**3GPP TSG-RAN2 Meeting #129bis** **R2-25xx**

**Wuhan, China, Apr 7-11, 2025**

**Agenda Item:** 8.2.2

**Work Item:** Ambient\_IoT\_Solutions

**Source:** Qualcomm Incorporated

**Title:** Email discussion report: [POST129][035][AIoT] Paging

**Document for:**Discussion/Decision

# Background

RAN#106 approved WI for Ambient IoT in [1]. One of the objectives for RAN2 is listed as follows:

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| * + Specify the necessary functions and procedures for an Ambient IoT compact protocol stack and lightweight signalling procedure to enable DO-DTT and DT data transmission:     - A-IoT Paging, including subsequent paging for the same service. Support the options that a paging message contains one identifier, and that a paging message contains no identifier. Temporary identifier is not supported, unless required by SA WGs.   Note: RAN2 aims to design a paging message format such that multiple identifiers can be contained in one paging message, for forward compatibility purposes. |

RAN2#129 discussed on paging aspects and made some agreements, and to discuss further, RAN2#129 allocated following email discussion:

* [POST129][035][AIoT] Paging (Qualcomm)

Intended outcome: Discuss and address the remaining paging FFSs considering the agreements this meeting: FFS device behaviour if multiple requests are received in parallel (if needed), FFS how reader will generate “transaction ID”, FFS the size of transaction ID.

Deadline: Long

Below is the list of RAN2#129 agreements with yellow highlights added to the FFSes:

**Agreements**

1. Parallel service requests by the same reader is not supported.
2. The device is expected to only perform one procedure at a time. FFS device behaviour if multiple requests are received in parallel (if needed).
3. The “transaction ID” can be generated by reader based on CN corelation ID. FFS how reader will generate “transaction ID”. FFS the size of transaction ID
4. 1 bit solution is excluded. FFS the size. Aim to have a reasonable size.
5. RAN2 acknowledges that multi-reader scenario may exist but we will not specify something specific for this purpose. We can rely on transaction ID and implementation to handle it.

**Agreements on paging ID**

1. The “one identifier” in the paging message includes both the case of “one single device identifier” and “one group identifier”/”filtering criteria”, while the exact format of latter is supposed to be designed by SA2.
2. The current assumption is that the paging identifier is transparent to the A-IoT MAC Layer and carried by upper layer. FFS if there is really a need for visibility in the MAC layer

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| **Agreements**   1. The A-IoT paging message can include a number of msg1 resources 2. From RAN2 perspective, after initial paging message, the R2D transmission which determines the Msg1 resource(s), can be achieved by one of the below two ways, unless RAN1 concludes to use L1 signaling later:   **Way-1**: introducing new R2D message other than the paging message, e.g., QueryRep-like; or  **Way-2***:* reusing the same paging message, using field(s) to indicate it is only to determine the Msg1 resource(s) and omitting the paging identifier (device ID/group ID) field  3. The service type of A-IoT (e.g., inventory only, inventory + command) is not included in paging message. |

This document is the report of the email discussion [POST129][035][AIoT] Paging.

# Contact information

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| --- | --- | --- |
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# Discussion on device behaviour if multiple requests are received in parallel

## Multiple paging for Different Service Requests

Note that following is already agreed which anticipates a device **should not expect to receive** another service request **from the same reader** while there is one ongoing procedure.

1. Parallel service requests by the same reader is not supported.
2. The device is expected to only perform one procedure at a time.

However, *not expect to receive* does not guarantee it will not happen. What would be the device behaviour if another service request **is received from the same reader** while there is one ongoing procedure? Thus, RAN2 has captured the FFS on device behaviour if multiple requests are received in parallel (if needed).

In addition, the above agreement #1 only covers the same reader case, i.e. different reader case is still open. However, an agreement relevant to this scenario is the following:

5. RAN2 acknowledges that multi-reader scenario may exist but we will not specify something specific for this purpose. We can rely on transaction ID and implementation to handle it.

**Q1: Should it be possible for the device to distinguish between whether the another (different) service request is received from the same reader vs the another (different) service request is received from a different reader?**

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| **Company** | **Yes/No** | **Comment** |
| Lenovo | No | Since A-IoT device is expected to perform only one procedure at the same time, no matter whether a different service request is received from the same reader or a different reader, the device cannot respond to it due to the capability limitation. Thus there has no need to distinguish between above two cases. |
| vivo | No | On the one hand, we see little possibility that the device is performing an ongoing procedure while encountering another service request, i.e., considering the low capability of device type 1, the same reader does not trigger parallel services toward one device at one time, different readers are expected to coordinate by implementation to avoid parallel service requests at the same time. In turn, there is no need for a device to identify readers.  On the other hand, similar view as above, it is unnecessary for the device to distinguish the paging message from the same or a different reader. As agreed that the device is expected to only perform one procedure at a time, it should not be involved in another (different) service request no matter if it is from the same or a different reader. |
| OPPO | No | No. agree with Lenovo |
| Huawei, HiSilicon | No | Device can differentiate the “different service” based on transaction ID, but cannot differentiate the same or different reader. It is agreed to not consider using reader ID to differentiate the multiple reader case. |
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**Summary:** TBD

**Q2: If answer to Q1 is yes, would the device behavior be different between: another (different) service request is received from the same reader vs another (different) service request is received from a different reader while there is one ongoing procedure?**

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| **Company** | **Yes/No** | **Comment** |
| OPPO |  | Regardless of another service request is coming from the same or different reader, the A-IOT device behavior shall be aligned, i.e., only performing one procedure at a time. This will reduce the complexity of A-IOT device. After the end of the procedure the A-IOT device shall respond to the related A-IOT paging message for a different service request |
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**Summary:** TBD

**Q3: What would be the device behavior if another (different) service request is received from the same reader while there is one ongoing procedure?**

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| **Company** | **Comment** |
| Lenovo | Since it was agreed in last meeting parallel service requests by the same reader is not supported, we are wondering the motivation for this scenario. If this happens, we assumed the device will ignore the different service request received from the same reader if there is ongoing procedure. |
| vivo | We do not think this case will happen, since the agreement does not support “parallel (another, different) service requests by the same reader”. That is, the reader itself should ensure that it would not trigger paging related to another service request towards a device, which has not successfully finished an ongoing procedure. |
| OPPO | The A-IOT device should just discard the following paging message if it has already been in a access process and before the end of the process, i,e, either the device considers that the process has been successfully finished or the process has been failed ( and re-access is needed) . |
| Huawei, HiSilicon | Single reader can control the paging to send. So, the reader shall not send another new paging if there is on-going procedure. It is up to reader implantation to guarantee “Parallel service requests by the same reader is not supported”.  In any case, the device behavior is: If the transaction ID received in the paging message differs from the one currently maintained by the device, the device will update its currently maintained transaction ID to the received value. |
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**Summary:** TBD

**Q4: What would be the device behavior if another (different) service request is received from a different reader while there is one ongoing procedure?**

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| **Company** | **Comment** |
| Lenovo | Considering there has no specific priority or latency requirements for A-IoT related services. If there is ongoing procedure, we assumed that the device will ignore the different service request if received from a different reader. |
| vivo | As mentioned in Q1, we see little possibility of such case.  However, once it happens, from the device perspective, itself cannot tell it is from a different reader but only it is related to another service request. In this sense, if the ongoing procedure is not finished, the device should ignore this another (different) service request. |
| OPPO | Regardless multi-reader or one-reader scenario, the A-IOT device behavior is the same: only performing one procedure at a time. |
| Huawei, HiSilicon | Device behavior is same as above Q3, i.e. update the stored transaction ID.  In our assumption, it is still up to the NW implementation to avoid the interleaved/parallel services in multiple reader case.  If multiple neighbor readers deployed belonging to the same BS, which should be one typical deployment, the coordination can be done by this BS implementation, to control the order of the services triggered by readers.  In case of multiple readers deployed belonging to the different BSs, which is not typical deployment for indoor scenario (i.e., one BS should be able to cover one factory), it is up to OAM to configure the isolate resources among BSs. As one example below, reader will not perform one service procedure across two discontinuous resources.    Please note that pure device solution, e.g., “device ignoring the new service”, does not work unless the transaction ID is carried in **all** R2D message. This is because, in case of interleaved services from different readers, the R2D messages (other than paging) from other reader-2 will impact the ongoing procedure of device under this reader-1. Hence, it requires transaction ID in all R2D message to let the device to filter out the R2D messages from neighbor reader.    Therefore, this issue has to be left to network. |
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**Summary:** TBD

The above questions deal with ‘different’ service requests while a procedure is already ongoing at the device. However, the same service request may be transmitted again in R2D direction (and this could be from the same or a different reader).

## Multiple paging for Same Service Request

Some companies have assumed that ‘transaction ID’ would be used by the device to detect repeated paging for the same service request, while others have indicated transaction ID may not be sufficient, especially if there is no coordination between the readers and the transaction ID is not large enough. Different views on reader ID, service ID etc. has been brough up before.

**Q5: Should it be possible for the device to distinguish between whether the same service request is received from the same reader vs the same service request is received from a different reader?**

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| **Company** | **Yes/No** | **Comment** |
| Lenovo | Yes | For resource and energy efficient consideration, the device needs to avoid the redundant responses from the same service request in principle. However, as discussed in RAN3 for locating purpose, CN may send a command to one or more readers associated with the A-IoT device to locate the device, in this case, the service request may be the same and whether the device needs to response it needs further discussion.  Therefore, the device is suggested to distinguish whether the same service request is received from the same reader or different reader. |
| vivo | No | RAN3 has agreed the case that CN allocates the same service request to different readers, possibly in order to improve the inventory efficiency. And the rational device behavior is only to successfully respond once when receiving the same service request from different readers for most scenarios. Moreover, one reader sending multiple paging messages for the same service request is to increase the successful inventory rate, where the device also only needs to successfully respond once.  Regarding the **multi-reader scenario** for the proximity service, the device is expected to respond to multiple readers for a same service. But as the agreement enlightened, the CN can assign readers with different correlation IDs and therefore reader can generate different transaction IDs for a single service. That is, we rely on CN but not the device to identify readers if the device is required to respond to different readers; and from the device point of view, the issue fallback to the device behavior of another (different) service request while there is one ongoing procedure as illustrated in Q4.  In this sense, we see no necessity for the device to distinguish whether the same service is from the same or a different reader. The device only needs to judge whether itself has successfully responded (i.e., successfully access to a reader) to such service request. |
| OPPO | Maybe | If we achieve the agreement that in multi-reader scenario, we need to let the A-IOT device to respond to A-IOT paging messages corresponding to the same service request coming from different readers, then the device shall distinguish whether the same service request is received from the same reader or a different reader, since the device behaviors are different when receiving paging message from the reader vs from a different reader.  On the other hand, we don’t find any clue that in the last RAN2 meeting we agree to rely on **CN** implementation. Even if CN assign readers with different correlation ID, still it could be possible for the readers to use the same transaction ID to trigger the A-IOT paging message, since the transaction ID space is so limited. |
| Huawei, HiSilicon | No | If they are “same service”, i.e. using the same transaction ID, without differentiating the one from same vs. different readers, device always uses the transaction ID to determine whether to skip the subsequent paging or not. |
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**Summary:** TBD

Now let’s go to the device’s expected behaviour for the **same** service request received again.

**Q6: If answer to Q5 is yes, would the device behavior be different between: the same service request is received from the same reader vs the same service request is received from a different reader after the device has previously responded to the same service request?**

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| **Company** | **Yes/No** | **Comment** |
| Lenovo | Yes | As commented in Q5, if location scenario is considered, then the device needs to distinguish whether the same service request is received from the same reader or different reader. Corresponding device behavior for responding can be different. |
| OPPO | yes | For the same-reader case, the device shall not respond to the message if it has already successfully finished the procedure before. For the multi-reader case, the device shall respond to the message |
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**Summary:** TBD

**Q7: What would be the device behavior if same service request is received from the same reader after device has previously responded to the same service request?**

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| **Company** | **Comment** |
| Lenovo | As discussed in SI phase, if the same service request is received from the same reader, the device skips to respond to the same service request to avoid duplicate responses. |
| vivo | It needs clarification on “device has previously responded to the same service request”, since the device behavior can be different depending on whether the previous response is successful or not.  If the device considers the previously-responded service request is successfully responded before receiving the same service request, it should ignore this same service request. On the contrary, if the previous service is not finished yet and the device receives this same service request, the device should response to such same service request. |
| OPPO | Agree with vivo. If successfully finished, then the device shall skip the following same service request; otherwise, the device shall respond to the same service request. |
| Huawei, HiSilicon | The device behavior for such case has been agreed already: if the device has successful performed the same procedure, device will not response the subsequent same service request. Otherwise, device will response. |
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**Summary:** TBD

**Q8: What would be the device behavior if same service request is received from a different reader after device has previously responded to the same service request?**

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| **Company** | **Comment** |
| Lenovo | For locating scenario, CN may indicate one or more readers associated with the A-IoT device to find the A-IoT device by transmitting the A-IoT paging message. From the A-IoT device perspective, it may receive multiple A-IoT paging messages from different readers (e.g., BS, intermediate node etc.) associated with the same service request. In this case, our view is that device needs to respond to the service request at least for location purpose.  Regarding to how the device to distinguish the same service request is from a same or different reader, reader ID is introduced or based on transaction ID can be further discussed. If transaction ID is used, the coordination among readers may be needed, or rely on CN implementation to generate different correlation ID for the same locating service request. |
| vivo | As mentioned in Q1, we see little possibility of deploying such case.  Once it happens, with no differentiation on reader, the device behavior is illustrated in Q7. |
| OPPO | If we achieve the agreement that in multi-reader scenario, we need to let the A-IOT device to respond to A-IOT paging messages corresponding to the same service request coming from different readers, the A-IOT device shall respond to the A-IOT paging message corresponding to the same service request coming from another reader. |
| Huawei, HiSilicon | RAN2 acknowledges that multi-reader scenario may exist but we will not specify something specific for this purpose. We can rely on transaction ID and implementation to handle it.  Based on the RAN2 agreement, “same service request” to the device means the same transaction ID. So, it is up to the CN to use the suitable correlation ID for each service.  In the case in Q8, it is the CN choice to use same correlation ID for different readers for this “same service”. Then, CN expects the device to not redundantly response from different readers. |
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**Summary:** TBD

# Discussion on transaction ID

Note that RAN2 has agreed the following:

5. RAN2 acknowledges that multi-reader scenario may exist but we will not specify something specific for this purpose. We can rely on transaction ID and implementation to handle it.

Following question is to confirm the companies understanding on use of the transaction ID.

**Q9: Is transaction ID sufficient for the device to confirm that the received service request is the same service request from the same/different reader that the device has already received/responded to?**

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| **Company** | **Yes/No** | **Comment** |
| Lenovo | Yes | Device can determine whether to respond the received paging message with the assistance of appropriate transaction ID generation mechanism and CN implementation. One of the possible mechanisms is as follows:   * Different readers generate same transaction ID based on the same correlation ID from CN. In this way, device doesn’t send duplicated response to different readers for the service request with same correlation ID. * For the proximity/locating service, CN sends service requests with different correlation ID to different readers. So readers generate different transaction ID, and device responds to each reader. |
| vivo | Yes | Based on the agreement “the “transaction ID” can be generated by reader based on CN corelation ID”, the transaction ID is specific to a single service, where the CN correlation ID is used to identify a single service request between network interfaces.  In this sense, the device is able to identify the currently-received paging message is related to the same or different service request from the one it has already received/responded to, by comparing whether the transaction ID is same or different. |
| OPPO | No | For multi-reader scenario, only if transaction ID bit space is quite large, then even without reader ID or coordination between the different readers on usage of the transaction ID, the probability of collision of the transaction IDs to be used for different service requests from different reader could be low. However, that will require lots of signaling overhead, maybe more than 10 bit is required.  For same-reader case, we should rely on the reader implementation to not issue a recently used transaction ID to a new service request paging message to avoid the wrap around problem, if the transaction ID bit space is reasonable large. |
| Huawei, HiSilicon | Yes | It is already agreed. |
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**Summary:** TBD

**Q10: If your answer to Q9 is no, what else is needed for the device to confirm that the received service request is the same service request from the same/different reader that the device has already received/responded to?**

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| **Company** | **Comment** |
| OPPO | For multi-reader scenario, to confirm that if the received service request comes from a different reader at 100% confidence level, a reader ID is required to be carried in the A-IOT paging message. |
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**Summary:** TBD

## Generation of Transaction ID

RAN2 has agreed that the transaction ID can be generated by reader based on CN correlation ID. However exact details have not been discussed. Furthermore, whether there is a standard-specified coordination mechanism between the readers is more relevant for RAN3. Following questions are to understand from RAN2 point of view, how do companies envision the transaction ID being generated by the readers.

**Q11: Is there a need for coordination between the readers when generating transaction ID?**

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| **Company** | **Yes/No** | **Comment** |
| Lenovo | Depends | It depends on whether the transaction ID generation mechanism is specified or not.   * Opt 1: Explicit signaling between readers may not be needed if generation mechanism is specified, i.e., readers can achieve alignment based on the specified generation mechanism, e.g., use the LSB X bits of correlation ID as the transaction ID. * Opt 2: If it’s up to reader implementation to generate transaction ID or reader randomly select X bits among all bits of correlation ID to generate transaction ID, different readers may generate same/different transaction ID for different/same service, causing misunderstanding on device. To avoid the situation, explicit signaling between readers is needed in this case.   We prefer Opt1 which does not introduce signaling overhead between readers and has less impact to RAN3. |
| vivo | See comments | To make transaction ID unique to a service is to ensure the generation method is unified for all readers per AIOTF. With the same method towards the same correlation ID, the reader itself is able to generate the same transaction ID for the same service without coordination with other readers.  From RAN2 perspective, we prefer to avoid reader coordination, and it can be more like a requirement to SA2/RAN3 to specify a unified generation method of correlation ID among readers. But the final decision is up to other WGs. |
| OPPO | No | Bearing in mind that topology 2 needs to be supported in future. For future-proof, we don’t know think that coordination between the readers shall be pursued. For topology 2, this will require the SL communication capability of readers. For instance, the UE reader, in the first step, shall find a neighbor UE reader via SL discovery procedure. |
| Huawei, HiSilicon | Seems no | Reader can use the rightmost 3 bits of the correlation ID from CN as the transaction ID. Or, other reader implementation example can map one CN correlation ID to its transaction ID, to somehow make the transaction ID different if the correlation ID is different. |
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**Summary:** TBD

**Q12: How is the transaction ID generated by the Reader based on CN correlation ID?**

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| **Company** | **Comment** |
| Lenovo | As commented above, we prefer to specify a simple generation mechanism. Using the unique part of the correlation ID as the transaction ID is simple and efficient, e.g., use the LSB bits (last X bits). |
| vivo | We consider this issue is more related to SA2/RAN3’s design, which should take into account that the uniqueness of CN correlation ID within a certain period over a certain area. |
| OPPO | By now the details of the pattern of the CN correlation ID is still being discussed in SA2, so we don’t know whether or not it is possible to ensure the uniqueness of the transaction ID in a certain time duration by making some processing of the CN correlation ID to generate the transaction. But one general principle should be follows:  A newly received CN correlation ID shall be mapped to a transaction ID that has not been used recently, i.e., leaving enough time gap for reusing the same transaction ID in order to let A-IOT devices recognize that latter A-IOT paging message shall correspond a new service request.  Regarding Lenovo’s opinion, we don’t know yet whether there will be a unique part of the correlation ID. Also, the transaction ID bitstream length is limited, we can not make sure that for different service, the transaction ID could be different. |
| Huawei, HiSilicon | See above. But, we don’t have to specify the reader behavior. |
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**Summary:** TBD

## Size of Transaction ID

RAN2 has captured the following regarding the size of Transaction ID:

4. 1 bit solution is excluded. FFS the size. Aim to have a reasonable size.

**Q13: What should be the size of the ‘transaction ID’? (Note that 1 bit is already excluded and RAN2 aim is to have a reasonable size. So, please clarify why/how more/less bits are needed/sufficient.)**

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| **Company** | **Comment** |
| Lenovo | Unfortunately, we don’t know yet the structure and length of the correlation id.  As reference the length of the LCS Correlation ID is minimum 1 character and maximum 255 characters. And depending on the encoding scheme one or multiple bytes are needed to encode a character, e.g. 1 to 4 bytes may be needed to encode a character in case of UTF-8.  Therefore, it may be better to defer the discussion on the size of the transaction id and coordinate first with SA2 on the details of the correlation id (structure and length). |
| vivo | From AS perspective to avoid duplicated responses, we consider at least 3-bit is a reasonable size of the transaction ID.  To be specific, the size depends on the maximum number of services that the CN may trigger towards a device within a certain time period and the flexible adjustment room for likely wrap-around case. Recurring RFID, 4 parallel services are allowed for a device. If we totally reuse, 2-bit length can be too extreme which requires CN limitation. To be more competent than RFID, 3-bit transaction ID means that no more than 8 services can be triggered towards a device, which allows CN more flexibility to reduce time latency at a tolerable expense and avoids the possibility of wrap-around.  Most importantly, agree with Lenovo, we still believe the size of transaction ID requires SA2 evaluation. To be specific, RAN2 should have consensus on its usage and requirement in AS layer, keep SA2/RAN3 informed ANS ask them about Q11-13 on transaction ID design. |
| OPPO | 3-4 bit is enough for the same-reader case. For multi-reader scenario, if reader ID is not supported, then more than 10 bits are required since for one overlapped coverage area, may be 3 to 4 reader’s A-IOT paging message could be heard. |
| Huawei, HiSilicon | 2 or 3 bits should be sufficient for indoor case. |
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**Summary:** TBD

# Discussion on visibility of paging identifier to the MAC layer

The relevant agreement from RAN2#129 is copied again:

1. The “one identifier” in the paging message includes both the case of “one single device identifier” and “one group identifier”/”filtering criteria”, while the exact format of latter is supposed to be designed by SA2.
2. The current assumption is that the paging identifier is transparent to the A-IoT MAC Layer and carried by upper layer. FFS if there is really a need for visibility in the MAC layer

Separately, the reply LS from SA3 in R2-2501502 indicates the following SA3 conclusions captured in S3-251048:

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| The following aspects and principles are agreed for the conclusion on KI#3  - A mechanism to protect AIoT device ID based on the use of temporary ID shall be supported.  - Mechanism shall allow unambiguous identification of the AIoT device  - A mechanism to re-synchronize de-synchronized temporary IDs shall be supported.  Editor’s Note: Additional conclusions on solution are FFS |

The above seems to imply that the temporary ID, instead of the AIoT device ID, is to be used as AIoT paging identifier. However, RAN2 has not discussed this in detail.

**Q14: Please provide your view one whether the paging identifier needs to be visible to the MAC layer. If yes, why?**

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| **Company** | **Yes/No** | **Comment** |
| Lenovo | No | According to above information provided by the Rapp, we understand this temporary ID that used as paging ID, is generated by the core network e.g. AIoTF based on the device ID. It is not suitable to let AS layer to further process the id e.g. filter or re-group. To us it is unnecessary to let paging identifier visible to the MAC layer. |
| vivo | No, see comments | The primary thing is that the paging identifier is recognized and handled by A-IoT NAS layer or MAC layer. From our perspective, the paging identifier is allocated by AIOTF and maintained at A-IoT NAS layer. If the paging identifier is visible to AS layer, it violates the end-to-end design criterion. In this sense, we see no need to make it visible to MAC layer.  However, when temporary ID is supported as a form of paging identifier, it can be viable that such paging identifier to be visible to MAC layer from technical perspective. But we think the benefit of visibility needs to be proved further and depends on other WGs’ progress. |
| OPPO | No | Our initial though was to make the ID visible to the MAC layer, which leaves more time for the MAC layer to determine the random-access resource index and the resource time-frequency location for Msg1 transmission. But such purpose could be also fulfilled by the implementation, e.g., the NAS layer sends a confirmation flag to the MAC layer to trigger it to do the msg1 transmission preparation work, as soon as the NAS layer confirms this device has been paged.  In addition, consider the possible security problem brought by making the ID visible to the MAC layer, and more signaling overhead may be incurred, we agree that such ID shall not be visible to the MAC layer. |
| Huawei, HiSilicon | No | We don’t support any MAC layer sub-group paging solution. |
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**Summary:** TBD

# Misc/Other

**Q15: Please list below if there are other open issues which should be addressed in this email discussion.**

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| **Company** | **Issue/Question** | **Comment/Details** |
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**Summary:** TBD

# Summary

TBD

# References

[1] RP-243326, New Work Item: Solutions for Ambient IoT (Internet of Things) in NR, RAN#106, Dec 2024