3GPP RAN WG2 Meeting #131bis R2-250xxxx

Prague, CZ, Oct 13rd –17th, 2025

**Agenda Item: 8.2.1**

**Source: Huawei, HiSilicon**

**Title: Summary of A-IoT MAC open issues (outcome of [POST131][021][AIoT] MAC Running CR)**

**Document for: Discussion and Decision**

# Introduction

The following document includes a list of open issues and the suggested resolutions.

# Contact information

Please provide your contact information.

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# Remaining open issues for specification 38.391

## List of the open issues and type of issue

The status of the open issues has been updated in tracking mode according to the latest agreement. The rapporteur observes there are three remaining issues:

* How to capture security parameter in Paging message (Issue 1-7)
* Checking whether there is new case for “no upper layer data available” other than long writing operation which may impact to how to set MDI field (Issue 3-7)
* Paging ID length impact from new SA2 LS in S2-2507793 (Issue 1-3)

The above issues seem not to be straightforward, so the rapporteur marks the classification as “To be discussed by company contributions”. Further discussion in next meeting would be based on companies’ contribution.

The rapporteur also would like to remind companies that CT1 sent an LS in the Oct meeting in C1-255679 (LS on the maximum supported AIoT NAS container length). The rapporteur doesn’t foresee impact to MAC, which means it’s not an open issue of MAC, however, for the convenience of tracking protentional discussion points for next meeting, the handling of this LS has still been included in the open issue list as new issue 4-6. The reply LS is supposed to be easy, but if companies think it’s necessary, it can be discussed by contribution.

More details of the remaining issues can be found in the table below, with the highlighted shading of the corresponding table cells.

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| Issue number, brief title | Issue description | Issue classification |
| **Group 1: Paging** |
| **Subgroup: Multi-reader scenario** |
| Issue 1-1: multi-reader paging | If a device gets a new service request while one procedure is still ongoing, whether/how to specify device behaviour or leave it to implementation, and the end of procedure if needed.* *Rel-19 devices are not expected to receive parallel service request for overlapping reader scenario based on network implementation. Capture this in stage 2 specification.*
* *The Rel-19 device always responds to the new service indicated by the received paging message applicable for that device. Capture this in stage 3 specification.*
* *Send LS to RAN3 to notify them of agreements 1 and 2*
* *Parallel service request for overlapping reader scenario can be addressed in Rel-20*
* *Status in running CR: captured in 5.2.*
 | Addressed/closed |
| **Subgroup: Transaction ID** |
| Issue 1-2: transaction ID  | Whether/how to specify how the reader generate Transaction ID, and the size* *Relevant agreements:*
* *6 bits for Transaction ID length.*
* *RAN2 confirms how to generate transaction ID is left to reader (no spec impact)*
* *Status in running CR: the field is captured in 6.2.1.1 with the detailed format.*
 | Addressed/closed |
| **Subgroup: Paging message content** |
| Issue 1-3:Paging ID length field | The field to indicate the paging ID length, e.g., how many bits, taking into account of CT4 and SA2 inputs.* *Relevant agreements:*
* *8-bit length field (in unit of bit) is assumed to indicate the paging ID length, based on current SA2/CT4 conclusion.*
* *However, in Aug meeting, SA2 sent a new LS to RAN2 in S2-2507793 on AIoT Device Permanent ID Length, indicating SA2 identified requirements for longer device ID, and the rapporteur understand this will impact the length of paging ID as well, e.g., 600 bits are needed instead of 256 bits. Therefore, in Oct meeting, RAN2 needs to discuss how to reply the SA2 LS, and how to handle the impact to paging ID length field.*
* *Status in running CR: the field name is captured in 6.2.1.1 with the detailed format.*
 | To be discussed by company contributions |
| Issue 1-4: AO number field | How to indicate the number of access occasions, e.g. the maximum number, the length of field, format design.* *Relevant agreements:*
* *Issue (1-4) For number of access occasions introduce exponential way, 4 bits, value range FFS*
* *Keep current agreement. The reader should provide enough access trigger to cover at least signalled AOs in current round, unless the reader choses to start the subsequent paging round. Capture in stage 2 and rapporteur will work in the wording.*
* *Status in running CR: the field name and format is captured in 6.2.1.1.*
 | Addressed/closed |
| Issue 1-5:Paging content for CFRA | As baseline, the transaction ID is absent in Paging message for CFRA. FFS on the need for the transaction ID for command case.* *Relevant agreements:*
	+ *RAN2 confirms the pervious RAN2 baseline that transaction ID is not included in paging message for CFRA. Clarify that CBRA can be used by reader for single device.*
* *Status in running CR: the CR is implemented assuming no transaction ID for CFRA.*
 | Addressed/closed |
| Issue 1-7: Security parameter | How to include the security parameters in Paging message.* *Based on SA3 LS in S3-252392, it’s understood that security is a mandatory feature to be supported by the Rel-19 devices. But companies also raised question during online discussion whether the security parameters can be optional, for instance the feature can be activated/controlled by network. And companies also mentioned that the signaling overhead of the current paging message design is an important aspect from RAN2 point of view. Then how to capture the security parameter has been postponed and expected more discussion in Oct meeting. In this case, this issue is classified as “to be discussed by contribution”, and the rapporteur would like to suggest companies also to consider more from RAN2 perspective when designing signaling in their contributions, in terms of e.g., signaling compatibility, flexibility, signaling overhead, and scalability.*
* *SA3 provided more information about the security design in LS S3-252933 in Aug meeting, which should be take into account.*
* *Relevant agreements:*
	+ *RAN2 thinks it is feasible from a signalling perspective to add the 128 bits. However, from RAN2 perspective the less overhead the better, so SA3 should avoid adding additional parameters if possible.*
	+ *Indicate to SA3 that RAN2 tries to minimize number of bits required. Have a maximum size of 1000bits, and whatever they include has to fit in the 1000bits considering bits from all TSG.*
	+ *RAN2 will wait for SA3 conclusions in October on whether the “128bit random number in the paging request message” is always required or not.*
	+ *Reply to SA3 (The LS is approved in R2-2506465)*
		- *RAN2 thinks it is feasible from a signalling perspective to add the 128 bits. However, from RAN2 perspective the less overhead the better, so SA3 should avoid adding additional parameters if possible.*
		- *Indicate to SA3 that RAN2 tries to minimize number of bits required. Have a maximum size of 1000bits, and whatever they include has to fit in the 1000bits considering bits from all TSG.*
		- *Indicate space pressure from all the WG*
* *Status in running CR: not captured yet*
 | To be discussed by company contributions |
| **Subgroup: Others** |
| Issue 1-6:Paging ID visibility | Whether Paging ID is invisible or visible to MAC.* *Relevant agreements:*
* *The paging ID is visible to the reader. No specification impact.*
 |  Addressed/closed |
| **Group 2: Random access** |
| **Subgroup: R2D trigger message and Msg1 related** |
| Issue 2-1:Msg1 resource selection | Whether/how to specify the device detailed behaviour of randomly selecting the Msg1 resource based on the R2D trigger message.* *Relevant agreements:*
* *A new R2D message other than the paging message is introduced for A-IoT device determining MSG1 resources unless RAN1 concludes to use L1 signaling. The R2D message indicates the start of a set of MSG1 resources that were configured in paging message.*
* *Assumption: The R2D message does not include slot number/count down number.*
* *For Msg1 resource selection procedure capture as guidance the countdown behaviour in the MAC specification (use TP in R2-2503952). Capture a NOTE that other implementation are allowed. X, Y will be signalled by paging message.*
* *Status in running CR: captured in 5.3.3.1.*
 | Addressed/closed |
| Issue 2-2:Paging&first R2D trigger message | Whether the R2D trigger message is needed in CFRA, and whether the first R2D trigger message will be merged into paging message in CBRA.* *The start of the first set of MSG1 resources is indicated by Paging message directly instead of the new R2D trigger messages. R2D trigger message is not sent in CFRA procedure. Come back if RAN1/4 sees any issues. Send LS to RAN1/RAN4.*
* *Status in running CR: captured.*
 | Addressed/closed |
| Issue 2-3: R2D trigger message byte alignment | The R2D trigger message should be byte aligned or not.* *Relevant agreements:*
* *Access Trigger message is 3 bits and no padding bits are added (i.e. not byte aligned)*
* *Status in running CR: captured.*
 | Addressed/closed |
| **Subgroup: CBRA procedure related** |  |
| Issue 2-4: CBRA failure detection | Further down selection between option B and C for msg2 monitor window in CBRA.* *Relevant agreements:*
	+ *The boundary is the reception of either the kth Access trigger message or the subsequent paging message. Reader implementation to send MSG2 immediately (before k) is allowed. K can be configured to be either 1 or 4 in paging message.*
* *Status in running CR: captured.*
 | Addressed/closed |
| **Subgroup: Msg2 content** |  |
| Issue 2-5:random ID differentiation in Msg2 | Whether to include frequency index along with RN16 in MSG2 to reduce collisions of MSG1 between different devices.* *Relevant agreements:*
* *3-bit frequency index is optionally included with each echoed random ID in MSG2. We have 1 bit in MSG2 to indicate presence/absence of the frequency information for all included RN16s.Status in running CR: captured.*
 |  Addressed/closed |
| Issue 2-6:number indication of echoed random IDs in Msg2 | Whether to indicate the number of echoed random IDs included in Msg2.* *Relevant agreements:*
	+ *No entry number is included in either Msg2 or NACK feedback message. RAN2 understands that device can decode the entries one by one till message end, other implementations are not precluded (we will not capture this in the spec).*
* *Status in running CR: the CR is implemented with no explicit number indication.*
 | Addressed/closed |
| Issue 2-7: present/absent indication of assigned AS ID in Msg2 | How to indicate the AS ID presence in Msg2.* *One bit indication is needed for each echoed random ID in Msg2 to indicate whether AS ID is present (i.e., assigned by reader) for this random ID..*
* *Status in running CR: captured.*
 | Addressed/closed |
| **Subgroup: CFRA procedure specific** |
| Issue 2-8: no re-access for CFRA | How to achieve “no re-access” for CFRA* *Relevant agreements:*
* *For CFRA, NACK feedback and re-access is not supported. FFS how to achieve.*
* *For CFRA, the device always responds to paging regardless of transaction ID (if we put a transaction ID) (i.e. as long as it is addressed to the corresponding device).*
* *Status in running CR: captured in 5.2.*
 | Addressed/closed |
| Issue 2-9: AS ID assignment in multi-device CFRA | Whether to consider multiple device scenario as to the AS ID in CFRA.* *This scenario is not supported*
* *Relevant agreements:*
* *ID is the only ID needed for addressing the device in R2D command message assuming for CFRA no multiple devices are performing the procedures with the given reader. FFS if we can assume or need to support multiple device scenario.*
* *For CFRA, the device always responds to paging regardless of transaction ID (if we put a transaction ID) (i.e. as long as it is addressed to the corresponding device*
* *Status in running CR: not captured.*
 | Addressed/closed |
| **Subgroup: NACK feedback** |
| Issue 2-10: NACK before paging or R2D trigger message | For the re-access due to reception of NACK indication before subsequent R2D message, whether the subsequent R2D message is the R2D trigger message or paging message.* *Relevant agreements:*
* *For msg3, we rely on whether the device receives NACK indication before subsequent R2D message to determine re-access. No need for a timer. FFS whether subsequent R2D message is trigger message or paging*
* *After MSG3 transmission, upon receiving NACK with its AS ID before subsequent paging or command addressed to this device from the reader, device determines it will perform re-access. FFS how to specify.*
* *Status in running CR: captured in 5.5.*
 | Addressed/closed |
| Issue 2-11: explicit message for NACK | Whether to use a new/explicit R2D message for NACK feedback.* *Relevant agreements:*
* *NACK based mechanism is supported for D2R messages to determine re-access for at least msg3. FFS details including whether we need a timer or explicit message and when reader sends feedback.*
* *NACK feedback is defined as an explicit message (i.e. new message type). AS ID(s) is/are included to indicate the failure for given device(s). Multiplexing of NACK feedback is supported in one message*
* *Status in running CR: captured.*
 | Addressed/closed |
| Issue 2-12: multiplexing for NACK indication | Whether to support multiplexing of information for multiple devices in NACK feedback.* *Relevant agreements:*
* *Support multiplexing of information for multiple devices in R2D message for msg2. FFS others for multicast messages.*
* *Multiplexing of NACK feedback is supported in one message*
* *Status in running CR: captured.*
 | Addressed/closed |
| **Group 3: Data transmission** |
| **Subgroup: Segmentation** |
| Issue 3-1: command for non-first segment | Whether upper layer command is included in the R2D message scheduling for non-first segment.* *Relevant agreements:*
* *FFS whether the reader always includes the command for retransmission of segments.*
* *R2D message scheduling non-first segment (re)transmission does not include upper layer command.*
* *Status in running CR: captured in 5.4.2.*
 | Addressed/closed |
| Issue 3-2: offset for first segment | Whether offset is included in the R2D message scheduling for the first segment and unsegmented message* *Relevant agreements:*
* *For the retransmission of the first segment/unsegmented D2R message, the reader sends the R2D message by including the upper layer command again. FFS whether offset zero is always included.*
* *For the first segment and unsegmented packet (re)transmission, the “offset” indicator in R2D is not present.*
* *Status in running CR: captured in 5.4.3.*
 | Addressed/closed |
| **Subgroup: AS ID** |
| Issue 3-3: AS ID release | Whether a release message is needed for AS ID release* *Relevant agreements:*
* *Explicit AS ID release message is not needed*
* *Status in running CR: captured.*
 | Addressed/closed |
| **Subgroup: D2R message content for data transmission** |
| Issue 3-4: D2R padding indication | How to indicate padding and the Length field for SDU (segmentation or non-segmentation) or padding and its size* *Relevant agreements:*
* *In case where MAC PDU includes both MAC SDU and padding, for D2R a field to indicate how many SDU bits are present is required. FFS how this is provided (i.e. SDU length field or padding length field). The size of length field is FFS.*
* *A mandatory length field directly indicates the length of D2R data MAC SDU to support varying lengths of D2R data. The size of length field is 7-bit in bytes.*
* *The offset indication for transmission/retransmission of the segments after the first segment of a D2R message is 7-bit length in bytes. Segmented SDUs are also byte aligned.*
* *Status in running CR: captured in 6.2.2.2.*
 | Addressed/closed |
| Issue 3-5: D2R message type | Whether to support D2R message type* *Relevant agreements:*
* *A 2 bits D2R message type is introduced in this release. For Rel-19 only one message type exists for D2R message. RN16 doesn’t include message type as already agreed.*
* *Status in running CR: captured.*
 | Addressed/closed |
| Issue 3-6: Write operation response | Whether the write command type may cause a case of ‘no upper layer data is available for a D2R scheduling’ due to long writing time.* *Relevant agreements:*
* *The device is expected to send a MAC response to the reader in the D2R occasion. The MAC response contains the NAS message if available at the D2R occasion. If there is no NAS message available to transmit at the D2R occasion then the response contains MAC with 0 SDU and padding as needed.*
* *Send LS to CT1 to inform the agreement 1 to CT1 and explain that we have an issue with delayed NAS write success response. RAN2 would prefer that this is handled by CT1 (and give the example of sending NAS response upon successful reception of write command). Ask if this can be handled by CT1*
* *Status in running CR: captured in 5.4.1.*
 | Addressed/closed |
| Issue 3-7: more data indication handling | How to set “more data indication” value in case of no NAS response available (i.e., zero SDU)* *Relevant agreements:*
	+ *The reader determines no data available case by SDU length 0. As more data indication is mandatory, the device sets this bit to "0".*
	+ *The reader, in response to 0 SDU in the device’s MAC response, may send a follow-up R2D Upper Layer Data Transfer message at a later time to schedule another D2R Upper Layer Data Transfer message from the device.*
	+ *The follow-up R2D Upper Layer Data Transfer message includes the Received Data Size field with the Received Data Size field set to value 0, without including the original command.*
	+ *RAN2 would like to check if there is a case where NAS doesn’t provide a response at all. If this case exists, RAN2 will discuss this issue.*
* *Regarding the above check point, it can be up to companies’ contribution.*
* *Status in running CR: captured.*
 | To be discussed by company contributions |
| **Subgroup: R2D message content for data transmission** |
| Issue 3-8: R2D TBS | How to handle the R2D TBS, which may impact R2D padding, byte-alignment design.* *Relevant agreements:*
* *Add a 7-bit R2D TBS field (in unit of byte) after R2D message type indication in variable-length R2D messages (i.e., Paging message, Random ID Response message, R2D Upper Layer Data Transfer message, NACK Feedback message).*
* *Access Trigger message is 3 bits and no padding bits are added (i.e. not byte aligned)*
* *Status in running CR: captured.*
 | Addressed/closed |
| **Group 4: Others** |
| **Subgroup: RAN1 parameters** |
| Issue 4-1:RAN1 parameters | How to handle RAN1 parameters if any, e.g. scheduling info in paging, Msg2, R2D command messages.* *Based on RAN1 LS in R1-2504915, the rapporteur created a subclause 6.2.1.7 in the MAC running CR to capture all the RAN1 agreement parameter, companies are encouraged to check the details and make comment if any.*
* *Status in running CR: a field named as D2R Scheduling Info is included in Paging message, Msg2 and R2D command message as a placeholder, and the details are captured in subclause 6.2.1.6 based on RAN1 inputs.*
 | Addressed/closed |
| Issue 4-6 | Whether/how to reduce the size of Frequency Resource Indication in D2R Scheduling Info field* *Relevant agreements:*
* *When a single D2R resource is signaled in R2D upper layer data transfer message , use 3-bit field to represent “Frequence Resource Indication” instead of the 8 bit bitmap.*
* *Status in running CR: captured.*
 | Addressed/closed |
| **Subgroup: MAC modelling issue** |
| Issue 4-2: transport channel | Whether transport channel concept is used for A-IoT MAC, i.e., between MAC and PHY, and whether logical channel concept or “SAP” is used on the interface between MAC and upper layer.* *Relevant agreements:*
* *Assume two transport channels are introduced between A-IoT MAC and PHY. One is for R2D, and the other is for D2R. Neither logical channel concept nor SAP is defined for the interface between A-IoT MAC and upper layers.*
* *Status in running CR: captured.*
 | Addressed/closed  |
| Issue 4-3 | Terminology, message names, field names, definitions used in MAC running CR* *Relevant agreements:*
	+ *Use as baseline the following message names, field names and definitions are to be used in A-IoT MAC:*
	+ *Message name: A-IoT Paging message, Access Trigger message, Random ID message, Random ID Response message, R2D Upper Layer Data Transfer message, D2R Upper Layer Data Transfer message.*
	+ *Field name: R2D Message Type, RA Type, Indication of Paging ID Presence, Length of Paging ID, Paging ID, Transaction ID, Number of Access Occasions, D2R Scheduling Info, Random ID, Echoed Random ID, AS ID, Assigned AS ID, More Data Indication, SDU Length, MAC Padding, Received Data Size.*
	+ *Definitions:*
	+ *Access occasion: A time-frequency resource for device(s) to transmit Msg1 (i.e., the Random ID message) during a CBRA procedure.*
	+ *AS ID: The AS layer identifier to address the specific device for R2D reception and D2R scheduling*
 | Addressed/closed |
| **Subgroup: MAC spec implementation to be checked in CR review** |
| Issue 4-4: MAC spec implementation | For some easy FFS (e.g., how to implement agreement in spec), the rapporteur took the liberty to propose some implementation resolution, and invite companies to check and review in the running CR.* *AS ID release: FFS for CFRA*
* *Msg2 retransmission: How to capture device behavior is FFS*
* *Segmentation: This implies that the R2D message will either have command or offset (but not both). FFS whether we define two message types or one message type with optional fields.*
* *NACK: FFS how to specify.*
* *Paging message format: FFS if more than one R bit is required.*
* *Access occasion number: value range FFS.*
 | Addressed/closed |
| **Subgroup:** Others |
| Issue 4-5: Forward compatibility | Whether to consider forward compatibility for R2D messages.* *Relevant agreements:*
	+ *For forward compatibility:*
	+ *- Paging message can be extended to add more fields at the end of the message in further releases, and Rel-19 devices ignore the extension parts added in future release instead of dropping the whole message, without extension indication. Future extension using the same message type is not supported for R2D messages other than paging message.*
	+ *- No version bit will be introduced*
	+ *- Remove the R-field in paging message from the running CR*
	+ *- Use 3-bit R2D message type..*
* *Status in running CR: captured.*
 | Addressed/closed |
| (New) Issue 4-6: CT1 LS on max NAS message size | In C1-255679 LS on the maximum supported AIoT NAS container length, CT1 asked about the maximum supported AIoT NAS container length in both R2D and D2R directions.* *Background and relevant agreements:*
	+ *In R1-2409250/R2-2409405 Reply LS to RAN2 on data block sizes for Ambient IoT, RAN1 indicated that from RAN1 perspective, a maximum TB size of around 1000 bits in PHY for R2D and D2R directions can be supported. Based on this, RAN2 design the SDU length and offset length as 7 bits, which is a sufficiently large value that can indicate the maximum integer number of bytes after subtracting the MAC overhead from 1000 bits.*
* *The rapporteur understands that RAN2 can reply CT1 with the above situation, and there is no additional impact to the current MAC signaling format,*
 | To be discussed by company contributions |

# Other open issues if identified

**Companies are invited to describe any other identified open issues not currently included within this document. Please note for the editorial suggestions/minor issues, as per chairlady’s guidance, companies are expected to give editorial inputs to the rapporteurs via email. No need to repeat those editorial issues here.**

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| **Company** | **Other identified open issues? (please describe)** |
| ASUSTeK | It hasn’t discussed that whether one R2D MAC PDU could include multiple R2D messages, for example, one R2D MAC PDU includes both NACK Feedback message and Access Trigger message. In our understanding, one R2D MAC PDU seems to include one R2D message. Since there is no length field for a R2D message with variable size, it’s not possible for the device to decode a R2D MAC PDU with multiple R2D messages. As a result, it can be clarify in spec that one R2D MAC PDU includes one R2D message. |
| Ofinno | How the “D2R Scheduling Info” is applied in sections “§5.4.2 D2R message transmission”, “§5.4.3 R2D message reception” and “§5.4.4 D2R segmentation” needs further discussion (e.g., some operation seems redundant, not necessary/correct). Points to consider/highlight: the “D2R Scheduling Info” could be provided via A-IoT paging message or R2D Upper Layer Data Transfer message and, there are two cases when an A-IoT device can initiate §5.4.4 (case (1) when size of the MAC PDU is larger than TBS provided and case (2) upon reception of R2D Upper Layer Data Transfer message containing the Received Data Size field not set to 0). |
| LGE | According to the TS 24.369, the following text is captured.

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| 5.2.5 Abnormal cases in the AIoT deviceThe following abnormal cases can be identified:a) Failure of authentication. If an AIoT device fails the authentication procedure as specified in 3GPP TS 33.369 [6], the AIoT device shall not respond to the AIoT paging message.b) Collision of AIoT paging. If a new AIoT paging is received while an inventory procedure is in progress, the AIoT device shall proceed with the ongoing inventory procedure and shall process the new AIoT paging after the completion of the inventory procedure. |

According to the current AIoT MAC specification, if the paging message is received, the AIoT device processes the paging message regardless of whether there is ongoing inventory procedure or not. This is because the simultaneous service request can be prevented by the network implementation. However, as highlighted in yellow above, it seems that the device needs to support simultaneous service request case, i.e., the device stores the paging message until completion of the on-going inventory procedure, and the device processes the stored paging message after completion of the inventory procedure. From the RAN2 point of view, the device does not store the paging message and the device processes the paging message right after the reception of the paging message. So, we think that there is a different understanding between the CT1 and RAN2. Thus, we think that it would be better to send the LS to CT1 in order to inform the RAN2 understanding and modify/remove the text in CT1 specification. |
| LGE | According to the TS 24.369, the permanent disable procedure is captured as follows.

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| 5.3.4 Permanent disable command procedure5.3.4.1 GeneralThe purpose of the permanent disable command procedure (see example in figure 5.3.4.1.1) is to permanently disable the communication capability of the AIoT device as specified in 3GPP TS 23.369 [2].AIoT deviceAIOTFPERMANENT DISABLE COMMANDPERMANENT DISABLE COMPLETEFigure 5.3.4.1.1: Permanent disable command procedure |

In addition, how to disable the communication capability of the AIoT device is captured in TS 23.369 as follows.

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| 5.2.2.3 Permanent Disable CommandAn AIoT Device may be permanently disabled. A permanently disabled AIoT Device does not respond to the Inventory Procedure, as described in clause 6.2.2.An AIoT Device is permanently disabled by the Permanent Disable command sent by an AIOTF to the AIoT Device.The Permanent Disable command is sent to an AIoT Device when an authorized AF uses the Permanent Disable command service operations as described in clause 5.2.2.1, or if the network determines to disable the AIoT Device. The Permanent Disable command is sent in the Command Request step and a response is sent in the Command Response step of the Command procedure described in clause 6.2.3. The AIoT Device responds indicating whether the Permanent Disable command was successful.NOTE: The trigger conditions when a network determines to disable the AIoT Device depends on operator and implementation policy.When the AIoT Device has received and verified a Permanent Disable command, it shall no longer respond to the inventory procedure. |

According to the above, the device shall not be perform the random access procedure after device is disabled.However, there is a case where the AIoT device can trigger the inventory procedure when the paging message without containing paging ID is received. If the paging message without containing paging ID is received, the device considers that the device is selected and indicate it to the upper layer. Then, the device performs the random access procedure. (Please refer to the text highlighted in yellow part as below)

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| 5.2 A-IoT pagingThe purpose of this procedure is to transmit *A-IoT Paging* message to one or more devices. The reader may include the *Paging ID* field to select a specific device or a group of devices, or may not include *Paging ID* field to select all devices.The device always monitors for the *A-IoT Paging* message, and determines whether the device is selected to initiate the access procedure.Upon receiving the *A-IoT Paging* message, the A-IoT MAC entity shall:1> if the *Access Type* field in the *A-IoT Paging* message indicates CBRA:2> if the device has no stored Transaction ID; or2> if the value of the *Transaction ID* field is different from the stored Transaction ID; or2> if the value of the *Transaction ID* field is the same as the stored Transaction ID, and the previous procedure was determined as failed for this Transaction ID as specified in clause 5.5:3> release the stored AS ID, if any;3> store the received value in *Transaction ID* field, if the device has no stored Transaction ID, or replace the previously stored Transaction ID with the current received value, if the value of the *Transaction ID* field is different from the stored Transaction ID;3> if the *Paging ID Presence Indication* field indicates *Paging ID* field is absent :4> consider the device is selected and indicate it to the upper layers;3> else:4> forward the content of the *Paging ID* field to the upper layers;4> if the upper layers indicate that the Paging ID is matched:5> consider the device is selected;3> if the device is selected:4> initiate Contention-Based Random Access procedure as specified in clause 5.3.1; |

Based on the above explanation, if the device is disabled, the device should not initiate CBRA procedure to reduce the collision ratio. For this, we think that the NAS layer should indicates that the device is disabled, and AIoT MAC should not respond to the paging message at all. How to capture this behavior should be discussed. |
| LGE | If the stored transaction ID is the same as the transaction ID indicated in the paging message and the previous procedure is failed, i.e., re-access case, the device does not need to deliver the paging ID to the upper layer. This is because, the reader transmits the same transaction ID for the same service request. (for the same service request, the same paging ID is contained in the paging message) Thus, if the value of the Transaction ID field is the same as the stored Transaction ID and the previous procedure was determined as failed for this Transaction ID, the device considers that the device is selected and indicate to the upper layer (similar to a case for the absent of the paging ID case). Thus, we think that the delivery of the paging ID for the re-access is not needed, and it causes the unnecessary processing overhead which unnecessarily consumes the battery. The following is our text proposal for this issue (Please refer to the text highlighted in yellow as below).

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| Upon receiving the *A-IoT Paging* message, the A-IoT MAC entity shall:1> if the *Access Type* field in the *A-IoT Paging* message indicates CBRA:2> if the device has no stored Transaction ID; or2> if the value of the *Transaction ID* field is different from the stored Transaction ID; or2> if the value of the *Transaction ID* field is the same as the stored Transaction ID, and the previous procedure was determined as failed for this Transaction ID as specified in clause 5.5:3> release the stored AS ID if any;3> store the received value in *Transaction ID* field, if the device has no stored Transaction ID, or replace the previously stored Transaction ID with the current received value, if the value of the *Transaction ID* field is different from the stored Transaction ID;3> if the device has been selected for the stored transaction ID; or3> if the *Paging ID Presence Indication* field indicates *Paging ID* field is absent:4> consider the device is selected and indicate to the upper layers;3> else:4> forward the value of the *Paging ID* field to the upper layers;4> if the upper layers indicate that the Paging ID is matched:5> consider the device is selected;3> if the device is selected:4> initiate Contention-Based Random Access procedure as specified in clause 5.3.1; |

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# Conclusions

The following proposals have been provided based on feedback to the above document:

# Appendix (Optional)

Agreements in RAN2#129 meeting and RAN2#129bis meeting:

 RAN2 understands that the service type of A-IoT (e.g. inventory, command) and whether the service is targeted for a single or multiple devices can always be provided. The approximate number of target devices can be provided if available.

8.2.2 A-IoT Paging

 Parallel service requests by the same reader is not supported.

 The device is expected to only perform one procedure at a time. FFS device behaviour if multiple requests are received in parallel (if needed).

 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

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

 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.

 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.

 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

 the A-IoT paging message can include a number of msg1 resources

 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

 The service type of A-IoT (e.g., inventory only, inventory + command) is not included in paging message.

 FFS which solution if any for device behavior if it gets a new service request while one procedure is still ongoing or leave it to implementation.

 RAN2 aims to design Rel-19 AIoT R2D messages extensible to accommodate devices and features of future release.

 Introduce an explicit 1 bit indication to indicate whether it is CFRA or CBRA per paging message

 A field indicating Paging ID length information is always included together with the paging ID field in the A-IoT paging message, except the case where no ID is included in the A-IoT paging message.

 The number of bits required for paging ID length field should be as small as possible. This would require the number of different Paging ID lengths to be small.

 Send an LS to SA2 to tak this into account for their design.

8.2.3 A-IoT Random Access

 For Rel-19, only 3-step CBRA is supported for A-IoT

 We will specify both CBRA and CFRA.

 Re-use the subsequent paging message to trigger re-access. There is no need to differentiate msg1 resource for initial access vs re-access.

 NACK based mechanism is supported for D2R messages to determine re-access for at least msg3. FFS details including whether we need a timer or explicit message and when reader sends feedback

 RAN2 assumes that device randomly selects among FDMA occasions as the baseline.

 In case of CBRA, only 16 bits random ID is included in Msg1. FFS can be revisited if message type will be needed for other D2R messages purposes

 RN16 is not included in the first D2R message in the CFRA procedure. AS ID is the only ID needed for addressing the device in R2D command message assuming for CFRA no multiple devices are performing the procedures with the given reader. FFS if we can assume or need to support multiple device scenario.

 A new R2D message other than the paging message is introduced for A-IoT device determining MSG1 resources unless RAN1 concludes to use L1 signaling. The R2D message indicates the start of a set of MSG1 resources that were configured in paging message.

 Assumption: The R2D message does not include slot number/count down number.

 A-IoT Msg2 contains one or multiple echoed random ID(s) from A-IoT Msg1 of different A-IoT devices.

 Same Msg2 format is used for initial transmission and retransmission of Msg2.

 For CBRA, as a baseline, NACK based mechanism is applied only to the Msg3. May come back for D2R data, if the NACK feedback indication is needed for the purpose to stop/terminate the “on-going procedure” and release the AS ID accordingly (depending on other later discussion).

 For msg3, we rely on whether the device receives NACK indication before subsequent R2D message to determine re-access. No need for a timer. FFS whether subsequent R2D message is trigger message or paging

 For CFRA, NACK feedback and re-access is not supported. FFS how to achieve

 FFS on end of procedure

8.2.4 A-IoT Data Transmission and Other general aspects

 For CBRA, it is up to Reader to decide whether to reuse the random ID as the AS ID or to assign a new AS ID. FFS how this is signalled, which message is used and size of AS ID.

 From device perspective, it is only required to use one AS ID.

 CFRA is not supported for group ID

 RAN2 assumes, AS ID is needed for CFRA at least for inventory + command procedure

 For CFRA, if a valid AS ID is not already assigned, continue the discussion on AS-ID assignment based on the following options:

 Option 2: the device includes a random ID in “Msg 1”. And same as CBRA, it is up to Reader to decide whether to reuse the random ID as the AS ID or to assign a new AS ID.

 Option 3: New “Msg 2” for AS ID assignment, complementary option or independent from option 2

Option 4: “Msg 2” (including the “Command”) for AS ID assignment, complementary option or independent from option 2

 To support segmentation, a 1 bit indication is introduced to indicate whether there is more data or not, if SA2 indicates that CN can provide an estimated expected D2R message size. If not possible, FFS if the 1 bit is sufficient.

 Segment retransmission is supported.

 For segment retransmission, reader explicitly indicates an offset in the MAC layer– e.g. number of bits successfully received so far (from the start). FFS This implies that unsegmented packet can also be retransmitted. FFS if this applies to msg3

 R2D segmentation is not supported for R19 A-IoT.

 From RAN2 perspective only the following types of procedures will be considered in the normative phase: “Inventory only” and “Inventory and command”.

 AS ID is applied for Inventory + command case;

 AS ID is not included in D2R message except Msg 1 (RN16 in Msg 1 has been agreed.

 For both CFRA and CBRA, the AS ID size is same as RN 16, i.e. 16 bits.

 Do not specify the reader behaviour on how exactly the ASID is generated.

 The device releases the AS ID upon power off (no stage 3 specification impact);

 The device only keeps one AS ID at a time.

 For CFRA, command message is used for AS ID assignment

 For CBRA, Msg 2 is used for AS ID assignment

 The device releases the AS ID at least:

 - upon receiving Paging with new transaction id for that device, i.e. different session/service

 - when it triggers new msg1 transmission as a result of receiving Paging message (i.e. it has to generate a random ID for CBRA)

 - FFS other cases for release ASID to avoid keeping it indefinitely.

 For the retransmission of the first segment/unsegmented D2R message, the reader sends the R2D message by including the upper layer command again. FFS whether offset zero is always included.

 FFS whether the reader always includes the command for retransmission of segments.

 1-bit indication is sufficient to indicate whether more D2R data will be sent

 For inventory response, RAN2 assumes that segmentation is not applied. RAN2 assumes that the reader can avoid segmentation by reader being aware of inventory response size. Notify SA2 about this assumption.

Agreements on MAC PDU format design

 Aim to design simple MAC PDU format design

 Support multiplexing of information for multiple devices in R2D message for msg2. FFS others for multicast messages

 At least the following field are required for at least for R2D in the MAC header– message type, length for SDU and variable part(s).

 FFS whether for D2R we need message type field, any length and need for padding

 Specify message types and contents. As starting point consider the following MAC message types.

 R2D MAC PDU (Paging/R2D trigger (depending on agreement on WF))

 D2R MAC PDU (MSG1) (FFS if this requires a MAC header or not)

 R2D MAC PDU (MSG2)

 D2R MAC PDU (MSG3 and data)

 R2D MAC PDU (R2D data)

 Other message types are FFS. The message types may evolve based on functionality agreements.

 The MAC PDU should be byte-aligned, assuming the allocated TBS value is in the unit of byte. The actual TBS value depends on RAN1. FFS for R2D trigger message

 RAN2 assumes that the upper layer data SDU is byte-aligned, and an LS can be sent to CT1.

 The D2R MAC PDU size will correspond to the TBS size indicated in the R2D message

 The MAC padding is supported at least for D2R from RAN2 perspective. The device includes padding bits if there is no more data and there is still space available in the TBS.

 In case where MAC PDU includes both MAC SDU and padding, for D2R a field to indicate how many SDU bits are present is required. FFS how this is provided (i.e. SDU length field or padding length field). The size of length field is FFS.

Agreements in RAN2#130 meeting

1 Use as baseline the following message names, field names and definitions are to be used in A-IoT MAC:

− Message name: A-IoT Paging message, Access Trigger message, Random ID message, Random ID Response message, R2D Upper Layer Data Transfer message, D2R Upper Layer Data Transfer message.

− Field name: R2D Message Type, RA Type, Indication of Paging ID Presence, Length of Paging ID, Paging ID, Transaction ID, Number of Access Occasions, D2R Scheduling Info, Random ID, Echoed Random ID, AS ID, Assigned AS ID, More Data Indication, SDU Length, MAC Padding, Received Data Size.

− Definitions:

o Access occasion: A time-frequency resource for device(s) to transmit Msg1 (i.e., the Random ID message) during a CBRA procedure.

o AS ID: The AS layer identifier to address the specific device for R2D reception and D2R scheduling

2 One bit indication is needed for each echoed random ID in Msg2 to indicate whether AS ID is present (i.e., assigned by reader) for this random ID.

3 NACK feedback is defined as an explicit message (i.e. new message type). AS ID(s) is/are included to indicate the failure for given device(s). Multiplexing of NACK feedback is supported in one message

4 Assume two transport channels are introduced between A-IoT MAC and PHY. One is for R2D, and the other is for D2R. Neither logical channel concept nor SAP is defined for the interface between A-IoT MAC and upper layers.

**Agreements on parallel service request**

1. Rel-19 devices are not expected to receive parallel service request for overlapping reader scenario based on network implementation. Capture this in stage 2 specification.
2. The Rel-19 device always responds to the new service indicated by the received paging message applicable for that device. Capture this in stage 3 specification.
3. Send LS to RAN3 to notify them of agreements 1 and 2
4. Parallel service request for overlapping reader scenario can be addressed in Rel-20

**Agreements on paging**

1. For CFRA, as a baseline the fields related to the transaction ID, indication of paging ID present/absent and number of access occasions are absent. FFS on the need for the transaction ID for command case.
2. For CFRA, the device always responds to paging regardless of transaction ID (if we put a transaction ID) (i.e. as long as it is addressed to the corresponding device).
3. To ensure forward compatibility for paging with multiple identifiers, introduce at least one R field. FFS if more than one R bit is required.
4. Rel-19 devices would ignore the content of future release instead of ignoring the whole paging message.
5. Issue (1-4) For number of access occasions introduce exponential way, 4 bits, value range FFS

**Agreements**

1. For Msg1 resource selection procedure capture as guidance the countdown behaviour in the MAC specification (use TP in [R2-2503952](file:///C%3A%5CUsers%5Cpanidx%5COneDrive%20-%20InterDigital%20Communications%2C%20Inc%5CDocuments%5C3GPP%20RAN%5CTSGR2_130%5CDocs%5CR2-2503952.zip)). Capture a NOTE that other implementation are allowed. X, Y will be signalled by paging message
2. The start of the first set of MSG1 resources is indicated by Paging message directly instead of the new R2D trigger messages. R2D trigger message is not sent in CFRA procedure. Come back if RAN1/4 sees any issues. Send LS to RAN1/RAN4
3. FFS R2D byte alignment dependent on TBS size discussion

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| Agreements on RA1 Exclude the option of MSG2 transmission and any retransmission of MSG2 happens within a predefined time window (based on timer)2 A device expecting MSG2 assumes CBRA failure if its MSG2 is not received before a boundary, where the boundary can be further downselected between option B and C below. A device receiving MSG2 within this boundary transmits MSG3. The device does not process MSG2 (re)transmission received after the boundary. * Option B – the boundary is the reception of either the next R2D trigger message or the subsequent paging message
* Option C – the boundary is the reception of either the kth R2D trigger message or the subsequent paging message (K is FFS)
* Option A (the boundary being the subsequent paging only) is excluded.

 For option C, further discuss in terms of complexity at the device vs reader flexibility.3 Including frequency index along with RN16 in MSG2 to reduce collisions of MSG1 between different devices is feasible. FFS Discuss further whether to include it.**Agreements on NACK reception:**1. After MSG3 transmission, upon receiving NACK with its AS ID before subsequent paging or command addressed to this device from the reader, device determines it will perform re-access. FFS how to specify.

**Agreements on RN16/AS ID maintainance:**1. Confirm a device is not expected to maintain both AS ID and RN16. After msg2 reception, RN16 becomes AS ID, if new AS ID was not assigned by reader.

This implies that the reader cannot change AS ID and RN16 pair across message 2 retransmission. How to capture device behavior is FFS |

**Agreements**

1. R2D message scheduling non-first segment (re)transmission does not include upper layer command.
2. For the first segment and unsegmented packet (re)transmission, the “offset” indicator in R2D is not present.
3. This implies that the R2D message will either have command or offset (but not both). FFS whether we define two message types or one message type with optional fields.

**Agreements**

1. The device is expected to send a MAC response to the reader in the D2R occasion. The MAC response contains the NAS message if available at the D2R occasion. If there is no NAS message available to transmit at the D2R occasion then the response contains MAC with 0 SDU and padding as needed.
2. Send LS to CT1 to inform the agreement 1 to CT1 and explain that we have an issue with delayed NAS write success response. RAN2 would prefer that this is handled by CT1 (and give the example of sending NAS response upon successful reception of write command). Ask if this can be handled by CT1

**Agreement on MAC PDU format**

1. A mandatory length field directly indicates the length of D2R data MAC SDU to support varying lengths of D2R data. The size of length field is 7-bit in bytes.
2. The offset indication for transmission/retransmission of the segments after the first segment of a D2R message is 7-bit length in bytes. Segmented SDUs are also byte aligned.
3. FFS D2R message type. Current running CR will capture no message type, but we can revisit this next meeting and also consider if any other bits are needed for the MAC header
4. The length field inside MAC for SDU is not needed for R2D messages, assuming R2D MAC padding is not needed. FFS can come back if padding is needed depending on granularity of TBS (only if needed)

**Agreements**

- For CBRA, to avoid AS ID being occupied for unnecessary time and to keep alignment between reader and device on AS ID release, device can release AS ID upon receiving paging message with different transaction ID, no matter the paging message is for it or not. FFS for CFRA

- FFS for need for release message

Agreements in RAN2#131 meeting

**Agreements**

1. RAN2 thinks it is feasible from a signalling perspective to add the 128 bits. However, from RAN2 perspective the less overhead the better, so SA3 should avoid adding additional parameters if possible.
2. Indicate to SA3 that RAN2 tries to minimize number of bits required. Have a maximum size of 1000bits, and whatever they include has to fit in the 1000bits considering bits from all TSG.
3. RAN2 will wait for SA3 conclusions in October on whether the “128bit random number in the paging request message” is always required or not.
4. Reply to SA3

- RAN2 thinks it is feasible from a signalling perspective to add the 128 bits. However, from RAN2 perspective the less overhead the better, so SA3 should avoid adding additional parameters if possible.

- Indicate to SA3 that RAN2 tries to minimize number of bits required. Have a maximum size of 1000bits, and whatever they include has to fit in the 1000bits considering bits from all TSG.

- Indicate space pressure from all the WG

**Agreements**

1 RAN2 confirms how to generate transaction ID is left to reader (no spec impact)

2 8-bit length field (in unit of bit) is assumed to indicate the paging ID length, based on current SA2/CT4 conclusion.

3 RAN2 confirms the pervious RAN2 baseline that transaction ID is not included in paging message for CFRA. Clarify that CBRA can be used by reader for single device.

4 No entry number is included in either Msg2 or NACK feedback message. RAN2 understands that device can decode the entries one by one till message end, other implementations are not precluded (we will not capture this in the spec).

5 R2D TBS information is not included in the Access Trigger message.

6 Add a 7-bit R2D TBS field (in unit of byte) after R2D message type indication in variable-length R2D messages (i.e., Paging message, Random ID Response message, R2D Upper Layer Data Transfer message, NACK Feedback message).

7 6 bits for Transaction ID length.

8 Explicit AS ID release message is not needed.

9 For forward compatibility:

- Paging message can be extended to add more fields at the end of the message in further releases, and Rel-19 devices ignore the extension parts added in future release instead of dropping the whole message, without extension indication. Future extension using the same message type is not supported for R2D messages other than paging message.

- No version bit will be introduced

- Remove the R-field in paging message from the running CR

- Use 3-bit R2D message type.

10 A 2 bits D2R message type is introduced in this release. For Rel-19 only one message type exists for D2R message. RN16 doesn’t include message type as already agreed.

11 Access Trigger message is 3 bits and no padding bits are added (i.e. not byte aligned)

* The paging ID is visible to the reader. No specification impact.

**Agreements**

1 Keep current agreement. The reader should provide enough access trigger to cover at least signalled AOs in current round, unless the reader choses to start the subsequent paging round. Capture in stage 2 and rapporteur will work in the wording.

**Agreements**

1. RAN2 confirms that R2D trigger message does not include slot number/count down number in this release
2. RAN2 acknowledges the problem, and it is up to reader implementation to avoid the mismatch between reader and device due to the miss of the A-IoT paging message with updated configurations in this release. RAN2 will not add any explicit information in this release to address this problem

**Agreements**

1. 3-bit frequency index is optionally included with each echoed random ID in MSG2. We have 1 bit in MSG2 to indicate presence/absence of the frequency information for all included RN16s.
2. The boundary is the reception of either the kth Access trigger message or the subsequent paging message. Reader implementation to send MSG2 immediately (before k) is allowed. K can be configured to be either 1 or 4 in paging message.

**Agreements on no data available due to delay in NAS**

1. The reader determines no data available case by SDU length 0. As more data indication is mandatory, the device sets this bit to "0".
2. The reader, in response to 0 SDU in the device’s MAC response, may send a follow-up R2D Upper Layer Data Transfer message at a later time to schedule another D2R Upper Layer Data Transfer message from the device.
3. The follow-up R2D Upper Layer Data Transfer message includes the Received Data Size field with the Received Data Size field set to value 0, without including the original command.
4. RAN2 would like to check if there is a case where NAS doesn’t provide a response at all. If this case exists, RAN2 will discuss this issue.

**Agreements**

To ensure byte alignment for the variable size R2D message:

1. Paging and Msg2 (Variable bit length): add one “fill field” in the end of the message (1~7bits).
2. NACK feedback (AS ID entry(ies) self-aligns, message type is 3-bit fixed): add R-bit(s) after message type field.
3. R2D upper layer data message (data SDU self-aligns, other fields are of fixed bits): add R bits after CI field to differentiate R-bit number when data SDU or received data size is present. Confirm MAC padding field and SDU length field are not needed.
4. R bit is set to zero in this release and ignored by the receiver.
5. What’s included in the fill field is not specified, but device ignores the fill field.
6. When a single D2R resource is signaled in R2D upper layer data transfer message , use 3-bit field to represent “Frequence Resource Indication” instead of the 8 bit bitmap.
* Upon reception of NACK message addressed to the device, its AS ID is released