[102-e-NR-5G\_V2X\_NRSL-PHYstructure-03] Email discussion/approval w.r.t. “PSFCH sequence related”: 4A (as in the summary) by 08/20, with potential TPs by 8/25 – Jeongho (Samsung)

The current text for PSFCH in TS38.211 is as below.

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| 8.3.4.2 PSFCH format 08.3.4.2.1 Sequence generationThe sequence $x\left(n\right)$ shall be generated according to$$x\left(n\right)=r\_{u,v}^{α,δ}\left(n\right)$$$$n=0,1,…,N\_{sc}^{RB}-1$$where $r\_{u,v}^{\left(α,δ\right)}(n)$ is given by clause 6.3.2.2 with the following exceptions:- $m\_{cs}$ is given by clause 16.3 of [5, TS 38.213]; - $m\_{0}$ is given by clause 16.3 of [5, TS 38.213];- $l$ is the OFDM symbol number in the PSFCH transmission where $l=0$ corresponds to the first OFDM symbol of the PSFCH transmission;- $l'$ is the index of the OFDM symbol in the slot that corresponds to the first OFDM symbol of the PSFCH transmission in the slot given by [5, TS 38.213] |

In RAN1#102-e, the five contributions [CATT], [Huawei, HiSilicon], [OPPO], [Sharp], [NTT DCM] raised the issues related to PSFCH sequence.

With the current specifications, it is necessary to define $u$, $v$, and $α$. In order to define those parameters, the followings are to be discussed in this thread.

* Group/sequence hopping
	+ A1. Depending on whether to be supported or not, how to define the hopping parameter $u$ and $v$
* For alpha,
	+ B1. How to define m\_init
	+ B2 How to define c\_init

# **A1. How to define u and v**

Two contributions propose to use u = n\_ID mod 30, where n\_ID is given by *hoppingID\_PSFCH* and v=0.

(This is the same as replacing *hoppingId* with *hoppingID\_PSFCH* and pucch\_GroupHopping=’neither’.)

Please provide your views and reason.

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| **Company** | **Views** |
| NTT DOCOMO | Support; i.e. *hoppingId* is replaced with *hoppingID\_PSFCH* and *pucch\_GroupHopping* = *neither*.Performance gain of sequence/group hopping has not identified so far. *neither* should be OK. |
| OPPO | Agree. |
| Qualcomm | Agree with the proposal from Docomo.The benefit of sequence or group hopping in the context of PSFCH has not been shown. |
| Sharp | Support in principle. In TS38.211, for the case when *hoppingId* is absent, n\_ID=cell ID. While a cell ID is not always available, e.g. for an OOC SL UE. Thus, besides replacing *hoppingId* with *hoppingID\_PSFCH*(and v=0), we propose that if *hoppingID\_PSFCH* is not configured, n\_ID=source ID.  |
| LG Electronics  | We are supportive that *hoppingID\_PSFCH* replace *hoppingId.* According to the following agreement, we do not need to define default value for u. *Agreements made in RAN1#99:** *CDM between PSFCH transmissions from different UEs in the same PRB is supported as follows:*
	+ *Cyclic shift can be selected based on*
		- *the L1 source ID of TX UE for unicast and groupcast option 1.*
		- *the L1 source ID of TX UE and the member ID of RX UE in groupcast option 2.*
		- *FFS whether or not to use additional parameter(s) for the selection (e.g., using PSCCH DM-RS, etc) 🡪 to conclude this week*
	+ *Base sequence is*
		- *(Pre-)configured per resource pool*

Since we do not have replacement of pucch\_GroupHopping, we are supportive that pucch\_GroupHopping=’neither’ for PSFCH. In our understanding, the important thing is that the same base sequence will be used by all the UEs in a resource pool.  |
| ZTE, Sanechips | Support. No need to support sequence/group hopping given no discussion/consensus on the gain. |
| vivo | Agreed in principle, with the following comments:1. It seems RAN2 define it in a slightly different name:

SL-PSFCH-Config-r16 ::= SEQUENCE { sl-PSFCH-Period-r16 ENUMERATED {sl0, sl1, sl2, sl4} OPTIONAL, -- Need M sl-PSFCH-RB-Set-r16 BIT STRING (SIZE (10..275)) OPTIONAL, -- Need M sl-NumMuxCS-Pair-r16 ENUMERATED {n1, n2, n3, n6} OPTIONAL, -- Need M sl-MinTimeGapPSFCH-r16 ENUMERATED {sl2, sl3} OPTIONAL, -- Need M sl-PSFCH-HopID-r16 INTEGER (0..1023) OPTIONAL, -- Need M sl-PSFCH-CandidateResourceType-r16 ENUMERATED {startSubCH, allocSubCH} OPTIONAL, -- Need M ...}1. As commented by Sharp, this parameter *sl-PSFCH-HopID* is optional without default value in RRC. Then RAN1 may have to handle the case of *sl-PSFCH-HopID* is not configured. But the proposal from Sharp is a little confusing to us on what the “source ID” is. Does it refer to the source ID of the UE transmitting the PSFCH? An alternative is to define a default value for n\_ID.
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| Huawei, HiSilicon | We are supportive for the proposal in principle, n\_ID can be given by *hoppingID\_PSFCH* and v=0, but if the *hoppingID\_PSFCH* is not configured, CRC of associated PSSCH can be used. This is because the cell ID, which is used when *hoppingId* is absent in NR Uu, is not always available in sidelink. |
| Ericsson | We are supportive of the proposal from DCM. Moreover, for the case when*hoppingID\_PSFCH* is not (pre)configured, we believe n\_ID=source ID can be used, where source ID is the ID of UE transmitting PSSCH.  |
| CATT | Agree |
| Samsung | Agree. Also, as the agreement captured by LGE, the base sequence is (pre-)configured per resource pool. So, there is no case such that *hoppingID\_PSFCH* is not configured. |
| Intel | Agree w/ proposal |
| Futurewei | Agree with the proposal. When when*hoppingID\_PSFCH* is not (pre)configure, a value different for each PSFCH needs to be used in order to reduce interference. We do not have strong view on which value to use (source, ID, etc) |
| Apple | Agree with the proposal. We do not need to apply group and sequence hopping for PSFCH.  |
| Nokia, NSB | Agree. Sequence/group hopping has not been discussed. |

**Summary**

Based on the majority, the higher layer parameter *hoppingID\_PSFCH* can be used for u. Then the remaining issue is the case that the higher layer parameter *hoppingID\_PSFCH* is not configured for the resource pool. In that case, RAN1 needs further discussion on the alternatives.

Proposal 1

For group and sequence hopping for PSFCH, the following is used.

* u = n\_ID mod 30 and v = 0, where
	+ n\_ID is given by *hoppingID\_PSFCH* when configured.
* RAN1 further discusses for the case that *hoppingID\_PSFCH* is not configured with
	+ Alt 1. Its error case. (i.e., *hoppingID\_PSFCH* should be configured.)
	+ Alt 2. n\_ID = fixed value (e.g., 1010, 0)
	+ Alt 3. n\_ID = source ID (which is the source ID of UE transmitting the associated PSSCH)
	+ Alt 4. n\_ID = CRC of the associated PSSCH

# **B1. How to define m\_init**

$m\_{init}$ is introduced for interlaced PUCCH format. Therefore, $m\_{init}=0$ can be used for PSFCH.

Please provide your views and reason.

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| **Company** | **Views** |
| NTT DOCOMO | Support; i.e. $m\_{init}=0$No spec update is assumed. |
| OPPO | $$m\_{init}=0$$ |
| Qualcomm | Agree with the proposal |
| Sharp | Support |
| LG Electronics | We support $m\_{init}=0$. This parameter is used for unlicensed band operation.  |
| ZTE, Sanechips | Support |
| vivo | Agree with the proposal. |
| Huawei, HiSilicon | Agree.  |
| Ericsson | Support |
| CATT | Agree |
| Samsung | Agree |
| Intel | Agree w/ proposal |
| Futurewei | Support |
| Apple | Agree |
| Nokia, NSB | Agree |

**Summary**

Based on the majority views, the following is proposed.

Proposal 2

For PSFCH sequence generation, $m\_{int}=0$ is used.

# **B2. How to define c\_init**

The remaining issue is how to define the pseudo-random sequence  used for .

Three contributions propose to the following alternative to define $c(i)$.

* Alt 1. C\_init = *hoppingID\_PSFCH*
* Alt 2. Depending on the source ID
* Alt 3. Depending on the CRC of the PSSCH

Please provide your views and reason.

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| **Company** | **Views** |
| NTT DOCOMO | Alt 1.Reuse NR-Uu. |
| OPPO | Alt 1 |
| Qualcomm | Alt 1.The benefit of other alternatives has not been demonstrated. |
| Sharp | Alt 1 for *hoppingID\_PSFCH* is configured, otherwise Alt2.For presence of *hoppingID\_PSFCH*, we support to reuse NR Uu, i.e. Alt1, for absence of *hoppingID\_PSFCH*, Alt 2 is preferred.  |
| LG Electronics | We are supportive of Alt 1 with default value of 1010. **Randomization across different UEs shall not be applied to c(i) for n\_CS.** When different n\_CS values are used across different UEs, CDM between PSFCH with different m\_0 is no longer valid. To be specific, it can make the gap between alpha values of different PSFCH resources smaller than target delay spread, and the orthogonality coming from CS will be lost. If the default value of n\_ID is needed, we can consider that 1010 replace $N\_{ID}^{cell}$ as in other sequence generation discussion.  |
| ZTE, Sanechips | Alt 1 |
| vivo | Alt 1 if *sl-PSFCH-HopID* is configured.**In the case of *sl-PSFCH-HopID* is not configured, we prefer to use a default value instead, e.g., n\_ID = 0**.**Comment to Alt 2**: Does the “source ID” refer to the source ID of the UE transmitting the PSFCH?  |
| Huawei, HiSilicon | Alt. 3.The pseudo-random sequence generator shall be initialized with, where  is the CRC of the associated PSSCH. |
| Ericsson | We support Alt 1 if *hoppingID\_PSFCH* is configured, otherwise Alt2 (C\_init = source ID of UE transmitting PSSCH). |
| CATT | Alt 1 |
| Samsung | Alt 1. No need to support further randomization methods without the verification on performance gain. |
| Intel | Support Alt.1 |
| Futurewei | Alt. 1 |
| Apple | Alt. 1 |
| Nokia, NSB | Alt 1 |

**Summary**

Based on the majority, the higher layer parameter *hoppingID\_PSFCH* can be used. Then, similar to A1, the remaining issue is the case that the higher layer parameter *hoppingID\_PSFCH* is not configured for the resource pool. In that case, RAN1 needs further discussion on the alternatives.

Proposal 3

For the initialization of c(i) for the calculation of n\_cs for PSFCH sequence, the following is used.

* C\_init = *hoppingID\_PSFCH* when configured.
* RAN1 further discusses for the case that *hoppingID\_PSFCH* is not configured with
	+ Alt 1. Its error case. (i.e., *hoppingID\_PSFCH* should be configured.)
	+ Alt 2. C\_init = fixed value (e.g., 1010, 0)
	+ Alt 3. C\_init = source ID (which is the source ID of UE transmitting the associated PSSCH)
	+ Alt 4. C\_init = CRC of the associated PSSCH

Reference

1. R1-2005292 Remaining details on physical layer structure for the sidelink FUTUREWEI
2. R1-2005307 Remaining issues of NR sidelink physical layer structure ZTE, Sanechips
3. R1-2005338 Remaining issues on physical layer structure for NR sidelink vivo
4. R1-2005646 Discussion on sidelink physical layer structure MediaTek Inc.
5. R1-2005667 Remaining issues on physical layer structure for NR sidelink CATT
6. R1-2005740 Discussion on essential corrections in physical layer structure LG Electronics
7. R1-2005761 TP on 1st symbol duplication for AGC NEC
8. R1-2005786 Remaining issues of V2X PHY layer structure Mitsubishi Electric RCE
9. R1-2005796 Remaining details of sidelink physical layer structure Huawei, HiSilicon
10. R1-2005846 Remaining opens for NR-V2X sidelink physical layer structure Intel Corporation
11. R1-2005997 Remaining issues on physical structure for NR sidelink OPPO
12. R1-2006074 Remaining issues on PHY structure for NR V2X InterDigital, Inc.
13. R1-2006099 On Physical Layer Structures for NR Sidelink Samsung
14. R1-2006254 Remaining issues for sidelink physical layer structure Spreadtrum Communications
15. R1-2006433 TPs related to PHY structures Ericsson
16. R1-2006484 On Remaining Issues of Sidelink Physical Layer Structure Apple
17. R1-2006535 Remaining issue on physical layer structure for sidelink in NR V2X Panasonic Corporation
18. R1-2006557 Remaining issues on physical layer structure for NR sidelink Sharp
19. R1-2006584 Remaining issues on sidelink physical layer structure on NR V2X ASUSTeK
20. R1-2006693 Maintenance for sidelink physical layer structure NTT DOCOMO, INC.
21. R1-2006768 Sidelink Physical Layer Structure Qualcomm Incorporated

Appendix. Sequence and CS hopping for PUCCH in TS38.211

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| 6.3.2.2 Sequence and cyclic shift hoppingPUCCH formats 0, 1, 3, and 4 use sequences $r\_{u,v}^{\left(α,δ\right)}(n)$ given by clause 5.2.2 with $δ=0$ where the sequence group $u$ and the sequence number $v$ depend on the sequence hopping in clause 6.3.2.2.1 and the cyclic shift $α$ depends on the cyclic shift hopping in clause 6.3.2.2.2.6.3.2.2.1 Group and sequence hoppingThe sequence group $u=\left(f\_{gh}+f\_{ss}\right) mod 30$ and the sequence number $v$ within the group depends on the higher-layer parameter *pucch-GroupHopping*:- if *pucch-GroupHopping* equals 'neither' where  is given by the higher-layer parameter *hoppingId* if configured, otherwise $n\_{ID}=N\_{ID}^{cell}$.- if *pucch-GroupHopping* equals 'enable'  where the pseudo-random sequence  is defined by clause 5.2.1 and shall be initialized at the beginning of each radio frame with  where  is given by the higher-layer parameter *hoppingId* if configured, otherwise $n\_{ID}=N\_{ID}^{cell}$.- if *pucch-GroupHopping* equals 'disable' where the pseudo-random sequence  is defined by clause 5.2.1 and shall be initialized at the beginning of each radio frame with $c\_{init}=2^{5}\left⌊{n\_{ID}}/{30}\right⌋+\left(n\_{ID} mod 30\right)$ where  is given by the higher-layer parameter *hoppingId* if configured, otherwise $n\_{ID}=N\_{ID}^{cell}$.The frequency hopping index $n\_{hop}=0$ if intra-slot frequency hopping is disabled by the higher-layer parameter *intraSlotFrequencyHopping*. If frequency hopping is enabled by the higher-layer parameter *intraSlotFrequencyHopping*,  for the first hop and  for the second hop.6.3.2.2.2 Cyclic shift hoppingThe cyclic shift $α$ varies as a function of the symbol and slot number according to$$α\_{l}=\frac{2π}{N\_{sc}^{RB}}\left(\left(m\_{0}+m\_{cs}+m\_{int}+n\_{cs}\left(n\_{s,f}^{μ},l+l'\right)\right) mod N\_{sc}^{RB}\right)$$where- $n\_{s,f}^{μ}$ is the slot number in the radio frame- $l$ is the OFDM symbol number in the PUCCH transmission where $l=0$ corresponds to the first OFDM symbol of the PUCCH transmission,- $l'$ is the index of the OFDM symbol in the slot that corresponds to the first OFDM symbol of the PUCCH transmission in the slot given by [5, TS 38.213]-  is given by [5, TS 38.213] for PUCCH format 0 and 1 while for PUCCH format 3 and 4 is defined in clause 6.4.1.3.3.1-  except for PUCCH format 0 when it depends on the information to be transmitted according to clause 9.2 of [5, TS 38.213]. - $m\_{int}$ is given by- $m\_{int}=5n\_{IRB}^{μ}$ for PUCCH formats 0 and 1 if PUCCH shall use interlaced mapping according to any of the higher-layer parameter *useInterlacePUCCH-Common-r16* or *useInterlacePUCCH-Dedicated-r16*, where $n\_{IRB}^{μ}$ is the resource block number within the interlace;- $m\_{int}=0$ otherwiseThe function  is given by $n\_{cs}\left(n\_{s,f}^{μ},l\right)=\sum\_{m=0}^{7}2^{m}c\left(8N\_{symb}^{slot}n\_{s,f}^{μ}+8l+m\right)$where the pseudo-random sequence  is defined by clause 5.2.1. The pseudo-random sequence generator shall be initialized with , where  is given by the higher-layer parameter *hoppingId* if configured, otherwise $n\_{ID}=N\_{ID}^{cell}$. |