**3GPP SA WG2 Meeting #162 S2-2405437**

**Changsha, China, April 15 – 19, 2024**

**Source: Ericsson, ZTE**

**Title: KI #1, #2, #3, New Solution: AF Based Solution**

**Document for: Approval**

**Agenda Item: 19.14**

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

*Abstract of the contribution: The contribution discusses and proposes a new solution for AF based solution for KI#1, 2 and 3.*

**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.

This pCR proposes an AF based solution to enable the support of Ambient IoT devices.

**2. Proposal**

It is proposed to agree the following changes to 3GPP TR 23.700-13 v0.2.0:

\* \* \* 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 |  | X |  |
| #2 |  | X |  |
| #3 | X | X | X |
| #4 | X | X | X |
| #5 |  | X | X |
| #6 | X | X | X |
| #7 | X | X |  |
| #8 | X | X |  |
| #9 | X | X | X |
| #10 | X | X |  |
| #11 |  |  | X |
| #12 | X | X | X |
| #X | X | X | X |

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

## 6.X Solution #X: AF Based Solution for Topology 2

### 6.X.1 Description

This solution proposes an AF based solution, which addresses KI#1, KI#2 and KI#3.

In this solution, it is AF who is in charge of the intermediate UE for the Ambient IoT operations, including communicating with and determining intermediate UEs, sending operation commands to and receiving results from intermediate UEs. As the licensed spectrum is owned by MNO, it is proposed to let network provide the radio resource information towards the intermediate UEs about the spectrum information for the over-the-air interface between Intermediate UEs and AIoT devices.

Editor's note: It is FFS about the improvements by locating more functions in CN, e.g., AF get locations of Intermediate UEs from CN but not from UEs; CN may determine Intermediate UEs on behalf of AF.

#### 6.X.1.1 Reference Architecture

The Figure 6.X.1.1-1 illustrates the architecture for AF based solution:



Figure 6.X.1.1-1: System Architecture of AF Based Solution

This solution focuses on Topology 2.

Editor's note: It is FFS whether and how the solution can be evolved for Topology 1.

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

- UDM/UDR: The authorization information of Intermediate UE for AIoT is stored in UE subscription data

- AMF: Receive AIoT capability information from UE and authorize based on the subscription data in UDM/UDR.

- NG-RAN: Provide spectrum information towards authorized intermediate UE.

- Intermediate UE:

- Provide Ambient IoT capability information to AMF and receive the authorization information

- Receive the instruction from AF and perform Ambient IoT operations (e.g., inventory, command, etc.) on the proper spectrum. The radio resource information is received from NG-RAN

- Receive command results from AIoT devices and send to AF.

- AF:

- UE AIOT layer interactions with Intermediate UEs

- Determine Intermediate UEs, send the instruction to the Intermediate UEs, and receive responses from Intermediate UEs.

Editor's note: Further involvement of the CN is FFS, including how to perform access control for devices, and how to perform charging towards CHF.

#### 6.X.1.2 Protocol Stack

The Figure 6.X.1.2-1 illustrates the protocol stack for AF based solution:



Figure 6.X.1.2-1: Protocol Stack for AF Based Solution

Within the protocol stack:

- UE AIoT layer: between AF and UE reader. AF provides Ambient IoT operation commands to Intermeidate UEs via UE AIoT layer.

- App layer: The application layer protocol between AIoT devices and AF.

- Uu AS layer: On top of the existing Uu AS layer, radio resource information request from UE reader to NG-RAN.

It is assumed that the end-to-end protection is implemented between AF and AIoT devices.

NOTE 1: The UE AIOT layer and App layer are assumed to be defined by SA2 (Stage 2 aspects) and CT1 (Stage 3 aspects).

NOTE 2: The Details of the protection between AIoT device and AF and the protection between AIoT device and UE reader are assumed to be addressed by SA3.

The UE AIOT layer messages between AF and UE reader can be transferred via PDU session user plane. AF delivers downlink messages towards Intermediate UE and receives uplink messages from Intermediate UE via UPF. As an alternative option, AF may communicate with UE reader via control plane, by utilizing the Control Plane CIoT 5GS Optimisation. The downlink messages are sent by AF, and delivered through NEF, SMF, AMF, NG-RAN towards Intermediate UE. The uplink messages are sent by the Intermediate UE, and delivered through NG-RAN, AMF, SMF, NEF towards AF.

### 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 AIoT Service Authorization for Intermediate UE

The Registration procedure for UE is performed as defined in clause 4.2.2.2 of TS 23.502 with the following additions:

- UE includes the AIoT Intermediate node capability as part of “5GMM capability” in Registration Request message.

- The AMF obtains the AIoT Subscription data as part of the user subscription data from UDM using Nudm\_SDM service

- The AMF determines whether the UE is authorized to work as Intermediate UE for AIoT based on UE’s AIoT Intermediate node capability and the AIoT Subscription data. The AMF includes the authorization information as part of UE context in NGAP message sent to NG-RAN.

In Service Request procedure, N2 Handover prodcure, Xn Handover procedure, and when receiving Subscriber Data Update to AMF, the AMF includes the authorization information in NGAP message sent to NG-RAN.

#### 6.X.2.2 Inventory Procedure

The Inventory procedure can be initiated by the AF to discover one or more AIoT devices in a specific area via Intermediate UEs.



Figure 6.X.2.2-1: Inventory Procedure

1. Via the Intermediate UE’s PDU session user plane or control plane, the Intermediate UE communicates with the AF to transport UE AIOT layer messages, including location information reporting.

2. The AF determines Intermediate UEs based on the location information reported by the Intermediate UEs, as well as the area AF intended to perform inventory.

3. The AF sends Inventory Request towards the selected Intermediate UEs via Core Network and NG-RAN over PDU session user plane. The Inventory Request includes the device information, inventory strategy information.

- The device information could be device ID, device group ID, and/or device type. The device type refers to type 1, 2A or 2B in TR 38.769 [8].

NOTE 1: It’s up to RAN to determine whether the device type is useful or not for Intermediate UE, based on the assumptionon of harmonized air interface.

- The inventory strategy information contains, e.g., the inventory frequency and inventory period to guide the reader 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. For flexibility, the delta inventory may require the device to respond if it is reading by a different reader, even if the device has performed the inventory procedure, which requires the AIoT devices to keep the reader ID.

- 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.

4. The Intermediate UE interacts with NG-RAN for radio resource allocation

NOTE 2: The detail of this function is assumed to be defined by RAN.

5. The Intermediate UE initiates inventory based on device information as well as the inventory strategy information provided by the AF. To be able to differentiate readers in delta inventory, the Intermediate UE may provide reader identity information to enable the AIoT devices to understand they are read by which Intermediate UE. Considering the mobility of the Intermediate UE (e.g., when the Intermediate UE and some devices move together to another room, in the following delta inventory, the devices can regard the Intermeidate UE in a new room as a different reader than the one they have responded), the reader identity information can be a combination of an application layer reader ID and the location information.

6. The AIoT Device reports the device ID. 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 reader, it should skip the reporting.

7. The Intermediate UE may perform aggregation for the device ID, based on the report aggregation information provided by the AF. Within the aggregation period, the Intermediate UE will buffer the device IDs reported from the AIoT devices. The Intermediate UE may stop buffering and send report immediately, if it determines no further report from devices. When the aggregation period expires, the Intermediate UE sends the report. For those device ID report after the aggregation period, if it is needed by the AF, the Intermediate UE sends the report. Otherwise, it will be dropped.

8. The Intermediate UE sends Inventory Response or Notification Request towards the AF for the device ID or the aggregated device ID information.

The Intermediate UE may perform periodic inventory following the instructions from AF, as described in Solution#8.

#### 6.X.2.3 Command Procedure

The Command procedure is initiated by the AF to request one or more AIoT devices in a specific area to execute a command via Intermediate UEs. The device may or may not send back the command results depends on the command.



Figure 6.X.2.3-1: Command Procedure

1. Via the Intermediate UE’s PDU session user plane or control plane, the Intermediate UE communicates with the AF to transport UE AIOT layer messages, including location information reporting.

2. The AF determines Intermediate UEs based on the location information reported by the Intermediate UEs, as well as the area AF intended to perform command.

3. The AF sends Command Request towards the selected Intermediate UEs via Core Network and NG-RAN over user plane. The Command Request includes the command, device information, result aggregation information.

- The command is the command to be executed in the device, including read, write, enable, disable, or other application specific command.

- The device information could be device ID, device group ID, and/or device type. The device type refers to type 1, 2A or 2B in TR 38.769 [8].

NOTE 1: It’s up to RAN to determine whether the device type is useful or not for Intermediate UE, based on the assumptionon of harmonized air interface.

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

4. The Intermeidate UE interacts with NG-RAN for radio resource allocation

NOTE 2: The detail of this function is assumed to be defined by RAN.

5. The Intermediate UE delivers the command to the AIoT devices.

6. The AIoT Device executes the command and send back the result to the Intermediate UE if needed.

7. The Intermediate UE may perform aggregation for the result, based on the report aggregation information provided by the AF. Within the aggregation period, the Intermediate UE will buffer the results from the AIoT devices. The Intermediate UE may stop buffering and send report immediately, if it determines no further results from devices. When the aggregation period expires, the Intermediate UE sends the report. For those results after the aggregation period, if it is needed by the AF, the Intermediate UE sends the report. Otherwise, they will be dropped.

8. The Intermediate UE sends Command Response or Notification Request towards the AF for the result or the aggredated results.

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

The following NFs are impacted:

- UDM/UDR: Store the authorization information of Intermediate UE for AIoT

- AMF: Receive AIoT capability information from UE and authorize based on the subscription data in UDM/UDR.

- NG-RAN: Provide spectrum information towards authorized intermediate UE.

- Intermediate UE:

- Provide Ambient IoT capability information to AMF and receive the authorization information

- Receive the instruction from AF and perform Ambient IoT operations (e.g., inventory, command, etc.) on the proper spectrum. The radio resource information is received from NG-RAN

- Receive responses from AIoT devices and send to AF.

- AF:

- UE AIOT layer interactions with Intermediate UEs

- Determine Intermediate UEs, send the instruction to the Intermediate UEs, and receive responses from Intermediate UEs.

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