3GPP TSG-RAN WG2 Meeting #111-e R2-200xxxx

Electronic, August 17th – 28th 2020

Agenda Item: 8.7.2

Source: Interdigital (Rapporteur)

[AT111-e][603] Scope, requirements, and scenarios (Interdigital)

Document for: Discussion, Decision

# Introduction

The following offline discussion was kicked off at RAN2#111-e:

* [AT111-e][603][Relay] Scope, requirements, and scenarios (InterDigital)

      Scope: Discuss proposals on the scope, requirements, and scenarios for UE-to-network and UE-to-UE relaying, including:

* Coverage scenarios
* Connectivity scenarios
* Uu and PC5 RATs
* RRC states for relaying
* Cast types for the PC5 link
* Potential reuse of requirements from earlier releases (e.g. FeD2D, LTE ProSe relaying)

      Intended outcome: Summary with potential agreeable TP

      Deadline:  Monday 2020-08-24 1200 UTC

The summary of this email discussion is discussed in document.

# Discussion

## Uu and PC5 RATs

A number of contributions [3][11][9][18][4] discuss the RAT to be supported on Uu and PC5. Specifically, PC5 supports both LTE sidelink (Rel15) and NR sidelink (Rel16). Furthermore, the Uu link for the case of UE to NW relay can be either LTE or NR. Furthermore, for UE to UE relay, any of the in-coverage UEs could, in theory, be controlled by LTE or NR, as Rel-16 supports LTE controlling NR sidelink.

**Question 1: Which of the following RAT(s) should be supported for PC5 for the UE-to-NW Relay and UE to UE relay?**

* **a) NR PC5**
* **b) LTE PC5**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO | a |  |
| Ericsson (Tony) | A | We believe that addressing the crossRAT functionality in case of relay it would require too much work and efforts. Given the limited time we have we prefer to consider only the NR PC5 RAT. |
| Qualcomm | a) | In SA2 scoping, it only has NR PC5:  NR based PC5 is considered. |
| MediaTek | a) NR PC5 | We believe the scope of the study item means NR PC5 based relaying operation. |
| Lenovo, MotM | A |  |
| Huawei | a) |  |
| FirstNet | a) &b) |  |
| Interdigital | a) |  |

**Question 2: Which of the following RAT(s) should be supported for Uu link of the UE to NW relay?**

* **a) NR: Relay UE is connected to an gNB**
* **b) LTE: Relay UE is connected to an ng-eNB**

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| Company | Response | Comments |
| OPPO | A | Even though LTE can be considered for L3 U2N relay (considering the smaller delta part compared to L2), it is preferred to focus on NR during the study phase to have a common ground for L23 comparison. |
| Ericsson (Tony) | A | Our preference is to have this functionality only for NR UE under an NR gNB. |
| Qualcomm | a) | b) may have LTE spec change. Considering the current schedule of SI is already tough, we prefer to focus on NR gNB |
| MediaTek | a) | We prefer a focused scope and not complicate the things during the study. |
| Lenovo, MotM | A | b) only if there’s any strong/ specific need identified e.g. for public safety. |
| Huawei | a) | This has been confirmed by SA2. |
| FirstNet | a) &b) |  |
| Interdigital | a) |  |

**Question 3: For UE to UE relay using LTE/NR PC5, should we support the scenario where any of the Ues are controlled by the other RAT (e.g. LTE controlling NR PC5)?**

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| Company | Response | Comments |
| OPPO | No |  |
| Ericsson (Tony) | No | We should support this feature only within NR PC5 capable Ues. |
| Qualcomm | No | Considering the current schedule of SI is already tough, we prefer to focus on NR PC5 and NR gNB, i.e. no cross-RAT control for relay |
| MediaTek | No | We prefer a focued scope for the study |
| Lenovo, MotM | No | Will be easier to focus on the same-RAT situation first i.e. cross-RAT can be included later if real need is identified. |
| Huawei | No | Focus on the gNB controled NR PC5. |
| FirstNet | Yes | When NR PC5 is de facto, one may wander into LTE cell |
| Interdigital | No | We prefer to focus the study on the relaying solution, and address cross RAT later if needed. |

## Coverage Scenarios for UE-to-NW Relay

According to Rel-17 NR SL Relay SID [1], the primary motivation for SL relaying for UE to NW relay is for coverage extension and power efficiency. Coverage scenarios which can be considered to address this motivation are:

* UE-to-NW relay is in-coverage (IC)
* Remote UE is either in-coverage (IC) or Out-of-coverage (OOC)

**Question 4: Do you agree to the following coverage scenarios for UE to NW relay?**

* **a) Relay UE in coverage, and remote UE out of coverage**
* **b) Relay UE in coverage, and remote UE in coverage**

**If not, explain why.**

|  |  |  |
| --- | --- | --- |
| Company | Response (Y/N to a/b) | Comments |
| OPPO | Y (i.e., a and b) |  |
| Ericsson (Tony) | A and B | We should not limit the study on the solution only to the cases where the remote UE is in coverage. This is also not in line with the SA1 use cases and for which we need to address the requirements. During this study we need to consider both case and we may decide to downprioritize one during the normative work.  Further, for the case of remote UE incoverage, we need to highlight that the use of relay is only performed if the Uu connectivity is not available. Otherwise, the Uu connectivity is always prioritized (or at least the network has full control of it). |
| Qualcomm | a), b) | OK to follow LTE |
| MediaTek | Both Yes to a) and b) |  |
| Lenovo, MotM | Y (both) |  |
| Huawei | Yes to a)+b) |  |
| FirstNet | a) &b) |  |
| Interdigital | Yes (both) | We should follow LTE. |

It is further pointed out in [2][7] that for the remote UE in coverage, it can be in coverage of the same or different gNB/ng-eNB.

**Question 5: For the remote UE in coverage, which scenario(s) should be supported?**

1. **Remote UE in coverage of the same gNB/ng-eNB as the relay UE**
2. **Remote UE in coverage of a different gNB/ng-eNB as the relay UE**

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| Company | Response (Y/N) | Comments |
| OPPO | See comment | we do not think one has to care the serving-gNB of remote UE since our preference is not considering remote UE has a simultaneous active Uu connection, but just the relayed connection is active.  Therefore, regardless of the remote UE geo-location (in the coverage of a same /different cell or not), it connected to network via the relay UE, so located at the same cell from CN perspective. |
| Ericsson (Tony) |  | We believe it does not matter whether the remote UE is in coverage of one of multiple gNB. The actions to be performed are the usual ones that are done in Uu (i.e., about which gNB to select). |
| Qualcomm | a) and  b) needs further discussion | We think a) should be supported of course  For b), one issue is whether the remote UE will get conflicted configuration (from SIB) compared with configuration of relay if remote UE and relay are in different coverage of different gNB. But we agree that this scenario is possible. Then as compromise, we can agree b) if RAN2 can agree that no further enhancement for this scenario, e.g. assuming that NW coordination can ensure aligned relay configuration between remote UE and relay without RAN3 impact. |
| MediaTek | Y to a) | b) with lower priority. |
| Lenovo, MotM | Y (both) | Both should be studied and supported. There may be situations when a remote UE looks for a relay of the same serving cell. Also, RRC state of a remote UE may play a role as well as an example for service continuity. |
| Huawei |  | We don’t need to clearly agree something on this question. As commeeted by OPPO and Ericsson, we agreee remote UE will alwasy be controled by relay UE’s gNB once connected via relay. |
| FirstNet | a) &b) |  |
| Interdigital | See comments | Both a) and b) were possible in LTE Rel13, and captured as a scenario in FeD2D. Therefore we see no reason to exclude b) in the captured scenarios at this point. However, we should down-prioritize this scenaro if we see any RAN impacts during study. |

## Coverage Scenarios for UE-to-UE Relay

For UE to UE relay, the coverage of the network seems to have less of an impact to the scenarios, given the main goal is extending coverage of the sidelink transmissions. [2][3][4][5][7] indicate we should support in-coverage, partial coverage, and out of coverage scenarios, while [6] indicates that the out of coverage scenario should be deprioritized. For the partial coverage scenario, in theory, any of the UEs (source, relay, or target) could be in coverage or out of coverage. In [3] it is further indicated that for the partial coverage case, at least the relay UE should be in coverage. Companies are asked to further comment below if the partial coverage case is supported, whether there should be any restrictions/limitations.

**Question 6: Which coverage scenarios should be supported for the UE to UE relay?**

1. **All UEs (Source, Relay, Target) in coverage**
2. **All UEs (Source, Relay, Target) out of coverage**
3. **Partial coverage: At least one of the UE(s) in coverage, and the others out of coverage**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO | See comment | Since our preference is there is no need for UE-to-UE relay to be visible to RAN, there is no need to care the coverage status of Ues in a U2U relay connection. |
| Ericsson (Tony) | a)-b)-c) | For c) we need to consider only the scenario when the relay UE is in coverage. |
| Qualcomm | All (a/b/c) | We understand b) is the main use scenario for UE-to-UE relay. Then, if b) is precluded, we will not understand why UE-to-UE relay is still in scoping. |
| MediaTek | a), b), c) |  |
| Lenovo, MotM | All | The coverage scenarios must also function irrespective of network coverage i.e. the solutions need not depend on network coverage being available for one or the other UE. A common solution for three cases is expected. |
| Huawei | See comments | Share the view with OPPO. If we assume there is no RAN involvement, we don’t need to specify/exclude any particular scenarios. |
| FirstNet | All | Intentionally going off-line for tactical reasons |
| Interdigital | All (a/b/c) | We think a common relaying solution is possible regardless of the coverage scenarios, however, the relaying should at least be able to support different resource allocation modes (mode 1/2), which will differ depending on the coverage scenario. |

**Question 7: Should there be any limitations/assumptions for the partial coverage case (e.g. relay UE always in coverage)? Please specify.**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO |  | See reply to Q6. |
| Ericsson (Tony) |  | For the partial coverage scenario we need to consider only the scenario when the relay UE is in coverage. |
| Qualcomm | No | As indicated in Q6, we think all Ues being OOC is the main use scenario for UE-to-UE relay. So, we think it will be odd to preclude this scenario for UE-to-UE relay. |
| MediaTek | No | For UE-to-UE relay, one valid scenario is that one remote UE is in coverage and the other remote UE and relay UE are out of coverage. Thus, we don’t think there should be any limitation/assumption for partical coverage case. |
| Lenovo, MotM | No |  |
| Huawei | No, see comments | Similar as the comments in Q6. |
| FirstNet |  | No limitations |
| Interdigital | No | For scenario c), we agree that the relay UE in coverage may result in some differences (e.g. with respect to resource allocation) but there seems no reason to restrict this scenario to the case where the relay is in coverage, given that the OOC case is supported. |

Similar to Question 5, it may be possible for any of the source UE, relay UE, or target UE to be in the coverage of the same of different gNB/ng-eNB. Companies are asked whether to the SI should cover all these scenarios, or whether to prioritize certain sub-cases.

**Question 8: Should the UE to UE relay scenarios allow different UEs (source, relay, target) to be in coverage of different gNB(s)/ng-eNB(s)?**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO |  | See reply to Q6. |
| Ericsson (Tony) | No | It may be too difficult to handle the case where the UEs are in coverage of different gNBs. Of course we may specify that in such a case pre-configuration is used, but we prefer to avoid studying this scenario in this study item. |
| Qualcomm | Yes with comments | Similar to our comment in Q5, one issue is whether the 2 remote UE will get conflicted configuration (from SIB) compared with configuration of relay if remote UE and relay are in different coverage of different gNB. But we agree that this scenario is possible. Then as compromise, we can agree it if RAN2 can agree that no further enhancement for this scenario, e.g. assuming that NW coordination can ensure aligned relay configuration between remote UE and relay without RAN3 impact. |
| MediaTek | Yes, but | It should be lower priority when different UEs are in coverage of different gNB(s)/ng-eNB(s). |
| Lenovo, MotM | Yes | A general model should work irrespective of the network coverage. |
| Huawei | No | Anyway, simple scenario should be the startign point. |
| FirstNet | Yes | Presence of small cells, picocells, along with macro may restrict everybody to be on same cell |
| Interdigital | Yes with comments | We agree not to limit this scenario at this point, and if there are significant impacts identified to RAN, this scenario can be de-prioritized. |

## Connectivity Scenarios

In legacy UE to NW relaying, a PC5 link between the remote UE and relay is assumed to allow relaying of data. In Rel16 NR V2X, a PC5-RRC connection was introduced for unicast. It can likely be concluded that relaying requires such PC5-RRC connection before relaying of data can be initiated.

**Question 9: For UE to NW relaying, do you agree that relaying is possible only when the remote UE and relay UE have a PC5 RRC connection? If not, explain why.**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO |  | The only exceptional case would be for system information delivery, where at least the MIB/SIB1 related part can be forwarded to remote UE in the proximity before PC5 connection being established. |
| Ericsson (Tony) | No with comment | This may be true only for the L2 architecture. In case of L3 the could be no need of the PC5-RRC |
| Qualcomm | Yes | We prefer to reuse Rel-16 NR V2X procedure to establish a unicast PC RRC connection first, which is common for L2 and L3 relay. Otherwise, we may need signifcant spec work for a new PC5 link establishment procedure. |
| MediaTek | Agree |  |
| Lenovo, MotM | Yes for L2 relay and No for L3 relay | For L3 UE-Network relay, the PC5-RRC connection could be unnecessary.  For L2 UE-Network relay, the PC5-RRC connection is needed since the remote UE should be reachable (visibility principle) from gNB perspective. |
| Huawei | Yes | If we only focus on the unicast PC5 link, then that is the case. |
| FirstNet | - | May depend on selection of L2 or L3 relay |
| Interdigital | Yes with comments. | Even in L3, if we follow LTE baseline, a PC5-link is required, and this translates to a PC5-RRC connection if Rel16 NR sidelink is assumed. We also agree with OPPO, that there may be exceptions that need further study. |

In Rel14 FeD2D SI [8], the following scenarios were captured (shown below). Effectively, these scenarios represent the coverage scenarios discussed in the first section, where the remote UE can either have a connection to the remote UE, or have no connection to the remote UE.



Figure 1: Coverage scenarios [8]

**Question 10: For each coverage scenario agreed in section 2.2, do you agree to study the scenarios where the remote UE is either connected to the relay UE (via a PC5-RRC connection) or not connected to the relay UE? If not, explain why.**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO |  | As replied to Q9, the no-connection case is OK if the intention is to study the SI-delivery. Otherwise, it is just a temporary stage before/after connection establishment/release, and there is no key issue to address from it. |
| Ericsson (Tony) | Yes (no support for scenario 5 and 6) | We are okay with scenario 1, 2, 3, 4 but we prefer to not study scenario 5 and 6 in this release as they bring in too much complexity. |
| Qualcomm | See comments | We don’t fully understand what does “study the scenario not connected to the relay“ means. If remote is not connected to relay, isn’t it within scoping of discovery and relay (re)selection? We don’t think anyone will challenge to study discovery and relay (re)selection. So we think clarification is needed for the intention of this question.  For the scenarios, we support 1)-4). We can agree 5)/6) if RAN2 can agree that no further enhancement for this scenario, e.g. assuming that NW coordination can ensure aligned relay configuration between remote UE and relay without RAN3 impact. |
| MediaTek | No | We should depriortize the scenarios where the remote UE is not connected to the relay UE. The focus should be put on scenario where the remote UE is connected to the relay UE via a PC5-RRC connection. |
| Lenovo, MotM | Yes | A more general study, independent of a PC5 RRC connection, should be done. RAN2 may prioritize certain scenarios. |
| Huawei | No | The assumption should be "remote UE and relay UE has the unicast PC5 connection", when discussing the relaying data. Before the discovery procedure, any case is possible.  We are not sure the question is clear itself. |
| Interdigital | Yes | We think the intent of scenarios 2) and 3) in FeD2D were to address how the UE initiates establishment of the link for relaying (and not the relaying itself) as described in TR 36.746.  *The following procedures are supported for these scenarios:*  *- In Scenario 2, either the evolved ProSe Remote UE or the network can initiate establishing a link between the evolved ProSe Remote UE and the evolved ProSe UE-to-Network Relay UE;*  *- In scenario 3, either the evolved ProSe Remote UE or the network can initiate establishing a link between the evolved ProSe Remote UE and the evolved ProSe UE-to-Network Relay UE;*  *- It can be considered if there should be further restrictions on the network initiated cases.*  Since discovery/relay selection and link establishment are part of the study, we think it makes sense to capture these scenarios, similar to FeD2D. |

Similarly, for UE to UE relay, the source UE can have a relayed PC5 connection with the target UE already established, or may need to establish the PC5 connection (e.g. using discovery and connection establishment procedures).

**Question 11: For each coverage scenario agreed in section 2.3, do you agree to study the scenarios where the source and target UE have either a PC5 link established, or have no link established? If not, explain why.**

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| Company | Response | Comments |
| OPPO | No | Without the related isuse of SI-delivery as replied to Q9, we do not need to address the scenario where there is no connection between Ues, i.e., it is just a temporary stage before/after connection establishment/release, and there is no key issue to address from it. |
| Ericsson (Tony) | No | Only the case where the source UE and target UE has no possibility to establish a PC5 link should be studied. If a direct PC5 can be used, this should be always preferred. |
| Qualcomm | See comments | Similar to Q10, we don’t fully understand the intention of this question. We think clarification is needed |
| MediaTek | Yes | Both should be studied. The combined procedure of relay discovery and connection establishment should be subject to the decison to be made by SA2. |
| Lenovo, MotM | Yes | A more general study, independent of a PC5 RRC connection, should be done. RAN2 may prioritize certain scenarios. |
| Huawei | No | Agree with OPPO |
| Interdigital | Yes | Similar to our reasoning in the previous question, we think discovery/connection establishment for the UE to UE relay should be studied by RAN2 (in conjunction with SA2) so this scenario is relevant for that reason. |

[3] [9][10][11] discusses the MR-DC architectures in both cases of UE to NW relay and UE to UE relay. In NR sidelink, MR-DC is down-prioritized in that the UE operating in sidelink is assumed to be scheduled by the MN only. Most companies indicate that for relaying, the same assumption can be taken with regards to MR-DC in this SI.

**Question 12: Can the same assumption taken in NR V2X related to MR-DC be taken for the relay UE in a UE to NW relay and UE to UE relay: the relay UE if connected on Uu via MR-DC is scheduled on sidelink only by the MN? If not, explain why.**

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| Company | Response | Comments |
| OPPO |  | According to email discussion for R16 V2X capability in from RAN2#110 ([707]), there are companies even tend to exclude the co-configuration of MR-DC and sidelink, so we suggest to focus on SA case only in the study to reduce the dimensions for L23 comparison. |
| Ericsson (Tony) | Yes | We can apply the same principles of Rel-16 |
| Qualcomm | No (MR-DC without any restriction) | For L3 relay, we think its Relay Uu link is different from NR Rel-16 V2X scenario, and don’t understand why MR-DC needs to be precluded.  In L3 relay, the Uu PDCP terminates on Relay, and PC5-PDCP also terminates on Relay. Note that relay may not have any sidelink transmission when it performs traffic forwarding. The packet received/sent by Relay over Uu is no different from a packet generated by itself. Then, we don’t think any limitation should be put on Relay Uu link on MR-DC.  In L2 relay, we prefer to have same scenario as L3 relay. So, we request to study the same scenario. |
| MediaTek | Yes |  |
| Lenovo, MotM |  | Starting with SA case is fine but later same principles should apply to a Rel. 16 NR V2X UE and Rel 17 SL relay. |
| Huawei | No | Let’s focus on the SA. It is R17, EN-DC is not the major deployment. And, NR-DC is mainly for larger thoughput, which is not the scope of SL relay. |
| Interdigital | No | We can assume SA scenario for simplicitly. |

In addition to MR-DC, multiconnectivity of the relayed link is also discussed in [10][4]. For the UE to NW relay, in stage 1 description of TS 22.261, the connectivity models for the remote UE are as follows:

6.9 Connectivity models

6.9.1 Description

The UE can connect to the network directly (direct network connection), connect using another UE as a relay UE (indirect network connection), or connect using both types of connections. […]

Although connection to the network by the remote UE with both types of connections (direct or indirect) are possible, [4] prefer not to consider simultaneous Uu and PC5 connection, as was assumed in FeD2D.

**Question 13: Which connectivity scenarios should be supported for the remote UE in UE to NW relaying?**

1. **Active link with only the relay or directly with Uu, but not both.**
2. **Active link with both the relay UE and with Uu supported simultaneously**
3. **Active links with different relay Ues supported simultaneously**

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| Company | Response | Comments |
| OPPO | A | It is preferred to simplify the dimension of the scenarios, in order to focus on the comparison of L23 solution during the study, considering the limited timefor this study. |
| Ericsson (Tony) | a) |  |
| Qualcomm | a) |  |
| MediaTek | a) |  |
| Lenovo, MotM | a) |  |
| Huawei | a) |  |
| FirstNet | See comments | a)Yes, b)No-already connected to network, c)yes |
| Interdigital | a) | Single link should be preferred, as in FeD2D. |

UE to UE relaying was not considered in the past 3GPP releases. Similar to UE to NW relay, for UE to UE relay, the SI could support only a single active link between the source and target UE, or could support relaying between the source and target via multiple paths (whether direct or indirect).

**Question 14: Which connectivity scenarios should be supported for the source UE in UE to UE relaying?**

1. **Active link to the target UE either directly or via a relay UE, but not both**
2. **Active link with a target UE both directly and via a relay UE**
3. **Active links with a target UE supported via different relay Ues**
4. **Active links with two different target Ues via two different relay Ues**

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| Company | Response | Comments |
| OPPO | A | It is preferred to simplify the dimension of the scenarios, in order to focus on the comparison of L23 solution during the study, considering the limited timefor this study. |
| Ericsson (Tony) | a) with comment | If the target can be connected to the source via a direct link, than there is no need for relay. |
| Qualcomm | a) |  |
| MediaTek | a) |  |
| Lenovo, MotM | a), b), c) and d) | We should support all scenarios for diversity (increasing reliability and reducing delay) purpose. The requirements will go upwards from 5 or 6 ‘9’s now (see PQI 91 in TS 23.287) to 7, 8 or even 9 ‘9’s in future applications. |
| Huawei | A) | Other cases can be studied in WI pahse if time allowed. |
| FirstNet | See comments | a)No, b)Yes-The Relay could be connected to aother UE that you may want to communicate with. C)Yes |
| Interdigital | A) | Agree with Huawei and OPPO |

## Cast Types for the PC5 Link

NR Sidelink supports unicast, groupcast, and broadcast. For UE to NW relay, support of groupcast or broadcast would depend on MBS work, which is yet to be concluded. For this reason, the SI could focus on the unicast case for PC5, which was suggested by multiple companies.

**Question 15: Do you agree to support only unicast traffic for the UE to NW relay?**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO | Yes |  |
| Ericsson (Tony) | Yes |  |
| Qualcomm | Need clarification | If it means the traffc being forwarded, as mentioned by Rapporteur, support of groupcast or broadcast for UE-to-NW relay depends on MBS. Since MBS is not concluded, we also see no point to support unicast between remote UE and relay.  If it is discovery message, it can be broadcast/groupcast  If it is paging or SIB forwarding, we assume PC5 RRC can work, but we are not sure whether we can preclude PC5 broadcast SIB at this stage. |
| MediaTek | Yes |  |
| Lenovo, MotM | No | Reliability and coverage extension are at least as important for GC and BC, at least the most critical/ emergency signaling uses GC or BC and so it is best to benefit in terms of coverage extension and reliability here. |
| Huawei | Yes |  |
| FirstNet | No | Will be using several multicast for mission critical services |
| Interdigital | Yes | We think the data traffic being relayed should consist only of unicast traffic. |

For UE to UE relay, PC5 already supports groupcast/broadcast. Relaying of broadcast may have limited applications. However, for groupcast, there may be two scenarios:

* Groupcast traffic is relayed by a source UE via a UE to UE relay
* Unicast traffic is relayed by a source UE via multiple UE to UE relays

**Question 16: In addition to unicast, which (if any) of the following should be supported?**

1. **Groupcast traffic relayed by a source UE via a UE to UE relay**
2. **Unicast traffic relayed by a source UE via multiple UE to UE relays**
3. **None (avoid/de-prioritize any non-unicast cases for UE to UE relay)**
4. **others**

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| Company | Response | Comments |
| OPPO | c | It is preferred to simplify the dimension of the scenarios, in order to focus on the comparison of L23 solution during the study, considering the limited timefor this study. |
| Ericsson (Tony) | c) |  |
| Qualcomm | Align with U2N conclusion | Althogh we agree that groupcast may be helpful for UE-to-UE relay, we prefer to follow guideline of SID:  “ NOTE 2: It is assumed that UE-to-network relay and UE-to-UE relay use the same relaying solution.” |
| MediaTek | c) |  |
| Lenovo, MotM | a and b | Reliability and coverage extension are important. |
| Huawei | c |  |
| FirstNet | See commnets | 1. Yes, b) Yes, c) No |
| Interdigital | c | Similar to our response from the previous question. |

## RRC States for Relaying

The RRC state discussion will depend on

* whether the discussion is for UE to NW relay, or UE to UE relay
* whether L2 relay or L3 relay is assumed

For L3 UE to NW relay, Rel13 (ProSe UE to NW Relays) assumed the following:

* A relay UE or remote UE could perform relay discovery in either IDLE or CONNECTED
* A relay UE is performing active relaying of data is in RRC\_CONNECTED.

**Question 17: Can similar assumptions be made for RRC state of relay/remote UE as Rel13 be made for L3 UE to NW relay case, namely:**

1. **Relay or remote UE can perform relay discovery in either IDLE, INACTIVE, CONNECTED**
2. **A relay UE must be in RRC\_CONNECTED to perform active relaying of data**

**If not, explain why.**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO | Yes | For remote UE, it can be OOC additionally |
| Ericsson (Tony) | Yes | Remote UE OoC should also be considered. |
| Qualcomm | Yes | Prefer to follow LTE. And remote UE can be OOC |
| MediaTek | Yes |  |
| Lenovo, MotM | Yes |  |
| Huawei | Yes |  |
| FirstNet | Yes |  |
| Interdigital | Yes |  |

For L2 UE to NW relay, the assumptions in FeD2D SI may be taken as a baseline. In that study, the RRC state of the remote/relay UE can change independently of the state of the PC5-RRC connection. However, when unicast data is being relayed, both relay and remote UE are assumed to be in RRC\_CONNECTED.

**Question 18: Can similar assumptions be made for RRC state of relay/remote UE as Rel14 FeD2D for L2 UE to NW relay case, namely:**

1. **Relay/remote UE RRC states can change independantly of the state of the PC5-RRC connection**
2. **Both Relay and remote UE must be in RRC\_CONNECTED to perform active relaying of data**

**If not, explain why.**

|  |  |  |
| --- | --- | --- |
| Company | Response | Comments |
| OPPO | Comment on i, and OK to ii | Ii is apparently OK  For i, we are not sure if all combination is OK, e.g., the combination of connected-remote-UE and idle/inactive-relay-UE is apparenetly not feasible.  Additionally, for remote UE, it can be OOC. |
| Ericsson (Tony) | Yes with comment | For i) we believe that network should have the control on whether the remote and relay UE in CONNECTED can perform discovery when in coverage.  For ii) we think that only the relay UE should be in CONNECTED for relaying the data, but the remote UE can be OoC or in a different RRC state. |
| Qualcomm | Yes for ii)  Comment for i) | For i), we think there should be some couping between RRC state of relay and RRC state of remote UE. For example, when relay UE is in IDLE, remote can’t be in CONNECTED |
| MediaTek | Yes | We think the assumption on RRC state can be made as such. But the exact solutions to support the independant RRC state at Remote UE and Relay UE can be studied later on or at the normative phase. |
| Lenovo, MotM | Same comment as Oppo |  |
| Huawei | Yes to ii),  but not sure about i) | To clarify the question,we assume following table is what the i)+ii) referes to:   |  |  |  | | --- | --- | --- | | **Remote UE RRC State** | **PC5-RRC connected?** | **Relay UE RRC State** | | IDLE/ CONNECTED | ✗ | IDLE/ CONNECTED | | IDLE | ✓ | IDLE/ CONNECTED | | CONNECTED | ✓ | CONNECTED |   When there is no PC5-RRC connection between remote UE and relay UE, the RRC state in i) is for direct connection. There is no need of disucss the direct RRC state in that case, which is purely legacy issue.  So, I assume the intension of the two bullets is for the case there is PC5-RRC connection. We are wondering if the followings are the correct intention.   |  | | --- | | When there is PC5 connction betwee remote and relay UE:   1. **Relay UE can be in either IDLE or CONNECTED, if no active relaying of data with remote UE in IDLE;** 2. **Both Relay and remote UE must be in RRC\_CONNECTED to perform active relaying of data;** | |
| Interdigital | Yes. | In FeD2D, the intent of i) is that there is no direct dependance of PC5-RRC connection with Uu RRC state – namely, the remote UE could change its Uu RRC state independantly while remaining PC5-RRC connected. This princiciple should still hold.  With resepect the combinations which are allowed/not allowed. We think only the case pointed out by OPPO is not allowed. |

In addition to these baseline assumptions, which states to be considered to support paging of a remote UE needs to be further considered and is discussed in a number of contributions [6][9] [13][14][15][16]. One question discussed is whether the relay and/or remote UE should support RRC\_INACTIVE.

**Question 19: For L2 UE to NW relay, should RRC\_INACTIVE state be supported by the remote UE in either/both of the following cases:**

1. **When the remote UE has an active PC5-RRC connection (i.e. to receive RAN paging)**
2. **When the remote UE does not have an active PC5-RRC connection (i.e. to support relay discovery)**

**If not, explain why.**

|  |  |  |
| --- | --- | --- |
| Company | Response | Comments |
| OPPO |  | For ii, it is just a temporay stage since finally discover is to assist remote UE on relay reselection, and a relay UE is to be reseelcted for remote UE to camp on (establish PC5 connection) to receive paging.  Although logically we see it is feasible to discuss inactive UE, it is preferred to deprioritize the INACTIVE state, in order to simplify the dimension of the scenarios, in order to focus on the comparison of L23 solution during the study, considering the limited timefor this study. |
| Ericsson (Tony) | Yes |  |
| Qualcomm | Yes for i) and ii) |  |
| MediaTek | Yes for i) and ii) | i): The RRC\_INACTIVE state can be supported by the remote UE when there is active PC5 connection between Relay UE and Remote UE, which means the data transmission between Remote UE and gNB is suspended but PC5 unicast link is still alive.  ii): on top of i), Remote UE may lose connection with Relay UE during its RRC\_INACTIVE state. Then Remote UE can discover another Relay UE or connect to the gNB via direct path. |
| Lenovo, MotM |  | Remote UE can have any RRC state (Connected, Idle, Inactive or OOC). |
| Huawei | See comments | In the SI pahse, we can deprioritize the inacitve state. It could be supported in WI phase. In SI pahse, we can assume the same priciple of IDLE applies to INACTIVE. |
| Interdigital | Yes for both, with comments | We agree with Huawei, that for the purposes of the SI phase, the same principles of IDLE should apply to INACTIVE. |

**Question 20: For L2 UE to NW relay, should RRC\_INACTIVE state be supported by the relay UE in either/both of the following cases:**

1. **When it has at least one PC5-RRC connection with a remote UE (i.e. for power savings at the relay when relayed connections are not active)**
2. **When it has no PC5-RRC connections with any remote Ues (i.e. to support relay discovery)**

**If not, explain why.**

|  |  |  |
| --- | --- | --- |
| Company | Response | Comments |
| OPPO |  | Although logically we see it is feasible to discuss inactive UE, it is preferred to deprioritize the INACTIVE state, in order to simplify the dimension of the scenarios, in order to focus on the comparison of L23 solution during the study, considering the limited timefor this study. |
| Ericsson (Tony) | Yes with comment | Ok to support RRC\_INACTIVE for the relay UE, expect for the case when the remote UE state is RRC\_CONNECTED. In such a case, this should not be a valid configuration. |
| Qualcomm | Yes with comment | As Ericsson mentioned, we don’t think all possible RRC state combination is possible. So, we need to study it. |
| MediaTek | Yes | Both cases can be supported. However, we can foucs on the discussion for i). We think that ii) can be subject to legacy operation and not so relevant. |
| Lenovo, MotM |  | better to start with the assumption that relay is RRC Connected. |
| Huawei | See comments | In the SI pahse, we can deprioritize the inacitve state. It could be supported in WI phase. In SI pahse, we can assume the same priciple of IDLE applies to INACTIVE. |
| Interdigital | Yes with comment | Same response as previous question. |

For UE to UE relay, sidelink traffic is being relayed. Since sidelink traffic in Rel16 V2X is allowed in any RRC state (based on NW decision), the RRC state for the Ues involved in UE to UE relaying could be controlled similar to the non-relayed case. In that case, all RRC states for the remote UE, target UE and relay UE can be assumed, and could be independent of the relaying traffic.

**Question 21: Can any RRC state be assumed for the relay/remote Ues that are in coverage for UE to UE relaying? If not, explain why or what restrictions are needed.**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO |  | Since our preference is there is no need for UE-to-UE relay to be visible to RAN, there is no need to care the coverage status and RRC state of Ues in a U2U relay connection. |
| Ericsson (Tony) | See comments | We belive that the following combinations are valid/invalid:   |  |  |  | | --- | --- | --- | | **RL UE state** | **RM UE state** | **Validity** | | CONNECTED | CONNECTED | Valid | | CONNECTED | INACTIVE | Valid | | CONNECTED | IDLE | Valid | | INACTIVE | CONNECTED | Invalid | | INACTIVE | INACTIVE | Valid | | INACTIVE | IDLE | Valid | | IDLE | CONNECTED | Invalid | | IDLE | INACTIVE | Valid | | IDLE | IDLE | Valid | |
| Qualcomm | Yes | For UE-to-UE relay, we don’t see much restriction on RRC state for now because RRC state of Uu can operate independently of UE-to-UE relaying. |
| MediaTek | Yes | We think the assumption is correct. However, we did not see the relationship between the UE-to-UE relaying operation and the RRC state the UE stays. UE-to-UE relaying can operate in a Uu RRC state aganostic manner (in case of in coverage). Any thing specific to the RRC state based operation is up to legacy precedure. |
| Lenovo, MotM |  | U2U relaying should even work when both relay and remote Ues are OOC; all other cases are subset of this. |
| Huawei |  | We share the same view as OPPO |
| Interdigital | Yes | We do not see any restriction on the RRC states for UE to UE relay. |

## Requirements

Some companies [2][7] have discussed re-using or inheriting requirements from FeD2D to serve as a baseline for high level requirements for this work. These inherited requirements include requirements on:

* Visibility and reachability
  + The relay should be discoverable and reachable to the remote UE and the remote UE should be reachable by the network.
* Traffic Differentiation
  + The gNB should be able to distinguish between traffic originating from the remote UE and from the relay UE, as well as between traffic from different remote Ues relayed by the same relay UE
* Power consumption
  + Power consumption of the relay UE should be minimized as a primary requirement. As a secondary requirement, power consumption of the relay UE should not be negatively impacted.
* Device complexity
  + Device complexity of the remote UE should be taken into account as a primary requirement. As a secondary requirement, complexity of the relay UE should not be negatively impacted.
* Efficient signaling
  + Signaling over both PC5 and Uu for discovery, selection, connection, management, release, etc. should support efficient operation
* Service continuity
  + Efficient/fast path switching should be supported from one relay to another relay, or between a relay and Uu link (and vice versa). Service continuity should be supported for these switching scenarios.
* Security
  + Security (confidentiality and integrity protection) should be supported end to end between the remote UE and the gNB (for UE to NW relay) or between the source/target UE (for UE to UE relay)
* QoS Support
  + End-to-end service requirements should be met for various QoS configurations

[2][7] further assumes/shows that these requirements are also applicable to the UE to NW relay case.

**Question 22: For UE to NW relay and UE to UE relay, which of the of the requirements from FeD2D can be re-used for this work?**

1. **Visibility**
2. **Traffic Differentiation**
3. **Power Consumption**
4. **Device Complexity**
5. **Efficient Signaling**
6. **Service Continuiuty**
7. **Security**
8. **QoS support**

|  |  |  |
| --- | --- | --- |
| Company | Response | Comments |
| OPPO |  | We are not sure whether all of the requirement from FeD2D which is typically applicable to L2 can be applied to L3 relay as well.  Our understanding is that this requirement discussion would be essentially related to the pros/cons analysis between L23 in the end of this study, so would suggest to avoid such discussion at the current phase. |
| Ericsson (Tony) |  | In principle, we are okay with considering iii), iv), v) vi), viii).  However, when considering the requirements, those should be applicable to both L2 and L3 architecture. |
| Qualcomm |  | Agree with Ericsson |
| MediaTek |  | Agree with OPPO and Ericsson, for iv) Device Complexity, as a secondary requirement, complexity of the relay UE should not be negatively impacted may not be needed. A relay UE of course will be much complexity than remote UE, but also a relay UE should be less complexity than base station. |
| Lenovo, MotM |  | All principles should be applicable, unless shown otherwise. |
| Huawei |  | Agree with OPPO. The requirement is clear from the SID. The question is more like L2/L3 pros and cons. We can touch that after we finalize the solution. |
| Interdigital | See comments | We think the above requirements can be a starting point (since they are well aligned with the requirements in SA) and can serve for L2/L3 pros/cons analysis. |

**Question 23: Are there any requirements not mentioned in the previous question that should also be considered?**

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| --- | --- | --- |
| Company | Response | Comments |
| Interdigital |  | Support of Relay/remote UE authorization should be considered, as was not explicitly mentioned in 36.746 as a relaying requirement. |
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|  |  |  |

## Prioritization of Work

A number of contributions deal with how to prioritize work between UE to NW relay and UE to UE relay [17][18][19]. The majority company view in [17] suggest to focus first on UE to NW relay and any issues to UE to UE relay which are common to UE to NW relay. Following this, issues specific to UE to UE relay can be addressed in the SI, if time permits, of be considered as left overs in the WI. On the other hand, [11][9][19] suggest to de-prioritized UE to UE relays. Most companies did not explicitly provide a view on such prioritization, however.

**Question 24: Do you agree with the approach discussed in [17] for prioritization between UE to NW relay and UE to UE relay:**

* **First focus on UE to NW relay and issues of UE to UE relay with similar solution as UE to NW relay**
* **Study issues specific to UE to UE relay if time permits, with leftovers in the WI**

|  |  |  |
| --- | --- | --- |
| Company | Response | Comments |
| Ericsson (Tony) | Study first solution that are common to U2N and U2U | Our priority should be to study solution that are common to the U2N and U2U architecture.  All other architecture-specific solution can be posposted. |
| Qualcomm | Agree with Ericsson |  |
| MediaTek | Yes | Focus on UE to NW relay and issues of UE to UE relay with similar solution as UE to NW relay |
| Lenovo, MotM |  | Better to focus on solutions that cover both U2N and U2U. Then separately work in remaining issues that apply to only one of these. Commonality of solutions will reduce cost and will increase 3gpp efficiency. |
| Huawei | Agree | Is there anything really common for U2N and U2U? How can we deprioritize the protocol stack discussion, which is definitely not common for U2N and U2U?  We are not sure how does”priorizite only the common part“ help the L2/L3 comparison. We should complete the comprehensive study to at least U2N, so that we are clear on the soluiton before we make the SI conclusion. |
| Interdigital | Agree | We think there will need to be aspects resolved which are specific to UE to UE relays because the scenario is different, and protocol stack discussions will have differences. The differences can be identified in the SI and completed in the WI, if time in the SI does not permit. |

Some companies gave their view on whether prioritization between L2 and L3 relay work is needed [18][3][17] [20][21]. There it would seem that most companies prefer to study both L2 and L3 relay, and then evaluate whether each solution can satisfy the requirements.

**Question 25: Should any prioritization of work between L2/L3 architecture be done during the SI? Please comment.**

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| --- | --- | --- |
| Company | Response | Comments |
| OPPO | No | Our understanding of the study work at WG level is to provide the pros/cons analysis for RAN related aspects, while the final prioritization between L23 is anyway to happen at plenary level, even possibly together with SA(2). |
| Ericsson (Tony) | No | Is not RAN2 responsibility to prioritize one between L2 and L3 relay, but it will be up to RAN/SA plenary to decide which way to go.  Therefore, no prioritization should be done. |
| Qualcomm | No | Same view as OPPO and Ericsson |
| MediaTek | No | No need to make such prioritization |
| Lenovo, MotM | No | This topic aims to study both L2 and L3 relay and analyze the Cons and Pros. One of them is priorizied or both can be supported can be decided in RAN plenary together with SA. |
| Huawei | No | We shoudl foucs on completion of both L2 and L3 study in R2. |
| Interdigital | No | We agree that no prioritization is done in RAN2 between the architectures and that we focus on pros and cons analysis |

**Question 26: Should RAN2 consider any additional prioritization of work during the SI apart for aspects mentioned previously?**

|  |  |  |
| --- | --- | --- |
| Company | Response | Comments |
| Ericsson (Tony) | No |  |
| Qualcomm | Yes | We prefer to priortize topics which are common to L2 and L3 relay, e.g. Discovery and Relay (re)selection. |
|  |  |  |

# Conclusion

# References

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3. R2-2006570 - Scenarios and Assumptions on Sidelink Relay – Mediatek
4. R2-2006603 - Scenarios for sidelink relay – OPPO
5. R2-2007626 - Initial considerations for SL relaying – Kyocera
6. R2-2007099 - Discussion on NR Sidelink Relay Scenarios - Apple, Convida Wireless
7. R2-2006758 - Discussion and TP on Requirements and Scenarios for SL Relays – Interdigital
8. 3GPP TS 36.746, “Study on further enhancements to LTE Device to Device (D2D), User Equipment (UE) to network relays for Internet of Things (IoT) and wearables (Release 15)”, v15.1.1.
9. R2-2007039 - Scope and Scenarios of SL relay – Vivo
10. R2-2006735 - Initial considerations on NR sidelink relay - ZTE Corporation, Sanechips
11. R2-2006609 - Clarification on the Scenarios for NR Sidelink Relay – CATT
12. R2-2006856 - NR SL-based UE-to-UE relay for unicast SL - Nokia
13. R2-2006610 - User and Control Plane Procedures for L2 UE-to-NW Relay – CATT
14. R2-2007101 - Discussion on Control Plane mechanisms for Layer 2 Relay – Apple
15. R2-2006571 - RRC States for Relaying - MediaTek Inc.
16. R2-2006604 - Protocol stack and CP procedure for SL relay – OPPO
17. R2-2008046 - General considerations on working for NR SL relay - Huawei, HiSilicon, Apple, CMCC, China Telecom, China Unicom, MediaTek Inc., Sharp, Spreadtrum, Xiaomi, ZTE Corporation, Sanechips
18. R2-2006554 - Discussion on sidelink relay study item scope and focus areas prioritization – Qualcomm
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20. R2-2007202 - High-level requirements – Samsung
21. R2-2006721 - Considerations on the Study of NR Sidelink Relay - Futurewei
22. R2-2006572 - Architecture Options for Sidelink Relay – Mediatek
23. R2-2006857 - Casting types in NR SL-based relays – Nokia
24. R2-2006866 - Scope, Requirements and Scenarios in NR Sidelink Relaying – Fujitsu
25. R2-2006968 - NR sidelink relay scenarios – Samsung
26. R2-2007290 - Service continuity scenarios for sidelink relay – Ericsson
27. R2-2007293 - Scope and initial steps for SL relay – Ericsson
28. R2-2007775 - Discussion on UE-to-network coverage extension – ETRI
29. R2-2008017 - Scope and scenarios for NR sidelink relay- LG Electronics Inc.