**3GPP TSG-RAN WG4 Meeting #95-e R4-200xxxx**

**Electronic Meeting, 25 May - 5 June, 2020**

**Agenda item:** 6.13.1.5

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for [95e][119] NR\_RF\_FR1\_Part\_2

**Document for:** Information

# Introduction

This email thread discusses the RF requirements for Tx switching between two uplink carriers in agenda 6.13.1.5.

List of candidate target of email discussion for 1st round and 2nd round:

* 1st round: Invite companies to review the recommended WF in each sub-topic, and provide comments (if any) in section 1.3 and 2.3.
* 2nd round:

# Topic #1: CRs

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2006032 | China Telecom | Proposal 1: For UL-MIMO, capture the following sentence as normative text in 38.101-1 and 38.101-3* The UE indicating support of UL Tx switching shall be able to transmit both two-layer and single-layer PUSCH transmissions on carrier 2.

Proposal 2: No clarification on power class in time mask requirements for Tx switching.Observation 1: The current CR structure and text in R4-2006033/4 could already be able to ensure that UE could be able to transmit simultaneously single-layer single port on both of the UL carriers. |
| R4-2006033 | China Telecom, ZTE, CMCC, China Unicom, KDDI | CR to TS 38.101-1: Switching time mask between two uplink carriers in UL CA and SUL |
| R4-2006034 | China Telecom, ZTE, CMCC, China Unicom, KDDI | CR to TS 38.101-3: Switching time mask between two uplink carriers in EN-DC |
| R4-2006290 | CATT | CR to TS 38.101-1: Requirements for supporting Tx switching between two uplink carriers in UL CA and SUL |
| R4-2006291 | CATT | CR to TS 38.101-3: Requirements for supporting Tx switching between two uplink carriers in EN-DC |
| R4-2006364 | Apple Inc. | Proposal 1: IF RAN4 does not agree to introduce relaxed MPR requirements for transparent tx diversity and UL MIMO, then there is no ambiguity about the UE’s power class capabilities in the context of the Case 1 / Case 2 switching.Proposal 2: IF RAN4 does agree to introduce relaxed MPR requirements for transparent tx diversity and/or UL MIMO, but does not agree to introduce any related signaling which the UE can use to inform the network which requirement is applicable, then there can be ambiguity about the UE’s power class capabilities in the context of the Case 1 / Case 2 switching.Proposal 3: IF RAN4 does agree to introduce relaxed MPR requirements for transparent tx diversity and/or UL MIMO, and also the related signaling, then there is no ambiguity about the UE’s power class capabilities in the context of the Case 1 / Case 2 switching.Proposal 4: Transparent tx diversity is not assumed in case 1 for UL tx switching. |
| R4-2006513 | Nokia, Nokia Shanghai Bell | Proposal 4: Agree that with UL Tx switching the UE shall meet all the UE maximum power requirements of the indicated UE power class for all of its transmissions including single layer transmission with 1 Tx port and two-layer transmission with 2-port Proposal 5: Define clearly in the UE requirements that also with UL Tx switching the UE shall meet all the UE maximum power requirements of the indicated UE power class for all of its transmissions. Observation 1: RAN1 has not yet agreed EN-DC functionality in TS38.214. |
| R4-2006514 | Nokia, Nokia Shanghai Bell | CR to TS 38.101-1: Time mask requirements for switching between 1Tx and 2Tx transmissions for inter-band UL CA and SUL case |
| R4-2006515 | Nokia, Nokia Shanghai Bell | CR to TS 38.101-3: Time mask requirements for switching between 1Tx and 2Tx transmissions for inter-band EN-DC without SUL |
| R4-2006804 | CMCC | Proposal 1: It is proposed to capture the following text in the spec:The UE indicating support for the switching between single-layer transmission with one antenna connector and two-layer transmission with two antenna connectors on two uplink carriers configured in different NR bands shall be able to transmit both two-layer and single-layer transmissions on the uplink carrier 2.Proposal 2: It is proposed to capture the following text in the spec:Power class declaration for the uplink transmission switching follows the general definition of power class, and is not changed due to the dynamic switching between the two uplink carriers. |
| R4-2006943 | Huawei, HiSilicon | Observation 1: No need to clarify in terms of power classes for UE switching between UL carriers in the RAN4 spec.Observation 2: It is network’s liberty to configure either single-port or two-port SRS and corresponding PUSCH scheduling on carrier 2 under case 2 of UE switching between UL carriers. |
| R4-2006944 (Not available) | Huawei, HiSilicon | Clarification on 2Tx carrier for UE switching between 1Tx carrier and 2Tx carrier  |
| R4-2006945 | Huawei, HiSilicon | CR to 38101-1 on switching between 1Tx carrier and 2Tx carrier |
| R4-2006946 | Huawei, HiSilicon | CR to 38101-3 on switching between 1Tx carrier and 2Tx carrier |
| R4-2007080 | OPPO | Observation 1: In EN-DC and CA, UE will report one power class for total capability and no separate power class for each branch.Observation 2: The previous agreement “Power class declaration will NOT be changed between case 1 and case 2” still cannot solve the max power ambiguity between case 1 and case 2, since anyway after UE power class is reported there is no way for UE to change the power class declaration.Observation 3: Specify this unclear WF “Power class declaration will NOT be changed between case 1 and case 2” in spec is meaningless.Observation 4: It is possible for UE (e.g. case1 23+26 and case2 26+26) to transmit much higher power in one case than the other.Proposal 1: To make progress and solve the ambiguity in UE design, it is proposed to make common understanding that the max power UE can transmit in case 1 and case 2 shall be same in CA and EN-DC scenario. |

## Remaining issues on CR text

### Issue 1-1: Condition of the presence of the switching period

***Related information from RAN1:***

* *LS from RAN1 in R4-2006129 (R1-2003072)*
	+ *for uplink Tx switching, in RAN1 #100b-e, the following agreements on inter-band UL CA have been reached:*
		- *For inter-band UL CA, if UE reports via capability signaling to support uplink Tx switching, UE further reports via capability signaling which option (between Option 1 and Option 2) is supported.*

*Option 1: If uplink Tx switching is configured, UE is not expected to be scheduled or configured with UL transmission on carrier 2 for case 1.*

|  |  |  |
| --- | --- | --- |
|  | *Number of* ***Tx chains*** *in WID (carrier 1 + carrier 2)* | *Number of* ***antenna ports*** *for UL transmission (carrier 1 + carrier 2)* |
| *Case 1* | *1T+1T* | *1P+0P* |
| *Case 2* | *0T+2T* | *0P+2P, 0P+1P*  |

*Option 2: If uplink Tx switching is configured, UE can be scheduled or configured with UL transmission on both carrier 1 and carrier 2 for case 1.*

*o    UE can be scheduled or configured with UL transmission on either carrier 1 or carrier 2.*

*o    UE can be scheduled or configured with UL transmission on both carrier 1 and carrier 2 simultaneously.*

|  |  |  |
| --- | --- | --- |
|  | *Number of* ***Tx chains*** *in WID (carrier 1 + carrier 2)* | *Number of* ***antenna ports*** *for UL transmission (carrier 1 + carrier 2)* |
| *Case 1* | *1T+1T* | *1P+0P, 1P+1P, 0P+1P* |
| *Case 2* | *0T+2T* | *0P+2P, 0P+1P* |

* *RAN1 endorsed CR for Tx switching (*[*R1-2003148*](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2003148.zip)*)*
	+ *In the CR,* ***the conditions under which the switching gap may be present*** *are defined for each of the cases ([EN-DC], Carrier Aggregation, Supplementary Uplink).*
		- *Note that for EN-DC, the condition of the presence of the switching gap is still under discussion in RAN1, and will be captured in TS 38.214 after RAN1 agreement is reached.*

***Observations from the RAN1 agreement and CR:***

* *For UL CA and SUL, both 1-port and 2-port transmissions can be scheduled or configured on carrier 2 of case 2, where the 1-port transmission includes 1-port PUSCH, PUCCH and PRACH. For EN-DC, related discussion is still on-going in RAN1.*
* *The conditions under which the switching gap may be present are specified in RAN1 spec TS 38.214. RAN4 only needs to specify the UE core requirements under the conditions specified in RAN1 spec.*

***RAN4 proposals on how to capture the conditions of uplink switching (take UL CA for example):***

* Option 1 (China Telecom)
	+ The switching time mask … is only applicable when uplink transmission is switched between NR UL carrier 1 capable of one transmit antenna connector and NR UL carrier 2 capable of two transmit antenna connectors, where the two uplink carriers are in different bands with different carrier frequencies.
* Option 2 (CATT)
	+ the time mask… is only applicable when Tx chain is switched between NR UL carrier 1 with one transmit antenna connector and NR UL carrier 2 with two transmit antenna connectors.
* Option 3 (Nokia)
	+ the time mask requirements in this clause apply for the UE indicating support for the switching between single-layer transmission with one antenna port and two-layer transmission with two antenna ports on two uplink carriers configured in different NR bands.
* Option 4 (Huawei)
	+ The switching time mask… is only applicable when uplink transmission is switched between NR UL carrier 1 on which the UE is capable of using one transmit antenna connector and NR UL carrier 2 on which the UE is capable of using two transmit antenna connectors, where the two uplink carriers are in different bands with different carrier frequencies in FR1.
* **Summary of different options**
	+ The main differences of different options above are marked in red, and the key point is to use the wording “antenna connector” or “antenna port”.

***Moderator’s recommendation:***

* Based on the observations from the RAN1 agreement, RAN1 CR as well as the RAN4 proposals, the recommended WF is given below (take UL CA for example):
	+ Use option 1 for RAN4 CR:
		- The switching time mask … is only applicable when uplink transmission is switched between NR UL carrier 1 capable of one transmit antenna connector and NR UL carrier 2 capable of two transmit antenna connectors, where the two uplink carriers are in different bands with different carrier frequencies.
	+ Meanwhile, send LS to RAN5: RAN4 recommend that in RAN5 conformance test, UL carrier 1 is configured with 1 antenna port, and UL carrier 2 is configured with 2 antenna ports.

### Issue 1-2: UL-MIMO on carrier 2

***Agreement in RAN4 #94e (R4-2002815):***

* *Rank adaptation*
	+ *Capture the following RAN4 #93 agreement as normative text in 38.101-1 and 38.101-3*
		- *For UE supporting UL Tx switching, it is mandated to support 2-layer UL-MIMO transmission and single-layer transmission on carrier 2 following the BS scheduling and rank adaptation (if rank adaptation is applicable).*

***Proposals***

* Option 1 (Nokia):
	+ The UE indicating support for the switching between single-layer transmission with one antenna port and two-layer transmission with two antenna ports on two uplink carriers configured in different NR bands shall be able to transmit both two-layer and single-layer transmissions on the uplink carrier with two-layer transmission.
* Option 2: Difference compared to option 1 are marked, just to simplify the sentence in proposal 1 (China Telecom)
	+ The UE indicating support of UL Tx switching shall be able to transmit both two-layer and single-layer PUSCH transmissions on carrier 2.
* Option 3: Difference compared to option 1 are marked (CMCC)
	+ The UE indicating support for the switching between single-layer transmission with one antenna connector and two-layer transmission with two antenna connectors on two uplink carriers configured in different NR bands shall be able to transmit both two-layer and single-layer transmissions on the uplink carrier 2.
* Option 4 (Huawei)
	+ For UE supporting uplink Tx switching, it is scheduled both 2-layer and single-layer PUSCH transmissions on carrier 2.

***Moderator’s recommendation:***

* Considering the issue of using antenna connector or antenna port is discussed in issue 1-1, is it agreeable to use the simplified sentence in Option 2?
* Recommended WF
	+ Capture the following as normative text in 38.101-1 and 38.101-3 (option 2):
		- The UE indicating support of UL Tx switching shall be able to transmit both two-layer and single-layer PUSCH transmissions on carrier 2.

### Issue 1-3: UE requirement for simultaneous transmission on both UL carriers for UL-CA and EN-DC

***Issue:***

* For UL-CA and EN-DC, how to ensure that UE is able to simultaneously transmit on both of the UL carriers?

***Proposals (take UL CA as example):***

* Option 1 (China Telecom, CATT):
	+ The switching time mask requirement for UL inter-band CA is part of the requirement for inter-band CA, so it should go under section 6.3A.3.3, as shown below (the proposal was originally from QC in RAN4 94e-bis):
		- Section 6.6A.3.3.1 specifies the general requirement for inter-band UL CA
		- Section 6.3A.3.3.2 specifies the switching time mask requirement which is applicable to UE declaring the support of UL Tx switching.

*---------------------- 38.101-1 CR for UL CA (submitted in R4-2006033) ----------------------*

*6.3A.3.3 Transmit ON/OFF time mask for inter-band CA*

*6.6A.3.3.1 General*

*For inter-band carrier aggregation with uplink assigned to two NR bands, the general output power ON/OFF time mask specified in clause 6.3.3.1 is applicable for each component carrier during the ON power period and the transient periods. The OFF period as specified in clause 6.3.3.1 shall only be applicable for each component carrier when all the component carriers are OFF.*

*6.3A.3.3.2 Time mask for switching between two uplink carriers*

*The switching time mask specified in this sub-clause is applicable for an uplink band pair of a inter-band UL CA configuration when the field of capability uplinkTxSwitchingPeriod is present,……*

*---------------------- 38.101-1 CR for UL CA (submitted in R4-2006033) ----------------------*

* Option 2 (CATT, Nokia):
	+ State at the beginning of the time mask requirements that the general requirements shall also be applied:
		- In addition to the requirements in 6.6A.3.3.1, the time mask specified in this sub-clause is applicable for UE

***Moderator’s recommendation:***

* Implement both option 1 and option 2 in the CR
* Recommended CR structure and text (take UL CA as example)

*6.3A.3.3 Transmit ON/OFF time mask for inter-band CA*

*6.6A.3.3.1 General*

*For inter-band carrier aggregation with uplink assigned to two NR bands, the general output power ON/OFF time mask specified in clause 6.3.3.1 is applicable for each component carrier during the ON power period and the transient periods. The OFF period as specified in clause 6.3.3.1 shall only be applicable for each component carrier when all the component carriers are OFF.*

*6.3A.3.3.2 Time mask for switching between two uplink carriers*

*In addition to the requirements in 6.6A.3.3.1, the switching time mask specified in this sub-clause is applicable for an uplink band pair of a inter-band UL CA configuration when the field of capability uplinkTxSwitchingPeriod is present,……*

### Issue 1-4: Additional requirements for CA option 2

***Proposals:***

* Option 1 (Nokia):
	+ Specify the following additional requirements for CA option 2
		- If the UE supports [uplinkTxSwitchingOption2], the UE shall be able to transmit simultaneously single-layer transmission with one antenna port on both of the two uplink carriers configured in different NR bands without any switching period or transient period.
* Option 2 (China Telecom, CATT, Huawei):
	+ This is the general UE requirements for inter-band UL CA as discussed in issue 1-3. No need to define additional UE requirements.

***Moderator’s recommendation:***

* Recommended WF
	+ Is option 2 agreeable?

### Issue 1-5: Clarification on power class

***Agreement in RAN4 #94e (R4-2002815):***

* *Capture the following RAN4 #93 agreement on power class clarification in 38.101-1 and 38.101-3*
	+ *Power class declaration will NOT be changed between case 1 and case 2.*
	+ *Rel-16 power class singaling will be followed for Tx switching between case 1 and case 2.*
* *Further discuss how to capture the above clarification*

***Proposals:***

* Option 1: No clarification on power class in time mask requirements for Tx switching (China Telecom, CATT, Nokia, Huawei)
	+ Nokia: This can either be done as part of the new time mask requirements for UL switching or alternatively also as part of the UE power class related requirements.
* Option 2: Add clarification in time mask requirements for Tx switching (Nokia, CMCC, OPPO)
	+ Option 2a (Nokia):
		- Agree that with UL Tx switching the UE shall meet all the UE maximum power requirements of the indicated UE power class for all of its transmissions including single layer transmission with 1 Tx port and two-layer transmission with 2-port
		- Define clearly in the UE requirements that also with UL Tx switching the UE shall meet all the UE maximum power requirements of the indicated UE power class for all of its transmissions.
	+ Option 2b (CMCC):
		- Power class declaration for the uplink transmission switching follows the general definition of power class, and is not changed due to the dynamic switching between the two uplink carriers.
	+ Option 2c (OPPO):
		- To make progress and solve the ambiguity in UE design, it is proposed to make common understanding that the max power UE can transmit in case1 and case2 shall be same in CA and EN-DC scenario.
* Option 3 (Apple)
	+ Proposal: Transparent tx diversity is not assumed in case 1 for UL tx switching.

***Moderator’s recommendation:***

* Recommended WF
	+ No clarification on power class in time mask requirements for Tx switching
	+ Discussion can be continued as general discussion for UE power class. If any agreement achieved, to be captured in UE power class related requirements.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | Issue 1-1: Condition of the presence of the switching periodIssue 1-2: UL-MIMO on carrier 2Issue 1-3: UE requirement for simultaneous transmission on both UL carriers for UL-CA and EN-DC Issue 1-4: Additional requirements for CA option 2Issue 1-5: Clarification on power class |
| Company B | Issue 1-1: Condition of the presence of the switching periodIssue 1-2: UL-MIMO on carrier 2Issue 1-3: UE requirement for simultaneous transmission on both UL carriers for UL-CA and EN-DC Issue 1-4: Additional requirements for CA option 2Issue 1-5: Clarification on power class |
|  |  |
|  |  |
|  |  |

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR tdoc number** | **Comments collection** |
| R4-2006033, China Telecom, ZTE, CMCC, China Unicom, KDDI | Company A |
| Company B |
|  |
| R4-2006034, China Telecom, ZTE, CMCC, China Unicom, KDDI | Company A |
| Company B |
|  |
| R4-2006290, CATT | Company A |
| Company B |
|  |
| R4-2006291, CATT | Company A |
| Company B |
|  |
| R4-2006514, Nokia, Nokia Shanghai Bell | Company A |
| Company B |
|  |
| R4-2006515, Nokia, Nokia Shanghai Bell | Company A |
| Company B |
|  |
| R4-2006945, Huawei, HiSilicon | Company A |
| Company B |
|  |
| R4-2006946, Huawei, HiSilicon | Company A |
| Company B |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Topic #2** | *Tentative agreements:* *Candidate options:* *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
|  |  |
|  |  |

## Discussion on 2nd round

## Summary on 2nd round

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
|  |  |

# Topic #2: Applicability on DL interruption

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2006513 | Nokia, Nokia Shanghai Bell | Proposal 1: RAN4 to specify that DL interruptions due to UL Tx switching are not allowed for any EN-DC band combinations.Proposal 2: DL interruptions are only allowed for band combinations where it is difficult to avoid DL interruptions in practical UE implementations. Proposal 3: Specify in TS38.133 for which band combinations DL interruptions are allowed. |

## Open issues summary

### Issue 2-1: Applicability on DL interruption for different band combinations

***Agreement in RAN4 #94e-bis (R4-2005664, WF in RF session):***

* *Define different capabilities for UEs with and without DL interruption*
	+ *Whether to allow DL interruption for each band combination can be discussed later after the signaling for DL interruption is defined.*
* *At the same time, RAN4 recognizes that DL interruption causes significant negative system impacts especially on LTE carriers in EN-DC scenarios [R4-2005101]*
	+ *Companies can provide more results in May*

***Proposals:***

* Proposals for EN-DC:
	+ Option 1: DL interruptions due to UL Tx switching are not allowed for any EN-DC band combinations. (Nokia)
* Proposals for FDD+TDD CA:
	+ Option 1: DL interruptions are only allowed for band combinations where it is difficult to avoid DL interruptions in practical UE implementations. (Nokia)

***Moderator’s recommendation:***

* Recommended WF
	+ TBA based on the feedback from more companies

### Issue 2-2: Capture of the applicability on DL interruption

***Agreement in RAN4 #94e-bis (R4-2005416, WF in RRM session):***

* *If the DL interruptions are allowed and the DL interruption applicability is agreed to be captured in RF specification, RRM can directly refer to RF spec. Otherwise, the DL interruption applicability is captured in RRM spec.*

***Proposals:***

* Option 1: Specify in RRM spec for which band combinations DL interruptions are allowed. (Nokia)

***Moderator’s recommendation:***

* Recommended WF
	+ TBA based on the feedback from companies

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | Issue 2-1: Applicability on DL interruption for different band combinationsIssue 2-2: Capture of the applicability on DL interruption |
| Company B | Issue 2-1: Applicability on DL interruption for different band combinationsIssue 2-2: Capture of the applicability on DL interruption |
|  |  |
|  |  |
|  |  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Topic#1** | *Tentative agreements:* *Candidate options:**Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
|  |  |