**3GPP TSG-RAN Meeting # 89-e RP-201672**

**Electronic Meeting, September 14-18, 2020**

**Agenda item:** 9.1.2

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for BS EMC & DL 1024QAM FR1

**Document for:** Information

# Introduction

The documents intent to capture companies’ comments on the following two work areas related to RAN4 led non-spectrum Rel-17 WIs.

* Topic #1: BS EMC
* Topic #2: DL 1024 QAM for NR FR1

# Work area #1: BS EMC

## Draft WID submitted to RAN#88-e

The latest draft WID on BS EMC was submitted to RAN#88-e in RP-200787.

## Issues related to BS EMC for discussion

* Sub-topic 1-1: Core WI objectives
* Sub-topic 1-2: Performance WI objectives
* Sub-topic 1-3: Timeline e.g. TU per meeting
* Sub-topic 1-4: Any other issue

## Companies’ views

*Interested companies to provide comments on the sub-topics in the following sections*

### Sub-topic 1-1: Core WI objectives

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| **Company** | **Comments** |
| ZTE | Technically we agree that it is beneficial to simply the MSR EMC testing, since some test configurations of MSR RF may no need for MSR EMC testing. We are fine with the objective part. |
| Ericsson | Thanks ZTE for your comment.  |
| Xiaomi | We believe the proposal can help to save test time. However, as this is the simplification of test configurations, we are not sure why core part will be influenced. |
| Huawei | General comment is that this topic was brought by the proponents to RAN4 for number of meetings, where technical comments were received and discussed with companies involved in EMC-related topics. The idea of testing simplification is attractive, however the way to achieve such simplification was not concluded in RAN4, with number of technical questions remaining unanswered. Furthermore, the technical motivation of such simplification for EMC testing was questioned by some companies, e.g. how to reassure that there are no harmful emission for all the configurations that were omitted by such simplification. Potential implementation specific aspects of the MSR BS were not addressed either. Therefore we have concerns how the WI is expected to proceed. The core objectives cover many items which are for investigation – this is not seen appropriate for a Work Item.The WI proposal is for MSR BS, while relation of the proposal to the AAS BS specification (which is also an MSR) remains nuclear. |
| Ericsson | The goal with this proposal is not to change the core part, but to use this information as input to guide/shape the EMC testing simplification proposal.Although, the topic was brought to RAN4 meetings, one of the main comments during the discussion was the need for an adequate space/work item to cover this type of proposal. By proposing this WI, we want to guarantee that the topic will have an adequate allocation providing participants with the time for a deeper technical discussion. It also gives the time to work on the specific aspects of the implementation.When including items for investigation, what we want to highlight is the necessary process to reach a the final specification. In other words, we see the investigation and the specification as part of the same process to achieve the goals of the WI.The scope of the WI including AAS BS specification needs to be included in the scope of the proposal.  |
| Nokia, Nokia Shanghai Bell | It is not clear what purpose do the objectives of the core part serve if the intention is just BS EMC simplification. For example, why there is a need to investigate and specify test configurations/capability sets? The objectives do not seem to deliver the simplification that is desired. In addition, there is a concern that the objectives may affect the core part, which should not be the case. Further clarification on each of the objectives is needed. |

### Sub-topic 1-2: Performance WI objectives

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| **Company** | **Comments** |
| ZTE | what does “Compare impact on different RATs of the EMC performance.” mean? |
| Ericsson | It means to consolidate the results obtained in the previous goals (related to emissions and immunity testing). This goal can be reformulated for the sake of clarity. Our proposal is: Consolidate and Analyse the results obtained on EMC performance on different RATs for radiated and immunity testing.  |
| Xiaomi | We believe there will be extra work besides performance of single RAT EMC. For example, if there is cross-RAT influence? |
| Huawei | See 1-1 |
| Ericsson | We understand Xiaomi and Huawei concerns on cross-RAT influence and consider important to include it as part of the WI. In the same line the time plan and goals can be adjusted to reflect this concerns. |
| Nokia, Nokia Shanghai Bell | The objectives of the performance part are not clear. What does it mean by the following: “Investigate EMC performance on different RATs for EMC radiated emission testing”? It is not clear how the objectives can lead to the simplification as promised. How much reduction in testing time is not obvious from the objectives? If the reduction is not significant, then is it worth the effort? Since there are many open issues surrounding the WI, further discussions (e.g., a study phase) are necessary before proceeding with a WI.  |

### Sub-topic 1-3: Timeline e.g. TU per meeting

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| **Company** | **Comments** |
| Huawei | Considering multiple items for investigation, related discussion and implementation, the considered TUs are seen as underestimated.  |
| Ericsson | The TUs can be adjusted considering the participants observations. |
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### Sub-topic 1-4: Any other issue

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| **Company** | **Comments** |
| ZTE | For the impacted TS, we have two questions:1: Why is the MSR EMC core part impacted? we think there are no EMC core work. According to the justification and objective, the WID is only for EMC testing simplification, i.e. perf part.2: Why are the MSR RF TS(i.e. TS 37.104/TS37.141) impacted? any MSR RF work? we don’t see the related contents in objective par, and in our understanding, only MSR EMC TS will be impacted. |
| Ericsson | Thanks for your questions: * Our proposal targets at EMC testing simplification but one of the proposed goals “Investigate and specify how to handle the radiated emission limits (ITU-R SM 329) for MSR within an EMC-only Capability Sets and Test Configuration” would requires look at the radiated emission section that is core part of the EMC spec. The goal is not to change the core part, but to use this information as input to guide/shape the EMC testing simplification proposal.
* In line with the previous point, the impact on TS 37.104 is more about using it as input for the study rather than modifying it. Regarding TS 37.141, the impact is associated to the use of the Test Configurations defined in this spec.
* The goal is only to impact the MSR EMC TS.
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| Xiaomi | Anyway, we believe this is a good starting point to save test time. However, as the simplification is applied, we need to be really careful to be “over simplified”.  |
| Huawei | The list of affected specifications includes BS RF specifications. This proposal was not discussed in RAN4 during RF session. Impact of this WI proposal on RF specifications is unclear (see also AAS BS comments above). |
| Ericsson | See comments above and subtopic 1-1 |
| Nokia, Nokia Shanghai Bell | The trade-off between the amount of reduction in test configurations and test coverage should also be assessed. It is not worth the effort if the potential gain is small.Further discussions are needed to understand the simplification approach.  |

## Summary of discussion

Some companies supported to include the core objectives while some companies have questioned the need for having the core part. It is also raised that the relation of the BS EMC work with AAS BS specification is unclear. There is also concern in removing one RAT during the testing as it will exclude emissions, which should otherwise be tested. Also some concern is raised on that the objectives may not deliver the test case simplification. Therefore, objectives need further clarification as to how the BS EMC test simplification can be achieved

It is therefore recommended to omit the core part and focus on EMC testing, clarify relation with AAS BS specification, clarify the objectives to ensure they achieve BS EMC test simplification and impact of other RAT (cross RAT influence) need to be evaluated in the WI phase. Recommended to have adequate TU or spread the work over sufficient number of meetings to ensure timely completion of the WID while keeping the work load manageable.

# Work area #2: DL 1024QAM for NR FR1

## Draft WID submitted to RAN#88-e

The latest draft WID on DL 1024QAM for NR FR1 was submitted to RAN#88-e in RP-201156.

## Issues related to DL 1024QAM FR1 for discussion

* Sub-topic 2-1: Core WI objectives
* Sub-topic 2-2: Performance WI objectives
* Sub-topic 2-3: Timeline e.g. TU per meeting
* Sub-topic 2-4: Any other issue

## Companies’ views

*Interested companies to provide comments on the sub-topics in the following sections*

### Sub-topic 2-1: Core WI objectives

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| **Company** | **Comments** |
| Qualcomm | The objectives as captured in the proposed WID are appropriate |
| Intel | RAN1 scope shall be kept simple and a minimum amount of changes recommended to be introduced. The DCI overhead for MCS indication should be kept unchanged comparing to Rel-15 and 5-bit MCS tables can be used. Similarly, same size 4-bit CQI tables can be used for 1024QAM. Ideally, LTE 1024QAM entries for MCS and CQI can be reused.DL 1024QAM is expected to be beneficial for both CPE and IAB use cases. Recommend to further discuss whether the requirements can be extended to IAB nodes. DL 1024QAM support can be defined as a per-band UE capability.The proposed Core part objectives can be modified as follows:

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| The objective is to specify downlink 1024QAM for NR PDSCH operation in FR1, together with related procedures, signalling and necessary RF requirements. The main objectives are:* Specify high order modulation for PDSCH [RAN1]
	+ Specify 1024QAM constellation as specified in E-UTRA for DL PDSCH
	+ Specify corresponding 5-bit MCS table with 1024QAM entries as defined in E-UTRA
		- Note: DCI overhead for MCS indication should be the same as in Rel-15
	+ Specify corresponding 4-bit CQI feedback with 1024QAM entries as defined in E-UTRA
* Specify corresponding RRC signalling and UE capabilities [RAN2]
	+ Note: DL PDSCH 1024QAM for FR1 should be defined as a per-band UE capability
* Specify corresponding BS, UE, and [IAB] RF requirements [RAN4]
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| MTK | Minimizing RAN1/RAN2 works is highly preferred.  |
| CMCC | OK with the objective, meanwhile, minimize RAN1/2 work should be considered. |
| Ericsson | In our view impact on RAN1/RAN2 should be minimal since LTE 1024QAM constellation and MCS/CQI table for 1024QAM will be reused. We agree with Intel that IAB (IAB-DU) RF requirements should be within the scope of the WI. In general Intel suggested updates are fine for us.Regarding the comments from Huawei, as we discussed in LTE 1024QAM, UE Rx EVM is challenging. The difference from LTE is we can assume the beam forming gain from BS side especially in mid-band, as we mentioned in draft WID (RP-201156) We expect the same SNR level is achieved as LTE 1024QAM. We also think 1024QAM with 3 or 4 layers may not happen so often especially in fading condition, but as we mentioned in the draft WID, the target is not only handset UE, but for the static links such as for fixed wireless access (FWA) links. |
| ZTE | As other companies comments, minimizing RAN1/RAN2 efforts should be considered.In addition, it’s not necessary to mention specific the number of bits for MCS and CQI in WID. |
| OPPO | It shall be clear on which UE types are targeting for RAN4 RF requirements definition, in the justification part it seems this 1024QAM is for static or very low mobility UEs, especially FWA, then this should be clarified in the Objective part.The frequency range targeting is also ambiguous, it seems <6GHz is targeting, this should also be clarified in objectives. |
| Samsung  | RAN1 scope shall be generic and leave RAN1 for detailed design for MCS and CQI. We are fine with the original wording in the WID. To Ericsson and Intel, whether to extend the scope to IAB shall be clearly specified in the WID.  |
| Huawei | We are not in favor to specify 1024QAM at the current stage.We are not sure if 1024QAM can provide the significant gain for most of cases in practical network, while we see the complexity, cost, and noticeable impacts on the implementation.For NR main stream band, the 4-layer on single carrier is mandatory. Combining 1024QAM with 4-layer transmission, the required SNR is very high especially in fading channel. Such SNR may be capped by UE Rx EVM and could not be achievable. For use case of 1024QAM with 2-layer, we are not sure if the achievable DL performance would be better than 256QAM with 3-layer or 4-layer. Thus we think that the use case of 1024QAM would be rare.It would be challenging for NR BS especially the wide area BS to ensure the perfect Tx EVM such that 1024QAM performance can be guaranteed, because BS needs transmit with relatively higher power, e.g., 53dBm@100MHz, compared to LTE BS. And such perfect Tx EVM seems over-demanding and very costly, which is only to ensure the good 1024QAM performance for a very small population of UEs which are near BS.It is also challenging for UE to ensure good Rx EVM to harvest the gain of 1024QAM. UE will do the link adaptation. UE may choose 256QAM with certain layers before choosing 1024QAM. So with link adaptation, most likely the use case of 1024QAM would be with 4-layer, which requires SNR which seems higher than 30dB. And such 30dB is just the SNR at transmitter side. Considering the beamforming gain, the received SNR at each Rx would be even higher, which means the Rx EVM should be around 0.02%. The demodulation performance of 1024QAM for NR is based on DMRS, for which we are not sure if the required SNR is similar to LTE or even higher than LTE. Maybe the required SNR would be even higher. From all the above aspects, the support of 1024QAM seems also demanding for UE to implement.The other aspect is that NR will use up to 100MHz channel bandwidth for a single CC in FR1. In such wider channel bandwidth supporting 1024QAM with higher layer would lead to higher power consumption for a UE especially when the RLM advanced receiver, which is specified in Rel-15, may be used. The increase of power consumption is not in linearly propotional to the increased channel bandwidth. In LTE 1024QAM is specified in a late stage for the scenario where UE is with less mobility and BS just covers the small area. We do not see the urgency to specify the 1024QAM at the current stage.Besides, we wonder if 1024QAM should be a RAN4-led WID? In LTE, RAN1 led the feasibility studies for 1024QAM where benefits/gains were evaluated.We would like to first address the above concerns before discussing the details for the WID objectives.The core part provided in draft WID is general. In our view, the BS power control dynamic, BS EVM and UE input level requirements should be specified. But before discussing the requirement, let us first agree on the need of 1024QAM. |
| Charter Communications, Inc. | The objectives as captured in the proposed WID are appropriate |

### Sub-topic 2-2: Performance WI objectives

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| **Company** | **Comments** |
| Qualcomm | The objectives as captured in the proposed WID are appropriate |
| Intel | The performance part needs to be extended to cover IAB nodes. |
| MTK | RAN4 may need to consider whether and how to jointly consider requirements for 8Rx (if agreed) and 1024QAM. |
| CMCC | OK with the objectives |
| Ericsson | We are fine with Intel suggestion to include BS RF and IAB-DU RF conformance tests. Regarding MTK comments, our preference is to use R16 as baseline which is 2Rx/4Rx. |
| ZTE | The proposed objectives are fine with us. |
| Huawei | See the comment for sub-topic 2-1.Before discussing the detailed objective for performance part, let us first agree on the need of 1024QAM. |
| Charter Communications, Inc | The objectives as captured in the proposed WID are appropriate |

### Sub-topic 2-3: Timeline e.g. TU per meeting

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| **Company** | **Comments** |
| Qualcomm | We expect the work to be straightforward since it is mostly “copy and paste” from LTE for the core part. A relatively small allocation like 0.25Tus for 2-3 meetings should suffice.For the performance part, the work should also be rather simple so an allocation between 0.25 and 0.5 Tus for 3-4 meetings should be enough. |
| Intel | The scope is quite limited and ~2-3 meetings for Core part and 2-3 meetings for Perf part with 0.25 - 0.5 TUs per meeting are needed in RAN4. Additional RAN1 TUs are required to handle the work and subject to further check with RAN1.  |
| MTK | RAN1 TU is required and should be minimized.Proposals from Qualcomm and Intel are OK to us. |
| CMCC | 1024QAM related requirements include EVM and RE power control dynamic range. Considering all those RF requirements for the other low modulation, e.g. 256QAM, 64QAM have been reused from LTE to NR specification. The same value may be reused with high probability. Hence, a relatively small TU is enough. |
| Ericsson | We agree relatively short allocation (e.g. 0.25 TU in core for 2-3 meetings), 0.25 TU over 2-3 meetings in RF performance, and 0.5 TU over 2-3 meetings for demodulation performance will be sufficient. |
| ZTE | We share similar views as Intel on the timeline |
| Huawei | See the comment for sub-topic 2-1.Before discussing the TU budget, let us first agree on the need of 1024QAM. |

### Sub-topic 2-4: Any other issue

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| **Company** | **Comments** |
| Intel | We are ok with the scope. However, technically speaking this should be a RAN1-led WI. Per prior discussion this item was not decided to be included in RAN1 Rel-17 package.  |
| Ericsson | Our preference is RAN1 starts from Q3/Q4 in 2020 and RAN4 can start next year in Q1. |
| ZTE | We also think this should be RAN1-lead WI instead of RAN4-lead WI, from RAN4 perspective, we might only need limited work for that. Reusing LTE 1024QAM requirements for NR 1024QAM. |
| Samsung | Not sure if RAN1 can complete the work before Q1 2021, RAN4 timeline shall be decided based on RAN1 schedule.  |
| Huawei | We agree with Intel. It should be a RAN1-led work item like what 3GPP did for LTE. |
| Charter Communications, Inc | We agree with Ericsson and time should be allotted to RAN1 before RAN4 starts their work |

## Summary of discussion

There is an overwhelming support from large number of companies for this WI in Rel-17 while one company does not see the gain of 1024QAM in FR1. As clarified by the proponent SNR comparable to LTE for which 1024QAM is specified is achievable in NR and as the target is for FWA with low speed/static links. One important feedback is to minimize the impact on RAN1 and RAN2. To this end there is suggestion to more explicitly state the RAN1/2 part. It is also suggested to focus on static or low mobility scenarios in FR1. It is also raised if joint 1024QAM + Rx can be considered in this WI. However, since 8Rx is not yet specified so the baseline can be 2Rx/4Rx. It is also suggested to include RF requirements for IAB-DU. It is also pointed out that core work in RAN1/RAN2 and RAN4, since is based on reusing from LTE 1024 QAM, will be relatively straight forward.

Based on the above feedback it is recommended to update the core and performance objectives. In terms of timeline it is suggested to have 0.25 TU per meeting over 2 quarters for RAN1/RAN2, 0.25 TU per meeting over 2 quarters for RAN4 RF core part, 0.5 TU per meeting for RAN4 UE demodulation performance part (2 quarters) and 0.5 TU per meeting for BS RF conformance tests (2 quarters).

# Work area #3: UE EMC

## Draft WID

During the RAN4#96-e UE EMC discussion, a WF R4-2012575 on UE EMC requirements extension have been agreed. It is proposed a new Rel-17 WID to work on this specific topic to clarify the UE EMC requirements for UEs with different features. Also current UE EMC test configuration is not clear as no specification can be found with certain information. So the WID will also include the test configuration accomplishment. With the above, we believe the UE EMC can be enhanced.

The WID is proposed after RAN4#96-e as [RP-20XXXX - New WID on UE EMC enhancement.doc](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_89e/Inbox/Drafts/BS%20EMC%20%26%201024QAM/RP-20XXXX%20-%20New%20WID%20on%20UE%20EMC%20enhancement.doc)

## Issues related to UE EMC for discussion

* Sub-topic 1-1: Core WI objectives
* Sub-topic 1-2: Performance WI objectives
* Sub-topic 1-3: Timeline e.g. TU per meeting
* Sub-topic 1-4: Any other issue

## Companies’ views

*Interested companies to provide comments on the sub-topics in the following sections*

### Sub-topic 3-1: Core WI objectives

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| **Company** | **Comments** |
| Ericsson | The proposed goals are OK. However, it would be important to clarify the points where the WID will lead to definition or specification the new features/levels/procedures. |
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### Sub-topic 3-2: Performance WI objectives

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| **Company** | **Comments** |
| Ericsson | The proposed goals seem reasonable.  |
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### Sub-topic 3-3: Timeline e.g. TU per meeting

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| **Company** | **Comments** |
| Ericsson | The proposal does not include a timeline which makes difficult to identify the potential time allocation. |
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### Sub-topic 3-4: Any other issue

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| **Company** | **Comments** |
| Ericsson | We believe this is a good starting point for the UE discussion. It would be important also to clarify if there would be any potential impact on the BS. |
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## Summary of discussion

The UE EMC was not part of the original work area (BS EMC and DL 1024 QAM FR1). However, there is some interest to start also a Rel-17 WI on UE EMC requirements and has also received positive response. Since this was included in the summary document at very late stage therefore it is recommended to further discuss contents of WI on UE EMC requirements at the RAN.