**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.7.1, 8.7.2, 8.7.3.2

**Source:** CATT

**Title:** Email discussion summary for RAN4#94e\_#15\_NR\_UE\_pow\_sav\_RF

**Document for:** Information

# Introduction

The interruption and switching time for maximum MIMO layer adaption case 2 needs to be finalized. This paper presents a summary for company proposals. It is encouraged to have discussions on the following topics for completion of maximum MIMO layer adaption case 2 requirements.

* Conclude power saving gain based on company simulation results
* BWP switching delay
* Interruption time

# Topic #1: Maximum MIMO layer adaption for case 2

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **R4-2000153** | Vivo | Proposal 1: Both type 1 and type 2 switch delay requirement should be introduced to the switch delay requirement of case 2 MIMO layer adaption.  Proposal 2: If proposal 1 is accepted, we suggest to introduce corresponding UE capability signalling.  Proposal 3: The interruption requirement of BWP switching is used for the case 2 MIMO layer adaption interruption requirement. |
| **[R4-2000601](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000601.zip)**  **R4-1913698** | CATT | 1. No obvious difference between type 1 and type 2 switching delay. (Results from R4-1913698) 2. Following the agreement in RAN4#92bis, no UE signalling usless the power saving gain difference is justified by using type 1 delay for type 2 UE |
| [**R4-2000767**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000767.zip) | Qualcomm, Inc. | 1. Type 2 BWP switching can bring more power saving gain than type 1 BWP switching delay. 2. Proposal: We propose two options for BWP switch delay requirement for MIMO layer adaptation only cases:   P1: From UE implementation flexibility perspective, additional capability signalling flag for MIMO layer only change is introduced to report BWP switch delay time, with options the same as general BWP switch delay, namely, type 1 and type 2 delay.  P2: From gNB implementation complexity perspective, no additional capability signalling is introduced, MIMO layer adaptation only case follows general BWP switch delay requirement. |
| **R4-2000787** | Apple | Proposal 1: reuse the existing delay and interruption requirements of legacy BWP switching to case 2 (Only the number of maximum MIMO layer is changed in the BWP before and after MIMO layer adaption).  The following proposals are mainly on demodulation which can be discussed in future meetings.  Proposal 2: RAN4 shall consider whether UE still needs to meet 4Rx demod requirement on those 4Rx-mandated bands when network configures the max\_MIMO\_layer\_num=2 to UE for power saving. In our understanding, there might be three options to address this issue from standardization perspective,  Option 1: Add applicability for demod requirement to state that 4Rx demod requirement is not applicable for UE with max\_MIMO\_layer\_num =2; and so does the test case  Option 2: set the max\_MIMO\_layer\_num =4 in the all related test cases applied for 4Rx-mandated bands  Option 3: Do not recommend this max MIMO layer adaptation feature for power saving and still make 4Rx demod requirements applicable in all the cases irrespective of the configured number of MIMO layers. |
| **R4-2000990** | Oppo | Proposal 1: The current BWP switch delay requirements for Type 1 and Type 2 UE in 38.133 are reused for case 1.  Proposal 2: Only define one set of delay requirement without additional UE capability for case 2.  Proposal 3: BWP switching interruption in R15 can be reused for the interruption for MIMO layer adaption for both case 1 and 2. |
| **[R4-2000969](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000969.zip)** | ZTE Corporation | Observation 1: for case 1 MIMO layer adaption with BWP switch, it’s not necessary to further add BWP switching delay in UE capability report.  Observation 2: for case 2 MIMO layer adaption without BWP change, if switching delay for case 1 and case are the same or only type 1 switching delay are agreed for case 2, then no UE capability report is needed. |
| **[R4-2001758](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001758.zip)** | Huawei, HiSilicon | Observation 1: From RF implementation perspective, type1 BWP switching delay defined in TS 38.133 is enough for UE switching off completely on the receiving RF chain.  Observation 2: New introduced BWP based features have better switching performance when there is no RF retuning and AGC settling. If MIMO layer adaption time(even other BWP based feature) reuse the BWP switching capability UE indicates, it will impact these Rel-16 features be commercial utilized and bring advantage to the NR network.  Proposal 1: the MIMO layer adaption delay for DCI/timer based BWP switching shall be defined as below:   |  |  |  | | --- | --- | --- | |  | NR Slot length (ms) | BWP switch delay TMIMOswitchDelay (slots) | | 0 | 1 | 1 | | 1 | 0.5 | 2 | | 2 | 0.25 | 3 | | 3 | 0.125 | 6 |   Proposal 2: the MIMO layer adaption delay for RRC based BWP switching shall be defined as the corresponding BWP switching delay in TS 38.133.  Proposal 3: The interruption time for MIMO layer adaption based on BWP switching is defined consistently with BWP switching interruption defined in TS 38.133. |
| **R4-2001655** | Huawei, Hi-Silicon | Proposal 1: BWP switching delay for type 1 in R15 can be reused for the delay for MIMO layer adaption case 2.  Proposal 2: BWP switching interruption in R15 can be reused for the interruption for MIMO layer adaption in case 2.  Proposal 3: We don't need to discuss UL MIMO layer adaption in R16. |
| **[R4-2001793](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001793.zip)** | MediaTek inc. | Observation 1: The latency performance for Type 1 UE is better than that for Type 2 UE. The difference can be up to 17.7% in FR1 and 15.2% in FR2.  Observation 2: The power saving gain for Type 2 UE is slightly better than that for Type 1 UE. The difference can be up to 2% in FR1 and up to 2.5% in FR2.  Observation 3: The Type 2 UE can achieve the higher power saving gain due to longer period with scheduling restriction, which however reduces the network scheduling flexibility.  Observation 4: Type 1 UE has similar power saving gain with Type 2 UE, whereas it has better latency performance and more scheduling opportunity when all power saving related features: MIMO layer adaptation, cross-slot scheduling, and SCell dormancy behaviour are jointly considered.  Observation 5: There are up to 10% additional power saving gain in FR1 and 40% in FR2 when all power saving related features: MIMO layer adaptation, cross-slot scheduling, and SCell dormancy behaviour are jointly considered.  Proposal 1: In Rel-16, Type 1 switching delay should be supported.  Proposal 2: Introduce one single new UE capability including all power saving related features that adopts BWP framework (MIMO layer adaptation, cross-slot scheduling, and SCell dormancy behaviour) in order to achieve the faster switching time, the better latency performance, and obtain more scheduling opportunity. |
| **R4-2002136** | Qualcomm | Observation 1: UE may share a same set of antennas and RF filters across different component carriers. Hence, change in number of MIMO layers in one carrier may impact RX tuning of other carriers.  Proposal 1: The interruption lengths during MIMO layer adaptation (case 2) are same as those during Rel-15 BWP switching. |
|  | | |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub topic 1-1: Power saving gain between type 1 and type 2 BWP switching delay

RAN4#92bis meeting reached an agreement that power saving gain shall be considered on how to determine switching delay for Maximum MIMO layer adaption case 2. Following the agreement, the power saving gain needs to be discussed and concluded first.

Open issues and candidate options before e-meeting:

**Issue 1-1: Evaluation results on power saving gain**

* Observations
  + Based on the agreement in RAN4#92bis and the company results summarized below, Type 1 switching delay cannot bring more power saving gain than type 2.

|  |  |  |
| --- | --- | --- |
| **Company** | **contribution** | **Power saving gain by using type 1 and type 2 switching delay** |
| Qualcomm | R4-2000767 | 1. More power saving gain by using type 2 than type 1 (~8% of the baseline) |
| MediaTek | R4-2001793 | 1. Slightly more power saving gain by using type 2 than type 1. (2% for FR1 and 3.5% for FR2) |
| CATT | R4-1913698Note | 1. No obvious difference between type 1 and type 2 switching delay. (~2%.) |
| Note: Contribution in RAN4#93 with slight different assumptions. | | |

* + Evaluations for combined features of MIMO layer adaption, cross-slot scheduling and Scell Dormancy.

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| --- | --- | --- |
| **Company** | **contribution** | **Power saving gain by using type 1 and type 2 switching delay** |
| MediaTek | R4-2001793 | More power saving gain by using type 1 than type 2 when MIMO layer adaption is combined with other features, e.g. cross-slot scheduling and Scell dormancy. |

* + There are also evaluations about the BWP impact on latency performance; however it is noted that latency was not accepted as a metric during RAN4#93 online discussions.
* Recommend agreements/observations
  + Maximum MIMO layer adaptation with type 1 BWP switching delay alone cannot bring more power saving gain than that with type 2 switching delay.
  + No further evaluation on power saving gain for combined features since it is beyond the scope of Rel-16 UE power saving WI.

### Sub-topic 1-2: swithcing and interruption for Case 2

Switching delay and interruption time is still not agreed for case 2.

**Issue 1-2: Switching time**

* Proposals

From the different proposals in company inputs and previous discussions, mainly 3 options are identified as following,

* + Option 1: Defining the type 1 requirements as minimum requirements for case 2
  + Option 2: MIMO layer adaption for Case 2 follows general BWP switch delay requirement.as for Case 1
  + Option 3: Introduce the requirements based on UE capability, e.g. allow a type 2 UE to report supporting type 1 delay for case 2.
* Recommended WF

Considering the situation, we propose that,

* + The requirement of switching time for maximum MIMO layer adaption in case 2 is based on
    - Option 2 “MIMO layer adaption for Case 2 follows general BWP switch delay requirement as for Case 1” in Rel-16.

**Issue 1-3: Interruption time**

* Proposals:
  + The interruption time for MIMO layer adaption based on BWP switching is defined consistently with BWP switching interruption defined in TS 38.133. (Huawei, Qualcomm, vivo, Oppo, CATT)
* Recommended WF
  + The interruption time for MIMO layer adaption based on BWP switching is defined consistently with BWP switching interruption defined in TS 38.133.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |
| Nokia, Nokia Shanghai Bell | Sub topic 1-1: We accept the recommended WF to not do further evaluations on power saving gains for the combined features in Rel-16  Sub-topic 1-2: We accept the recommended WF that also for the Case 2 Rel-15 BWP switch delay requirements are re-used.  Sub-topic 1-3: We accept the recommended WF that interruption time is part of the BWP switch delay requirements as in Rel-15. |
| vivo | Sub-topic 1-2: We can accept option 3 or option 2. If new capability signaling cannot be agreed in this meeting, option 2 should be used.  Sub-topic 1-3: We accept the recommended WF. |
| ZTE | Sub topic 1-2: we support option 2 that MIMO layer adaption for case 2 follow general BWP switch delay and without any further signalling report to network.  Sub topic 1-3: we are also fine for intteruption time for MIMO layer adaption based on BWP switching.  As case 1 and case 2 have the same BWP switching delay and then from RRM perspective, maybe it’s not necessary to differentiate case 1 and case 2 anymore. |
| Apple | Sub topic 1-2: we support option 2 as our proposal “reuse the existing delay and interruption requirements of legacy BWP switching to case 2”  Sub topic 1-3: We support the recommended WF as our proposal “reuse the existing delay and interruption requirements of legacy BWP switching to case 2” |
| OPPO | Sub-topic 1-2: We proposed to only define one set (type 2) of delay requirement without additional UE capability for case 2. If it cannot be accepted in this meeting, we can compromise to option 2.  Sub-topic 1-3: Agree with recommended WF. |
| QC | **Issue 1-1: Evaluation results on power saving gain**  We agree with the recommended WF  **Issue 1-2: Switching time**  We agree with the recommended WF, “MIMO layer adaption for Case 2 follows general BWP switch delay requirement as for Case 1” in Rel-16  **Issue 1-3: Interruption time**  We agree with the recommended WF |
| MediaTek | **Issue 1-1: Evaluation results on power saving gain**  Suggestion: RAN4 to follow the performance metrics and simulation assumptions agreed in TR38.840. In TR38.840, the agreed performance metrics including:   * UE power saving gain, * System performance (Latency, Scheduling delay, User throughput).   CATT: Firstly, many thanks for MediaTeck for continuous input and the comments.  We donot deny that there are multiple metrics in TR 38.840. But how to use the metrics should be correctly interpreted. Since this is power saving WI, a solution should have power saving gain first and then we can consider in conjunction with other metrics as a whole. It is confusing to specify a solution that don’t have any advantage on power saving gain but only specify it from other perspective in the power saving WI.  <Comment on recommended agreements/observations >  Against recommended agreements/observations.  According to our evaluation results, the Type 2 UE can achieve the higher power saving gain due to the adopting of longer switching delay with scheduling restriction, which however reduces the network scheduling flexibility. Besides, the latency performance for Type 1 UE is better than that for Type 2 UE. The difference can be up to 17.7% in FR1 and 15.2% in FR2. Not to mention that RAN4 has never reached consensus on the performance metrics. It is not convincing to apply power saving gain as the only performance indicator. If power saving gain is the only metric, then why not to agree on a 10ms delay, which saves even more power?  In FR2, the difference of switching delay between Type 1 and Type 2 UE is up to 12 slots. If Type 2 switching delay is adopted and Network would like to remain the same scheduling flexibility with Type 1 UE, the DRX inactivity timer and DRX on duration timer lengths have to be further extended and the Type 2 UE will even consume more power than the Type 1 UE.  CATT: As said above, we should justify the power saving gain first. But the simulation results from Qualcomm, MediaTek and CATT already give us very clear answer that using type 1 cannot bring more power saving gain than type 2. I am confused where the recommended observation is wrong. Our discussion should be in a pragmatic way. The agreement in RAN4#92bis may be not a perfect one for everybody, but it is based on group consensus with everyone involved and is a right direction for us to move forward.    <Comment on R4-2000767>  The simulation assumptions violate the principles specified in TR38.840.  Besides, we see the risk to make decision based on only 1 evaluation case.  **Issue 1-2: Switching time**  RAN4 has never reached consensus on only 3 options should be considered. Therefore, we would like to propose another one:  Introduce one single new UE capability including all power saving related features that adopts BWP framework (MIMO layer adaptation, cross-slot scheduling, and SCell dormancy behaviour) in order to achieve the faster switching time, the better latency performance, and obtain more scheduling opportunity.  CATT： There is not BWP framework in 3GPP. The BWP is a standalone feature in NR. The power saving study in Rel-16 is based on the power saving gain in individual domain, such as time frequency and space. This is totally a new proposal coming to this meeting. Some features are even not in the scope of Rel-16 UE power saving WI. We don’t know how to move forward with such a proposal out of the WI scope.  We can also compromise to option 1 and 3.  <Comment on recommended WF and option2> Against recommended WF and option 2.  If option 2 is adopted and we apply the same capability for these 2 cases, we don’t see any enhancement of latency or scheduling flexibility from this results.  **Issue 1-3: Interruption time**  We are fine to reuse the BWP switching interruption time for MIMO layer adaptation. |
| Huawei | **Issue 1-1: Evaluation results on power saving gain**  In Rel-16 we may not have enough time to further evaluate the power saving gain, but we have different view of the observations. Evaluation of power saving gain should consider other aspects, e.g. latency to give a whole picture of the system performance. Further more, we should follow the WID agreed in RAN meeting that the switching time are based on RF architecture. The evaluation on power saving gain is out of RAN4 working scope in the WI.  **Issue 1-2: Switching time**  Technically, only option 1 is reasonable for MIMO layer adaptation, as we discussed in the paper, RF time can be reduced much due to no retuning and AGC settling. It is under discussion in RRM session on dormancy behaviour which is also BWP switch based, we can see that many features may introduce in the future based on BWP, if all new features just follow Rel-15 requirement, we don't see any improvement but just degradation. If no consensus on switching time can be reached in Rel-16, we suggest to have further study of switching time in Rel-17.  **Issue 1-3: Interruption time**  We are fine with the recommended WF. |
| CATT | As the moderator, we would like to thank all the comments and feedback.  We would also like to clarify the motivation for the recommended WF.  In RAN2#92bis meeting, all the involved companies have a very difficult discussion on whether to tighten the requirement and whether to introduce signalling. Finally an agreement was captured in the Chairman’s Note. Power saving gain shall be justified if signalling is introduced.  In RAN4#93 meeting, 3 options were put on table for discussion. We all have tried option1 as proposed by MediaTek. However, it was not possible to move forward with option 1 at all since there are several companies showed concern due to implementation limitation.  In this meeting, the simulation results from Qualcomm, MediaTek and CATT are quite aligned on power saving gain analysis. Type 1 delay alone cannot bring more power saving gain than type 2. It means Option 3 is not justified.  Given this situation we proposed option2 and we think this is already the best we can do in Rel-16. Reusing the current requirement will not have impact on power saving gain. |
| Intel | Issue 1-2: we support option 2, i.e. existing BWP delay and related interruption can be reused.  Issue 1-3: we support the recommended WF. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | 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** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations 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 provides recommendation on CRs/TPs Status update*

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| --- | --- |
| **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”* |

# Topic #1: Title

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-20xxxxx | Company A | Proposal 1:  Observation 1: |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 1-1: TBA**

* Proposals
  + Option 1: TBA
  + Option 2: TBA
* Recommended WF
  + TBA

### Sub-topic 1-2

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 1-2: TBA**

* Proposals
  + Option 1: TBA
  + Option 2: TBA
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | 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** |
| **Sub-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”* |