**3GPP TSG-WG SA2 Meeting #166 *S2-24012488***

**Orlando, US, 18th Aug – 22nd Nov, 2024 (revision of S2-2402126)**

**Source: Huawei, HiSilicon**

**Title: Key Issue #1: Conclusion update to address the ENs**

**Document for: Approval**

**Agenda Item: 19.14.1**

**Work Item / Release: FS\_AmbientIoT / Rel-19**

*Abstract: Conclusion update to clarify the functionalities of AIoTF to address the related ENs.*

# 1. Discussion

## 1.1 Overview

We examine the ENs that remain in the TR conclusion and provide updates to address them, along with updates to align protocol stacks and architectures in all the relevant options. We’ve split this into 3 parts, covering the common aspects, followed by topology 1 and the topology 2 aspects.

## 1.2 Common Editor’s Notes

Editor's note: How addressing works for UL traffic (i.e. how the BS Reader identifies the appropriate AMF to which to forward UL messages) in the indirect path via AMF is FFS.

Editor's note: How addressing works for UL for Option B is FFS.

This open issue is general for DO-DTT traffic types, the key point is to route responses from Ambient IoT Devices to the AIoTF that initiated the request. Basically, to deliver the information between AF and an AIoT Device over 5GS, the 5GC needs to maintain the association within the 5GC for a specific AF request from the time it accepts the AF request to the time the AF request is completed:

- 1) NEF discovers and selects the AIOTF(s) to handle an AF request. The NEF creates the association with each target AIOTF.

- 2) The AIOTF initiates a Task corresponding to the AF request, assign a TASK ID to correlate the request and response, and generates the related MASK and other parameters for the AF request. The AIOTF will record the NEF address as part of the Task context. The AIOTF selects the Reader(s) for the request.

- 3) Where the request to the Reader goes via an AMF (i.e., for BS Readers (T1 Indirect case) and UE Readers (T2 RRC Indirect case – Opt b)) the AIOTF will use an Namf service operation, and the AMF knows therefore which AIOTF to route response back to. An identifier for the AIOTF is included in request towards RAN (either AIOT-RAN for T1 or gNB for T2).

- 3) The Reader performs the request from AIOTF and RAN passes the response (which includes the TASK ID) to the AMF over NGAP and includes the AIOTF identifier for the AIOTF provided in the request. The AMF uses the AIOTF identifier to route the response (which includes the TASK ID) to the requesting AIOTF.

- 4) The AIOTF collects the responses, determines which Task they are for based on the included TASK ID and routes the responses to the associated NEF address, and the NEF responds to the AF. The association between AIOTF and the NEF is released when the AIOTF completes the Task.

The similar concepts are proposed in sol#10 (transaction), sol#17 (task), sol#19 (AIoT Session), sol#20 (AIoT operation session), sol#42 (AIoT Session) etc.

**Proposal-1:** Capture the Task handling functionality as part of the AIoTF function to clarify how the addressing works for UL traffic.

Editor's note: Whether and how the validation of the Ambient IoT Device ID is done will be concluded by SA WG3.

ID validation includes three aspects: 1) whether the device is subscribed as a legal user to use operator’s resources, 2) privacy protection of the device ID, this is similar with SUPI and SUPI, 3) ID authentication, the user is authenticated with the credentials using like 5G-AKA procedures.

The 1st aspect is more relevant with the function and procedural aspects, at least this part is in the scope of SA2 to decide. The 2nd aspect and 3rd aspect are in SA3 scope.

**Proposal-2:** Clarify that checking whether the device is subscribed as part of the AIoTF function to address part of the open issue and to rephrase the EN.

Editor's note: Whether an AIoT NAS protocol is supported between the AIoT Device and the AIoTF, and what is the supported functionality, is FFS.

Editor’s Note: The details of the protocol stack are FFS.

3GPP shall be responsible for the E2E call flow without relying on other protocols. If a service operation is transferred at APP layer, it means that customised AIoT Devices are produced, which can lead to higher cost, due to e.g. smaller production volumes for each customisation, potentially more complex stock management etc..

An AIoT specific NAS between the AIoT Device and AIOTF provides a way for the 5GC to have communication with the AIoT Device without RAN having to be involved in all the exact details of every flow end to end and what exactly is being communicated. There always needs to be information about the requested operation and its associated parameters, the AIoT specific NAS header is a small delta on those parameters. There is a small AIoT specific NAS overhead with the introduction of the AIoT specific NAS Header, compared with a hop-by-hop approach. This could be a single octet (or less if 8-bit alignment is not required). This small AIoT specific NAS overhead brings limited impacts for the most commonly used inventory and read scenarios, considering many benefits it brings.

AIoT Specific NAS, is not the legacy NAS protocol supported by UE. It is a light-weight protocol considering the low-complex nature of the Ambient IoT Devices, and corresponds to the general AIoT Device “upper layer”, which is similar as the concept of AIoT AS layer used for AIoT lower layer, between the AIoT Device and AIOTF.AIoT specific NAS will be an important building block for future enhancements and evolution of the specification in the future, it is not just related to security, but overall functionality, for example the basic operations like Read/Write.

Therefore, AIoT specific NAS to support information transfer for Ambient services between AIoT Device and 5GC is recommended.

The name of the protocol can be left for stage 3 to decide. However, it is noteworthy that from AIoT Device point of view, it supports the protocol with core network regardless of the topology or transport used by the topology.

**Proposal-3:** Conclude to support AIoT specific NAS and update protocol stacks to include it.

Editor's note: How the aggregation can be done is FFS.

Aggregation can not only be done by AIOTF, the AIOTF can also instruct the Reader to perform the aggregation before transferring the responses back to the AIoTF in case there is no need for interactive authentication, e.g., inventory procedure. This is to mitigate signal storms in the 5GS. The aggregation is performed for the same Task based on the e.g., period time, number of devices, task ID etc.

The similar concepts are proposed in sol#10, 18, 22, 31 etc.

**Proposal-4:** Clarify how the aggregation is done and the reader can also perform aggregation as AIOTF instructed.

Editor's note: Whether and what AIoT Device related information (e.g. AIoT Device last known Reader ID, optionally the result of AIoT device validation result, etc.) is stored in the AIOTF, are FFS.

Editor's note: Whether the UDM should store the device related information is FFS.

A network may have multiple AIOTF instances therefore to synchronize the device related information between them, it is better to store the information in the UDM, as part of the UDM AIoT specific subscription-like information.

**Proposal-5:** Clarify that the AIOTF manages the device related information in a UDM, and the details are left to Key Issue #2 conclusion.

Editor's note: The details of the NF profile are FFS.

The NF profile in the NRF is used by the NEF to discover the instances of AIOTF. The similar parameters for NF discovery can be introduce to help discover AIOTF instances, like NF type, Reader Set IDs etc.

**Proposal-6:** Clarify that NF profile is used to discover the AIOTF instances and details of the NF profile is to be determined in the normative phase.

In addition, this contribution also clarifies that the AIoTF needs to collect the Reader information (like Reader Set ID, Reader ID, Reader type, Reader status, etc.) so as to discover and select the candidate or target Readers for the received AF request. In case of down selection of candidate UE Readers at RAN node, the which UE a UE Reader ID is related to needs to be understood by the RAN node.

**Proposal-8:** Clarify that the reader management is part of the AIoTF function.

## 1.3 Topology 1 Specific Editor’s Notes

Editor’s Note: The relationship between the AIoT RAN and (other) gNB functionality is FFS.

RAN3 contribution (R3-247036) concludes an A-IoT RAN (i.e. SA2 term “AToT RAN”) includes “common reader function” and “A-IoT RAN node function”.

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Figure (from R3-247036): Logical system architecture for topology 1

Some relevant information is:

Definition of the common reader function: A function that communicates with the A-IoT device by means of A-IoT radio.

Definition of A-IoT RAN node function: A function that contains e.g., the control of the A-IoT radio resources used towards the A-IoT device.

It is observed that an A-IoT RAN (i.e. SA2 term “AIoT RAN”) only supports Ambient IoT specific functionalities.

The relationship between a gNB and AIoT RAN node function is clarified that, NG-RAN (AIoT Enabled), is a gNB supporting A-IoT RAN node function in topology 2, which is able to communicate with UE Reader via NR Uu interface.

It is also clarified that NG-RAN (AIoT Enabled) could support both topology 1 and topology 2, this is an implementation matter.

Based on the above analysis, the above-mentioned Editor’s note that AIoT RAN (aka. AIoT RAN node function) supports only Ambient IoT specific functionalities. Definition of AIoT RAN node function is referred to in R3-247036.

**Proposal 1:** **the AIoT RAN (aka. A-IoT RAN node function in TR 38.769) supports only Ambient IoT specific functionalities. Definition of A-IoT RAN node function is referred to R3-247036.**

Editor’s Note: The AMF enhancements are FFS.

Editor’s Note: Details of the Service (e.g. whether it is a new service, whether the existing Namf service is enhanced is FFS).

The Editor’s notes are under under Figure 8.1.2-6 Example Protocol Between AIoTF and AIoT Device for Topology 1 (indirect Path via AMF).

Two scenarios need to be considered (1) support of AIoT service (2) management of AIoT RAN “reader functionality”.

1. Support of AIoT service

 It was agreed that within this architecture option, AIOTF supports the Ambient IoT functionalities while the AMF supports the transport of the AIoT signalling between the AIoT RAN and the AIOTF.

 In addition, the AIoT Service (inventory, command) context is maintained between AIoT RAN and AIOTF, so the transport by AMF is not based on any AMF local context. Typically, this type of service uses AMF service “non-UE message transfer”, which is an existing service used for scenarios like Location service, PWS, et al.

 In summary, the interaction between the AIOTF and AMF reuses “Non-UE N2 Message Operations” defined in clause 5.2.2.4, TS 29.518. It is expected the AIoT related parameter e.g. Reader IDs and requests for Readers to perform operations, will be the new input parameter to the existing service operation.

 On the NG interface, whether to define new message to convey the AIoT Reader Control parameters/container/PDU, will be decided by RAN3.

2. Management of AIoT RAN “reader functionality”

 This procedure is triggered by the AIoT RAN to exchange the BS Reader functionality support to the AMF/AIOTF. It is up to RAN3 to decide which existing message or new message is used to carry the Ambient IoT BS Reader functionality. In all the cases, AIoT RAN is configured with one or multiple AIOTF address(es) is configured in the AIoT RAN, and used by the AIoT RAN to exchange the AIoT Reader capability to the AIOTF. AIoT RAN provides the AIOTF address(es) in the NGAP message to the AMF, and AMF forwards the AIoT Reader capability of the AIoT RAN to the AIOTF based on the AIOTF address(es). The AMF uses the “Non-UE N2 Message Operations” to forward the AIoT Reader capability to the AIOTF. This enables routing from the AIOTF towards specific BS Readers via a known AMF.

**Proposal 2: AMF service “Non-UE N2 Message Operations” is reused between AMF and AIoTF. New input parameters e.g. Reader IDs/Reader requests for this service operation will be defined. Whether new NG interface message(s) are used will be determined by RAN3.**

## 1.4 Topology 2 Specific Editor’s Notes

Editor's note: Which option to use, i.e. whether gNB/AIoT RAN connect to AIoTF directly (Option A in Figure 8.1.3.3-1) or via AMF (Option B in Figure 8.1.3.3-2) is FFS.

For topology 2, RRC based solution, option A needs the gNB to additionally have a new interface towards the AIOTF, in addition to the NGAP association to the AMF. This brings additional impacts to the existing gNB nodes. Whereas, the option B reuses the existing NGAP association with minor AMF service enhancements, this is more suitable for topology 2. Thus, it is proposed to only use option B for RRC based solution.

**Proposal-6:** Conclude that only option B for RRC based solution is feasible to be supported.

This contribution also aligns the protocol stacks and clarifies that, in case of topology 1 the same protocols can be used between AIoT RAN and AMF for indirect architecture option and between AIoT RAN and AIoTF for direct architecture option.

# 2. Text Proposal

It is proposed to capture the following changes vs. TR 23.700-13.

\* \* \* \* First change \* \* \* \*

## 8.1 Interim Conclusion on Key Issue #1

### 8.1.1 General

Key issue #1 includes the following aspects:

- System architecture identified along with the solutions for KI#2 and KI#3.

Key issue#2 aspect on "Ambient IoT Device subscription management" and key issue#3 aspect on "Ambient IoT service exposure" is considered in this section.

The following aspects common for Topology 1 and Topology 2 are concluded as principles for normative work:

Editor's note: Final conclusions are assumed to be taken in coordination with RAN WGs.

Editor's note: Information needed for radio resource allocation to readers is FFS and requires cooperation with RAN WG2/RAN WG3.

Editor's note: Which architecture options described in the following clauses will be concluded is FFS.

1. A new core network function is introduced to support Ambient IoT (e.g. AIOTF) service for both the topology 1 and topology 2. The AIoTF performs the following functionality.

a. The AIOTF manages the device related information in the network..

b. The AIOTF registers itself in the NRF with its NF profile, this is to enable the discovery of AIOTF instances e.g. by an NEF. The details of the NF profile will be completed in normative phase.

c. The AIOTF has reader related information (e.g. Reader ID, Reader type, Reader status, etc.). When the AIOTF receives an AIoT service request from the AF, the AIOTF performs reader selection and triggers the BS/UE Readers to perform AIoT service operations towards the AIoT Devices(s).

d. The AIOTF aggregates the service operation results (including the removal of the duplicated devices records) from AIOT RANs and UE Readers and sends to AF. Additionally, the AIOTF may instruct AIOT RAN or UE Reader to aggregate the service operation results from AIoT devices. The aggregation can be performed based on an aggregation time period or number of devices and Task ID.

Editor's note: For RRC based solution of topology 2, whether the aggregation can be performed by the RAN is FFS and coordination with RAN WGs is needed.

h. The AIOTF generates a Task ID for each AF requested Ambient IoT Service, and maintains the association (AF ID, Task ID, NEF address, Mask etc.). The Task ID is sent by the AIOTF to the UE Reader or AIOT RAN in a request and is returned by the AIOT RAN or UE Reader in order to enable the AIOTF to relate responses to a given request. The AMF (if used to route the requests) additionally provides an AIOTF identifier with the request from the AIOTF which is returned with the response(s) related to the request, so the AMF can be routed back the requesting AIOTF.

NOTE x: The Reader is able to associated paging and responses to it on the air interface, as described in Protocol stack and signalling procedures in TR 38.769.

2. A Permanent AIoT Device ID is stored in the AIoT Device and the UDM or a Credential Holder's AAA server. The AIOTF checks whether the AIoT Device ID from AIoT Device has a subscription and retrieves it.

Editor's note: Whether and how the AIoT Device ID privacy protection and ID authentication is done will be concluded by SA WG3.

3. The AIoT Device does not distinguish whether the connectivity topology is Topology 1 or Topology 2, nor the transport used by the AIoT Reader.

NOTE: The AIoT device is also agnostic to the potential different architectures if more than one architecture is concluded for both the topology 1 and topology 2.

Editor's note: Whether an AIoT NAS protocol is supported between the AIoT Device and the AIoTF, and what is the supported functionality, is FFS.

### 8.1.2 Architecture to Support Topology 1

The principles and aspects in this clause are agreed to support Topology 1:

- The new core network function (AIOTF) is introduced to support Ambient IoT functionality, described in clause 8.1.1, with the following features for topology 1:

- Communicate with BS Reader (i.e. AIoT RAN), either directly or via an AMF, to trigger e.g. inventory request and command request).

NOTE 1: It is assumed AIoT RAN (aka. A-IoT RAN node function in TR 38.769) supports only Ambient IoT specific functionalities. Definition of A-IoT RAN node function is defined by RAN WGs. There is no assumption about whether the AIoT RAN (i.e. BS Reader) also has gNB functionality for NR-Uu or not.

NOTE x1: NGAP is used when the AIOTF directly communicates with the AIOT RAN (i.e. over the Nx reference point) or indirect communication with AIOT RAN via an AMF (i.e. over the N2 reference point).

NOTE 2: It is assumed Ambient IoT services can be deployed independently from existing deployments.

NOTE 3: It is not expected a deployment will use both direct communication between AIOT RAN and an AIOTF and indirect communication between AIOT RAN and an AIOTF via an AMF. How to choose which option to deploy is not defined and the choice can be based on, for example, using a direct communication path for a local deployments.

* The signalling transport for NGAP at the A-IoT RAN node is SCTP/IP.

**When a AIOT RAN and the AIOTF communicate directly:**

- The AIOTF communicates with a BS Reader via a direct interface reference point Nx.

- Figure 8.1.2-1 below shows the aspects related to Topology 1 (direct path) architecture in reference point representation architecture with other NFs removed.



Figure 8.1.2-1: Non-Roaming 5G System Architecture (Direct Path)

- Figure 8.1.2-2 below shows the aspects related to Topology 1 (direct path) architecture in reference point representation with other NFs removed.



Figure 8.1.2-2: Non-Roaming 5G System Architecture in reference point representation (Direct Path)

NOTE 4: NGAP used over Nx reference point will support procedures and information to be exchanged as specified by RAN WG2, RAN WG3 and SA WG2.

NOTE 5: The protocol stack used between the AIoTF and AIOT RAN will be concluded by RAN WG3.

- Figure 8.1.2-3 below shows the aspects related to Topology 1 (direct path) protocol stack between AIOT RAN and AIoTF.



Figure 8.1.2-3: Example Protocol Stack between AIoTF and AIoT Device for Topology 1 (Direct Path)

NOTE X: Whether AIoT Reader Control is transported by NGAP or is part of the NGAP protocol will be determined by RAN3.

**When AIOT RAN and the AIoTF communicate indirectly via an AMF:**

- The AIoTF connects with AIOT RAN via an AMF. NGAP over the N2 reference point between the AIOT RAN and AMF supports Ambient IoT services including delivery of inventory/command messages.

NOTE 6: If network isolation is required an AMF instance is deployed for supporting the AIOTF communication with AIOT RAN.

- NGAP between AIOT RAN and the AMF is enhanced to support Ambient IoT Services.

NOTE 7: The details of the enhancements will be concluded by RAN WG3.

- The AMF shall be enhanced to support Services which are used by an AIoTF for Ambient IoT Operations to support AIoT requests towards Readers, including e.g. the requested operation, target BS Readers etc.

- The AMF passes information between AIOT RAN (e.g. operation requests and responses) and the AIOTF.

- Figure 8.1.2-4 below shows the aspects related to Topology 1 (indirect path via AMF) architecture in reference point representation with other NFs removed.



Figure 8.1.2-4: Non-Roaming 5G System Architecture (indirect Path via AMF)

- Figure 8.1.2-5 below shows the aspects related to Topology 1 (indirect Path via AMF) architecture in reference point representation with other NFs removed.



Figure 8.1.2-5: Non-Roaming 5G System Architecture in reference point representation (indirect Path via AMF)

- Figure 8.1.2-6 below shows the aspects related to Topology 1 (indirect path via AMF) protocol stack between AIOT RAN and AIoTF.



Figure 8.1.2-6: Example Protocol Between AIOTF and AIoT Device for Topology 1 (indirect Path via AMF)

NOTE X: Whether AIoT Reader Control is transported by NGAP or is part of the NGAP protocol will be determined by RAN3.

\* \* \* \* End of changes \* \* \* \*