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 |
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**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. |
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**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 |  |
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## 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.**

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| Company | Response (Y/N to a/b) | Comments |
| OPPO | Y (i.e., a and b) |  |
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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. |
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## 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. |
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**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. |
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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. |
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## 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. |
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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. |
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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. |
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[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. |
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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. |
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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**

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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. |
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## 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 |  |
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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. |
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## 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 |
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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.**

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| 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. |
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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.**

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| 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. |
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**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.**

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| 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. |
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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. |
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## 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**

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

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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**

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

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# 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.