**3GPP TSG RAN Meeting #90e RP-20xxxx**

**Electronic Meeting, December 7 – 11, 2020**

**Agenda item:** 9.1.5

**Source:** Moderator (Qualcomm)

**Title:** Moderator's summary for email discussion [90E][47][RAN4\_repeater]

**Document for:** Discussion

# 1 Introduction

Repeaters are an integral part of cellular deployments. NR deployments tapping on new spectrum at higher bands in FR1 and FR2 pose coverage challenges that Repeaters could efficiently address. This is the main reason why we believe that having a Rel-17 NR Repeater project is of paramount importance.

In this document, we will provide a summary for the email discussion on RAN4 NR Repeaters WI scope during RAN#90-e.

The Tdocs input to the discussion are:

[1] RP-202748, “Summary of email discussions on NR Repeaters”

[2] RP-202750, “Motivation paper for NR Repeaters”

[3] RP-202749, “New WID proposal for NR Repeaters”

[4] RP-202813, “New WID proposal for NR Repeaters r1”

Note that [1] captures the email discussions which took place after RAN#89-e (a reference to the email discussions before RAN#89-e is available in the same Tdoc as an Annex). The items that were discussed after RAN#89-e were the following:

* Topic 0: Overall interest on NR repeaters RAN4 project in Rel-17
* Topic 1: Frequency range and duplexing of interest for NR repeaters (e.g., FR1 FDD/TDD, FR2)
* Topic 2: Objectives of candidate WID (e.g., RF/EMC requirements, assess benefits of smart repeaters, etc)
* Topic 3: Other WG involvement
* Topic 4: Other issues

The following Proposals were made in [1]:

**Proposal 1**: Approve RAN4 project on NR repeaters in Rel-17.

**Proposal 2**: Consider FR1 (FDD and TDD) and FR2 bands.

Note that IAB has defined RF requirements for FR1 TDD bands (n41, n77, n78, n79) and FR2 bands (n257, n258, n259, n260, and n261) in Rel-16.

**Proposal 3**: Have WI objective for RF repeaters RF and EMC requirements, as we all, assessment of coverage/performance advantages from having knowledge on UL/DL configuration and/or spatial (beam) information.

In addition, a WID proposal was put forth in [3]. The proposal in [3] was slightly modified taking into account some comments made offline by supporting companies leading to the WID proposal in [4].

Given the two rounds of email discussions that we already had for this project proposal, we would not want to replicate those discussions yet one more time. Instead, we would like to focus this discussion on the actual Objectives in [4].

# 2 WI Objectives

[4] supported by Qualcomm, Commscope, MediaTek Inc., Verizon Wireless, CMCC, Telstra, Telecom Italia, Deutsche Telekom, Orange, Charter Communications Inc, T-Mobile USA, KT Corp., AT&T, British Telecom, China Telecom, KDDI, CableLabs, CHTTL proposes the following Objectives for the Rel-17 WI on NR Repeaters:

Normative work phase objective [RAN4]

* Specify RF(1) and EMC requirements for NR repeaters
* Consider FR1 (FDD and TDD) and FR2 (TDD) bands

Study phase objective [RAN4]

* Assess the coverage/performance advantages of smart repeaters over RF repeaters offered by having side control information to selectively apply amplify-and-forward relay operation assuming availability of the following [RAN4]:
  + Timing information, i.e., slot and symbol UL/DL configuration
  + Transmitter and receiver spatial information, i.e., beam information
* Checkpoint at RAN#93 to task RAN1 and RAN2 as necessary to determine the specification impact and assess complexity level versus IAB to support smart repeaters and decision on how to proceed with normative work

For all of the above objectives, the leveraging of RF specifications for LTE repeater and IAB should be sought while targeting a substantial simplification of the overall specification and associated cost and implementation.

(1) These requirements would include (but not be limited to):

* Operating bands and channel arrangement
* Output power
* Frequency stability
* Out of band gain
* Operating band unwanted emissions
* Protection of the BS receiver in the operating band
* Spurious emissions
* Co-existence
* Error Vector Magnitude
* Input Intermodulation
* Output intermodulation
* Adjacent Channel Rejection Ratio

## Feedback on WID Objectives

**Q1**: Are these Objectives agreeable?

**Q2**: If Objectives are not agreeable, please provide the reason and state which Objective(s) would be agreeable.

|  |  |  |
| --- | --- | --- |
| **Company** | **Q1: Agreeable?** | **Q2: Comments** |
| Qualcomm | Yes | -- |
| CommScope | Yes | -- |
| T-Mobile USA | Yes | -- |
| China Telecom | Yes |  |
| Verizon | Yes | -- |
| CMCC | Yes |  |
| CHTTL | Yes |  |
| Telstra | Yes | -- |
| KT | Yes |  |
| Deutsche Telekom | Yes | We clearly see focus on the normative objectives part as this is the baseline for any other enhancement and is missing for NR already since Rel-15 (see also my comment sent on this email tread before this table was created). |
| MediaTek | Yes | -- |
| Ericsson | No | Regarding the Study Phase objectives, as commented in the e-mail discussions we think that a study on smart repeaters involves other WGs and goes beyond the scope of RAN4. It also necessitates a large amount of TUs.  Regarding the normative phase:  For FDD, creating an NR repeater spec based on the E-UTRA specification is straightforward.  For TDD, there are some potential complexities. It is not clear whether a repeater will do some kind of beamforming on a proprietary basis or what power level (power and EIRP) it will have. If it does not behave like a defined UE power class in uplink slots then it does not fit the co-existence analysis done in RAN4 and will not guarantee co-existence between operators. If we would attempt to capture some description of what repeaters may/may not do and do co-existence analysis in RAN4 this would need a lot of TU.  Also, if the repeater synchronizes to the TDD pattern it is not clear how it should behave with respect to timing advance and whether this impacts co-existence.  Regarding emissions, to avoid co-existence issues the repeater would need to meet BS requirements in DL slots and UE requirements in UL slots. If the repeater would adapt its emissions behavior between DL and UL slots, then testing would need to establish that the repeater correctly synchronizes and knows the TDD pattern. This would necessitate a potentially complex discussion on how to define the requirements and testing.  Potentially some RAN1 input may be needed in relation to how the repeater synchronizes, does timing advance, impacts the MIMO operation etc.  So we think that TDD repeaters need some more consideration, and it is better to start with FDD. |
| Nokia | This is not the right question for the present discussion! As stated by the Chairman, “the goal is to identify a small core set of functions that brings the most added value with reasonable work effort.” | In principle, these objectives are interesting, but for now we have to identify a small core set. As highlighted already by DT, this should comprise the first objective, which is also the most needed:  Normative work phase objective [RAN4]   Specify RF(1) and EMC requirements for NR repeaters   Consider FR1 (FDD and TDD) and FR2 (TDD) bands  The “study phase objective”, “assess the coverage/performance advantages of smart repeaters over RF repeaters”, cannot be done until the above is done, and it cannot be done by RAN4 alone – it needs RAN1 and RAN2 input from the start. This aspect should be considered separately later, when the proper comparison can be done in all relevant groups between RF repeaters and IAB nodes.  Regarding “while targeting a substantial simplification of the overall specification and associated cost and implementation”, it is not clear what the reference point is for the substantial simplification. It would be better to say “while targeting specification and implementation simplicity.”  Finally, RAN#94 would be a more realistic completion target for the normative work. |
| Huawei | No | Regarding the work phase objective, agree with Ericsson that FDD would be straightforward and the scope of the WI is controllable. For TDD bands, besides the issues identified by Ericsson, it is noted that most NR TDD bands support large frequency range compared to FDD bands, “out of band gain” is listed as one requirement to be studied in the objective, just because repeater could cause interference in the network as well. The network performance impact of repeater to wider NR band is not clear so far, which also deserves to be studied.  For the Study phase objective, even it only lists RAN4 as affected working group, the involvement of other working group may not be avoided. The study will cause overly work load not only to RAN4 but also to other groups. Considering so many WI/SI proposed in this RAN meeting on top of heavy workload of existing topics in RAN4, we think the WI scope must be reduced. Thus the study phase objective shall not be considered in the WI.  We also think that the WI should be started with FDD. |
| Sony | Yes | We are generally fine with the proposal. We think the study phase is also a critical part of the WI to initial the evolution from RF repeater to smart repeater, and it should be included. |
| AT&T | Yes | -- |
| ORANGE | Yes |  |
| Intel | No | 1) The objectives for FR1 are fine for us  2) For FR2, so far, no RF Repeater is defined in NR and the basic RF repeater performance is unclear. The reference RF repeater design should be clarified at least for FR2 before Smart Repeater enhancements can be investigated. We think in the initial stage studies shall focus on the identification of the baseline FR2 repeater and identification of candidate enhancements (smart repeater) can be considered after this work is done. Study stage for identification of baseline FR2 repeater is preferable.  3) For the “Normative work phase objective” – is it intended to specify basic or smart repeaters? |
| Charter Communications, Inc | Yes | -- |
| Cablelabs | Yes |  |
| Samsung | No | For work phase objectives, we also agreed with Huawei and Ericsson that scope need to limit to FR1 FDD. LTE Repeaters specification can be used as starting point.  For study phase objective, the study of performance gain of smart repeater requires other RAN1/2 involvement. The study is certainly beyond RAN4 scope. Considering the overall capacity in WG in REl-17, study phase objectives shall be removed from this RAN4 SI. |

In reply to Intel’s question “For the “Normative work phase objective” – is it intended to specify basic or smart repeaters?”, the answer is that the normative work objective was meant to specify basic repeaters in Rel-17.

# 2 Observations and Proposal

**Observation 1:** There is a broad support for having a RAN4 project on NR Repeaters in Rel-17. All the participating companies showed interest and the discrepancy lies on the objectives for the project.

**Observation 2:** According to some companies, the “study objective” in the WID proposal requires involvement from other WGs, namely, RAN1 and RAN2.

**Observation 3:** Some companies would like to focus the Repeater work on FR1 FDD (already done in LTE) while the majority of companies want to do the Repeater work for all type of NR bands, i.e., FR1 FDD/TDD and FR2.

According to the moderator and the expressed majority view, it is important for NR Repeaters to cover all types of bands. Indeed, the majority of new NR bands which will necessitate Repeaters the most are higher frequency FR1 TDD bands (n77, n78, n79) on top of some other TDD bands which already were very relevant for LTE TDD deployments (e.g., n41). In addition, NR introduces FR2 operation with new bands (n257, n258, n259, n260, n261). Note that all these bands are already supported in IAB specifications [5].

Despite the broad interest in the smart repeater part of the project and as proposed by the RAN chairman to contain the scope of new projects to RAN4 workload, we recommend the following as the outcome of this email discussion:

**Proposal**: Approve Rel-17 RAN4 WI on NR Repeaters targeting completion by RAN#94 and with the following objective (normative objective from WID proposal in [4]):

Normative work phase objective [RAN4]

* Specify RF(1) and EMC requirements for NR repeaters
* Consider FR1 (FDD and TDD) and FR2 (TDD) bands

For the above objective, the leveraging of RF specifications for LTE repeater and IAB should be sought.

(1) These requirements would include (but not be limited to):

* Operating bands and channel arrangement
* Output power
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* Adjacent Channel Rejection Ratio

# References

[1] RP-202748, “Summary of email discussions on NR Repeaters”

[2] RP-202750, “Motivation paper for NR Repeaters”

[3] RP-202749, “New WID proposal for NR Repeaters”

[4] RP-202813, “New WID proposal for NR Repeaters r1”

[5] 38.174, “NR; Integrated Access and Backhaul (IAB) radio transmission and reception”