**3GPP TSG-RAN WG2 Meeting #115-e R2-210xxxx**

**Online, Aug 16th – 27th, 2021**

**Agenda Item: 8.19.2**

**Source: ZTE Corporation**

**Title: Summary of [AT115-e][111][CE] Msg3 repetition**

**Document for: Discussion and decision**

# Introduction

This document summarizes the following offline discussion.

* [AT115-e][111][CE] Msg3 repetition (ZTE)

Initial scope: Continue the discussion on p4-p9 from [R2-2107745](file:///C:\Data\3GPP\Extracts\R2-2107745%20Consideration%20on%20Msg3%20repetition%20in%20CE.docx), p2-p7 from [R2-2107220](file:///C:\Data\3GPP\Extracts\R2-2107220_RAN2%20enhancements%20for%20Msg3%20repetition.docx), p3 from [R2-2107008](file:///C:\Data\3GPP\Extracts\R2-2107008_MAC%20Aspects%20of%20UL%20Coverage%20Enhancements.doc) and p1-p3 from [R2-2108003](file:///C:\Data\3GPP\Extracts\R2-2108003.docx)

Intended outcome: Summary of the offline discussion with e.g.:

* + - List of proposals for agreement (if any)
    - List of proposals that require online discussions
    - List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Monday 2021-08-23 10:00 UTC

Initial deadline (for rapporteur's summary in R2-2108895): Monday 2021-08-23 16:00 UTC

Proposals marked "for agreement" in R2-2108895 not challenged until Tuesday 2021-08-24 0800 UTC will be declared as agreed via email by the session chair (for the rest the discussion will further continue online).

# Contact from companies

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| --- | --- |
| Company | Email |
| Lenovo | hchoi5@lenovo.com |
| Qualcomm | Linhai He (linhaihe@qti.qualcomm.com) |
| Ericsson | Jonas Sedin (Jonas.sedin@ericsson.com) |
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# Background

Following agreements were reached after first (Wednesday) online discussion:

Agreements:

1. RAN2 should focus on Msg3 repetition for 4-step RACH, unless RAN1 makes solid conclusion to support Msg3 repetition for fallbackRAR
2. Agreed. Msg3 repetition is applicable to all cases that trigger 4-step CBRA procedure (can come back if we identify that some specific case should not be covered)
3. A separate RSRP threshold is introduced for requesting Msg3 repetition.

# Discussion

## Msg3 repetition on NUL/SUL

A NR cell can be configured with both NUL carrier and SUL carrier, so far, RAN1 hasn’t discussed whether Msg3 repetition can be configured on SUL carrier. In [3], it lists the following 4 scenarios:

* **Scenario 1: Cell is configured with only NUL, and Msg3 repetition is enabled;**
* **Scenario 2: Cell is configured with both NUL and SUL, and Msg3 repetition is only configured on NUL;**
* **Scenario 3: Cell is configured with both NUL and SUL, and Msg3 repetition is only configured on SUL;**
* **Scenario 4: Cell is configured with both NUL and SUL, and Msg3 repetition is configured on both NUL and SUL.**

For flexibility, it is proposed to confirm all above scenarios can be supported in Rel-17. So Msg3 repetition function can be enabled on either NUL or SUL, or both.

Companies are invited to show your views on this.

**Q1. From RAN2 perspective, do companies agree Msg3 repetition can be configured on either NUL or SUL, or both?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo | Yes |  |
| Qualcomm | Yes | It can be left to network configuration. We don’t see use cases to exclude any one of the above configuration scenarios. |
| Ericsson | NA | RAN1 did not discuss SUL at all. While we are neutral, I think it would make sense to check with RAN1. |
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According to RAN2 agreement, a separate RSRP threshold will be introduced for requesting Msg3 repetition. When measured RSRP is below the threshold, UE can request network to enable Msg3 repetition.

So if answer ‘Yes’ to Q1, the next question is whether separate RSRP thresholds are needed for requesting Msg3 repetition on NUL and SUL. Companies are invited to show your views.

**Q2. If answer ‘Yes’ to Q1, do companies agree separate RSRP thresholds are needed for requesting Msg3 repetition on NUL and SUL?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo | Yes |  |
| Qualcomm | No | Whether a UE is allowed to request Msg3 repetition only needs to depend on whether its RSRP measurement is below a threshold. NUL does have long cell range, but that does not mean it can give UE extra link budget. |
| Ericson | No | In general we should strive to reduce the amount of new RACH thresholds, but in this case it is not needed.  The reason being that since SUL has its own BWP configuration that includes RACH configuration that further includes thresholds that can be configured to be different for SUL and NUL. Thus when we introduce the separate RSRP threshold for requesting msg3 repetitions in the RACH config, the same threshold could be used for SUL. |
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Based on online discussion, some companies think we should consult RAN1 on the support of Msg3 repetition on NUL/SUL. From rapporteur’s point of view, I think this more relates to network deployment, and it has no RAN1 impact, so RAN2 should be able to make decision. But if there is strong concern, we can send LS to RAN1 for confirmation. Companies are invited to show your view on whether LS is needed.

**Q3. Do companies think RAN2 needs to ask RAN1 if they have concern on support of Msg3 repetition on NUL&SUL (e.g. sending LS)?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo | Yes | We think it’s good to inform RAN1 about our agreements on NUL/SUL, so that they can raise concerns if they have any. |
| Qualcomm | No | We don’t have a strong view. But at least for now we don’t see a need to consult RAN1 on this issue. |
| Ericsson | Yes | We do not think a strong concern is needed to check in with RAN1. They are after all the leading work group and as far as we know they did not even discuss SUL, then it could be good to see why that is the case. |
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## Potential impact on cell selection

In [3] and [2], the impact on cell selection are discussed. In short, for UEs capable of Msg3 repetition, even if its RSRP results is lower than legacy UEs, the UE is able to RACH and get connected to the target cell, because Msg3 repetition can help make up the shortage in link budget. So the UL coverage for Msg3 capable UEs can be different from those non-Msg3 capable UEs. This is similar to SUL.

For SUL, separate cell selection/reselection threshold can be broadcasted in SIB, similarly, separate cell selection threshold (e.g. Qrxlevmin, Qqualmin) needs to be provided for UEs capable of Msg3 repetition.

Based on online discussion, one company commented this is out of scope of WID. (The objective of WID is copied/pasted below)

* **Specify mechanism(s) to support Type A PUSCH repetitions for Msg3 [RAN1, RAN2]**

From rapporteur point of view, for supporting Type A PUSCH repetition for Msg3, RAN2 is responsible to study any potential RAN2 impact, the objective does not preclude any technical point. In addition, some company commented Msg1 repetition is not supported, thus UL coverage can not be extended. But according to the study in RAN1, PRACH has better performance than PUSCH, so PRACH is not bottle neck of UL transmission. That is why Msg3 repetition is considered instead of Msg1 repetition.

Companies are invited to show your views.

**Q4. Do companies agree separate cell access thresholds (e.g. Qrxlevmin, Qqualmin) can be provided for UEs capable of Msg3 repetition?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo | No | It is our understanding that the Msg3 enhancements are targeted only for UEs in connected state. Therefore, we think that cell (re)selection should not be impacted. We should not extend the scope of the WI unnecessarily. Unclarities of the WI scope can be discussed in RAN plenary. |
| Qualcomm | Yes | UEs capable of Msg3 repetition can access a cell at lower minimum RSRP than legacy UEs. Therefore, Qrxlevmin and Qqualmin, which are the minimum Rx and quality levels allowed for a cell, should be set differently for coverage enhanced UEs.  We agree with the rapporteur’s argument above that the WID does not restrict RAN2 from studying any particular upper-layer procedures impacted by msg4 repetition. |
| Ericsson | No | We do not think that this is needed.  As this is out of the scope of the WID (and not discussed during RAN1 WI or SI), this would need a strong motivation and in this case this is an enhancement rather than something that is really needed to be fixed.  For LTE CE new cell reselection parameters was introduced when there were significant amount coverage extension on all channels which is not the case here. There are network implementation methods to increase coverage of msg3 through for instance more msg3 retransmissions, but this has not resulted in a new cell reselection parameters. |
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## Handling of Contention Resolution Timer

In current TS 38.321, the start of contention resolution timer is described as below (for HARQ retransmission):

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| 5.1.5 Contention Resolution  Once Msg3 is transmitted the MAC entity shall:  1> start the *ra-ContentionResolutionTimer* and restart the *ra-ContentionResolutionTimer* at each HARQ retransmission in the first symbol after the end of the Msg3 (re)transmission;  1> monitor the PDCCH while the *ra-ContentionResolutionTimer* is running regardless of the possible occurrence of a measurement gap; |

Regarding Msg3 repetition, the handling of ra-ContentionResolutionTimer is discussed in several contributions, in summary, there are 3 options (companies please double check if any option is missing):

* Option 1: (Re)start *ra-ContentionResolutionTimer* in the first symbol after all Msg3 repetitions [2][4].



* Option 2: (Re)start *ra-ContentionResolutionTimer* in the first symbol after each Msg3 repetition [3].



* Option 3: Start *ra-ContentionResolutionTimer* in the first symbol after 1st Msg3 transmission, and does not restart it after follow-up Msg3 repetitions [1].



For Option 2 and Option 3, early Msg3 repetition termination can be supported. But some companies commented there is challenge for UE to monitor PDCCH before finishing all the repetitions. Although this was discussed in RAN1 before, and no consesus was reached. From rapporteur’s point of view, this should be discussed and determined in RAN2, because it mainly impact MAC spec.

So regarding above options, companies are invited to show your views.

**Q5. Which option do companies prefer for handling *ra-ContentionResolutionTimer* in Msg3 repetition?**

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| **Company** | **Option 1/2/3** | **Comments** |
| Lenovo | Option 1 | Is a straightforward solution. |
| Qualcomm | Option 1 | For two reasons:   * Msg3 repetition should leverage joint channel estimation to maximize the coverage. For joint channel estimation to work, UE needs to maintain phase continuity between repetitions. It is very challenging if UE has to switch between DL reception (monitoring PDCCH monitoring for Msg4) and UL Tx (Msg3). * If network does its estimation right, the number of repetitions scheduled by network should be such that it can successfully decode Msg3 only after most or all repetitions are performed. Hence in most cases, monitoring PDCCH for Msg4 too early wastes UE power.   Lastly, some companies have argued that in the current MAC spec each repetition is modelled as a retransmission. We think that is only a matter of modelling for simpler spec text. We do not need to force that model into Msg3 repetition. |
| Ericsson | Option 1 | First of all PUSCH early termination was discussed during study item phase but was not agreed and is not in the scope of PUSCH enhancements. RAN2 should thus not introduce these type of solutions.  For Option 1: This is how it was introduced in LTE CE and we see no reason why we would do anything else.  For Option 2: See above on PUSCH early termination.  Option 3: This might be problematic with legacy, since the contention resolution timer would be the same for legacy and msg3 repetition UEs. With repetitions, the time from msg3 transmission and msg4 reception would be smaller for msg3 repetition UEs and for some values for ra-ContentionResolutionTimer the network could not schedule enough repetitions. |
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In [4], is also proposes to not extend ra-ResponseWindow and ra-ContentionResolutionTimer for Msg3, because PDCCH/PDSCH for Msg2/4 repetition are not supported in CE.

Proposal 3: No extension is needed for *ra-ResponseWindow* and *ra-ContentionResolutionTimer* for MSG3 repetition.

Rapporteur understand this may also relate to the discussion in Q5 (e.g. if Option 3 is adopted). Companies are invited to show your views on this.

**Q6. For MSG3 repetition, do companies agree extension of *ra-ResponseWindow* and *ra-ContentionResolutionTimer* is not needed?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo | Yes | DL coverage enhancements are not in WI scope. |
| Qualcomm | Agree | No extension is necessary. |
| Ericsson | Yes |  |
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## Separate RA parameters for Msg3 repetition

In [2], it mentions with Msg3 repetition, Msg1 transmission may become the coverage bottleneck in RACH procedure, so to achieve full benefit of Msg3 repetition, we can consider other method to improve the performance of Msg1 transmission, i.e. through different Tx power control and more transmission opportunities, more specifically:

(copied/pasted the text/proposal from [2])

* *preambleReceivedTargetPower* is the initial Msg1 Tx power. As a UE eligible for Msg3 repetition has poorer link quality than average UEs, its Msg1 Tx should have higher initial power to increase the likelihood of success.
* Size of power ramping step depends on expected interference level. Since a UE eligible for Msg3 repetition has poorer link quality, it is more likely located near cell edge and subject to inter-cell interference. Therefore, it can benefit from larger power ramping step size when overcoming interference in its Msg1 transmission.
* *preambleTransMax* controls the maximum number of Msg1 Tx. Since a UE eligible for Msg3 repetition has poorer link quality, it makes sense for the UE to have more retransmission opportunities to ensure comparable coverage with repeated Msg3.

Proposal 1. Msg1 transmission by UE to request Msg3 repetitions can be configured with its specific set of *preambleReceivedTargetPower*, *powerRampingStep*, *powerRampingStepHighPriority, preambleTransMax* and *groupBconfigured.*

**Q7. Do companies agree with above Proposal 1?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo | No | Msg1 enhancements were discussed during the SI phase but during scoping of the WI in RAN#90-e, no consensus could be reached to consider Msg1 enhancements in the WI. Therefore, we should not extend the scope of the WI unnecessarily. Unclarities of the WI scope can be discussed in RAN plenary. |
| Qualcomm | Yes | We are the proponent |
| Ericsson | Yes | I think we are fine with those parameters being configured except for *powerRampingStepHighPriority*. This is a part of random access prioritization parameters that I think RAN2 should discuss separately how it applies to msg3 repetitions. FFS how all of these are configured. |
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## Msg3 repetition for preamble group B

In [2], it proposes to allow network to configure Msg3 repetition also for Preamble group B.

Proposal 2. Preamble group B can be jointly configured with Msg3 repetition.

Preamble group B is used to request a large UL grant for Msg3, although repetition of large Msg3 looks resource consuming, but in [2], it explains Msg3 repetition can be useful for some use case, e.g. for UEs with only small amount of data to send and can leverage RACH based SDT or when cell loading is low. And it is fully within network’s control.

Companies are invited to show your views on whether to support Msg 3 repetition for large Msg3 case.

**Q8. Do companies agree preamble group B can be jointly configured with Msg3 repetition?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo |  | We think that this should be coordinated with RAN1. We don’t know which Msg3 sizes they have considered yet in the design of Msg3 repetitions. Therefore, we suggest to add this question in the LS to RAN1. |
| Qualcomm | Yes | We think that in some cases group B can be useful even when UE needs support of coverage enhancement. One example is RA-SDT for sensors (RedCap), which typically have tight link budget and are power sensitive. When network configures dedicated PRACH resources for those UEs, joint configuration between group B and Msg3 repetition hence is very useful.  What we are proposing is that we do not need to explicitly prohibit network from joint configuration between group B and Msg3 repetition. That decision can be left to network. |
| Ericsson | Yes | Sure, this could be beneficial for msg3 repetitions as in some cases this could allow for SDT. FFS how it is configured. |
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Similarly, for preamble group B, in [2], it is proposed to configure separate set of RA parameters for Msg3 repetition.

Proposal 3. If preamble group B is configured for Msg3 with repetitions, network can configure it with a separate set of ra-Msg3SizeGroupA, messagePowerOffsetGroupB, numberOfRA-PreamblesGroupA.

Companies are invited to show your views.

**Q9. If answer ‘Yes’ to Q8, do companies agree with above P3?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm | Yes | The same argument for Q7 applies |
| Ericsson | Yes | Yes, We think this is fine, but we can discuss more. |
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On top of Q7, rapporteur thinks it worth to discuss whether network can control whether to enable Msg3 repetition for group B? For instance, if a cell is configured with preamble group B, can network enable Msg3 repetition only for preamble group A, or only for preamble group B, or both?

**Q10. If answers ‘Yes’ to Q8, for a cell configured with preamble group B, can network decide whether to enable/disable Msg3 repetition for preamble group B (e.g. only configure Msg3 repetition for preamble group A)?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm | Yes | Network should have that flexibility |
| Ericsson | FFS | We are not sure. Let us decide on the design above first. We do not see how this is aligned with what is described above. This sounds like legacy group A/B can be configured with repetitions. But we can discuss more. |
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## Msg3 repetition for specific beams

In [3], it mentions that Msg3 repetition may only be needed when UE is the coverage of partial beams. From network perspective, network can determine these ‘problematic’ beams based on MDT (e.g. RLF report). Considering RAN1 agreed to use “separate preamble with shared RO” approach for requesting Msg3 repetition, it will be a challenge for network to configure RACH resources for Msg3 repetition (because preamble resource is quite limited).

If network is able to only enable Msg3 repetition for partial beams, then network only needs to reserve RACH resources (e.g. RA preambles) for those problematic beams, more RACH resources can be reserved for other purpose.

Rapporteur understands this relates to RACH partition discussion, but it will be good if companies can confirm whether such requirement is needed. So we can provide guidance to the common session.

**Q11. Do companies think there is requirement to allow network to only enable Msg3 repetition on specific beams (e.g. in order to reduce the RACH resources reserved for CE purpose)?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo |  | We were told by our RAN1 colleagues that RAN1 is discussing this topic. So, it may be good to coordinate with RAN1 on this topic. |
| Qualcomm | See comment | We can understand the intention behind the proposal. But this requires discussion on whether PRACH or RACH resources can be configured on a per-beam basis, which has much bigger scope than Msg3 repetition. Maybe it can be discussed under A.I. 8.18. |
| Ericsson | No | We do not think that this type of optimizations are needed. Similar things were suggested for 2-step random access with similar optimization-abilities, but it was not pursued.  Also agree with QC that this could be discussed within the context of RA partitioning. |
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## Way to indicate the number of Msg3 repetitions

In [4], it further discusses the solutions for indicating the number of Msg3 repetitions in Msg2.

* Option 1: Using an information field from the existing information fields in RAR UL grant;
* Option 2: Using MAC RAR for indication

Above two options are provided by RAN1, and Option 1 has already been agreed in RAN1, so this paper proposes to discuss Option 2 in RAN2, and suggest not to consider it because extend/reuse existing RAR MAC CE is not straightforward and defining a new MAC CE requires more discussion and specification effort in RAN2.

Proposal 1: No enhancements on MAC RAR are needed for MSG3 repetition.

Rapporteur notices that RAN1 is only discussing the details of Option 1 at recent meetings. So it seems Option 2 will not considered. But it would be good to confirm company’s understandings.

**Q12. Do companies agree there is no need to enhance MAC RAR for Msg3 repetition (i.e. only Option 1 is used to indicate the number of Msg3 repetitions)?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo | Yes | We were told by our RAN1 colleagues that RAN1 agreed on Option 1 as Working Assumption. Further details of Option 1 are under discussion and subject to downselection (either use the MCS field or TPC field or TDRA field). Due to this we see no reason to introduce another option from RAN2 side. |
| Qualcomm | Agree | We don’t see any reasons why Option 1, which is already agreed by RAN1, is not good enough and RAN2 need to study other enhancements. |
| Ericsson | NA | RAN1 is currently working on this and it would be better to have them decide. We propose that we do not make any agreements on this in order not to interfere with their work. |
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## UE capability

Regarding UE capability of Msg3 repetition, in [2], it proposes to not introduce UE capability, because PRACH resource for requesting Msg3 repetition is signalled in system information. If network wants to know the percentage of UE’s capability, other methods can be used. E.g. RACH report via MDT.

Rapporteur thinks this makes sense for initial access UEs, but we also need to consider other RACH events (e.g. handover, BFR) which UE is in RRC\_CONNECTED mode. Note that for BFR, network can configure separate RACH resource in BFR configuration, and for handover to non-initial BWP in target cell, the common RACH resource (for CBRA) is provided via RRC dedicated signalling.

**Q13. Do companies agree there is no need to introduce UE capability for Msg3 repetition?**

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| **Company** | **Yes or No** | **Comments** |
| Lenovo | Postpone | We should wait for RAN1 progress. RAN1 is discussing whether the UE capability of supporting Msg3 PUSCH repetition needs to be reported after initial access procedure or not. |
| Qualcomm | Yes | All RACH enhancements for RRC Idle/Inactive are optional features, not UE capabilities.  For RRC Connected, because Msg3 repetition is for CBRA only, RACH resources for Msg3 repetition are configured by common signaling. So network does not need to know whether UE supports msg3 repetition or not. |
| Ericsson | No | We just do not see a reason why we wouldn’t introduce a capability bit for it. One reason is related to connected mode configuration. Other reason is the problem of relying on SON or RACH report for an indication of msg3 repetition support is two-fold: 1) this requires the UE to also implement SON features, and 2) SON will not address msg3 repetitions in Rel-17 as far as I know. |
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# Conclusions

*To be added…*

# References

1. R2-2107008 MAC Aspects of UL Coverage Enhancements Samsung Electronics Co., Ltd discussion Rel-17 NR\_cov\_enh-Core
2. R2-2107220 RAN2 enhancements for Msg3 repetition Qualcomm Incorporated discussion Rel-17 NR\_cov\_enh-Core
3. R2-2107745 Consideration on Msg3 repetition in CE ZTE Corporation, Sanechips discussion Rel-17 NR\_cov\_enh-Core
4. R2-2108003 On support of Type A PUSCH repetitions for Msg3 CATT discussion Rel-17 NR\_cov\_enh-Core