**3GPP TSG RAN WG1 #104bis-e R1-210xxxx**

**e-Meeting, April 12th – 20th, 2021**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Agenda item:** 8.11.1.2

**Source:** Moderator (LG Electronics)

**Title:** Feature lead summary for AI 8.11.1.2 Inter-UE coordination for Mode 2 enhancements

**Document for:** Discussion and information

1. **Contents to be discussed in Tuesday’s GTW (Apr. 13th)**

After reviewing contributions submitted in this meeting, FL observed that the following two approaches can be considered for the inter-UE coordination.

* *Approach 1: Inter-UE coordination to help UE-B’s resource selection procedure (i.e., in a semi-static manner)*
	+ *UE-A explicitly sends the set of resources preferred and/or non-preferred for UE-B’s transmission*
		- *The information includes time-and-frequency resources preferred and/or non-preferred for UE-B’s transmission*
	+ *SCI or higher layer signaling is used to transmit the coordination information*
	+ *Request signaling or pre-defined event/condition triggers the transmission of coordination information*
* *Approach 2: Inter-UE coordination to confirm a validity of UE-B’s selected/reserved resources (i.e., in a dynamic manner)*
	+ *UE-A implicitly sends the set of resources non-preferred for UE-B’s transmission and/or the set of resources where the resource conflict is detected*
		- *The information includes the presence of expected/potential and/or detected resource conflict on UE-B’s transmission resource*
	+ *PSFCH format is used to transmit the coordination information*
	+ *Pre-defined event/condition triggers the transmission of coordination information*

Based on the observations mentioned above, the following draft proposals were made from FL’s perspective:

***FL’s proposal****:*

* *Support the following schemes of inter-UE coordination in Mode 2:*
	+ *Inter-UE Coordination Scheme 1:*
		- *UE-A sends to UE-B the set of resources preferred and/or non-preferred for UE-B’s transmission*
			* *The coordination information includes time-and-frequency resources preferred and/or non-preferred for UE-B’s transmission*
				+ *FFS on details including a possibility of down-selection between the preferred resource set and the non-preferred resource set*
				+ *FFS whether or not to introduce additional information*
			* *Down select to one among the following tree options for the container of coordination information*
				+ *1st SCI*
				+ *2nd SCI*
				+ *Higher layer signaling (e.g., MAC CE, PC5 RRC)*
	+ *Inter-UE Coordination Scheme 2:*
		- *UE-A sends to UE-B the set of resources non-preferred for UE-B’s transmission and/or the set of resources where the resource conflict is detected*
			* *The coordination information includes the presence of expected/potential and/or detected resource conflict on UE-B’s transmission resource*
				+ *FFS on details including a possibility of down-selection between the expected/potential conflict and the detected resource conflict*
				+ *FFS whether or not to introduce additional information*
			* *PSFCH format is used to convey the coordination information*
				+ *FFS on details including whether to (pre)configure separately PSFCH resource set from that of SL HARQ feedback*

***FL’s proposal****:*

* *For Inter-UE Coordination Scheme 1, at least the following information is used to determine the time-and-frequency resources preferred and/or non-preferred for UE-B’s transmission*
	+ *UE-A’s sensing result*
		- *FFS on details including how to obtain it*
	+ *UE-A’s SL resources selected for multiple transmissions of different TBs*
	+ *UE-A’s configured resources for UL*
* *For Inter-UE Coordination Scheme 2, at least the following information is used to determine the set of resources non-preferred for UE-B’s transmission and/or the set of resources where the resource conflict is detected*
	+ *Time resource conflict between UE-B and other UE(s) in the same group*
		- *FFS on details including which information (e.g., destination ID) is used to determine it*
	+ *UE-A’s sensing result*
		- *FFS on details including how to obtain it*

***FL’s proposal****:*

* *Down select one or more of following options for determining UE-A (transmitting the inter-UE coordination information) and UE-B (receiving and using the inter-UE coordination information):*
	+ *Option 1: UE-A is the intended receiver of UE-B*
	+ *Option 2: UE-A (e.g., RSU, platooning header) and UE-B are determined by higher layer*
	+ *FFS on applicable scenarios/inter-UE coordination schemes for each option*
1. **Summary of contributions**
* How UE-A and UE-B are determined
	+ Option 1: UE-B is a PSCCH/PSSCH TX UE for data transmission, and UE-A is the intended receiver of UE-B [OPPO,3] [Spreadtrum,4] [vivo,5] [Fraunhofer,12] [CMCC,14] [Xiaomi,16] [Intel,17] [Samsung,20] [Sony,22] [LG,24] [Lenovo,29] [DCM,30]
	+ Option 2: UE-A and UE-B are determined via higher layer (e.g. application layer) [Huawei,1] [vivo,5] [Apple,18] [Sony,22] [LG,24]
	+ Option 3: UE-A is pre-defined, and UE-B is UEs that can receive inter-UE coordination information from other UE [LG,24]
* How/when UE-A determines the contents of “A set of resources”, including consideration of UL scheduling?
	+ Type of “A set of resources”
		- For Type A and/or Type B
			* based on its sensing result of UE-A [Huawei,1] [Nokia,2] [OPPO,3] [vivo,5] [MediaTek,8] [Fujitsu,9] [Fraunhofer,12] [CMCC,14] [ZTE,15] [Xiaomi,16] [Intel,17] [Apple,18] [InterDigital,28] [Lenovo,29]
			* based on UE-A’s transmission [vivo,5] [Fraunhofer,12] [ZTE,15] [Apple,18] [Qualcomm,19] [LG,24] [NEC,27]
				+ SL transmission [vivo,5] [Qualcomm,19] [LG,24]
				+ UL transmission [vivo,5] [LG,24]
			* based on UE-A’s decision in higher layer [Huawei,1] [LG,24]
			* based on semi-static information [Intel,17] [LG,24]
		- For Type B and/or Type C
			* based on expected/potential resource conflict [vivo,5] [MediaTek,8] [Fujitsu,9] [Fraunhofer,12] [Xiaomi,16] [Intel,17] [Apple,18] [Qualcomm,19] [LG,24] [NEC,27] [DCM,30] [Ericsson,34]
				+ PSSCH TX and PSSCH RX [vivo,5] [Intel,17] [Apple,18] [LG,24] [DCM,30]
				+ PSSCH TX and PSSCH TX [vivo,5] [Apple,18] [LG,24]
				+ PSFCH TX and PSFCH RX [vivo,5] [Apple,18] [DCM,30]
				+ PSFCH TX and PSFCH TX [vivo,5] [Apple,18] [DCM,30]
				+ SL TX and UL TX [vivo,5] [Intel,17] [LG,24] [DCM,30]
				+ SL RX and UL TX [vivo,5] [Intel,17] [LG,24] [DCM,30]
			* based on detected resource conflict [Intel,17] [Apple,18] [Qualcomm,19] [LG,24] [NEC,27] [Ericsson,34]
				+ PSSCH TX and PSSCH RX [Intel,17] [Apple,18] [Qualcomm,19] [LG,24]
				+ PSSCH TX and PSSCH TX [Apple,18] [Qualcomm,19] [LG,24]
				+ PSFCH TX and PSFCH RX [Apple,18]
				+ PSFCH TX and PSFCH TX [Apple,18]
				+ SL TX and UL TX [Intel,17] [Qualcomm,19] [LG,24]
				+ SL RX and UL TX [Intel,17] [Qualcomm,19] [LG,24]
	+ Other information in the inter-UE coordination information
		- For Type A and/or B
			* Recommended TX parameters [MediaTek,8]
			* Sensing information [Fujitsu,9] [Apple,18] [Hyundai,32] [ASUSTeK,33]
			* Source ID of UE-B [Fujitsu,9] [Hyundai,32]
			* Destination ID associated with UE-B [Fujitsu,9] [Hyundai,32]
			* Resource conflict type [Fujitsu,9] [Apple,18]
			* Indication of information type (e.g. Type A or Type B) [Fraunhofer,12] [Convida,25]
			* Indication about the intended recipient UE [Fraunhofer,12] [LG,24]
			* Resource pool index [Fraunhofer,12]
		- For Type B and/or Type C
			* Resource conflict type (e.g., resource collision or half-duplex restriction) [Intel,17] [LG,24]
			* Indication of information type (e.g. Type B or Type C) [Intel,17] [LG,24]
* When UE-A sends ”A set of resources” to UE-B, including which UE(s) sends it
	+ For Type A and/or Type B
		- Explicit Trigger-based based coordination procedures [Huawei,1] [Nokia,2] [OPPO,3] [Spreadtrum,4] [vivo,5] [CATT,7] [Fujitsu,9] [FUTUREWEI,10] [Zhejiang Lab,11] [Fraunhofer,12] [Mitsubishi,13] [CMCC,14] [ZTE,15] [Xiaomi,16] [Apple,18] [Samsung,20] [ITL,21] [Sony,22] [LG,24] [Sharp,26] [NEC,27] [InterDigital,28] [Lenovo,29]
			* Information carried by the explicit triggering
				+ the parameters related to the sensing procedure of UE-B [Huawei,1] [Nokia,2] [OPPO,3] [CATT,7] [Fujitsu,9] [Fraunhofer,12] [ZTE,15] [Xiaomi,16] [InterDigital,28] [Lenovo,29]
				+ A set of preferred or non-preferred resources determined at UE-B [Nokia,2] [OPPO,3]
			* Container of the explicit triggering
				+ SCI format [Huawei,1] [OPPO,3] [Fujitsu,9] [FUTUREWEI,10]
				+ PSFCH format [Apple,18]
				+ Higher layer signaling [OPPO,3] [Fujitsu,9] [LG,24]
		- Event-trigger based coordination procedures [Huawei,1] [Fujitsu,9] [FUTUREWEI,10] [Zhejiang Lab,11] [Fraunhofer,12] [Mitsubishi,13] [CMCC,14] [Xiaomi,16] [ITL,21] [Sony,22] [LG,24] [NEC,27] [InterDigital,28] [Lenovo,29]
			* Based on (pre)configured periodicity [Huawei,1] [ITL,21] [LG,24]
			* Based on RSRP measurement [MediaTek,8] [CMCC,14] [ITL,21]
			* Based on distance between UE-A and UE-B [Mitsubishi,13] [CMCC,14] [Xiaomi,16] [ITL,21]
			* When the coordination information is updated for UE-B [LG,24]
			* Based on decision in higher layer [LG,24]
			* Based on congestion status [LG,24]
			* Based on SL HARQ-ACK state at UE-A side [Lenovo,29]
	+ For Type B and/or Type C
		- Explicit Trigger-based based coordination procedures [Intel,17]
			* Container of the explicit triggering
				+ 1st SCI format [Intel,17]
		- Event-trigger based coordination procedures
			* Based on detection of resource conflict [Spreadtrum,4] [vivo,5] [MediaTek,8] [Fujitsu,9] [Xiaomi,16] [Intel,17] [Apple,18] [LG,24] [InterDigital,28] [Lenovo,29]
		- Validity check of transmitting inter-UE coordination information
			* Based on distance between UE-A and UE-B(s) [Intel,17] [LG,24]
			* Based on RSRP from UE-A to UE-B(s) [Intel,17] [LG,24] [Lenovo,29]
			* Based on L2 ID(s) from UE-B [Huawei,1] [LG,24]
			* Based on distance between UE-Bs [LG,24]
			* Based on communication range requirement [LG,24]
* How UE-A sends ”A set of resources” to UE-B, including container used for carrying it, implicitly or explicitly or both
	+ For Type A and/or Type B
		- 1st SCI format [Nokia,2] [Spreadtrum,4] [MediaTek,8] [FUTUREWEI,10] [Xiaomi,16] [Lenovo,29]
		- 2nd SCI format [Huawei,1] [OPPO,3] [Spreadtrum,4] [vivo,5] [CAICT,6] [MediaTek,8] [Fraunhofer,12] [CMCC,14] [Xiaomi,16] [Samsung,20] [Sony,22] [Lenovo,29]
		- Higher layer signaling (e.g. MAC CE and/or PC5-RRC) [OPPO,3] [Spreadtrum,4] [vivo,5] [MediaTek,8] [Fraunhofer,12] [ZTE,15] [Intel,17] [LG,24] [NEC,27] [Lenovo,29]
		- PSFCH format [OPPO,3] [Sony,22]
	+ For Type B and/or Type C
		- PSFCH format [vivo,5] [CAICT,6] [MediaTek,8] [Xiaomi,16] [Intel,17] [Apple,18] [LG,24] [NEC,27] [Lenovo,29] [DCM,30]
			* Priority is inherited by the priority indicated by TX UE [Intel,17] [LG,24] [Lenovo,29]
	+ Further consideration of using a single signaling to transmit one or multiple “set of resources” to multiple of UEs [OPPO,3] [LG,24]
	+ Retransmission of the inter-UE coordination information
	+ Further consideration on whether shared or dedicated resource is used for inter-UE coordination signaling [Nokia,2]
* How/when/whether UE-B receives “A set of resources” and takes it into account in the resource selection for its own transmission
	+ For Type A and/or Type B
		- How UE-B performs resource (re)selection procedure upon receiving the inter-UE coordination information
			* Combine UE-B’s sensing results and resource set provided from UE-A [Huawei,1] [OPPO,3] [vivo,5] [CATT,7] [FUTUREWEI,10] [Fraunhofer,12] [CMCC,14] [Xiaomi,16] [Apple,18] [ETRI,23] [LG,24] [Convida,25] [NEC,27] [InterDigital,28] [Lenovo,29] [Hyundai,32]
			* Use resource set provided from UE-A without a consideration of UE-B’s sensing results [Huawei,1] [vivo,5] [FUTUREWEI,10] [Fraunhofer,12] [Apple,18] [ETRI,23] [Convida,25] [InterDigital,28] [Hyundai,32]
			* Reselect UE-B’s reserved resources [OPPO,3] [Apple,18] [LG,24] [Lenovo,29]
			* It is up to UE-B how to use it [Zhejiang Lab,11] [ZTE,15] [Samsung,20]
		- Cast type of UE-B that can use inter-UE coordination information
			* Unicast [Huawei,1] [OPPO,3] [Spreadtrum,4] [vivo,5] [Fujitsu,9] [Fraunhofer,12] [Mitsubishi,13] [Xiaomi,16] [Samsung,20] [ETRI,23] [LG,24] [Convida,25] [Lenovo,29]
			* Groupcast with HARQ-ACK feedback Option 1 [Spreadtrum,4] [vivo,5] [Fujitsu,9] [Fraunhofer,12] [Mitsubishi,13] [Samsung,20] [LG,24] [Convida,25] [Lenovo,29]
			* Groupcast with HARQ-ACK feedback Option 2 [Huawei,1] [OPPO,3] [Spreadtrum,4] [vivo,5] [Fujitsu,9] [Fraunhofer,12] [Mitsubishi,13] [Samsung,20] [ETRI,23] [LG,24] [Lenovo,29]
			* Broadcast [Spreadtrum,4] [vivo,5] [Fujitsu,9] [Mitsubishi,13] [LG,24] [Convida,25] [Lenovo,29]
		- Validity check of the received inter-UE coordination information at UE-B side
			* Based on RSRP in coordination information [Fujitsu,9]
			* Based on distance between UE-A and UE-B [Fujitsu,9] [Fraunhofer,12] [Mitsubishi,13] [LG,24]
			* Based on RSRP from UE-A to UE-B [Fraunhofer,12] [LG,24]
			* Based on information about target UE of the inter-UE coordination information [Fraunhofer,12] [LG,24]
			* Based on whether the indicated resource set is inside UE-B’s selection window
	+ For Type B and/or Type C
		- How UE-B performs resource (re)selection procedure upon receiving the inter-UE coordination information
			* UE-B performs retransmission on the already selected resource(s) [Intel,17] [Qualcomm,19]
			* UE-B reselect all or a subset of its own selected resource(s) [vivo,5] [MediaTek,8] [Fujitsu,9] [Intel,17] [LG,24] [NEC,27] [DCM,30]
			* Continue to use the selected resource(s) [Intel,17]
			* Skip all or a subset of its own selected resource(s) [Intel,17]
			* Further consideration on what is the non-preferred resource set for the resource conflict indication [LG,24]
		- Cast type of UE-B that can use inter-UE coordination information
			* Unicast
			* Groupcast with HARQ-ACK feedback Option 1 [Fujitsu,9] [Qualcomm,19]
			* Groupcast with HARQ-ACK feedback Option 2
			* Broadcast
		- Validity check of the received inter-UE coordination information at UE-B side
			* Resources for initial transmission of UE-B [LG,24]
			* Resources for retransmission of UE-B of which HARQ-ACK state is not ACK [LG,24]
			* Based on HARQ-ACK state at UE-B side [LG,24]
			* Based on the number of (re)transmission of the same TB at UE-B side [LG,24]
* Others
	+ Further consideration of indication to UE-A of ID(s) used by UE-B and the intended receiver(s) of UE-B’s transmission [Nokia,2]
	+ Further consideration of congestion control for inter-UE coordination signaling [Fujitsu,9] [Zhejiang Lab,11] [Intel,17] [LG,24]
	+ Further consideration on the unmonitored slot at UE-B side [Fujitsu,9] [LG,24]
	+ Further consideration on the impact on Rel-16 UE sharing the same resource pool with UEs using inter-UE coordination operation [Samsung,20] [Panasonic,31]
	+ Further consideration on SL DRX to determine “A set of resources” at UE-A side [ASUSTeK,33]
1. **Reference**
2. R1-2102324 Inter-UE coordination in sidelink resource allocation Huawei, HiSilicon
3. R1-2102362 Inter-UE coordination in mode 2 sidelink resource allocation Nokia, Nokia Shanghai Bell
4. R1-2102412 Inter-UE coordination in mode 2 of NR sidelink OPPO
5. R1-2102468 Discussion on inter-UE coordination in sidelink resource allocation Spreadtrum Communications
6. R1-2102540 Discussion on mode-2 enhancements vivo
7. R1-2102576 Considerations on mode 2 enhancements CAICT
8. R1-2102607 Discussion on inter-UE coordination in mode 2 enhancement CATT, GOHIGH
9. R1-2102690 Discussion on Mode 2 enhancements MediaTek Inc.
10. R1-2102720 Considerations on inter-UE coordination for mode 2 enhancements Fujitsu
11. R1-2102781 Discussion on techniques for inter-UE coordination FUTUREWEI
12. R1-2102798 Inter-UE coordination for mode 2 enhancements Zhejiang Lab
13. R1-2102812 Resource Allocation Enhancements for Mode 2 Fraunhofer HHI, Fraunhofer IIS
14. R1-2102826 Inter-UE coordination for enhanced resource allocation Mitsubishi Electric RCE
15. R1-2102898 Discussion on enhancements for mode-2 resource allocation CMCC
16. R1-2102921 Discussion on the inter-UE coordination ZTE
17. R1-2102966 Discussion on inter-UE coordination Xiaomi
18. R1-2103049 Inter-UE coordination solutions for sidelink resource allocation mode-2 Intel Corporation
19. R1-2103122 Discussion on Inter-UE Coordination Apple
20. R1-2103185 Reliability and Latency Enhancements for Mode 2 Qualcomm Incorporated
21. R1-2103258 On Inter-UE Coordination for Mode2 Enhancements Samsung
22. R1-2103271 Inter-UE coordination for mode 2 enhancement ITL
23. R1-2103315 Discussion on reliability and latency enhancements for mode 2 Sony
24. R1-2103332 Discussion on mode 2 enhancements ETRI
25. R1-2103379 Discussion on inter-UE coordination for Mode 2 enhancements LG Electronics
26. R1-2103417 On Inter-UE Coordination for Mode 2 Enhancements Convida Wireless
27. R1-2103484 Discussion on inter-UE coordination for Mode 2 enhancements Sharp
28. R1-2103518 Discussion on mode 2 enhancements NEC
29. R1-2103538 On Inter-UE coordination for Mode 2 enhancement InterDigital, Inc.
30. R1-2103549 Discussion on inter-UE coordination for Mode 2 enhancements Lenovo, Motorola Mobility
31. R1-2103593 Resource allocation for reliability and latency enhancements NTT DOCOMO, INC.
32. R1-2103605 Inter-UE coordination for Mode 2 enhancements Panasonic Corporation
33. R1-2103636 Discussion on mode 2 enhancements Hyundai Motors
34. R1-2103648 Discussion on V2X mode 2 enhancements ASUSTeK
35. R1-2103705 Mode 2 enhancements using Inter-UE coordination Ericsson
36. **Appendix**

**4.1 Conclusions made in RAN1#103-e meeting**

* ***Conclusion****:*
	+ *The schemes of inter-UE coordination in Mode 2 are categorized as being based on the following types of “A set of resources” sent by UE-A to UE-B:*
		- *UE-A sends to UE-B the set of resources preferred for UE-B’s transmission*
			* + *e.g., based on its sensing result*
		- *UE-A sends to UE-B the set of resources not preferred for UE-B’s transmission*
			* + *e.g., based on its sensing result and/or expected/potential resource conflict*
		- *UE-A sends to UE-B the set of resource where the resource conflict is detected*
		- *FFS: details of resource conflict, e.g., including type of resource conflict*
		- *FFS: details of sensing operation at UE-A side*
		- *FFS: which type(s) of resource set information is(are) beneficial/feasible to which cast type(s)*
		- *Note: these different types may be used in combination with each other*
	+ *From RAN1 perspective, further study on the feasibility/benefit of inter-UE coordination is required*
	+ *Send an LS to RAN plenary*
		- *Final LS in* [*R1-2009841*](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_103%5CDocs%5CR1-2009841.zip)
* ***Conclusion****:*
	+ *For the schemes of inter-UE coordination identified as feasible/beneficial, at least the following aspects are further discussed.*
		- *How/when UE-A determines the contents of ”A set of resources”, including consideration of UL scheduling*
		- *When UE-A sends ”A set of resources” to UE-B, including which UE(s) sends it*
		- *How UE-A and UE-B are determined*
		- *How UE-A sends ”A set of resources” to UE-B, including container used for carrying it, implicitly or explicitly or both*
		- *How/when/whether UE-B receives “A set of resources” and takes it into account in the resource selection for its own transmission*
		- *How/whether to define the relationship between support/signaling of inter-UE coordination and cast type*

**4.2 Conclusions made in RAN1#104-e meeting**

* ***Conclusion****:*
	+ *RAN1 concludes that the inter-UE coordination in Mode 2 is feasible, and is beneficial (e.g., reliability, etc.) compared to Rel-16 Mode 2 RA, and thus recommends specification of the feature.*
		- *The detailed observations can be found in the attachment of the LS*
* *Draft LS in* [*R1-2102165*](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104%5CDocs%5CR1-2102165.zip)*, along with the attachment* [*R1-2102166*](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_104%5CDocs%5CR1-2102166.zip)*, is approved (with a typo fix)*
	+ *Final LS in R1-2102168*