**3GPP TSG RAN WG1 #120bis R1-2502743**

**Wuhan, China, April 7th – 11th, 2025**

**Agenda Item: 9.15.14**

**Source: Moderator (AT&T)**

**Title: Summary of UE features for Rel-19 TEI and other relevant issues**

**Document for:** **Discussion/Decision**

# Introduction

This document presents the summary of email discussion [120bis-R19-UE\_features] during RAN1 #120bis. According to the Chair’s Notes:

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| [120bis-R19-UE\_features] Email discussion on Rel-19 UE features – Ralf (AT&T), Naoya (DOCOMO), Hiroki (DOCOMO)* To be used for sharing updates on online/offline schedule, details on what is to be discussed in online/offline sessions, tdoc number of the moderator summary for online session, etc
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The following was discussed during RAN1 #120bis within the scope of [120bis-R19-UE\_features].

# Summary of Contributions Submitted to RAN1 #120bis

The following is the moderator’s summary of contributions submitted to RAN1 #120bis in this agenda item.

## Two simultaneous SRS carrier switching

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| Company | Summary |
| ZTE Corporation/Sanechips [1] |  |
| Huawei/HiSilicon [2] | As a follow-up to the previous discussion on the UE capability, a consensus seems that * the existing UE capabilities *uplinkTxSwitchingPeriod* and *SRS-SwitchingTimeNR* can be utilized;
* Based on the two UE capability values reported for the concerned carriers, the switching time is derived by two methods below, which one is applied is indicated by the UE capability,
	+ Value 1: the maximum among {A, B}
	+ Value 2: A + B
		- A is the maximum *uplinkTxSwitchingPeriod* across the set of carriers having chains in the current state and the source carrier for SRS carrier switching.
		- B is *SRS-SwitchingTimeNR* as reported by the UE

Additionally, the value 1 (i.e. maximum method) was proposed as default value if the UE capability is not reported.In the description of the UE capability, the term “Tx chains” should be avoided because it has never been clearly defined in current specifications. Similarly, the term “operation state” should also be avoided because it is applicable only to a UE capable of “dualUL” sub feature but not applicable to the case of “switchedUL” and SUL feature according to sub-clause 6.1.6 of TS 38.214.With the above, our proposal is,**Proposal 2: Include the following FGs for TEI-19 and endorse the table in Appendix.*** **Feature xx-4**
* **Feature group: the determination method of switching time for UEs configured with both UL Tx switching and SRS carrier switching.**
* **Components:**
	+ **Support of determination method of switching time for UEs configured with UL Tx switching on at least UL carrier 1 and carrier 2 and configured with SRS carrier switching on UL carrier 3 in a case where an SRS carrier switching is triggered for SRS transmission on UL carrier 3 and the UE is currently in a UE state that if any UL transmission with the maximum number of supported UL-MIMO ports would be transmitted on the UL carrier 2 configured as source carrier for the SRS carrier**
	+ **switching, an UL Tx switching would have been triggered according to sub-clause 6.1.6 of TS 38.214.**
* **Notes:**
	+ **Component 1 candidate values: {maximum, sum}**
	+ **Note1: value “maximum” means that the switching time is determined as the maximum value among {A, B} while value “sum” means the sum between A and B where B is SRS-SwitchingTimeNR as reported by the UE and A is the maximum value of uplinkTxSwitchingPeriod across the set of UL carriers involved with the hypothetically triggered UL Tx switching in the aforementioned UE state (as in S6.1.6 of TS 38.214) and the source carrier for SRS carrier switching.**
	+ **Note2: if the capability is not reported, value “maximum” is the default value.**
* **Type: Per BC**
* **Prerequisite feature groups: RAN1 FG 2-56 and RAN4 FG 7-1**

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| xx | xx-4 | determination method of switching time for UEs configured with both UL Tx switching and SRS carrier switching | Support of determination method of switching time for UEs configured with UL Tx switching at least on UL carrier 1 and carrier 2 and configured with SRS carrier switching on UL carrier 3 in a case where an SRS carrier switching is triggered for SRS transmission on UL carrier 3 and the UE is currently in a UE state that if any UL transmission with the maximum number of supported UL-MIMO ports would be transmitted on the UL carrier 2 configured as source carrier for the SRS carrier switching, an UL Tx switching would have been triggered according to sub-clause 6.1.6 of TS 38.214. | RAN1 FG 2-56 and RAN4 FG 7-1 | Yes | n/a |  | Per band combination | n/a | n/a | n/a | Component 1 candidate values:{maximum, sum}Note1: value “maximum” means that the switching time is determined as the maximum value among {A, B} while value “sum” means the sum between A and B where B is SRS-SwitchingTimeNR as reported by the UE and A is the maximum value of uplinkTxSwitchingPeriod across the set of UL carriers involved with the hypothetically triggered UL Tx switching in the aforementioned UE state (as in S6.1.6 of TS 38.214) and the source carrier for SRS carrier switching.Note2: if the capability is not reported, value “maximum” is the default value. | Optional with capability signaling |

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| Apple [3] |  |
| Qualcomm Incorporated [4] | In RAN1#118b, the following TEI was agreed:

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| --- |
| AgreementFor the indication of whether a UE can simultaneously perform SRS carrier switches * *srs-SwitchingAffectedBandsListNR-r17* is the baseline for indication.
	+ *Details about UE capability will be discussed in UE feature session.*
	+ *The structure of UE capability signalling is reused*
* Two SRS carrier switches are considered to be simultaneous if the SRS transmission (including RF retuning time) in both CCs overlap in time.
* A UE that indicates it is not capable of simultaneous SRS carrier switching among a set of switching pairs is not expected to be configured / scheduled with simultaneous SRS carrier switching in the set of switching pairs.
* Note: except for UE capability, the spec impact is only 38.214.
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In RAN1#109, the following was agreed (which resulted in the addition of *srs-SwitchingAffectedBandsListNR-r17*):Agreement

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| TEI17, NR\_newRAT-Core | 2x-1-2 | Affected bands for inter-band CA during SRS carrier switching | 1. Indicate which other bands in the band combination are affected by the SRS switch.2. The dropping rules / timelines apply to the indicated bands when SRS carrier switching on target CC and other UL on source CC are overlapped in the same symbol. | 2-56 |   |   |   | Per BC |   |   |   | Note : If this new indication is missing, the UE defaults to Rel-15 behavior.For each “source-target” pair (as indicated by srs-SwitchingTimesListNR), the UE can indicate which other bands in the band combination are affected by the SRS switch.This is a working assumption. | Optional with capability signalling  |

The corresponding capability was agreed and endorsed in the Rel-17 UE features in R1-2207923. We propose to reuse the same capability to indicate for which bands we can support simultaneous switching. Note that we change the logic from *srs-SwitchingAffectedBandsListNR-r17*: while the R17 capability indicates for which bands the UE cannot perform simultaneous transmission, the new R19 capability indicates for which bands the UE can perform simultaneous transmission.Proposal 1: Support the following UE feature for Rel-19 TEI [Simul\_SRSCS]:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
|  |  | Support of simultaneous SRS carrier switching | 1.- Support simultaneous SRS carrier switches. Two SRS carrier switches are considered to be simultaneous if the SRS transmission (including RF retuning time) in both CCs overlap in time | 2-56 | Yes | N/A | Simultaneous SRS CS across multiple CC is not supported | Per band combination | N/A | N/A | N/A | For each “source-target” pair (as indicated by srs-SwitchingTimesListNR), the UE can indicate with which other target bands in the band combination can SRS carrier switching be simultaneously triggered | Optional with capability signaling |

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## SR triggered SSSG switching

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| Company | Summary |
| ZTE Corporation/Sanechips [1] |  |
| Huawei/HiSilicon [2] | In RAN1#120, it was agreed that UE shall fallback to a search space set group (SSSG) which is considered as densely monitored SSSG after a PUCCH carrying an SR is transmitted. Considering different network vendors may have different consideration of SSSG index allocated for densely monitored SSSG, a RRC parameter is agreed to be used to configure the designated SSSG index for fallback. The detailed agreement is shown in the introduction part.For the UE capability, related UE capabilities introduced in Rel-17 are as following:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 29. NR\_UE\_pow\_sav\_enh | 29-3b | 2 search space sets group switching | Support of 1-bit indication of SSSG switching between 2 SSSGs by scheduling DCI, and timer based SSSG switching, if PDCCHSkippingDurationList is not configured |  |
| 29. NR\_UE\_pow\_sav\_enh | 29-3c | 3 search space sets group switching | Support of 2-bit indication of SSSG switching among 3 SSSGs by scheduling DCI and timer based SSSG switching, if PDCCHSkippingDurationList is not configured | 29-3b |
| 29. NR\_UE\_pow\_sav\_enh | 29-3d | 2 search space sets group switching with PDCCH skipping | Support of 2-bit indication of SSSG switching between 2 SSSGs, PDCCH skipping by scheduling DCI, and timer based SSSG switching | 29-3a, 29-3b |
| 29. NR\_UE\_pow\_sav\_enh | 29-3e | Support Search space set group switching capability 2 for FR1 | Search space set group switching Capability-2 according to Table 10.4-1 of 38.213 for SSSG switching. | 29-3b |

For the TEI feature introduced, we have the following proposal:**Proposal 3: Include the following FGs for TEI-19 and endorse the table in Appendix.*** **Feature xx-5**
* **Feature group:** **Fallback to a SSSG with designated index after a PUCCH carrying an SR is transmitted.**
* **Components:**
	+ **Support of start PDCCH monitoring according to search space sets with a designated group index and stops PDCCH monitoring according to search space sets with a group index other than the designated SSSG index from the first slot that is at least** $P\_{switch}$ **symbols after the last symbol of a PUCCH carrying an SR, if the UE is instructed to monitor PDCCH according to search space sets with the SSSG index other than the designated SSSG index before the transmission of PUCCH carrying the SR**
* **Notes:**
	+ **Note1:** $P\_{switch}$ **symbols is specified in Table 10.4-1 of TS 38.213.**
* **Type: Per Band**
* **Prerequisite feature groups: one of {RAN1 FG 29-3b, FG 29-3c, FG29-3d, FG29-3e}**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| xx | xx-5 | Fallback to a SSSG with designated index after a PUCCH carrying an SR is transmitted | Support of start PDCCH monitoring according to search space sets with a designated group index and stops PDCCH monitoring according to search space sets with a group index other than the designated SSSG index from the first slot that is at least $P\_{switch}$ symbols after the last symbol of a PUCCH carrying an SR, if the UE is instructed to monitor PDCCH according to search space sets with the SSSG index other than the designated SSSG index before the transmission of PUCCH carrying the SR. | one of { FG 29-3b, FG 29-3c, FG29-3d, FG29-3e} | Yes | n/a |  | Per band  | n/a | n/a | n/a | Note1: $P\_{switch}$ symbols is specified in Table 10.4-1 of TS 38.213 | Optional with capability signaling |

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| Apple [3] |  |
| Qualcomm Incorporated [4] | In RAN1#120, the following TEI was agreed:

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| Agreement* If a UE is instructed to monitor PDCCH according to search space sets with a group index other than adesignated index, the UE stops PDCCH monitoring according to search space sets with the group index and start PDCCH monitoring according to search space sets with the designated group index from the first slot that is at least P\_switch symbols after the last symbol of a PUCCH carrying an SR.
* Introduce corresponding UE capability and RRC parameters to enable/disable the above feature and indicate the designated SSSG index.
* Send LS to RAN2 to inform above agreement and ask for the support of the UE capability and the corresponding RRC parameters.
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The required UE capability is to indicate the support for the TEI [SRTrig\_SSSGSwitch] feature. Therefore, the following UE feature is suggested. Proposal 2: Support the following UE feature for Rel-19 TEI [SRTrig\_SSSGSwitch]:

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory /Optional |
|  |  | SR-triggered search space set group switching | Indicates whether the UE supports switching to a SSSG with a designated index after transmission of SR, if the UE was monitoring PDCCH according to a SSSG with a different index than the designated one. | 29-3b, 29-3c, and/or 29-3d | yes | n/a | SR-triggered SSSG switching is not supported | Per Band | n/a | n/a | n/a |  | Optional with capability signalling |

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## SRS carrier switching and UL Tx switching

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| Company | Summary |
| ZTE Corporation/Sanechips [1] |  |
| Huawei/HiSilicon [2] |  |
| Apple [3] |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group  | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
|  |  | Report inter-cell switchingtime when source is sharing Tx chain | 1. SRSCSTimewithTxSwitchingList
 |  | Yes | n/a |  | BC | n/a | n/a | n/a | Indicates a list of SRSCSTimewithTxSwitching, for each pair of NR “source-target” bands in the band combination. The UE shall include the same number of entries, and listed in the same order as in srs-SwitchingTimesListNR. For a particular “source-target” pair (as indicated by srs-SwitchingTimesListNR), if more than one UL bands share Tx chain with the source (as indicated by supportedBandPairListNR-r16), the reported value is applied to all those UL bands (e.g. UE reports based on largest switching time among all possible triples for the particular “source-target” pair). A UE reporting this list, shall also report both supportedBandPairListNR-r16 and srs-SwitchingTimesListNR. For a particular “source-target” pair, the report entry is optional, and if not reported by UE, max(uplinkTxSwitchingPeriod-r16, SRS-SwitchingTimeNR) is assumed for the configured triple is assumed. | Optional with capability signalling |

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| Qualcomm Incorporated [4] |  |

## Frequency hopping enhancement for positioning

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| Company | Summary |
| ZTE Corporation/Sanechips [1] | In RAN1#120 meeting, the following agreement was achieved to support non-RedCap UE performing SRS frequency hopping for positioning.

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| Agreement* Extend Rel-18’s UL frequency hopping UL SRS for positioning transmission to non-RedCap UEs in a single carrier
* UE capability for non-RedCap UEs for UL SRS frequency hopping for positioning transmission

Send LS to RAN2 to inform this agreement, whether new parameter is needed is up to RAN2 discussion. |

As discussed in our companion contribution, all positioning SRS FH enhancements in Rel-18 including FH configuration parameters for SRS resource, measurement report and collision handling can be extended to non-RedCap UE SRS FH for positioning. UE features for non-RedCap UEs for positioning SRS FH can refer to FG 41-5-2, FG 41-5-2a and FG 41-5-3.

|  |  |  |
| --- | --- | --- |
| **UE capabilities for Rel-18 RedCap UE positioning** | **Components for Rel-18 RedCap UE positioning** | **non-RedCap UEs positioning SRS FH for Rel-19 TEI** |
| FG 41-5-2 Support of positioning SRS with Tx frequency hopping in RRC\_CONNECTED for RedCap UEsFG 41-5-2a Support of positioning SRS with Tx frequency hopping in RRC\_INACTIVE for RedCap UEs | 1. Maximum SRS bandwidth across all hops
 | Reuse the component and its candidate valuesFR1: {40, 50, 80, 100}FR2: {100, 200, 400} |
| 2. Maximum number of hops  | Reuse the component and its candidate values{2,3,4,5,6} |
| 1. RF Tx retuning time between consecutive hops
 | 0us should also be introduced in addition to FG41-5-2/41-5-2a candidate values. For non-RedCap UEs, extra RF Tx retuning time may not be needed given that the UE have a capability of transmitting up to 100MHz in FR1.FR1: {0us, 70us, 140us, 210us}FR2: {0us, 35us, 70us, 140us} |
| 1. Switching time between active BWP and frequency hop
 | Since the separate BWP does not necessarily have to be outside the active UL BWP for non-RedCap UEs, 0us should also be introduced in addition to FG41-5-2/41-5-2a candidate values for switching time between active BWP and frequency hop.{0us, 100us, 140us, 200us, 300us, 500us} |
| 5. Overlapping PRB(s) between adjacent hops | Reuse the component |
| 6. Support of {0,1,2,4} overlapping PRB(s) between adjacent hops | Reuse the component  |
| 1. Maximum number of positioning SRS resources with Tx frequency hopping
 | Reuse the component and its candidate valuesPeriodic: {1,2,4,8,16,32,64}Aperiodic: {0,1,2,4,8,16,32,64}Semi-persistent: {0,1,2,4,8,16,32,64} |
| FG 41-5-3UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window | Support of UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window | Reuse the component  |

Based on the above analysis, we support the following new UE features for non-RedCap UEs positioning SRS frequency hopping:**Proposal 2: Support the following FGs for TEI on non-RedCap UE positioning SRS frequency hopping.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 67-x | Support of positioning SRS with Tx frequency hopping in RRC\_CONNECTED  | 1. Maximum SRS bandwidth across all hops2. Maximum number of hops3. RF Tx retuning time between consecutive hops4. Switching time between active BWP and frequency hop5. Overlapping PRB(s) between adjacent hops6. Support of {0,1,2,4} overlapping PRB(s) between adjacent hops7. Maximum number of positioning SRS resources with Tx frequency hopping | 13-8 | Yes | n/a | Positioning SRS with Tx hopping in RRC\_CONNECTED is not supported | Per band | n/a | n/a | n/a | Component 1 candidate values:FR1: {40, 50, 80, 100}FR2: {100, 200, 400}Component 2 candidate values: {2,3,4,5,6}Component 3 candidate values:FR1: {0us, 70us, 140us, 210us}FR2: {0us, 35us, 70us, 140us}Component 4 candidate values:{0us, 100us, 140us, 200us, 300us, 500us}Component 7 candidate values:Periodic: {1,2,4,8,16,32,64}Aperiodic: {0,1,2,4,8,16,32,64}Semi-persistent: {0,1,2,4,8,16,32,64}Note: No additional UE requirements shall be specified for the case of Tx hopping with non-overlapping hops compared to the case of Tx hopping with overlapping hops, e.g., a UE is not responsible for keeping phase continuity across the hops in either case of overlapping or non-overlapping hopsNeed for location server to know if the feature is supported | Optional with capability signalling |
| 67-y | Support of positioning SRS with Tx frequency hopping in RRC\_INACTIVE  | 1. Maximum SRS bandwidth across all hops2. Maximum number of hops3. RF Tx retuning time between consecutive hops4. Switching time between active BWP and frequency hop5. Overlapping PRB(s) between adjacent hops6. Support of {0,1,2,4} overlapping PRB(s) between adjacent hops7. Maximum number of positioning SRS resources with Tx frequency hopping | 27-15b | Yes | n/a | Positioning SRS with Tx hopping in RRC\_INACTIVE is not supported | Per band | n/a | n/a | n/a | Component 1 candidate values:FR1: {40, 50, 80, 100}FR2: {100, 200, 400}Component 2 candidate values: {2,3,4,5,6}Component 3 candidate values:FR1: {0us, 70us, 140us, 210us}FR2: {0us, 35us, 70us, 140us}Component 4 candidate values:{0us, 100us, 140us, 200us, 300us, 500us}Component 7 candidate values:Periodic: {1,2,4,8,16,32,64}Semi-persistent: {0,1,2,4,8,16,32,64}Note: No additional UE requirements shall be specified for the case of Tx hopping with non-overlapping hops compared to the case of Tx hopping with overlapping hops, e.g., a UE is not responsible for keeping phase continuity across the hops in either case of overlapping or non-overlapping hopsNeed for location server to know if the feature is supported | Optional with capability signalling |
| 67-z | UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window | Support of UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window | 67-y | No | N.A. | UE does not support the UL time window for SRS for positioning with Tx frequency hopping | Per band | N.A. | N.A. | N.A. |  | Optional with capability signaling |

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| Huawei/HiSilicon [2] | In Rel-18 RedCap positioning, three FGs were introduced, i.e. FG 41-5-2, FG 41-5-2a and FG 41-5-3. The table related to these FGs is provided below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 41. NR\_pos\_enh2 | 41-5-2 | Support of positioning SRS with Tx frequency hopping in RRC\_CONNECTED for RedCap UEs | 1. Maximum SRS bandwidth across all hops2. Maximum number of hops3. RF Tx retuning time between consecutive hops4. Switching time between active BWP and frequency hop5. Overlapping PRB(s) between adjacent hops6. Support of {0,1,2,4} overlapping PRB(s) between adjacent hops7. Maximum number of positioning SRS resources with Tx frequency hopping | 13-8, one of {28-1,48-1} |
| 41. NR\_pos\_enh2 | 41-5-2a | Support of positioning SRS with Tx frequency hopping in RRC\_INACTIVE for RedCap UEs | 1. Maximum SRS bandwidth across all hops2. Maximum number of hops3. RF Tx retuning time between consecutive hops4. Switching time between active BWP and frequency hop5. Overlapping PRB(s) between adjacent hops6. Support of {0,1,2,4} overlapping PRB(s) between adjacent hops7. Maximum number of positioning SRS resources with Tx frequency hopping | 27-15b, one of {28-1,48-1} |
| 41. NR\_pos\_enh2 | 41-5-3 | UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window | Support of UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window | 41-5-2 |

We believe that the three non-RedCap UEs’ features need to be added to the UE feature list for TEI-19: SRS hopping for positioning in CONNECTED, SRS frequency hopping for positioning in INACTIVE, and UTW.**Proposal 1: Include the following FGs for TEI-19 positioning and endorse the table in Appendix.*** **Feature xx-1**
* **Feature group:** Support of positioning SRS with Tx frequency hopping in RRC\_CONNECTED for non-RedCap UEs.
* **Prerequisite feature groups:** 13-8
* **Feature xx-2**
* **Feature group:** Support of positioning SRS with Tx frequency hopping in RRC\_INACTIVE for non-RedCap UEs.
* **Prerequisite feature groups:** 27-15b
* **Feature xx-3**
* **Feature group:** UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window for non-RedCap UEs.
* **Prerequisite feature groups:** xx-1

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Need for the gNB to know if the feature is supported** | **Applicable to the capability signalling exchange between UEs (Sidelink WI only)”.** | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Capability interpretation for mixture of FDD/TDD and/or FR1/FR2** | **Note** | **Mandatory/Optional** |
| xx | xx-1 | Support of positioning SRS with Tx frequency hopping in RRC\_CONNECTED for non-RedCap UEs | 1. Maximum SRS bandwidth across all hops2. Maximum number of hops3. RF Tx retuning time between consecutive hops4. Switching time between active BWP and frequency hop5. Overlapping PRB(s) between adjacent hops6. Support of {0,1,2,4} overlapping PRB(s) between adjacent hops7. Maximum number of positioning SRS resources with Tx frequency hopping | 13-8 | Yes | n/a | Positioning SRS with Tx hopping in RRC\_CONNECTED is not supported | Per band | n/a | n/a | n/a | Component 1 candidate values:FR1: {40, 50, 80, 100}FR2: {100, 200, 400}Component 2 candidate values: {2,3,4,5,6}Component 3 candidate values:FR1: {70us, 140us, 210us}FR2: {35us, 70us, 140us}Component 4 candidate values:{100us, 140us, 200us, 300us, 500us}Component 7 candidate values:Periodic: {1,2,4,8,16,32,64}Aperiodic: {0,1,2,4,8,16,32,64}Semi-persistent: {0,1,2,4,8,16,32,64}Note: No additional UE requirements shall be specified for the case of Tx hopping with non-overlapping hops compared to the case of Tx hopping with overlapping hops, e.g., a UE is not responsible for keeping phase continuity across the hops in either case of overlapping or non-overlapping hopsNeed for location server to know if the feature is supported | Optional with capability signalling |
| xx | xx-2 | Support of positioning SRS with Tx frequency hopping in RRC\_INACTIVE for non-RedCap UEs | 1. Maximum SRS bandwidth across all hops2. Maximum number of hops3. RF Tx retuning time between consecutive hops4. Switching time between active BWP and frequency hop5. Overlapping PRB(s) between adjacent hops6. Support of {0,1,2,4} overlapping PRB(s) between adjacent hops7. Maximum number of positioning SRS resources with Tx frequency hopping | 27-15b | Yes | n/a | Positioning SRS with Tx hopping in RRC\_INACTIVE is not supported | Per band | n/a | n/a | n/a | Component 1 candidate values:FR1: {40, 50, 80, 100}FR2: {100, 200, 400}Component 2 candidate values: {2,3,4,5,6}Component 3 candidate values:FR1: {70us, 140us, 210us}FR2: {35us, 70us, 140us}Component 4 candidate values:{100us, 140us, 200us, 300us, 500us}Component 7 candidate values:Periodic: {1,2,4,8,16,32,64}Semi-persistent: {0,1,2,4,8,16,32,64}Note: No additional UE requirements shall be specified for the case of Tx hopping with non-overlapping hops compared to the case of Tx hopping with overlapping hops, e.g., a UE is not responsible for keeping phase continuity across the hops in either case of overlapping or non-overlapping hopsNeed for location server to know if the feature is supported | Optional with capability signalling |
| xx | xx-3 | UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window for non-RedCap UEs | Support of UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window | xx-1 | No | n/a | UE does not support the UL time window for SRS for positioning with Tx frequency hopping | Per band | N.A. | N.A. | N.A. |  | Optional with capability signaling |

 |
| Apple [3] |  |
| Qualcomm Incorporated [4] |  |

## 32 HARQ processes for TN in FR1 and FR2-1

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| --- | --- |
| Company | Summary |
| ZTE Corporation/Sanechips [1] | For TEI on ‘32 HARQ processes for TN in FR1 and FR2-1’, the following agreements were reached.

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| --- |
| AgreementSupport a maximum of 32 HARQ process numbers for TN in FR1 and FR2-1 in Rel-19.* Introduce new UE capabilities, by duplicating the Rel-17 UE FGs 24-8/24-9 defined for FR2-2 to FR1 and FR2-1.
	+ The reporting granularity of the UE capabilities is changed to ‘per FSPC’.
* Introduce new RRC parameters, harq-ProcessNumberSizeDCI-0-1-Ext-r19, harq-ProcessNumberSizeDCI-1-1-Ext-r19, harq-ProcessNumberSizeDCI-0-2-Ext-r19, harq-ProcessNumberSizeDCI-1-2-Ext-r19, harq-ProcessNumberSizeDCI-0-3-Ext-r19, harq-ProcessNumberSizeDCI-1-3-Ext-r19.
* For FR1, the above downlink related parameters can only be configured when the maximum number of layers configured for PDSCH is up to 4.
* For FR1, the above uplink related parameters can only be configured when the maximum number of layers configured for PUSCH is up to 4.

Agreement * For up to 32 HARQ process numbers for TN in FR1 and FR2-1,
	+ The value ranges of the new RRC parameters are defined as follows
		- harq-ProcessNumberSizeDCI-0-1-Ext-r19 with value range of ‘INTEGER (5)’,
		- harq-ProcessNumberSizeDCI-1-1-Ext-r19 with value range of ‘INTEGER (5)’,
		- harq-ProcessNumberSizeDCI-0-2-Ext-r19 with value range of ‘INTEGER (0..5)’,
		- harq-ProcessNumberSizeDCI-1-2-Ext-r19 with value range of ‘INTEGER (0..5)’,
		- harq-ProcessNumberSizeDCI-0-3-Ext-r19 with value range of ‘INTEGER (0..5)’,
		- harq-ProcessNumberSizeDCI-1-3-Ext-r19 with value range of ‘INTEGER (0..5)’.
 |

Based on the agreement, duplication of Rel-17 UE FGs 24-8/24-9 defined for FR2-2 to FR1 and FR2-1 is adopted with changing the reporting granularity to ‘per FSPC’.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 24-8 | 32 DL HARQ processes for FR 2-2 | Support 32 HARQ processes in DL for 120/480/960 kHz | 24-1 | Yes | N/A | 32 DL HARQ processes for FR 2-2 is not supported | Per band | N/A | N/A | N/A | A UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL in FR2-2 | Optional with capability signalling |
| 24-9 | 32 UL HARQ processes for FR 2-2 | Support 32 HARQ processes in UL for 120/480/960 kHz | 24-1 | Yes | N/A | 32 UL HARQ processes for FR 2-2 is not supported | Per band | N/A | N/A | N/A | A UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for UL shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for UL in FR2-2 | Optional with capability signalling |

With above, we propose the following FGs for the TEI. **Proposal 1: Support the following FGs for TEI on 32 HARQ process numbers for TN in FR1 and FR2-1.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 67-x | 32 DL HARQ processes for TN in FR1 and FR2-1 | Support 32 HARQ processes in DL for TN in FR1 and FR2-1 |  | Yes | N/A | 32 DL HARQ processes for TN in FR1 and FR2-1 is not supported | Per FSPC | N/A | N/A | N/A | For FR1, the maximum number of layers configured for PDSCH is up to 4 | Optional with capability signalling |
| 67-y | 32 UL HARQ processes for TN in FR1 and FR2-1 | Support 32 HARQ processes in UL for TN in FR1 and FR2-1  |  | Yes | N/A | 32 UL HARQ processes for TN in FR1 and FR2-1 is not supported | Per FSPC | N/A | N/A | N/A | For FR1, the maximum number of layers configured for PUSCH is up to 4 | Optional with capability signalling |

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| Huawei/HiSilicon [2] |  |
| Apple [3] |  |
| Qualcomm Incorporated [4] |  |

# Discussion Items during RAN1 #120bis

After review of contributions submitted to RAN1 #120bis in this agenda item, the following topics were identified by the moderator for discussion during RAN1 #120bis.

**General comments**

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| Company | Comments/Questions/Suggestions |
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## Two simultaneous SRS carrier switching

After review of contributions submitted to RAN1 #120bis in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following Rel. 19 UE FGs (yellow highlighting, if any, shows text that’s not yet agreed)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 67. TEI19 | 67-1 | Determination method of switching time for UEs configured with both UL Tx switching and SRS carrier switching | Support of determination method of switching time for UEs configured with UL Tx switching at least on UL carrier 1 and carrier 2 and configured with SRS carrier switching on UL carrier 3 in a case where an SRS carrier switching is triggered for SRS transmission on UL carrier 3 and the UE is currently in a UE state that if any UL transmission with the maximum number of supported UL-MIMO ports would be transmitted on the UL carrier 2 configured as source carrier for the SRS carrier switching, an UL Tx switching would have been triggered according to sub-clause 6.1.6 of TS 38.214. | RAN1 FG 2-56 and RAN4 FG 7-1 | Yes | n/a | Simultaneous SRS CS across multiple CC is not supported | Per band combination | n/a | n/a | n/a | Component 1 candidate values: {maximum, sum}Note: value “maximum” means that the switching time is determined as the maximum value among {A, B} while value “sum” means the sum between A and B where B is SRS-SwitchingTimeNR as reported by the UE and A is the maximum value of uplinkTxSwitchingPeriod across the set of UL carriers involved with the hypothetically triggered UL Tx switching in the aforementioned UE state (as in S6.1.6 of TS 38.214) and the source carrier for SRS carrier switching.Note: if the capability is not reported, value “maximum” is the default value. | Optional with capability signaling |

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| Company | Comments/Questions/Suggestions |
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## SR triggered SSSG switching

After review of contributions submitted to RAN1 #120bis in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following Rel. 19 UE FGs (yellow highlighting, if any, shows text that’s not yet agreed)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 67. TEI19 | 67-2 | Fallback to a SSSG with designated index after a PUCCH carrying an SR is transmitted | Support of start PDCCH monitoring according to search space sets with a designated group index and stops PDCCH monitoring according to search space sets with a group index other than the designated SSSG index from the first slot that is at least $P\_{switch}$ symbols after the last symbol of a PUCCH carrying an SR, if the UE is instructed to monitor PDCCH according to search space sets with the SSSG index other than the designated SSSG index before the transmission of PUCCH carrying the SR. | one of {29-3b, 29-3c, 29-3d, 29-3e} | Yes | n/a | SR-triggered SSSG switching is not supported | Per band | n/a | n/a | n/a | Note: $P\_{switch}$ symbols is specified in Table 10.4-1 of TS 38.213 | Optional with capability signaling |

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| Company | Comments/Questions/Suggestions |
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## SRS carrier switching and UL Tx switching

After review of contributions submitted to RAN1 #120bis in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following Rel. 19 UE FGs (yellow highlighting, if any, shows text that’s not yet agreed)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 67. TEI19 | 67-3 | Reporting inter-cell switching time when source is sharing Tx chain | Support of SRSCSTimewithTxSwitchingList |  | Yes | n/a | Reporting inter-cell switching time when source is sharing Tx chain is not suppproted  | Per BC | n/a | n/a | n/a | Indicates a list of SRSCSTimewithTxSwitching, for each pair of NR “source-target” bands in the band combination. The UE shall include the same number of entries, and listed in the same order as in srs-SwitchingTimesListNR. For a particular “source-target” pair (as indicated by srs-SwitchingTimesListNR), if more than one UL bands share Tx chain with the source (as indicated by supportedBandPairListNR-r16), the reported value is applied to all those UL bands (e.g. UE reports based on largest switching time among all possible triples for the particular “source-target” pair). A UE reporting this list, shall also report both supportedBandPairListNR-r16 and srs-SwitchingTimesListNR. For a particular “source-target” pair, the report entry is optional, and if not reported by UE, max(uplinkTxSwitchingPeriod-r16, SRS-SwitchingTimeNR) is assumed for the configured triple is assumed. | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
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## Frequency hopping enhancement for positioning

After review of contributions submitted to RAN1 #120bis in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following Rel. 19 UE FGs (yellow highlighting, if any, shows text that’s not yet agreed)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 67. TEI19 | 67-4 | Support of positioning SRS with Tx frequency hopping in RRC\_CONNECTED for non-RedCap UEs | 1. Maximum SRS bandwidth across all hops2. Maximum number of hops3. RF Tx retuning time between consecutive hops4. Switching time between active BWP and frequency hop5. Overlapping PRB(s) between adjacent hops6. Support of {0,1,2,4} overlapping PRB(s) between adjacent hops7. Maximum number of positioning SRS resources with Tx frequency hopping | 13-8 | Yes | n/a | Positioning SRS with Tx hopping in RRC\_CONNECTED is not supported | Per band | n/a | n/a | n/a | Component 1 candidate values:FR1: {40, 50, 80, 100}FR2: {100, 200, 400}Component 2 candidate values: {2,3,4,5,6}Component 3 candidate values:FR1: {0us, 70us, 140us, 210us}FR2: {0us, 35us, 70us, 140us}Component 4 candidate values:{0us, 100us, 140us, 200us, 300us, 500us}Component 7 candidate values:Periodic: {1,2,4,8,16,32,64}Aperiodic: {0,1,2,4,8,16,32,64}Semi-persistent: {0,1,2,4,8,16,32,64}Note: No additional UE requirements shall be specified for the case of Tx hopping with non-overlapping hops compared to the case of Tx hopping with overlapping hops, e.g., a UE is not responsible for keeping phase continuity across the hops in either case of overlapping or non-overlapping hopsNeed for location server to know if the feature is supported | Optional with capability signalling |
| 67. TEI19 | 67-5 | Support of positioning SRS with Tx frequency hopping in RRC\_INACTIVE for non-RedCap UEs | 1. Maximum SRS bandwidth across all hops2. Maximum number of hops3. RF Tx retuning time between consecutive hops4. Switching time between active BWP and frequency hop5. Overlapping PRB(s) between adjacent hops6. Support of {0,1,2,4} overlapping PRB(s) between adjacent hops7. Maximum number of positioning SRS resources with Tx frequency hopping | 27-15b | Yes | n/a | Positioning SRS with Tx hopping in RRC\_INACTIVE is not supported | Per band | n/a | n/a | n/a | Component 1 candidate values:FR1: {40, 50, 80, 100}FR2: {100, 200, 400}Component 2 candidate values: {2,3,4,5,6}Component 3 candidate values:FR1: {0us, 70us, 140us, 210us}FR2: {0us, 35us, 70us, 140us}Component 4 candidate values:{0us, 100us, 140us, 200us, 300us, 500us}Component 7 candidate values:Periodic: {1,2,4,8,16,32,64}Semi-persistent: {0,1,2,4,8,16,32,64}Note: No additional UE requirements shall be specified for the case of Tx hopping with non-overlapping hops compared to the case of Tx hopping with overlapping hops, e.g., a UE is not responsible for keeping phase continuity across the hops in either case of overlapping or non-overlapping hopsNeed for location server to know if the feature is supported | Optional with capability signalling |
| 67. TEI19 | 67-6 | UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window for non-RedCap UEs | Support of UL Time Window and transmission of SRS for positioning with Tx Frequency hopping within the window | 67-5 | No | N.A. | UE does not support the UL time window for SRS for positioning with Tx frequency hopping | Per band | N.A. | N.A. | N.A. |  | Optional with capability signaling |

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| Company | Comments/Questions/Suggestions |
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## 32 HARQ processes for TN in FR1 and FR2-1

After review of contributions submitted to RAN1 #120bis in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following Rel. 19 UE FGs (yellow highlighting, if any, shows text that’s not yet agreed)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 67. TEI19 | 67-7 | 32 DL HARQ processes for TN in FR1 and FR2-1 | Support 32 HARQ processes in DL for TN in FR1 and FR2-1 |  | Yes | N/A | 32 DL HARQ processes for TN in FR1 and FR2-1 is not supported | Per FSPC | N/A | N/A | N/A | For FR1, the maximum number of layers configured for PDSCH is up to 4 | Optional with capability signalling |
| 67. TEI19 | 67-8 | 32 UL HARQ processes for TN in FR1 and FR2-1 | Support 32 HARQ processes in UL for TN in FR1 and FR2-1  |  | Yes | N/A | 32 UL HARQ processes for TN in FR1 and FR2-1 is not supported | Per FSPC | N/A | N/A | N/A | For FR1, the maximum number of layers configured for PUSCH is up to 4 | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
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# Conclusion

Agreements reached during RAN1 #120bis as part of this agenda item are summarized in [ ].

# References

1. R1-2501916, Discussion on UE features for Rel-19 TEIs, ZTE Corporation/Sanechips
2. R1-2502253, UE features for TEI-19 features, Huawei/HiSilicon
3. R1-2502649, UE features for Rel-19 TEI SRSCS\_ULTxSwitch, Apple
4. R1-2502875, UE features for Rel-19 TEI, Qualcomm Incorporated