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

**e-Meeting, January 25th – February 5th, 2021**

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

**Source:** Moderator (LG Electronics)

**Title:** Feature lead summary for AI 8.11.1.2 Feasibility and benefits for mode 2 enhancements

**Document for:** Discussion and information

1. **Summary of evaluation results**

In RAN1#103-e meeting, RAN1 listed up three types of “A set of resources” for inter-UE coordination in Mode 2:

* Type A: UE-A sends to UE-B the set of resources preferred for UE-B’s transmission
  + e.g., based on its sensing result
* Type B: 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
* Type C: UE-A sends to UE-B the set of resource where the resource conflict is detected

The summary of evaluation results is as follows:

* For Type A without sensing at UE-B,
  + When a UE-A transmits multiple Type A information to multiple UE-B(s),
    - It is assumed that R16 Mode 2 RA is used to determine resources for inter-UE coordination signalling.
      * 5.4% PRR gain is observed in highway scenario for periodic unicast traffic at 320m [Huawei, R1-2100206].
        + Coverage of 200m is extended in highway scenario at PRR=0.95.
  + When a UE-A is the intended RX UE of UE-B,
    - Assumptions on latency and signalling overhead of transmitting and processing coordination information
      * R16 Mode 2 RA is used to determine resources for inter-UE coordination signalling,
        + PRR loss is observed in highway and urban scenarios for aperiodic unicast traffic at 320m and 150m accordingly [Intel, R1-2100673].
      * No latency and no signalling overhead (genie-aided modelling)
        + PRR gain is observed in highway and urban scenarios for aperiodic unicast traffic at 320m and 150m accordingly [Intel, R1-2100673]
      * No latency and signalling of transmitting and processing coordination information
        + 3.4% PRR gain is observed in highway scenario for aperiodic unicast traffic at 300m [Samsung, R1-2101232].

Coverage of 5m is extended in highway scenario at PRR=0.95.

* For Type A and/or Type B with sensing at UE-B,
  + When a UE-A is the intended RX UE of UE-B,
    - Assumptions on latency and signalling overhead of transmitting and processing coordination information
      * R16 Mode 2 RA is used to determine resources for inter-UE coordination signalling,
        + [1-4.3]% PRR gain is observed in highway scenario for periodic unicast traffic at 320m [Huawei, R1-2100206].

Coverage of [10-100]m is extended in highway scenario at PRR=0.95.

* + - * + No PRR gain is observed in highway and urban scenario for periodic unicast traffic at 320m and 100m [Intel, R1-2100673]
      * No latency and no signalling overhead (genie-aided modeling)
        + No PRR gain is observed in highway and urban scenario for aperiodic unicast traffic [Intel, R1-2100673]
        + 2.5% PRR gain is observed in highway scenario for periodic unicast traffic at 320m [Intel, R1-2100673]
        + 1.5% PRR gain is observed in urban scenario for periodic unicast traffic at 100m [Intel, R1-2100673]
      * No signalling overhead and latency of 3ms+2 slots,
        + 7.6% PRR gain is observed in urban scenario for periodic unicast traffic at 150m [OPPO, R1-2100142].

Coverage of 20m is extended in highway scenario at PRR=0.95.

* + - * No signalling overhead and latency of 2ms,
        + 20% PRR gain is observed in highway scenario for periodic unicast traffic at 320m [CATT, R1-2100352].

Coverage of 20m is extended in highway scenario at PRR=0.95.

* + - * + No PRR gain is observed in highway scenario for aperiodic unicast traffic [CATT, R1-2100352].
      * No latency and 1 sub-channel in a slot for signalling overhead of transmitting and processing coordination information
        + 3% PRR gain is observed in urban scenario for aperiodic unicast traffic at 150m [vivo, R1-2101791].

No coverage is extended in highway scenario at PRR=0.95.

* + - * + 4.3% PRR gain is observed in urban scenario for periodic unicast traffic at 150m [vivo, R1-2101791].

Coverage of 15m is extended in highway scenario at PRR=0.95.

* + - * + If 20% of slots are used for UL TX of UE-A,

9% PRR gain is observed in urban scenario for periodic unicast traffic at 150m [vivo, R1-2101791].

Coverage of 40m is extended in highway scenario at PRR=0.95.

* + - * + If 50% of slots are UL TX of UE-A,

46% PRR gain is observed in urban scenario for periodic unicast traffic at 150m [vivo, R1-2101791].

* + - * 10% of resources are used for signalling related to coordination and latency of 10 slots,
        + PRR loss is observed in highway scenario for periodic groupcast traffic at 320m [Fujitsu, R1-2100746].
      * No latency and signalling of transmitting and processing coordination information
        + 6% PRR gain is observed in highway scenario for periodic unicast traffic at 320m [Mitsubishi, R1-2100828].

Coverage extension of 50m in highway scenario at PRR=0.95.

* + - * + 3.2% PRR gain is observed in highway scenario for periodic groupcast traffic at 320m [Mitsubishi, R1-2100828].

Coverage extension of 50m in highway scenario at PRR=0.95.

* + - * + 0.2% PRR gain is observed in urban scenario for aperiodic groupcast traffic at 50m [Qualcomm, R1-2101486].

Coverage of 1.2m is extended in highway scenario at PRR=0.95.

Coverage of 5m is extended in highway scenario at PRR=0.99.

* + - * + 1.2% PRR gain is observed in highway scenario for periodic groupcast traffic at 320m [Fujitsu, R1-2100746].

Coverage of 20m is extended in urban scenario at PRR=0.95.

Coverage of 40m is extended in urban scenario at PRR=0.99.

* + - * Latency of N= 1, 2, 4 logical slots and no signaling overhead
        + N= 1 slot: 3.2% PRR gain is observed in highway scenario for periodic groupcast traffic at 320m [Mitsubishi, R1-2100828].

Coverage extension of 50m in highway scenario at PRR=0.95.

* + - * + N= 2 slots: 2.2 % PRR gain is observed in highway scenario for periodic groupcast traffic at 320m [Mitsubishi, R1-2100828].

Coverage extension of  30m in highway scenario at PRR=0.95.

* + - * + N= 4 slots: 2 % PRR gain is observed in highway scenario for periodic groupcast traffic at 320m [Mitsubishi, R1-2100828].
        + Coverage extension of  30m in highway scenario at PRR=0.95.
      * When UE-A is determined by UE-B via PC5-RRC,
      * The UE-A is further determined by UE-B via PC5-RRC, and fixed overhead (10RB/100bit) are assumed without latency
        + 2.6% PRR gain is observed in highway scenario for periodic broadcast traffic at 320m [ZTE, R1-2100925].

Coverage of 40m is extended in highway scenario at PRR=0.95.

* + - * + 5.8% PRR gain is observed in urban scenario for periodic broadcast traffic at 150m [ZTE, R1-2100925].

Coverage of 10m is extended in urban scenario at PRR=0.95.

* For Type C,
  + Evaluation assumptions
    - UE-A is one of the RX UE of UE-B within the communication range requirement from the UE-B, if any.
    - PSFCH format is used for convey resource conflict indication.
  + When the communication range requirement is smaller than or equal to 200m,
    - For the post-conflict indication,
      * [0.4-1.3]% PRR gain is observed in highway scenario for aperiodic and periodic groupcast traffic at 50m [Intel, R1-2100673 (aperiodic traffic only)] [Fujitsu, R1-2100746].
        + Coverage of [5-25]m is extended in highway scenario at PRR=0.95.
        + Coverage of [50-60]m is extended in highway scenario at PRR=0.99.
      * 1.2% PRR gain is observed in highway scenario for aperiodic groupcast traffic at 300m [Intel, R1-2100673].
      * 1% PRR gain is observed in urban scenario for periodic groupcast traffic at 50m [Fujitsu, R1-2100746].
        + Coverage of 10m is extended in highway scenario at PRR=0.95.
      * 0.7% PRR gain is observed in urban scenario for aperiodic groupcast traffic at 50m [Fujitsu, R1-2100746].
        + Coverage of 25m is extended in highway scenario at PRR=0.99.
      * 0.5% PRR gain is observed in urban scenario for aperiodic groupcast traffic at 50m [Qualcomm, R1-2101486].
        + Coverage of 2.5m is extended in highway scenario at PRR=0.95.
        + Coverage of 10m is extended in highway scenario at PRR=0.99.
      * PRR loss is observed in highway scenario for aperiodic groupcast traffic compared to R16 Mode 2 RA with minimum number of (re)transmissions of 2 [Intel, R1-2100673].
  + When the communication range requirement is larger than or equal to 240m,
    - For the post-conflict indication,
      * [0.1-0.5]% PRR gain is observed in highway scenario for aperiodic groupcast traffic at 320m [Intel, R1-2100673] [Ericsson, R1-2101804].
        + Coverage of 25m is extended in highway scenario at PRR=0.95.
        + Coverage of [10-50]m is extended in highway scenario at PRR=0.99.
      * PRR loss is observed in highway scenario for aperiodic groupcast traffic compared to R16 Mode 2 RA with minimum number of (re)transmissions of 2 [Intel, R1-2100673].
    - For the pre-conflict indication,
      * 0.3% PRR gain is observed in highway scenario for aperiodic groupcast traffic at 320m [Ericsson, R1-2101804].
        + Coverage of 40m is extended in highway scenario at PRR=0.99.
    - For the mix of pre-conflict and post-conflict indication,
      * 0.6% PRR gain is observed in highway scenario for aperiodic groupcast traffic at 320m [Ericsson, R1-2101804].
        + Coverage of 70m is extended in highway scenario at PRR=0.99.
  + When no communication range requirement is configured,
    - For the post-conflict indication,
      * 3% PRR gain is observed in highway scenario for periodic unicast traffic at 50m [MediaTek, R1-2100606].
        + Coverage of 10m is extended in highway scenario at PRR=0.95.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Source (tdoc number)** | **Evaluation Scenario** | **What is the relationship between UE-A and UE-B, including additional latency and signaling overhead model** | **How UE-A determines the set of resources, including the form of the information** | **When UE-A sends the set of resources to UE-B** | **How UE-A sends the set of resources to UE-B, including container and signaling overhead model** | **How/when UE-B takes the received set of resources into account in the resource selection for its own transmission, including additional latency model** | **Gain over Rel.16 Mode-2 RA** |
| OPPO [R1-2100142] | Unicast,  Urban,  Periodic  (UUP) | UE-A is receiver of UE-B. | Type B. | 2 slots after UE-A receiving the triggering signalling from UE-B | Not modelled | The latency of transmitting and processing coordination information is set to 3ms.  UE-B precludes resources overlapping with the indicated set, and selects resource from the remaining. | PRR gain is 1% at the range of 50m.  PRR gain is 7.6% in the range at 150m.  PIR gain is 5ms in average in the range of [100m,240m].  Coverage of 20m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99. |
| Huawei [R1-2100206] | Unicast,  Highway,  Periodic  (UHP) | **Scheme 1:**  UE-A is the UE closest the center of UE group in geographical sense.  UE-B(s) are other UEs in the UE group.  **Scheme 2&3:**  UE-A is receiver of UE-B. | Type A.  **Scheme 1:**  The set of resources is the resources for UE-B’s transmission.  **Scheme 2&3:**  The set of resources is the identified candidate resource set obtained by UE-A’s sensing and resource exclusion procedure. | When UE-A receives the trigger information from UE-B.  The request signalling occupies one sub-channel in a slot.  **Scheme 1:**  Resources for the request are (pre)configured by UE-A.  **Scheme 2&3:**  Resources for the request are obtained by UE-B’s sensing and exclusion procedure. | The signalling of the set of resources occupies one sub-channel in a slot.  Resources for the signalling are obtained by UE-A’s sensing and exclusion procedure. | **Scheme 1:**  UE-B uses the transmission resources provided by UE-A.  **Scheme 2:**  UE-B takes the union of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set  **Scheme 3:**  UE-B takes the intersection of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set. | **Scheme 1:**  PRR gain is 5.4% at the range of 320m.  Coverage of 200m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99.  **Scheme 2:**  PRR gain is 4.3% at the range of 320m.  Coverage of 100m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99.  **Scheme 3:**  PRR gain is 1% at the range of 320m.  Coverage of 10m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99. |
| CATT [R1-2100352] | Unicast,  Highway,  Periodic  (UHP) | UE-A is receiver of UE-B. | A mix of Type A and Type B.  UE-A determines the possible transmission occasions of UE-A as Type B resource set. | When UE-A receives the trigger information from UE-B. | Not modelled | The latency of transmitting and processing coordination information is set to 2ms.  UE-B takes the intersection of UE-B’s S\_A and Type A resource set to obtain the final candidate resource set.  UE-B will preclude all the resources of Type B resource set. | **Type A only:**  PRR gain is 11% at the range of 300m  Coverage of 50m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99.  **Type B only:**  PRR gain is 9% at the range of 300m  Coverage of 50m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99.  **Mix of Type A and B:**  PRR gain is 20% at the range of 300m.  Coverage of 100m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99. |
| CATT [R1-2100352] | Unicast,  Highway,  Aperiodic  (UHA) | UE-A is receiver of UE-B. | A mix of Type A and Type B.  UE-A determines the possible transmission occasions of UE-A as Type B resource set. | When UE-A receives the trigger information from UE-B.  Resources for the request are obtained by UE-B’s sensing and exclusion procedure. | Not modelled | The latency of transmitting and processing coordination information is set to 2ms.  UE-B takes the intersection of UE-B’s S\_A and Type A resource set to obtain the final candidate resource set.  UE-B will preclude all the resources of Type B resource set. | No PRR gain. |
| vivo [R1-2101791] | Unicast,  Urban,  Aperiodic and periodic  (UUA and UUP) | UE-A is receiver of UE-B. | Type A. | Once resource (re)-selection is triggered at UE-B, the assistance info is provided by UE-A | 1 sub-channel and 1 slot signalling overhead is assumed; 0ms latency is assumed | Based on mixed candidate resource set derived by TX UE and RX UE | 3% PRR gain at the range of 150m.  Coverage of 10m is extended at PRR=0.95.  No coverage is extended at PRR=0.99. |
| vivo [R1-2101791] | Unicast, Urban, Aperiodic and Periodic (UUA and UUP) | UE-A is receiver of UE-B. | Type-B | UE-A inform its SL transmission resource to UE-B |  | UE-B preclude the occasion of UE-A’s transmission | 2%-3% PRR gain at the range of 150m.  Coverage of 5m is extended at PRR=0.95. |
| vivo [R1-2101791] | Unicast,  Urban,  Aperiodic and Periodic  (UUA and UUP)  UL/SL coexistence | UE-A is receiver of UE-B. | Type B.  UE-A determines Type A resource set to further consider half-duplex problem and TX/TX overlap b/w UL and SL. | UE-A inform its UL transmission resource to UE-B |  | TX UE further precluding on UE-A’s SL occasion which incur SL TX and UL RX occasion overlap or SL TX and UL TX occasion overlap | **No UL slot:**  4.3% PRR gain at the range of 150m.  Coverage of 15m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99.  **20% UL slot:**  5.4% PRR gain at the range of 50m.  9% PRR gain at the range of 150m.  Coverage of 40m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99.  **50% UL slot:**  46% PRR gain in 150m. |
| MediaTek [R1-2100606] | Unicast,  Highway,  Periodic  (UHP) | UE-A is receiver of UE-B.  UE-B can include TX UEs other than the intended TX UE of UE-A. | Type C and Type B.  When UE-A determines the resources reserved by UE-B as non-preferred resources, then the UE-A transmits non-preferred resource indication to UE-B.  Otherwise, the UE-A will transmit the resource reserved by UE-B as non-preferred resource for other TX UE’s transmission. | Upon receiving a new reservation. | PSFCH format is used for non-preferred resource indication. | Upon receiving an inter-UE coordination message, a UE drops the concerned reservation and reselects resources | 3% PRR gain in 50m.  []% PRR gain in 320m.  Coverage of 10m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99. |
| Intel [R1-2100673] | Groupcast (Option 1 with target range of 200m),  Highway,  Aperiodic  (GHA) | UE-A is another receiver of UE-B within the target range. | Type C. | When UE-A observes half-duplex restriction for the same UE group.  (Post-conflict indication) | PSFCH resource for groupcast HARQ-ACK feedback is reused. | Upon receiving NACK from UE-A, UE-B performs retransmission. | **Reference is R16 Mode 2:**  0.4% PRR gain in 50m.  1.2% PRR gain in 300m.  Coverage of 25m is extended at PRR=0.95.  Coverage of 60m is extended at PRR=0.99.  **Reference is Mode 2 RA with minimum (re)transmissions of 2:**  0.1% PRR loss in 50m.  2% PRR loss in 300m.  Coverage of 20m is reduced at PRR=0.95.  No coverage is extended at PRR=0.99. |
| Intel [R1-2100673] | Groupcast (Option 1 with target range of 400m),  Highway,  Aperiodic  (GHA) | UE-A is another receiver of UE-B within the target range. | Type C. | When UE-A observes half-duplex restriction for the same UE group.  (Post-conflict indication) | PSFCH resource for groupcast HARQ-ACK feedback is reused. | Upon receiving NACK from UE-A, UE-B performs retransmission. | **Reference is R16 Mode 2:**  0.5% PRR gain in 320m.  0% PRR gain in 400.  Coverage of 25m is extended at PRR=0.95.  Coverage of 50m is extended at PRR=0.99.  **Reference is Mode 2 RA with minimum (re)transmissions of 2:**  0.5% PRR loss in 320m.  1% PRR loss in 400m.  No coverage is extended at PRR=0.95.  No coverage is extended at PRR=0.99. |
| Intel [R1-2100673] | Unicast (AN disabled),  Highway,  Periodic  (UHP) | UE-A is receiver of UE-B. | Type A. | When UE-A receives the trigger information from UE-B.  Signalling for the request is not modelled. | Resources for the signalling are obtained by UE-A’s sensing and exclusion procedure. | UE-B takes the intersection of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set. | 0% PRR gain. |
| Intel [R1-2100673] | Unicast (AN disabled),  Highway,  Aperiodic  (UHA) | UE-A is receiver of UE-B. | Type A. | When UE-A receives the trigger information from UE-B.  Signalling for the request is not modelled. | Resources for the signalling are obtained by UE-A’s sensing and exclusion procedure. | **Scheme 2:**  UE-B uses the transmission resources provided by UE-A. | **Scheme 2:**  15% PRR loss in 300m. |
| Not modelled | **Scheme 1:**  UE-B takes the intersection of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set.  **Scheme 2:**  UE-B uses the transmission resources provided by UE-A. | **Scheme 1:**  0% PRR gain.  **Scheme 2:**  5% PRR gain in 300m. |
|  | Unicast (AN disabled),  Urban,  Periodic  (UUP) | UE-A is receiver of UE-B. | Type A. | When UE-A receives the trigger information from UE-B.  Signalling for the request is not modelled. | Resources for the signalling are obtained by UE-A’s sensing and exclusion procedure. | UE-B takes the intersection of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set. | 0% PRR gain. |
|  | Unicast (AN disabled),  Urban,  Aperiodic  (UUA) | UE-A is receiver of UE-B. | Type A. | When UE-A receives the trigger information from UE-B.  Signalling for the request is not modelled. | Resources for the signalling are obtained by UE-A’s sensing and exclusion procedure. | **Scheme 2:**  UE-B uses the transmission resources provided by UE-A. | **Scheme 2:**  9% PRR loss in 150m. |
| Not Modelled | **Scheme 1:**  UE-B takes the intersection of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set.  **Scheme 2:**  UE-B uses the transmission resources provided by UE-A. | **Scheme 1:**  0% PRR gain.  **Scheme 2:**  8% PRR gain in 150m. |
| Ericsson [R1-2101804] | Groupcast (Option 1 with target range of 500m)  Highway,  Aperiodic | Any UE. | Type C.  **Scheme 1:**  A UE detects that a collision has taken place on a sub-channel or it detects that two UEs from the same group are in a half-duplex situation  **Scheme 2:**  A UE checks if the reservation overlaps some other reservation received earlier. If there is an overlap and the RSRP associated new reservation exceeds a certain threshold, the UE sends one bit.  **Scheme 3:**  Combination of Scheme 1 and 2. | **Scheme 1:**  When UE-A observes a collision on a sub-channel or a half-duplex restriction for the same UE group.  **Scheme 2:**  Upon receiving a new (overlapping) reservation.  **Scheme 3:**  Combination of Scheme 1 and 2. | PSFCH format is used, and it can be shared with multiple UE-A(s) for the same problematic resources. | **Scheme 1:**  Upon receiving NACK from UE-A, UE-B performs retransmission.  **Scheme 2:**  Upon receiving an inter-UE coordination message, a UE drops the concerned reservation and reselects resources  **Scheme 3:**  Combination of Scheme 1 and 2. | **R16 Mode 2 RA:**  **Scheme 1:**  0.1% PRR gain in 320m.  Coverage of 20m is extended at PRR=0.975.  Coverage of 10m is extended at PRR=0.99.  **Scheme 2:**  0.3% PRR gain in 320m.  Coverage of 50m is extended at PRR=0.975.  Coverage of 40m is extended at PRR=0.99.  **Scheme 3:**  0.6% PRR gain in 320m.  Coverage of 100m is extended at PRR=0.975.  Coverage of 70m is extended at PRR=0.99.  **Gain over Random RA (Scheme 2):**  1% PRR gain in 320m.  Coverage of 100m is extended at PRR=0.975.  Coverage of 70m is extended at PRR=0.99. |
| Fujitsu [R1-2100746] | Groupcast (Option 1 with target range of 100m)  Highway,  Periodic  (GHP) | UE-A is another receiver of UE-B. | Type C. | When UE-A observes half-duplex restriction for the same UE group.  (Post-conflict indication) | PSFCH resource for groupcast HARQ-ACK feedback is reused. | Upon receiving NACK from UE-A, UE-B performs retransmission. | 1% PRR gain in 50m.  Coverage of 5m is extended at PRR=0.95. |
| Fujitsu [R1-210746] | Groupcast (Option 1 with target range of 100m)  Urban,  Periodic  (GUP) | UE-A is another receiver of UE-B. | Type C. | When UE-A observes half-duplex restriction for the same UE group.  (Post-conflict indication) | PSFCH resource for groupcast HARQ-ACK feedback is reused. | Upon receiving NACK from UE-A, UE-B performs retransmission. | 1% PRR gain in 50m.  2% PRR loss in 100m.  Coverage of 10m is extended at PRR=0.95. |
| Fujitsu [R1-210746] | Groupcast (Option 1 with target range of 100m)  Highway,  Aperiodic  (GHA) | UE-A is another receiver of UE-B. | Type C. | When UE-A observes half-duplex restriction for the same UE group.  (Post-conflict indication) | PSFCH resource for groupcast HARQ-ACK feedback is reused. | Upon receiving NACK from UE-A, UE-B performs retransmission. | 1.3% PRR gain in 50m.  Coverage of 50m is extended at PRR=0.99. |
| Fujitsu [R1-210746] | Groupcast (Option 1 with target range of 100m)  Urban,  Aperiodic  (GUA) | UE-A is another receiver of UE-B. | Type C. | When UE-A observes half-duplex restriction for the same UE group.  (Post-conflict indication) | PSFCH resource for groupcast HARQ-ACK feedback is reused. | Upon receiving NACK from UE-A, UE-B performs retransmission. | 0.7% PRR gain in 50m.  Coverage of 25m is extended at PRR=0.99. |
| Fujitsu [R1-210746] | Groupcast (Option 1 with target range of 320m)  Highway,  Periodic  (GHP) | UE-A is receiver of UE-B. | Type A and B. | When UE-A receives the trigger information from UE-B. | Not modelled. | UE-B takes the intersection of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set. | 1% PRR gain in 320m.  Coverage of 40m is extended at PRR=0.99.  Coverage of 20m is extended at PRR=0.95. |
| Fujitsu [R1-210746] | Groupcast (Option 1 with target range of 320m)  Highway,  Periodic  (GHP) | UE-A is receiver of UE-B. | Type A and B. | When UE-A receives the trigger information from UE-B. | 10% of PRBs in a RP is always reserved for the signalling of the inter-UE coordination and the request. | The latency of transmitting and processing coordination information is set to 10 slots in average.  UE-B takes the intersection of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set. | 1% PRR loss in 320m.  Coverage of 30m is reduced at PRR=0.95. |
| Mitsubishi [R1-2100828] | Unicast (AN disabled),  Highway,  Periodic  (UHP) | UE-A is receiver of UE-B. | Type B. (an ordered /prioritized list of non-preferred resources with RSRP above a pre-defined /preconfigured RSRP threshold) | Once resource (re)-selection is triggered at UE-B, the assistance info is provided by UE-A | Not modelled. | UE-B will preclude all the resources of Type B resource set.  In the case of blocking situation (not enough remaining resources), RSRP-based thresholding at UE-B may re-integrate some of the excluded resources in the inverse order from the ordered list provided by UE-A. | 6% PRR gain in 320m.  Coverage extension of 50m at PRR=0.95.  Coverage extension of []m at PRR=0.99.  7% PRR gain at 420m. (comm range) |
| Mitsubishi [R1-2100828] | Groupcast,  Highway,  Periodic  (GHP) | UE-A(s) is/are selected candidate(s) out of the receivers of UE-B. | Type B. (an ordered /prioritized list of non-preferred resources with RSRP above a pre-defined /preconfigured RSRP threshold) | Once resource (re)-selection is triggered at UE-B, assistance info is provided by UE-A(s) within a certain range from UE-B. | Not modelled. | When the TX (UE B) receives the assistance reports from the candidate UE A(s), it carries out a second round of prioritization of the non-preferred resources based on the number of occurrences of a given non preferred resource in the received assistance reports.  UE-B will preclude all the resources of Type B resource set.  In the case of blocking situation (not enough remaining resources), RSRP-based thresholding at UE-B may re-integrate some of the excluded resources in the inverse order from the ordered/prioritized list of non-preferred resources | 3.2% PRR gain in 320m.  Coverage extension of 50m at PRR=0.95.  Coverage of []m is extended at PRR=0.99.  7% PRR gain in 420m. (comm range) |
| Mitsubishi [R1-2100828] | Groupcast,  Highway,  Periodic  (GHP) | UE-A(s) is/are selected candidate(s) out of the receivers of UE-B. | Type B. (an ordered/ prioritized list of non-preferred resources with RSRP above a predefined/ preconfigured RSRP threshold) | Once resource (re)-selection is triggered at UE-B, the assistance info is provided by UE-A(s)  within a certain range from UE-B, with a delay of N= 1,2 or 4 logical slots | Not modelled. | When the TX (UE B) receives the assistance reports from the candidate UE A(s), it carries out a second round of prioritization of the non-preferred resources based on the number of occurrences of a given non preferred resource in the received assistance reports.  UE-B will preclude all the resources of Type B resource set.  In the case of blocking situation (not enough remaining resources), RSRP-based thresholding at UE-B may re-integrate some of the excluded resources in the inverse order from the ordered/prioritized list of non preferred resources | Latency N= 1 Slot: 3.2% PRR gain in 320m.  Coverage extension of 50m at PRR=0.95.  Coverage extension of []m at PRR=0.99.  5% PRR gain in 420m. (comm range)  Latency N= 2 Slots: 2.2% PRR gain in 320m.  Coverage extension of 30m at PRR=0.95.  Coverage of []m is extended at PRR=0.99.  3% PRR gain in 420m. (comm range)  Latency N= 4 Slots: 2% PRR gain in 320m.  Coverage extension of 30m at PRR=0.95.  Coverage of []m is extended at PRR=0.99.  1% PRR gain in 420m. (comm range) |
| ZTE [R1-2100925] | Broadcast,  Highway,  Periodic  (BHP) | UE-A is receiver of UE-B, which is further selected by UE-B via PC5-RRC. | Type A. |  | Information bits: 300 bits  Resource overhead: 10 RB | UE-B takes the intersection of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set. | 2.6% PRR gain in 320m.  Coverage of 40m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99. |
| ZTE [R1-2100925] | Broadcast,  Urban,  Periodic  (BUP) | UE-A is receiver of UE-B, which is further selected by UE-B via PC5-RRC. | Type A. |  | Information bits: 300 bits  Resource overhead: 10 RB | UE-B takes the intersection of UE-B’s S\_A and UE-A’s S\_A to obtain the final candidate resource set. | 5.8% PRR gain in 150m.  Coverage of 10m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99. |
| Samsung [R1-2101232] | Unicast,  [Highway],  Periodic  (UHP) | UE-A is receiver of UE-B. | Type A. | When UE-A receives the trigger information from UE-B. | Not modelled. | UE-B uses the transmission resources provided by UE-A. | 60% PRR gain in 300m.  No coverage is extended at PRR=0.95.  No coverage is extended at PRR=0.99. |
| Samsung [R1-2101232] | Unicast,  Highway,  Aperiodic  (UHA) | UE-A is receiver of UE-B. | Type A. | When UE-A receives the trigger information from UE-B. | Not modelled. | UE-B uses the transmission resources provided by UE-A. | 3.4% PRR gain in 300m.  Coverage of 5m is extended at PRR=0.95.  Coverage of []m is extended at PRR=0.99. |
| Qualcomm [R1-2101486] | Groupcat (Option 1 with target range of 60m)  Urban  Aperiodic  (GHA) | UE-A is another receiver of UE-B. | Type C. | When UE-A observes resource conflict for the same UE group.  (Post-conflict indication) | PSFCH resource for groupcast HARQ-ACK feedback is reused. | Upon receiving NACK from UE-A, UE-B performs retransmission. | 0.5% PRR gain in 50m.  []% PRR gain in 150m.  Coverage of 2.5m is extended at PRR=0.95.  Coverage of 10m is extended at PRR=0.99. |
| Qualcomm [R1-2101486] | Groupcat (Option 1 with target range of 60m)  Urban  Aperiodic  (GHA) | UE-A is receiver of UE-B. | Type B. | Whenever forwarding UEs have data to transmit | Not modelled. | UE-B will preclude all the resources of Type B resource set. | 0.2% PRR gain in 50m.  []% PRR gain in 150m.  Coverage of 1.2m is extended at PRR=0.95.  Coverage of 5m is extended at PRR=0.99. |

Please check whether the above evaluation methodology and gain are correctly captured or not, and provide input, if any, **by January 26th, 4:59pm UTC**. You can also make correction directly in the above summary of evaluation results.

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | See corrections above. Given that our scenario has PRR>0.95 for almost every simulated case, we have included results at PRR=0.975 instead |
| vivo | See correction above. |
| ZTE | Updates on the details simulation methodology including overhead modelling and scenario. |
| Fujitsu | * Some corrections are made to align the summary and the table. * Some irrelevant results are deleted. E.g., for a simulation with the target range of 100m, the results for a range larger than 100m is not so relevant and thus deleted. * Another result with ideal coordination information report is added. In the contribution, we also provided the result for an ideal case. This is newly added in the summary and the table. |

1. **FL’s observation on evaluation results**

In this RAN1 meeting, it needs to make conclusion on the feasibility/benefit of inter-UE coordination and send an LS to RAN plenary meeting. In this sense, FL made the following observation after reviewing the submitted evaluation results.

***FL’s observation on evaluation results****:*

* *Type A and/or B*
  + *For the case when one UE-A indicates the preferred resource set to each of multiple UE-Bs,*
    - *one company claimed that the inter-UE coordination is beneficial compared to Rel-16 Mode 2 RA.*
  + *For the case when UE-A is the intended receiver of UE-B,* 
    - *nine companies claimed that the inter-UE coordination is beneficial compared to Rel-16 Mode 2 RA*
      * *One company claimed that the gain of this solution becomes larger under the scenario where UL transmission can overlap with SL transmission/reception.*
    - *three companies claimed that the inter-UE coordination has no gain under certain scenarios (e.g., highway and/or urban scenario for aperiodic unicast traffic, highway scenario for periodic groupcast traffic)*
* *Type C*
  + *For the case when UE-A indicates the resource conflict in previous transmission (i.e., post conflict),*
    - *five companies claimed that the inter-UE coordination is beneficial compared to Rel-16 Mode 2 RA*
      * *one company claimed that the inter-UE coordination has a lower gain with Rel-16 Mode 2 RA with ensuring the minimum number of (re)transmissions.*
  + *For the case when UE-A indicates the resource conflict in future (i.e., pre-conflict),*
    - *one company claimed that the inter-UE coordination is beneficial compared to Rel-16 Mode 2 RA and the gain is higher than the case when UE-A indicates the resource conflict in previous transmission*

Please provide comment, if any, on the above FL’s observation **by January 26th, 4:59pm UTC**. Note that after finishing checking this observation, FL has a plan to provide/discuss potential conclusions on the feasibility/benefit of inter-UE coordination.

|  |  |
| --- | --- |
| Company | Comment |
| NTT DOCOMO | Firstly, thank you so much for your efforts on evaluations.  Then, three comments from our side.  - In our understanding, pre-collision indication is a part of type B, and post-collision indication is intended as type C. However, the above FL’s observation seems to include pre-collision indication in both type-B (UL vs SL) and type C (second bullet). Correct categorizing is preferred.  - In the above FL’s observation, type A and type B are treated in the same bullet. However, as abovementioned, type B includes pre-collision indication. This implies that achievable gain is different among type A and type B. Separate analysis is preferable.  - Regarding type A, many companies show some gain under periodic traffic, not aperiodic. As presented in QC’s contribution, sharing latency is a key aspect for discussion on ‘beneficial or not’. From this perspective, type A is good scheme only for periodic transmission. As you know, NR-SL supports aperiodic transmission, which is one of the important features. For aperiodic transmissions, pre/post collision indication achieves performance gain as some companies kindly evaluated. This point should be included in the above observation and corresponding conclusion should consider it. |
| CATT, GOHIGH | Thanks for the summary.  Regarding the categorizing the observations, it would be better to separate the observations of each resource coordination type for periodic transmission and aperiodic transmission. For example, from our evaluation results, there is no gain for the aperiodic transmission with resource coordination type A and/or type B. |
| vivo | Thank you for the summary. Our view is as below  1. Firstly, we prefer to list the observation based on each type, i.e., A,B and C  2.For type-A, UE-A can assist multiple UE-Bs which is connected to UE-A from our perspective. We do not think it is reasonable to distinguish whether ‘UE-B is multiple UE’ or ‘target receiver’  3.For type-C, we prefer to add the following observation: type B based solution set upper bound of performance gain for type-C based solution, which proves that type-C based solution is beneficial. The reason is as following  Type B (non-preferred resource set) is trying to avoid the resource conflict due to collision, HD or TX/TX overlap, while type C is based on conflict detection/resolution. In our understanding, for some solution, type B based solution can set performance upper bound for type C based solution (In our simulation, the type-B based solution to address HD and TX/TX overlap issue can be implemented in a way to notify the future resource conflict, i.e., Type-C based pre-conflict indication). |
| Fujitsu | In our contribution, we provide two simulation results for inter-UE coordination. The simulation results show the gain for one scenario, but no gain for the other scenario. However, only the result “without gain” is counted in the above observation. To also capture the result “with gain”, for the observation “eight companies claimed that the inter-UE coordination is beneficial compared to Rel-16 Mode 2 RA”, the wording “eight companies” should be changed to “nine companies”. |
| OPPO | We share the view that post-collision should go to Type B rather than Type C. According to the definition of Type B and Type C (reproduced below), expected/potential resource conflict pre-conflict in the future is covered by Type B, resource conflict happened in the past is covered by Type C.   * *Type B: 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* * *Type C: UE-A sends to UE-B the set of resource where the resource conflict is detected* |
| Samsung | Even though we have listed up 3 Types in the last meeting. In our understanding, it is not clear the difference between Type B and C. As OPPO commented, there is a confusion. This should be discussed in this meeting and we should make it clear in order to discuss evaluation results and also decide final inter-UE coordination schemes in next time. |
| Huawei, HiSilicon | We share similar view with Docomo that pre-collision is part of Type-B since it indicates future resources which are not preferred for UE-B’s transmission. Post-collision can be Type-C. So we suggest to put pre-collision under Type-B to be more accurate.  Type-A and Type-B are different solutions, and better to be analysed separately. |

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 [1] [2] [4] [5] [6] [10] [16] [19] [27]
  + Option 2: UE-A and UE-B is determined via higher layer (e.g. application layer) [3] [5] [7]
  + Option 3: UE-A is pre-defined, and UE-B is UEs that can receive inter-UE coordination information from other UE [7]
  + Further consideration on the case when a leading-UE to suggest transmission resources to other UE(s) in a UE group [3] [5] [7] [18] [22] [33]
* How/when UE-A determines the contents of “A set of resources”, including consideration of UL scheduling?
  + Type of “A set of resources”
    - Type A: UE-A sends to UE-B the set of resources preferred for UE-B’s transmission
      * e.g., based on its sensing result
    - Type B: 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
    - Type C: UE-A sends to UE-B the set of resource where the resource conflict is detected
    - Companies views
      * Option 1: Support Type A only [3] [5] [27]
      * Option 2: Support both Type A and Type B [2] [4] [6] [7] [10] [13] [14] [15] [17] [18] [19] [24] [25] [28] [29] [36]
      * Option 3: Support Type C [10] [14] [22] [28] [32]
      * Option 4: Support Type B only [35]
      * Option 5: Type B + Type C [12]
  + Other information in the inter-UE coordination information
    - Type indicator for a set of resources [6] [7] [13] [28][4]
    - Indication about the intended recipient UE [13]
    - Resource pool index [13] [23]
    - Source ID of UE-B [14] [21]
    - Destination ID associated with UE-B [14] [21]
    - Associated RSRP [21] [28] [34]
    - Associated RX priority [28] [34]
    - Common DRX configuration [29]
    - Recommended TX parameters [29]
  + Further consideration on the assumption of the behavior of UE-A to determine the inter-UE coordination information [8]
* When UE-A sends ”A set of resources” to UE-B, including which UE(s) sends it
  + Explicit Trigger-based based coordination procedures [2] [3] [4] [5] [6] [13] [14] [15] [16] [17] [19][20] [22] [24] [25] [26] [27] [28] [30] [33]
    - Condition that UE-B transmit the triggering
      * When UE-B triggers resource selection procedure [2] [5] [7]
      * When UE-B fails TB reception [20]
      * Upon receiving scheduling request [20]
    - Information carried by the explicit triggering
      * the parameters related to the sensing procedure of UE-B [3] [4] [14] [19][22] [28]
      * the parameters related to TX packet of UE-B [7]
    - Container of the explicit triggering
      * 2nd SCI format [3] [14]
      * MAC CE [14]
      * PSFCH format [7] [28]
  + Event-trigger based coordination procedures [3] [5] [6] [7] [12] [13] [14] [16] [17] [20] [24] [25] [26] [29] [30] [32] [33] [35]
    - Based on (pre)configured periodicity [3] [7] [29] [30]
    - Based on detection of resource conflict [5] [12] [13] [16] [20] [26] [29] [32] [35]
    - When the coordination information is updated for UE-B [7]
    - Based on decision in higher layer [7] [20]
    - Based on congestion status [13]
    - Based on distance between UE-A and UE-B [17] [24] [26] [29]
    - Based on RSRP measurement [24]
* How UE-A sends ”A set of resources” to UE-B, including container used for carrying it, implicitly or explicitly or both
  + Container
    - SCI format 1-A [1] [24] [26] [29]
    - 2nd SCI format [1] [2] [3] [13] [14] [18] [24] [26] [27] [29] [33] [36]
    - MAC CE [7] [14] [20] [29] [33] [36]
    - PC5-RRC [2] [19] [20] [33] [36]
    - PSFCH format [2] [12] [14] [18] [20] [28] [32]
  + Retransmission of the inter-UE coordination information
  + Further consideration on whether shared or dedicated resource is used for inter-UE coordination signaling [8] [32]
* How/when/whether UE-B receives “A set of resources” and takes it into account in the resource selection for its own transmission
  + Whether UE-B can skip sensing operation
    - UE-B does not perform its own sensing operation
    - UE-B performs its own sensing operation [7] [24]
  + 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 [2] [3] [7] [13] [14] [20] [21] [22] [24] [25] [26] [28] [31][4]
    - Use resource set provided from UE-A without a consideration of UE-B’s sensing results [2] [3] [13] [21] [22] [25] [28] [31]
    - UE-B performs retransmission on the already selected resource(s) [32]
    - UE-B reselect all or a subset of its own selected resource(s) [2] [7] [10] [12] [20] [28] [31] [32] [35]
    - It is up to UE-B how to use it [6] [27]
  + Cast type of UE-B that can use inter-UE coordination information
    - Unicast [2] [3] [5] [6] [7] [12] [13] [14] [16] [17] [19][25] [26] [27] [31] [33] [36][4]
    - Groupcast with HARQ-ACK feedback Option 1 [5] [6] [7] [12] [13] [14] [16] [17] [19][22] [27] [31] [32] [33] [36]
    - Groupcast with HARQ-ACK feedback Option 2 [2] [3] [5] [6] [7] [12] [13] [14] [16] [17] [19][22] [25] [27] [31] [33] [36]
    - Broadcast [6] [7] [12] [14] [16] [17] [22] [31] [33]
  + Validity check of the received inter-UE coordination information at UE-B side
    - Based on distance between UE-A and UE-B [7] [13] [14]
    - Based on RSRP from UE-A to UE-B [7] [13] [14]
    - Based on information about target UE of the inter-UE coordination information [7]
    - Based on whether the indicated resource set is inside UE-B’s selection window [7] [13]
* Others
  + Further consideration of using a single signaling to transmit one or multiple “set of resources” to multiple of UEs [2] [14] [22]
  + Further consideration on the case when UE-B receives multiple inter-UE coordination information from one or multiple UE-A(s) [6] [7] [13] [33]
  + Further consideration of congestion control for inter-UE coordination signaling [7] [29]
  + Further consideration on the unmonitored slot at UE-B side [7] [14]
  + Additional inter-UE coordination schemes do not show noticeable gain when practical evaluation assumptions are considered [11]
  + Further consideration of using inter-UE coordination for UE with limited RX capability [12]
  + Further consideration on the impact on Rel-16 UE sharing the same resource pool with UEs using inter-UE coordination operation [23] [29]
  + Further consideration of retransmission of inter-UE coordination signaling [29]
  + Further consideration on SL DRX to determine “A set of resources” at UE-A side [34]

1. **Reference**
2. R1-2100047 Views on resource allocation enhancements for sidelink communication FUTUREWEI
3. R1-2100142 Inter-UE coordination in mode 2 of NR sidelink OPPO
4. R1-2100206 Inter-UE coordination in sidelink resource allocation Huawei, HiSilicon
5. R1-2100352 Discussion on feasibility and benefits for mode 2 enhancements CATT, GOHIGH
6. R1-2101791 Discussion on mode-2 enhancements vivo
7. R1-2100493 Inter-UE coordination for mode 2 Zhejiang Lab
8. R1-2100518 Discussion on feasibility and benefits for mode 2 enhancements LG Electronics
9. R1-2100539 Inter-UE coordination in mode 2 sidelink resource allocation Nokia, Nokia Shanghai Bell
10. R1-2100547 Feasibility and benefits for mode 2 enhancements TCL Communication Ltd.
11. R1-2100606 Discussion on Mode 2 enhancements MediaTek Inc.
12. R1-2100673 On feasibility and benefits of inter-UE coordination for sidelink mode-2 design Intel Corporation
13. R1-2101804 Feasibility and benefits of mode 2 enhancements for inter-UE coordination Ericsson
14. R1-2100702 Resource Allocation Enhancements for Mode 2 Fraunhofer HHI, Fraunhofer IIS
15. R1-2100746 Considerations on inter-UE coordination for mode 2 enhancements Fujitsu
16. R1-2100767 Sidelink resource allocation for Reliability enhancement Lenovo, Motorola Mobility
17. R1-2100802 Discussion on feasibility and benefit of mode 2 enhancements Spreadtrum Communications
18. R1-2100828 Inter-UE coordination for enhanced resource allocation Mitsubishi Electric RCE
19. R1-2100871 Discussion on reliability and latency enhancements for mode 2 Sony
20. R1-2100925 Discussion on inter-UE coordination ZTE, Sanechips
21. R1-2100947 Discussion on feasibility and benefits for mode 2 enhancements NEC
22. R1-2100963 Discussion on feasibility and benefits for mode 2 enhancements Hyundai Motors
23. R1-2100982 On inter-UE coordination for Mode 2 enhancement InterDigital, Inc.
24. R1-2101004 Mode 2 enhancements in sidelink Panasonic Corporation
25. R1-2101061 Discussion on reliability and latency enhancements for mode-2 resource allocation CMCC
26. R1-2101087 Discussion on feasibility and benefits for mode 2 enhancements ETRI
27. R1-2101098 Feasibility and benefits for mode2 enhancements Xiaomi
28. R1-2101232 On Feasibility and Benefits for Mode2 Enhancements Samsung
29. R1-2101358 Inter-UE Coordination for Mode 2 Resource Allocation Apple
30. R1-2101401 Discussion on Sidelink Mode-2 Resource Allocation Enhancements ROBERT BOSCH GmbH
31. R1-2101409 Inter-UE coordination for mode 2 enhancement ITL
32. R1-2101423 On NR Sidelink Resource Allocation Mode 2 Enhancement Convida Wireless
33. R1-2101486 Reliability and Latency Enhancements for Mode 2 Qualcomm Incorporated
34. R1-2101551 Discussion on feasibility and benefits for mode 2 enhancements Sharp
35. R1-2101574 Discussion on V2X mode 2 enhancements ASUSTeK
36. R1-2101631 Resource allocation for reliability and latency enhancements NTT DOCOMO, INC.
37. R1-2101647 Feasibility and benefits for NR Sidelink mode 2 enhancements CEWiT