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**

|  |  |  |
| --- | --- | --- |
| 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) |  |
| Kyocera | a) |  |
| vivo | a) | NR based is sufficient |
| Intel (Rafia)  rafia.malik@intel.com | a) | As the SID states “*This study item targets to study single-hop NR sidelink-based relay“,* we think it is clear that we need to focus on NR PC5. |
| Xiaomi | A | We prefer to study the NR PC5 first. Inter RAT relay should be deprioritized. |
| CATT | a) |  |
| Sony | a |  |
| ZTE | 1. & b) | The UE-to-Network relay UE can be served by an ng-eNB, that is, NR-PC5 between remote UE and relay UE and LTE-Uu between relay UE and ng-eNB who connects to 5GC are considered. |
| Nokia | A |  |
| Fraunhofer | a) | The limited timeline of this SI, but also considering SA2 scoping, may only allow to consider NR PC5. |
| Samsung | a) |  |
| Convida | 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**

|  |  |  |
| --- | --- | --- |
| 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 |  |
| 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) |  |
| Kyocera | a) |  |
| vivo | a) | NR Uu is considered with high priority |
| Intel (Rafia) | a) | We think the focus should be on NR during study item phase |
| Xiaomi | A | Inter RAT relay should be deprioritized. |
| CATT | a) |  |
| Sony | a |  |
| ZTE | a |  |
| Nokia | A |  |
| Fraunhofer | a) | Preference should be given to NR. |
| Samsung | a) |  |
| Convida | A | Our preference is to focus the study only on NR case. |

**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)?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | No | We are fine not to include cross-RAT control to reduce specification impact. |
| Vivo | No | We do not see the necessity of cross-RAT scenario |
| Intel (Rafia) | No |  |
| Xiaomi | No | Inter RAT relay should be deprioritized. |
| CATT | No |  |
| Sony | No |  |
| ZTE | Yes | Regarding support of L3 UE-to-Network relay in NR, for NR Uu control LTE PC5, the impact to LTE-Uu is limited and acceptable. |
| Nokia | No | This study should focus on NR PC5 in Rel-17 and also NR PC5 controlled by gNB (i.e. no inter-RAT control of NR PC5 by LTE). |
| Fraunhofer | No | Due to the limited time units, only NR controlled UEs should be considered. |
| Samsung | No |  |
| Convida | No | Our prefrence is to focus the study only on NR PC5 case. |

## 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) |  |
| ZTE |  |  |

|  |  |  |
| --- | --- | --- |
| Huawei | Yes to a)+b) |  |
| FirstNet | a) &b) |  |
| Interdigital | Yes (both) | We should follow LTE. |
| Kyocera | a and b |  |
| vivo | a), b) |  |
| Intel (Rafia) | a) and b) |  |
| Xiaomi | Y to both | Scenario a is straightforward. Scenario b is also possible during the UE leaving gNB coverage. But scenario b should not last for long. UE should try to stay connected with gNB as much as possible. |
| CATT | a),b) |  |
| Sony | A,b |  |
| ZTE | 1. B)\_ |  |
| Nokia | a) and b) |  |
| Fraunhofer | a),b) |  |
| Samsung | a), b) |  |
| Convida | Yes to a and b |  |

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**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | b | We assume b would also cover scenario a). |
| Vivo | Ok for a).  For b) FFS | Firstly, we think that the two scenarios are valid and possible.  But for case b), details should be FFS such as:  For L2 relay, when remote UE is initially in Idle mode under gNB1, it may trigger relay selection/establishment to a relay UE under gNB2. That is to say, the remote UE is RRC connected mode with gNB2 but with SIB information of gNB1. As in legacy behaviors, the remote UE will priorize the dedicated configuration. But if some dedicated configuration is absent, the remote UE will use common SIB configuration of different gNB. Is this an expected remote UE behavior? |
| Intel (Rafia) | a) and b) |  |
| Xiaomi | Both | Remote UE should try to select the relay UE which is in the same coverage of gNB with remote UE. The data forwarding could be done within the same gNB. The signaling exchange between gNB could be avoided. |
| CATT | a),b) | The case that the remote UE performs path switch between direct Uu link and indirect relay link, and the relay UE is in a different gNB should be supported. |
| Sony | A, b | Both scenarios should be supported. |
| ZTE | 1. & b) | The Question is bit blurred. From our perspective, for remote UE performing relay UE selection, of course it can select any relay UE with intra/inter gNB coverage. But as OPPO mentioned, we should avoid simultaneous connection scenario, i.e. remote UE direct connects to the Uu link while have an active PC5-RRC connection with a relay UE. |
| Nokia | a) and b) | Both should be studied. Scenario b) is also important: a Remote UE can move away from Relay UE to the coverage area of a different gNB  We also think that this should not increase the complexity significantly |
| Fraunhofer | a) and b) | a) should obviously be supported.  b) should be considered, if no further impact on RAN2 is expected |
| Samsung | a) | Both a) and b) seem to be possible but we prefer to studying with the assumption of a) |
| Convida | See comment | We do not think same gNB coverage versus versus different gNB coverage is relevant if the case of simultaneous Uu connectivity and connectivity via UE relay is not supported. This question can be reconsidered once RAN2 has reached a conclusion on whether or not remote UE supports simultaneous Uu connectivity and connectivity via UE relay. |

## 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**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | a, b and c |  |
| vivo | a), b), c) | We do not see any difference between those scenarios. The only question we should address is wheteher the UE to UE relay operation should be visible to RAN or not |
| Intel (Rafia) | a), b), c) |  |
| Xiaomi | All | . |
| CATT | All | There isn’t any motivation to exclude any coverage scenarios for the UE to UE relay |
| Sony | a) b) c) |  |
| ZTE | All | The coverage scenario should be decoupled with UE to UE relay. |
| Nokia | a) and b) and c) |  |
| Fraunhofer | a), b), c) | All choices are important: b) and c) are both essential for coverage enhancement; a) mostly for power efficiency |
| Samsung | a), b), c) |  |
| Convida | a), c), b) See comment | b) can be depriotized i.e. only supported is time allowed and there is a design commonality with a) or c) that can be re-used as much as possible. |

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

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | No | For this scenario, at least one of the UEs may be in coverage, but it’s not limited to only relay UE in coverage. |
| vivo | No |  |
| Intel (Rafia) | No | For the U2U relay scenario, there is no SA2 requirement for the relay UE to be in-coverage, so all applicable scenarios as in Question 6 should be considered at this stage |
| Xiaomi | No |  |
| CATT | No |  |
| Sony | No |  |
| ZTE | No |  |
| Nokia | No |  |
| Fraunhofer | No | See reply to Q6. |
| Samsung | No | Source UE or target UE can also be in-coverage. |
| Convida | See comment | Answer to this question depends in part on the support of out of coverage scenario. In our view, if out of coverage scenario is supported, then no need to restrict the relay UE to always be in coverage for the partial coverage case. . |

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)?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | Yes | We prefer not to have such a limitation in the study phase. |
| Vivo | Yes | In legacy R16 V2X, the peer Ues may be in coverage of different gNBs, which is similar with UE-to-UE relay case. |
| Intel (Rafia) | No | For the UE-to-UE case, same/different gNB coverage case would not make a difference and therefore these sub-cases need not be considered at this stage. |
| Xiaomi | Yes | The traffic ends at remote Ues, which is not related to gNB. |
| CATT | Yes with comments | For scenario perspective, we think this scenario is feasible. But considering the configuration conflict issue should be considered, it can be deprioritized. |
| Sony | Yes |  |
| ZTE | Yes | The network coverage scenario should be decoupled with UE to UE relay. |
| Nokia | Yes | We agree that there can be technical issues when UEs are in the coverage of different RAN nodes, but we think that it is important to cover that scenario as well |
| Fraunhofer | Yes | Any in coverage scenario, including UEs in coverage of different gNB(s)/ng-eNB(s), should be considered. |
| Samsung | See comment | We do not see difference for coverage scenarios between the two models (UE-NW relay, UE-UE relay). So the same scenario as chosen for Q5 should be applied to UE-to-UE relay. |
| Convida |  | See feedback to Q5. |

## 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.**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | No | We think it’s too early to have this conclusion as some PC5-S messages from the relay UE may be sent without PC5-RRC and may depend on whether L2 or L3 relay is used. |
| vivo | See comment | For remote UE data traffic, we agree that relaying occurs only after remote UE and relay UE establish a PC5 RRC connection. But for paging and SIB delivery, detailed mechanisms are FFS now. |
| Intel (Rafia) | See Comment | For unicast communication, having PC5 RRC connection is the most obvious option. Our understanding as per SID is to only consider *single hop*, thereby we don’t see how we can get around without setting up a PC5 RRC connection over sidelink.  For L3 relay type, broadcast communication is technically possible in which case PC5 RRC connection is not required, but we think that in order to keep things simple, unicast operation for relaying should be adopted as the baseline for both L2 and L3 relaying. |
| Xiaomi | No | Agree with Ericsson. |
| CATT | Yes | As said by OPPO, the only exceptional case is for system information delivery. But since NR is on-demand SI, hence it had excluded the case that the relay UE and remoteUE has no connection, but forwarding the SIB through broadcast in this SID. |
| Sony | Yes |  |
| ZTE | Yes | Considering the limited time slot for this SI, it is preferred to limit to only unicast scenario for Rel-17 UE to network relay. |
| Nokia | Yes | We think that a PC5 link between Remote UE and Relay UE should be established first before relaying can start. This is indepedent if L2 or L3 Relay is used. |
| Fraunhofer | See comments | Advantage of yes: the unified approach for L2 and L3 and use the Rel-16 PC5 RRC as baseline.  Advantage of no: flexibility in case of L3 PC5-RRC is not necessary. |
| Samsung | Agree with comment | Not always but there could be a case PC5 unicast connection is needed between remote UE and relay UE regardless of L2 or L3, then Rel-16 PC5 unicast procedures can be reused. |
| Convida | Yes with comment | Considering the QoS and security related objective of the SI, a PC5-RRC connection before the relaying of data is initiated will make the simplify the design and make it more flexible. Off course as OPPO indicated above, system information such as the ones includes in MIB/SIB1 could be forwarded to the remote UEs UE in the proximity before PC5 connection being is established. |

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.**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | Yes |  |
| vivo | Yes | See comment to Q9. |
| Intel (Rafia) | See comments (need clarification) | Scenarios 1,4,5 are to be supported.  It is not clear to us what “no connection to the relay” means in Figure 1. As OPPO has mentioned, we think the scenarios with no connection to the relay UE are only transitory in nature and that the remote UE needs to set up a PC5 unicast connection to the relay UE for any subsequent relayed transmission to occur. In that sense, Scenarios 2,3,6 are inherrently already covered under 1,4,5 respectively and we do not think they strictly need to be captured. At least 2 and 6 are definitely not needed even if we assume the Uu link is used in scenario 3. |
| Xiaomi |  | Need to clarify the intention of the scenario where remote UE is not connected to the relay. We think the remote UE has to connect to relay after path switching. |
| CATT | No | As commented in Q9, the only exceptional case is for system information delivery. But since NR is on-demand SI, hence it had excluded the case that the relay UE and remoteUE has no connection, but forwarding the SIB through broadcast in this SID. That is to say scenario 2/3 can be excluded.  For scenario 5, the direct Uu link between gNB and the remote UE should be removed. Dual connectivity with both direct and indirect links is not considered. |
| Sony | Yes | The connection status between relay and remote UE is either connected or not connected. |
| ZTE | No with comment | Agree with Qualcomm’s intention that this question is not clear, for the whole relay procedure, remote UE should of course find a relay UE when it does not set any PC5-RRC connection with any relay UE, but when the remote UE would like to perform relay service transmission, it needs to set up PC5-RRC link with a relay UE. In this case, further clarification is needed. But if rapporteur would like to check if remote UE can perform relay service transmission(exclude relay discovery and relay UE selection), then PC5-RRC connection is a must. |
| Nokia | Yes for 1, 4, 5, see comments | We do not understand the scenarios when there is no connection between the Remote UE and the Relay UE. As Qualcomm commented relay discovery and selection should be in the scope of the study. Note that scenario 5 is also needed for make-before-break type of mobility between direct and relay connected connections |
| Fraunhofer | See comments | We support the scenarios 1 - 4. Also we were not sure how exactly to interpret the question, i.e. we agree to Qualcomm’s comments.  Additionally, we also should consider the scenarios and requirements for public safety. |
| Samsung | Yes with comment | All the scenarios are possible, but RAN2 can deprioritize certain scenario with taking into account Q5 and Q8. |
| Lenovo, MotM | Yes | A more general study, independent of a PC5 RRC connection, should be done. RAN2 may prioritize certain scenarios. |
| Convida | Yes with comment | As for the scenarios 5 and 6, as we indicated for Q5, we do not think same gNB coverage versus different gNB coverage is relevant if the case of simultaneous Uu connectivity and connectivity via UE relay is not supported. Support for scenario 5 and 6 can be discussed once RAN2 has reached a conclusion on whether or not remote UE supports simultaneous Uu connectivity and connectivity via UE relay. |

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.**

|  |  |  |
| --- | --- | --- |
| 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. |
| 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. |
| Kyocera | Yes | We assume in this case the no link established case is simply the stage at which the source UE is attempting to find relay UE(s) for PC5 connection. |
| vivo | See comments | We think that the co-existence of direct PC5 link and relay link does not need to be considered due to the high complexity. |
| Intel (Rafia) | See Comment | As Q10, our understanding is that having no link established is a temporary state only.  Direct PC5 link can be established between source and target UE and may be studied under path switching scenarios from direct PC5 to relayed PC5 and vice versa, under service continuity as in [2] |
| Xiaomi |  | Need to clarify the intention of the scenario where remote UE is not connected to the relay. We think the source and target remote UE has to connect to relay after path switching. |
| CATT | No | Since NR is on-demand SI, hence the relay UE and remoteUE has no connection, but forwarding the SIB through broadcast can be excluded from this SID. |
| Sony | Yes | If the question is whether the source and target UE have either a relayed PC5 link established or no relayed PC5 link established, then the answer is Yes. |
| ZTE | See comment | Clarification is needed, but if the intention is asked whether it is need to study remote and relay UE performing relay service without PC5-RRC connection, the answer is no. |
| Nokia | See comment | We do not understand the question (see also comment on Q10 |
| Fraunhofer | See comment | Both scenarios should be studied. |
| Samsung | Yes with comment | The same connectivity scenarios can be considered as Q10. |
| Convida | Yes with comment | This question requires clarification. Is this question referring to the support of simultaneous direct path (PC5) and connectivity via UE relay. If so, our view is this should not be considered a spart of this study. However, service continuity scenario with the remote UE transitioning from direct path (PC5) to connectivity with UE relay and vice-versa should be studied. Additonally, RAN2 may need to study discovery procedures in support of the path establishment. |

[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.**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | No | We don’t think it’s necessary to exclude SN for scheduling sidelink. |
| vivo | Yes | No need to complicate the design |
| Intel (Rafia) |  | UE scheduling should be common for U2U and U2N. We agree that focus/priority should be SA case only. |
| Xiaomi | Yes |  |
| CATT |  | Agree with OPPO. |
| Sony |  | We agree to focus on SA scenario first. |
| ZTE | No(MR-DC without any restriction) | Agree with Qualcomm. |
| Nokia | Yes |  |
| Fraunhofer | Yes |  |
| Samsung | Yes | In MR-DC, we prefer to apply the same assumption (MN control) as Rel-16 NR SL comm. |
| Convida | Yes |  |

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**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | b and c | For reliability, we think connections with multiple connections will be needed. |
| Vivo | a) | Keep the design simple in this release |
| Intel (Rafia) | a) | We think that (b) is a temporary state in service continuity scenario when performing path switching between Uu and relay PC5. |
| Xiaomi | A | We think U2N relay is used to provide coverage extension in this study item. It’s strange to keep relay connection when there is available Uu connection. |
| CATT | a) |  |
| Sony | a |  |
| ZTE | A with comment | If we just focus on relay scenario and exclude normal sidelink scenario. |
| Nokia | a) but see comment | We assume that make-before-break type of mobility between direct and relay connected connections should be supported |
| Fraunhofer | a) | Option a has to be supported.  All 3 options are possible. However, studying b and c may depend on the timeline of the SI. |
| Samsung | a) |  |
| Convida | A |  |

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**

|  |  |  |
| --- | --- | --- |
| 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 |
| Kyocera | b and c | Same comment as Q13. |
| vivo | a) |  |
| Intel (Rafia) | a) |  |
| Xiaomi | A |  |
| CATT | a) |  |
| Sony | A |  |
| ZTE | A) |  |
| Nokia | A |  |
| Fraunhofer | a) | Option a has to be supported.  All 3 options are possible. However, studying b and c may depend on the timeline of the SI. |
| Samsung | a) |  |
| Convida | A |  |

## 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?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | No | We assume groupcast for PC5 will be different from the MBS work in Uu. |
| Vivo | Yes | For this release unicast is sufficient |
| Intel (Rafia) | Yes | We are not sure how groupcast can be supported in L3 relaying. In any case, we agree with the majority of the companies above that unicast support should be prioritized at this stage. |
| Xiaomi | Yes with comment | There may be broadcast signaling, e.g. SI. But we understand the question only refer to user plane data. |
| CATT | Yes |  |
| Sony | Yes with comments | Agree with others regarding the broadcast signalling |
| ZTE | Yes |  |
| Nokia | Yes |  |
| Fraunhofer | See comments | We agree with Qualcomm.  Increased reliability and coverage extension based on relaying are of major importance especially for (safety-) critical and emergency communication, also for broadcast and groupcast communication. Therefore, also groupcast and broadcast should be considered. |
| Samsung | Yes |  |
| Convida | Yes |  |

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**

|  |  |  |
| --- | --- | --- |
| 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 | 1. Similar to our response from the previous question. |
| Kyocera | b | To achieve better robustness multiple UE to UE relays should be considered. |
| Vivo | c) | See comment to Q15 |
| Intel (Rafia) | c) | Based on Rel-16 SL design, AS layer is unaware of the group composition and related information and it is generally left to upper layers. We think supporting a) and b) would require significant work at AS layer, therefore c) seems to be the most feasible option. |
| Xiaomi | c |  |
| CATT | c) |  |
| Sony | c |  |
| ZTE | C) |  |
| Nokia | C |  |
| Fraunhofer | a), b) | We agree with Qualcomm.  Besides reliability and coverage enhancements, multiple services could require different cast types. |
| Samsung | a), b) | In Rel-16 NR SL, since PC5 connection support all three cast types, either groupcast based or unicast based should be available. |
| Convida | a) and b) |  |

## 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.**

|  |  |  |
| --- | --- | --- |
| 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 |  |
| Kyocera | Yes | We assume if the relay UE is OOC, it belongs to the U2U relay scenario. |
| vivo | Yes | Remote UE can be in OOC |
| Intel (Rafia) | Yes | These two assumptions also apply to L2 relay. |
| Xiaomi | Yes |  |
| CATT | Yes | Remote UE can be OOC. |
| Sony | Yes |  |
| ZTE | Yes |  |
| Nokia | Yes |  |
| Fraunhofer | Yes | Rel-13 assumption could apply also for NR relaying. Remote UE OOC should be also considered. |
| Samsung | Yes |  |
| Convida | Yes | Remote UE OoC should also be considered for i) |

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. |
| Kyocera | Yes | Regarding ii), we assume even if the remote UE is OOC it is still RRC\_CONNECTED in L2 relaying. |
| vivo | Yes for ii). For i) see comment | In case remote UE has data traffic, the relay UE should be in connected mode and cannot change to Idle or INACTIVE. So the relay UE RRC state cannot independently change. |
| Intel (Rafia) | Need clarification | Not sure what the intention of (i) is. To enable relay functionality, relay UE should be RRC\_CONNECTED during active data communication, but it doesn’t have to be RRC\_CONNECTED otherwise. Similar to Huawei’s comment, we understand that it is referring to legacy procedure when the relay UE is not RRC\_CONNECTED, then there can be PC5-RRC between the two UEs. We might need further clarification on this aspect. Our comments on Q17 are also applicable here.  We think (ii) should be assumed however would like to note that since FeD2D focused on wearables use-case with no assumption of a PC5-RRC connection, we are not sure if it should be used as baseline for assumptions here. |
| Xiaomi | Yes to ii) | We prefer remote and relay UE should stay in connected after path switching. |
| CATT | Yes for ii)  Comment for i) | Agree with Qualcomm. For some cases, the RRC state of remote UE relies on whether the relay UE is in CONNECTED. |
| Sony | depends | For ii), remote UE is in CONNECTED mode if unicast is supported over PC5. |
| ZTE | Yes with comment | Agree with OPPO, we need to exclude the combination of connected remote UE with idle/inactive relay UE for i) |
| Nokia |  | This is not related to scope, requirements, and scenarios. The answer to this question may depend on the L2 Relay solution and requires further study. This should not be agreed at this point |
| Fraunhofer | Yes with comments | Q18 seems only to consider unicast.  ii: is fine for unicast; for OOC any RRC state should be considered.  i: not all combinations of RRC states may apply. |
| Samsung | Yes with comment | For i) similar concern with OPPO/Qualcomm |
| Convida | Yes with Comment | Share same view as OPPO for i) i.e. not clear if all combination is OK, e.g., the combination of connected-remote-UE and idle/inactive-relay-UE is apparenetly not feasible. |

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. |
| Kyocera | Yes |  |
| vivo | See comments | Firstly RRC\_Inactive for a remote UE needs to be clarified, does it refer Uu state via a relay link or a direct link? We do not think RRC\_Inactive for a remote UE via a relay link has much necessary because the coverage of a relay UE is very small. RRC\_Connected mode when data burst and RRC\_Idle mode when only SIB/paging delivery are reasonable. |
| Intel (Rafia) | Yes, with comments | Similar to our comment for earlier questions, it seems that (ii) is a temporary state before connection establishment. For SI phase, it can assumed that connection is already established when discussing supported scenarios as in [2].  On i) it depends on whether we plan to support paging for the remote UE through relay. |
| Xiaomi | Yes for ii) | We prefer remote and relay UE should stay in connected after path switching |
| CATT | Yes |  |
| Sony | Yes |  |
| ZTE | Yes |  |
| Nokia |  | The answer to this question may depend on the L2 Relay solution and requires further study. This should not be agreed at this point. |
| Fraunhofer | Yes |  |
| Samsung | Yes |  |
| Convida | Yes |  |

**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. |
| Kyocera | Yes |  |
| vivo | Yes for ii) | Case i) can be investigated, for example in case of small data stransmission from the remote UE(s) the relay UE can be in INACTIVE mode,. |
| Intel (Rafia) | Yes, see comment | We suggest focus should be on supporting (i). Similar to our previous comment, (i) also depends on whether paging will be supported for remote UE through relay UE. |
| Xiaomi | Yes for ii) | We prefer remote and relay UE should stay in connected after path switching |
| CATT |  | It needs to be further studied. |
| Sony | Yes |  |
| ZTE | Yes |  |
| Nokia |  | The answer to this question may depend on the L2 Relay solution and requires further study. This should not be agreed at this point |
| Fraunhofer | Yes | Further study might be needed. |
| Samsung | Yes with comment | Regarding i) we share the view with Ericsson/Qualcomm. |
| Convida | Yes |  |

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.**

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera | Yes | We don’t see that any restriction to RRC state is needed. It is up to the NW to decide the UE’s RRC state. |
| vivo | Yes, but | We assume Uu and PC5 data transmission are not related. |
| Intel (Rafia) | Yes | Uu RRC restrictions are not relevant for U2U relaying. |
| Xiaomi | Yes | The data ends at remote Ues, which is not related to gNB. |
| CATT |  | No need to restrict RRC state for U2U relay. |
| Sony | Yes |  |
| ZTE | Yes | We share the same view as OPPO |
| Nokia | Yes | We do not see any reasons to limit UE-to-UE relay scenarios depending on the UEs Uu RRC connection state |
| Fraunhofer | Yes | We share the same view as Qualcomm and Lenovo. |
| Samsung | Yes | RRC state is agnostic to UE-to-UE relaying. |
| Convida | Yes |  |

## 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. |
| vivo | See comment | For UE to UE relay, visibility is not required |
| Intel (Rafia) |  | Inline with the SID objectives, Power Consumption (iii) and Device complexity (iv) are deprioritized for SI based on our understanding. |
| Xiaomi |  | Agree with Ericsson. |
| CATT |  | We are OK with all requirement except for i) and ii) which are common for both L2 and L3 relay . |
| Sony |  | We are ok with all requirements |
| ZTE |  | Agree with OPPO and Ericsson. |
| Nokia | In principle i, iii, iv, v, vi, vii, viii | We think that the requirements should be independent whether L2 or L3 Relay is selected |
| Fraunhofer | Yes | Agree with Ericsson. |
| Samsung |  | Agree with Ericsson |
| Convida |  | We are ok with requirements ii) – viii). All the listed requirements with the exception of the visibility requirement are either requirements that motivate/justify the SI, or just resonable design requirements such as device complexity requirement. As for the visibility requirement, this could be the result of the design choices particularly the architecture choice between L2 and L3 relay. It might become unavoidable that without fulfiling the visibility requirement, some other requriements such as QoS and security related requirements might not be achievable. |

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

|  |  |  |
| --- | --- | --- |
| 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. |
| Kyocera |  | We don’t think U2N relay and U2U relay requirements should be combined together. For example, visibility and traffic differentiation from FeD2D study are not necessarily applicable to U2U relay. Otherwise, we think the remaining requirements from iii) to viii) are all useful. |
| Intel (Rafia) | Common Relay Architecture | For NR sidelink relay, both L2 and L3 relay architectures are considered, however, it is assumed that both the UE-to-UE as well as the UE-to-Network NR sidelink relay have a common architecture, i.e. both support either L2 or L3 relaying functionality. |

## 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. |
| Kyocera | Both U2N and U2U | Equal priority to both relay types should be considered in the study. |
| vivo | Agree with Ericsson |  |
| Intel (Rafia) | Yes | Technical aspects of both U2U and U2N anyways need to be discussed to identify those only specific to U2U case. |
| Xiaomi | Yes |  |
| CATT | Yes |  |
| Sony | Yes |  |
| Nokia |  | In the beginning RAN2 should focus on issues common for UE-to-NW and UE-to-UE relays. And within those issues RAN2 should start with issues that are common for L2 and L3 relays |
| Samsung |  | Agree with Ericsson |
| Convida | Yes |  |

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.**

|  |  |  |
| --- | --- | --- |
| 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 |
| Kyocera | No |  |
| vivo | No |  |
| Intel (Rafia) | No | Technical aspects of both L2 and L3 relay should be put on the table. |
| Xiaomi | No |  |
| CATT | No | Agree with OPPO and Ericsson. |
| Sony | No |  |
| Nokia | No | It is not RAN2 responsibility to select between L2 and L3 relays |
| Samsung | Yes | We think it is so tough to study all the relay architectures i.e., L3 and L2 for both UE-to-NW relaying and UE-to-UE relaying. Rather we should prioritize one architecture and study to support the required aspects for UE-to-NW relaying and UE-to-UE relaying. |
| Convida | No |  |

**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. |

|  |  |  |
| --- | --- | --- |
| Vivo | No |  |

|  |  |  |
| --- | --- | --- |
| Intel (Rafia) | No |  |
| CATT | No |  |
| Nokia | Yes | Agree with Qualcomm: RAN2 should start with issues that are common for L2 and L3 relays |
| Samsung | No |  |
| Convida | No |  |

# Conclusion

# References

1. RP-193253 – New SID: Study on NR Sidelink Relay (OPPO)
2. R2-2006717 - Requirements, Assumptions and Supported Scenarios for NR Sidelink Relay – Intel
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
19. R2-2007043 - Scope and scenarios on NR sidelink relay- Spreadtrum Communications
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.