[94e-11-R18-DSS] - Version 0.0.5
RAN

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Agenda Item: 8A.1

Source: Ericsson

Title: Moderator's summary of discussion [94e-11-R18-DSS]

Document for: Information

1 Introduction

This contribution is the moderator summary of the discussion of the potential Rel-18 work item scope for the Dynamic Spectrum Sharing (DSS). It is a continuation of the discussion that took place in October where the moderator's summary can be found in RP-212682[1] and a draft WID proposal in RP-212730[2].

The goal of the discussion is to discuss and provide the final scope of this work item. The discussion on whether to include a DSS WID in the Rel-18 work is part of the discussion led by the chairman and is not included here.

Please avoid any input like "We support / we do not support" without giving additional justification and motivation as this is not a "number counting" driven discussion. Instead justify your view with strong technical arguments and/or tangible commercial interests (near & longer terms).

The input documents to the discussion are listed in the reference section.

2 Initial Round

2.1 Updated draft WID

The draft WID from the October discussion has been updated according to the chairman's instruction with rapporteur names and the proposed updates to the WID objective given in RP-213469[3]:

- Investigate the performance, and enabling LTE CRS to puncture NR PDCCH and how to interact with DMRS if there is the performance gain from the additional PDCCH resources.
- Specify necessary, if any, UE performance requirements for improvement of NR spectrum efficiency for LTE-NR co-existence
    - Specify necessary UE demodulation performance requirements (RAN4)

The draft WID can be found in the RAN#94-e drafts inbox:

https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_94e/Inbox/Drafts/%5B94e-11-R18-DSS%5D/Initial%20Phase/RP-21xxxx_WID_DSS.docx

Also, the RAN4 performance objective has been updated to clarify that it is related to the core objectives.

Companies can provide input on the justification and the objectives in the feedback form.

Feedback Form 1: Views on the justification and objectives of the draft DSS WID

1 – Classon Consulting

for FUTUREWEI This item was approved in the package with very limited TU, which match well the objectives in the draft WID. This discussion should NOT be taken as an invitation to double or triple the size of the WID. We do not support adding any additional objectives. If there is consensus that the objective in the current WID should be REPLACED with a different objective, we can consider it, but so far no other objective seems to have more support than the one currently included.

Some additional notes should probably be added to help guide the study.

2 – CMDI

Based on the guidance from RP-213469 that for each project should try to avoid ”generic enhancement”-like scope, here the objective is saying ”investigate the performance.....”, ”how to interact with DMRS”, which make the objective quite vague. Here seems to assume that LTE and NR are full overlappled over each other, which is only unvoidable in very narrow carrier bandwidth, e.g., 5MHz, considering the frequency sharing scenario, however, if the the bandwidth is 10MHz or 20MHz, and when the LTE usage is low, why we have to configure the LTE span the whole 10MHz or 20MHz? in this case, we can limit the LTE carrier to 5MHz and NR span 20MHz with appropriate CORESET and search space configuration, this case should also be taken into account in the comparison. In addition, considering we have already introduce multiple solutions for PDCCH capacity enhancement, including Scell scheduling Pcell, and the sing DCI scheduling in this release, we do not see strong motivation to introduce this new mechanism to complicate the UE implementation due to rare use case.

However, as part of the package, we think the scope should be refined without introducing any new DMRS pattern as below:

~~Investigate the performance~~,Study the PDCCH capacity gain, and if needed, enable~~ing LTE CRS to~~ NR PDCCH puncturing for co-lacated LTE CRS collision, ~~and how to interact with DMRS if there is the performance gain from the additional PDCCH resources.~~

3 – Guangdong OPPO Mobile Telecom.

We are generally fine with the objectives of draft DSS WID. However, it seems missed which group is responsible for the 1st bullet, we think both RAN1 and RAN2 are required to investigate the 1st bullet. If the performance gain is confirmed, then it is necessary for RAN2 to investigate NR signaling to configure LTE CRS pattern that is applicable to NR PDCCH. So we suggest to clarify the 1st bullet more:

− Investigate the performance, and enabling LTE CRS to puncture NR PDCCH and how to interact with DMRS if there is the performance gain from the additional PDCCH resources.[RAN1, RAN2]

- Investigate NR signaling to configure LTE CRS pattern that is applicable to NR PDCCH [RAN2]

4 – Huawei Tech.(UK) Co.. Ltd

It should be clarified in the justification section that the baseline for comparison is where NR PDCCH is within the first three OFDM symbols of a slot (FG 3-1), otherwise Rel-15 FG 3-5b is another baseline that would allow placing NR PDCCH in later symbols without LTE CRS where only NR PDSCH needs rate-matching. Our understanding of the intent is not to specify NR PDCCH reception in symbols with LTE CRS REs outside the first 3 symbols of an NR slot.

We therefore propose the following clarification for the justification section:

NR PDCCH would be a bottleneck of DSS and the situation will become worse with NR traffic increasing, because the current specification cannot allow more than one NR PDCCH symbols in cells with four LTE CRS ports ***for a NR UE monitoring NR PDCCH according to FG 3-1****. To maximize the resource utilization and increase the PDCCH capacity for DSS, it would be beneficial to allow NR PDCCH reception in symbols overlapping with LTE CRS.*

5 – vivo Communication Technology

We are fine with the updates as well as HW's clarification.

6 – QUALCOMM JAPAN LLC.

We are OK with the current justification and objectives.

We consider that the performance benefit and the specification/implementation impact would highly depend on the detailed design options and hence, WG discussions are necessary. The current objective allows some level of design flexibility without broadening the scope.

7 – Samsung Electronics Co.

- We are fine with this updated draft WID. We share the above Futurewei's view.
- Also fine with above Huawei's clarification.

8 – LG Electronics Inc.

We are fine with the updated draft WID (and Huawei's clarification).

9 – Nokia France

Nokia: we are fine with the updated draft WID and with Huawei's clarification. In view of the magnitude of the overall Rel-18 package and the importance of managing the workload in RAN, we do not support adding any further objectives.

2.2 Discussion points from input contributions

In this section, the various proposals from the input contributions in [4], [5], [6] and [7] are up for discussing

2.2.1 Collision handling between NR PDCCH and LTE PCFICH / PHICH channels

In [4], RP-212911 from Intel, it is proposed to add the following to the objective on NR PDCCH reception in symbols with LTE CRS:

- Study and if needed specify NR PDCCH reception in symbols with LTE CRS REs
    - Investigate the performance, and enable LTE CRS to puncture NR PDCCH and DMRS if there is the performance gain from the additional PDCCH resources.
    - Investigate necessity for collision handling between NR PDCCH and LTE PCFICH / PHICH channels

Companies can provide input on adding collision handling to the objective on NR PDCCH reception in symbols with LTE CRS REs.

Feedback Form 2: Views on including collision handling between NR PDCCH and LTE PCFICH / PHICH channels to the objective of the DSS work item.

1 – Apple GmbH

In general, we are not supportive of NR PDCCH/DMRS to rate match LTE CRS

In Rel-15, we do have FG3-2, i.e., NR PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot, in order for NR PDCCH to avoid LTE CRS.

In Rel-17, we further enhance the DSS by allowing cross carrier scheduling for SpCell as well. Cross carrier scheduling is supported for SCell in Rel-15/16

Furthermore, even for PDSCH, we do not support PDSCH DMRS to rate match LTE CRS at the RE level, instead, we perform DMRS symbol shift. The issue is that if we perform DMRS rate match LTE CRS, UE has to support handling of non-uniform DMRS processing. For PDCCH, DMRS is in every symbol and we cannot do symbol shift.

Lastly, before RRC connection set up, there is no way that UE can be mandated to support the PDCCH RE level rate match LTE CRS. Also, for the CSS such as Type 0/0A/1/2, it is typically cell specific and it is not possible to do RE level rate match.

Overall, we really doubt there would be any need in real deployment for NR PDCCH to rate match LTE CRS at RE level.

2 – Ericsson LM

Handling of overlap with LTE PCFICH, PHICH is transparent in NR specs unlike CRS for which an explicit restriction on NR PDCCH is currently specified that we are proposing to remove. Given this, we do not see a strong need for additional specification of collision handling wrt. these channels.

3 – Classon Consulting

for FUTUREWEI We do not support this objective.

4 – CMDI

Support no new objectives.

5 – Beijing Xiaomi Electronics

Unlike CRS, PHICH/PCFICH is transmitted in a dynamic manner and is transparent for NR UE. Furthermore, both PHICH and PCFICH are transmitted on the first OFDM symbol in a slot. It seems no big problem to avoid the collision by implementation. We don't see strong motivation of considering the collision between LTE PHICH/PCFICH and NR PDCCH.

6 – MediaTek Inc.

CRS is transmitted on fix RE locations in all RBs and subframes, while RE locations of PCFICH and PHICH depend on some further parameters (like phich-Resource in MIB). In our view, we should firstly work on CRS of which the degradation has been well observed in real network and is relatively easier to be handled.

Regarding PCFICH and PHICH, we do not see them as very urgent to be included at this WID. The motivation is not justified. We also doubt whether this further scope extension is feasible according to the current TU allocation. Perhaps they are better to be considered as some next step after CRS.

7 – Intel Corporation (UK) Ltd

We support to have RAN1 discussion on the proposed aspect of collision handling between NR PDCCH and LTE PCFICH and PHICH that may have some impact on the expected gains. We are also OK to consider it with the second priority if TU is limited.

8 – Guangdong OPPO Mobile Telecom.

Handling of overlap with LTE PCFICH/PHICH is transparent in NR specs. So we do not see a strong reason to specify it.

9 – Huawei Tech.(UK) Co.. Ltd

LTE PCFICH and PHICH are essential to legacy LTE UEs, so NR PDCCH and its DMRS should be punctured by the BS in any RE where it collides with co-located LTE PCFICH/PHICH, even if the UE is not aware of it (contrary to the UE being aware of rate-matching around LTE CRS REs). It is the only possible solution and should be the assumption for the evaluation of performance gain.

Therefore, a suggestion for changes (on top of RP-21xxxx*WID*DSS.DOCX) is

- Investigate enabling LTE CRS/**PCFICH/PHICH** to puncture NR PDCCH and how to interact with **NR PDCCH** DMRS if there is any performance gain from the additional PDCCH resources.

Additionally, the scope should be clarified that the symbol location of NR PDCCH is at the first three OFDM symbol of a slot, as commented on the justification section. Therefore, a suggestion for changes is

- Study and if needed specify NR PDCCH reception in symbols with LTE CRS REs **within the first 3 symbols of an NR slot**. [RAN1]

10 – China Telecomunication Corp.

Given the discussion on the "Collision handling between NR PDCCH and LTE PCFICH / PHICH channels" here, it looks we need to first clarify the target scenario for NR PDCCH puncturing over CRS. Our original understanding is that:

- The study of NR PDCCH puncturing over LTE CRS is only focusing on the scenario with 4 CRS ports, but not applied to 2 CRS ports, and,
- LTE PDCCH/PCFIC/PHICH is only transmitted in the 1st OFDM symbol, NR PDCCH (for Rel-18 UE supporting the PDCCH puncturing) can be transmitted from the 2nd OFDM symbol.

But now it seems companies have different understanding on the target scenario. So, we need to first clarify the target scenario for the study on PDCCH puncturing over CRS.

11 – vivo Communication Technology We don't think it is necessary to handle the collision between NR PDCCH and LTE PCFICH/PHICH. Unlike the CRS, the PCFICH/PHICH is not always-on signal, thus the collision can be handled by network scheduler.
12 – QUALCOMM JAPAN LLC. We do not think this is essential. Typically, LTE PCFICH/PHICH are transmitted on OFDM symbol #0 of a subframe. Network can avoid the collision by either (1) configuring NR-PDCCH reception not on the symbol #0 of a slot, or (2) not transmitting LTE PCFICH/PHICH or NR-PDCCH on the colliding REs in transparent manner when/if collision would occur. Specification support for collision handling between NR PDCCH and LTE PCFICH/PHICH would require (non-trivial) extra work/discussion on the need/benefit and design impact. Considering the limited TUs and the expected work load, we consider this is not part of the objective.
13 – Samsung Electronics Co. We don't see the need for inclusion of collision handling between NR PDCCH and LTE PCFICH / PHICH. Like other's comments, NR spec does not have explicit restriction over LTE PCFICH/PHICH.
14 – ZTE Corporation We also think it is unnecessary to let both RAN4 and RAN1 involve the simulation. Perhaps, RAN4 can define the requirement first, then RAN1 can do simulation and check if some enhancements are needed.
15 – ZTE Corporation Sorry I post my comment in wrong place, please ignore the above comment.
16 – LG Electronics Inc. We have similar view with other companies. We don't see the need to include handling for PCFICH/PHICH which is transmitted/determined in dynamic manner.
17 – CATT We do not think it is necessary to include collision handling between NR PDCCH and LTE PCFICH / PHICH as commented by other companies.
18 – Nokia France Nokia: We agree with the comment from Qualcomm.

2.2.2 Dynamic indication of CRS rate matching

This objective was also discussed in the previous rounds of scope discussions.

In [4], RP-212911 from Intel, it is proposed to add the following objective:

- Study and if needed specify dynamic indication of CRS rate matching

In [5], RP-212946 from Ericsson, it is proposed to add the following objective:

- Support DCI based dynamic adaptation of rate-matching around LTE CRS pattern (s)
  - Current CRS rate matching specifications and already existing DCI fields should be reused when viable

Companies can provide input on adding this objective to the scope of the DSS work item including:

- Should the objective of Dynamic indication of CRS rate matching be added
- Is a study phase needed for this objective?

Feedback Form 3: Views on including dynamic indication of CRS rate matching to the scope of the DSS work item.

1 – Apple GmbH Do do not see the need for this objective LTE CRS configuration is semi-static. Even for power saving purpose, NW has some proprietary LTE CRS muting techniques, e.g., when the cell is idle, the decision is semi-static too. We do not see why we need a DCI to change CRS rate matching pattern. DCI is only needed is NW changes the decision on the order of ms or we need some low latency on the order of ms, which does not seem to be justifiable in the field
2 – Ericsson LM To increase the flexibility of DSS for potential future enhancements, dynamic CRS rate-matching pattern switching via DCI should be supported. DCI based switching at symbol/RB level is already supported in the specs, and the existing mechanism can be reused for CRS rate-matching with minor spec changes (example TPs illustrating spec impact shown in RP-212946). As discussed earlier (e.g., RP-212420), in common deployments, the level of CRS interference and the strongest interferer itself (i.e., v-shift) can change. Without DCI-based switching, frequent RRC signaling to turn on/off rate-matching and/or to match the pattern of strongest interferer is needed, which is undesirable. As for measurements to determine the adaptation, gNB can use the L1/L3 measurements in existing specifications. We prefer to not have a study phase for the objective. The framework for DCI based switching is already present in the specs which can be reused, and additional study on the solutions is not needed.
3 – Classon Consulting for FUTUREWEI We do not support this objective.

4 – CMDI

This objective seems to relate nothing to do with DSS, but maily for interference cancellation, which should not be considered in this project.

5 – Beijing Xiaomi Electronics

we don't support the proposed objective. We share the same views with Apple, CRS is a cell-specific reference and can be semi-statically configured via RRC signaling for NR UE. There is no need to dynamically indicate the CRS pattern.

6 – ZTE Corporation

The feasibility seems not clear compared with semi-statically configured CRS rate matching pattern selection considering how gNB could know the best CRS RM pattern in a timely way. Hence, we think it is reasonable to focus on semi-static CRS rate matching.

7 – AT&T

Agree with Ericsson. This feature seems to provide a lot of utility with very limited specification impact. For the same reason, a study should not be necessary, as the specification impact is apparent. The use cases should also be well understood, however, we acknowledge some companies seem not convinced. Nevertheless, as operator, we see this feature as highly relevant to future deployments, and especially given the small specification impact, we think there is no reason to exclude this objective. 3GPP often spends significant time and effort on features that never see the light of day. DSS has a very strong history of being deployed word wide, so its enhancements should be of high priority to the ecosystem, esp. when the specification effort is so limited and isolated.

8 – MediaTek Inc.

A clarification on the issue itself. As the intention is to use DCI for dynamic rate-matching, we believe that the rate-matching is for PDSCH reception, rather than PDCCH. This part is not very clear from the problem formulation.

With above understanding, we support to introduce dynamic indication of CRS rate matching. We are fine to drop the study phase. The benefit over RRC based solution is very clear to us. It reduces the frequent RRC re-configuration overhead. Some companies mentioned that CRS are semi-statically configured. However, UE location and signal strength from serving and interference cells can change more frequently. Network can request UE to report some L3 measurement results to help network make the decision on whether to enable the rate-matching and which rate-matching pattern(s) should be used. The spec impact are very limited in our view. Some legacy rate-matching patterns can be directly re-used. The enhancement can be done within current TU assumption.

9 – Intel Corporation (UK) Ltd

We support the dynamic indication of CRS rate matching objective be added to the WI. This is beneficial to also support dynamic adaptation scheme in addition to already existing semi-static signalling scheme.

10 – Guangdong OPPO Mobile Telecom.

We do not see the need for this objective. Firstly, it is an inter-cell interference issue not DSS specific issue. Comparing with interference from PDSCH, CRS interference may not be a key issue, especially for high load case. Secondly, it is not clear how gNB knows the strongest CRS interference pattern in UE side,

if gNB can not know the strongest CRS interference pattern exactly, the gain from dynamic indication of CRS pattern can not be guaranteed.

11 – Huawei Tech.(UK) Co.. Ltd

According to the previous discussions, this objective has never been justified by any potential gain within a reasonable scenario. Especially, from feasibility perspective, it is unclear how a gNB can have dynamic assessment of CRS interference for a UE to enable this dynamic rate-matching around CRS without UE reporting of CRS interference measurement.

12 – SoftBank Corp.

We are supportive to include this scope. Increase of DSS performance is one of the most important aspects.

13 – China Telecomunication Corp.

We understand the issue with semi-static RRC indication, and the motivation of dynamic (or faster) indication of interfering CRS RM pattern, considering the UE movement in practical. But we would still like to know how could gNB know the best CRS RM pattern in a timely way? e.g., by L1 or L3 neighboring cell measurement, by inter-RAT LTE measurement or NR measurement? Also, the overhead or system impact due to the L1/3 measurement, as well as the overall benefits over the Rel-17 CRS-IM need to be studied.

Adding this objective is ok for us, but a study should be needed at first.

14 – QUALCOMM JAPAN LLC.

We think the objective from RP-212946 can be added with a minimal work load.

15 – vivo Communication Technology

It is not clear from the question on whether this dynamic CRS rate matching is only for PDSCH only, or for both PDSCH and PDCCH. In the former case, it is not clear why only the PDSCH is concerned if the strongest CRS is changed. In the later case, it is not clear how this dynamic CRS rate matching is applied to PDCCH and can be done within the current TU assignment.

16 – Telstra Corporation Limited

We support Ericsson proposal and strongly agree with AT&T's position. DSS is being deployed today and will remain active for many years, particularly for sub-1GHz deployments. Given the low expected TU cost & limited specification impact we think it appropriate to move directly to the normative phase.

17 – Samsung Electronics Co.

Not support.

We understand current objective of draft WID is outcome of repeated and non-converged discussion so far.

18 – Telia Company AB

We agree with Ericsson, AT&T, SoftBank and Telstra on the position to include DCI based dynamic adaptation of rate-matching around LTE CRS pattern(s) as part of Release 18 DSS work item. Practical DSS performance evolution is required by many operators currently rolling out DSS features from earlier releases as pointed out by AT&T. Also the TU amount seems reasonable compared to DSS performance gains achieved (RP-212420) and CR implementation could be quite straightforward as in the example CR in annex A of RP-212946.

19 – Deutsche Telekom AG

This seems to be the most interesting and relevant enhancement for DSS.

In general the objectives need to be narrowed-down to those which provide immediate benefits for DSS performance.

20 – LG Electronics Inc.

We have similar view with other companies.

We don't see the need to have dynamic indication for handling of CRS which is transmitted/determined in semi-static manner.

21 – TELECOM ITALIA S.p.A.

Some view as expressed by several operators. This is important to improve DSS and therefore it should be included (and no need for a study phase)

22 – Orange

We support E/// proposal. LTE CRS intereference is a serious issue with DSS, and the current Rel-16 mechanisms to provide rate-matching around neighbour cells is not dynamic enough. If activated when not required, this generates a high signaling overhead. We see a DCI-based dynamic activation, with activation "only when needed", as the right approach to make rate-matching around neigbour cells a deployable feature.

23 – CATT

We do not see the need to support dynamic indication of CRS rate matching.

24 – Nokia France

We agree with the comment from Samsung. While recognising very much the importance of DSS, we need to be transparent there is no point in specifying complicated "enhancements" that do not bring gain in real deployments. It is still clear that L3 measurements, which are the only relevant information available to the gNB, are not sufficiently dynamic to give any advantage from dynamic CRS RM compared to the existing specifications.

25 – VODAFONE Group Plc

We support the views expressed by AT&T and Orange.

26 – Verizon UK Ltd

Agree with Ericsson, AT&T and other operators that this is a useful feature to have, if feasible.

27 – TELENOR ASA

We agree with Ericsson, and several operator colleagues that we should include DCI based dynamic adaptation of rate-matching around LTE CRS pattern(s) as part of Release 18 DSS work item. As specification work seems quite straight forward, there is no need for study phase.

2.2.3 Need for study for NR PDCCH reception in symbols overlapping with LTE CRS

In [5], RP-212946 from Ericsson, it is proposed to skip the study and go directly for specifying this feature:

- ~~Study and if needed specify~~ Support NR PDCCH reception in symbols with LTE CRS REs.
  - ~~Investigate the performance, and enable LTE CRS to puncture NR PDCCH and DMRS if there is the performance gain from the additional PDCCH resources.~~
  - Note: The UE is not required to rate-match NR PDCCH and corresponding DMRS around LTE CRS for this objective

In [6], RP-213205 from CMCC, it is proposed to only do the study first and leave for further discussion if any normative work should be included in Rel-18:

- Study ~~and if needed specify~~ NR PDCCH reception in symbols with LTE CRS REs.
  - Investigate if there is performance gain by enabling ~~the performance, and enable~~ LTE CRS to puncture NR PDCCH and DMRS ~~if there is the performance gain from the additional PDCCH resources~~.

Companies can provide input on whether the study should be removed or if there should only be a study for this objective.

Feedback Form 4: Views on the need for study for NR PDCCH reception in symbols overlapping with LTE CRS.

1 – Apple GmbH At least, study is needed. Regarding the proposal from Ericsson in RP-212946. We have two questions 1. First of all, if it is supported, it is UE optional feature. The CR should not be to remove an existing paragraph in the current specification as proposed in the contribution, otherwise, it is NBC. 2. Secondly, since there is no rate matching, what about the UE PDCCH demod performance, i.e., how UE handles interference from LTE CRS? Is this objective RAN4 oriented, like CRS-IC currently discussed in RAN4?
2 – Ericsson LM First we would like to respond to Apple's questions above: 1. yes, (of course) the change should be backwards-compatible since previous release UEs will continue to have the restriction 2. LTE CRS will puncture the NR PDCCH which leads to some performance degradation, however, as we have shown in RP-212946 (Annex B2), the gain outperforms the degradation.
3 – Ericsson LM On the "need for study", we do not believe a study phase is necessary. Specification work is very limited (example TPs illustrating spec impact shown in our contribution RP-212946) and expected performance benefits are clear (more resources opened up for sending NR PDCCH).

4 – Classon Consulting

for FUTUREWEI Study is necessary

The study should consider reasonably typical DSS bands and antenna configurations.

The study should consider the presence of ”legacy” DSS UEs.

The study should consider relevant prior release features.

5 – CMDI

Study is necessary. It is proposed to make the objective clearer.

~~Investigate the performance~~,Study the PDCCH capacity gain, and if needed, enable~~ing LTE CRS to~~ NR PDCCH puncturing for co-lacated LTE CRS collision, ~~and how to interact with DMRS if there is the performance gain from the additional PDCCH resources.~~

6 – ZTE Corporation

We also think study is needed since the benefit should be verified first.

7 – AT&T

NR PDCCH capacity is one of the most pressing issues in real world deployments. The Rel. 15 FG 3-2, referenced by Apple, has not been widely adopted. Rel. 15 NR PDSCH rate matching, on the other hand, has been globally deployed and made DSS the global success story it is. Given that global success of DSS, and the serious need for NR PDCCH capacity, irrespective of CA, we don’t see the benefit of a study phase. The benefits are clear, and 3GPP should commence with normative work from the onset.

8 – Intel Corporation (UK) Ltd

We support Ericsson proposal in [5] to skip study phase and directly start normative work.

9 – Guangdong OPPO Mobile Telecom.

Study is necessary. However, considering some companies prefer to specify it directly. We could compromise to the objectives of draft DSS WID and involve RAN2 to investigate signaling.

10 – MediaTek Inc.

We are fine to skip the study, but the UE bahavior from the note in RP-212946 from Ericsson is not very clear to us. We suggest to add the following modifications

- Note: The UE is not required to rate-match NR PDCCH and corresponding DMRS around LTE CRS and not required to implement interference handling on LTE CRS for this objective.

The intention of this modification is to avoid mandating complicated UE implementation for interference handling in PDCCH (but still allowed). Different from PDSCH, the benefit of extra effort on interference handling cannot be directly observed from the end-user throughput. We want to avoid the case that UE burns out all its power in decoding PDCCH but never detects a single DL/UL grant.

11 – Huawei Tech.(UK) Co.. Ltd

A study cannot be skipped for the following reasons:

- LTE CRS REs will also puncture the PDCCH DMRS, so it is not obvious that sufficiently good PDCCH BLER can be achieved even with a large aggregation level. In this sense, a study is needed first.
- As discussed above, NR PDCCH and DMRS are also punctured by LTE PCFICH/PHICH, resulting in PDCCH BLER degradation. In a typical DSS scenario with 10MHz bandwidth, the LTE overhead at the first symbol is 4*50 (50 PRB)+4*4 (PCFICH) +4*37* (7 PHICH group)=300 REs, i.e. a 50% overhead. Such performance degradation has to be evaluated first.
- Any increase of UE complexity is expected to be modest and needs justification with evaluated gains.

12 – SoftBank Corp.

We support the view by Ericsson, and we are OK to skip the study phase.

13 – China Telecomunication Corp.

We think a WI with study phase is a good compromise among different proposals. The following should be considered in the study:

1) Clarify that the study of NR PDCCH puncturing over LTE CRS is only focusing on the scenario with 4 CRS ports, and it is not applied to the scenario of 2 LTE CRS ports.

2) Consider there are "legacy" DSS UEs not supporting the Rel-18 PDCCH puncturing feature. In such case, LTE PDCCH is transmitted in 1st OFDM symbol, NR PDCCH for Rel-18 DSS UE supporting PDCCH puncturing is transmitted from the 2nd OFDM symbol, then what should be the assumption on the OFDM symbol for NR PDCCH for "legacy" DSS UE (Rel-15 to Rel-17 DSS UE) not supporting PDCCH puncturing over CRS?

14 – vivo Communication Technology

The study phase is needed to evaluate the performance impacts due to puncturing, as well as any potential solutions.

15 – Samsung Electronics Co.

Keep study phase.

16 – QUALCOMM JAPAN LLC.

We are OK to have the study as per the current WID objective. Performance benefits with reasonable complexity/specificat impact should anyway be demonstrated under target scenarios.

17 – Telia Company AB

We agree with Ericsson, AT&T, Intel and SoftBank views to skip the study phase and go directly to normative work as gains have been shown in Annex B2 (RP-212946) and specification work and impact seems small based on our understanding (Annex B1 of RP-212946).

18 – LG Electronics Inc.

We also think study phase is necessary to verify scenarios and performance benefits.

19 – TELECOM ITALIA S.p.A.

ok to skip the study phase

20 – Nokia France As the main benefit is increasing NR PDCCH capacity, we do not see that a study is necessary, but we are OK either way.
21 – VODAFONE Group Plc In line with the views expressed by several other operators, we support this objective. Considering the gains have been shown and the spec impact is small, it seems ok to skip the study phase.
22 – Verizon UK Ltd Support skipping the study phase. It is relatively clear already so time can be better used for specification work.
23 – TELENOR ASA We share the views expressed by several operator colleagues. We agree on the objective and are fine with skipping the study phase.

2.2.4 Specify two overlapping CRS patterns

In [7], RP-213392 from ZTE and China Telecom, it is proposed to add the following objective to the scope of the work item:

- Specify two overlapping CRS patterns (still semi-statically configured) in the cases without configuring multi-DCI based MTRP

Companies can provide input on adding this objective to the scope to the DSS work item.

Feedback Form 5: Views on including to the scope of the DSS work item to specify configuring semi-statically two overlapping CRS patterns

1 – Apple GmbH We might be more open for this, which can be used to handle infra-frequency multi-cell CRS interference cancellation as being discussed in RAN4, i.e., NW to provide CRS assistance information of the neighboring cell for UE at the coverage boundary
2 – Ericsson LM Dynamic switching between semi-statically configured RM patterns provides potential for more throughput enhancement on NR side. It should be possible to configure two overlapping CRS patterns even in the cases without configuring multi-DCI based MTRP.
3 – CMDI Considering the limited TU for the project, it should not be pursued in this project.

4 – Beijing Xiaomi Electronics

We are open on this point. It can provide more concrete information on the neighbor cells with respect to interference, which may be beneficial to the overall performance.

5 – ZTE Corporation

Support this enhancement. There is no need to extend TU for this proposal as the existing Rel-16 two CRS pattern lists can be reused and only very minor specification effort is expected.

Based on the current RAN1/2 specification, support of two CRS rate matching patterns overlapping in frequency is feasible only if PDSCH transmission scheme is multi-DCI based MTRP. However, in the ongoing RAN4 WI discussion, two CRS rate matching patterns are assumed no matter multi-DCI based MTRP is configured or not. Technically, for cell edge UEs regardless of PDSCH transmission scheme, two CRS patterns should be supported to avoid serious interference from two LTE cells.

6 – Intel Corporation (UK) Ltd

We are open to the proposal in [7] to relax the existing restrictions for overlapping CRS configuration. The study phase seems needed to understand benefits of the propose scheme (RAN4 baseline) to the rate matching scheme around whole OFDM symbol with CRS. The available TU should be also considered.

7 – Guangdong OPPO Mobile Telecom.

Similar as dynamic indication of CRS pattern, the issue is an inter-cell issue, not DSS specific issue. Comparing with interference from PDSCH, CRS interference may not be a key issue, especially for high load case. Taking limited TU for this item into account, we do not want to add more objectives.

8 – MediaTek Inc.

We are supportive to this issue. The scenario is already justified because it is the same as one of the scenarios considered in RAN4. The extra effort seems to be small and it can be jointly considered with dynamic rate-matching mechanism.

9 – Huawei Tech.(UK) Co.. Ltd

Rel-17 CRS-IC has been specified especially for this target scenario and has higher PDSCH throughput than the proposal. It is not clear what potential gain could be achieved on top of Rel-17 CRS-IC. We prefer to avoid multiple options specified for the same target scenario.

10 – SoftBank Corp.

We are open for this enhancement. This functionality would be useful at the cell boundary.

11 – China Telecomunication Corp.

We support this objective.

As explained in RP-213392, the 2 CRS-RM pattern scheme has already been considered in Rel-17 evaluation for CRS interference handling in the scenario of single TRP, and this objective is just to enable something we thought it was already supported.

Moreover, the spec impact is very minor, and no additional TU is needed for this objective.

12 – vivo Communication Technology Similar to 2.2.2, it is not clear from the question on whether it is for PDSCH only, or for both PDSCH and PDCCH. In the former case, it seems that the Rel-17 CRS-IC is targeting the same scenario. In the later case, we are not sure if it can bring the gain considering this double-CRS overhead.
13 – Samsung Electronics Co. For clarification, what would be the relation with ongoing RAN4 WI?
14 – ZTE Corporation To vivo, this is for only PDSCH. We agree this is targeting for the similar scenario as Rel-17 CRS-IM. The motivation is to avoid serious interference from serving LTE cell and one neighbor LTE cell if UE doesn't support Rel-17 smart receiver. To Samsung, one evaluation assumption of RAN4 WI is also support of two CRS patterns. But RAN4 has agreed there will not be RAN1 impact at begining. That is, RAN4 will not specify two CRS patterns overlapping in frequency for PDSCH rate matching.
15 – TELECOM ITALIA S.p.A. Same view as Softbank
16 – LG Electronics Inc. We think it is better not to add something beyond the draft WID in Section 2.1, considering the limited TUs. From DSS perspective, we don't see the necessary of this feature which seems related to general CRS interference handling.
17 – VODAFONE Group Plc Same view as Softbank.
18 – Nokia France This is already supported in the Rel-16 specs via Feature Group 14-1a with *overlapRateMatchingEUTRA-CRS-r16*, so nothing needs to be added.
19 – Verizon UK Ltd Open to this, same view with other operators.

2.3 Conclusion Initial Round

Based on the discussion in the initial round, the following conclusions are made:

Updated draft WID:

It is proposed to add the following:

- Add RAN2 signaling specification as a separate subbullet and RAN2 as secondary group

- Add Huawei's update to the justification, but instead of referring to the feature group it is proposed to spell it out:

  NR PDCCH would be a bottleneck of DSS and the situation will become worse with NR traffic increasing, because the current specification cannot allow more than one NR PDCCH symbols within the first 3 symbols of a slot in cells with four LTE CRS ports

Collision handling between NR PDCCH and LTE PCFICH / PHICH channels

This proposal received little support. Hence it is proposed not to pursuit further discussion.

Conclusion:

- No further discussion on collision handling between NR PDCCH and LTE PCFICH / PHICH channels

Dynamic indication of CRS rate matching

A majority of the companies giving input, support including this objective with most seeing no need for a study. Given this majority, which included strong operator support, it is proposed to continue the discussion in the intermediate round to allow the proponents to address the concerns. Therefore, the proponents are encouraged to address the issues raised by companies at the start of the intermediate round.

Conclusion:

- Continue discussion in the intermediate round

Need for study for NR PDCCH reception in symbols overlapping with LTE CRS

Companies are equally split between the need for a study for this. The moderator proposes to stick with the original proposal of a study as in the draft WID.

Conclusion:

- Keep the objective as in the draft WID

Specify two overlapping CRS patterns

A majority of companies are open for this enhancements. Concerns raised was the workload, the relation to the Rel-17 RAN4 CRS-IC study and whether this is supported in the specifications already. Further discussions to where the proponents should address the concerns raised.

Conclusion:

- Continue discussion in the intermediate round

3 Intermeadiate Round

3.1 Updated draft WID

Proposed update to justification:

NR PDCCH would be a bottleneck of DSS and the situation will become worse with NR traffic increasing, because the current specification ~~can~~does not allow more than one NR PDCCH symbols within the first 3 symbols of a slot in cells with four LTE CRS ports. To maximize the resource utilization and increase the PDCCH capacity for DSS, it would be beneficial to allow NR PDCCH reception in symbols overlapping with LTE CRS.

Proposed update to objectives:

- Study and if needed specify NR PDCCH reception in symbols with LTE CRS REs, [RAN1]
  - Investigate enabling LTE CRS to puncture NR PDCCH and how to interact with DMRS if there is the performance gain from the additional PDCCH resources.
  - If agreed to be specified, specify required signaling [RAN2]

RAN2 is added as secondary group.

The draft WID can be found in the RAN#94-e drafts inbox:

https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_94e/Inbox/Drafts/%5B94e-11-R18-DSS%5D/Intermediate%20Round/RP-21xxxx_WID_DSS%20v2.docx

Companies can provide input on the justification and the objectives in the feedback form.

Feedback Form 6: Further views on the justification and objectives of the draft DSS WID

1 – Ericsson Inc. The update to the Objective to add a second sub-bullet on signaling (and add RAN2 as secondary WG) seems to be based comment from Oppo. There is no need for RAN2 investigation on how to configure CRS pattern applicable for NR PDCCH (as mentioned in Oppo comment), especially since puncturing is mentioned in first sub-bullet. We prefer to delete the second sub-bullet.
2 – CMDI In the first round, it is proposed to remove ”how to interact with DMRS”, since it is not clear what it means, does it mean to adapt the DMRS pattern, e.g., by indicating polluted DMRS RE or introducing new DMRS pattern, or anything eles? Could Moderator elaborate a bit more? based on the guidance in the approved package, we should avoid such kind to generic description in the objective
3 – Samsung Electronics Co. We suggest to remove following texts in current WID. We understand they are not part of WID but for email discussion only.

- Section 3: [Justification for additional potential objective(s) can be added, if agreed]
- Section 4.1: [Other additional objective(s) can be added, if agreed]

4 – China Telecommunications

Based on the discussion on "Collision handling between NR PDCCH and LTE PCFICH / PHICH channels" in the initial round, the target scenario for NR PDCCH puncturing over CRS is not clear not us. Does it focus on scenarios with 4 CRS ports, or both 2 and 4 CRS ports? i.e., does it imply NR PDCCH reception from the 2nd OFDM symbol, or from the 1st OFDM symbol?

5 – QUALCOMM JAPAN LLC.

We are OK with the Moderator's update on draft WID v2. Regarding "how to interact with DMRS", we propose to keep it due to the reason we pointed out in the first round. DMRS handling is not as simple as PDCCH RE puncturing and therefore, interaction with DMRS and its performance/implementation impact should be investigated further.

6 – BOUYGUES Telecom

We believe that the the PDCCH bottlneck in DSS is an important matter that will become critical pretty soon, with the increase of NR traffic.

Having the possibility to use PDCCH in the second symbol of the TTI looks like a straightforward and natural solution, having the merit of simplicity, lack of impact on LTE legacy UEs and will be supported by NR UEs without any need of some fancy features.

Furthermore, the gain looks quite obvious (number of available CCEs for NR-PDCCH), while the loss in PDCCH decoding efficiency is rather limited (annex B2 of RP-212946).

We support Ericsson view and we don't see a need for a study phase for this item.

7 – vivo Communication Technology

The updates look good to us, except the new sub-bullet of "If agreed to be specified, specify required signaling". We are not sure what signaling is required. Given that RAN2 is added as the secondary WG, there would not be any problem once RAN2 signaling is identified.

8 – MediaTek Inc.

We are also fine to the current version of the WID. On collision between LTE CRS and NR PDCCH DMRS, we share similar view as Qualcomm that the UE complexity to deal with punctured DMRS is far more difficult than punctured PDCCH. We can leave the solution to be discussed in RAN1. In other word, we suggest to keep "how to interact with DMRS".

9 – SoftBank Corp.

We are fine with the moderator proposal.

10 – LG Electronics Inc.

We are fine with the updated draft WID.

11 – Beijing Xiaomi Electronics

We share the same views with Qualcomm and MTK, "how to interact with DMRS" should be kept.

12 – Classon Consulting

for FUTUREWEI agree with the comments that the DMRS aspect is not so clearly written in the objective. Does the how include doing nothing? Perhaps moving it to the subbullet and explaining more would help.

13 – VODAFONE Group Plc

We are fine with the revised WID.

14 – Apple GmbH

We do not see the need of the bullet ”If agreed to be specified, specify required signaling [RAN2]”

Again

We do have FG3-2 which allows NR PDCCH to be anywhere in a slot to avoid LTE CRS.

Then we have completely flexible cross carrier scheduling to avoid LTE CRS

Lastly, even for PDSCH, we do not require DMRS to be punctured by LTE CRS but only symbol shift and symbol shift is not applicable to PDCCH DMRS since PDCCH DMRS is in every symbol.

Furthermore, some CORESET cannot perform LTE CRS rate match since they might be used before RRC connection setup and some of them are cell-specific and even NW would not want to do it since there are legacy UEs in the system and this is UE optional feature.

Even from the actual deployment, we do not see such an issue and FG3-2 itself can be enough

15 – Huawei Tech.(UK) Co.. Ltd

A clarification is suggested for the phrase “how to interact with DMRS”. Does the investigation include the impact on LTE legacy UEs in a case where LTE CRS is punctured out due to overlaps with NR PDCCH DMRS? In our understanding, it is supposed to have no impact on the LTE side. If so, suggest a change:

· Investigate enabling LTE CRS to puncture NR PDCCH and how to ~~interact with~~ affect NR PDCCH DMRS if there is the performance gain from the additional PDCCH resources.

As commented before, the scope should be clear for what PDCCH resources/feature are targeted at. The following change is proposed again:

Study and if needed specify NR PDCCH reception in symbols with LTE CRS REs within the first 3 symbols of an NR slot, [RAN1]

Another clarification is needed for LTE PCFICH/PHICH. It is OK to keep LTE PCFICH/PHICH be transparent in NR specification as multiple companies suggested. But it cannot be assumed that eNB/gNB can coordinate to avoid overlaps between LTE PCFICH/PHICH and NR PDCCH at the first symbol of an NR slot for the following reasons,

· LTE PCFICH/PHICH is cell-specific resources and may be shared by serving multiple legacy LTE UEs.

· For LTE legacy UEs, the timeline from LTE PUSCH transmission to PHICH reception is fixed. There is no room for eNB to coordinate.

· The LTE PHICH resources can be spread out in frequency domain for the whole carrier bandwidth. For example, 7 PHICH groups are spread out the whole 10 MHz LTE bandwidth, instead of being concentrated within contiguous PRBs.

· The amount of LTE PCFICH/PHICH REs is not trivial. In a typical DSS scenario with 10MHz bandwidth, the LTE overhead at the first symbol is 4*50 (50 PRB)+4*4 (PCFICH) +4*3*7 (7 PHICH group)=300 REs, i.e. a 50% overhead.

Therefore, a note for clarification is suggested

· Investigate enabling LTE CRS to puncture NR PDCCH and how to ~~interact with~~ affect NR PDCCH DMRS if there is the performance gain from the additional PDCCH resources.

o Note: LTE PCFICH/PHICH is transparent to NR UEs and it is an evaluation assumption that NR PDCCH transmission at the first symbol of a NR slot can be punctured out by a gNB for LTE PCFICH/PHICH.

16 – Telia Company AB

We generally agree, but is the second bullet really needed? Delete the second sub-bullet as proposed by Ericsson and Apple.

17 – AT&T

Either way is fine, but deleting the second sub-bullet is preferred.

18 – Intel Corporation (UK) Ltd

We are fine with the objective, however, some refinements to the first sub-bullet may be needed to make text more readable. In addition, it seems there existing signalling of CRS can be reused, so the second subbullet may not be needed.

- Study and if needed specify NR PDCCH reception in symbols with LTE CRS REs, [RAN1]
  - Investigate performance benefits of enabling LTE CRS to puncture NR PDCCH including ~~how to interact~~ interaction of LTE CRS with NR PDCCH DMRS ~~if there is the performance gain from the additional PDCCH resources~~.
  - ~~If agreed to be specified, specify required signaling [RAN2]~~

Regarding collision handling with "LTE PCFICH / PHICH channels". One of the intentions of adding this bullet to the first objective was to understand impact of these LTE channels on the expected performance benefits. We are OK not to mention the corresponding aspect as part of WID assuming that possible presence of these channels is considered as part of the proposed study phase.

19 – TELENOR ASA

We support the views of Ericsson and Telia and AT&T. Basically ok, but prefer to delete second sub-bullet.

20 – Nokia France

We basically support the latest version. We agree with the comments from Samsung, and with the companies proposing deleting the second sub-bullet.

3.2 Dynamic indication of CRS rate matching

Continue discussion on whether to include this objective. The proponents should at the start of the discussion provide feedback to the issues raised in the initial round.

Feedback Form 7: Further views on including dynamic indication of CRS rate matching to the scope of the DSS work item.

1 – Ericsson Inc.

Below are our follow up comments/responses to issues/questions raised in initial round.

Why we need a DCI to change CRS rate matching pattern? DCI is only needed if NW changes the decision on the order of ms or we need some low latency on the order of ms, which does not seem to be justifiable in the field

- Ericsson: Having to change the CRS pattern frequently via RRC even at 10s or 100s of ms timescale is not a good approach in practical NW. DCI based indication avoids the need for such frequent RRC signaling.

How gNB could know the best CRS RM pattern in a timely way? ... L3 measurements, which are the only relevant information available to the gNB, are not sufficiently dynamic to give any advantage from dynamic CRS RM compared to the existing specifications

- Ericsson: Our understanding is both L1 and L3 measurements can be used by NW to estimate the appropriate CRS rate-matching pattern without requiring spec changes. Since how to use the measurements is gNB implementation issue, we do not see need for study on this.

Rate-matching is for PDSCH reception, rather than PDCCH. This part is not very clear from the problem formulation

- Ericsson: Intention of proposal is to have rate matching for PDSCH. If needed, this can be clarified explicitly "Support DCI based dynamic adaptation of **PDSCH** rate-matching around LTE CRS pattern (s)".

About the link to DSS topic, the proposed solution is improve performance of DSS and CRS RM has been discussed in similar context earlier.

Finally, on comments related to time budget, the objective can be added with minimal work load since existing DCI based rate-matching adaptation can be reused and not much spec effort is needed.

2 – CMDI

Even the reconfiguraiton my last order of tens of ms, but the interference will not change in order of seconds or minutes, in this sense, we do not see strong motivation to introduce this dynamic indication, let alone it is a new objective to the package.

3 – Samsung Electronics Co.

The key questions remain:

- (a) In case of L3 measurement/report, we don't see additional gain over the existing semi-static approach.
- (b) In case of L1 measurement/report, how will the gNB know the proper CRS pattern "instantly" before it changes in order for L1 to make sense?
- (c) What is the PUCCH resource overhead for all UEs to report timely measurements and how does that overhead compared to any savings of REs in DL (for the TDD NR bands)?
- (d) Is the L1 report a new UCI type or a MAC CE?

- (e) What is the accuracy of L1 measurements and the impact of measurement/detection errors?
- (f) What is the gain over power boosting (in case of QPSK-modulated PDSCH)?

As a general comment, it is not a "small work load" that matters but the ratio of the "work load" over the possible feasibility/gains; if the latter are 0, the trade-off is obviously unacceptable.

4 – China Telecommunications

Although the configuration of L1/3 measurements is gNB implementation issue, we hope to understand better how it could work with the existing L1/3 measurements, as well as the overhead/system impact due to frequent measurement and reporting of neighboring cell LTE/NR signal strength. This is the prerequisite to enable the dynamic indication of CRS rate matching in real network.

5 – vivo Communication Technology

- Firstly, we think 3.2 and 3.3 should be discussed together, and if necessary, only one of them can be agreed given that they are mainly targeting the same problem (neighbor cell interference for cell edge UE).
- Secondly, for cell edge UE, there could be more than one strongest interfering CRSs, but the interference environment would not be chagne rapidly. Dynamically rate-matching from one CRS to another does not seem to resolve the interference issue. Moreover, if there is more than one interfering CRSs, the whole CRS symbol would be problematic. Then it may be better to avoid the CRS symbol when scheduling the PDSCH, which already can be supported by NR.

6 – LG Electronics Inc.

We have similar view with other companies.

We don't see strong need to introduce this dynamic indication since interference situation from CRS would basically be semi-static and it would be hard to ensure timely adaptation even with dynamic indication.

7 – MediaTek Inc.

The intention of this proposal is to provide network a tool to deal with LTE CRS interference to UE. It is eventually up to network on how to use it. In our view, both L1 and L3 RSRP/SINR measurements can be used by network to make decision.

Regarding how fast the interference will change, it highly depends on UE speed and the environment. We do not believe that 3GPP should only focus on low mobility UEs in DSS scenario.

Regarding the overhead, typically UE already reports the L1 measurement results periodically. We do not see extra overhead in this case. L3 measurement may add some additional overhead but the reporting periodicity could be completely decided by network to reach a good performance-overhead trade off.

As for the L1 measurement accuracy, it is already there in RAN4 spec.

8 – Classon Consulting

for FUTUREWEI Do not support adding this objective, the gains are not clear and it expands quite a bit the scope beyond the time budget.

9 – Apple GmbH

Even given the justification provided, we are still skeptical this will be deployed, i.e., DCI based dynamic CRS rate matching pattern indication. It does require a lot of NW smartness to track the dynamics of the system and many of those information is only available at the device side. Strictly speaking, if we need something dynamic, MAC-CE could be another option since DCI is a constant overhead. But on the other side, in an ideal world, if NW is willing to take those extra steps to track the channel condition, coverage condition of each UE in a very advanced way, it looks good on paper. However, the assumption is that we still live in a world of LTE and NR has to coexist with LTE, which set things back to certain extend.

10 – Huawei Tech.(UK) Co.. Ltd

As commented by several companies, there are three key points to reiterate

o Current objective of draft WID is outcome of repeated and non-converged discussion for such proposal of dynamic indication.

o There is no existing L1 measurement for LTE CRS in NR specification. A gNB cannot have dynamic assessment of CRS interference for a UE to enable this dynamic rate-matching around CRS.

o If L3 measurements are to be relied on, it is not sufficiently dynamic. The existing semi-static configuration should be more than sufficient.

Additionally, it is not true that the proposal is an analogy to the existing Rel-15 dynamic RE-level RM for the following reasons,

o The NR CSI-RS that Rel-15 dynamic RE-level RM addresses is aperiodic, but LTE CRS is periodic.

o The NR CSI-RS is transmitted in the same gNB as that for NR PDSCH transmission, whose interference presence can be well controlled by the same gNB. However, the interference of LTE CRS is from a neighboring LTE eNB and thus cannot be turned off dynamically by the gNB.

Therefore, we don't feel the proposal has limited specification impact nor is feasible

11 – AT&T

We agree with the assessment by Ericsson and the corresponding proposals that L1 indication is highly beneficial for the operation of a practical network.

12 – Intel Corporation (UK) Ltd

We support objective with study on dynamic indication of CRS rate matching pattern.

13 – TELENOR ASA

We agree with Ericsson assessment.

14 – Ericsson Inc.

Additional responses to the follow up comments below

With DCI based adaptation, the NW will have the flexibility to decide how often and how aggressively to handle the rate matching adaptation without need for frequent RRC signalling. MAC CE based adaptation would need more specification effort while DCI based adaptation can be done by reusing existing mechanisms. As also indicated by MTK, how frequently the interferer/interference level change depends on aspects such as shadowing and user mobility.

On "*There is no existing L1 measurement for LTE CRS in NR specification*", as clarified earlier, such measurements are not required to estimate appropriate CRS rate-matching pattern and existing L1 and L3 measurement framework is sufficient.

On power boosting, it increases intercell interference and requires the power per RE to vary between symbols (will not work for 16QAM or higher). DCI based rate matching does not have these issues and is more adaptable.

On spec impact and link to existing DCI based rate matching indication, we have shown in RP-212946 how to reuse the existing mechanisms with minimal change.

15 – Nokia France

As also commented by other companies, including some operators, it has still not been demonstrated how DCI-based CRS RM can work correctly with the available knowledge of the interfering cell information, and without incurring high uplink overhead in additional signalling. The questions raised already by other companies above remain, and this item would require significant work for a benefit that cannot be shown. We are therefore not able to support using RAN1 time for this. Let's focus this WI on the objective that does have consensus on giving a useful benefit for DSS, namely increasing the NR PDCCH capacity.

16 – Verizon UK Ltd

As an operator, of course we view dynmiac DCI positively and would like to have the tool if possible. We understand the reservations from some companies. A better understanding of the benefit is the key.

3.3 Specify two overlapping CRS patterns

Continue discussion on whether to include this objective. The proponents should at the start of the discussion provide feedback to the issues raised in the initial round.

Feedback Form 8: Furrther views on including to the scope of the DSS work item to specify configuring semi-statically two overlapping CRS patterns

1 – ZTE Corporation

Thanks many companies and operators are more open or supportive of this proposal.

As we explained in our tdoc RP-213392, support of 2 CRS-RM patterns has been specified in Rel-15/16, but only applicable for the case when multi-DCI based MTRP PDSCH is configured (this is a restriction). For cell edge UEs without multi-DCI based MTRP feature, it is beneficial to support this for the cases without configuration of multi-DCI based MTRP in order to avoid CRS interference from LTE serving cell and one LTE neighbor cell in DSS scenario. Actually, the scenario is already justified because it is the same as one of the scenarios considered in RAN4 as some companies mentioned. The extra spec effort will be very minor, e.g. to revise/remove the restriction.

@Nokia, The current UE capability already supports 2 CRS-RM patterns as you mentioned, however, from description of 38.331 and 38.214, gNB is not allowed to configure two CRS patterns overlapping in frequency if multi-DCI based MTRP PDSCH is not configured. That's why we say the proposal has been justified somehow. Please see the detailed evidence in our tdoc RP-213392

2 – ZTE Corporation

More clarifications for the following specific concerns:

For concern on TU, as we clarified above, the spec impact is very minor, and no additional TU is needed for this item.

For Huawei's concern, as we replied to vivo before, the motivation is to avoid serious interference from serving LTE cell and one neighbor LTE cell if UE doesn't support Rel-17 smart receiver (the Rel-17 UE feature needs enhanced receiver, and needs higher UE capability/complexity). We should also note that two CRS-RM patterns have been supported for multi-DCI based MTRP.

3 – China Telecom Corporation Ltd.

On the relation to the Rel-17 RAN4 CRS-IM study:

RAN4 work on CRS interference handling has a study phase and a follow-up normative phase:

- In the study phase, the 2nd CRS-RM pattern is considered as one of the schemes in the evaluation on coping with the CRS interference. At that time, RAN4 thought the 2nd CRS-RM pattern with single TRP was already supported from Rel-16, since the 2nd CRS-RM pattern capability is not related to multiple-TRP related capability from UE capability perspective.
- In the normative phase, RAN4 only focus on CRS-IM receiver considering the performance gain and UE implementation feasibility, i.e., no further work on CRS-RM.

So, this 2nd CRS-RM pattern with single TRP is not included in the RAN4 Rel-17 work, and we can do it in Rel-18 DSS WI.

On the Workload:

We just need to remove the restriction on the multi-TRP for the 2nd CRS-RM pattern, minor spec impact is needed.

4 – vivo Communication Technology

- Firstly, we think 3.2 and 3.3 should be discussed together, and if necessary, only one of them can be agreed given that they are mainly targeting the same problem (neighbor cell interference for cell edge UE).
- Secondly, currently the NR UE already supports rate-matching around P-ZP-CSI-RS resource sets. Then, it can be addressed by using the P-ZP-CSI-RS resources to form the multi-CRS pattern. This may not be optimal (e.g., consuming a number of CSI-RS resoruces for rate-matching purpose), but dose not require spec/implementation change.

5 – ZTE Corporation

To vivo, thanks your flexibility on one of proposals in 3.2 and 3.3. Regarding your second comment, ZP CSI-RS was actually discussed in Rel-15/16. To form one 4-ports CRS pattern, 24 single-port ZP CSI-RS resources are needed which consume very large number of CSI-RS resources for rate-matching purpose as you mentioned. This is even worse if two CRS pattern lists are supported. That's why Rel-15/16 doesn't replace CRS RM pattern with ZP CSI-RS.

6 – MediaTek Inc.

We agree with ZTE and China Telecom's point that the intention is to remove the restriction that only UE supporting multi-TRP can be configured with the 2nd CRS-RM pattern. The spec impact is extremely small.

7 – Classon Consulting

for FUTUREWEI if this objective is to be included, it should be written in the very specific way of removing the restriction.

8 – Apple GmbH

In general, we should be okay. However, the true issue is when CRS-IM is discussed in RAN4, whether NW is willing to commit to provide the CRS configuration of the neighbor cell instead of replying on UE detection, etc. Based on my knowledge, infra-vendor is reluctant to provide or commit to help UE, instead simply pushing the burden to the UE.

The main benefit of this is to help UE to perform CRS IC at coverage boundary, and NW needs to commit to do this as part of RAN4 work. Otherwise, it is merely a feature to make specification more complicated and capability discussion more complicated

9 – Huawei Tech.(UK) Co.. Ltd

Our previous comment seems not addressed yet, here it is reiterated a bit. Since the Rel-17 CRS-IC has been introduced, a double functionality for the same scenario should be avoided, especially when there is no potential gain. In TR 38.833 (S6.2 of RP-212947), it is clearly concluded that the proposed solution is underperformed by both CRS-IC and LLR weighting, as copied below.

"

RAN4 initial observations from link-level evaluation results for 15 kHz SCS and synchronous network:

- CRS-IC with the assumption of NW signaling can achieve better performance compared to RM scheme 1.
- CRS-IC without NW assistant signaling achieve similar or lower performance compared to CRS-IC schemes with the assumption of NW signalling.
- LLR weighting with the assumption of NW signaling can achieve better or similar performance compared to RM scheme 1.
- LLR weighting without NW assistant signaling achieve similar or lower performance compared to LLR weighting with the assumption of NW signalling.
- Note: RM scheme 1 is under the assumption that RM always applied for the strongest interference cell.

Scheme #1 is described as Rel-16 CRS-RM for 1 interference cell (The rate matched CRS is always the first dominant interference) in Table 5.3.1.4-1: Summary of simulation cases

10 – Intel Corporation (UK) Ltd

We are open for the corresponding enhancement in Rel-18 as it provides to avoid interference with CRS using NW-based solution that is beneficial for UE not capable of CRS-IM. However, we propose to include this objective also with study phase to compare performance with sub-optimal solution based on the rate matching around the whole OFDM symbol containing CRS.

11 – Nokia France

Thanks to ZTE for pointing out that there is a configuration restriction to the existing functionality in 38.214 and 38.331. We'd be open to lift this restriction of configuring two overlapping patterns only with mTRP. We agree that there is no TU impact, and if this does not get done in the Rel-17 CRS-IM work, it could be taken in the Rel-18 DSS WI. The objective should be very specific:

"Allow a UE to support, and be configured with, two overlapping CRS RM patterns regardless of support or configuration of multi-TRP."

3.4 Conclusion Intermediate Round

Updated draft WID:

Based on the input to discussion, the following is observed and proposed:

- Seems the moderator was wrong on the support for the signaling subbullet and it will be removed
- Several companies request clarifying what is meant with "how to interact with CRS". The moderator proposes the following wording:
  - Investigate enabling LTE CRS to puncture NR PDCCH, ~~and how to interact with~~ including the impact to NR PDCCH DMRS and if there is performance gain from the additional PDCCH resources
- Including PCFICH and PHICH was raised again, but based on the discussion in the initial round it is proposed not to pursuit this further

Dynamic indication of CRS rate matching / Specify two overlapping CRS patterns

The situation seems similar to the initial round where more companies are in favor, but still many opposing. The discussion of these two might benefit of some GTW time and the moderator will ask the RAN chairman for that. For the final round, companies can comment on the wording of the potential objectives resulting from these:

- Support DCI based dynamic adaptation of PDSCH rate-matching around LTE CRS pattern (s) [RAN1, RAN2]
  - Current CRS rate matching specifications and already existing DCI fields should be reused when viable
- Specify two overlapping CRS patterns (still semi-statically configured) without having to configure multi-DCI based MTRP [RAN1, RAN2]

4 Final round

4.1 Updated draft WID

Proposed update to objectives:

- Study and if needed specify NR PDCCH reception in symbols with LTE CRS REs, [RAN1]
  - Investigate enabling LTE CRS to puncture NR PDCCH, ~~and how to interact with~~ including the impact to NR DMRS if there is the performance gain from the additional PDCCH resources.

The draft WID can be found in the RAN#94-e drafts inbox:

https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_94e/Inbox/Drafts/%5B94e-11-R18-DSS%5D/Final%20Round/RP-21xxxx_WID_DSS%20v3.docx

Companies can provide input on the justification and the objectives in the feedback form.

Feedback Form 9: Comments on updated draft WID

1 – vivo Communication Technology

- We slightly prefer the original wording (i.e., how to interact with) as it seems to be clearer, but we can live with the updated objective.
- In section 7, it seems that RAN2 is removed from the secondary WG. We would like to clarify that we don't think RAN2 should be added for the objective 1, but we think RAN2 should be kept as secondary WG for the whole DSS WI for supporting UE capability signaling.

2 – OPPO

Without RAN2 signaling telling UE the exact CRS pattern(s) to be used in puncturing, what UE can do is to make an implementation-based guess on puncturing pattern. The existing NR signaling on LTE CRS pattern is designed for PDSCH, which may be transmitted fully or partially in resources corresponding to LTE MBSFN region. Therefore the existing signaling for PDSCH may miss something for PDCCH. In short, the PDCCH puncturing without signaling support may make things either better or worse. It is not clear to us how the RAN4 requirement would be if this objective can survive to normative work. Comparing to what has been discussed so far for PDSCH, which has both RAN2 signaling support and L1 dynamic indication, the PDCCH protection is unexpectedly weakened. This conflicts to the original intention of this WID to handle the performance bottleneck due to LTE CRS impact to PDCCH. In fact, without sufficient protection on PDCCH, the PDCCH-based dynamic indication for PDSCH rate-matching may get nothing improved.

3 – OPPO

OPPO cont' If there is an assumption in the WID that the investigation can assume the LTE-CRS patterns currently configured for PDSCH are also applicable to PDCCH (again, this may lead to some small changes in 38.331), it is then fine to us.

4 – KT Corp.

Even if KT prefers original wording this proposal is also acceptable.

5 – SoftBank Corp.

We are fine with the proposal.

6 – China Telecom Corporation Ltd.

We asked the target scenario of NR PDCCH puncturing over CRS in the initial round and intermediate round:

Does it focus on scenarios with 4 CRS ports, or both 2 and 4 CRS ports? i.e., does it imply NR PDCCH reception from the 2nd OFDM symbol, or from the 1st OFDM symbol?

In the justification part of the WID, it says:

NR PDCCH would be a bottleneck of DSS and the situation will become worse with NR traffic increasing, because the current specification does not allow more than one NR PDCCH symbols within the first 3 symbols of a slot in cells with ***four LTE CRS ports****.*

In "Annex B2: Evaluation of NR PDCCH reception in symbols with CRS" of RP-212946, the evaluation is done for the scenario **with 4 CRS ports and NR PDCCH transmitted from the 2nd OFDM sybmol** (PDCCH is punctured by CRS in the 2nd OFDM sybmol).

But the current WID objective is not clear about the target scenario, or the target scenario is to be discussed during the WI phase? We are fine with either approach, but would like to understand what the current wording of objective means. We are not sure if we are the only one who has this question, but as we know, the CRS port number is different in different operators' deployments (we'd like to know if this enhancement is relevant to our deployment).

7 – Samsung Electronics Co.

Thanks. We support the latest update in the draft WID v3.

8 – QUALCOMM JAPAN LLC.

We prefer "*how to interact with*" but can live with the update.

One minor comment: "*PDCCH*" seems missing, i.e., it would be "*including the impact to NR PDCCH DMRS*".

9 – Beijing Xiaomi Electronics

We are fine with the proposal.

10 – CATT

We are fine with the latest objective.

11 – LG Electronics Inc.

We are fine with the latest updated WID (without further addition).

12 – Intel Corporation (UK) Ltd

We are fine with the latest version of objective with small update to include NR PDCCH DM-RS

13 – KDDI Corporation

We are fine with the updated objectives.

14 – MediaTek Inc.

We prefer the original wording more. The current wording may lead to the understanding that puncturing PDCCH DMRS is the only solution. Another possible modification is the change ', including' to 'and', e.g.,

Investigate enabling LTE CRS to puncture NR PDCCH~~, including~~ and the impact to NR DMRS if there is the performance gain from the additional PDCCH resources

15 – Huawei Tech.(UK) Co.. Ltd

One of our previous comments was not considered for the second time without any explanation and has to be reiterated again below, similar to the concern expressed by China Telecom. The scope of the objective should be clear for what PDCCH resources/feature are targeted at, otherwise it implicitly allows introducing the functionality to any symbol of a NR slot with LTE CRS REs, which requires more evaluations in the study. Even if this was mentioned in the justification section, it should be clarified in the objective. Mediatek's suggestion looks good.

Proposed change:

Study and if needed specify NR PDCCH reception in symbols with LTE CRS REs **within the first 3 symbols of an NR slot**. [RAN1]

· Investigate enabling LTE CRS to puncture NR PDCCH, ~~including~~ **and** the impact to ~~how to interact with~~ NR **PDCCH** DMRS if there is the performance gain from the additional PDCCH resources.

Additionally, we share similar view as China Telecom on whether the first symbol in a NR slot is within the target scenario for NR PDCCH is expected to be clarified, because the first symbol is heavily occupied by LTE PCFICH/PHICH as commented before. Our understanding is that it is within the scope of the proposed objective.

16 – Classon Consulting

for FUTUREWEI Thanks to improve the wording, this looks better

17 – Nokia France

The revised WID is OK. We are also OK with mentioning the first 3 symbols as proposed by Huawei.

18 – AT&T

This is acceptable to us

19 – VODAFONE Group Plc

The revised WID is ok for us.

20 – Ericsson Inc.

OK to clarify NR PDCCH DMRS as commented by Qualcomm. Other parts prefer to keep current version.

21 – Telia Company AB

We support the revised WID.

22 – Verizon UK Ltd

We are fine with the revised WID.

4.2 Additional objectives

In preparation of a possible GTW-session, companies can give input on the wording of the potential objectives:

- Support DCI based dynamic adaptation of PDSCH rate-matching around LTE CRS pattern (s) [RAN1, RAN2]
  - Current CRS rate matching specifications and already existing DCI fields should be reused when viable
- Specify two overlapping CRS patterns (still semi-statically configured) without having to configure multi-DCI based MTRP [RAN1, RAN2]

Feedback Form 10: Comments on wording of potential objectives

1 – vivo Communication Technology

We understand this discussion is only to refine the wording.

First bullet:

- It should have a upper limit of how many LTE CRS pattern a UE need to prepare for dynamic adaptation, e.g.:
  Support DCI based dynamic adaptation of PDSCH rate-matching around *[up to 2]* LTE CRS pattern (s)

Second bullet:

- The current objective is not very clear and should be updated, e.g.:
  ~~Specify~~ Support PDSCH rate-matching around two semi-statically configured overlapping CRS patterns ~~(still semi-statically configured)~~ without ~~having to~~ configuring~~e~~ multi-DCI based MTRP

2 – OPPO

We are ok to the 2nd bullet if the wording is considered clear enough in showing what should be specified, i.e., just lifting the existing restrictions in the spec.

For the 1st bullet, based on the discussion so far, we think it is better to have a ”study” phase to confirm the justification. So the wording revision can be like below:

- Study and, if proved necessary, s~~S~~upport DCI based dynamic adaptation of PDSCH rate-matching around [up to 2] LTE CRS pattern (s) [RAN1, RAN2]
  - Current CRS rate matching specifications and already existing DCI fields should be reused when viable

3 – China Telecom Corporation Ltd.

For the first bullet on dynamic CRS-RM, we are ok to add this objective if there is a study phase. To OPPO, it seems only the RM pattern to the neighboring LTE cell needs to be dynamic (or to be faster than semi-static), but the RM pattern for serving cell CRS is semi-static.
For the second bullet on semi-static RM, the updated objective from vivo looks ok. As said, this bullet implies minor spec impact, and it is to enable something we thought it was already supported.

4 – CATT

Regarding the wording of the two objectives, we have the following comments:

1) For the first bullet, we agree with OPPO and China Telecom that a study phase is needed if included.

2) For the second bullet, we would like to make it clearer based on vivo’s wording.

- ~~Specify~~ Support PDSCH rate-matching around two semi-statically configured ~~overlapping~~ CRS patterns which are fully overlapping in frequency~~(still semi-statically configured)~~ without ~~having to~~ configuring~~e~~ multi-DCI based MTRP

5 – ZTE Corporation

For the second bullet, CATT’s revision is more algined with the current 38.331. for clarification, we suggest the following wording

- ~~Specify~~ Support PDSCH rate-matching around two semi-statically configured ~~overlapping~~ CRS patterns overlapping in frequency(**the same as existing 38.331**) without ~~having to~~ configuring~~e~~ multi-DCI based MTRP

6 – Beijing Xiaomi Electronics

For the second bullet, the ’overlapping CRS patterns’ is a little bit misleading as it gives the impression that CRS RE from different patterns are fully overlapped with each other. We understand that the intention is the two configured CRS patterns should have something different from a combination of center carrier, bandwidth, different AP number and v-shift. Hence we think the version from CATT is cleared and we are supportive to the wording from CATT.

7 – Intel Corporation (UK) Ltd

We are fine with both objectives for Rel-18 NR with study phase before normative work.

If possible, it should be also clarified whether objective 1 also includes dynamic disabling of CRS rate matching and the maximum number of CRS rate matching patterns overlapping / non-overlapping that can be simultaneously indicated to the UE for PDSCH reception.

8 – MediaTek Inc.

On the 2nd objective, we can change 'overlapping' to 'concurrent'.

9 – Huawei Tech.(UK) Co.. Ltd

Regarding the first bullet for DCI-based dynamic rate-matching, based on the two rounds of discussions, there were clearly thirteen companies against with the following long list of unsettled concerns. The proposed objective is the outcome of repeated and non-converged discussion for such proposal of dynamic indication. Even if some of these companies may now be ready to accept as a study objective, this basically doubles the amount of RAN1 work compared to the endorsed package in RP-213469.

Unclear motivation:

- Don't see strong need to introduce this dynamic indication since interference situation from CRS would basically be semi-static.
- What is the gain over power boosting (in case of QPSK-modulated PDSCH)?
- The gains are not clear and it expands quite a bit the scope beyond the time budget.
- If there is more than one interfering CRSs, the whole CRS symbol would be problematic. Then it may be better to avoid the CRS symbol when scheduling the PDSCH, which already can be supported by NR.
- It does require a lot of NW smartness to track the dynamics of the system and many of those information is only available at the device side.
- Incurring high uplink overhead in additional signalling.

Infeasibility or additional significant spec impacts:

- There is no existing L1 measurement for LTE CRS in NR specification. A gNB cannot have dynamic assessment of CRS interference for a UE to enable this dynamic rate-matching around CRS.
- If L3 measurements are to be relied on, it is not sufficiently dynamic. The existing semi-static configuration should be more than sufficient.
- For the **hypothetic** L1 measurement, implying significant spec impact and WG discussions

o In case of L1 measurement/report, how will the gNB know the proper CRS pattern "instantly" before it changes in order for L1 to make sense?

o What is the PUCCH resource overhead for all UEs to report timely measurements and how does that overhead compared to any savings of REs in DL (for the TDD NR bands)?

o Is the L1 report a new UCI type or a MAC CE?

o What is the accuracy of L1 measurements and the impact of measurement/detection errors?

o It has still not been demonstrated how DCI-based CRS RM can work correctly with the available knowledge of the interfering cell information, and without incurring high uplink overhead in additional signalling.

- It is not true that the proposal is an analogy to the existing Rel-15 dynamic RE-level RM for the following reasons,

o The NR CSI-RS that Rel-15 dynamic RE-level RM addresses is aperiodic, but LTE CRS is periodic.

o The NR CSI-RS is transmitted in the same gNB as that for NR PDSCH transmission, whose interference presence can be well controlled by the same gNB. However, the interference of LTE CRS is from a neighboring LTE eNB and thus cannot be turned off dynamically by the gNB.

In response to the reply "such measurements are not required to estimate appropriate CRS rate-matching pattern and existing L1 and L3 measurement framework is sufficient.", it is quite obviously not the case according to the comments other companies. Particularly, the potential interfering neighboring cells are typically more than 1 cell, as the evaluation assumption in TR 38.833. Without measurement on appropriate CRS rate-matching pattern, a gNB does not know which interfering neighboring cell with itself CRS pattern should be indicated to a UE for rate-matching dynamically.

Therefore, we don't feel this objective for dynamic indication of LTE CRS patterns is necessary.

Regarding the second sub objective, as commented before, it is unnecessary to introduce a duplicate functionality by a solution that has been clearly concluded by 3GPP as an inferior solution in TR 38.833 (S6.2 of RP-212947),. Even the solution of LLR weighting with modest complexity outperforms it.

10 – Classon Consulting

for FUTUREWEI It is disappointing that the TU guidance continues to be ignored. But for discussion purposes, the dynamic adaptation would need to have a study phase and should be written similar to the main objective. For the last one, it seems the wording above is confusing....why not just write is as: Remove the restriction that only UE supporting multi-TRP can be configured with the 2nd CRS-RM pattern ?

11 – ZTE Corporation

@Huawei For the second proposal, as we mentioned before, this proposal provides to avoid interference with CRS using NW-based solution that is beneficial for UE not capable of CRS-IM which needs higher UE capability and complexity. We have to note that two overlapping CRS patterns have been supported in Multi-DCI based MTRP case. This proposal is just to remove the restriction and specify something like what we thought has been agreed.

12 – Nokia France

For the first objective, there is a huge amount that would need to be studied first, as already indicated for example by Huawei in their comment above. There is no mention of the impacts on measurements, reporting, RAN4 requirements, etc. Also it is not clear how already existing DCI fields can be reused and what is meant by "when viable". This proposal is not viable.

For the second objective, we agree with several other companies that the wording does not relate well to the actual proposed specification change. We propose: "Allow a UE to support, and be configured with, two overlapping CRS RM patterns regardless of support or configuration of multi-TRP."

13 – Apple GmbH

Dynamic indication of LTE CRS for rate matching needs at least a study phase

14 – OPPO

Add to previous OPPO comments From previous comments on DCI-based dynamic adjustment of CRS RM pattern, it seems the motivation is that the semi-static adjustment is too slow (as at 1s or longer scale),

but there is no rational in previous discussion to explain why MAC-CE is also not qualified. So if there is a study phase, we think MAC-CE should be included as another candidate.

15 – Ericsson Inc.

For the wording of second bullet, prefer text suggested by Nokia.

4.3 Conclusions Final Round

Based on the discussion in the initial round, the following conclusions are made:

Updated draft WID:

It is proposed to keep the objective text as proposed for the final round. The final version is in RP-213559.

For the additional objectives:

Proposals for wording:

- Support DCI based dynamic adaptation of PDSCH rate-matching around up to 2 LTE CRS pattern(s) [RAN1, RAN2]
    - Current CRS rate matching specifications and already existing DCI fields should be reused when viable
- Allow a UE to support, and be configured with, two overlapping CRS RM patterns regardless of support or configuration of multi-TRP [RAN1, RAN2]

The moderator notes that for the TU-budget to hold, no additional study phase can be included in the work item for these.

5 References

RP-212682, “Moderator’s summary for discussion [RAN94e-R18Prep-22] Potential RAN4 enhancements (including both <5MHz in dedicated spectrum and DSS (Dynamic Spectrum Sharing) aspects)”, RAN4 chair (Huawei)

RP-212730, “New WI: Enhancement of NR Dynamic spectrum sharing (DSS)”, RAN4 chair (Huawei)

RP-213469, “Summary for RAN Rel-18 Package”, RAN Chair (Qualcomm), RAN1 Chair (Samsung), RAN2 Chair (MediaTek), RAN3 Chair (ZTE), RAN4 Chair (Huawei)

RP-212911, “Discussion on scope of Rel-18 DSS enhancements”, Intel Corporation

RP-212946, “On DSS enhancements in Rel-18”, Ericsson

RP-213205, “Discussion on WID on enhancement of NR Dynamic spectrum sharing (DSS)”, CMCC

RP-213392, “Discussion on Rel-18 NR DSS enhancement”, ZTE, China Telecom