# **[100b-e-NR-5G\_V2X\_NRSL-SL\_PHY\_Procedure-04] CSI reporting latency bound and association with CSI trigger**

[100b-e-NR-5G\_V2X\_NRSL-PHY-Procedure-04] Email discussion/approval regarding CSI reporting latency bound and association with CSI trigger

* Introduction and time/frequency location of SL CSI reference resource
* How to determine the latency bound of SL CSI reporting
* Whether/how to associate the reported CSI with the CSI trigger

till 4/24, with potential TPs by 4/29 (Hanbyul, LGE)

Q1: Do you agree the following proposals for the definition of SL CSI reference resource in the time and frequency domain?

* Proposal
  + For a given CSI trigger, CSI reference resource in time domain is the slot where the CSI trigger is received
  + For a given CSI trigger, CSI reference resource in frequency domain is the PRBs scheduled for the PSSCH in the CSI reference resource slot

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| Company | Answer |
| NTT DOCOMO | Support, if the following is correct understanding:  If it is allowed that CSI report is triggered multiple times, and when RX-UE receives multiple CSI triggers, the above proposal implies that CSI is calculated based on the CSI-RS in the PSCCH/PSSCH with **the LAST** CSI report. |
| Huawei, HiSilicon | Basically agree.  In the time domain, we think better to restrict the reference resource to the slot which carries the “latest” CSI trigger. This is because multiple CSI triggers might be received over a time. This simplification allows a one-to-one correspondence between CSI trigger and CSI report. |
| Apple | Agree |
| ZTE,Sanechips | agree |
| Intel | Agree, this is in line with the prior agreements on SL CSI supporting |
| Futurewei | Agree |
| OPPO | Agree |
| CATT | This issue should discuss together with Q3. Otherwise UE can not know the associated CSI trigger and the related PSSCH resource. |
| Lenovo&MM | Agree |
| vivo | Agree |
| LG | We are supportive of this proposal for the case when there is only one CSI trigger before the corresponding CSI reporting. For other case when there are more than one CSI triggers before the corresponding CSI reporting, the RX UE can transmit SL CSI reporting for each CSI trigger. Since each CSI reference resource could be associated with different set of PRBs and the associated CSI-RS power would be different, it is not preferred to ignore some CSI trigger. |
| Panasonic | We support above proposal. |
| Samsung | Agree |
| Ericsson | Agree |
| Qualcomm | Agree |
| Nokia, NSB | Agree. To address the multiple CSI triggers issue, suggest revising the 1st proposal as “For a given CSI trigger, CSI reference resource in time domain is the slot where the CSI trigger is ~~received~~ transmitted” |
| Bosch | Agree. Also we support Nokia’s modification to clarify the multiple CSI triggers. |
| InterDigital | Agree |

**Observation:**

* **Majority view is to agree the proposal in principle.**
  + **Some companies mentioned clarification in the context of the multiple CSI triggers.**

Q2: How can the UE reporting SL CSI know the latency bound? What is the signaling mechanism of the latency bound for sidelink CSI reporting MAC CE?

- Option 1: (Pre)configuration in a resource pool

- Option 2: PC5-RRC signaling from CSI triggering UE to CSI reporting UE

- Option 3: Explicit SCI indication from CSI triggering UE to CSI reporting UE

- Option 4: Others (please specify it)

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| Company | Preferred option | Comments |
| NTT DOCOMO | Option 2 | Required bound is dependent on each PDB. When multiple services are considered, PDB would be different among services and/or UEs. Fixed and/or common value is not desirable solution for the latency bound.  CSI-RS configuration is delivered on PC5-RRC message. The same solution is reasonable. |
| Huawei, HiSilicon | Option 2 + Option 3 | We think one latency bound or a list of latency bounds can be configured. When only one bound is configured, option 2 is utilized. When a list of latency bounds is used, it provides better flexibility at the TX UE side. It may decide the latency bound dynamically based on the service type or whether the last CSI report is successfully received or not. The list will be configured by PC5-RRC, and SCI (option 3) is used to explicitly indicate the used latency bound. |
| Apple | Option 2 | The resource pool (pre)configuration does not fit for channel condition of every pair of Ues and does not fit for every data QoS. The explicit SCI indication increases the L1 signaling overhead. |
| ZTE, Sanechips | Option 1 | FFS whether it is a per resource pool configuration |
| Intel | Option 2 | Per resource pool and/or per QoS configuration may not make much sense since the channel quality is not dependent on QoS or resource partitioning in general. Option 2 can allow Ues to tune the latency bound according to channel coherence times. |
| Futurewei | Option 1 or 2 | Either option is fine for us |
| OPPO | Option 3 | The latency boundary of CSI reporting can be based on the priority in SCI. |
| CATT | Option 2 | SL-CSI feedback is only supported in unicast, there is an available PC5-RRC connection between the unicast peers. And the latency bound could be changed due to the variation of service type and channel environment (e.g. variation of UE speed). |
| Lenovo&MM | Option 2 | At least, option 2 should be supported. In addition, option 1 can also be supported. |
| Vivo | Option 1 | If SCI/PC5-RRC is used for configuration, UE may always use 3ms latency bound, i.e., the greedy implementation. Whether it is per pool or per BWP can be FFS. |
| LG | Option 2 | Depending on the TX UE-RX UE pair, the range of latency bound for sidelink CSI reporting would be different. Meanwhile, when the latency bound for sidelink CSI reporting is PC5-RRC configured without any restriction, it would be possible that the all the Ues set the small latency bound for sidelink CSI reporting, and it can make resource selection procedure for sidelink CSI reporting MAC CE difficult. To bypass this problem, it can be considered that the minimum value of latency bound for sidelink CSI reporting MAC CE is (pre)configured in a resource pool. |
| Panasonic | Option 2 | For Unicast transmission, CSI-RS configuring is delivered on PC5-RRC. The same solution seems reasonable |
| Samsung | Option 1 or 2 | Either option is fine for us |
| Ericsson | Option 2 |  |
| Qualcomm | Option 4 | Follow the QoS parameters of the logical channel. It is up to UE to select which LCH the CSI report is sent on |
| Nokia, NSB | Option 1 or 2 | Sidelink CSI reporting is using MAC CE. Dynamic signaling of this bound (Option 3) is unnecessary. We would prefer Option 1. |
| Bosch | Option 1 and Option 2 | Initially, CSI reporting latency bound can be (pre)configured per resource pool (Option 1). Later, the latency bound can be overwritten by PC5-RRC. |
| InterDigital | Option 3 | The latency bound is closely tied with UE speed as the latency bound allows that the outdated CSI is not transmitted from Rx UE so that the congestion is reduced in the resource pool. Since we don’t have any speed restriction in each resource pool, option-1 doesn’t make any sense. The option 2 can be used assuming that the relative UE speed won’t change for the life of a unicast link but I don’t think that is the case. Then the only option left is option 3 to handle the case that the UE speed changes during the life of the unicast link. We may accept semi-static configuration if a Tx UE can change the CSI latency bound via MAC-CE. |

**Observation:**

* **Option 1: ZTE, Futurewei, vivo, Samsung, Nokia, Bosch (6)**
* **Option 2: DOCOMO, Apple, Intel, Futurewei, CATT, Lenovo, LGE, Panasonic, Samsung, Ericsson, Nokia, Bosch (12)**
* **Option 3: Huawei, OPPO, InterDigital (3)**
* **Other: Qualcomm**

Q2-1: In case where UE determines the SL CSI latency bound, how is the determination done?

- Option A: By UE implementation

- Option B: Based on UE speed

- Option C: Others (please specify it)

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| Company | Preferred option | Comments |
| NTT DOCOMO | Option A | Bound would be related to PDB, channel busy ratio, etc. We do not understand why only UE speed should be considered. |
| Huawei, HiSilicon | Option A | The latency bound depends more strongly on service priority, link-level factors such as MCS table, and so on, than only on speed. UE may take into account whatever it needs to when setting the latency bound. |
| Apple | Option A | The channel status depends on relative speed of peer UEs, instead of absolute speed. The relative UE speed is hard to obtain. Hence, we do not think it is based on UE speed. |
| ZTE, Sanechips | Option A |  |
| Intel | Option A |  |
| Futurewei | Option A |  |
| OPPO | Option C | Based on priority in SCI. A mapping between priority and latency boundary can be (pre-)configured. |
| Lenovo&MM | Option A |  |
| LG | Option A | SL CSI latency bound would be depending on the service type, variations on the interference. The interference variation would be dependent on the UE speed, congestion, channel busy ratio, and/or channel environment. In other words, the suitable SL CSI latency bound would be different case by case. In those point of views, it is up to UE implementation to decide the SL CSI latency bound. |
| Panasonic | Option A | Multiple factors including QoS and channel busy ratio are taken into account by UE implementation but not only UE speed. |
| Samsung | Option A (conditioned with Option 2 in Q2) | In our understanding, Q2-1 is assumed that Option 2 in Q2 is applied. When Option 1 in Q2 is applied, one value is (pre-)configured in a resource pool within range of 3-20ms. When Option 2 in Q2 is applied, CSI requesting UE needs to determine value within range of 3-20ms indicates to CSI reporting UE by PC5-RRC |
| Ericsson | Option A | We do not think UE speed should be used to determine the latency bound for CSI report. |
| Qualcomm | Option C | Follow the QoS parameters of the logical channel. It is up to UE to select which LCH the CSI report is sent on |
| Nokia, NSB | Option A | By UE implementation. |
| Bosch | Option A |  |
| InterDigital | Option B | The major factor to determine the latency bound of the CSI is the UE speed. The reported CSI will be used for any unicast transmission so it doesn’t make sense that it is determined based on QoS. But, we understand other factors can be also taken into account. Therefore, we are also fine with Option A. |

**Observation:**

* **Majority view is to determine SL CSI latency bound by UE implementation (Option A).**

Q3: Do you think the specification needs to support an overlap of SL CSI reporting window of different CSI trigger, i.e., first CSI trigger is transmitted and second CSI trigger is transmitted additionally before the latency bound of the first CSI reporting?

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| Company | Answer |
| NTT DOCOMO | Specification should clarify RX UE behavior for re-trigger of CSI report.  CSI triggering could be failed e.g. due to TX collision/half-duplex. In this case, CSI trigger would be transmitted several times. However, let us assume that actually the RX-UE receives both trigger successfully. UE behavior for this case is unclear in the current specification. Which trigger does the UE report CSI based on? When is the correct latency bound? |
| Huawei, HiSilicon | No. We think the TX UE should not trigger another CSI procedure before CSI report is received or the corresponding latency bound is exceeded. Otherwise, the relationship between the CSI triggers and the CSI reports will be rather complicated. |
| Apple | In general, we do not support the overlap of SL CSI reporting window of different CSI triggers. This simplifies the operations at both Tx UE and Rx UE, as well as reducing potential L1 signaling overhead. |
| ZTE, Sanechips | No needs to support this. Non-overlap of reporting window could be assumed for unicast. |
| Intel | We are OK to either leave such cases unexpected to a UE, or to introduce simple handling, w/o enforcing a UE to provide CSI report based on processing of multiple CSI-RS occasions. |
| Futurewei | We are okay to have overlapping supported by the spec as it is hard to avoid |
| OPPO | Whether two CSI reporting window can be overlapped can be supported. while that can be left to UE implementation. No specification work is needed. |
| CATT | No. If more than one SL-CSI RS occasions are transmitted before the corresponding CSI report, there could be some ambiguous to determine the CSI reference. From Rx UE perspective, it may loss some reception opportunity due to prioritization operation. If Rx UE feedback the CSI report in the overlapped CSI report window, Tx UE can’t know which Tx occasion is used for CSI measurement. |
| Lenovo&MM | In general, we do not preclude the case in which overlapping is supported. How to address the problem introduced by this case can be left to UE implementation. |
| vivo | We slightly prefer non-overlapping. Otherwise, the association b/w CSI-RS resource and CSI feedback resource have to be associated by definition some rule. |
| LG | Yes. Since the sidelink CSI-RS would be confined within the associated PSSCH transmission, the UE may measure narrowband CQI. In addition, the transmit power of TX power would be different for each CSI trigger. Depending on the transmit power of CSI-RS, the measured SINR could be different, therefore the estimated CQI also can be different for each CSI trigger as well. Considering latency budget, it can be considered that the TX UE triggers CSI reporting multiple times in a short duration of time, and each CSI reporting can be associated with different narrowband and the different transmit power of CSI-RS. |
| Panasonic | The latest CSI trigger should be used should be clarified in the specification. |
| Samsung | We think that the specification does not need to mandate this. This issue does not need to be discussed in this meeting. |
| Ericsson | No. We also think that UE should not trigger another CSI report unless the latency bound of previous trigger is expired. |
| Qualcomm | No. |
| Nokia, NSB | No, not in the Rel-16 time frame. |
| Bosch | No, non-overlapping triggers should be assumed. |
| InterDigital | Yes, we support overlapping of SL CSI reporting window of different CSI triggers so that a Tx UE may get CSI information of different subchannel which is already supported in NR Uu. If this is not supported, at least Tx UE behavior should be specified to address the ambiguity (e.g., restrict not to trigger a new CSI for the same Rx UE within the CSI reporting window of the previous trigger) |

**Observation:**

* **Yes: DOCOMO, Intel, Futurewei, OPPO, Lenovo, LGE, Panasonic, InterDigital (8)**
  + **Some of the companies responded that no specification work is needed for this case (OPPO, Lenovo)**
* **No: Huawei, Apple, ZTE, CATT, vivo, Ericsson, Qualcomm, Nokia, Bosch (9)**

Q3-1: If the answer to Q3 is yes, does the CSI triggering UE need to know which CSI trigger is associated with a received CSI report? If so, how?

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| Company | Answer |
| NTT DOCOMO | Not needed. |
| Futurewei | if the overlapped ones are all reported then it is needed to know. However, as only WB CSI are reported, only reporting the latest triggered CSI should be sufficient. |
| OPPO | Not needed |
| Lenovo&MM | Not needed |
| LG | Yes. In our view, different CSI reporting would be associated with different narrowband. Furthermore, the transmit power of CSI-RS would be different slot-by-slot. In this case, the TX UE needs to know which CSI triggering is associated with the received CSI reporting. For instance, the CSI reporting can include the slot offset with respect to the slot containing CSI reporting to indicate the associated CSI reference slot.  Since the octet for the sidelink CSI reporting MAC CE uses 5 bits, the remaining 3 bits can be used to indicate the slot offset. |
| Panasonic | Not needed as the majority can be the latest CSI trigger. |
| Qualcomm | Yes. There are cases where it’s still beneficial, including when no explicit reporting bound is defined. We need an association between the triggering CSI in and the CSI report for that purpose. |
| InterDigital | Yes, if overlapping of multiple CSI reporting window is supported. A CSI trigger index may be provided in both CSI triggering and CSI reporting. |

**Observation:**

* **Three companies responded that some indication is needed for the association.**

==============================<Start of Initial Proposal>===============================

**Proposal 4-1:**

* **The specification allows a UE to send multiple CSI triggers with overlapping CSI report windows in a given unicast session. No specification work is expected to handle this case.**
* **A UE sends SL CSI reporting for each received CSI trigger.**

// FL’s note

* This proposal is based on the view that CSI reporting window overlap is not supported and no specification work is needed to allow the overlap.
* If the first bullet is agreed, I assume that RAN1 will not consider solutions such as multiplexing reports corresponding to different CSI triggers and canceling a report when a new trigger is received. This leads to the conclusion that there is always one CSI report for one received CSI trigger.

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| Company | Comments |
| NTT DOCOMO | Not support.  For HARQ FB-based retransmission, the proposal is OK since UE can wait HARQ FB to know whether the trigger was successful or not.  But for blind retransmission, a UE would trigger SL CSI report in each TX. If CSI report corresponding to each trigger is transmitted, it leads to more collisions of TX. It is undesirable.  If CSI report can be triggered with HARQ FB = enabled, we are OK to support the proposal. |
| InterDigital | Disagree.  The proposal seems to handle the multiple CSI triggers interesting way. Based on the proposal, if my understanding is correct, the association between CSI trigger and CSI reporting is supported implicit manner with a time order (e.g., the first triggered CSI will be reported first and the second triggered CSI will be reported later). But, this doesn’t address the ambiguity issues since a Rx UE may miss the first CSI trigger and the reported CSI based on the second CSI trigger may be considered as the first CSI trigger at a Tx UE. Not sure it works without explicit association information.  If we don’t want to support multiplexing of multiple CSI triggers, at least some explicit indication of CSI trigger should be supported even though each CSI trigger is reported in different time. If we don’t want to handle multiple CSI triggers with overlapping reporting window, we should restrict Tx UE behavior not to trigger CSI with overlapping reporting window. |
| Ericsson | Ok. |
| Huawei, HiSilicon | We do not agree. If there are multiple triggers to a window, spec work is needed. The proposal is not whole. Otherwise the TX UE does not know to which trigger a report corresponds, and/or the reports must somehow be combined or selected or etc. before transmission.  A one-to-one mapping can be specified easily: by stating that either the CSI report must be received, or the latency bound of the CSI report must expire, before TX UE can send another CSI trigger. |
| Intel | Although this is sub-optimal, but it is OK in this stage. We understand the current proposal implies that a UE should deal with the ambiguity on its own. If the UE does not want the uncertainty, it can wait for the expiration of the latency bound before another CSI request.  We are also open to more explicit handling. |
| Samsung | We now agree that some UE behavior should be discussed and specified to address the ambiguity on multiple CSI triggers. If the purpose of multiple CSI triggers is to get more CSI information, such CSI enhancement can be discussed in the feature releases. Originally, Rel-16 sidelink CSI-RS and CSI reporting has very limited functions and this was a result of compromise to introduce sidelink CSI feature. We agree that current proposal still has ambiguity issues as pointed out from Interdigital. Also, there are still many companies who do not want to trigger multiple CSI with overlapping reporting window. So, in order to resolve this issue, we suggest the following proposal:  **Proposal 4-1:**  **The specification does not allow a UE to send multiple CSI triggers with overlapping CSI report windows in a given unicast session** |
| CATT | No, we think this issue should be addressed. Otherwise the ambiguous issue can not be solved. |
| Lenovo&MM | Agree |
| Panasonic | We are OK with proposal. |
| Qualcomm | We disagree that no update to spec is necessary. If multiple CSI period is allowed, UE need to have a slot index to clearly associate with the triggering slot. There can be control decode failure on Rx side, which leads to confusion on Tx side. The CSI report size is small, and we will need to pad bits anyway, so adding slot index will provide the benefit at no cost. Given we can clearly associate CSI report with CSI trigger, we do not think second bullet is needed anymore. UE will report CSI for all CSI triggering. We're can accept multiple trigger if that's the majority view, but explicit association between the trigger and report would be needed. |
| ZTE,Sanechips | The proposal seems to create certain issue but not willing to solve. We slightly prefer not to support overlapping window. |
| vivo | Multiple CSI in an overlapped window can bring more CSI information, only if the association b/w CSI-RS and CSI report can be decided. Hence, the technical merit does not exist by applying the proposal. Moreover, the second bullet force a RX UE to transmit many useless CSI, which incur resource waste.  For simplicity, we prefer to use the proposal from Samsung |

**Proposal 4-2: The time and frequency location of the SL CSI reference resource is determined as follows:**

* **For a given CSI trigger, CSI reference resource in time domain is the slot where the CSI trigger is received**
* **For a given CSI trigger, CSI reference resource in frequency domain is the PRBs scheduled for the PSSCH in the CSI reference resource slot**

// FL’s note

* I understand that CSI reference resource is defined at the UE receiving CSI trigger. Thus, CSI trigger cannot be used in the definition as some of them may not be received.
* If Proposal 4-1 is agreed, there is one-to-one mapping between a CSI trigger and a CSI report. Then, no clarification is necessary regarding multiple CSI triggers. On the other hand, mentioning “latest” CSI trigger seems to imply that, when a UE received first trigger and then received second trigger during the preparation of CSI report for the first trigger, the UE shall measure CSI again using the second trigger.

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| Company | Comments |
| NTT DOCOMO | Up to conclusion for Q4-1. |
| InterDigital | We support this proposal independently from Q4-1. The CSI reference resource shouldn’t be arbitrary. If Tx UE doesn’t know which resource is used for the CSI measurement, the reported CSI is kind of useless information. |
| Ericsson | Agree |
| Huawei, HiSilicon | The proposal is OK, but it will need refining for specification purposes to establish the time-domain association of a trigger to its report that is based on the reference resource. |
| Intel | Agree |
| Samsung | Support |
| CATT | If non-overlapped reporting window is agreed, then we are fine with this proposal. |
| Lenovo&MM | Support |
| Panasonic | Support |
| Qualcomm | Agree |
| ZTE, Sanechips | ok |
| vivo | Agree |

**Proposal 4-3:**

* **The latency bound of SL CSI report is signaled from CSI triggering UE to CSI reporting UE via PC5-RRC.**
* **The CSI triggering UE determines the latency bound by its implementation.**

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| Company | Comments |
| NTT DOCOMO | Support. |
| InterDigital | Not support the first bullet. I’m not sure if it is reasonable assumption that the UE relative speed won’t change during the life of unicast link. Similar to DM-RS time density adaptation for which the major factor to make decision at Tx UE will be relative UE speed and it will be indicated in SCI.  We can accept the second bullet although we still think that the latency bound should be determined based on the UE speed. |
| Ericsson | Agree |
| Huawei, HiSilicon | First bullet has a technical problem that if only PC5-RRC can be used to set the latency bound, but the UE has TBs which have various different latency requirements, the requirements cannot in general be met. E.g. if PC5-RRC has set the latency bound to 10 ms, but SL-URLLC traffic arrives and needs a CSI report in 4 ms, there has to be PC5-RRC reconfiguration, and back to 10 ms again afterwards.  This is addressed by allowing the 2nd-stage SCI to choose a particular latency bound from a PC5-RRC configured list.  Note that the same situation exists in SL DM-RS, for the same reason: to avoid repeated re-configuration, there is a per RP list followed by SCI indication.  Second bullet is OK. |
| Intel | In general, OK. To resolve flexibility concerns, it can be further configured per priority. |
| Samsung | Support |
| CATT | We are fine with this proposal |
| Lenovo&MM | Support |
| Panasonic | Support |
| Qualcomm | We do not agree. We think UE should follow the QoS parameters of the logical channel. It is up to UE to select which LCH the CSI report is sent on |
| ZTE, Sanechips | We prefer NW configuration, but can accept the proposal. |
| vivo | UE would always use the min value of the latency bound by greedy implementation, i.e., 3ms, however, a short latency bound is useful only if UE speed is high or some other urgent situation. The greedy implementation impacts the resource selection of the CSI reporting UE, e.g., less candidate resource or many PSSCH transmission containing MAC CE only, this may degrade PRR performance of the system. We think the latency bound should be restricted by NW configuration. |

===============================<End of Initial Proposal>===============================

==============================<Start of Updated Proposal>=============================

**Proposal 4-1:**

* **The specification does not allows UE to send multiple CSI triggers with overlapping CSI report windows in a given unicast session.**

**Proposal 4-2: The time and frequency location of the SL CSI reference resource is determined as follows:**

* **For a given CSI trigger, CSI reference resource in time domain is the slot where the CSI trigger is received**
* **For a given CSI trigger, CSI reference resource in frequency domain is the PRBs scheduled for the PSSCH in the CSI reference resource slot**

**Proposal 4-3:**

* **The latency bound of SL CSI report is signaled from CSI triggering UE to CSI reporting UE via PC5-RRC.**
* **The CSI triggering UE determines the latency bound by its implementation.**
* **Send an LS to RAN2 to inform the agreement.**

===============================<End of Updated Proposal>=============================