# **[101-e-NR-5G\_V2X\_NRSL-SL\_PHY\_Procedure-01] Email discussion/approval regarding: power control**

[101-e-NR-5G\_V2X\_NRSL-SL\_PHY\_Procedure-01] Email discussion/approval regarding: power control

* + Issue 1-1: The lower bound of the transmitted PSFCH number in Case 1-2 and Case 2-2
	+ Issue 1-2: How to determine the number of transmitted PSFCHs when P\_(O,PSFCH) is not provided
	+ Issue 1-3: RS used to derive DL pathloss for open-loop power control based on DL pathloss.

Till 5/29, with potential TPs by 6/4 – Hanbyul (LGE)

**1. The lower bound of the transmitted PSFCH number in Case 1-2 and Case 2-2**

Agreements in RAN1#100bis-e

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| When the UE supports up to Nmax,psfch simultaneous PSFCH transmissions in a PSFCH TX occasion and UE have Nreq PSFCHs to be transmitted in a given PSFCH TX occasion, the UE selects N PSFCHs for actual transmission with ascending order of the priority in a PSFCH TX occasion as follows: * Case 1: When Nreq<=Nmax,psfch and is (pre-)configured,
	+ Case 1-1: N=Nreq if the sum of for the Nreq PSFCHs is smaller than or equal to determined for the Nreq PSFCH transmissions.
	+ Case 1-2: Otherwise, N is up to UE implementation under N >= X >= 1.
* Case 2: When Nreq>Nmax,psfch and is (pre-)configured, the UE firstly selects Nmax,psfch PSFCHs with ascending order of the priority.
	+ Case 2-1: N=Nmax,psfch if the sum of for the Nmax,psfch PSFCHs is smaller than or equal to determined for the Nmax,psfch PSFCH transmissions.
	+ Case 2-2: Otherwise, N is up to UE implementation under N >= X >= 1.
* Down select X in RAN1#101-e
	+ Alt 1: X = max {1, the largest value which doesn’t lead to the power limited case}
	+ Alt 2: X= 1
	+ Other alternatives are not precluded.
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Q1: For Case 1-2 and Case 2-2, how is N determined?

* Option 1-1: X = max {1, the largest value which doesn’t lead to the power limited case}
* Option 1-2: X=1
* Option 1-3: Others (please specify)

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| Company | Preferred option | Comment |
| LG | Option 1-1 (or Option 1-3 as an alternative) | We think that the UE needs to transmit a number of PSFCHs as much as possible until the power limited case occurs. If it is too burden to calculate the value of X as the largest value which doesn’t lead to the power limited case, alternatively, it can be considered that the value of X is set to a specific number such as the number of PSFCHs with the highest priority in order to prevent a UE from dropping too many PSFCHs on its implementation. For instance, if the number of PSFCH with the highest priority is four and if the number of PSFCHs with the secondly highest priority is three, X will be minimum value between four and Nmax,psfch. It would be much easier to calculate it.  |
| Sharp | Option 1-2 | Since N is up to UE implementation in this case, it would be better to leave more flexibility to the UE. |
| OPPO | Option 1-2 | Agree with Sharp. X=1, and N>=X, there is more flexibility forUE to select the value of N.  |
| NTT DOCOMO | Option 1-2 | Although UE should transmit PSFCHs as many as possible, transmit power for each PSFCH TX should keep high enough. The best number of PSFCH transmissions would be dependent on each situation, condition. To specify it will require further RAN1 work. Up to UE implementation for N is the best solution in the current phase while it is not the best from technical perspective. |
| Qualcomm | Option 1-2 |  |
| vivo | Option 1-2 | Agree with sharp |
| ASUSTeK | Option 1-1 | To mitigate impact of dropping PSFCH(s), UE should try to transmit PSFCHs as much as possible without exceeding power limitation. |
| Samsung | Option 1-2 | X=1 could leave higher flexibility and avoid additional system complexity. |
| Huawei, HiSilicon | 1-1 | As many services as possible should be provided with HARQ feedback, while tx power is available. Other options, such as X=1, will mean that no lower bound to service performance can be derived from the specifications.It is not a complex procedure for the UE to select the set of PSFCHs, because it is already agreed it will work in order through the priorities. It only has to check, after adding the next PSFCH, if the power limit has been reached. (Tie break can be left to UE choice).While X<N, the UE still has available power to transmit the (X-N) PSFCHs without reducing the transmissions’ power. There appears to be no system-level advantage to N=1, but the system is left in an unpredictable state. |
| CATT | Option 1-2 | The intention of option 1-1 is to explicitly support as much as possible simultaneous PSFCH transmissions, which can potentially provide better performance. However, option 1-1 requests much specification effort. Regarding option 1-2, it is a super set of option 1-1 which can also support option 1-1 by UE implementation. Considering that the Rel-16 NR V2X is in maintenance phase, in order to avoid too much specification effort, we prefer option 1-2. |
| Intel | Option 1-1 | It is straightforward to find suitable N which does not lead to power limitation, using prioritization rules and UE implementation. If such functions are not implemented in the UE, then even cases 1-1, 2-1 are questionable. |
| CMCC | Option 1-1 | Although Option 1-2 leave more flexibility to UE implementation, the system performance is hard to anticipate, and it will cause unnecessary performance degradation if too small number of the PSFCH are transmitted based on UE implementation with no power limitation. We can further consider Option 1-3 proposed by LG. However, if companies’ concern for Option 1-1 is the computation complexity, we do not understand how much computation complexity is introduced and how serious it is. |
| Ericsson | Option 1-1 |  |
| ZTE, Sanechips | Option 1-2 | Option 1-1 implicitly requires Pcmax to be exclusively used by SL PSFCH only. We do not see a need to set such restriction in Rel-16.  |
| Apple | Option 1-1 | Option 1-1 improves system performance by sending as many PSFCH as possible.In our view, it is not difficult to calculate the largest value which doesn’t lead to the power limited case, (e.g., ). |
| InterDigital | Option 1-1 | It is beneficial to have consistent UE behavior by setting the X value according to the maximum power constraint. |
| FUTUREWEI | Option 1-1 | Dropping PSFCHs should be avoided whenever possible. |
| Panasonic | Option 1-2 | As Pcmax is determined by the number of the assignment and location of the transmission, currently the condition is rather chicken and egg situation when N is more than 1. Therefore, X=1 is sufficient and it solves chicken and egg situation. |
| Nokia, NSB | Option 1-1 | Option 1-2 with X=1 is the simplest approach. This means that the UE can only transmit single PSFCH when its combined multiple PSFCH transmission exceeds PCMAX, although the UE has its capacity to support Nmax,psfch transmission. X=1 means that UE may switch of Nmax,psfch number of PSFCH transmission to single PSFCH transmission. Since we have the agreement to support multiple simultaneous PSFCH transmission, this simplification of X=1 won’t provide any benefit. Therefore, we shall support Option1-1, where the PCMAX is the limiting factor to determine X. |

Observation: Determination of N in Case 1-2 and 2-2:

* Option 1-1: LG, ASUSTeK, Huawei, HiSi, Intel, CMCC, Ericsson, Apple, InterDigital, Futurewei, Nokia, NSB (12 companies)
* Option 1-2: Sharp, OPPO, DOCOMO, Qualcomm, vivo, Samsung, CATT, ZTE, Sanechips, Panasonic (10 companies)
* Option 1-3: LG

**2. How to determine the number of transmitted PSFCHs when P\_(O,PSFCH) is not provided**

Q2: If is not provided, how is N determined?

* Option 2-1: N is up to UE implementation with X=1
* Option 2-2: N=1
* Option 2-3: N= min(Nreq, Nmax,psfch)
* Option 2-4: Others (please specify)

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| Company | Preferred option | Comment |
| LG | Option 2-3 | We think that the meaning of Po,psfch is not provided is that the system does not intend to ensure the nominal transmit power of each PSFCH. With this understanding, we think that it is also allowable for a UE to transmit all the PSFCHs based on its capability.  |
| Sharp | Option 2-1 |  |
| OPPO | Option 2-1 | If Po,psfch is not provided, that means power control based on DL PL is disabled or SL is on ITS band. In that case, UE can use maximal TX power for PSFCH transmission. If >1 PSFCH is required for transmission, it is up to UE implementation to determine N. |
| NTTDOCOMO | Option 2-1 | Although UE should transmit PSFCHs as many as possible, transmit power for each PSFCH TX should keep high enough. The best number of PSFCH transmissions would be dependent on each situation, condition. To specify it will require further RAN1 work. Up to UE implementation is the best solution in the current phase while it is not the best from technical perspective. |
| Qualcomm | Option 2-1 | Sending more is not always better, as now the Tx power per PSFCH reduced significantly due to MPR and power sharing. Tx power per PSFCH is 23dBm if 1 PSFCH is sent, it is <= 13dBm if 2 is sent (due to MPR, estimated around 7dB and 3dB or power sharing). While such low Tx power is acceptable in some cases, it is not desirable to always enforce it. |
| vivo | Option 2-1 | N is selected between 1 and min(Nreq, Nmax,psfch), which is aligned with the principle when P\_(O,PSFCH) is provided |
| ASUSTeK | Option 2-1 | If is not provided, the DL pathloss-based sidelink power control seems not work. Thus, N can be up to UE implementation with X=1 and N <= min(Nreq, Nmax,psfch). |
| Samsung | Option 2-1 | In this scenario, the most appropriate number of simultaneously transmitted PSFCHs should depends an actual situation. The same rule as when P\_(O,PSFCH) is provided should be used for consistency. |
| Huawei, HiSilicon | 2-1, possibly. | In this case, power control has not been configured, so the gNB has decided not to control the system. In that case, it can be left to the UE’s judgement.However, it is not clear if UE is required to use its whole available transmission power, or if it can decide to transmit less than (adjusted) Pcmax. This should be agreed at the same time as 2-1, otherwise a solution more like 1-1 would be appropriate. |
| CATT | Option 2-1 | If Po,psfch is not provided, it means power control based on DL PL is disabled. It could left for UE implementation.  |
| Intel | Option 2-4 | To align with other operations, assume P\_(O,PSFCH) is not provided is equal to alpha = 0, P\_(O,PSFCH) = Pcmax. And under this assumption, other agreements are reused. |
| CMCC | Option 2-1 |  |
| Ericsson | Option 2-3 |  |
| ZTE, Sanechips | Option 2-1 |  |
| Apple | Option 2-1 |  |
| FUTUREWEI | Option 2-1 |  |
| Panasonic | Option 2-1 |  |
| Nokia, NSB | Option 2-3 | N= min(Nreq, Nmax,psfch) |

Observation: Determination of N when P\_{O,PSFCH} is not provided

* Option 2-1: Sharp, OPPO, DOCOMO, Qualcomm, vivo, ASUSTek, Samsung, Huawei, HiSi, CATT, CMCC, ZTE, Sanechips, Apple, Futurewei, Panasonic (16 companies)
* Option 2-2:
* Option 2-3: LG, Ericsson, Nokia, NSB (4 companies)
* Option 2-4: Intel (1 company)

Q3: If is not provided, what is the UE transmit power of each PSFCH transmission when N is determined by the conclusion of Q2?

* Option 3-1: where determined for the N PSFCH transmission
* Option 3-2: Others (please specify)

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| Company | Preferred option | Comment |
| LG | Option 3-1 | For simplicity, the UE can use all the UE transmit power regardless of the number of PSFCH transmissions.  |
| Sharp | Option 3-1 |  |
| OPPO | Option 3-1 |  |
| NTTDOCOMO | Option 3-1 |  |
| Qualcomm | Option 3-1 |  |
| vivo | Option 3-1 |  |
| ASUSTeK | Option 3-1 |  |
| Samsung | Option 3-1 |  |
| Huawei, HiSilicon | 3-1 | It is natural to allocate equal power for multiple PSFCH transmissions |
| CATT | Option 3-1 |  |
| Intel | Option 3-1 |  |
| CMCC | Option 3-1 |  |
| Ericsson | Option 3-1 |  |
| ZTE, Sanechips | Option 3-1 |  |
| Apple | Option 3-1 |  |
| InterDigital | Option 3-1 |  |
| FUTUREWEI | Option 3-1 |  |
| Panasonic | Option 3-1 |  |
| Nokia, NSB | Option 3-1 |  |

Observation: All companies responded that Option 3-1 is agreeable.

**3. RS used to derive DL pathloss for open-loop power control based on DL pathloss**

Q4: Do you agree that one of the RS resources used to derive DL pathloss for PUSCH power control is reused for the DL pathloss for the power control of PSCCH/PSSCH/PSFCH? If yes, which option do you prefer? If no, please specify which other RS resource is used for PSCCH/PSSCH/PSFCH power control.

* Option 4-1: DL pathloss used for PUSCH transmission scheduled by DCI format 0\_0
* Option 4-2: DL pathloss used for PUSCH transmission scheduled by DCI format 0\_1
* Option 4-3: DL pathloss used for PUSCH transmission before the UE is provided with dedicated higher layer parameters
* Option 4-4: Others (please specify)

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| Company | Answer and preferred option | Comment |
| LG | Option 4-1 | It is not desirable to introduce SRI field for DCI format 3\_0, and to configure SRS resources for the purpose of supporting SL. Meanwhile, depending on the situation on the UL side, it would be possible to change the RS used for RSRP measurement.  |
| Sharp | Option 4-1 |  |
| OPPO | Option 4-3 | The UE can be either in RRC-connected or RRC-idle state. For the later case, UE is not configured to monitor DCI format 0-0 or 0-1 for PUSCH transmission. We can follow the same mechanism as NR Uu to derive the DL PL based on a RS resource from the SS/PBCH block that the UE uses to obtain MIB. |
| Qualcomm | Option 4-3 | a SS/PBCH block that the UE uses to obtain MIB. This covers all cases. |
| ASUSTeK | Option 4-4(See comment) | Considering a UE can be in RRC-connected or RRC-idle state, Option 4-1 and Option 4-2 are not unified solution. Option 4-3 seems to imply V2X UE to keep receiving MIB, even in RRC-connected. Moreover, if UE can detect multiple SS/PBCH blocks, it is questionable how to derive DL pathloss for sidelink power control.Considering original motivation of UL interference mitigation, we propose to “*Take minimum value of DL pathloss across multiple SS/PBCH blocks and/or configured CSI-RS*”.  |
| Huawei, HiSilicon | 4-1 + 4-3 | The procedure of deriving DL pathloss for PUSCH power control can be reused. SL operation is supported for IDLE/INACTIVE and CONNECTED modes. When a UE is in idle/inactive, there is no PUSCH transmission for the UE, and option 4-3 can be used. Otherwise, when a UE is in connected mode, and granted a PUSCH by DCI 0-0 or DCI 0-1, the same DL pathloss as PUSCH can be used. |
| CATT | 4-3 | We share the same views as OPPO and Qualcomm. SS/PBCH block based DL pathloss can cover all the cases. |
| Intel | 4-3 | Since DL PL based power control should not be very precise in order to provide co-existence level, it is sufficient and universal to apply PL measured during initial access procedures, i.e. no need for dedicated configuration. |
| Ericsson |  | We propose to reuse NR Uu procedure i.e. either use CSI-RS or SSB as RS. Moreover, in our understanding the options in the proposal are really not clear to us. |
| ZTE, Sanechips | 4-3 | We prefer a unify solution for IDLE UE and Connected UE. 4-1 and 4-2 can only apply to a connected UE.Agree with OPPO and QC, SSB should be the used RS to derive DL pathloss. |
| Apple | Option 4-3 | Unified solution for idle mode UE and connected mode UE.  |
| InterDigital | Option 4-3 |  |
| FUTUREWEI | Option 4-3 | The option works for both idle and connected UEs |
| Panasonic | Option 4-3 | We also share the same views as OPPO/Qualcomm/CATT. SS/PBCH block based DL pathloss can cover all the cases. |
| Nokia, NSB | Option 4-3 |  |

Observation: RS used to derive DL pathloss for open-loop power control

* Option 4-1: LG, Sharp, Huawei, HiSi (CONNECTED) (4 companies)
* Option 4-2:
* Option 4-3: OPPO, Qualcomm, Huawei, HiSi (IDLE/INACTIVE), CATT, Intel, ZTE, Sanechips, Apple, InterDigital, FUTUREWEI, Panasonic, Nokia, NSB (14 companies)
* Option 4-4: ASUSTeK (1 company)

Proposal for agreement v001

Proposal 1:

* For Case 1-2 and Case 2-2 of simultaneous transmissions of PSFCH, the lower bound X of the number of actually transmitted PSFCH is given by X = max {1, the largest value which doesn’t lead to the power limited case}

Proposal 2:

* When P\_(O,PSFCH) is not provided,
	+ The number of actually transmitted PSFCH N is up to UE implementation with X=1.
	+ The transmit power of each PSFCH is where determined for the N PSFCH transmission.

Proposal 3:

* For open-loop power control based on DL pathloss, the UE calculates DL pathloss using a RS resource from the SS/PBCH block that the UE uses to obtain MIB.