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| 3GPP TS 23.abc V0.1.0 (2025-01) |
| Technical Specification |
| 3rd Generation Partnership Project;Technical Specification Group Services and System Aspects;Architecture support forAmbient power-enabled Internet of Things;Stage 2(Release 19) |
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Contents

Foreword 5

1 Scope 6

2 References 6

3 Definitions of terms, symbols and abbreviations 6

3.1 Terms 6

3.2 Abbreviations 6

4 Architecture model and concepts 7

4.1 General concept 7

4.2 Architecture 7

4.2.1 General 7

4.2.2 Architecture for AIoT RAN Readers 7

4.2.2.1 General 7

4.2.2.2 Direct interface between AIOTF and A-IOT RAN 7

4.2.2.3 Indirect interface via AMF between AIOTF and A-IOT RAN 8

4.3 Reference points 8

4.4 Service-based interfaces 9

4.5 Functional Entities 10

4.5.1 Ambient IoT Device 10

4.5.2 AIoT Readers 10

4.5.3 AIOTF 10

4.5.4 NEF 10

4.5.5 AF 10

4.5.6 NRF 10

4.5.7 AMF 10

4.6 Protocol Stacks 10

4.6.1 General 10

4.6.2 Protocol Stack between AIoT Device and AF 10

4.6.2.1 General 10

4.6.2.2 Protocol Stack between AF and AIoT Device for AIoT RAN Direct Path 11

4.6.2.3 Protocol Stack between AF and AIoT Device for AIoT RAN Indirect Path 11

5 High level functionality and features 12

5.1 General 12

5.2 Ambient IoT Services 12

5.3 AIoT Reader Selection 12

5.4 Assistance information provided to AIoT RAN node 12

5.5 AIoT Device Profile Management 12

5.6 AF authorization to the Ambient IoT Services 12

5.7 Identifiers 12

5.7.1 General 12

5.7.2 Ambient IoT Device Permanent Identifier 12

6 Ambient IoT Procedures 13

6.1 General 13

6.2 Procedure for Inventory 13

6.3 Procedure for Command 13

7 Network Functions Services 13

7.1 General 13

7.2 AIOTF services 13

7.3 AMF services 13

7.4 NEF services 13

7.5 ADM services 13

Annex A (informative): Change history 14

# Foreword

This clause is mandatory; do not alter the text in any way other than to choose between "Specification" and "Report".

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.

# 1 Scope

The present document specifies architectural enhancements to the 5G system to support Ambient power-enabled Internet of Things, complying to the requirements in TS 22.369 [1] applicable to the Ambient IoT Device types, traffic types, use cases and connectivity topologies defined in TS 38.300 [5].

# 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 22.369: "Service requirements for Ambient power-enabled IoT".

[3] 3GPP TS 23.501: "System Architecture for the 5G System (5GS); Stage 2".

[4] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[5] 3GPP TS 38.300: "NR; Overall description; Stage-2"

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms 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].

**Ambient IoT Device:** An Ambient IoT device is an IoT device powered by energy harvesting, with limited energy storage capability.

## 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].

AIoT Ambient IoT

AIOTF Ambient IoT Function

# 4 Architecture model and concepts

## 4.1 General concept

Ambient IoT is a service that can be provided by the 5GS based to support Ambient power-enabled IoT devices that are powered by energy harvesting, being either battery-less or with limited energy storage capability (e.g., using a capacitor) and the energy is provided through the harvesting of radio waves, light, motion, heat, or any other suitable power source.

The 5GS System architecture for Ambient IoT include the following functions and procedures for:

- Ambient IoT Device identification;

- Ambient IoT Device inventory;

- Providing to, and obtaining from, an Ambient IoT Device application data;

## 4.2 Architecture

### 4.2.1 General

### 4.2.2 Architecture for AIoT RAN Readers

#### 4.2.2.1 General

An A-IoT RAN may support one or more AIoT Readers which provide communication services towards Ambient IoT Devices. 5GS system architecture for Ambient IoT supports the following paths to access an AIoT RAN:

- Direct Path: AIOTF communicates with a AIOT RAN via a direct interface, as shown in clause 4.2.2.2.

- Indirect Path via AMF: AIOT RAN and the AIOTF communicate indirectly via an AMF, as shown in clause 4.2.2.3.

#### 4.2.2.2 Direct interface between AIOTF and A-IOT RAN

Figure 4.2.2.2-1 depicts the Ambient IoT architecture showing how the AIOTF access A-IoT RAN by a direct interface.



Figure 4.2.2.2-1: A-IoT RAN – AIOT Direct Interface Architecture

Figure 4.2.2.2-2 depicts the Ambient IoT architecture, using the reference point representation, showing how the AIOTF access A-IoT RAN by a direct interface.



Figure 4.2.2.2-2: A-IoT RAN – AIOT Direct Interface Architecture in reference point representation

#### 4.2.2.3 Indirect interface via AMF between AIOTF and A-IOT RAN

Figure 4.2.2.3-1 depicts the Ambient IoT architecture, using the service-based interfaces showing how the AIOTF access A-IoT RAN by an indirect interface via an AMF.



Figure 4.2.2.3-1: A-IoT RAN – AIOT Indirect Interface Architecture

Figure 4.2.2.3-2 depicts the Ambient IoT architecture, using the reference point representation showing how the AIOTF access A-IoT RAN by an indirect interface via an AMF.



Figure 4.2.2.3-2: A-IoT RAN – AIOT Indirect Interface Architecture in reference point representation

## 4.3 Reference points

The Ambient IoT Architecture contains the following reference points:

**Ny:** Reference point between the AIoT Device and the AIOTF.

**Nx:** Reference point between the A-IoT RAN and the AIOTF.

The following reference points show the interactions that exist between the NF services in the NFs. These reference points are realized by corresponding NF service-based interfaces and by specifying the identified consumer and producer NF service as well as their interaction in order to realize a particular system procedure.

**Na:** Reference point between the AIOTF and the AMF.

**Nb:** Reference point between the AIOTF and the NEF.

**Nc:** Reference point between the AIOTF and the NRF.

In addition to the relevant reference points defined in TS 23.501 [3], in the case of Ambient IoT, these referenece points are as follows:

**N2:** Reference point between the A-IoT RAN and the AMF.

**N33:** Reference point between NEF and AF.

## 4.4 Service-based interfaces

**Naiotf:** Service-based interface exhibited by the AIOTF.

In addition to the relevant services defined in TS 23.501 [3] for the following service-based interfaces, in the case of Ambient IoT, the services can be provided by corresponding NF are as follows:

**Namf:** Service-based interface exhibited by AMF.

**Nnef:** Service-based interface exhibited by NEF.

**Naf:** Service-based interface exhibited by AF.

**Nnrf:** Service-based interface exhibited by NRF.

## 4.5 Functional Entities

### 4.5.1 Ambient IoT Device

### 4.5.2 AIoT Readers

### 4.5.3 AIOTF

### 4.5.4 NEF

### 4.5.5 AF

### 4.5.6 NRF

### 4.5.7 AMF

## 4.6 Protocol Stacks

### 4.6.1 General

This clause specifies the protocol stacks between entities used for AIoT. The protocol stacks include the following:

- Protocol stacks between AIoT Device and AFs.

### 4.6.2 Protocol Stack between AIoT Device and AF

#### 4.6.2.1 General

The general protocol stack between an AIoT Device, AIoT RAN, AIOTF and AF is shown in Figure 4.6.2.1-1.

The protocol stacks and routing of information between an AIOT RAN and the AIOTF protocol is defined in other clauses depending upon the architecture used, e.g. directly between AIoT RAN containing an AIoT Reader and the AIOTF, indirectly between AIoT RAN containing an AIoT Reader and the AIOTF via an AMF.



**Legend:**

- **AIoT NAS**: The NAS protocol between AIoT Device and AIOTF.

- **AIoT AS**: It is between the AIoT Device and the AIoT RAN is specified in TS 38.300 [5].

- **AIoT Data**: It is the application data exchanged between the AIoT Device and AF.

Figure 4.6.1-1: Protocol Stack Between AIoT Device and AF

The AIoT RAN may communicate to AIOTF via different paths, see clause 4.2.2.1. The AIoT RAN protocol stack remains the same and is agnostic to the difference paths.

* Direct Path: When the AIoT RAN communicates with AIOTF via the direct path, the protocol stack is specified in clause 4.6.2.2.
* Indirect Path: When the AIoT RAN communicates with AIOTF indirectly via an AMF, the protocol stack is specified in clause 4.6.2.3.

#### 4.6.2.2 Protocol Stack between AF and AIoT Device for AIoT RAN Direct Path



Legend:

- **AIoT Reader Control**: It is between the AIOTF and AIoT RAN.

Figure 4.6.2.2-1: Protocol Stack between AF and AIoT Device for Direct Path option

#### 4.6.2.3 Protocol Stack between AF and AIoT Device for AIoT RAN Indirect Path



Figure 4.6.3.1-2: Protocol Stack between AF and AIoT Device for Indirect Path via AMF option

In this Protocol Stack, AIoT NAS messages are transferred via the AMF transparently.

Editor’s note: Whether AIoT Reader Control is transported by NGAP or is part of the NGAP protocol will be updated based on RAN WG3 decision.

Editor’s note: The reference to AIoT AS Layer protocol will be updated based on RAN1 or RAN2 decision.

# 5 High level functionality and features

## 5.1 General

## 5.2 Ambient IoT Services

## 5.3 AIoT Reader Selection

## 5.4 Assistance information provided to AIoT RAN node

The AIOTF provides the assistance information to the AIoT RAN together with the service operation requests. The AIOTF determines the assistance information provided to the AIoT RAN based on the information received from the AF. The Assistance information is used by the AIoT RAN for performing service operations, e.g. radio resource allocation.

The following assistance information may be provided:

- AIoT service type (e.g. Inventory, Command);

- Optionally, approximate number of AIoT devices based on AF request;

- Optionally, approximate D2R message size based on AF request.

Editor's note: Other assistance information may be added later if necessary.

Editor's note: How the AIOTF determines the assistance information (e.g. approximate number of AIoT Devices, approximate D2R message size) without input from the AF is FFS.

## 5.5 AIoT Device Profile Management

## 5.6 AF authorization to the Ambient IoT Services

## 5.7 Identifiers

### 5.7.1 General

### 5.7.2 Ambient IoT Device Permanent Identifier

# 6 Ambient IoT Procedures

## 6.1 General

## 6.2 Procedure for Inventory

## 6.3 Procedure for Command

# 7 Network Functions Services

## 7.1 General

## 7.2 AIOTF services

## 7.3 AMF services

## 7.4 NEF services

## 7.5 ADM services

Annex A (informative):
Change history

|  |
| --- |
| Change history |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2025-01 | SA2#166 AH-e | S2-2501256 | - | - | - | Proposed skeleton agreed at SA2#166AH-e | 0.0.0 |
| 2025-01 | SA2#166 AH-e | - | - | - | - | Inclusion of documents approved in SA2#166AH-e:S2-2501253, S2-2501254, S2-2501255, S2-2501257, S2-2501258. | 0.1.0 |

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