**3GPP TSG-RAN** **WG2 Meeting #111-e R2-200xxxx**

**Electronic, 17th – 28th August 2020**

**Agenda Item: 6.1.2**

**Source: China Telecom**

**Title: Summary of offline 019 UE cap UL TX switching**

**Document for: Discussion and decision**

# Introduction

This document summarizes the following offline discussion.

* [AT111-e][019][NR16] UE cap UL TX switching (China Telecom)

Scope: Treat R2-2006985, 7604, 7949, 7085, 8106, 7086, 7950, 7087, 6895, 6896

Deadlines: Short UE Caps

This offline discussion includes contributions [1]-[10] which were moved from 6.15.

Rapporteur suggests to divide to discussion into two phases:

Phase I: solution selection, Deadline 2020-08-19 19:00 UTC

Phase II: CR/LS details, Deadline 2020-08-21 07:00 UTC

# Discussion

## Remaining issues for UE capability report

In RAN2#110e meeting, the following agreement on UE capability reporting was achieved,

* In the new BC list, the UE reports a mixed UE capability which exceeds its total Tx number, e.g., 1Tx on carrier 1 and 2 Tx on carrier 2 and relies on NW side to figure out 1Tx+2Tx can only be used in a TDM manner.

The remaining issue whether report 1T+1T capability in new BC list for option2 was discussed in [1][2][3][4].

**Issue 1: whether report 1T+1T capability in new BC list for option2.**

[2] thought there is no particular use of advertising 1Tx+1Tx or 0Tx+2Tx in *BandCombination-UplinkTxSwitch-r16* and proposed that

* The band combinations where UL Tx switching is supported can only contain two UL carriers, where 1Tx is advertised on one of the carriers and 2Tx is advertised in the other carrier.

[3] had an observation that whether to report 1T+1T in addition to agreed 1T+2T UE capability is the specific issue for inter-band CA/EN-DC option2 and proposed that

* RAN2 to confirm apart from the agreed 1T+2T UE capability there is no need to report 1T+1T UE capability in new BC list specific for inter-band CA/EN-DC option2.

[4] thought it is unclear whether some capabilities would make a difference when carrier 2 switches to 1Tx, and proposed that

* Send a LS to RAN1/RAN4 for ask in Option 2 for carrier 2, whether 1Tx UE capability can be derived from 2Tx UE capability.

Therefore, there are two potential solutions for this issue:

* **Solution 1-a: no need to report 1T+1T UE capability in new BC list specific for option2 [2][3].**
* **Solution 1-b: send a LS to RAN1/RAN4 for ask in Option 2 for carrier 2, whether 1Tx UE capability can be derived from 2Tx UE capability [4].**

Please note the deadline for the solution selection, i.e., Question 1, is 2020-08-19 19:00 UTC. IF Solution 1-b is preferred, we would discuss the LS details then and the LS discussion deadline will be 2020-08-21 07:00 UTC. [6] provided a draft LS.

**Question 1: do companies prefer Solution 1-a or Solution 1-b? Any comments?**

|  |  |  |
| --- | --- | --- |
| Company | Solution 1-a/ Solution 1-b/  other | Comments if there is any |
| Ericsson | Other | We do not think the new BC list is necessary and it is obvious that it creates new problems (e.g. fallback issues).  A UE supporting option 2 shall indicate the corresponding band combinations in the legacy list, since this is what a legacy gNB can use (UL CA with 1 layer on each carrier). We see no need to convey the same information in a new band combination list. |
| OPPO | 1-b | So the problem is whether RAN2 can ensure in option-2 for carrier-2, the reported 2-Tx capability can be used to derive the 1-Tx capability (here the 1-Tx is for the capability of carrier-2 when UL-switching is configured, and even NW would check the old BC-list to find the 1-Tx capability, it is not sure whether the 1-TX capability in old BC list for TX-switching not being configured is the same as the 1-TX capability for TX-switching being configured).  We believe it is out of the scope of RAN2, so that a LS to RAN1/4 is a safer way to solve this. |
| Huawei | Prefer 1-a, but can accept 1-b | Based on previous agreement that UE will anyway report 1T@carrier1+2T@carrier2 UE capabilities in new BC list, we think it is possible to derive 1T @carrier2 UE capability for Option-2. **Note that there is not much ambiguity of 1T capability, so we think it is possible to derive 1T cap from 2T cap, but NOT the case to derive 2T cap form 1T cap.**  But we also understand the concerns raised by companies, so we are also ok to send LS to RAN4/RAN1 for further issue checking. |
| Qualcomm Incorporated (Masato) | 1-a | Reporting UE capabilities for 1T+2T is sufficient. |
| CMCC | 1-a | In our view, 1Tx can be derived from the 2Tx capability. If UE report support of option2, and UE report 1Tx in carrier 1 and 2Tx in carrier 2, it means UE supports switching between 1Tx+1Tx and 0Tx+2Tx. So we don’t see the necessity to send the LS. |

There is a sequent issue raised in [2] for the UE capability signalling structure. [2] thought there is no particular advantage between indicating support of UL Tx switching in *BandCombination-UplinkTxSwitch-r16* rather than using *BandCombinationList*, and proposed that

* RAN2 to discuss whether it is still beneficial to keep a separate band combination list for the support of UL Tx switching.

We discussed the problem that introducing a new BC list for UL Tx switching or using legacy BC list in RAN2#109bis-e [12] and RAN2#110e [13]. The majority choose to introduce a new BC list, which was agreed to introduce a new BC list [14], because of the following concerns for using legacy BC list:

-backward compatibility,

-fallback BC supporting UL Tx switching when its superset BC without such capability,

-difficulty to identify the specific parameters impacted by UL Tx switching.

According to the proposal of [2], the question would be re-opened as whether keep a separate band combination list for the support of UL Tx switching or use the legacy BC list, which is aligned with the motivation of the proposal of [2] in Rapporteur’s understanding. If there is any analysis of pros and cons for either option, companies can offer it in the below table.

**Issue 2: whether keep a separate band combination list for the support of UL Tx switching or use the legacy BC list.**

Please note the deadline for Question 2 is 2020-08-19 19:00 UTC. If we need corresponding CRs, we would discuss the CRs details then and the CRs discussion deadline will be 2020-08-21 07:00 UTC. [2] provided a text proposal for using legacy BC list.

**Question 2: do companies prefer to keeping a separate band combination list for the support of UL Tx switching or using the legacy BC list? Any comments, including analysis of pros and cons?**

|  |  |  |
| --- | --- | --- |
| Company | Keep New BC list/  use legacy BC list | Comments if there is any |
| Ericsson | Use legacy BC list | We think that 1+1 case is signalled in the legacy list and the 2+0 case is also signalled in the legacy list as two separate FeatureSetEntries. The **legacy** gNB can “switch” between those configurations by means of RRC configuration (i.e. not using DCI signalling for UL TX switching which we are doing now).  The open question then becomes how signal to the **new** gNB that the UE supports UL TX switching on these FeatureSetEntries. We think new fields can be added to the FeatureSetEntry corresponding to 1+1. These new fields would indicate that the UE supports switching to 2+0 and/or 0+2 (in the corresponding FeatureSetUplinkPerCC).  This structure would also   * resolve the issue of the implicit fallbacks as the legacy gNB sees the band combinations as usual * have less signalling overhead * be easier to maintain as there is no need to add the same future fields to both lists. |
| OPPO | New BC list | We do not see motivation to revert the previous agreement on this. |
| Huawei | New BC list | We do not see motivation to revert the agreement of new BC list either.  We doubt it is even feasible to use the method proposed in [2], as only *FeatureSetUplinkPerCC* is extended to include MIMO layer capability. We think there are other UE capabilities outside of *FeatureSetUplinkPerCC* can also be different in UL Tx switching case (2T@carrier2), compared with normal CA operation (1T@carrier2). In this case, we need to check all the capabilities reported per BC case by case.  Whether to use a new BC list or legacy BC list was raised long time ago, and has been fully discussed and evaluated. After that, we made the agreement to introduce new BC list. The current signalling structure designed based on the new BC list works well, we do not agree to revert it and pursue an unclear solution at this stage. |
| Qualcomm Incorporated (Masato) | New BC list | Do not see a strong reason to overturn the previous agreement.  As indicated in the previous section, we do not see the need of indicating UE capabilities separately for 0T+1T, 1T+1T and so on. |
| CMCC | New BC list | RAN2 already agreed to introduce new BC list for UL Tx switching. We prefer to not revert the previous agreement |

## Fallback band combinations

In last RAN2 meeting, RAN2 made the following agreements:

* Do not consider the lower order band combination from the parent band combination with UL Tx switching as fallback band combination.
* Confirm that for a parent band combination without UL Tx switching, UE is allowed to report a lower order band combination with UL switching.

The issue how to interpret fallback BC in new BC list in [1][2][3][4][5].

**Issue 3: how to interpret fallback BC in new BC list.**

For issue 3, we can directly go to the details of the corresponding CRs or TPs in [7] (R2-2007950, which has been revised to R2-2008100[11] with updating source companies), [8] and [5]. The changes are copied under the solutions respectively.

**Solution3-a: Changes for 38.306 in [11].**

| ***supportedBandCombinationList-UplinkTxSwitch***  Defines the NR inter-band UL CA, SUL and/or EN-DC band combinations where UE supports dynamic UL Tx switching. UE only includes this field if requested by the network. A lower order band combination not including a band pair supporting UL Tx switching reported in the parent band combination is not considered to be a fallback band combination of the parent band combination. For an inter-band UL CA band combination that supports UL Tx switching, the UE shall also support the inter-band UL CA without UL Tx switching in a band combination with the same band entries. | UE | No | No | No |
| --- | --- | --- | --- | --- |

**Solution3-b: Changes for 38.306 in [8].**

| ***supportedBandCombinationList-UplinkTxSwitch***  Defines the NR inter-band UL CA, SUL and/or EN-DC band combinations where UE supports dynamic UL Tx switching. UE only includes this field if requested by the network.  Lower order band combinations with only carrier 1 or only carrier 2 from parent band combination with UL Tx switching are not considered as fallback band combinations. | UE | No | No | No |
| --- | --- | --- | --- | --- |

**Solution3-c: Changes for 38.306 and 38.331 in [5].**

Changes for 38.306 in [5]:

| ***supportedBandCombinationList-UplinkTxSwitch***  Defines the NR inter-band UL CA, SUL and/or EN-DC band combinations where UE supports dynamic UL Tx switching. UE only includes this field if requested by the network. A fallback band combination resulting from the reported band combination, which includes at least carrier 1 and carrier 2 for a band pair supporting UL TX switching, shall be supported by the UE. | UE | No | No | No |
| --- | --- | --- | --- | --- |

[5] also proposed that

* Clarify in 38.331 that no need to consider UL-switching during removal of fallback-BC, so that lower order band combination (e.g., band A/B-only) can be removed as fallback-BC of the parent band combination reported in *supportedBandCombinationList* even if the the same patent band combination supports UL-switching (i.e., is also reported in *supportedBandCombinationList-UplinkTxSwitch*), and agree either Alt-1 or Alt-2 of the TP in Annex-I,

and provided the text proposal for 38.331 by adding either one of the following two notes to 38.331 5.6.1.4:

* **Alt-1:** NOTE 5: UL TX switching capability is not taken in account when evaluating “the same capabilities of another band combination”.
* **Alt-2:** NOTE 4: When compiling the list of “candidate band combinations”, for a same band combination supporting UL TX switching, two separate entries for the band combination shall be included, for with and without UL TX switching capability.

**Question 3a: For 306, which solution do companies prefer? Any comments or other text proposals?**

|  |  |  |
| --- | --- | --- |
| Company | Solution 3-a/ Solution 3-b/  Solution 3-c/  other | Comments /other text proposals |
| Ericsson | Other | If we go for a single band combination list (see previous question), there is no fallback issue.  According to clause 5.6.1.4 of 38.331 a band combination is only removed (i.e. not signalled) if it supports only **the same** capabilities as its parent band combination. That means that if a child band combination supports UL TX switching, but its parent band combination does not, the UE shall signal both of them. There is no need for any further clarification.  The actual fallback problem arises if we keep the new list and if the UE includes a band combination in the new list but omits the corresponding band combination, but without supporting UL TX Switching, from the legacy list. If the corresponding band combination is implicitly supported (i.e. not signalled), the legacy gNB would not understand it. We do not think this issue is addressed by any of the solutions above.  Furthermore, the current procedure in clause 5.6.1.4 is probably not correct as the UE would add band combinations for UL TX Switching to the legacy band combination list only or add them to both lists. |
| OPPO | 3-c | Firstly, our understanding is that for a BC supporting UL-switching, it has to be reported in both old and new BC list, in order for backwards compatibility of legacy gNB. When it is reported in the old BC list, it only includes the capability for UL-switching not configured.  The problem is if a patent-BC supports UL-switching, how for NW to assume the capability of child-BC (contains only carrier-1/2) not supporting UL-switching. We understand the main intention of 3-a/b/c are the same, i.e., from network perspective, when it receives the reported UE capability in the new BC list, it is not to be used for the fallback BC (only carrier-1 or only carrier-2) when UL-switching is not configured.  However, 3a/b describes the intention in a way to re-define the definition of fallback BC: *lower order band combination.. is not considered as fallback band combination*. But the fallback-BC is not defined per-BC-list, but is defined in a BC-list-agnostic way – “**Fallback band combination:** A band combination that would result from another band combination by releasing at least one SCell or uplink configuration of Scell, or SCG. An intra-band non-contiguous band combination is not considered to be a fallback band combination of an intra-band contiguous band combination.”. And in 331, the definition is used to remove the fallback-BC entries from the “candidate BC list”, before setting the old/new BC list, i.e., the usage of the “fallback BC” definition has nothing to do with the old/new BC list at all. |
| Huawei | 3-a | [Proponent]  We understand the intention of three solutions is the same, so we are open to discuss the wording.  In response to Ericsson’s comments, we also share the same view with OPPO that UE can report normal capabilities (without UL Tx switching) in legacy BC list and UL Tx switching capabilities in new BC list for the same BC. And legacy/new network looks into legacy BC list for normal UE capabilities while new network looks into new BC list for UL Tx switching capabilities. The fallback BC will not cross legacy BC list and new BC list. Therefore, UE will not omit any BC from legacy BC list. This is also our initial intention to decouple legacy BC list and new BC list to avoid any misalignment/interoperability issues between UE and network. |
| Qualcomm Incorporated (Masato) | 3-c | Positive sentence which is easy to understand. |
| CMCC | Slightly prefer 3-a | We agree that the intention of 3 options are the same. The wording can be further discussed.  We slightly prefer option 3-a, which further clarifies that“  For an inter-band UL CA band combination that supports UL Tx switching, the UE shall also support the inter-band UL CA without UL Tx switching in a band combination with the same band entries.” |

**Question 3b: For 331, which solution do companies prefer? Any comments or other text proposals?**

|  |  |  |
| --- | --- | --- |
| Company | Yes change is needed (and in this case, would 3-c is preferred or some other option) / No change is not needed | Comments /other text proposals |
| OPPO | Yes, 3-c | As clarified in 8106, now following the procedural text 331, when the UE composes the “candidate BC list”, for a BC A+B supporting UL switching, the fallback BC entry of A-only and B-only cannot be removed although it should be.  The change in 3-c is to clarify that:   1. To confirm the A/B-only should be removed from the candidate BC list, when the procedural text in 331 is used; 2. And to remove A/B-only, since the current 331 procedural text cannot achieve that, how to clarify/revise the text in order to achieve it. |
| Qualcomm Incorporated (Masato) |  | It is not a good idea to make all this hidden in RRC procedural text. Prefer to capture the intended behaviour in 38.306. |

## Introducing power boosting in UL Tx switching CA case

In the RP#88e meeting, the support of power boosting for CA case was discussed. The following exception sheet [2] and the WF [3] were approved/endorsed during the meeting.

The exception sheet for NR\_RF\_FR1 included the following bullet as

|  |
| --- |
| RAN2:   * The capability to indicate support of power boosting for CA case, and the RRC signalling to indicate whether such power boosting for CA case is allowed will be specified. |

The corresponding part of the WF is copied as below,

|  |
| --- |
| For RAN2, the capability to indicate support of power boosting for CA case, and the RRC signaling to indicate whether such power boosting for CA case is allowed will be specified in Q3, while keep the RAN2 CR pack to this RAN plenary as approved. The capability for 3dB power boosting is defined per band combination. No spec change for RAN2 RRC procedures and MAC procedures. Send the LS to RAN2 in this RAN plenary. |

As indicated above, RAN2 should specify the UE capability and RRC configuration when the UE supports power boosting for CA case in UL Tx switching.

**Issue 4: Introducing power boosting in UL Tx switching CA case.**

For issue 3, we can directly go to the details of the corresponding CRs [9][10] or TPs for RRC configuration in [2]. [2] proposed that

* a single field is included per band combination to indicate support of power boosting for CA case. This field can only be present if UL Tx switching is supported in the band combination.

The changes for the capability to indicate support of power boosting for CA case are provided in [9] for 38.306 and [10] for 38.331.

**Solution4-a: the changes of 38.306 and 38.331 for the capability to indicate support of power boosting for CA case in [9][10].**

**Question 4: do companies agree with the changes for the capability to indicate support of power boosting for CA case are provided in [9] for 38.306 and [10] for 38.331? Any comments or text proposals?**

|  |  |  |
| --- | --- | --- |
| Company | yes/yes but…/no | Comments/ text proposals |
| Ericsson | Yes |  |
| OPPO | Yes |  |
| Huawei | Yes |  |
| Qualcomm Incorporated (Masato) | Yes |  |
| CMCC | Yes |  |

The changes forthe RRC signaling to indicate whether such power boosting for CA case is allowed are provided in [10] and [2] in different ways. [10] introduced a single field *uplinkTxSwitchingPowerBoosting* while [2] proposed that the field *uplinkTxSwitchingCarrier* is used to indicate the configuration of power boosting for CA.

**Solution4-b: introduce a signle field *uplinkTxSwitchingPowerBoosting* to indicate the configuration of power boosting for** **UL Tx switching CA case as the changes of 38.331 in [10].**

**Solution4-c: use the field *uplinkTxSwitchingCarrier* to indicate the configuration of power boosting for UL Tx switching CA case as the changes of 38.331 in section 5.2 of [2].**

**Question 5: do companies prefer Solution4-b or Solution4-c for the RRC signaling to indicate whether such power boosting for UL Tx switching CA case is allowed? Any comments or text proposals?**

|  |  |  |
| --- | --- | --- |
| Company | Solution4-b/Solution4-c/other | Comments/ text proposals |
| Ericsson | Solution 4-c | We can also accept solution 4-b. |
| OPPO | 4-b | proponent |
| Huawei | 4-b |  |
| Qualcomm Incorporated (Masato) | 4-b |  |
| CMCC | 4-b | 4-b is more clear |

# 3 Conclusions

Based on the discussion above, we have the following proposals.

# Reference

1. [R2-2006985](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_111-e\\Docs\\R2-2006985.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_111-eDocsR2-2006985.zip) Discussion on remained issues of UL Tx switching China Telecom discussion
2. [R2-2007604](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_111-e\Docs\R2-2007604.zip) Remaining issues for UL Tx Switching Ericsson discussion
3. [R2-2007949](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_111-e\Docs\R2-2007949.zip) Remaining issues on dynamic UL Tx switching Huawei, HiSilicon, ZTE Corporation, Sanechips discussion Rel-16 NR\_RF\_FR1
4. [R2-2007085](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_111-e\Docs\R2-2007085.zip) Remaining issues on UL switching Apple, OPPO discussion Rel-16 TEI16, NR\_RF\_FR1
5. [R2-2008106](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_111-e\Docs\R2-2008106.zip) Discussion on fallback-BC for UL TX switching OPPO discussion Rel-16 TEI16, NR\_RF\_FR1
6. [R2-2007086](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_111-e\Docs\R2-2007086.zip) Draft LS on UE capability derivation from 2Tx to 1Tx in UL Tx switching Apple LS out Rel-16 TEI16, NR\_RF\_FR1 To:RAN1, RAN4
7. [R2-2007950](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_111-e\Docs\R2-2007950.zip) CR on clarification of fallback BC and prerequisite of CA case in supportedBandCombinationList-UplinkTxSwitch Huawei, HiSilicon, ZTE Corporation, Sanechips CR Rel-16 38.306 16.1.0 0399 - F NR\_RF\_FR1
8. [R2-2007087](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_111-e\Docs\R2-2007087.zip) Fallback band combination exception for UL Tx switching Apple, China Telecom, OPPO CR Rel-16 38.306 16.1.0 0372 - F TEI16, NR\_RF\_FR1
9. [R2-2006895](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_111-e\Docs\R2-2006895.zip) CR to 38.306 on introducing power boosting in UL Tx switching CA case ZTE Corporation, Sanechips, China Telecom, Huawei, HiSilicon, OPPO CR Rel-16 38.306 16.1.0 0369 - C NR\_RF\_FR1
10. [R2-2006896](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_111-e\Docs\R2-2006896.zip) CR to 38.331 on introducing power boosting in UL Tx switching CA case ZTE Corporation, Sanechips, China Telecom, Huawei, HiSilicon, OPPO CR Rel-16 38.331 16.1.0 1753 - C NR\_RF\_FR1
11. R2-2008100 CR on clarification of fallback BC and prerequisite of CA case in supportedBandCombinationList-UplinkTxSwitch Huawei, HiSilicon, China Telecom, ZTE Corporation, Sanechips CR Rel-16 38.306 16.1.0 0399 1 F NR\_RF\_FR1
12. R2-2004201 Report of [AT109bis-e][045][NR16 Other] UL TX Switching-NR\_FR1
13. R2-2006112 Report of [AT110e][026][Other] UL Tx switching
14. Draft\_RAN2\_110-e\_Meeting\_Report\_v2