3GPP TSG-RAN WG2 #116e R2-21xxxxx

Electronic meeting, November 1st – 12th 2021

Agenda Item: 9.1.3

Source: Ericsson

Title: [Post115-e][302] [NBIOT/eMTC R17] carrier selection (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This document is to gather input from companies for below email discussion:

* [post115-e][302] [NBIOT/eMTC R17] carrier selection (Ericsson)

Scope: progress open issues, main aim is to converge on option 1c vs. 2a for decision in next meeting.

Intended outcome: Report to next meeting

Deadline: long

The two options are listed below

* Option 1c: Network enables UE to select a Rel-17 paging carrier by providing the coverage information (CEL/Rmax) for the carrier selection to the UE in dedicated signalling
* Option 2a: NW indicates the carrier to use explicitly via dedicated signalling based on information determined within the NW.

# 2 Contact Information

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| Company | Contact: Name (E-mail) |
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# 3 Discussion

RAN2 has been discussing the two options below for paging carrier selection,

* Option 1c: Network enables UE to select a Rel-17 paging carrier by providing the coverage information (CEL/Rmax) for the carrier selection to the UE in dedicated signalling
* Option 2a: NW indicates the carrier to use explicitly via dedicated signalling based on information determined within the NW.

There are different views regarding which of these options should be specified. Let’s have a look at the commonalities and differences.

In option 1c, the eNB provides an Rmax/CEL value to the UE so that the UE can select a paging carrier based on such value when it is released to idle mode. In option 2a, the eNB maps the UE directly to a paging carrier by indicating the paging carrier explicitly. This is in principle quite similar in both options. In option 1c there has to be also additional means for the network to indicate which paging carrier should the UE select in case there are multiple paging carrier with the same Rmax/CEL value.

Another similarity between these two Options is the sort of information that needs to be signalled between the eNB and the MME as part of the paging information container. For option 1c, it would be the Rmax/CEL value and for option 2a it is the paging carrier.

Once the UE is in idle mode monitoring the paging carrier as indicated by the network explicitly (as in option 2a) or implicitly (as in option 1c), there has to be means for the UE to check whether its coverage has stayed the same since it has been released to idle mode. Otherwise, the UE would not know whether it is time for the UE to reconsider its selection for the paging carrier. RAN2 has agreed that UE metric for determining carrier suitability and selection is based on NRSRP and a hysteresis/longer averaging/timer is used such UE metric based on NRSRP. It has also been agreed that whenever this criterion is met paging carrier as indicated by the network explicitly or implicitly is used, otherwise the UE should use the fallback mechanism.

Note that upon cell change RAN2 has agreed on two alternatives for option 1c and for option 2a UE performs the fallback to the legacy mechanism.

In the rest of this document, these two options are discussed with respect to the following aspects

* Impact on paging strategy
* Load Balancing
* Exception case handling (deletion, addition or change of carrier)
* Specification and Implementation Complexity

## 3.1 Impact on paging strategy

For option 1c there are two alternatives to consider when cell change happens, as mentioned above. These alternatives are Alt 1 UE to select a paging carrier based on previously determined “coverage level” and broadcasted paging carrier configuration in the new cell, and Alt 2 fallback mechanism. It has been claimed that Alt 1 will be beneficial, especially if the UE happens to be in the same or better coverage with respect to the previous cell since there will not be any need for fallback and the UE would continue to monitor the paging carrier with the same Rmax/CEL. On the other hand, it has also been claimed that such flexibility for the UE makes it challenging for the network to predict which paging carrier the UE may be monitoring and thus have an impact on the network paging strategy. Yet another claim was that cells may have different coverage (Tx power, CE levels, quality interference) and thus it may not be suitable to use the Rmax/CEL value determined in the previous cell to determine the paging carrier in the new cell.

For option 2a and Alt2 for option 1c, fallback mechanism is performed, which is the legacy paging carrier mechanism based on UE\_ID.

Q1: Companies are requested to provide feedback regarding the impact of these two alternatives for Option 1c on the paging strategy mechanism.

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**Summary: TBD**

## 3.2 Load Balancing

There has been no consensus on which option would provide means for the network to perform a uniform distribution of UEs to paging carriers.

In option 1c, the eNB and the UE would know which carrier to use or to monitor for paging messages based on the following formula in TS 36.304

floor(UE\_ID/(N\*Ns)) mod W < W(0) + W(1) + … + W(n)

In option 2a, the eNB would allocate a paging carrier to the UE when it is released to idle mode. In both options, it would be up to the network to make sure that UEs are uniformly distributed to the paging carriers as UEs would simply monitor the allocated paging carrier. Basically:

In Option 1c; the above formula needs to be computed by both eNB and individual UE and in option 2a it would be performed only by eNB.

One should also consider the mobile UEs moving in between cells which would make it harder for the network to maintain a uniform distribution unless UEs coming from neighbouring cells monitor legacy paging carriers based on UE\_IDs, i.e., use fallback mechanism, after cell reselection.

Q2: Companies are requested to illustrate the load balancing solution, how option 1c and option 2a can perform load balancing. Please elaborate on whether there is any difference between options when performance on uniform distribution is considered and what are pros/cons of each option with respect to load balancing.

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**Summary: TBD**

In actual network deployments when the number of users grow in a certain area, additional carrier may be required. The additional carrier generally has similar characteristics as compared to the deployed carrier. Hence, it is expected that different carriers may be configured with same Rmax value, especially if the network assumes/knows that there are many UEs, which have camped in the cell, that happen to be in similar coverage. In such case how will the network ensure that UEs are distributed uniformly.

Q3: Companies are requested to illustrate the load balancing solution, how option 1c and option 2a can perform load balancing in that case; i.e., if another paging carrier is added with similar characteristics; e.g. same Rmax due to capacity concerns.

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## 3.3 Exception case handling (deletion or change of carrier)

In this section we consider the scenario when network releases, adds or changes the configuration of a paging carrier so that the associated Rmax/CEL value changes.

For option 1c, it has been stated that the network can reconfigure the paging carriers with respect to their Rmax/CEL values so that the UEs would select accordingly once update takes place, i.e., after system information update notification. For option 2a, it has been stated that such update can be conveyed to the UEs with no need to change the carriers assigned to the UEs, but rather using pointers that are mapped to the actual carriers using a mapping table broadcast as part of system information.

Q4: Companies are requested to provide their view on exception case handling; e.g. when an assigned or selected carrier is deleted. Is there any benefit/drawback for any of the options (1c, 2a) and why?

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Summary: TBD

Another aspect to consider is when a new paging carrier with power boosting is added, an existing paging carrier is power boosted or a power boosted paging carrier is released.

Q5 Companies are requested to provide their views regarding how scenarios mentioned above are handled for option 1c and option 2a.

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## 3.4 Specification and Implementation complexity

Regarding the specification and implementation impacts, it is mainly the specification effort and UE/eNB implementation that needs to be considered.

Based upon the discussion so far, the paging carrier selection would be influenced by two key factors:

a) Rmax

b) DRX

Companies are requested to provide their input on the specification details such as TS 36.304 paging carrier formula update based upon their preferred option.

TS 36.304 Current Paging formula

floor(UE\_ID/(N\*Ns)) mod W < W(0) + W(1) + … + W(n)

How would the above Rmax and DRX based selection would be accommodated by the above formula. What updates are needed; if any?

Q6: Companies are requested to provide details of formula update needed to support each of their preferred option or can also provide for both options?

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Q7: Companies are requested to give input on the steps that UE would need to perform for the carrier selection considering multiple factors such as Rmax and DRX and describe the UE implementation effort/complexity level for their preferred option or can also provide for both options?

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Q8: Companies are requested to give input on the steps that eNB would need to perform the carrier selection considering multiple factors such as Rmax and DRX and describe the eNB implementation effort/complexity level for their preferred option or can also provide for both options?

Note: Of-course eNB implementation is not standardized here it is more to understand some steps that would be needed to gauge some complexity involved.

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Q9: Companies are requested to give an opinion based upon answer of above 3 questions regarding the complexity comparison between option 1c and option 2a. Please provide any additional comments as deemed necessary. Which option has less complexity?

* Option 1c
* Option 2a

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## 3.5 Other

Please provide any other input or other pros/cons for both options, if any.

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Summary: TBD

# 4 Conclusion

This paper focused on comparion of coverage based paging carrier selection option 1c and option 2a . Corresponding proposals are listed as follows:

TBD