**3GPP SA WG2 Meeting #161 S2-2403407**

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**Source: Ericsson**

**Title: KI #2, New Solution: Inventory for AIoT Devices using AIOTF**

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*Abstract of the contribution: The contribution discusses and proposes a new solution for inventory based on enhanced architecture to support Ambient IoT Device.*

**1. Introduction**

Ambient IoT devices are IoT devices powered by energy harvesting, being either battery-less or with limited energy storage capability (e.g. using a capacitor). It can have, e.g., lower complexity, smaller size, reduced capabilities and lower power consumption than previously defined 3GPP IoT devices. The data rate of Ambient IoT devices is usually low.

In KI#2 of TR 23.700-13 v0.1.0, the study objectives include:

- Study whether subscription management, registration management and/or connection management are necessary for an Ambient IoT Device or a group of Ambient IoT Devices, and if so identify the necessary state machine(s), procedures and functionality considering the Ambient IoT Devices capability and characteristics.

This pCR proposes a solution to study the aspects above.

**2. Proposal**

It is proposed to agree the following changes to 3GPP TR 23.700-13 v0.1.0:

\* \* \* Start of Change \* \* \* \*

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |
| --- | --- |
|  | Key Issues |
| Solutions | Key Issue #1 | Key Issue #2 | Key Issue #3 |
| #1 |  |  |  |
| #2 |  |  |  |
| #X |  | X |  |

\* \* \* Next of Change (ALL TEXTS ARE NEW) \* \* \* \*

## 6.X Solution #X: Inventory for AIoT Devices using AIOTF

### 6.X.1 Description

This solution addresses subscription, registration and connection management aspect of Key Issue #2, which is based on the the following system architecture.

The functional entities defined in TS 23.501 [4] are reused with the exception for the following additions:

- Ambient IoT Function (AIOTF): AIOTF is introduced to support AIoT services, with some AMF’s functionalities integrated, which includes:

- A-RAN (Ambient IoT RAN) connectivity.

- Inventory handling and device context management.

- Authentication and authorization for the access, which triggers interaction with AUSF/UDM

- Collect charging data and interact with CHF for charging.

- Routing the request from AF (via NEF) to A-RAN, for DO-DTT/DT traffic types.

- Routing the response from A-RAN to AF (via NEF) for DO-DTT traffic type.

Editor's note: It is FFS whether AIOTF needs to support further functionalities.

- UDM: UDM is enhanced to store and manage the AIoT device information. The device information contains the device ID, device status information (e.g. enabled/disabled/permanently disabled), as well as CN related information (e.g. serving NF).

- NEF: NEF is enhanced to expose AIoT specific services towards AF.

- CHF: CHF is enhanced for the charging for AIoT services.

NOTE 1: The charging aspects is to be studied by SA5.

- NRF: NRF is enhanced to support the new NF type AIOTF and the corresponding NF profile.

- AUSF: AUSF is enhanced for the authentication for the access from AIoT devices.

NOTE 2: The security aspects are to be studied by SA3.

Editor's note: The functions of the NFs need to be updated to align with the solutions for KI#2 and KI#3, and to be aligned with A-RAN WGs, SA3 (for security), SA5 (for charging).

The Figure 6.X.1-1 illustrates the enhanced architecture to support AIoT devices using AIOTF for inventory.



Figure 6.X.1-1: System Architecture to support AIoT Devices using AIOTF for Inventory

Editor's note: It is FFS whether and how to address other services/use cases than inventory with this architecture.

Editor's note: It is FFS whether and how much of NGAP is re-used for interface between A-RAN and AIOTF.

This solution focuses on Topology 1.

Editor's note: It is FFS whether and how the solution can be evolved for Topology 2.

The AIoT device information can be stored in UDM, which is similar as the subscription data. The device information contains the device ID, device status information (e.g. enabled/disabled/permanently disabled), as well as CN related information (e.g. serving NF).

For enabling registration management, the some AIoT devices are assumed not to be able to initiate the registration on their own. However, such passive AIoT devices can respond to messages from the network, which make them discoverable by the network. The procedure that is used to make the AIoT devices discoverable can be called an inventory procedure.

Editor's note: It is FFS whether none of the AIoT device types can initiate registration on their own.

The inventory procedure can be triggered by an AF sending an inventory request towards CN, and CN sends a request to A-RAN. The AIoT devices respond to the inventory request from A-RAN and send their device IDs. Such inventory procedure triggered by an AF can be called application inventory procedure.

The AF may further provide the inventory strategy information (e.g., inventory frequency, inventory period) to enable CN or A-RAN to perform periodic inventory to allow the newly coming AIoT devices to be discovered, without further explicit requests from the AF.

For the application inventory or periodic inventory, depends on device capabilites, the authentication and authorizaiton may be performed, and the CN allocated device ID which is similar as 5G-GUTI may be passed to the device. For those devices, the device contexts are stored in AIOTF, including the security contexts.

When application inventory or periodic inventory procedure is triggered, the network may indicate whether all targeted devices need to respond the inventory, or only those devices which haven’t been “inventoried” towards this A-RAN node should respond.

When AIoT devices move to a new A-RAN node, by responding the inventory, the network can also keep track of the serving A-RAN nodes, so that the network can route the request effectively which is sent from the AF to one or more specific AIoT devices.

NOTE: When AIoT devices move, the AIoT devices does not perform cell re-selection like logic.

For connection management, when in CM-CONNECTED state, the device is known by the network and DL data can be delivered to the service A-RAN node directly. When in CM-IDLE state, the detailed location of the device is unknown, so that before delivering DL data, CN needs to look up the device.

Editor's note: It is FFS whether there are needs to enable functionality enabling similar functionality as CM-IDLE and CM-CONNECTED states enables, and whether CN (i.e., AIOTF) needs to perform different actions accordingly, when DL data need to be delivered.

### 6.X.2 Procedures

NOTE: The message names in the procedures below are descriptive. It is assumed that the names are updated with corresponding SBI based names where applicable during the normative phase.

#### 6.X.2.1 Application Inventory Procedure

The application inventory procedure is initiated by the AF to discover one or more AIoT devices in a specific areaö.



Figure 6.X.2.1-1: Inventory Procedure

1. The AF sends Inventory Message Request to the NEF, containing the area information, device information, optinal inventory strategy information, and optional report aggregation info.

- The area information could be the external geographical area information.

- The device information could be device ID, device group ID, and/or device type.

Editor's note: Details of device type is FFS.

- The inventory strategy information contains, e.g., the inventory frequency and inventory period to guide the readers to perform the inventory periodically. It also indicates whether all the targeted devices need to respond (full inventory), or only those who haven’t performed the inventory procedure (delta inventory) should respond.

- The location required indicates whether the AF requests the location information of the AIoT devices provided.

- The report aggregation info indicates whether the reports need to be aggregated or not for a specific aggregation period, and whether the reports are needed after the aggregation period.

2. The NEF auhorizes the request from the AF and perform the area tA-RANslation to tA-RANslate external area information to the internal area information. Within the authorization, the NEF further check whether the AF is authorized to get the location information of the device.

3. The NEF sends NRF query with internal area information to query AIOTFs serving the area.

4. The NEF sends the Inventory Request to the AIOTFs with the internal area information, device information and optionally inventory strategy information, optional location required information.

5. The AIOTF discovers A-RANs based on internal area information.

6. The AIOTF sends an NGAP message (Inventory Request) to the A-RANs with the internal area information, device information and inventory strategy information, and optional location required information.

7. The A-RAN (reader) initiates inventory based on device information as well as the inventory strategy information provided by the AF. The A-RAN may provide reader identity information (e.g. A-RAN ID) to enable the AIoT devices to understand they are read by which A-RAN node.

8. The AIoT Device reports the device ID, and optional device capability information. If the Inventory procedure indicates only who haven’t performed the inventory procedure should respond, and if the AIoT Device has performed the inventory procedure towards this A-RAN node, it should skip the reporting.

9. The A-RAN sends an NGAP message (Inventory Response or Inventory Notify) to the AIOTF, containing the device ID and the optional device capability information provided by the device. The A-RAN may further provide location information (ULI) of the device, if requested from the AIOTF and allowed by local policy. The A-RAN may further provide an end indicator to inform the AIOTF whether it is the last inventory response for the inventory round.

Editor's note: Details of what location information A-RAN provides is FFS.

10. The AIOTF validates the device ID via interacting with AUSF and UDM. The AIOTF may further check the device capability information from the device subscription data stored in the UDM for the device capability information.

Editor's note: The check of the device capability information is FFS.

Based on the device capability info from the device and/or device information data in UDM, if the AIoT device is capable of handling authentication and authorization, step 11 – step 13 are executed:

Editor's note: The use of the step 11-13 is FFS.

11. The AIOTF together with AUSF and UDM, triggers authentication and authorization procedures towards the AIoT device.

12. The AIOTF may further allocates CN device ID and sends to the AIoT device.

13. The AIOTF registers with the UDM (UECM) for the device access.

14. The AIOTF may perform aggregation for the device ID, based on the report aggregation information provided by the AF. Within the aggregation period, the AIOTF will buffer the device IDs reported from the AIoT devices. The AIOTF may stop buffering and send report immediately, if it receives end indicator from A-RAN in step 9. When the aggregation period expires, the AIOTF sends the report. For those device ID report after the aggregation period, if it is needed by the AF, the AIOTF sends the report. Otherwise, it will be dropped.

15. The AIOTF sends Inventory Response or Notification Request towards the NEF for the device ID or the aggregated device ID information.

16. The NEF sends Inventory Response or Notification Request towards the AF for the device ID or the aggregated device ID information.

#### 6.X.2.2 Periodic Inventory Procedure

The periodic inventory procedure is initiated by the CN or A-RAN, which follows the instructions from the AF,



Figure 6.X.2.2-1: Periodic Inventory Procedure

The AIOTF or the A-RAN may initiate the periodic inventory procedure based on the inventory strategy information provided by the AF, to enable the AIoT devices to be discovered when they newly enter the coverage area.

The step 1 - step 11 are similar as step 6 - step 16 in clause 6.X.2.1, with the following additions:

1. It will be performed only when it is AIOTF to initiate the periodic inventory. The inventory strategy should be set to delta inventory.
2. It can be performed without step 1, if it is A-RAN who initiates the periodic inventory. The inventory strategy should be set to delta inventory.
3. The AIOT device responds if it hasn’t been “inventoried”. Using the reader identity information (e.g. A-RAN ID) over the air, AIOT device determines if it is being read by a new A-RAN node and responds the inventory. The device may provide CN allocated device ID if it received before.

6. Can be skipped if the AIOTF finds AIoT device has performed the authentication and authorization with the network, based on CN allocated device ID.

7. Can be skipped if the AIOTF decides not to allocate a new CN allocated device ID by local policy.

8. Can be skipped if the AIOTF has registered towards UDM.

9. The AIOTF may use the aggregation period provided by the AF, or a locally configured value or even skip the aggregation, based on local policy. If the AIoT device responds the inventory procedure due to the A-RAN is a new reader, the device ID may not be sent to AF via NEF, unless AF requires the location information.

10. The AIOTF sends Inventory Notify Request towards the NEF for the device ID or the aggregated device ID information.

11. The NEF sends Inventory Notify Request towards the AF for the device ID or the aggregated device ID information.

### 6.X.3 Impacts on services, entities and interfaces

Editor's note: The services, entities and interfaces are FFS.

\* \* \* End of Change \* \* \* \*