such as a USIM pretending it is in the same device with another USIM for illegal activities. **Do you have any concern on this topic?**

Feedback Form 30:

1 – Qualcomm CDMA Technologies

No, we don't think there is a security problem. In Rel-17, SA2/CT1 is already introducing UE signaling that it is a MUSIM UE and SA3 has not had any issues with such signaling. In any case, each USIM has separate security credentials and does separate registration.

2 – vivo Mobile Communication Co.

We agree the issue exists and should be discussed.

6. General questions

One company mentioned whether networks need to coordinate with each other still valid for all these cases as in Rel 17. From our point of view, coordination between different networks is not requested in Rel 17 and should not be considered in rel 18 also.

Q6.1: Do you think it is a basic assumption that coordination between different networks is not considered for all these topics?

Feedback Form 31:

1 – Qualcomm CDMA Technologies

Coordination between different networks should not be considered. If this is desired, such work should start in SA2. However, as described above, we support RAN-level coordination for the same network.

2 – vivo Mobile Communication Co.

Yes, network coordination is not possible in some deployment scenarios, hence we should avoid requirement for network coordination.

Q6.2: Any further comments or questions to moderator's response.

Feedback Form 32:

1 – ZTE Corporation

Thanks for the answers to the round 1 questions.

For UE request Network A to release SCG or deactivate Scell, to differentiate from UAI for power saving and overheating, we agree that NW needs to be aware it is for multi-SIM. For UE indicating the specific SCells which are impacted, what is the expected NW reaction upon reception of such information?

2 – HuaWei Technologies Co.

We think the MUSIM scope should be kept reasonable and we understand the main intention from companies is to support capability coordination for dual Tx/Rx, including MIMO layers, CA/DC relevant capabilities but this requires further discussion case by case. The SCG/Scell release can be considered consequently. We do not think to mix up different issues like power saving, IDC into MUSIM is good.

2.6.5 2nd round: Response to companies' feedback

In the second round Q&A, further questions related to uplink power sharing and SCell/SCG deactivated are raised.

1. SCG/Scell release for multi-sim purpose

Q1: For UE indicating the specific SCells which are impacted, what is the expected NW reaction upon reception of such information? @ZTE

A1: We think the NW has to release or deactivated the specific SCells according to UE's request. Otherwise the UE will lose the SCells anyway.

2. Uplink power sharing between different USIMs

Q1 □ Adjust configured output power between two USIMs can be left for UE implementation. Why it has to be synchronized with the network? @CATT

A1: When single USIM activated, the network has accurate information of UE's maximum output power and remaining uplink power. However, when multiple USIMs activated, the maximum output power of one USIM may be restricted. From network's point of view, the UE behavior should be predictable, otherwise the network will have inaccurate estimation of channel condition or the network will allocate uplink resources that UE cannot afford. We think at least the UE should report the network to what degree it restrict the output power

Q2: When UE decide to drop the connection of one USIM for out of power, can it reuse the procedure of UE request to leave connected statuses for multi-SIM purpose in Rel 17? @CATT

A2: Yes, we could consider reusing the procedure of UE request to leave connected statuses for dual Tx/ dual Rx UE in this case.

2.6.6 2nd round: Moderator's summary

Companies participating in the second round Q&A also show their views on the scope of these topics.

1. Capabilities coordination for multi-sim purpose

There is no objection on supporting capabilities coordination for multi-SIM purpose. Three companies explicitly agree that at least capabilities related MIMO layers, CA/DC combinations and SRS transmitting need to be considered. One company mentioned that at least RF and baseband related capabilities and features will need to be considered.

- Moderator think capabilities coordination for multi-SIM purpose should be considered in the first place.

2. SCG/Scell release for multi-sim purpose

There is no objection on supporting SCG/Scell release/deactivated for multi-sim purpose in Rel 18.

Two companies explicitly support this topic. One company think we should avoid introduce new mechanism if an issue can be handled with existing solutions.

- Moderator thinks new mechanism or enhancement to existing UAI can be considered to enable SCG/Scell release/deactivated for multi-sim purpose.

3. Uplink power sharing between different USIMs

There is no consensus on this topic. Although companies agree that issues related to Uplink power sharing between different USIMs exist. Two companies think there is no need to specify anything and want to left for UE implementation. One company would like to consider further how to handle this issue.

- Moderator thinks it can be left to UE to decide how to adjust output power between USIMs, however, at least the UE should report the network to what degree it has restrict the output power.

4. Interference between different USIMs

4.1 Define TX RF or Rx RF requirements.

There is no consensus on this topic. One company thinks it is unnecessary to define new RF requirement for dual Tx/ dual Rx Multi-SIM UEs. One company thinks it may need further consideration. One company supports to do so.

- Moderator thinks this topic may need further discussion.

4.2 Enhancement to IDC scheme for multi-USIM purpose

One company mentioned that IDC is not multi-SIM specific issue. Two companies support to enhance IDC scheme. One company thinks it may need further consideration.

- Moderator thinks a common solution to cover all interference scenarios can be a potential way.

5. Optimization on intra-PLMN (two USIMs from the same operator) for multi-USIM devices

Two companies explicitly show their support on this topic and propose several optimization directions such as enhancement on RRM and mobility, sharing the same PO, sharing the same PHY and MAC between two USIMs. One company think it is power saving topic.

There is no consensus on security issues on this topic. One company thinks there is no security issue but one company thinks security issues exist.

- Moderate thinks security issues need further discussion and the direction of optimization need to converge.

6. Coordination between different networks

It seems companies reach a consensus that coordination between different networks is not considered for all these topics.

3 Summary

3.1 MultiRadio Multi Connectivity ([1])

A total of 14 companies have participated in the two rounds discussion on MR-MC for Rel-18, 14 for the first round and 8 for the second round. During the discussion, the majority of companies (12/14 for Round1 and 8/8 for Round2) are more interested in or supported multi-layer deployment scenario, i.e. Multi-SN connectivity. The most interested issues on Multi-SN connectivity include the number of simultaneous UL transmissions and DL receptions, fast SCG activation and deactivation, and UL selective activation.

The potential proposals from moderator based on 2 rounds discussion are as follows:

Proposal 1: To have a dedicated WI for Multi Radio Multi connectivity (MR-MC) in Rel-18.

Proposal 2: High priority scenario or use case for MR-MC in Rel-18 is multi-layer deployment, i.e. multi-SN connectivity.

- Focus on at most 2 simultaneous UL transmissions and extension to 3DL receptions in Rel-18

Proposal 3: Potential scopes for multi-SN connectivity include:

- Specify fast SCG activation and deactivation mechanism

- Specify UL selective activation mechanism such as dynamic UL switching

Proposal 4: Other objectives can be further discussed including bearer management, UE capability management, measurement aspects and so on.

3.2 Flexible Spectrum Fusing ([2])

There are totally 12 companies participating in the discussion and raising their valuable comments/questions. We give the responses for each of comments/questions on 1st round and 2nd round. Based on which, we perceive that majority companies (at least 8 companies) are optimistic to this topic or part of the objectives.

It is worth to mention that we have the very potential scenarios of 700/800/900MHz and 1.8/2.1GHz for future deployment. The existing CA or single cell framework could make the spectrum combination work, but as these low frequency bands are much more valued and some of them are fragmented, enhancement based on CA or single cell will be quite necessary to benefit these spectrums utilization. Therefore, by considering the comments received, we revise and propose the objectives as following

1) Scenarios: Focus on the spectrum frequency of which the bands are neighboring, e.g. 700MHz/800MHz/900MHz or 1.8GHz/2.1GHz and their subsets, etc

- Consider co-locate deployment for the multiple bands for fusing

- Limit multiple bands for fusing to be neighboring bands

2) Frameworks

- The frameworks to achieve flexible spectrum fusing include multiple cells of CA and single cell

- Whether to down-select the framework is FFS.

3) For multiple cells of CA, enable flexible configuration of downlink and uplink physical carrier for one cell in one or multiple frequency bands (RAN1, RAN2)

- Flexible uplink and downlink carrier linkage (FDD and TDD)

- One downlink physical carrier can be shared by multiple cells

- Apply to connected mode, whether apply to idle/inactive mode is FFS

4) For single cell with multiple downlink and multiple uplink carriers, specify single cell mapped into non-contiguous bandwidth of one or multiple frequency bands, subject to aggregated cell bandwidth no more than Rel-17 maximum carrier bandwidth per cell. (RAN1, RAN2)

-A band combination of multiple bandwidths of the same duplex mode can be mapped into single cell

- Apply to both connected mode and idle/inactive mode

5) Combine PDCCHs from multi-carriers and allocate in one of carriers (RAN1, RAN2)

- enable one PDCCH schedules multiple bandwidths across multiple carriers.

- extend to use a single DCI to schedule more than 2 carriers.

6) Simplify SSB designation to allocate in one of carriers (RAN1, RAN2)

- Option1: Restrict SSB in only one carrier

- Option2: SSB could be allocated in more than one carrier

7) RF impact (RAN4)

- Impact to UE and BS RF

>Option1: impact to both UE and BS RF

>Option2: impact to only UE RF

- Whether to restrict bands to same duplex

>Option1: restrict bands to same duplex (sharing Tx chain if feasible)

>Option2: not restrict bands to same duplex

- Number of tx chains for UE architecture

>Option1: keep/Increase number of Tx chains by at least two to enable low frequency bands concurrent transmission

>Option2: Share the same Tx chain for neighboring bands in low frequency such as sub-1GHz

>Option3: No concurrent transmission, restrict the uplink transmission within single band

- REFSENS, MSD requirements and other band specific requirements

>Option1: Reuse CA requirements to cover the bands for flexible combination

>Option2: Define new requirements for the pairing bands.

Also, company had concern to the benefit and feasibility of this work, we gave the detailed response to the specific concern regarding benefit and feasibility. Hopefully that could make sense, we are also fine to discuss based on the detailed issue which may be well continued in email round-trip.

So, to summarize, we have two proposals as the conclusion of this topic.

Proposal 1: Consider the above revised objectives for Flexible Spectrum Fusing as starting point to further discuss in email

Proposal 2: Continue to discuss the benefit and feasibility in email if company still had concern to this aspect.

3.3 Uplink enhancements ([3])

15 companies participated in the discussion on uplink enhancements, and most of the companies show their interests in uplink enhancement. During the discussion, valuable comments/questions from companies are received and clarified/answered by moderator, including: relation between coverage enhancement and capacity enhancement, necessity of coverage enhancement in Rel-18, solutions for uplink coverage enhancement, solutions for uplink capacity enhancement, etc.

From the moderator's point of view, we have the following proposals:

Proposal 1: Dedicated WI(s) on uplink enhancement is/are considered in Rel-18.

Proposal 2: From uplink coverage aspect, there is no need to re-evaluate to identify the bottleneck channel in Rel-18.

Proposal 3: For uplink coverage enhancement, candidate solutions are listed as follows:

- PUSCH enhancement

*** PUSCH repetition type B enhancement.**

*** Higher layer compression, e.g. packet aggregation.**

*** UE transmit waveform design to reduce MPR, e.g. including tone reservation, FDSS (Frequency Domain Spectral Shaping) with and without spectral extension for QPSK.**

- PUCCH enhancement

*** Sequence based PUCCH with UCI payload up to 11 bits.**

-PRACH enhancement

*** Multiple PRACH transmissions with the same/different beam(s).**

- Other solutions are not precluded.

Proposal 4: For uplink capacity enhancement, candidate solutions are listed as follows:

- CA enhancement to enable flexible spectrum allocation

- * **Flexible linkage between downlink and uplink carriers.**
- * **Scell with uplink carrier only.**
- **DMRS enhancement**
- * **More than 12 orthogonal DMRS ports for uplink.**
- * **DMRS overhead reduction, e.g. lower DMRS density for each port, DMRS sharing across multiple uplink slots.**
- **8 transmission layers for uplink.**
- **1024 QAM for uplink.**
- **UE cooperation in uplink transmission.**

3.4 Mobility enhancement ([4])

During the email-discussion, a total of 13 companies participated in the first round discussion and 7 companies participated in the second round discussion, most participant companies show their interest on study mobility enhancement in R18. A lot of constructive comments and questions were received and we have further explained/clarified our motivation and solutions. Based on the comments and opinions received, moderator wants to raise following proposals:

Proposal 1: The further mobility enhancement should be included in R18.

Proposal 2: Reduction of data interruption for mobility procedures (i.e. FR2 handover, MCG change, PSCell change, coexistence of DAPS and CHO, etc...) should be included in R18, detailed solutions can be discussed in the further.

Proposal 3: Robustness enhancement for mobility procedures (i.e. NG-based CHO, coexistence of CHO and CPAC, etc...) can be considered to be included in R18, detailed solutions can be discussed in the further.

Proposal 4: Fast failure detection and recovery especially for FR2 can be considered in R18.

3.5 Multi-Sim ([5])

9 companies participate in the discussion of Multi-SIM device enhancement in Rel 18. The topics which are interested or supported by companies can be summarized into 5 categories.

1. UE initiated capabilities coordination for multi-sim purpose

2. UE initiated SCG/Scell release for multi-sim purpose

3. Uplink power sharing between different USIMs

4. Interference between different USIMs

5. Optimization on intra-PLMN for multi-USIM devices

There is a common understanding that coordination between different networks is not considered for all these topics.

It seems all participants support to consider Topic 1 and Topic 2. Companies show interests in the capabilities coordination and the SCG/Scells deactivate mechanism.

Plenty of companies [5/9] have concerns on Topic 3 and topic 4. For topic 3, although companies admit that issues related to uplink power sharing between different USIMs exist, there is no consensus on whether spec work is needed. For topic 4, 1 company thinks it is unnecessary to define RF requirements for multi-SIM. Some companies suggest that IDC should be considered as a common solution for all interference scenarios not just for multi-SIM.

Two companies show big interests in optimization on intra-PLMN scenario. However, there is no consensus on the security issue of this topic.

According to round1 and round2 discussion, the potential proposals from moderator are as follows:

Proposal 1: Enhancement on Multi-SIM devices are considered in Rel-18.

Proposal 2: UE initiated capabilities coordination for Multi-SIM purpose is considered with high priority.

Proposal 3: UE initiated SCG/Scell release/deactivation for Multi-SIM purpose is considered with high priority.

Proposal 4: Further discuss on uplink power sharing issues and to reach consensus on following aspect:

- **Whether a mechanism to inform network of the UE restriction on uplink power is needed?**
- **Whether a scheme on how to adjust the transmitting power is needed?**

Proposal 5: Further discuss on issues of interference between USIMs and to reach consensus on following aspect:

- **Whether new TX RF or Rx RF requirements for Multi-SIM should be specified?**
- **Whether enhancement on IDC should be considered within Multi-SIM WI or under a general solution.**

Proposal 6: Further discuss on optimization for intra-PLMN scenario and to reach consensus on following aspect:

- **Whether any security issue needs to be solved?**
- **What kinds of optimization should be considered?**

4 Reference

[1] 3GPP RWS-210143, “Multi Radio Multi Connectivity for Rel-18”, China Telecom, Rel-18 workshop, June 28 – July 2, 2021.

[2] 3GPP RWS-210147, “Flexible Spectrum Fusing for Rel-18”, China Telecom, Rel-18 workshop, June 28 – July 2, 2021.

[3] 3GPP RWS-210149, “NR uplink enhancements for Rel-18”, China Telecom, Rel-18 workshop, June 28 – July 2, 2021.

[4] 3GPP RWS-210151, “Further enhancement on NR mobility for Rel-18”, China Telecom, Rel-18 workshop, June 28 – July 2, 2021.

[5] 3GPP RWS-210299, “Discussion on Multi-SIM devices enhancement in Rel-18”, China Telecom, Rel-18 workshop, June 28 – July 2, 2021.