**3GPP TSG-RAN2 Meeting #117 Electronic**  **R2-220xxxx**

**February 21 – March 3, 2022**

**Source: Samsung**

Title: Report of [AT117-e][024][ePowSav] PDCCH skip (Samsung)

**Document for: Report and Decision**

**Agenda Item: 8.9.3.2.2**

# Introduction

* [AT117-e][024][ePowSav] PDCCH skip (Samsung)

Scope: Treat R2-2203708. Determine agreeable points, points for discussion if needed

Intended outcome: Report

Deadline: In time for CB online W2 Tuesday

**Deadline for companies’ inputs**: Monday, Feb 28th, 12:00 UTC

# Discussion

RAN2 has discussed the impact of PDCCH skipping on SR and RA procedure. Following agreements were made in RAN2#116bis-e:

1. UE ignores PDCCH skipping while the SR is pending.
2. If PDCCH skipping is applied to RNTI(s) monitored during RAR/MsgB window, the UE ignores PDCCH skipping during the RAR/MsgB window.
3. UE ignores PDCCH skipping while contention resolution timer is running.

# PDCCH skipping and SR

|  |  |
| --- | --- |
| **Source** | **Proposal** |
| Samsung [1] | Proposal : UE ignores PDCCH skipping **on all serving cells of the corresponding CG** while SR is pending. |

**Q1: Do you agree that UE ignores PDCCH skipping on all serving cells of the corresponding CG while SR is pending?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Samsung | Yes | In the last RAN2 meeting, it was agreed that the UE ignores PDCCH skipping while SR is pending. It should be clarified further whether UE ignores PDCCH skipping **on all the scheduling serving cells or only on the SpCell**. In case of SR, UL grant can be scheduled by any serving cell for cancelling the SR. So in this case, UE should ignore PDCCH skipping on all the serving cells of the cell group. |
| OPPO | Yes | Agree with Samsung. |
| Intel | Yes |  |
| Qualcomm | See comment | We think LCP restriction needs to be considered here. If the SR is triggered by new data arrival from a logical channel which is configured with *allowedServingCells*, then UE only needs to ignore PDCCH skipping on the serving cells configured in the *allowedServingCells* of that logical channel.  This can make a difference in UE power saving in interband CA configuration. |
| ZTE | Yes | No extra optimization the PDCCH skipping |
| LG | Comments | We think MAC entity should not be impacted by PDCCH skipping at all. Whether to apply PDCCH skipping in certain cases is RAN1 issue. We don’t see the need to discuss this issue in RAN2. |
| DENSO | Yes | Agree on Q1 |
| CATT | Yes | Agree with ZTE, no further optimization is needed. |
| Huawei, HiSilicon | Yes | Agree with Samsung. |
| Sequans | Yes |  |
| vivo | comments | We agree with LG that the PDCCH skipping should be transparent to MAC entity, and this issue should be determined by RAN1. |
| Ericsson | Yes |  |
| Xiaomi | Yes, but | Do we need to consider dual-DRX?  For dual-DRX, SR will trigger the Serving Cells in a DRX group into active, so can we say “**UE ignores PDCCH skipping on all serving cells of the corresponding DRX group while SR is pending**”? |
| Nokia | comments | Agree with Qualcomm on LCP aspect, in principle enough to just wake up for the cells that are in the allowed list for the LCH that triggered the SR where the UL grant might come from.  No need to consider DRX group. In case of DC though, it should be only the cells within the same cell group where the SR is sent. |

**Summary:**

9 companies support the proposal as it is.

One company suggested to consider DRX group and suggest that “UE ignores PDCCH skipping on all serving cells of the corresponding DRX group while SR is pending”. One company suggested that there is no need to consider DRX group.

Two companies indicated that PDCCH skipping should be transparent to MAC entity, and this issue should be determined by RAN1.

*<Rapporteur’s views> RAN2 has discussed impact of PDCCH skipping on SR and RA in RAN2#116bis and agreed several proposals. The proposal is further clarification of agreement made in RAN2. An LS was sent to RAN1 asking whether RAN1 prefer to capture the agreed proposals in RAN1 spec or RAN2 spec. Based on RAN1 preference, the agreed agreements will be either captured in MAC or RAN1 spec.*

Two companies suggested that it is enough to just wake up for the cells that are in the allowed list for the LCH that triggered the SR.

*<Rapporteur’s views> There are several triggers for SR (e.g. SR for BSR, SR for BFR, SR for consistent LBT failure recovery). Specifying different behaviour for each of these cases seems complex.*

Based on majority views, proposal is to agree the following (Note that we can consider LS to RAN1 to inform about the agreements):

**Proposal 1: UE ignores PDCCH skipping on all serving cells of the corresponding CG while SR is pending**.

# PDCCH skipping and Random Access

|  |  |
| --- | --- |
| **Source** | **Proposal** |
| Samsung [1] | Proposal: During RAR/MsgB window, UE ignores PDCCH skipping on SpCell.  Proposal: UE ignores PDCCH skipping on SpCell while contention resolution timer is running. |
| Vivo [2] | Proposal : Clarify the agreements made in RAN2#116bis-e as follows and confirm that there is no impact on RAN2 specification.   * From RAN2 point of view, if PDCCH skipping is applied to RNTI(s) monitored during RAR/MsgB window, the UE still monitors the PDCCH which schedules RAR during RAR/MsgB window, while there is no impact on RAN1 behaviour on PDCCH skipping, e.g. there is no need for UE to monitor USS and type-3 CSS; * From RAN2 point of view, UE still monitors PDCCH which schedules Msg3 or Msg4 while contention resolution timer is running, while there is no impact on RAN1 behaviour on PDCCH skipping, e.g. there is no need for UE to monitor USS and type-3 CSS.   *[Rapporteur’s Comments]: In case of 4 step RA, UE needs to monitor PDCCH addressed to C-RNTI in recovery search space for RA triggered for BFR. In case of 2 step RA UE needs to monitor USS to receive PDCCH addressed to C-RNTI, if C-RNTI was included in MsgA. While contention resolution timer is running, for contention resolution, UE monitor PDCCH addressed to C-RNTI in USS, if C-RNTI was included in Msg3.*  *RAN2 has also sent an LS (R2-2201960) to RAN1 in last meeting and we do not need to discuss whether there is any RAN1 impact or not. Also if RAN1 decides to capture aspects related to ignoring PDCCH skipping in RAN1 specification, RAN2 specification change is not needed.* |
| Xaomi [7] | If PDCCH skipping is applied to RNTI(s) monitored during RAR/MsgB window, the UE ignores PDCCH skipping during the RAR/MsgB window on Pcell/Pscell for CA case. |

**Q2: Do you agree that if PDCCH skipping is applied to RNTI(s) monitored during RAR/MsgB window, UE ignores PDCCH skipping on SpCell?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Samsung | Yes | In the last RAN2 meeting, it was agreed that the UE ignores PDCCH skipping during the RAR/MsgB window.  It should be clarified further whether UE ignores PDCCH skipping on all the scheduling serving cells or only on the SpCell.  According to TS 38.321, UE needs to monitor PDCCH (addressed to RA-RNTI/MsgB-RNTI/C-RNTI) of the SpCell during RAR/MsgB window for RAR/MsgB, so UE should ignore PDCCH skipping only on SpCell |
| OPPO | Yes |  |
| Intel | Yes |  |
| Qualcomm | Yes |  |
| ZTE | Yes |  |
| LG | Comments | We think MAC entity should not be impacted by PDCCH skipping at all. Whether to apply PDCCH skipping in certain cases is RAN1 issue. We don’t see the need to discuss this issue in RAN2. |
| DENSO | Yes |  |
| CATT | Yes |  |
| Huawei, HiSilicon | Yes | Agree with Samsung. |
| Sequans | Yes |  |
| vivo | comments | First, we agree with LG that PDCCH skipping should have no impact to MAC.  Considering this issue is being discussed in RAN1, we prefer not to discuss this further in RAN2 and wait for response from RAN1 on the PDCCH skipping and RACH. |
| Ericsson | Yes |  |
| Xiaomi | Comments | RAN1 has agreed that PDCCH skipping only applies for USS and type-3 CSS.  For PDCCH (addressed to RA-RNTI/MsgB-RNTI) during RAR/MsgB window for RAR/MsgB, it is type1 PDCCH CSS. And According to RAN1, PDCCH skipping will not aplly to it.  Need to confirm with RAN1 or wait for more RAN1 input. |
| Nokia | Yes |  |

**Summary:**

11 companies support the proposal as it is.

Three companies indicated this should be either discussed in RAN1 or we should wait for more RAN1 input.

One company indicated that RAN1 has agreed that PDCCH skipping only applies for USS and type-3 CSS. For PDCCH (addressed to RA-RNTI/MsgB-RNTI) during RAR/MsgB window for RAR/MsgB, it is type1 PDCCH CSS. And According to RAN1, PDCCH skipping will not apply to it.

*[Rapporteur’s Views]: In case of 4 step RA, UE needs to monitor PDCCH addressed to C-RNTI in recovery search space for RA triggered for BFR. In case of 2 step RA UE needs to monitor USS to receive PDCCH addressed to C-RNTI, if C-RNTI was included in MsgA. So some RNTI monitoring is still impacted by PDCCH skipping.*

*Also note that Proposal includes “If PDCCH skipping is applied to RNTI(s) monitored during RAR/MsgB window” and we have already sent an LS to RAN1 for the same.*

Based on majority views, proposal is to agree the following (Note that we can consider LS to RAN1 to inform about the agreements):

**Proposal 2: If PDCCH skipping is applied to RNTI(s) monitored during RAR/MsgB window, UE ignores PDCCH skipping on SpCell.**

**Q3: Do you agree that UE ignores PDCCH skipping on SpCell while contention resolution timer is running?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Samsung | Yes | In the last RAN2 meeting, it was agreed that the UE ignores PDCCH skipping while contention resolution timer is running.  It should be clarified further whether UE ignores PDCCH skipping on all the scheduling serving cells or only on the SpCell.  According to TS 38.321, the PDCCH for contention resolution is received on SpCell. So while contention resolution timer is running, UE should ignore PDCCH skipping on SpCell. |
| OPPO | Yes |  |
| Intel | Yes |  |
| Qualcomm | Yes |  |
| ZTE | Yes |  |
| LG | Comments | We think MAC entity should not be impacted by PDCCH skipping at all. Whether to apply PDCCH skipping in certain cases is RAN1 issue. We don’t see the need to discuss this issue in RAN2. |
| DENSO | Yes |  |
| CATT | Yes |  |
| Huawei, HiSilicon | Yes | Agree with Samsung. |
| Sequans | Yes |  |
| vivo | Comments | First, we agree with LG that PDCCH skipping should have no impact to MAC.  Considering this issue is being discussed in RAN1, we prefer not to discuss this further in RAN2 and wait for response from RAN1 on the PDCCH skipping and RACH. |
| Ericsson | Yes |  |
| Xiaomi | - | Need to confirm with RAN1 or wait for more RAN1 input. |
| Nokia | Yes |  |

**Summary:**

10 companies support the proposal as it is.

Three companies indicated this should be either discussed in RAN1 or we should wait for more RAN1 input.

Based on majority views, proposal is to agree the following (Note that we can consider LS to RAN1 to inform about the agreements):

**Proposal 3: UE ignores PDCCH skipping on SpCell while contention resolution timer is running.**

# PDCCH skipping and UL HARQ reTx timer

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| --- | --- |
| **Source** | **Proposal** |
| Vivo [2] | Proposal: It is up to RAN1 to decide whether UE ignore PDCCH skipping (i.e., PDCCH skipping is cancelled) while UL HARQ reTx timer is running.  Proposal: PDCCH skipping is transparent to MAC layer. |
| Nokia [3] | Proposal: UE ignores PDCCH skipping (i.e., PDCCH skipping is cancelled) while *drx-RetransmissionTimerUL* is running.  Proposal: discuss if to restrict it to only when the PUSCH transmission includes high priority/delay sensitive traffic (i.e. configurable per LCH)/MAC CEs. |
| Oppo [4] | For dynamic grant, if UE receives PDCCH skipping command after UL HARQ reTx timer is started, UE should follow the network’s command and skip PDCCH monitoring.  For configured grant, if UE receives PDCCH skipping command before UL HARQ reTx timer is started, UE should ignore PDCCH skipping.  For configured grant, if UE receives PDCCH skipping command after UL HARQ reTx timer is started, UE should follow the network’s command and skip PDCCH monitoring. |
| Huawei [5] | Proposal: The UE ignores the PDCCH skipping if a MAC PDU is transmitted on a configured grant resource and the DRX UL reTx timer is running. |
| Ericsson [6] | Proposal: The PDCCH skipping duration is pre-empted when UE SR is pending, during Random Access and after transmission of CS grant with UL SPS, and CFRA/CBRA during BFR. |
| Xaomi [7] | UE ignores PDCCH skipping while UL HARQ reTx timer is running |

**Q4: Which one of the following options do you agree?**

* **Option 1: It is up to RAN1 to decide whether UE ignore PDCCH skipping while UL HARQ reTx timer is running.**
* **Option 2: UE ignores PDCCH skipping while *drx-RetransmissionTimerUL* is running.**
* Option 3: For configured grant, if UE receives PDCCH skipping command before UL HARQ reTx timer is started, UE should ignore PDCCH skipping.

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Comments (if any)** |
| Samsung | No strong view | We are ok with option 1 or option 2, follow majority view. |
| OPPO | Option 3 | For DG, as UL grant is scheduled by the network, if UE receives PDCCH skipping command after UL HARQ reTx timer is started, it would be reasonable to assume that network has correctly received the PUSCH and do not expect any further UL scheduling. Therefore, in this case, UE should follow the NW’s command and skip PDCCH monitoring.  For CG, if UE receives PDCCH skipping command before UL HARQ reTx timer is started, UE should ignore PDCCH skipping. If UE receives PDCCH skipping command after UL HARQ reTx timer is started, UE may assume there is no retransmission grant to be expected, therefore UE should follow the NW’s command and skip PDCCH monitoring. |
| Intel | Option 2 |  |
| Qualcomm | Option 1 or Option 3 | We are fine with Option 1.  Comments on Option 2 and 3:  If the PUSCH is dynamically scheduled, it is unlikely that PDCCH skipping is scheduled before its reTx timer. Therefore, if UE receives a skipping indication while the reTx timer is already running, UE should respect network’s scheduling apply skipping. So we do not support Option 2.  If the PUSCH is over CG, if reTx timer is triggered after a skipping is already ongoing, then UE should ignore skipping and monitor PDCCH. Otherwise, UE should apply skipping as in the DG case, for the same reason given above. Therefore, we think Option 3 can be supported. |
| ZTE | Option 1 | We are fine with option 1. |
| LG | Comments | We think MAC entity should not be impacted by PDCCH skipping at all. Whether to apply PDCCH skipping in certain cases is RAN1 issue. We don’t see the need to discuss this issue in RAN2. |
| DENSO | Option 1 |  |
| CATT | Option 3 | Same understanding as OPPO/QC. |
| Huawei, HiSilicon | Option 3 | We prefer option 3 |
| Sequans | Option 3 | Agree with OPPO |
| vivo | Option 1 | As far as we learned, RAN1 has discussed this issue for a long time, we don’t think we should make any conclusions in RAN2, and we could just wait for RAN1 decision. |
| Ericsson | Option 1 or Option 3 |  |
| Xiaomi | - | We need first to identy the case we are talking about:  Is UE receives PDCCH skipping command before or after UL HARQ reTx timer is started?  If it is before, I think UE should igore the skipping.  If it is after, I think UE should follow the NW.  *[Rapp Comments]: This is basically option 3, where PDCCH skipping is ignored if UE receives PDCCH skipping command before UL HARQ reTx timer is started.* |
| Nokia | Option 2 |  |

Summary:

Option 1: 7 companies

Option 2: 3 companies

Option 3: 7 companies

**Proposal 4: RAN2 to discuss and agree on one of the following for handling PDCCH skipping while UL HARQ reTx timer is running:**

* **Option A: It is up to RAN1 to decide whether UE ignore PDCCH skipping while UL HARQ reTx timer is running.**
* Option B: For configured grant, if UE receives PDCCH skipping command before UL HARQ reTx timer is started, UE should ignore PDCCH skipping.

# Others

|  |  |
| --- | --- |
| **Source** | **Proposal** |
| Ericsson [6] | Proposal : The UE starts *drx-OnDurationTimer* when the DCP occasion(s) overlap with the PDCCH skip duration.  *[Rapporteur’s Comments]: This issue was discussed in RAN2#116bise. No need to further discuss as RAN2 has already sent an LS (R2-2201960) to RAN1 in last meeting.* |
| Ericsson [6] | Proposal: The UE reports aperiodic CSI during Active Time and outside Active Time when expected independent from the PDCCH skipping period.  Proposal : The UE reports periodic CSI during Active time independent from the PDCCH skipping duration.  *[Rapporteur’s Comments]: This issue was discussed in RAN2#116bise. No need to further discuss as RAN2 has already sent an LS (R2-2201960) to RAN1 in last meeting.* |
| Ericsson [6] | Proposal: Introduce preferred skipping duration in *UEAssistanceInformation* message.  *[Rapporteur’s Comments]: This issue was discussed in RAN2#116bise (see summary document R2-2201915). Only one company out of 16 supported the proposal.* |
| Xaomi [7] | The *bwp-InactivityTimer* and/or *sCellDeactivationTimer* on relevant cell(s) are not impacted by PDCCH-skipping.  *[Rapporteur’s Comments]: There is no proposal on the table which states that the bwp-InactivityTimer and/or sCellDeactivationTimer on relevant cell(s) are not impacted by PDCCH-skipping. So no need to discuss.* |

**Q5: Do you agree to introduce preferred skipping duration in *UEAssistanceInformation* message ?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Samsung | No | Not essential. This issue was discussed in RAN2#116bise and not agreed (see summary document R2-2201915). |
| OPPO | No | Not essential. |
| Intel | No |  |
| Qualcomm | Yes |  |
| ZTE | No | Agree with Samsung |
| LG | No |  |
| DENSO | No | Agree with Samsung |
| CATT | No |  |
| Huawei, HiSilicon | No | Agree with Samsung |
| Sequans | No |  |
| vivo | No |  |
| Ericsson | Yes | This may give additional information to the NW in setting up the skipping duration to obtain the optimal power-saving gain and latency impact. |
| Xiaomi | No |  |
| Nokia | No |  |

**Summary:**

Support: 2 companies

Not support: 12 companies

Significant majority of the companies do not agree with the proposal.

# Conclusion

**Proposal 1: UE ignores PDCCH skipping on all serving cells of the corresponding CG while SR is pending**.

**Proposal 2: If PDCCH skipping is applied to RNTI(s) monitored during RAR/MsgB window, UE ignores PDCCH skipping on SpCell.**

**Proposal 3: UE ignores PDCCH skipping on SpCell while contention resolution timer is running.**

**Proposal 4: RAN2 to discuss and agree on one of the following for handling PDCCH skipping while UL HARQ reTx timer is running:**

**Option A: It is up to RAN1 to decide whether UE ignore PDCCH skipping while UL HARQ reTx timer is running.**

Option B: For configured grant, if UE receives PDCCH skipping command before UL HARQ reTx timer is started, UE should ignore PDCCH skipping.

# Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
| Samsung (Rapporteur) | Anil Agiwal | anilag@samsung.com |
| OPPO | Haitao Li | Haitao Li (lihaitao@oppo.com) |
| Qualcomm | Linhai He | linhaihe@qti.qualcomm.com |
| LG | Jonggil Nam | jonggil.nam@lge.com |
| CATT | Pierre Bertrand | pierrebertrand@catt.cn |
| Huawei, HiSilicon | Jagdeep Singh | jagdeep.singh6@huawei.com |
| Sequans | Noam Cayron | noam.cayron@sequans.com |
| Vivo | Chenli | Chenli5g@vivo.com |
| Ericsson | Tuomas Tirronen | Tuomas.tirronen@ericsson.com |
| Xiaomi | Yanhua Li | Liyanhua1@xiaomi.com |
| Nokia | Chunli Wu | Chunli.wu@nokia-sbell.com |
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# Reference

[1] R2-2202287 PDCCH Skipping in RRC\_CONNECTED Samsung Electronics Co., Ltd

[2] R2-2202311 Discussion on PDCCH Skipping in RRC\_CONNECTED vivo

[3] R2-2202883 UL PUSCH transmission impact on PDCCH skipping Nokia, Nokia Shanghai Bell

[4] R2-2202994 Discussion on PDCCH skipping OPPO

[5] R2-2203230 PDCCH skipping while UL reTx timer is running Huawei, HiSilicon

[6] R2-2203253 DCI-based power saving adaptation during DRX Active Time Ericsson

[7] R2-2202354 Discussion on remaining issues on UE power saving Xiaomi Communications