**3GPP TSG-RAN WG2 Meeting #117 electronic  *R2-220xxxx***

**Online, Feb 21st – Mar 3rd 2022**

**Agenda item: 9.1.2**

**Source: ZTE (email discussion rapporteur)**

**Title: Report of [AT117-e][301][NBIOT/eMTC R17] Carrier selection (ZTE)**

**Document for: Discussion and Decision**

# Introduction

This document is the report of the offline email discussion “*[AT117-e][301][NBIOT/eMTC R17] Carrier Selection (ZTE)*”, as indicated below:

* *[AT117-e][301][NBIOT/eMTC R17] Carrier Selection (ZTE)*

***Status****: Started*

 ***Scope:*** *Progress and converge on remaining open issues.*

 ***Intended outcome:*** *Report in R2-2203575,*

 ***Deadline:*** *Friday 25th February 1200 UTC*

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# Background

As background, the agreements achieved in RAN2#116bis e-meeting are listed below:

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| **Agreements [Online]*** *UE can be enabled/disabled coverage-based paging carrier selection via dedicated signalling. Presence or absence of the coverage information can be implicit enable/disable indication.*
* *In SIB, the value range for Rmax (npdcch-NumRepetitionPaging) in R17 paging carrier (list) configuration can be ENUMERATED {r1, r2, r4, r8, r16, r32, r64, r128}.*
* *In SIB, coverage specific nB is supported, e.g., a common nB value is configured for the R17 paging carrier(s) with same Rmax (npdcch-NumRepetitionPaging).*
* *Coverage-specific default DRX cycle is not supported.*
* *Working assumption: In SIB, coverage specific ue-SpecificDRX-CycleMin is supported, e.g., a common ue-SpecificDRX-CycleMin value is configured for the R17 paging carrier(s) with same Rmax (npdcch-NumRepetitionPaging).*
	+ *(FFS check whether there are any issues with the UE specific minimum DRX cycle per coverage level, can confirm WA if no issues.)*
* *Paging weight can still be used in coverage-based paging carrier selection.*
* *In SIB, both non-mixed operation mode and mixed operation mode can be supported in R17 paging carrier list configuration. They can be configured separately (as legacy).*
* *The extension in SIB22-NB can be used for providing R17 paging carrier list configuration.*
* *No “offset” (headroom) would be introduced for the configured NRSRP threshold.*
* *A configurable cell specific timer period can be applied when UE compares its serving cell NRSRP with the NRSRP threshold. FFS how to signal and value range.*
* *It’s specified that UE does not switch paging carrier if it has stayed less than [xx] seconds on the carrier or within a PTW. FFS value of [xx] seconds*
* *Coverage based paging carrier selection is enabled implicitly, i.e., when relevant parameters are provided to the UE during release.*
* *The Rel-17 paging carriers can also be used as the DL carriers for random access.*
* *No need to introduce a subgroup of paging carriers for the more easily changed CE level.*
* *In SIB, at most 2 coverage levels can be configured in R17 paging carrier list, each coverage level has one NRSRP threshold*
* *Rmax may be configured per carrier or per carrier group (coverage level).*
* *A paging carrier group index, e.g., the index to one of the two lists which correspond to the 2 coverage levels in SIB, is provided to the UE in dedicated signaling (when UE is released to idle).*
* *UE measured NRSRP can be reported to network for assisting the network to provide suitable coverage level related information. FFS how.*
* *FFS whether to introduce a new paging carrier list, e.g., DL-ConfigCommon-NB-r17, or just to extend PCCH-ConfigList-NB.*
* *FFS whether to send LS to RAN3 (at the start of the next meeting)*
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In [R2-2202739], the first round discussion on the open issues for CEL-based paging carrier selection has been performed. In the online discussion at RAN2#117 e-meeting, the following agreements have been achieved:

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| * RAN2 introduces a new ue-SpecificDRX-CycleMin parameter which is configured per coverage level.
* Same rules, e.g., to wait a certain period of time or avoid paging carrier switching in PTW would be applied no matter UE selects legacy paging carrier or coverage-based paging carrier.
* RAN2 use the way of extending PCCH-Config-NB to provide the R17 paging carrier list configuration in SIB.
* It’s RAN2 assumption that the assigned information to UE in dedicated signaling also need to be delivered to core network and sent back to eNB in next paging.
* UEPagingCoverageInformation RRC container is used to deliver the assigned information to UE in dedicated signaling to core network and sent back to eNB. A response LS to RAN3 would be sent as early as possible.
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In this document, we will further discuss the remaining issues and give proposals.

# Discussion

## Open Issue 1: Timer for avoiding paging carrier switching

In [R2-2202739], based on the companies’ comments on how to specify the hysteresis rules for avoiding paging carrier switching, the following group proposals are given:

**(Has been agreed)Proposal 2a: Same rules, e.g., to wait a certain period of time or avoid paging carrier switching in PTW would be applied no matter UE selects legacy paging carrier or coverage-based paging carrier.**

**Proposal 2b: RAN2 discuss and make choice in the following options for reducing paging carrier switching:**

* **Option 1: For the case with eDRX configuration, just to simply specify that UE does not switch paging carrier within a PTW. For the case without eDRX configuration, a timer is specified to reduce paging carrier switching.**
* **Option 2: Only one timer is specified to reduce paging carrier switching in all the cases, e.g., regardless of whether UE is in PTW.**

**Proposal 2c: This timer in Option 1 or Option 2 in Proposal 2b can be started after UE selects legacy paging carrier or coverage-based paging carrier. UE is allowed to switch paging carrier if timer expires.**

**Proposal 2d: The length of the timer in Option 1 or Option 2 in Proposal 2b is configurable. RAN2 further discuss what’s the unit of the timer: DRX cycle or seconds?**

During the online discussion, companies further mentioned the following questions:

* What’s the suitable value for the [xx] seconds, e.g., to avoid paging carrier switching between 2 consecutive paging occasions? Rapporteur indicate there are comments during offline that UE don’t need to perform paging carrier selection on each PO. And this timer can be flexibly configured.
* Which node can configure this timer? eNB or CN? Which signaling can be used to configure this timer?

Based on above discussion, companies are invited to give comments for the following questions:

**Q1a: Companies are invited to give your preference on the following options for the hysteresis rules:**

* **Option 1: For the case with eDRX configuration, just to simply specify that UE does not switch paging carrier within a PTW. For the case without eDRX configuration, a timer is specified to reduce paging carrier switching.**
* **Option 2: Only one timer is specified to reduce paging carrier switching in all the cases, e.g., regardless of whether UE is in PTW.**
* **Other option**

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| **Company** | **Option** | **Comment** |
| ZTE | Option 2 | It seems that this option needs less specification work. |
| Sequans | Option 2 | It is simpler and there is no reason to differentiate the two cases. |
| Huawei, HiSilicon | Option 2 |  |
| Qualcomm | Option 2 |  |
| Spreadtrum | Option 2 |  |
| MediaTek | Option 2 |  |
| NEC | Option 2 | Agree to go with a simpler way. |
| Ericsson | Option 1 | We don’t think that the specification impact should be considered as the most important aspect here. We do not expect that the impact would be different for both options, e.g., for option 1 there may be an extra line in the spec that states that the UE does not switch paging carrier within a PTW or something similar.One needs to also consider this from network standpoint since the network would not be able to know the status of this timer even though the timer is configured by the network. This means that the network may end up paging the UE on both carriers. |

**Q1b: Companies are invited to indicate whether the following draft proposal can be agreed?**

**Draft proposal:** The timer can be started after UE selects coverage-based paging carrier or legacy paging carrier. When the timer is running, UE stick to the current paging carrier. If timer expires, UE is allowed to switch paging carrier.

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| **Company** | **Yes or No** | **Comment** |
| ZTE | Yes |  |
| Sequans | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes |  |
| Spreadtrum | Yes |  |
| MediaTek | Yes |  |
| NEC | Yes |  |
| Ericsson | Yes in principle | Here’s a suggestion for revision: “The timer is started after UE switches to another paging carrier. When the timer is running, UE does not switch its current paging carrier. When timer expires, UE shall switch its paging carrier based on its coverage status with respect to what was configured by the network.” |

**Q1c: Companies are invited to indicate whether you can agree that this timer is configurable?**

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| **Company** | **Yes or No** | **Comment** |
| ZTE | Yes |  |
| Sequans | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes |  |
| Spreadtrum | Yes |  |
| MediaTek | Maybe | We don’t see a solid reason that this timer should be configurable. |
| NEC | Yes |  |
| Ericsson | Yes | We strictly think that the timer should be configurable by the network. The value range should cover at least values smaller than the possible values that DRX cycles are configured and infinity. We also think that there should be separate timers for switching from coverage based paging carrier to legacy paging carrier and vice versa. |

**Q1d: If the answer for Q1c is Yes, companies are invited to indicate which option in below is preferred on how to configure the time value?**

* **Option 1: In SIB**
	+ **Option 1-1: to configure a cell-specific time value**
	+ **Option 1-2: to configure a coverage-specific time value**
* **Option 2: in dedicated signaling, e.g., together with the provision of coverage level information to UE**
* **Option 3: in NAS signaling**
* **Other option**

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| **Company** | **Option** | **Comment** |
| ZTE | Option 1 | We are fine with both Option 1-1 and Option 1-2. If go for Option 1-2, this time value may be configured together with some other coverage level parameters, e.g., nB, RSRP threshold. |
| Sequans | Option 1(-1) | Option 1-1 is simplest and can apply for DRX-cycle-based timer, Option 1-2 would need to be used for seconds-based timer to account for likely DRX cycle |
| Huawei, HiSilicon | Option1-1 |  |
| Qualcomm | Option 1-1 | Cell specific. |
| Spreadtrum | Option 1 | No strong preference on option 1-1 and option 1-2. |
| MediaTek | Option 1-1 |  |
| NEC | Option 1-1 | It seems that this option is the simplest. |
| Ericsson | Option 1-1 or Option 2 |  |

**Q1e: Companies are invited to indicate which option in below is preferred for the unit and value range of this timer?**

* **Option 1: The unit of timer value is DRX cycle, please further indicate the suggested value range**
* **Option 2: The unit of timer value is second or millisecond, please further indicate the suggested value range**
* **Other option**

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| **Company** | **Option** | **Comment** |
| ZTE | Option 1 | May be 1~4? No strong justification.  |
| Sequans | Option 1 | This seems more natural as it takes the actual behavior into account. Not sure about the values, but 1 seems too small, changing carrier each time does not seem the right approach. |
| Huawei, HiSilicon | Option 2 | we have a timer in seconds for cell reselection with the range (0..21) so we do not see why seconds will not work. We thing 10 – 40 s (which is lso the length of the PTW) should be finefor option 1, we are not sure which DRX cycle is considered, cell default DRX or UE specific DRX. In the second case, we will have different UE behavior for no specific reason  |
| Qualcomm | DRX | 2 – 8 (3-bit value). It can be the DRX value of the fallback carrier to ensure the same-time duration. |
| Spreadtrum | Option 1 | We slightly think that up to 8 DRX cycles can be allowed. |
| MediaTek | Option 1 | A minimum value of 1 DRX cycle should be supported. |
| NEC | Option 2 | This seems less specification work. For Option 1, if take actual paging monitoring behavior into account, does that mean the DRX cycle should be the one UE actually use (instead of directly considering the default DRX or UE specific DRX)? |
| Ericsson | Option 2 | Please see our comments to the previous question. It does not matter if the unit is seconds or milliseconds. However we think we should have a value range that covers something shorter than the possible DRX cycles (320ms, 640ms, 1280ms, and 2560ms), e.g., 200ms, 500ms, 1000ms, and 2400ms. |

**Q1f: Any other issues for this timer?**

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| **Company** | **Comment** |
| Qualcomm | If value is configured in seconds then it should be at least as long as the 2-DRX cycles. |
| Ericsson | We think it should be possible to configure the timer with a value less than a DRX cycle. Please see our comments to Q1c and Q1e. |
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## Open Issue 2: UE report

In [R2-2202739], the following options for UE report have been discussed:

* **Option 1:** to make legacy Msg5 report mandatory.
* **Option 2:** to report an indication on whether the existing CQI report is suitable for coverage-based paging carrier selection.

8 companies provided views:

* 4 companies (ZTE, Spreadtrum, Ericsson, MediaTek) prefer Option 1 for UE report. Among them, 1 company think it can be conditionally mandatory for R17 UE supports Rel-17 paging carrier selection.
* 2 companies (Qualcomm, Sequans) prefer Option 2 for UE report.
* 2 companies (Huawei, Nokia) think additional UE assistance information is not necessary. NW may have some other info and the latest CQI only needs to be referred (note that in legacy, eNB can determine a CEL and send it to core network). Or if the UE cannot provide any information, the eNB eventually does not assign a coverage level. Among them. 1 companies against Option 2.

As this issue has been discussed several meetings, more companies think such UE report is useful but not so critical. Rapporteur think no need to spend too much time on this issue and give the following proposal:

**Proposal 3: CQI report in Msg5 is conditionally mandatory for R17 UE that supports Rel-17 paging carrier selection. No other UE report is supported.**

But during the RAN2#117e online discussion, some companies still want to have more discussion on this:

* *QC think this report only provides a short term view and may not be suitable for longer term configuration of paging carrier, the report is not intended for this purpose and have a serious concern with this. Nokia thinks this report is not essential. Sequans, Thales agree with QC.*
* *Ericsson think this is better than nothing. Huawei thinks it is useful for eNB, and it is not the only information that can be used.*
* *Sequans think it can be supported and configured but conditionally mandatory is not necessary.*

**Q2: Companies are invited to indicate whether you can agree the following draft proposal? If no, please elaborate the preferred other way.**

**Draft proposal:** Measurement report in Msg5 is conditionally mandatory for R17 UE that supports Rel-17 paging carrier selection. No other UE report is supported.

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| **Company** | **Yes or No** | **Comment** |
| ZTE | Yes | For the previous Option 2:* **Option 2:** to report an indication on whether the existing CQI report is suitable for coverage-based paging carrier selection.

We have mentioned the following concerns before:* What’s the content in the report? Is it a simple indication (e.g., “Yes” for suitable and “No” for unsuitable) or some other mapping format? If it’s just “suitable” or “unsuitable”, we don’t think it’s useful to the eNB.
* When to send such indication? In Msg5 or during the connection? We assume such report can only be sent in last RRC connection, e.g., before eNB provide coverage level information in release message to UE.

We also agree with the online comments that besides UE report, some other information can be used by eNB for evaluating the status of a UE in connected mode. So such UE report is not so essential. |
| Sequans | No | We have already agreed:“A configurable cell specific timer period can be applied when UE compares its serving cell NRSRP with the NRSRP threshold”Why would a report that is supposed to help NW estimate the same be any different? Otherwise, it may just be misleading. So, a 1-bit indication whether UE the reported NRSRP satisfies the same condition should be enough.And, since this is an estimation over some relatively long period, the exact time it is given should not matter much, and specifying is for Msg5 would make for consistent behavior.However, since it doesn’t seem other companies agree, at the least this should not be made conditionally mandatory, to not give the impression this is likely helpful. The NW has other mechanisms to request measurements if it still considers it useful. |
| Qualcomm | No | Agree with Sequans, if RAN2 does not agree to an indication than UE measurement report should not be made mandatory and the network should not assign coverage-based paging carrier if the measurement report is missing. |
| Spreadtrum | Yes | We think option 1 is simple and feasible. For option 2, there are some issues (e.g., how to define indication, how to send the indication) needed to be clarified.  |
| NEC | No | This report may not be suitable for longer term configuration, it can be configured but conditionally mandatory is not necessary. |
| Ericsson | Yes |  |

## Other issue

In previous meeting, RAN2 has agreement that “*In SIB, coverage specific nB is supported, e.g., a common nB value is configured for the R17 paging carrier(s) with same Rmax (npdcch-NumRepetitionPaging)*”. And later, we have another agreement that “*Rmax may be configured per carrier or per carrier group (coverage level)”*. Then companies can have the understanding that Rmax cannot represent the coverage level, or in other word, Rmax can be different for different coverage-based paging carriers even they belong to one coverage level group.

So the main part of the first agreement, e.g., “*coverage specific nB is supported*” has no issue, but the remaining part may cause confusion. Company give some rewording suggestion.

**Q3a: Companies are invited to indicate whether you can agree the following draft proposal? If no, please elaborate the reason.**

**Draft proposal: A previous agreement can be refined as below:**

* **In SIB, coverage specific nB is supported, e.g., a common nB value is configured for the R17 paging carrier(s) with same coverage level.**

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| **Company** | **Yes or No** | **Comment** |
| ZTE | Yes |  |
| Sequans | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes | This refinement of the agreement of course does not mean all paging carrier for a given coverage level are required to have the same Rmax, |
| Spreadtrum | Yes |  |
| MediaTek | yes |  |
| Ericsson | Yes but | Just to clarify; as stated by the rapporteur, companies had a different interpretation for the following agreement “*Rmax may be configured per carrier or per carrier group (coverage level)”*. The revision proposed above may clarify the proposal on nB. Then we assume this means that all paging carriers configured for a given coverage level are NOT required to have the same Rmax, as stated above by Qualcomm. |

**Q3b: Companies are invited to indicate whether there is any clarification needed for the achieved agreements?**

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| **Company** | **Comment** |
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**Q3c: Companies are invited to indicate whether there is any other issue for CEL-based paging carrier selection?**

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| **Company** | **Comment** |
| Huawei, HiSilicon | we need to discuss the behaviour for the case where the UE had a coverage based configuration before establishing the connection and is released w/o the eNB contacting the CN. i.e the WUS ‘noLastCellUpdate’ case.One option would be that the UE keep the configuration it had before to avoid mismatch with the eNB. The second option is to do nothing special, the case should be quite rare and the mismatch not critical as the eNB will page on both carriers after some time. We have a preference for option2, i.e. no specific behaviour, UE follows the RRCConnectionRelease message. |
| Qualcomm | We presser option 2, i.e., no specific behaviour, UE follows the *RRCConnectionRelease* message and it is responsibility of eNB to set contents of *RRCConnectionRelease* message correctly.We also like RAN2 to clarify how the following agreement should be implemented:* Rmax may be configured per carrier or per carrier group (coverage level).

In the running CR in R2-2202427 it is implemented as delta signalling i.e., the value can be configured for the first paging carrier in the group and for any carrier in the group for which Rmax is omitted apply the value immediately from the previous carrier in the group.Alt 1: A variation of the above is to provide a coverage-specific Rmax and all carriers for the same coverage group use the this Rmax unless explicitly signalled for a a carrier in pcch-Config-17vx,Alt 2: Third option is to make Rmax in pcch-Config-17vx mandatory but this means extra 2-bits for each carrier in pcch-Config-17vx.From bits usage point of view both the current solution and Alt 1 are the same, while Alt 2 will use extra bits. |
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# Conclusion

TBD

# References

[1] R2-2200030, Report of [Post116-e][311] NB-IoT carrier selection (ZTE), RAN2#116bise

[2] R2-2201786, Report of [AT116bis-e][301][NBIOT/eMTC R17] Carrier Selection (ZTE), RAN2#116bise

[3] R2-2201795, Report of [310] Carrier selection open issues (ZTE), RAN2#116bise

[4] R2-2202739 Report of [Pre117e-301] Carrier selection open issues (ZTE), RAN2#117e