**3GPP TSG-RAN WG2 Meeting #130 R2-250xxxx**

**, 2025**

**Agenda Item: 8.2.1**

**Source: Huawei, HiSilicon**

**Title: Initial Text Proposal for A-IoT MAC specification**

**Document for: Discussion and agreement**

# 1 Introduction

# 2 Discussion

During the CR drafting, the editor took the liberty of creating the message names and field names based on the RAN2 discussion and agreements, with the understanding that the naming has no impact to the functional parts. Therefore, the plan is to have a quick check on companies’ view during this CR review, instead of triggering online discussion just for naming. Companies are very welcome to provide suggestions of better message/field names in the following table.

1. Whether you have comments/suggestions on the terminologies/message name/field name used in the TP:

* **Message name:** A-IoT Paging message, Access Occasion 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/absence, 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, Length, MAC Padding, Received Data Size.
* **Definitions:**
	+ **Access occasion:** An opportunity of 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

|  |  |  |
| --- | --- | --- |
| Company name | Contact | Comments |
| CATT | Jianxiang Li | A dedicated message name for MSG3-the first D2R response carrying device ID may be required:1. 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).
2. 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
 |
| Lenovo | Jing HAN | * Access Occasion Trigger message: thinks *R2D trigger message* is easier to be understand.

ZTE: We are okay with R2D trigger message but to simplify we can also call this *trigger message* or *slot trigger message** Random ID message: thinks *CBRA Msg* is clearer.

ZTE: *Random ID message* is fine in our view. Or, it should be called *CBRA MSG1* if companies prefer to go this way. But then if we want to reference this in other specs (e.g. stage-2) we perhaps have to call it then A-IoT CBRA MSG1 which might start to get a bit too long. * Random ID Response message: thinks *CBRA Msg2* is clearer

ZTE: Existing wording is okay for us. No strong view. * Length: Depending on the further discussion, this field is better to be *Length of SDU*, or *Length of padding*

Access occasion: If we avoid to have Msg1 in message names, here is better to remove “Msg1”. Or we could have CBRA Msg1 names |
| ZTE  | Eswar | Echoed Random ID: We don’t need this. Can we simply not call this Random ID and reference this based on which message this is included it in?New Assigned ASID: Same as above. We don’t need this. The ASID should be replaced by the assigned ASID (if it is signalled) and UE simply maintains only one copy of ASID in memory. Otherwise, we have two variables, ASID and Assigned ASID and this is unnecessary. More Data Indication: This also indicates segmentation? So, maybe we need to have a common name?MAC Padding: we can just say “padding” Received Data Indicator: Data offset indication |
|  |  |  |

# **Initial Text Proposal for A-IoT MAC specification:**

|  |
| --- |
| 3GPP TS 38.391 V0.1.0 (2025-05) |
| Technical Specification |
| 3rd Generation Partnership Project;Technical Specification Group Radio Access Network;Ambient IoT Medium Access Control Protocol specification(Release 19) |
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|  |  |
|  |
| The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP.The present document has not been subject to any approval process by the 3GPPOrganizational Partners and shall not be implemented.This Specification is provided for future development work within 3GPPonly. The Organizational Partners accept no liability for any use of this Specification.Specifications and Reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organizational Partners' Publications Offices. |

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# Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The present document specifies the Medium Access Control (MAC) protocol of Ambient IoT.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 38.291: "Ambient IoT Physical layer".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**Device:**

**Reader:**

**Access occasion:** An opportunity of 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.

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

A-IoT Ambient IoT

CBRA Contention-Based Random Access

CFRA Contention-Free Random Access

D2R Device to reader

IoT Internet of Things

PDRCH Physical D2R channel

PRDCH Physical R2D channel

R2D Reader to device

# 4 General

## 4.1 Introduction

The objective of this clause is to describe the A-IoT MAC architecture and the A-IoT MAC entity of the device from a functional point of view.

## 4.2 A-IoT MAC architecture

Figure 4.2-1 illustrates a model of the A-IoT MAC entity; and it does not restrict implementations.

The A-IoT MAC entity of the device handles the data received or to be transmitted via the physical channels, i.e., PRDCH and PDRCH, as specified in TS 38.291 [2].



Figure 4.2-1: A-IoT MAC structure overview

*Editor’s Note: FFS whether the concept of transport channel is needed for A-IoT.*

## 4.3 Services

### 4.3.1 Services provided to upper layers

The A-IoT MAC layer provides the following services to upper layers:

- data transfer;

### 4.3.2 Services expected from physical layer

The A-IoT MAC layer expects the following services from the physical layer:

- data transfer;

## 4.4 Functions

The A-IoT MAC layer supports the following A-IoT MAC functions:

- construct MAC PDUs to be mapped onto D2R blocks and delivered to the physical layer;

- process MAC PDUs from R2D blocks delivered from the physical layer;

- message type determination;

- paging;

- random access;

- transfer of upper layer data;

- D2R segmentation;

- failure detection;

- interaction with upper layers.

# 5 A-IoT MAC procedures

## 5.1 General

The clause describes the A-IoT MAC procedures.

When the device is powered on, the device shall monitor the R2D messages on PRDCH, as specified in TS 38.291 [2], in order to perform the corresponding A-IoT MAC procedures.

## 5.2 A-IoT paging

The 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 include no *Paging ID* field to select all devices.

The device monitors the *A-IoT Paging* message, and determines whether the device is selected and initiates the random access procedure.

Upon receiving the *A-IoT Paging* message, the A-IoT MAC entity shall:

1> if the *Transaction ID* field included in the *A-IoT Paging* message is the same as the value stored by the device, if any:

2> if the previous procedure associated with the received value indicated in the *Transaction ID* field is determined as a failure as specified in clause 5.5:

3> consider the device is selected by this *A-IoT Paging* message;

1> else:

2> store the received value in *Transaction ID* field or replace the previously stored Transaction ID with the current received value;

*Editor’s Note: FFS device behaviour if multiple requests are received in parallel (if needed). 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.*

*Editor’s Note: For CFRA, NACK feedback and re-access is not supported. FFS how to achieve. FFS on end of procedure.*

2> if the *A-IoT Paging* message does not include *Paging ID* field:

3> consider the device is selected by this *A-IoT Paging* message and indicate to the upper layers;

2> else:

3> forward the value of the *Paging ID* field to the upper layers;

3> if the indication received from the upper layers indicates that the Paging ID is matched:

4> consider the device is selected by this *A-IoT Paging* message;

1> if the device is selected by this *A-IoT Paging* message:

2> release the stored AS ID if any;

*Editor’s Note: FFS other cases for release ASID to avoid keeping it indefinitely.*

2> apply the received the *D2R Scheduling Info* field in *A-IoT Paging* message and indicate it to the physical layer;

2> initiate the random access procedure as specified in clause 5.3;

## 5.3 A-IoT random access procedure

### 5.3.1 Initialization

Based on the parameters received in the *A-IoT Paging* message as defined in clause 5.2, the A-IoT MAC entity determines the random access type, i.e., Contention-Based Random Access (CBRA) or Contention-Free Random Access (CFRA). Subsequently, the A-IoT MAC entity performs the actions corresponding to the determined random access type, with the aim of acquiring the radio resources for the D2R upper layer data transmission as specified in clause 5.4.

### 5.3.2 Selection of random access type

If the random access procedure is initiated according to clause 5.2, the A-IoT MAC entity shall:

1> if the *RA Type* field in the *A-IoT Paging* message indicates CBRA:

2> perform Contention-Based Random Access procedure as specified in clause 5.3.3;

1> else (the *RA Type* field in the *A-IoT Paging* message indicates CFRA):

2> perform Contention-Free Random Access procedure as specified in clause 5.3.4;

### 5.3.3 Contention-Based Random Access procedure

#### 5.3.3.1 Selection of the access occasion for the D2R transmission of *Random ID* message

The A-IoT MAC entity shall:

1> randomly select an access occasion for transmission of the *Random ID* message among the access occasions configured in *A-IoT Paging* message;

1> perform the transmission of *Random ID* message, as specified in clause 5.3.3.2.

*Editor’s Note: More details may be added later according to further agreement if any, e.g., how the device determine the selected access occasion based on the Access Occasion Trigger message.*

#### 5.3.3.2 Transmission of *Random ID* message

The A-IoT MAC entity shall:

1> draw a 16-bit random number 'j' with equal probability in the range: 0 ≤ j < 216;

1> set the *Random ID* field to the ‘j’ in the *Random ID* message;

1> instruct the physical layer to transmit the *Random ID* message using the selected access occasion.

#### 5.3.3.3 Reception of *Random ID Response* message

Once the *Random ID* message is transmitted, and if a *Random ID Response* message is received, the A-IoT MAC entity shall:

1> if the value indicated in *Echoed Random ID* field in *Random ID Response* message is identical to the value of the *Random ID* field in the transmitted *Random ID* message:

2> consider this Random Access procedure is successfully completed;

2> if the *Assigned AS ID* field corresponding to the *Echoed Random ID* field is included:

3> set AS ID to the value indicated in the *Assigned AS ID* field and store the AS ID;

2> else:

3> set AS ID to the value of the *Random ID* field in the transmitted *Random ID* message and store the AS ID;

2> apply the received *D2R Scheduling Info* field in *Random ID Response* message and indicate it to the physical layer;

2> initiate the D2R message transmission as specified in clause 5.4.1.

### 5.3.4 Contention-Free Random Access procedure

The A-IoT MAC entity shall:

1> initiate the D2R message transmission as specified in clause 5.4.1.

## 5.4 A-IoT upper layer data transmission

### 5.4.1 D2R message transmission

Once the D2R Scheduling Info for D2R upper layer data transmission is received in the *A-IoT Paging* message or the *Random ID Response* message or the *R2D Upper Layer Data Transfer* message, the A-IoT MAC entity shall:

1> if the upper layer data is available to be transmitted:

2> if the size of the resulting MAC PDU including the total UL data is expected to be smaller than or equal to the resource size given by the D2R Scheduling Info:

3> generate the *D2R Upper Layer Data Transfer* message, including:

4> include the *Data SDU* field;

4> set the *More Data Indication* field to value 0;

4> the size of the resulting MAC PDU including the total UL data is expected to be smaller than the resource size given by the D2R Scheduling Info:

5> include the *MAC Padding* field;

3> instruct the physical layer to transmit the generated *D2R Upper Layer Data Transfer* message;

2> else (the size of the resulting MAC PDU including the total UL data is expected to be larger than the resource size given by the D2R Scheduling Info):

3> the upper layer data SDU is to be segmented according to clause 5.4.3;

### 5.4.2 R2D message reception

Once a R2D message is received, the A-IoT MAC entity shall:

1> if the device has stored an AS ID and the R2D message is addressed to the stored AS ID:

2> forward the upper layer data SDU to upper layers;

2> apply the *D2R Scheduling Info* field and indicate it to the physical layer for the following D2R message transmission, as specified in 5.4.1;

1> else:

2> if the device has no stored AS ID; and

2> if the R2D message is the *R2D Upper Layer Data Transfer* message; and

2> if CFRA procedure has been performed in the current procedure:

3> set AS ID to the value indicated in the *AS ID* field and store the AS ID;

3> forward the upper layer data SDU to upper layers;

3> apply the *D2R Scheduling Info* field and indicate it to the physical layer for the following D2R message transmission, as specified in 5.4.1.

*Editor’s Note: FFS whether the reader always includes the command for retransmission of segments.*

### 5.4.3 Segmentation

When an upper layer data SDU is to be segmented according to D2R upper layer data transmission procedure in clause 5.4.1, the A-IoT MAC entity performs this segmentation procedure for the original upper layer data SDU.

The A-IoT MAC entity shall:

1> if the D2R Scheduling Info is received in the *R2D Upper Layer Data Transfer* message:

2> generate the *D2R Upper Layer Data Transfer* message for this segment according to the D2R Scheduling Info as follows:

3> set the *Data SDU* field to include the segment which starts from the (x+1)th byte, indicated by the *Received Data Size* field, i.e., received x bytes, of the original upper layer data SDU;

*Editor’s Note: FFS whether offset zero is always included for the retransmission of the first segment/unsegmented D2R message.*

3> if the segment is the last segment of the original upper layer data SDU:

4> set *More Data Indication* field to value 0;

4> if the size of the resulting MAC PDU including the segment is expected to be smaller than the resource size given by the D2R Scheduling Info:

5> include the *MAC Padding* field;

3> else:

4> set *More Data Indication* field to value 1;

2> instruct the physical layer to transmit the *D2R Upper Layer Data Transfer* message.

*Editor’s Note: To be updated after concluding the format of the Command message (e.g. EN in 5.4.2).*

## 5.5 Failure detection

The A-IoT MAC entity shall:

1> if CBRA procedure fails; or

1> if the device receives NACK feedback, before subsequent R2D message:

2> consider that the current procedure associated with the stored Transaction ID failed.

*Editor’s Note: FFS how to determine failure of CBRA procedure.*

*Editor’s Note: FFS whether subsequent R2D message is trigger message or paging. FFS details on NACK feedback, including whether we need an explicit message.*

*Editor’s Note: FFS how to capture the agreement “For CBRA, as a baseline, NACK based mechanism is applied only to the Msg3.”.*

# 6 Protocol Data Units, formats and parameters

## 6.1 Protocol Data Units

### 6.1.1 General

An A-IoT MAC Protocol Data Unit (PDU) is the data unit format in which the A-IoT MAC message is encapsulated for transmission through the lower layer of the A-IoT protocol stack. An A-IoT MAC PDU is a bit string. The contents of each A-IoT MAC message are specified in clause 6.2 using tables to specify the fields in the message. In the tables, the most significant bit is the leftmost bit of the first line of the table, the least significant bit is the rightmost bit on the last line of the table, and more generally the bit string is to be read from left to right and then in the reading order of the lines. The bit order of each parameter field within a MAC PDU is represented with the first and most significant bit in the leftmost bit and the last and least significant bit in the rightmost bit.

An A-IoT MAC SDU is a bit string that is byte aligned (i.e., multiple of 8 bits) in length. A MAC SDU is included into a MAC PDU from the first bit onward.

The A-IoT MAC entity shall ignore the value of the Reserved bits in R2D MAC PDUs.

The R2D message type represents the set of A-IoT MAC messages that are sent from the reader to the device on the PRDCH. The values of R2D message type is specified in Table 6.1-1.

Table 6.1-1: R2D Message Type

|  |  |
| --- | --- |
| R2D Message Type value | R2D message name |
| 000 | Reserved |
| 001 | *A-IoT Paging* message |
| 010 | *Access Occasion Trigger* message |
| 011 | *Random ID Response* message |
| 100 | *R2D Upper Layer Data Transfer* message |
| 101 | Reserved |
| 110 | Reserved |
| 111 | Reserved |

The D2R message type is the set of A-IoT MAC messages that sent from the device to the reader on the PDRCH. The value of D2R message type is specified in Table 6.1-2.

Table 6.1-2: D2R Message type

|  |  |
| --- | --- |
| D2R Message Type value | D2R message name |
| NA | *Random ID* message |
|  | *D2R Upper Layer Data Transfer* message |
|  | Reserved |
|  | Reserved |
|  | Reserved |

*Editor’s Note: Other message types are FFS. The message types may evolve based on functionality agreements.*

*Editor’s Note: FFS whether we introduce D2R message type. Discuss after looking at the overall MAC header design and space before deciding whether we introduce message type or reserved bits.*

## 6.2 A-IoT MAC messages

### 6.2.1 R2D messages

#### 6.2.1.1 A-IoT Paging message

The fields in this message are defined as follows:

- *R2D Message Type*: This field indicates the message type. See the Table 6.1-1.

- *RA Type*: This field indicates CBRA or CFRA.

- *Indication of Paging ID presence/absence*: This field indicates whether Paging ID is present or absent.

- *Length of Paging ID*: This field indicates the Paging ID length information when Paging ID field is present.

- *Paging ID*: xxx

- *Transaction ID*: xxx

- *Number of Access Occasions*: This field indicates the number of access occasions.

- *D2R Scheduling Info*: This field indicates the physical layer parameters used for D2R scheduling.

*Editor’s Note: FFS if CFRA can omit the fields of transaction ID, Indication of Paging ID present/absence, Number of access occasions.*

*Editor’s Note: FFS the length of transaction ID.*

####

#### 6.2.1.2 *Access Occasion Trigger* message

Figure 6.2.1.2-1 shows the format of the *Access Occasion Trigger* message.

The field in this message is defined as follows:

- *R2D Message Type*: This field indicates the message type. See the Table 6.1-1.

#### 6.2.1.3 *Random ID Response* message (Msg2 in CBRA)

Figure 6.2.1.3-1 shows the format of the *Random ID Response* message.

The fields in this message are defined as follows:

- *R2D Message Type*: This field indicates the message type. See the Table 6.1-1.

- *Echoed Random ID*: 16 bits

- *Assigned AS ID*: This field provides the value of AS ID which is 16 bits.

- *D2R Scheduling Info*: This field indicates the physical layer parameters used for D2R scheduling.

*Editor’s Note: FFS how to indicate the new assigned AS ID is present or not. FFS how to include multiple echoed random ID(s) and D2R Scheduling Info (if also multiple).*

####

#### 6.2.1.4 *R2D Upper Layer Data Transfer* message

Figure 6.2.1.4-1 shows the format of the *R2D Upper Layer Data Transfer* message.

The fields in this message are defined as follows:

- *R2D Message Type*: This field indicates the message type. See the Table 6.1-1.

- *AS ID*: This field provides/indicates the value of AS ID.

- *Length*: xxx

- *Data SDU*: xxx

- *Received Data Size*: This field is to indicate the number of bytes successfully received by the reader.

- *D2R Scheduling Info*: This field indicates the physical layer parameters used for D2R scheduling.

*Editor’s Note: FFS whether offset zero is always included. FFS whether the reader always includes the command for retransmission of segments.*

###

### 6.2.2 D2R messages

#### 6.2.2.1 *Random ID* message (Msg1 in CBRA)

Figure 6.2.2.1-1 shows the format of the *Random ID* message.

The field in this message is defined as follows:

- *Random ID*: 16-bit random number



Figure 6.2.2.1-1 MAC PDU of *Random ID* message

#### 6.2.2.2 *D2R Upper Layer Data Transfer* message

Figure 6.2.2.2-1 shows the format of the *D2R Upper Layer Data Transfer* message.

The fields in this message are defined as follows:

*Editor’s Note: FFS whether for D2R we need message type field.*

- *More Data Indication*:

- *Length*: xxx

*Editor’s Note: FFS how this is provided (i.e. SDU length field or padding length field). The size of length field is FFS.*

- *Data SDU*: xxx

- *MAC Padding*: This field includes padding bits.

Annex <X> (informative):
Change history

|  |
| --- |
| Change history |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
|  |  |  |  |  |  |  |  |

Annex: RAN2 agreement

Please note the colour means:

Implemented

Not implemented, assuming no stage 3 impact; or override by later agreements

FFS

Agreements:

 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.

 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

 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

 3. 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

 1. 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.

 2. 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.

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

8.2.3 A-IoT Random Access

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

 2. We will specify both CBRA and CFRA.

 3. 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.

 1. 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

 2. 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.

 1. 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.

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

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

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

 1 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).

 2 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

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

 4 FFS on end of procedure

8.2.4 A-IoT Data Transmission and Other general aspects

1. 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.

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

3. CFRA is not supported for group ID

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

5. 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

1. 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.

2. Segment retransmission is supported.

3. 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

4. R2D segmentation is not supported for R19 A-IoT.

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

1 AS ID is applied for Inventory + command case;

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

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

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

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

6 The device only keeps one AS ID at a time.

7 For CFRA, command message is used for AS ID assignment

8 For CBRA, Msg 2 is used for AS ID assignment

9 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.

1 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.

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

3 1-bit indication is sufficient to indicate whether more D2R data will be sent

4 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

2. Aim to design simple MAC PDU format design

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

4. 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).

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

6. 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.

1 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

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

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

4 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.

5 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.