**3GPP TSG RAN WG1 Meeting #107bis-e R1-22xxxxx**

**e-Meeting, January 17th – 25th, 2022**

**Source: Moderator (vivo)**

**Title: Discussion summary #1 of [107bis-e-R17-52-71GHz-05]**

**Agenda item: 8.2.5**

**Document for:** [Status]

# Introduction

In this contribution, we summarize issues regarding PDSCH/PUSCH enhancements for new SCSs on supporting NR from 52.6 GHz to 71 GHz for the following email discussion in RAN1 #107bis-e.

[107bis-e-R17-52-71GHz-05] Email discussion/approval on timeline related aspects adapted to each of the new numerologies 480kHz and 960kHz – Huaming (vivo)

* 1st check point: January 20
* Final check point: January 25

Note that the scope of agenda 8.2.5 including defining maximum bandwidth for new SCSs, time line related aspects adapted to each of the new numerologies 480kHz and 960kHz, reference signals, scheduling particularly w.r.t. multi-PDSCH/PUSCH with a single DCI, HARQ, etc. In this summary, only issues related to bandwidth for new SCSs, time line related aspects adapted to each of the new numerologies 480kHz and 960kHz and reference signals are summarized. Issues related to scheduling particularly w.r.t. multi-PDSCH/PUSCH with a single DCI, HARQ are not in the scope of this summary.

# PDSCH/PUSCH enhancements for new SCSs

In this section, we provide a summary of issues, observations and proposals related to PDSCH/PUSCH enhancements for new SCSs discussed in the submitted contributions.

As in WID, the related objectives for this summary of agenda 8.2.5 are the following.

* Physical layer aspects including [RAN1]:
	+ In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported.

Note: Except for timing line related aspects, a common design framework shall be adopted for 480kHz to 960kHz

* + Time line related aspects adapted to 480kHz and 960kHz, e.g., BWP and beam switching timing, HARQ timing, UE processing, preparation and computation timelines for PDSCH, PUSCH/SRS and CSI, respectively.
	+ Evaluate, and if needed, specify the PTRS enhancement for 120kHz SCS, 480kHz SCS and/or 960kHz SCS, as well as DMRS enhancement for 480kHz SCS and/or 960kHz SCS.

## 2.1. Timeline

### Individual observations/proposals

The following are individual observations and proposals from the contributions.

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| Sources | Observations/proposals |
| [8, Samsung] | Proposal 1: For NR operation with 480 kHz and/or 960 kHz SCS, further discuss whether the following UE timeline parameters are scaled or not according to subcarrier spacing * *N* symbols for PDSCH corresponding to SI-RNTI in Clause 5.1 of TS38.214
* 14 symbols for SPS PDSCH cancelation in Clause 5.1 of TS38.214
* 42 symbols for SRS precoding information update in Clause 6.1.1.2 of TS38.214

Proposal 2: If scaling is necessary, adopt TP#1 in Appendix for TS38.214.============================== Start of TP #1 for TS 38.214 ==================================5.1 UE procedure for receiving the physical downlink shared channel=============================== Unchanged Text Omitted ===================================In a given scheduled cell, for any PDSCH corresponding to SI-RNTI, the UE is not expected to decode a re-transmission of an earlier PDSCH with a starting symbol less than *N* symbols after the last symbol of that PDSCH, where the value of *N* depends on the PDSCH subcarrier spacing configuration *μ,* with *N*=13 for *μ*=0, *N*=13 for *μ*=1, *N*=20 for *μ*=2, *N*=24 for *μ*=3, *N*=96 for *μ*=5, and *N*=192 for *μ*=6.=============================== Unchanged Text Omitted ===================================The UE is not expected to decode a PDSCH in a serving cell scheduled by a PDCCH with C-RNTI, CS-RNTI or MCS-C-RNTI and one or multiple PDSCH(s) required to be received according to this Clause in the same serving cell without a corresponding PDCCH transmission if the PDSCHs partially or fully overlap in time except if the PDCCH scheduling the PDSCH ends at least 14\*2max{0,*μ*-3} symbols before the earliest starting symbol of the PDSCH(s) without the corresponding PDCCH transmission, where *μ* and the symbol duration is based on the smallest numerology between the scheduling PDCCH and the PDSCH, in which case the UE shall decode the PDSCH scheduled by the PDCCH. When the PDCCH candidates are associated with a search space set configured with *searchSpaceLinking*, for the purpose of determining the PDCCH with C-RNTI, CS-RNTI or MCS-C-RNTI scheduling the PDSCH ends at least 14\*2max{0,*μ*-3} symbols before the earliest starting symbol of the PDSCH(s) without the corresponding PDCCH transmission, the PDCCH candidate that ends later in time among the two configured PDCCH candidates is used.=============================== Unchanged Text Omitted ===================================6.1.1.2 Non-Codebook based UL transmissionFor non-codebook based transmission, the UE can calculate the precoder used for the transmission of SRS based on measurement of an associated NZP CSI-RS resource. A UE can be configured with only one NZP CSI-RS resource for the SRS resource set with higher layer parameter usage in *SRS-ResourceSet* set to 'nonCodebook' if configured.- If aperiodic SRS resource set is configured, the associated NZP-CSI-RS is indicated via SRS request field in DCI format 0\_1 and 1\_1, as well as DCI format 0\_2 (if SRS request field is present) and DCI format 1\_2 (if SRS request field is present), where *AperiodicSRS-ResourceTrigger* and *AperiodicSRS-ResourceTriggerList* (indicating the association between aperiodic SRS triggering state(s) and SRS resource sets), triggered SRS resource(s) *srs-ResourceSetId*, *csi-RS* (indicating the associated *NZP-CSI-RS-ResourceId*) are higher layer configured in *SRS-ResourceSet*. The *SRS-ResourceSet(s)* associated with the SRS request by DCI format 0\_1 and 1\_1 are defined by the entries of the higher layer parameter *srs-ResourceSetToAddModList* and the *SRS-ResourceSet(s)* associated with the SRS request by DCI format 0\_2 and 1\_2 are defined by the entries of the higher layer parameter *srs-ResourceSetToAddModListDCI-0-2*. A UE is not expected to update the SRS precoding information if the gap from the last symbol of the reception of the aperiodic NZP-CSI-RS resource and the first symbol of the aperiodic SRS transmission is less than OFDM symbols, where the SCS configuration *μ* is the smallest SCS configuration between the NZP-CSI-RS resource and the SRS transmission. ============================== End of TP #1 for TS 38.214 ================================== |
| [16, Apple] | ***Proposal 1:*** *The slot configuration period and the existing FR2 TD UL/DL configuration using either 60 kHz or 120 kHz is reused for 480kHz/960kHz SCS and the number of configuration slots is scaled accordingly.*   |
| [17, Xiaomi] | ***Proposal 1: To allow the PDCCH monitoring adaptation feature applied in NR 52.6-71GHz,**** ***The value of the SSSG switching timer in slots for SSSG#1 and/or SSSG#2 can be configured as, {[4,8,12,16,...,640,1280,1600,2560,3200]} for 480kHz SCS, {[8,16,24,32,..., 1280,1600,2560,3200,6400]} for 960kHz SCS.***
* ***The candidate skipping values can be configured as {[4,8,12,16,...,640,1280,1600,2560,3200]} for 480kHz SCS, {[8,16,24,32,..., 1280,1600,2560,3200,6400]}.***
 |
| [20, LG] | **Proposal #13: Extend the value range {1, 2, 3, 4, 5, 6, 7, 8} of the HARQ Feedback Timing Indicator field in successRAR for 480/960 kHz SCS, in order to provide a HARQ feedback delay similar to that for 120 kHz SCS.**  |

### Summary on timeline

#### HARQ Feedback Timing Indicator for 2-step RACH procedure

The following were agreed in RAN1#107-e.

Agreement:

For NR operation with 480 kHz and/or 960 kHz SCS, select the following as the set of values for PDSCH-to-HARQ\_feedback timing indicator field in DCI format 1\_0.

* {7, 8, 12, 16, 20, 24, 28, 32} for 480 kHz and {13, 16, 24, 32, 40, 48, 56, 64} for 960 kHz

Agreement

For NR operation with 480 kHz and/or 960 kHz SCS, scale the corresponding values of 120 kHz SCS by 4 and 8 for 480 kHz and 960 kHz SCS respectively for the following UE timeline parameters for single and multi-PDSCH/PUSCH scheduling to maintain the same absolute time duration as that of 120 kHz SCS in FR2.

* + HARQ-ACK information in response to a SPS PDSCH release, *N* in 38.213 Section 10.2
	+ HARQ-ACK information in response to a detection of a DCI format 1\_1 indicating Scell dormancy, *N* in 38.213 Section 10.3
	+ Determination of the resource allocation table to be used for PUSCH, *Δ* in 38.214 Section 6.1.2.1.1
	+ UE PDSCH reception preparation time with cross carrier scheduling with different subcarrier spacings for PDCCH and PDSCH, *Npdsch* in 38.214 Section 5.5
	+ Application delay of the minimum scheduling offset restriction, *Zµ* in 38.214 Section 5.3.1

It is identified in [20, LG] that for the 2-step RACH procedure, the value of PDSCH-to-HARQ feedback timing indicator field is also used to determine the slot for the PUCCH with HARQ-ACK for successRAR. As in Clause 8.2A of TS38.213, the corresponding PUCCH slot is determined as *n+k+Δ*, where *n* is a slot of the PDSCH reception and *k* is indicated by a HARQ Feedback Timing Indicator field of the successRAR having a value from {1,2,3,4,5,6,7,8}. *Δ* is an additional SCS-specific slot delay for PUSCH transmission scheduled by RAR message defined by Table 6.1.2.1.1-5 in TS 38.214 and the values for 480/960 kHz were also determined to be 24/48 slots, respectively.

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| 8.2A in TS 38.213…If the UE detects the DCI format 1\_0, with CRC scrambled by the corresponding MsgB-RNTI and LSBs of a SFN field in the DCI format 1\_0, if applicable, are same as corresponding LSBs of the SFN where the UE transmitted PRACH, and the UE receives a transport block in a corresponding PDSCH within the window, the UE passes the transport block to higher layers. The higher layers indicate to the physical layer- an uplink grant if the RAR message(s) is for fallbackRAR and a random access preamble identity (RAPID) associated with the PRACH transmission is identified, and the UE procedure continues as described in clauses 8.2, 8.3, and 8.4 when the UE detects a RAR UL grant, or- transmission of a PUCCH with HARQ-ACK information having ACK value if the RAR message(s) is for successRAR, where - a PUCCH resource for the transmission of the PUCCH is indicated by PUCCH resource indicator field of 4 bits in the successRAR from a PUCCH resource set that is provided by *pucch-ResourceCommon* - a slot for the PUCCH transmission is indicated by a HARQ Feedback Timing Indicator field of 3 bits in the successRAR having a value from {1, 2, 3, 4, 5, 6, 7, 8} and, with reference to slots for PUCCH transmission having duration , the slot is determined as , where is a slot of the PDSCH reception, is as defined for PUSCH transmission in Table 6.1.2.1.1-5 of [6, TS 38.214], is the SCS configuration of the active UL BWP, and is provided by *Koffset* in *ServingCellConfigCommon*; otherwise, if not provided, - the UE does not expect the first symbol of the PUCCH transmission to be after the last symbol of the PDSCH reception by a time smaller than msec where is the PDSCH processing time for UE processing capability 1 [6, TS 38.214]… |

It is argued in [20, LG] that for 480/960 kHz SCS, current set of values of *k* (i.e., {1,2,3,4,5,6,7,8}) has a too low maximum value considering typical TDD UL:DL switching patterns which may cause a scheduling restriction in designating a valid PUCCH occasion for HARQ-ACK. It further argued that the agreed set of values of *k* for DCI format 1\_0, i.e., {7, 8, 12, 16, 20, 24, 28, 32} for 480 kHz and {13, 16, 24, 32, 40, 48, 56, 64} for 960 kHz may cause the time margin for N1 is repeatedly applied to *k+Δ* since *Δ* can be considered as time margin determined in consideration of the PDSCH processing time (i.e., N1) as well as MAC layer processing latency (i.e., 0.5 msec). [20, LG] proposed to extend current set of values where *k* can be defined as eight values starting at “1” and incrementing by “4” (or “8”) for 480 (or 960) kHz SCS.

Moderator’s comment:

It is moderator’s understanding that previous agreement made in RAN1#107-e only covers the set of values for PDSCH-to-HARQ\_feedback timing indicator field in DCI format 1\_0. Therefore, the values of PDSCH-to-HARQ\_feedback timing indicator field in successRAR require discussion.

Though, different from [20], moderator’s understanding on *Δ* is that *Δ* is mainly for MAC layer processing latency and not for PDSCH processing. The following proposal is formulated where multiple options are listed for discussion.

Proposal 1-1 (high priority)

For NR operation with 480 kHz and/or 960 kHz SCS, select one of the following options as the set of values for PDSCH-to-HARQ\_feedback timing indicator field in successRAR.

* Option 1: {1, 5, 9, 13, 17, 21, 25, 29} for 480 kHz and {1, 9, 17, 25, 33, 41, 49, 57} for 960 kHz
* Option 2: {7, 8, 12, 16, 20, 24, 28, 32} for 480 kHz and {13, 16, 24, 32, 40, 48, 56, 64} for 960 kHz (same as that in DCI format 1\_0)
* Option 3: {1, 2, 3, 4, 5, 6, 7, 8} (same as in existing specification)

Companies are encouraged to provide comments and/or to indicate preference to above options.

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| Company Name | Comments/Views |
| Xiaomi | Prefer Option 2, but can go with majority. |
| LG Electronics | • Option 1 may mean that it is necessary to define a new value, and Option 2 may mean reusing the value agreed upon for DCI 1\_0. There are two thing to consider when determining HARQ Feedback Timing Indicator field in successRAR. First, considering a typical TDD UL:DL pattern, there may be a problem with using the current values {1,2,3,4,5,6,7,8} as it is. Therefore, **Option 3 should be excluded**. Second, the motivation of the value of Option 2 for DCI 1\_0 is considering the PDSCH processing latency. However, Δ already covers PDSCH processing time. As specified in the last paragraph of the captured 213 spec, a PUCCH slot cannot be located before +0.5 msec after receiving the PDSCH. In addition, the Δ value for 480/960 kHz was determined by simply scaling the value of 120 kHz, which made Δ a sufficient value to cover the time of +0.5 msec. That is, Δ alone can cover not only the MAC processing delay but also the time required for the PDSCH processing. • From this point of view, we prefer to define a new value. For the new value, **Option 1 may be a valid candidate**. However, if there are concerns about the maximum value of Option 1, such as when discussing the value for DCI 1\_0, **changing only the smallest value of Option 2 to '1' may be a another candidate**.• At last, the wording of the proposal should be amended as follows to avoid any misunderstandings.*For NR operation with 480 kHz and/or 960 kHz SCS, select one of the following options as the set of values for HARQ Feedback Timing Indicator field in successRAR.* |
| Samsung | We support option 2 for consistency. Also, we are fine with option 1 with understanding that Δ is already scaled and thus larger than NT,1+0.5 ms. |
| Moderator | Wording update (highlighted in red) as LG commented into Proposal 1-1a. |
| DOCOMO | Prefer option 1 or option 2. |
| MediaTek | We support option 2. |
| Futurewei | We can accept Option 2 or Option 1.  |

##### Proposal 1-1a (high priority)

For NR operation with 480 kHz and/or 960 kHz SCS, select one of the following options as the set of values for HARQ Feedback Timing Indicator field in successRAR.

* Option 1: {1, 5, 9, 13, 17, 21, 25, 29} for 480 kHz and {1, 9, 17, 25, 33, 41, 49, 57} for 960 kHz
* Option 2: {7, 8, 12, 16, 20, 24, 28, 32} for 480 kHz and {13, 16, 24, 32, 40, 48, 56, 64} for 960 kHz (same as that in DCI format 1\_0)
* Option 3: {1, 2, 3, 4, 5, 6, 7, 8} (same as in existing specification)

Companies are encouraged to provide comments and/or to indicate preference to above options.

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| Company Name | Comments/Views |
| Qualcomm  | We support Option 2 |
| DOCOMO | Prefer option 1 or option 2. |
| MediaTek | We support option 2. |
| ZTE, Sanechips | Our recommendation is to rule out Option 3 since it may cause the scheduling restriction. We are fine with LG’s idea of changing the smallest value of Option 2 to '1' to ensure feedback efficiency. The values {7,8} for HARQ Feedback Timing Indicator field in successRAR is quite similar for a high SCS like 480kHz. |
| Nokia/NSB | We think that Option 3 is sufficient. We think that there is no reason to optimize 2-step PRACH scenario for 480 kHz and/or 960 kHz SCS.. |
| Apple | We support Option 2 |
| Huawei, HiSilicon | Based on the agreement on K1 indication in DCI 1-0, we prefer option 2. Agree with FL that the delta is for MAC processing. |

#### Slot configuration

[16, Apple] proposed that the slot configuration period in the UL/DL configuration of 38.213. Section 11.1 can be reused for 480kHz/960kHz SCS and the number of configuration slots scaled accordingly. Given that FR2-2 is part of FR2, the reference SCS used by the slot configuration period in UL/DL configuration for FR2 (60 kHz and 120 kHz) may be re-used for 480 kHz SCS and 960 kHz SCS and the existing FR2 TD UL/DL configuration using either 60 kHz or 120 kHz may be re-used. The number of configuration slots is scaled accordingly. As such for FR2-2, with *µ= 3,* *µ= 5* or *µ=6*, we can set  with P = 0.625 msec, P = 1.25 msec and P = 2.5 msec.

Moderator’s comment:

Moderator’s understanding is that current description of section 11.1 in TS38.213 already allows any existing slot configuration to be used for FR2-2.

Furthermore, It’s already captured in section 11.1 of TS 38.213 “A value  msec is valid only for . A value  msec is valid only for  or . A value  msec is valid only for , or , or .” With that, it is not clear to moderator that any specification change to section 11.1 of TS 38.213 is needed.

Formulate the following discussion point so that the proponent can clarify what is the expected specification impact and other companies can provide input.

##### Discussion point 1-2

Q1: Do you think any explicit RAN1 specification change is needed w.r.t. the slot configuration for NR operation with 480 and/or 960 kHz SCS? If so, please elaborate.

Proponent is encouraged to clarify and other companies are encouraged to provide views.

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| Company Name | Comments/Views |
| Samsung | We don’t think any RAN1 specification changes are needed for the slot configuration. As mentioned by FL, gNB may configure the slot format based on a subcarrier spacing no larger than any subcarrier spacings in a cell, i.e., 120kHz SCS is used for the reference subcarrier spacing.  |
| Qualcomm  | We agree with Samsung, no RAN1 spec changes are needed |
| DOCOMO | We think Apple comment seems valid that the value of P should be clarified for 480/960kHz SCS. Otherwise, DL/UL slot configuration periodicity is not clear for 480/960kHz SCS. We are fine with Apple’s proposal that “P = 0.625 msec, P = 1.25 msec and P = 2.5 msec” are valid for *µ= 5* or *µ=6.* |
| Futurewei | We agree that no explicit RAN1 specification change is needed w.r.t. the slot configuration for NR operation with 480 and/or 960 kHz SCS.  |
| ZTE, Sanechips | We agree with moderator’s comment. |
| Nokia, NSB | We think that this does not require any RAN1 specification change.  |
| Apple | We are fine with the consensus. |
| Huawei, HiSilicon | For 480/960kHz SCS, the reference SCS of 120kHz SCS can still be configured with P=0.625/1.25/2.5ms according to current spec. no need to change the spec |

#### SSSG switching timer and PDCCH candidate skipping values

The following was agreed in RAN1#107-e.

Agreement

From RAN1 perspective, for NR operation with 480 kHz and/or 960 kHz SCS, the value of minimum time gap for wake-up and Scell dormancy indication (DCI format 2\_6) is scaled by 4 and 8 of the corresponding value of 120 kHz SCS for 480 kHz and 960 kHz SCS respectively.

* Note: X in 38.213 Section 10.3 and 38.133 Section 8.2.1.2.7.
* Send LS to RAN4 to inform about RAN1’s agreement of the reference values and ask RAN4 to make final decision

[17, Xiaomi] observed that R16 power saving WUS feature can be applied on NR 52.6-71GHz given the above agreement. [17, Xiaomi] proposed to allow R17 DCI-based power saving feature for FR2-2 with 480 and/or 960 kHz SCS as well where SSSG switching timer and PDCCH skipping values for 480kHz and 960kHz SCS should be defined. The same scaling factor 4 and 8 can be applied based on the values for 120kHz. For example, the value of the SSSG switching timer in slots for SSSG#1 and/or SSSG#2 can be configured as, {[4,8,12,16,…,640,1280,1600,2560,3200]} for 480kHz SCS, {[8,16,24,32,…, 1280,1600,2560,3200,6400]} for 960kHz SCS. The candidate skipping values can be configured as {[4,8,12,16,…,640,1280,1600,2560,3200]} for 480kHz SCS, {[8,16,24,32,…, 1280,1600,2560,3200,6400]}.

The following are the relevant agreements made in Rel-17 UE power saving enhancements WI.

Agreement

Confirm the working assumptions with the following updates (extract from RAN1#106-bis agreements)

* The value of the timer in slots for monitoring PDCCH in the active DL BWP of the serving cell before moving to the default search space group is
* {1,2,3,…,20,30, 40, 50, 60, 80, 100} for 15 kHz SCS,
* {1,2,3,…,40, 60, 80, 100, 100,160,200} for 30 kHz SCS,
* {1,2,3,…,80, 120, 160, 200, 240, 320,400} for 60kHz SCS,
* {1,2,3,…,160, 240, 320,400, 480, 640,800} for 120kHz SCS

Agreement

* For value X in Beh 1A, candidate skipping values are
	+ Up to [100ms] length is supported,
		- The X is configured and indicated in the unit of slot.
			* Working assumption for candidate values for X
				+ {1,2,3,…,20,30, 40, 50, 60, 80, 100} for 15 kHz SCS,
				+ {1,2,3,…,40, 60, 80, 100, 120,160,200} for 30 kHz SCS,
				+ {1,2,3,…,80, 120, 160, 200, 240, 320,400} for 60kHz SCS,
				+ {1,2,3,…,160, 240, 320,400, 480, 640,800} for 120kHz SCS
	+ FFS: Equal to or longer than the applicable minimum scheduling offset
	+ FFS: additional symbol level / PDCCH monitoring period level skipping duration

Moderator’s comment:

It is moderator’s understanding that SSSG switching timer and PDCCH candidate skipping values agreed so far in Rel-17 UE power saving enhancements WI do not cover 480 and/or 960 kHz SCS yet. It is worth to discuss on high level whether feature introduced in Rel-17 UE power saving enhancements WI can be extended for NR operation with 480 and/or 960 kHz SCS. Once agreed, then we can discuss further what values for 480 and/or 960 kHz SCS to enable that feature. Note that the scaling principle proposed in [17] is straight forward and consistent with what applied to other timelines for 480 and/or 960 kHz SCS. Formulate the following questions for discussion.

##### Discussion point 1-3

Q1: Do you think SSSG switching and PDCCH skipping feature introduced in Rel-17 UE power saving enhancement WI can be extended for NR operation in FR2-2 with 480 and/or 960 kHz SCS? Please elaborate your reasoning.

Q2: If the answer to Q1 is yes, do you agree to scale the values corresponding for 120 kHz by 4 and 8 for 480 and 960 kHz SCS, respectively? Please elaborate your reasoning.

Q3: Do you think there are other expected additional specification changes to support this feature for NR operation in FR2-2 with 480 and/or 960 kHz SCS? If so, please elaborate.

Companies are encouraged to provide comments/answers to above questions.

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| Company Name | Comments/Views |
| Xiaomi | For Q1,Yes, SSSG switching and PDCCH skipping feature introduced in Rel-17 UE power saving enhancement WI can be extended for NR operation in FR2-2 with 480 and/or 960 kHz SCS. We don’t see any discrepancy and R16 DCI based power saving has already extended to FR2-2 with 480 and/or 960 kHz SCS, R17 DCI based power saving For Q2, Agree. Follow the same principle as we do to R16 minimum time gap for wake-up and Scell dormancy indication (DCI format 2\_6).For Q3,No, currently we don’t see other additional specification changes. |
| Samsung | Q1. Yes. Our view is that a feature agreed in other WI in parallel is applicable to FR2\_2 unless explicit agreements precluding the feature are made. So, we are ok to support SSSG switching and PDCCH skipping for FR2\_2 in principle. But, if we identify any issues for FR2\_2, we are also ok to not support these for FR2\_2. Q2. Basically, we agree with the scaling the maximum value. But, the candidate values should be further discussed. For example, the following two options are considered. **Option 1.** {1,2,3,…,160, 240, 320,400, 480, 640,800}\*4 for 480kHz{1,2,3,…,160, 240, 320,400, 480, 640,800}\*8 for 480kHz**Option 2.**{1,2,3,…,640, 960, 1280, 1600, 1920, 2560, 3200} for 480kHz{1,2,3,…,1280, 1920, 2560, 3200, 3840, 5120, 6400} for 9600kHzQ3. No additional specification works are expected. To be clear, it should be confirmed in Rel-17 UE power saving WI. |
| Qualcomm  | Q1: Yes, SSSG switching and PDCCH skipping feature introduced in Rel-17 UE power saving enhancement WI can be extended for NR operation in FR2-2 with 480 and/or 960 kHz SCS. We do not see strong motivation to prevent such extension. Q2: Yes, we agree. As mentioned by Xiaomi, we followed the same approach with R16 minimum time gap for wake-up and Scell dormancy indication (DCI format 2\_6).Q3: No.  |
| DOCOMO | Q1: Yes.Q2: Yes. To scale the values corresponding for 120 kHz by 4 and 8 for 480 and 960 kHz SCS is the most simplest way.Q3: No. |
| MediaTek | Q1:yesQ2: scaling by 4 and 8 for 480kHz and 960kHz should be considered in the maintenance stage.Q3:no |
| Futurewei | Q1: Yes. We agree with Xiaomi and see no strong motivation so far to prevent the feature be extended to FR2-2;Q2: Yes. Support to scale the values for 480/960kHz SCS;Q3: No. Currently see no additional specification change needed.  |
| ZTE, Sanechips | Q1:YesQ2: Yes, it is straightforward to scale the value of the SSSG switching timer and candidate skipping values.Q3: No |
| Nokia, NSB | SSSG switching is discussed under PDCCH AI (AI 8.2.2). We proposed to discuss it there (and not in here). The following working assumption was made in RAN1 #107-e |
| Apple | Q1: yesQ2: Yes, i.e. scaled by 4 and 8 of the corresponding value of 120 kHz SCS for 480 kHz and 960 kHz SCS respectivelyQ3: No |
| Huawei, HiSilicon | Q1: yesQ2: support to simply scale the value for 120kHz by 4 and 8 for 480kHz and 960kHz SCSQ3: NoWe are also fine to discuss it in 8.2.2 as P\_switch had be determined in that AI. |

#### Other timeline parameters

[8, Samsung] identified several timeline parameters and proposed to discuss whether for NR operation with 480 kHz and/or 960 kHz SCS, the following UE timeline parameters are scaled or not

* *N* symbols for PDSCH corresponding to SI-RNTI in Clause 5.1 of TS38.214
* 14 symbols for SPS PDSCH cancelation in Clause 5.1 of TS38.214
* 42 symbols for SRS precoding information update in Clause 6.1.1.2 of TS38.214

The corresponding TPs to scale these UE timeline parameters are provided in [8, Samsung].

Moderator’s comment:

Given *N* symbols for PDSCH corresponding to SI-RNTI is SCS dependent in Clause 5.1 of TS38.214, it makes sense to scale *N* value accordingly for 480 and/or 960 kHz SCS to assure enough processing time to receive a retransmission of PDSCH corresponding to SI-RNTI. Formulate the following proposal.

##### Proposal 1-4 (high priority)

For NR operation with 480 kHz and/or 960 kHz SCS, scale the value of *N* for 120 kHz SCS by 4 and 8 for 480 kHz and 960 kHz SCS respectively, where N symbols are for PDSCH corresponding to SI-RNTI in Clause 5.1 of TS38.214.

* The following example change to 38.214 Section 5.1 can be recommended to the editor to use at the editor’s discretion

 --- Unchanged parts omitted ---

In a given scheduled cell, for any PDSCH corresponding to SI-RNTI, the UE is not expected to decode a re-transmission of an earlier PDSCH with a starting symbol less than *N* symbols after the last symbol of that PDSCH, where the value of *N* depends on the PDSCH subcarrier spacing configuration *μ,* with *N*=13 for *μ*=0, *N*=13 for *μ*=1, *N*=20 for *μ*=2, ~~and~~ *N*=24 for *μ*=3, *N*=96 for *μ*=5, and *N*=192 for *μ*=6.

--- Unchanged parts omitted ---

Companies are encouraged to provide comments.

|  |  |
| --- | --- |
| Company Name | Comments/Views |
| Xiaomi | Agree with Proposal 1-4 in general. |
| LG Electronics | Support the proposal in general. |
| Samsung | We support the proposal |
| Qualcomm  | We agree with the proposal  |
| InterDigital | We agree with the proposal.  |
| DOCOMO | Support. |
| MediaTek | Support the proposal |
| Futurewei | Agree with the Proposal 1-4.  |
| ZTE, Sanechips | We support Proposal 1-4. |
| Nokia, NSB | We support Moderator’s proposal. |
| Apple | We support the proposal |
| Huawei, HiSilicon | support |

Moderator’s comment:

As argued in [8, Samsung], 14 symbols are used for minimum time duration to cancel a SPS PDSCH reception if the SPS PDSCH reception overlaps with a PDSCH reception scheduled by a DCI format. In case the same processing time as that for 120 kHz SCS is required for 480 and/or 960 kHz SCS, it makes sense to scale the 14 symbols according to subcarrier spacing in FR2\_2, where the subcarrier spacing is the minimum of PDSCH subcarrier spacing and PDCCH subcarrier spacing.

##### Proposal 1-5 (high priority)

For NR operation with 480 kHz and/or 960 kHz SCS, scale 14 symbols for SPS PDSCH cancelation in Clause 5.1 of TS38.214 by 4 and 8 for 480 kHz and 960 kHz SCS respectively**.**

* The following example change to 38.214 Section 5.1 can be recommended to the editor to use at the editor’s discretion

 --- Unchanged parts omitted ---

The UE is not expected to decode a PDSCH in a serving cell scheduled by a PDCCH with C-RNTI, CS-RNTI or MCS-C-RNTI and one or multiple PDSCH(s) required to be received according to this Clause in the same serving cell without a corresponding PDCCH transmission if the PDSCHs partially or fully overlap in time except if the PDCCH scheduling the PDSCH ends at least 14\*2max{0,*μ*-3} symbols before the earliest starting symbol of the PDSCH(s) without the corresponding PDCCH transmission, where *μ* and the symbol duration is based on the smallest numerology between the scheduling PDCCH and the PDSCH, in which case the UE shall decode the PDSCH scheduled by the PDCCH. When the PDCCH candidates are associated with a search space set configured with *searchSpaceLinking*, for the purpose of determining the PDCCH with C-RNTI, CS-RNTI or MCS-C-RNTI scheduling the PDSCH ends at least 14\*2max{0,*μ*-3} symbols before the earliest starting symbol of the PDSCH(s) without the corresponding PDCCH transmission, the PDCCH candidate that ends later in time among the two configured PDCCH candidates is used.

--- Unchanged parts omitted ---

Companies are encouraged to provide comments.

|  |  |
| --- | --- |
| Company Name | Comments/Views |
| Xiaomi | Agree with Proposal 1-4 in general. |
| LG Electronics | It is unclear to us. We would like to understand the need of scaling. The number of symbols, 14, is currently not scale with SCS in Rel-15/16. What are the difference between a case with 480/960 kHz and other SCSs. Proponents please elaborate motivations behind the proposal.  |
| Samsung | We support the proposal.The 14 symbols are required to decode a PDCCH scheduling PDSCH receptions before a soft buffer for canceled SPS PDSCH reception is corrupted. As pointed by LGE, the 14 symbols are fixed and independent to subcarrier spacing. Our understanding is that the 14 symbols are designed for the worst-case, i.e., 120kHz SCS. So, additional scaling might be necessary for 480/960kHz. It is worth noting that 14 symbols are comparable to *N*3=20 symbols in Clause 9.2.3 of TS38.213 at 120kHz SCS, where the *N*3 symbols includes PDCCH decoding time and PUCCH generation time. Also, we already decided to use *N*3 = 80 or 160 for 480kHz or 960kHz.  |
| Qualcomm  | We are okay with the proposal  |
| DOCOMO | Support |
| MediaTek | We support the proposal. |
| Futurewei | We are okay with the Proposal 1-5.  |
| ZTE, Sanechips | We are fine with this proposal. |
| Nokia, NSB | We support Moderator’s proposal. |
| Apple | We support the proposal |
| Huawei, HiSilicon | support |

Moderator’s comment:

Similarly, in Clause 6.1.1.2 of TS38.214, 42 symbols are used for minimum time duration to update SRS precoding information. Again, assuming the same processing time as that for 120 kHz SCS is required for 480 and/or 960 kHz SCS, the value of 42 should be scaled according to subcarrier spacing (the smallest subcarrier spacing between the aperiodic NZP-CSI-RN resource and the aperiodic SRS transmission).

##### Proposal 1-6 (high priority)

For NR operation with 480 kHz and/or 960 kHz SCS, scale 42 symbols for SRS precoding information update in Clause 6.1.1.2 of TS38.214 by 4 and 8 for 480 kHz and 960 kHz SCS respectively**.**

* The following example change to 38.214 Section 6.1.1.2 can be recommended to the editor to use at the editor’s discretion

 --- Unchanged parts omitted ---

For non-codebook based transmission, the UE can calculate the precoder used for the transmission of SRS based on measurement of an associated NZP CSI-RS resource. A UE can be configured with only one NZP CSI-RS resource for the SRS resource set with higher layer parameter usage in *SRS-ResourceSet* set to ‘nonCodebook’ if configured.

- If aperiodic SRS resource set is configured, the associated NZP-CSI-RS is indicated via SRS request field in DCI format 0\_1 and 1\_1, as well as DCI format 0\_2 (if SRS request field is present) and DCI format 1\_2 (if SRS request field is present), where *AperiodicSRS-ResourceTrigger* and *AperiodicSRS-ResourceTriggerList* (indicating the association between aperiodic SRS triggering state(s) and SRS resource sets), triggered SRS resource(s) *srs-ResourceSetId*, *csi-RS* (indicating the associated *NZP-CSI-RS-ResourceId*) are higher layer configured in *SRS-ResourceSet*. The *SRS-ResourceSet(s)* associated with the SRS request by DCI format 0\_1 and 1\_1 are defined by the entries of the higher layer parameter *srs-ResourceSetToAddModList* and the *SRS-ResourceSet(s)* associated with the SRS request by DCI format 0\_2 and 1\_2 are defined by the entries of the higher layer parameter *srs-ResourceSetToAddModListDCI-0-2*. A UE is not expected to update the SRS precoding information if the gap from the last symbol of the reception of the aperiodic NZP-CSI-RS resource and the first symbol of the aperiodic SRS transmission is less than OFDM symbols, where the SCS configuration *μ* is the smallest SCS configuration between the NZP-CSI-RS resource and the SRS transmission.

--- Unchanged parts omitted ---

Companies are encouraged to provide comments.

|  |  |
| --- | --- |
| Company Name | Comments/Views |
| LG Electronics | It is unclear to us. We would like to understand the need of scaling. The number of symbols, 42, is currently not scale with SCS in Rel-15/16. What are the difference between a case with 480/960 kHz and other SCSs. Proponents please elaborate motivations behind the proposal.  |
| Samsung | We support the proposal. For 42 symbols, as in proposal 1-5, our understanding is that the number of symbols for SRS precoding information update is designed for the worst-case case, i.e., 120kHz SCS. So, additional scaling might be necessary for 480/960kHz. |
| Qualcomm | We are okay with the proposal  |
| DOCOMO | Support. |
| Futurewei | Ok with the Proposal 1-6.  |
| ZTE, Sanechips | We are fine with this proposal. |
| Nokia, NSB | We support Moderator’s proposal. |
| Apple  | We support the proposal |
| Huawei, HiSilicon | Support |

## 2.2. Other issue(s)

### Individual observations/proposals

The following are individual observations/proposals from the contributions.

|  |  |
| --- | --- |
| Sources | Observations/proposals |
| [1, Futurewei] | *Proposal 3. For FR2-2, the DMRS bundling feature introduced by the CovEnh WI (for FR1 and FR2 120kHz) should not be applied to the case with non-contiguous multi-slot configured with SCS 120kHz.*  |
| [4, vivo] | Proposal 1: Closely monitor the progress on DMRS bundling in Rel-17 Coverage enhancement WI, especially the support on different TBs over multiple slots. Only when this is supported, it is possible to apply DMRS bundling for NR operation in FR2-2.Proposal : The timing error issue due to smaller SCS of SSB than that of data transmission can be resolved by gNB implementation, e.g., gNB transmits an NCD SSB of 960 kHz SCS and indicates UE to measure it, and no specification impact shall be introduced. |
| [8, Samsung] | Proposal 3: For 120kHz SCS of FR2\_2, RAN1 should conclude whether to support DMRS bundling across the multiple PUSCHs introduced in Rel-17 Coverage enhancement WI. |

### DMRS bundling across multiple PUSCHs

[1, Futurewei] observed that for operation between 52.6GHz to 71GHz, given slot level gaps are allowed for multi-PDSCH/PUSCH, and the maximum allowed gap size between individual PDSCH/PUSCH has not been restricted, and given the extended k0/k2 values, these gaps can be as large as 100+ slots. [1, Futurewei] argues that this is out of the scope of the scenario that is being studied by RAN4. Therefore, at least for the case of non-contiguous multi-slot, it is not recommended to apply the DMRS bundling feature for SCS 120kHz of FR2-2.

[4, vivo] observed that DMRS bundling introduced in Rel-17 Coverage enhancement WI only supports same TB over multiple slots, and the agreement on different TBs over multiple slots has not been reached yet in Coverage enhancement WI. Given multi-PUSCH scheduling in FR2-2 only supports different TBs over multiple slots, [4, vivo] proposed to wait for more progress on support of different TBs over multiple slots in Coverage enhancement WI before conclude this topic.

On the same topic, it is suggested in [8, Samsung] to focus on whether to support DMRS bundling for PUSCHs for 120kHz SCS of FR2\_2 and if supported, reuse the DMRS bundling for PUSCHs specified in CovEnh WI without any further change.

Moderator’s comment:

Note that this issue was discussed for multiple rounds in RAN1#107-e where no conclusion was made on whether or not DMRS bundling across multiple PUSCHs introduced in Rel-17 Coverage enhancement WI can be applied for 120 kHz SCS of FR2-2. Based on company views expressed in RAN1#107-e and contributions submitted to this meeting, the following options are listed for consideration.

##### Proposal 2-1 (high priority)

Regarding applicability of DMRS bundling across multiple PUSCHs introduced in Rel-17 Coverage enhancement WI for NR operation in FR2-2, select one of the following options as the conclusion in Rel-17:

* Option 1: DMRS bundling across multiple PUSCHs is not supported for NR operation in FR2-2
* Option 2: If DMRS bundling is supported for different TBs over multiple slots in Rel-17 Coverage enhancement WI, it can be applied across multiple PUSCHs with contiguous time domain resource for NR operation in FR2-2 with 120 kHz SCS
* Option 3: If DMRS bundling is supported for different TBs over multiple slots in Rel-17 Coverage enhancement WI, it can be applied across multiple PUSCHs for NR operation in FR2-2 with 120 kHz SCS
* Option 4: DMRS bundling across multiple PUSCHs with contiguous time domain resource is supported for NR operation in FR2-2 with 120 kHz SCS
* Option 5: DMRS bundling across multiple PUSCHs is supported for NR operation in FR2-2 with 120 kHz SCS
* Option 6: DMRS bundling across multiple PUSCHs is supported for NR operation in FR2-2

Note: If applied for NR operation in FR2-2, no further optimization for FR2-2 in Rel-17

Companies are encouraged to provide comments and indicate their preference/objection to the above options.

|  |  |
| --- | --- |
| Company Name | Comments/Views |
| LG Electronics | In the last meeting, many companies on this topic pointed out that the scenarios considered by CE WI and B52 WI are different and did not support to introduce DMRS bundling into FR2-2 without clear motivation for FR2-2. For the same reason, we do not support Options 3, 4, 5 and 6. Option 2 may also decide whether to apply to FR2-2 after the CE WI has discussed whether it applies to different TB. Therefore, we prefer Option 1 for now. |
| Samsung | We suggest to focus on Option 1 and 5.Since DMRS bundling specified in Rel-17 CovEnh WI only support same TB over multiple slots. So, we don’t need to discuss Option 2 and 3. For option 4, DMRS bundling specified in Rel-17 CovEnh WI already support non-contiguous time domain resource if the gap between two time domain resources are less than 14 symbols. So, we don’t make further restriction on FR2\_2. For option 6, in the last meeting, some companies have a concerns on 480/960kHz SCS because RAN1 and RAN4 does not take into account these subcarrier spacings. |
| Qualcomm  | We agree with Samsung, we can focus on fewer number of Options, Option 1 and 5 can be enough  |
| InterDigital | We agree with Samsung and Qualcomm. We can focus on Option 5 and 1.  |
| DOCOMO | We share Samsung’s view.  |
| Futurewei | Prefer Option 1; cannot accept Option 6. Regarding Option 5, it can be discussed if it is independent of the ‘If DMRS bundling is supported for different TBs…’ pre-requisite for Option 3 to be applicable for FR2-2 with 120 kHz SCS.  |
| ZTE, Sanechips | We agree with Samsung’s suggestion. |
| Lenovo, Motorola Mobility | In CE WI, no further discussion is expected on supporting joint channel estimation with different TBs. Therefore, we don’t think we should consider supporting joint channel estimation across multiple PUSCHs in FR2-2. Thus, we support Option 1 |
| Nokia, NSB | Our preference is Option 1So far DMRS bundling is supported only in a single TB scenario (i.e. TB repetition and TBoMS). It doesn’t make sense to extend the scope in another WI. The discussion should take place in Rel-17 CovEnh WI, and not in here. |
| Apple | We prefer Option 1 |
| Huawei, HiSilicon | We are supportive of extending DMRS bundling defined in CovEnh WI to FR2-2. The restriction of signal continuity can be adopted in FR2-2 even if there is gap between consecutive PDSCH/PUSCH scheduled by single DCI. If the proposal is within the scope of existing CovEnh design, e.g. 120kHz SCS, same TB and etc, we think the decision to support for FR2-2 can be left for CovEnh WI. |

### TRS enhancements

In [4, vivo], it is observed that the timing error issue due to smaller SCS of SSB than that of data transmission can be resolved by gNB implementation without any specification impact.

Moderator’s comment:

Note that this issue was discussed in RAN1#107-e where majority of companies think this issue may be considered in future release rather than in Rel-17. Given no companies propose any TRS enhancement with specification impact in this meeting, moderator’s suggestion is to de-prioritize this discussion in Rel-17.

##### Discussion point 2-2

Companies are encouraged to provide comments.

|  |  |
| --- | --- |
| Company Name | Comments/Views |
| Samsung | Agree with FL’s assessment. |
| InterDigital | Agree with the moderator’s comment  |
| DOCOMO | Agree with FL’s assessment |
| Futurewei | We agree with moderator’s assessment.  |
| ZTE, Sanechips | We agree with FL’s assessment.  |
| Nokia, NSB | Agree with Moderator’s proposal |
| Apple | We agree with the moderator’s assessment |
| Huawei, HiSilicon | Agree with FL’s assessment.  |

# Recommendation for GTW/email approval

TBD

# Conclusion

TBD

# Reference

1. [R1-2200025](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200025.zip) On several study points for PDSCH/PUSCH enhancements for Beyond 52.6GHz FUTUREWEI
2. [R1-2200048](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200048.zip) Remaining issues of PDSCH/PUSCH enhancement for 52-71GHz spectrum Huawei, HiSilicon
3. [R1-2200064](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200064.zip) Remaining issues for PDSCH/PUSCH enhancements to supporting 52.6-71 GHz band in NR InterDigital, Inc.
4. [R1-2200078](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200078.zip) Remaining issues on PDSCH/PUSCH enhancements for NR operation from 52.6GHz to 71GHz vivo
5. [R1-2200124](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200124.zip) Remaining issues of multi-PDSCH scheduling via a single DCI Fujitsu
6. [R1-2200145](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200145.zip) Remaining issues on PDSCH/PUSCH enhancements for up to 71GHz operation CATT
7. [R1-2200187](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200187.zip) PDSCH/PUSCH enhancements Nokia, Nokia Shanghai Bell
8. [R1-2200196](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200196.zip) Maintenance on PDSCH/PUSCH enhancements for NR from 52.6 GHz to 71 GHz Samsung
9. [R1-2200230](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200230.zip) Remaining issues on PDSCH/PUSCH enhancements for NR in FR2-2 NTT DOCOMO, INC.
10. [R1-2200263](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200263.zip) Remaining issues on the data channel enhancements for 52.6 to 71GHz ZTE, Sanechips
11. [R1-2200267](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200267.zip) Discussion on PDSCH/PUSCH enhancements for NR 52.6-71 GHz Panasonic Corporation
12. [R1-2200292](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200292.zip) PDSCH/PUSCH enhancements for NR in 52.6 to 71GHz band Qualcomm Incorporated
13. [R1-2200328](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200328.zip) Discussion on remaining issue for PDSCH/PUSCH enhancements OPPO
14. [R1-2200370](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200370.zip) Discussion on PDSCH/PUSCH enhancements for extending NR up to 71 GHz Intel Corporation
15. [R1-2200405](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200405.zip) PDSCH-PUSCH Enhancements Ericsson
16. [R1-2200412](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200412.zip) On remaining issues for PDSCH/PUSCH Enhancements Apple
17. [R1-2200461](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200461.zip) Remaining issues on PDSCH and PUSCH enhancements for NR 52.6-71GHz xiaomi
18. [R1-2200508](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200508.zip) Remaining issues on PDSCH/PUSCH enhancement for NR operation from 52.6GHz to 71GHz NEC
19. [R1-2200542](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200542.zip) Remaining discussion on multi-PDSCH scheduling design for 52.6-71 GHz NR operation MediaTek Inc.
20. [R1-2200568](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200568.zip) PDSCH/PUSCH enhancements to support NR above 52.6 GHz LG Electronics
21. [R1-2200631](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200631.zip) Discussion on multi-PUSCH scheduling ASUSTeK
22. [R1-2200632](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Docs/R1-2200632.zip) Remaining issues on PDSCH/PUSCH enhancement for NR from 52.6GHz to 71GHz WILUS Inc.