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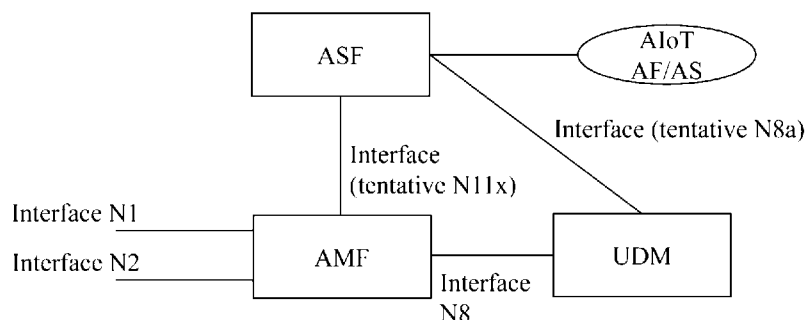


FIG. 1A

(57) Abstract: An Ambient Internet of Things (AIoT) system includes an AIoT service function (ASF) configured to facilitate an AIoT service delivery via a non-access stratum (NAS) signaling. The ASF is responsible for an AIoT service activation and/or deactivation, an AIoT device state management, an AIoT tag management, an AIoT service management, relaying one or more information elements or data, handling AIoT service charges, AIoT service charges, and/or interaction with an assess and mobility management function (AMF), a unified data management (UDM), and the one or more AIoT service providers.



AMBIENT IOT SYSTEM

TECHNICAL FIELD

5 [0001] The present disclosure relates to the field of communication systems, and more particularly, to an Ambient Internet of Things (AIoT) system.

BACKGROUND

[0002] Ambient Internet of Things (AIoT) devices are ambient power-enabled IoT devices, primarily powered through energy harvesting. The AIoT devices may either operate without
10 batteries or possess limited energy storage capabilities, e.g., using capacitors. Distinct from other devices like narrowband-internet of things (NB-IoT), cell phones, and 5G residential gateways (RGs), AIoT devices have unique characteristics. One of the characteristics for the AIoT devices is reliance on energy harvesting. The AIoT devices are battery-less and come with limited energy storage capabilities. In other words, its uptime is very limited either powered by harvested energy
15 or powered by some prolonged communications time or up time by on-device limited energy storage. This energy constraint only allows for a narrow time window in which the AIoT devices can communicate with a fifth generation (5G) system. Based on these limitations, it is imperative to design a communication protocol stack that is not only lightweight, but also ensure rapid communication establishment, minimizes transactions, optimizes energy efficiency, and
20 accelerates communication initiation. However, current technical solutions do not provide such a dedicated AIoT service function tailored to address unique requirements by the AIoT device. Further, current 5G systems lack the architecture and protocol stack for the AIoT devices to facilitate such communications.

[0003] Therefore, there is a need for an AIoT system, which can address the issues in the prior
25 art and other issues.

SUMMARY

[0004] An object of the present disclosure is to propose an Ambient Internet of Things (AIoT) system, which can address issues in the prior art and other issues, provide efficient and lightweight
30 architecture and communication, ensure rapid communication establishment, reduce transactions, improve energy efficiency, and/or accelerate communication initiation.

[0005] In an aspect of the present disclosure, an Ambient Internet of Things (AIoT) system includes an AIoT service function (ASF) configured to facilitate an AIoT service delivery via a non-access stratum (NAS) signaling.

[0006] Optionally, in some embodiments, the ASF is responsible for at least one of the following responsibilities: an AIoT service activation and/or deactivation, an AIoT device state management, an AIoT tag management, an AIoT service management, relaying one or more information elements or data from one or more AIoT tags and/or an AIoT reader to one or more AIoT service providers, an application server, or an application function (AF), handling AIoT service charges, relaying the one or more information elements or the data from the one or more AIoT service providers, the application server, or the AF to the AIoT reader and/or the one or more AIoT tags, AIoT service charges, and interaction with an assess and mobility management function (AMF), a unified data management (UDM), and the one or more AIoT service providers for one or more notification procedures when the AIoT tag is unavailable for information transfer.

[0007] Optionally, in some embodiments, the AIoT system includes the AMF, and the AMF is responsible for at least one of the following responsibilities: an ASF selection, an AIoT tag registration, reachability management, and/or mobility management, an access authentication and/or authorization, providing transport for one or more AIoT service information elements between the AIoT reader and the ASF, and relaying the one or more information elements or the data to and/or from the ASF.

[0008] Optionally, in some embodiments, the AIoT system further includes an AIoT AF and/or an AIoT AS, the ASF allows the AIoT AF and/or the AIoT AS to issue one or more commands to the AIoT reader and/or the one or more AIoT tags to support one or more AIoT services.

[0009] Optionally, in some embodiments, the AIoT system further includes the UDM, and the UDM is responsible for AIoT service subscription data.

[0010] Optionally, in some embodiments, the ASF supports at least one of following service operations: an activate operation, a deactivate operation, an AIoT uplink data operation, and/or an AIoT command operation.

[0011] Optionally, in some embodiments, the AIoT system further includes the one or more AIoT tags with one or more NAS capabilities.

[0012] Optionally, in some embodiments, the one or more AIoT tags with the one or more NAS capabilities are configured to perform at least one of following signaling procedures: a registration request procedure, a service request procedure, a message transfer service procedure, and a paging procedure.

[0013] Optionally, in some embodiments, the AIoT system further includes protocol stacks for the one or more AIoT tags with the one or more NAS capabilities.

[0014] Optionally, in some embodiments, the AIoT system further includes the one or more AIoT tags without NAS capabilities.

[0015] Optionally, in some embodiments, the one or more AIoT tags without the NAS capabilities are configured to perform at least one of following signaling procedures: a registration request procedure, a service request procedure, a message transfer service procedure, and a paging procedure.

5 [0016] Optionally, in some embodiments, the AIoT system further includes protocol stacks for the one or more AIoT tags without the NAS capabilities.

[0017] Optionally, in some embodiments, the AIoT system further includes a tag service layer (TSL), and when the one or more AIoT tags is requested to provide information to the AIoT reader, the TSL issues one or more commands to retrieve the information from the one or more AIoT tags.

10 [0018] Optionally, in some embodiments, the AIoT service subscription data in the UDM is configured to choose a serving ASF for the one or more AIoT tags.

BRIEF DESCRIPTION OF DRAWINGS

[0019] In order to illustrate the embodiments of the present disclosure or related art more clearly, the following figures will be described in the embodiments are briefly introduced. It is obvious
15 that the drawings are merely some embodiments of the present disclosure, a person having ordinary skill in this field can obtain other figures according to these figures without paying the premise.

[0020] FIG. 1A is a block diagram of an Ambient Internet of Things (AIoT) system including an AIoT service function (ASF) using reference point representation configured to implement some embodiments presented herein.

20 [0021] FIG. 1B is a block diagram of an AIoT system including an ASF using service-based interface configured to implement some embodiments presented herein.

[0022] FIG. 2 is a block diagram illustrating an AIoT system including an architecture for one or more AIoT tag/device with one or more non-access-stratum (NAS) capabilities configured to implement some embodiments presented herein.

25 [0023] FIG. 3 is a block diagram illustrating an AIoT system including protocol stacks for one or more AIoT tags/devices with one or more NAS capabilities configured to implement some embodiments presented herein.

[0024] FIG. 4 is a block diagram illustrating an AIoT system including an architecture for one or more AIoT tag/device without NAS capabilities configured to implement some embodiments
30 presented herein.

[0025] FIG. 5 is a block diagram illustrating an AIoT system including protocol stacks for one or more AIoT tags/devices without NAS capabilities configured to implement some embodiments presented herein.

[0026] FIG. 6 is a block diagram of an AIoT system including a pub/sub architecture-based deployment for ASF configured to implement some embodiments presented herein.

[0027] FIG. 7 is a block diagram of an example of a computing device according to an embodiment of the present disclosure.

5 [0028] FIG. 8 is a block diagram of a communication system according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0029] Embodiments of the present disclosure are described in detail with the technical matters, structural features, achieved objects, and effects with reference to the accompanying drawings as
10 follows. Specifically, the terminologies in the embodiments of the present disclosure are merely for describing the purpose of the certain embodiment, but not to limit the disclosure.

[0030] For clarify, throughout the present disclosure, the terms, “AIoT tag” and “AIoT device” and other similar terms are interchangeable and bear no difference in meaning. The terms, “Ambient IoT node”, “Ambient IoT reader”, “AIoT node”, “AIoT reader”, simply “reader” and
15 other similar terms are interchangeable and bear no difference in meaning. The terms, “AIoT Base Station”, “Base station with AIoT capabilities”, “Ambient IoT base station”, “Base station with Ambient IoT capabilities” and other similar terms are interchangeable and bear no difference in meaning in the present disclosure. The terms, “network element” and “network node” and other similar terms are interchangeable and bear no difference in meaning. The terms, “standalone” and
20 “independent” and other similar terms are interchangeable and bear no difference in meaning.

[0031] In some embodiments, the term “/” can be interpreted to indicate “and/or.” The term “configured” can refer to “pre-configured” and “network configured”. The term “pre-defined” or “pre-defined rules” in the present disclosure may be achieved by pre-storing corresponding codes, tables, or other manners for indicating relevant information in devices (e.g., including an AIoT
25 tag/tag and a network device). The specific implementation is not limited in the present disclosure. For example, “pre-defined” may refer to those defined in a protocol. It is also to be understood that in the disclosure, “protocol” may refer to a standard protocol in the field of communication, which may include, for example, an Long Term Evolution (LTE) protocol, new radio (NR) protocol and relevant protocol applied in the future communication system, which is not limited
30 in the present disclosure.

[0032] Some embodiments of the present disclosure provide an Ambient Internet of Things (AIoT) system, including an AIoT service function (ASF) configured to facilitate an AIoT service delivery via a non-access stratum (NAS) signaling. This can address issues in the prior art and other issues, provide efficient and lightweight architecture and communication, ensure rapid
35 communication establishment, reduce transactions, improve energy efficiency, and/or accelerate communication initiation.

[0033] In some embodiments, an AIoT Service over NAS architecture, protocol stacks, and a pub/sub architecture-based deployment scenario are disclosed. When communication originates from an AIoT tag (e.g., in certain cases where the AIoT tag has NAS capabilities) or originates from an AIoT Reader (e.g., in RICO mode, that is Reactive Interactive Connection Only, or Reader Initiated Connection Only), data or information elements are transmitted via uplink NAS transport. Conversely, for communications, terminates at the AIoT tag (e.g., in certain cases where the AIoT tag has NAS capabilities) or at the AIoT Reader, delivery of data or information elements occurs through N1/N2 Messages. This process negates the necessity to establish a PDU session, and there is no requirement for involvement from Session Management Function (SMF) and User Plane Function (UPF). This approach considerably diminishes the protocol stack's complexity.

[0034] Notably, there is no need for Non-Access-Stratum Session Management (NAS-SM) layer in this configuration. Instead, a streamlined AIoT Service is efficiently positioned to function on top of Non-Access-Stratum Mobility Management (NAS-MM) layer directly. NAS-SM: it supports the handling of Session Management between the UE and the SMF. It supports user plane PDU Session Establishment, modification and release. It is transferred via the AMF, and transparent to the AMF. NAS-MM: it supports registration management functionality, connection management functionality and user plane connection activation and deactivation. It is also responsible of ciphering and integrity protection of NAS signalling.

[0035] FIG. 1A illustrates an Ambient Internet of Things (AIoT) system including an AIoT service function (ASF) using reference point representation configured to implement some embodiments presented herein. FIG. 1B illustrates an AIoT system including an ASF using service-based interface configured to implement some embodiments presented herein. In this exemplary architecture as illustrated in FIG. 1A and FIG. 1B, the conventional SMF and UPF are replaced by a simplified network function such as AIoT Service Function (ASF). The ASF facilitates AIoT service delivery via NAS signaling without the need to establish a Protocol Data Unit (PDU) session.

[0036] In some embodiments, the ASF is responsible for at least one of the following responsibilities: an AIoT service activation and/or deactivation, an AIoT device state management, an AIoT tag management, an AIoT service management, relaying one or more information elements or data from one or more AIoT tags and/or an AIoT reader to one or more AIoT service providers, an application server, or an application function (AF), handling AIoT service charges (such as relevant AIoT service charging aspects), relaying the one or more information elements or the data from the one or more AIoT service providers, the application server, or the AF to the AIoT reader and/or the one or more AIoT tags (toward the AIoT reader and eventually to AIoT tags), AIoT service charges, and interaction with an access and mobility management function (AMF) via an interface in reference point representation (tentatively referred to as N11x) or service-based interface (tentatively referred to as Nasf), a unified data management (UDM) via an

interface in reference point representation (tentatively referred to as N8a) or service-based interfaces Nudm and a service-based interface tentatively referred to as Nasf, and the one or more AIoT service providers for one or more notification procedures when the AIoT tag is unavailable for information transfer. In some examples, the AIoT device state management includes temporary disable/enable, permanently disable, power-off, dormant, sleep, active, and/or charging/energy collecting/energy harvesting, etc. In some examples, The AS or AF may be a 3rd party AS or a 3rd party AF.

[0037]

It should be noted that the reference point representation or service-based representation of the interfaces N8a, N11x, Nasf are placeholders for the final names that will be adopted following standardization.

[0038] In some embodiments, the AIoT system includes the AMF. And, in addition to the existing functionalities currently defined in relevant 3GPP specifications, the AMF is responsible for at least one of the following new functionalities: an ASF selection, an AIoT tag registration, reachability management, and/or mobility management, an access authentication and/or authorization, providing transport for one or more AIoT service information elements between the AIoT reader and the ASF, and relaying the one or more information elements or the data to and/or from the ASF.

[0039] In some examples, AIoT Service Function (ASF) interacts with AMF to support bidirectional Ambient IoT communications over NAS signaling in 5G system. When the AIoT Service Function triggers a service request, the AIoT service function allows AMF to forward uplink data originated from the AIoT tag or the AIoT reader, and further forward them to AIoT AF and AS.

[0040] In some embodiments, the AIoT system further includes an AIoT AF and/or an AIoT AS, the ASF allows the AIoT AF and/or the AIoT AS to issue one or more commands to the AIoT reader and/or the one or more AIoT tags to support one or more AIoT services. For examples, the AIoT service function allows AIoT AF and AS to issue commands to the AIoT reader or AIoT tag to support AIoT tag disabling, shutdown, suspend, energy harvesting, energy indication, as well as various AIoT services, such as inventory, sensor, positioning, command/actuator, etc.

[0041] In some embodiments, the AIoT system further includes the UDM, and the UDM is responsible for AIoT service subscription data. In details, in some examples, the ASF is connected to the UDM through a service-based interface to offer 5G AIoT services to 5G subscribers. Table 1 illustrates a list of Ambient IoT service subscription data in the UDM.

[0042] Table 1: Ambient IoT Service Subscription Data

Subscription data Field	Description	Data Key	Data Sub Key

Ambient IoT Service Subscription	Indicate subscription to any Ambient IoT Service delivery over NAS irrespective of access type	Subscription Permanent Identifier (SUPI)	Serving Public Land Mobile Network (PLMN) identifier (ID) and optionally AIoT Service Provider ID
Ambient IoT Service Function (ASF) Information	Indicate ASF allocated for the AIoT tag or the AIoT reader, including ASF address and ASF ID	SUPI	
Associated AIoT Reader for a specific AIoT Tag	Indicate the associated AIoT Reader for an AIoT tag	SUPI	
Associated AIoT Reader for a group of AIoT tags	Indicate the associated AIoT Reader for a group of AIoT tags	Group ID	

[0043] The ASF supports at least one of following service operations: an activate operation, a deactivate operation, an AIoT uplink data operation, and/or an AIoT command operation. In some examples, the ASF supports one or more service operations as illustrated in Table 2.

5 **[0044]** Table 2: ASF Service Operations

Service Operation	Description
Activate	Authorize a specific AIoT tag or a group of AIoT tags to activate the AIoT service.
Deactivate	Remove AIoT service authorization from AIoT Service Function for a given service user.
AIoT Uplink Data	Send from AMF to ASF to allow AMF to use NAS signaling to carrier data it receives from the AIoT tag or the reader to ASF.
AIoT Command	This service operation allows AIoT AS/AF to issue command to a specific AIoT tag or a group of AIoT tags.

[0045] FIG. 2 illustrates an AIoT system including an architecture for one or more AIoT tag/device with one or more non-access-stratum (NAS) capabilities configured to implement some embodiments presented herein. In some embodiments, the AIoT system further includes the one or more AIoT tags with one or more NAS capabilities. In some examples, FIG. 2 illustrates an exemplary architecture for AIoT device with NAS capabilities in the presence of ASF.

[0046] FIG. 2 illustrates that, in some examples, an AIoT Base Station/gNB may include a module, e.g., AIoT Reader, designed to transmit a radio wave to activate AIoT tags, to support communication protocols ensuring interaction between the AIoT Base Station/gNB and AIoT tag, and to handle relevant 5G Ambient IoT procedures through N1 and N2 interfaces. The radio wave may take the form of a Carrier Wave to provide carrier frequency for backscattering communications between the Ambient IoT device and the AIoT Reader. The radio wave can also take the form of a type of Continuous Wave to provide energy harvesting source for the Ambient IoT devices. Alternatively, the radio wave could be a combination of Carrier Wave and Continuous Wave to provide both carrier frequency and energy harvesting source.

[0047]

[0048] Alternatively, an external radio wave generator might be outside of the AIoT Base Station/gNB. The Radio Wave generator operates independently by sending carrier wave or continuous wave for tag performing backscattering communications/energy harvesting or under the control of the AIoT Base Station/gNB via a defined communications interface to transmit carrier wave or continuous wave to allow AIoT device to perform backscattering communications/energy harvesting.

[0049] In some embodiments, the one or more AIoT tags with the one or more NAS capabilities are configured to perform at least one of following signaling procedures: a registration request procedure, a service request procedure, a message transfer service procedure, and a paging procedure.

[0050] In details, in some examples, when the AIoT tag accumulates sufficient energy either from the reader's radio wave or periodic energy transmissions, it becomes active. For AIoT tags with NAS signaling capabilities, the AIoT tag may initiate registration request, service request, and other signaling procedures. These messages are conveyed to the AMF via the AIoT Base Station/gNB or simply the AIoT Reader using UL NAS Transport. The AMF then forwards these messages and the Ambient IoT identities to the AIoT Service Function (ASF) through the N11x/Nasf interface.

[0051] In details, in some examples, the ASF might invoke Namf_Communication_N1N2Message Transfer service to send an acknowledgment message to the AMF.

[0052] In details, in some examples, for the Ambient IoT device terminated communications, a specific Ambient IoT paging procedure is required. Once the AIoT tag is located, the Namf_communicaiton_N1N2Message delivers the AIoT service data to the AIoT tag using NAS signaling.

5 [0053] FIG. 3 illustrates an AIoT system including protocol stacks for one or more AIoT tags/devices with one or more NAS capabilities configured to implement some embodiments presented herein. In some embodiments, the AIoT system further includes protocol stacks for the one or more AIoT tags with the one or more NAS capabilities. FIG. 3 illustrates that protocol stacks for AIoT device with NAS capabilities in the presence of ASF.

10 [0054] FIG. 4 illustrates an AIoT system including an architecture for one or more AIoT tag/device without NAS capabilities configured to implement some embodiments presented herein. In some embodiments, the AIoT system further includes the one or more AIoT tags without NAS capabilities. FIG. 4 illustrates that architecture for AIoT device without NAS capabilities in the presence of ASF. In details, FIG. 4 illustrates that, in some examples, the AIoT tag does NOT have
15 NAS signaling capabilities. The AIoT Reader residing on the AIoT Base Station/gNB or the AIoT Base Station/gNB performs NAS signaling functions on behalf of the AIoT tag. In some examples, when the AIoT tag accumulates sufficient energy, either from the reader's radio wave or through periodic energy transmissions, it becomes activated.

[0055] In some embodiments, the one or more AIoT tags without the NAS capabilities are
20 configured to perform at least one of following signaling procedures: a registration request procedure, a service request procedure, a message transfer service procedure, and a paging procedure.

[0056] In some examples, procedures for AIoT device without NAS capabilities in the presence of ASF are disclosed. In some examples, for AIoT tags without NAS signaling capabilities, for
25 AIoT tag/device-originated communications, upon the AIoT tag/device request, the AIoT reader or the AIoT Base Station/gNB initiates registration, service requests, and other signaling procedures on the tag's behalf. The AIoT reader or the AIoT Base Station/gNB utilizes an uplink (UL) NAS Transport to transmit data collected from individual or grouped tags to the AMF. Subsequently, the AMF forwards the messages and AIoT tag identities to the AIoT Service
30 Function (ASF) via the N11x/Nasf interface. In some examples, the ASF may employ the Namf_Communication_N1N2Message Transfer service to send an acknowledgment message back to the AMF. In some examples, the ASF may employ the Namf_Communication_N1N2Message Transfer service to send an acknowledgment message back to the AMF.

35 [0057] FIG. 5 illustrates an AIoT system including protocol stacks for one or more AIoT tags/devices without NAS capabilities configured to implement some embodiments presented herein. In some embodiments, the AIoT system further includes protocol stacks for the one or

more AIoT tags without the NAS capabilities. In other words, protocol stacks for AIoT device without NAS capabilities in the presence of ASF is disclosed.

[0058] In some examples, in the protocol stack, the Tag Service Layer (or other similar name/term, e.g., Data Service Layer, AIoT Tag Service Layer, AIoT Service Layer, or simply AIoT Layer) is responsible for handling the information defined by Ambient IoT service provider, or Ambient IoT network operator, or Ambient IoT device manufacture, or the end user. In some examples, the Tag Service Layer (TSL) could just provide a response to report its EPC (Electronic Product Code) code when the reader requests to perform such an operation, and the reader could further extract the corresponding information from the tagged object once activated. In some examples, the TSL layer could be responsible for interpreting the commands issued by the reader, or by the AIoT Application Server.

[0059] In some embodiments, the AIoT system further includes a tag service layer (TSL), and when the one or more AIoT tags is requested to provide information to the AIoT reader, the TSL issues one or more commands to retrieve the information from the one or more AIoT tags.

[0060] In some examples, when an AIoT tag is interrogated to give information to the requested AIoT reader. The Tag Service Layer (TSL) may issue commands to retrieve the requested information from the storage of the AIoT tag, to request lower layers to encode the information by using proper encoding format, to request lower layers to transmit the request information in proper Radio Frequency (RF) signal formats.

[0061] In FIG. 5, in some examples, a simplified protocol stack can also help establish connections and exchange data quickly and efficiently. Because the AIoT tag power is limited, such a protocol stack can quickly complete the connection and exchange data quickly and efficiently.

[0062] FIG. 6 illustrates an AIoT system including a pub/sub architecture-based deployment for ASF configured to implement some embodiments presented herein. In some embodiments, the AIoT service subscription data in the UDM is configured to choose a serving ASF for the one or more AIoT tags.

[0063] In some examples, given the vast presence of potentially millions of AIoT tags in field deployment, a flexible Publisher/Subscriber (Pub/Sub) system can be implemented as one possible embodiment to support scalability. In FIG. 6, AIoT tags T2 and T6 act as publishers and send messages related to both Topic 1 and Topic 2. Depending on the configuration in the Tag subscription profile in the UDM, AIoT Service Subscription data is used to choose the serving ASF for an AIoT tag or a group of AIoT tags.

[0064] In some examples, messages published by T2 are directed to ASF1. In some examples, messages published by T6 are directed to ASF2. In some examples, AIoT AS/AF1 subscribes to both Topic 1 and Topic 2, specifically from ASF1. As a result, AIoT service AS/AF1 receives messages: M1, M2, M3, M4, and M5. AIoT Service AS/AF2, on the other hand, subscribes to

Topic 2 from ASF1 and Topic 1 from ASF2. Consequently, it receives messages: M3, M4, M5, M6, and M7.

[0065] In the above some embodiments, an AIoT Service over NAS architecture and protocol stack are presented. When communication originates from the AIoT tag or originates from the AIoT Reader, or AIoT Base Station/gNB (e.g., in RICO mode), the data or information elements are transmitted via Uplink NAS transport. Conversely, for communications terminates at the AIoT tag or at the AIoT Reader, or the AIoT Base Station/gNB, the delivery of data or information elements occurs through the NAS N1N2 Messages. This process negates the necessity to establish a PDU session, and there is no requirement for the involvement of SMF and UPF. This approach considerably diminishes the protocol stack's complexity. Notably, there is no need for the NAS-SM layer in this configuration. Instead, a streamlined AIoT Service is efficiently positioned to function on top of the NAS-MM layer directly.

[0066] In summary, in some embodiments, exemplary lightweight architecture and protocol stacks for Ambient IoT service may include at least one of following benefits.

[0067] Scalability: the architecture and protocol stacks are scalable and can efficiently manage a large number of AIT devices in the network without straining system resources.

[0068] Reduced latency: the streamlined protocol and architecture can result in faster data transmission and processing, minimizing the lag time to allow the AIoT tag to complete information exchange and transactions in the limited energy storage time.

[0069] Higher reliability: fewer components and complexity can mean fewer points of failure, leading to a more reliable system.

[0070] Cost Efficiency: Lightweight architectures requires less processing power and storage, which results in cost savings on AIoT tags as well.

[0071] Easier Integration: integrating the AIoT devices into other systems or applications can be more straightforward.

[0072] Adaptability: the introduction of a dedicated AIoT service function NF means there is enough room to support further evolution of this server to cater to evolving requirements or emerging standards.

[0073] Lower maintenance: easier and less frequency maintenance, resulting in longer operational life and less downtime.

[0074] Commercial interests for some embodiments are as follows. 1. Solve issues in the prior art and other issues. 2. Provide efficient and lightweight architecture and communication, ensure rapid communication establishment, reduce transactions, improve energy efficiency, and/or accelerate communication initiation. 3. Some embodiments of the present disclosure can be used in many applications. Some embodiments of the present disclosure are used by chipset vendors, video system development vendors, automakers including cars, trains, trucks, buses, bicycles, moto-bikes, helmets, and etc., drones (unmanned aerial vehicles), smartphone makers,

communication devices for public safety use, AR/VR/MR device maker for example gaming, conference/seminar, education purposes. Some embodiments of the present disclosure are a combination of “techniques/processes” that can be adopted in video standards to create an end product. Some embodiments of the present disclosure propose technical mechanisms. The at least one proposed solution, method, system, and apparatus of some embodiments of the present disclosure may be used for current and/or new/future standards regarding communication systems. Compatible products follow at least one proposed solution, method, system, and apparatus of some embodiments of the present disclosure. The proposed solution, method, system, and apparatus are widely used in a communication system. With the implementation of the at least one proposed solution, method, system, and apparatus of some embodiments of the present disclosure, at least one modification/improvement to methods and apparatus of energy-related based routing selection are considered for standardizing.

[0075] FIG. 7 is an example of a computing device 1100 according to an embodiment of the present disclosure. Any suitable computing device can be used for performing the operations described herein. For example, FIG. 13 illustrates an example of the computing device 1100 that can implement apparatuses and/or methods illustrated in FIG. 1 to FIG. 6 using any suitably configured hardware and/or software. In some embodiments, the computing device 1100 can include a processor 1112 that is communicatively coupled to a memory 1114 and that executes computer-executable program code and/or accesses information stored in the memory 1114. The processor 1112 may include a microprocessor, an application-specific integrated circuit (“ASIC”), a state machine, or other processing device. The processor 1112 can include any of a number of processing devices, including one. Such a processor can include or may be in communication with a computer-readable medium storing instructions that, when executed by the processor 1112, cause the processor to perform the operations described herein.

[0076] The memory 1114 can include any suitable non-transitory computer-readable medium. The computer-readable medium can include any electronic, optical, magnetic, or other storage device capable of providing a processor with computer-readable instructions or other program code. Non-limiting examples of a computer-readable medium include a magnetic disk, a memory chip, a read-only memory (ROM), a random access memory (RAM), an application specific integrated circuit (ASIC), a configured processor, optical storage, magnetic tape or other magnetic storage, or any other medium from which a computer processor can read instructions. The instructions may include processor-specific instructions generated by a compiler and/or an interpreter from code written in any suitable computer-programming language, including, for example, C, C++, C#, visual basic, java, python, perl, javascript, and actionscript.

[0077] The computing device 1100 can also include a bus 1116. The bus 1116 can communicatively couple one or more components of the computing device 1100. The computing device 1100 can also include a number of external or internal devices such as input or output

devices. For example, the computing device 1100 is illustrated with an input/output (“I/O”) interface 1118 that can receive input from one or more input devices 1120 or provide output to one or more output devices 1122. The one or more input devices 1120 and one or more output devices 1122 can be communicatively coupled to the I/O interface 1118. The communicative coupling can be implemented via any suitable manner (e.g., a connection via a printed circuit board, connection via a cable, communication via wireless transmissions, etc.). Non-limiting examples of input devices 1120 include a touch screen (e.g., one or more cameras for imaging a touch area or pressure sensors for detecting pressure changes caused by a touch), a mouse, a keyboard, or any other device that can be used to generate input events in response to physical actions by a user of a computing device. Non-limiting examples of output devices 1122 include a liquid crystal display (LCD) screen, an external monitor, a speaker, or any other device that can be used to display or otherwise present outputs generated by a computing device.

[0078] The computing device 1100 can execute program code that configures the processor 1112 to perform one or more of the operations described above with respect to some embodiments illustrated in FIG. 1 to FIG. 6. The program code may be resident in the memory 1114 or any suitable computer-readable medium and may be executed by the processor 1112 or any other suitable processor.

[0079] The computing device 1100 can also include at least one network interface device 1124. The network interface device 1124 can include any device or group of devices suitable for establishing a wired or wireless data connection to one or more data networks 1128. Non limiting examples of the network interface device 1124 include an Ethernet network adapter, a modem, and/or the like. The computing device 1100 can transmit messages as electronic or optical signals via the network interface device 1124.

[0080] FIG. 8 is a block diagram of an example of a communication system 1200 according to an embodiment of the present disclosure. Embodiments described herein may be implemented into the communication system 1200 using any suitably configured hardware and/or software. FIG. 8 illustrates the communication system 1200 including a radio frequency (RF) circuitry 1210, a baseband circuitry 1220, an application circuitry 1230, a memory/storage 1240, a display 1250, a camera 1260, a sensor 1270, and an input/output (I/O) interface 1280, coupled with each other at least as illustrated.

[0081] The application circuitry 1230 may include a circuitry such as, but not limited to, one or more single-core or multi-core processors. The processors may include any combination of general-purpose processors and dedicated processors, such as graphics processors, application processors. The processors may be coupled with the memory/storage and configured to execute instructions stored in the memory/storage to enable various applications and/or operating systems running on the system. The communication system 1200 can execute program code that configures the application circuitry 1230 to perform one or more of the operations described above with

respect to FIG. 1 to FIG. 6. The program code may be resident in the application circuitry 1230 or any suitable computer-readable medium and may be executed by the application circuitry 1230 or any other suitable processor.

[0082] The baseband circuitry 1220 may include circuitry such as, but not limited to, one or more single-core or multi-core processors. The processors may include a baseband processor. The baseband circuitry may handle various radio control functions that may enable communication with one or more radio networks via the RF circuitry. The radio control functions may include, but are not limited to, signal modulation, encoding, decoding, radio frequency shifting, etc. In some embodiments, the baseband circuitry may provide for communication compatible with one or more radio technologies. For example, in some embodiments, the baseband circuitry may support communication with an evolved universal terrestrial radio access network (EUTRAN) and/or other wireless metropolitan area networks (WMAN), a wireless local area network (WLAN), a wireless personal area network (WPAN). Embodiments in which the baseband circuitry is configured to support radio communications of more than one wireless protocol may be referred to as multi-mode baseband circuitry.

[0083] In various embodiments, the baseband circuitry 1220 may include circuitry to operate with signals that are not strictly considered as being in a baseband frequency. For example, in some embodiments, baseband circuitry may include circuitry to operate with signals having an intermediate frequency, which is between a baseband frequency and a radio frequency. The RF circuitry 1210 may enable communication with wireless networks using modulated electromagnetic radiation through a non-solid medium. In various embodiments, the RF circuitry may include switches, filters, amplifiers, etc. to facilitate the communication with the wireless network. In various embodiments, the RF circuitry 1210 may include circuitry to operate with signals that are not strictly considered as being in a radio frequency. For example, in some embodiments, RF circuitry may include circuitry to operate with signals having an intermediate frequency, which is between a baseband frequency and a radio frequency.

[0084] In various embodiments, the transmitter circuitry, control circuitry, or receiver circuitry discussed above with respect to apparatuses and/or methods illustrated in FIG. 1 to FIG. 6 may be embodied in whole or in part in one or more of the RF circuitry, the baseband circuitry, and/or the application circuitry. As used herein, “circuitry” may refer to, be part of, or include an application specific integrated circuit (ASIC), an electronic circuit, a processor (shared, dedicated, or group), and/or a memory (shared, dedicated, or group) that execute one or more software or firmware programs, a combinational logic circuit, and/or other suitable hardware components that provide the described functionality. In some embodiments, the electronic device circuitry may be implemented in, or functions associated with the circuitry may be implemented by, one or more software or firmware modules. In some embodiments, some or all of the constituent components of the baseband circuitry, the application circuitry, and/or the memory/storage may be

implemented together on a system on a chip (SOC). The memory/storage 1240 may be used to load and store data and/or instructions, for example, for system. The memory/storage for one embodiment may include any combination of suitable volatile memory, such as dynamic random access memory (DRAM)), and/or non-volatile memory, such as flash memory.

5 [0085] In various embodiments, the I/O interface 1280 may include one or more user interfaces designed to enable user interaction with the system and/or peripheral component interfaces designed to enable peripheral component interaction with the system. User interfaces may include, but are not limited to a physical keyboard or keypad, a touchpad, a speaker, a microphone, etc. Peripheral component interfaces may include, but are not limited to, a non-volatile memory port,
10 a universal serial bus (USB) port, an audio jack, and a power supply interface. In various embodiments, the sensor 1270 may include one or more sensing devices to determine environmental conditions and/or location information related to the system. In some embodiments, the sensors may include, but are not limited to, a gyro sensor, an accelerometer, a proximity sensor, an ambient light sensor, and a positioning unit. The positioning unit may also be part of, or interact
15 with, the baseband circuitry and/or RF circuitry to communicate with components of a positioning network, e.g., a global positioning system (GPS) satellite.

[0086] In various embodiments, the display 1250 may include a display, such as a liquid crystal display and a touch screen display. In various embodiments, the communication system 1200 may
20 be a mobile computing device such as, but not limited to, a laptop computing device, a tablet computing device, a netbook, an Ultrabook, a smartphone, an AR/VR glasses, etc. In various embodiments, system may have more or less components, and/or different architectures. Where appropriate, methods described herein may be implemented as a computer program. The computer program may be stored on a storage medium, such as a non-transitory storage medium.

[0087] A person having ordinary skill in the art understands that each of the units, algorithm, and
25 steps described and disclosed in the embodiments of the present disclosure are realized using electronic hardware or combinations of software for computers and electronic hardware. Whether the functions run in hardware or software depends on the condition of application and design requirement for a technical plan. A person having ordinary skill in the art can use different ways to realize the function for each specific application while such realizations should not go beyond
30 the scope of the present disclosure. It is understood by a person having ordinary skill in the art that he/she can refer to the working processes of the system, device, and unit in the above-mentioned embodiment since the working processes of the above-mentioned system, device, and unit are basically the same. For easy description and simplicity, these working processes will not be detailed.

35 [0088] It is understood that the disclosed system, device, and method in the embodiments of the present disclosure can be realized with other ways. The above-mentioned embodiments are exemplary only. The division of the units is merely based on logical functions while other divisions

exist in realization. It is possible that a plurality of units or components are combined or integrated in another system. It is also possible that some characteristics are omitted or skipped. On the other hand, the displayed or discussed mutual coupling, direct coupling, or communicative coupling operate through some ports, devices, or units whether indirectly or communicatively by ways of electrical, mechanical, or other kinds of forms.

[0089] The units as separating components for explanation are or are not physically separated. The units for display are or are not physical units, that is, located in one place or distributed on a plurality of network units. Some or all of the units are used according to the purposes of the embodiments. Moreover, each of the functional units in each of the embodiments can be integrated in one processing unit, physically independent, or integrated in one processing unit with two or more than two units.

[0090] If the software function unit is realized and used and sold as a product, it can be stored in a readable storage medium in a computer. Based on this understanding, the technical plan proposed by the present disclosure can be essentially or partially realized as the form of a software product.

Or, one part of the technical plan beneficial to the conventional technology can be realized as the form of a software product. The software product in the computer is stored in a storage medium, including a plurality of commands for a computational device (such as a personal computer, a server, or a network device) to run all or some of the steps disclosed by the embodiments of the present disclosure. The storage medium includes a USB disk, a mobile hard disk, a read-only memory (ROM), a random access memory (RAM), a floppy disk, or other kinds of media capable of storing program codes.

[0091] While the present disclosure has been described in connection with what is considered the most practical and preferred embodiments, it is understood that the present disclosure is not limited to the disclosed embodiments but is intended to cover various arrangements made without departing from the scope of the broadest interpretation of the appended claims.

What is claimed is:

1. An Ambient Internet of Things (AIoT) system, comprising:
an AIoT service function (ASF) configured to facilitate an AIoT service delivery via a non-access stratum (NAS) signaling.
- 5 2. The AIoT system of claim 1, wherein the ASF is responsible for at least one of the following responsibilities:
an AIoT service activation and/or deactivation;
an AIoT device state management;
an AIoT tag management;
10 an AIoT service management;
relaying one or more information elements or data from one or more AIoT tags and/or an AIoT reader to one or more AIoT service providers, an application server, or an application function (AF);
handling AIoT service charges;
15 relaying the one or more information elements or the data from the one or more AIoT service providers, the application server, or the AF to the AIoT reader and/or the one or more AIoT tags;
AIoT service charges; and
interaction with an access and mobility management function (AMF), a unified data management (UDM), and the one or more AIoT service providers for one or more notification procedures when
20 the AIoT tag is unavailable for information transfer.
3. The AIoT system of claim 2, wherein the AIoT system comprises the AMF, and the AMF is responsible for at least one of the following responsibilities:
an ASF selection;
an AIoT tag registration, reachability management, and/or mobility management;
25 an access authentication and/or authorization;
providing transport for one or more AIoT service information elements between the AIoT reader and the ASF; and
relaying the one or more information elements or the data to and/or from the ASF.
4. The AIoT system of claim 2 or 3, wherein the AIoT system further comprises an AIoT AF and/or
30 an AIoT AS, the ASF allows the AIoT AF and/or the AIoT AS to issue one or more commands to the AIoT reader and/or the one or more AIoT tags to support one or more AIoT services.
5. The AIoT system of any one of claims 2 to 4, wherein the AIoT system further comprises the UDM, and the UDM is responsible for AIoT service subscription data.
6. The AIoT system of any one of claims 1 to 5, wherein the ASF supports at least one of following

service operations:

an activate operation;

a deactivate operation;

an AIoT uplink data operation; and/or

5 an AIoT command operation.

7. The AIoT system of any one of claims 2 to 6, wherein the AIoT system further comprises the one or more AIoT tags with one or more NAS capabilities.

8. The AIoT system of claim 7, wherein the one or more AIoT tags with the one or more NAS capabilities are configured to perform at least one of following signaling procedures:

10 a registration request procedure, a service request procedure, a message transfer service procedure, and a paging procedure.

9. The AIoT system of claim 7 or 8, wherein the AIoT system further comprises protocol stacks for the one or more AIoT tags with the one or more NAS capabilities.

15 10. The AIoT system of any one of claims 2 to 6, wherein the AIoT system further comprises the one or more AIoT tags without NAS capabilities.

11. The AIoT system of claim 10, wherein the one or more AIoT tags without the NAS capabilities are configured to perform at least one of following signaling procedures:

a registration request procedure, a service request procedure, a message transfer service procedure, and a paging procedure.

20 12. The AIoT system of claim 9 or 10, wherein the AIoT system further comprises protocol stacks for the one or more AIoT tags without the NAS capabilities.

13. The AIoT system of claim 12, wherein the AIoT system further comprises a tag service layer (TSL), and when the one or more AIoT tags is requested to provide information to the AIoT reader, the TSL issues one or more commands to retrieve the information from the one or more AIoT tags.

25 14. The AIoT system of any one of claims 5 to 13, wherein the AIoT service subscription data in the UDM is configured to choose a serving ASF for the one or more AIoT tags.

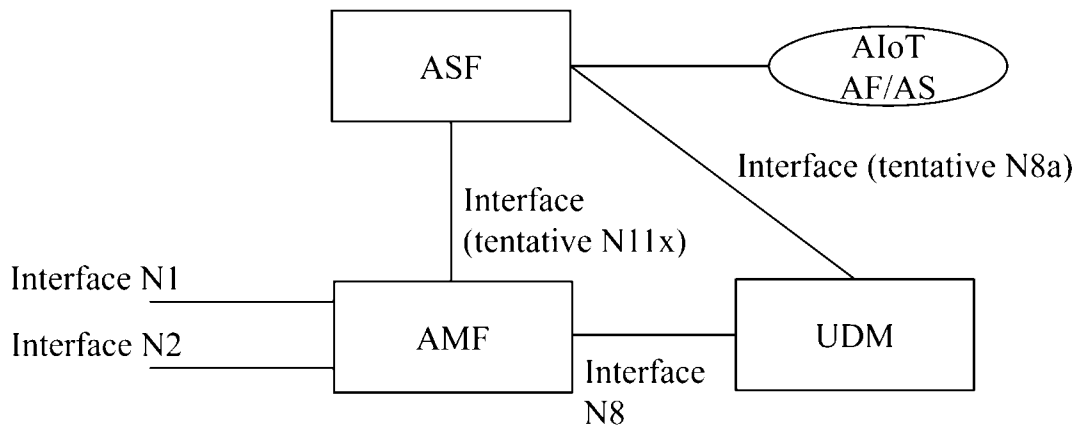


FIG. 1A

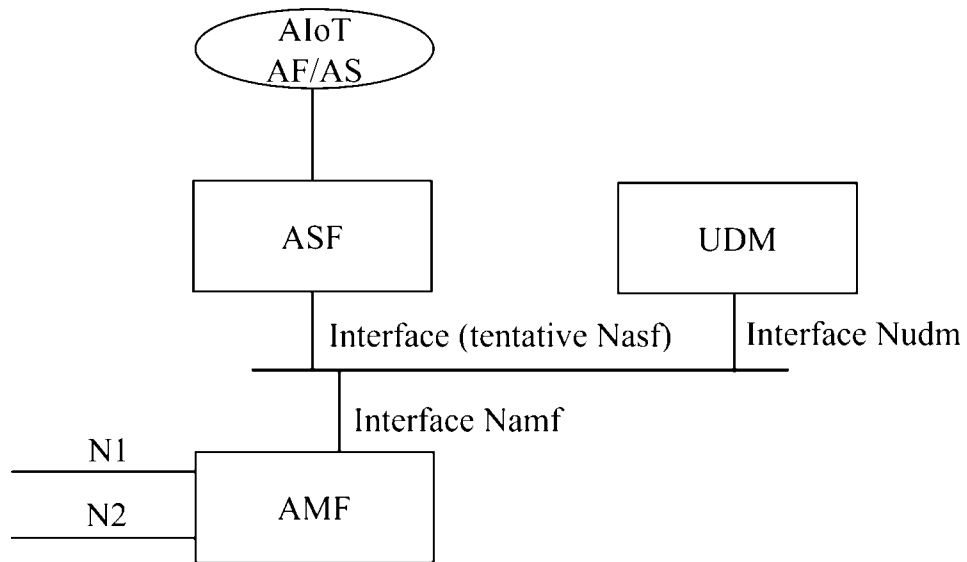


FIG. 1B

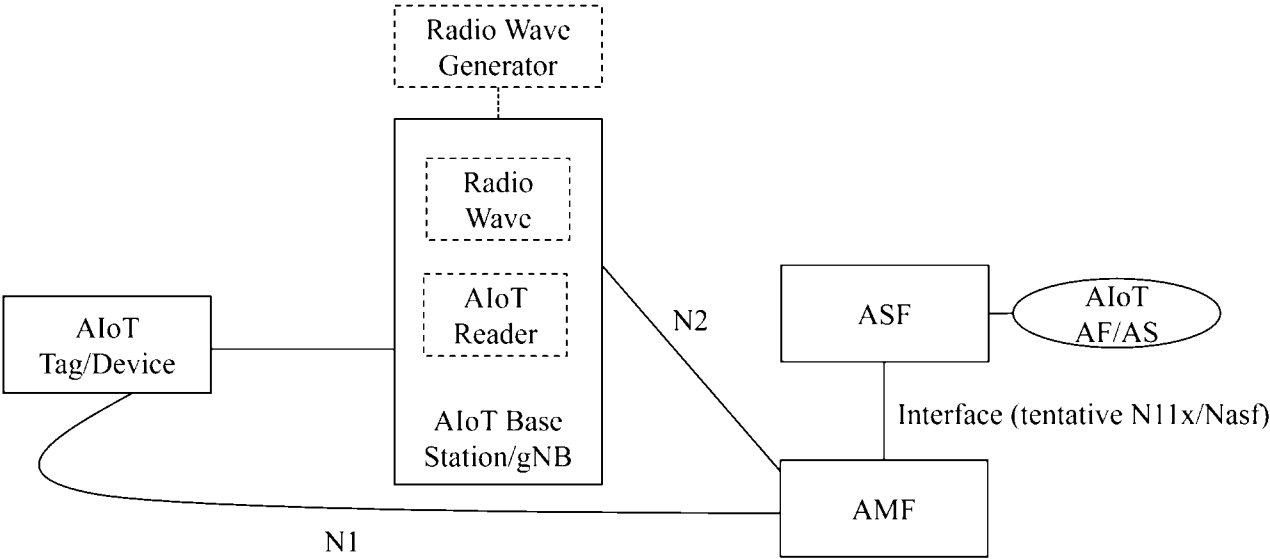


FIG. 2

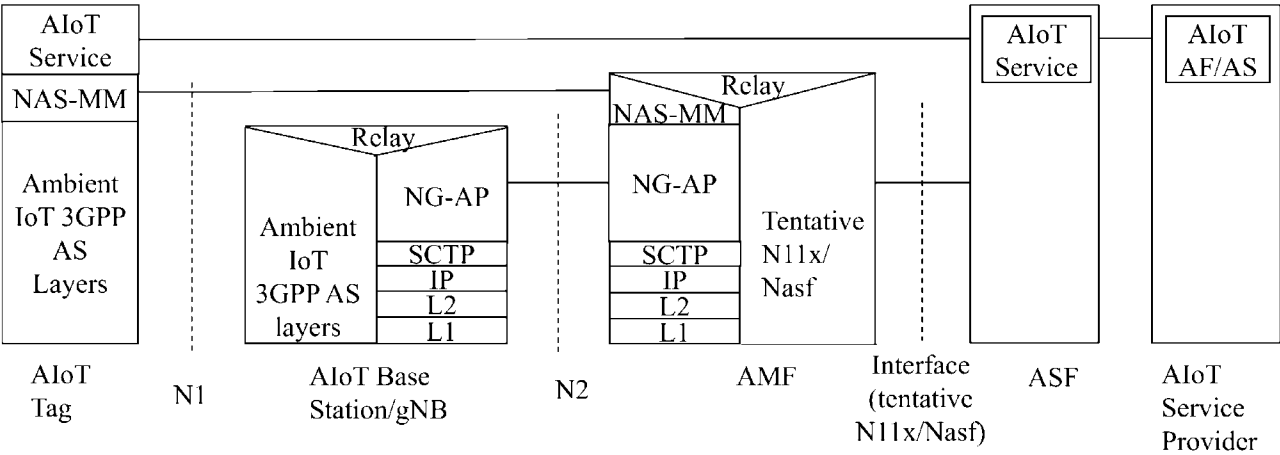


FIG. 3

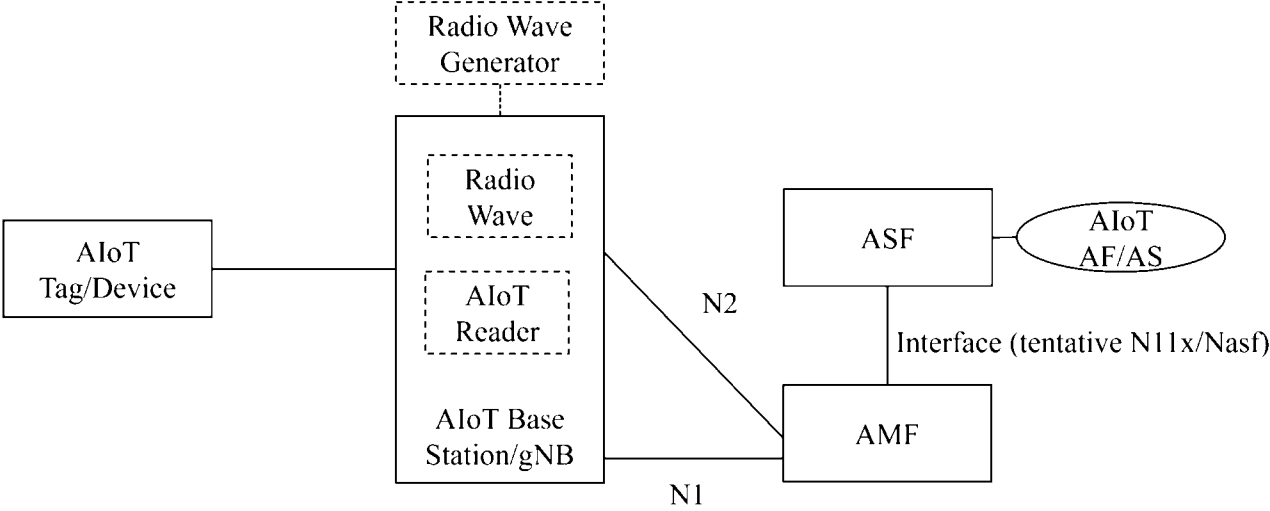


FIG. 4

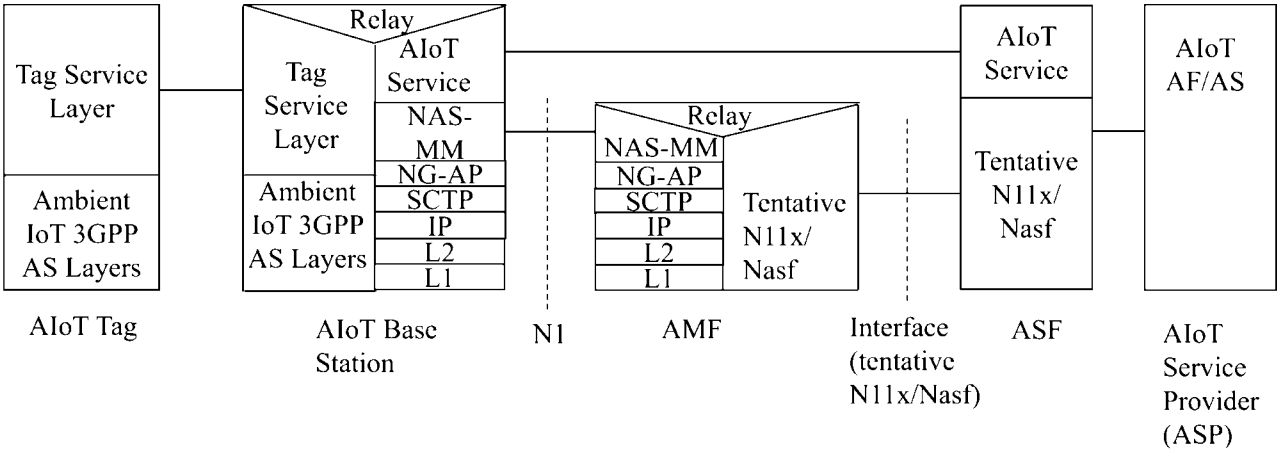


FIG. 5

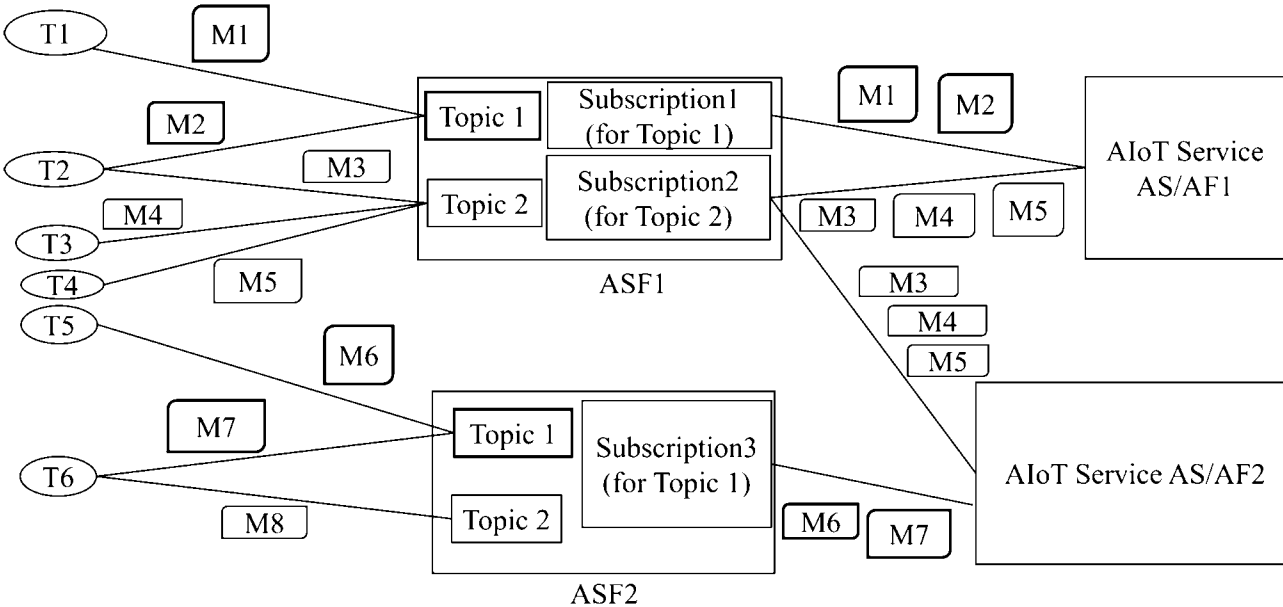


FIG. 6

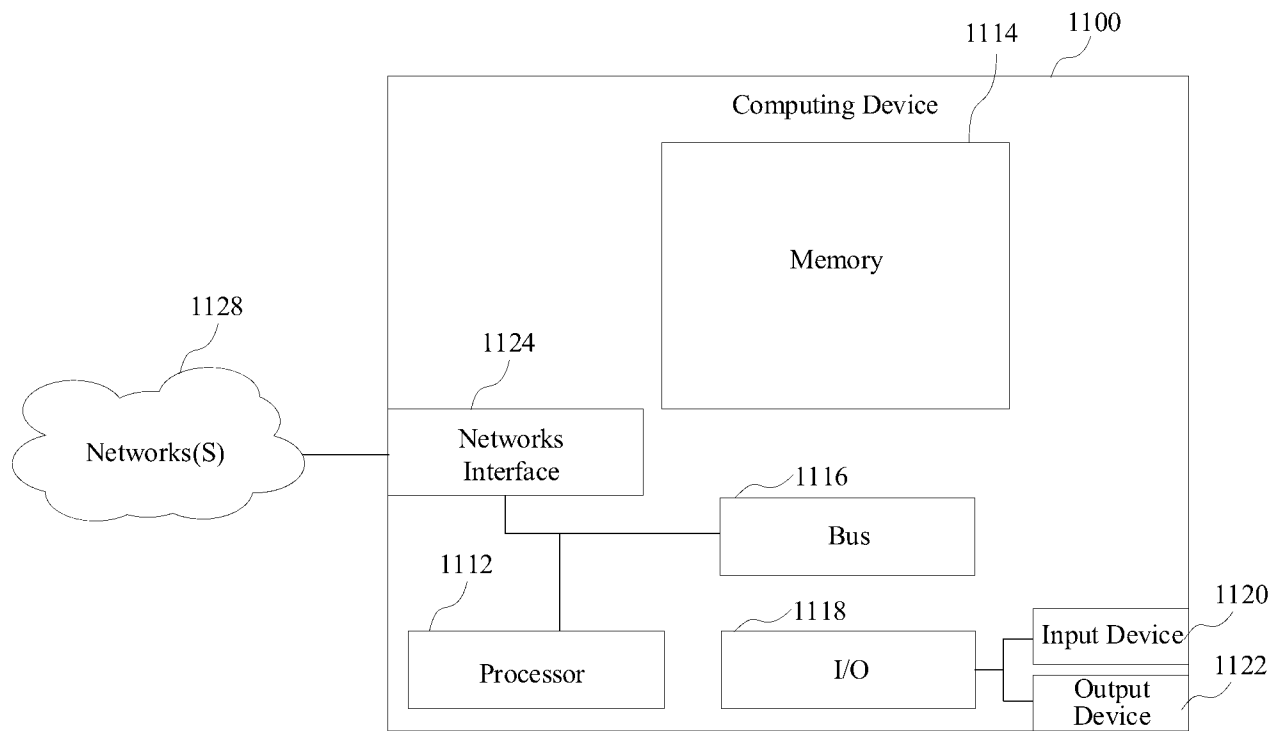


FIG. 7

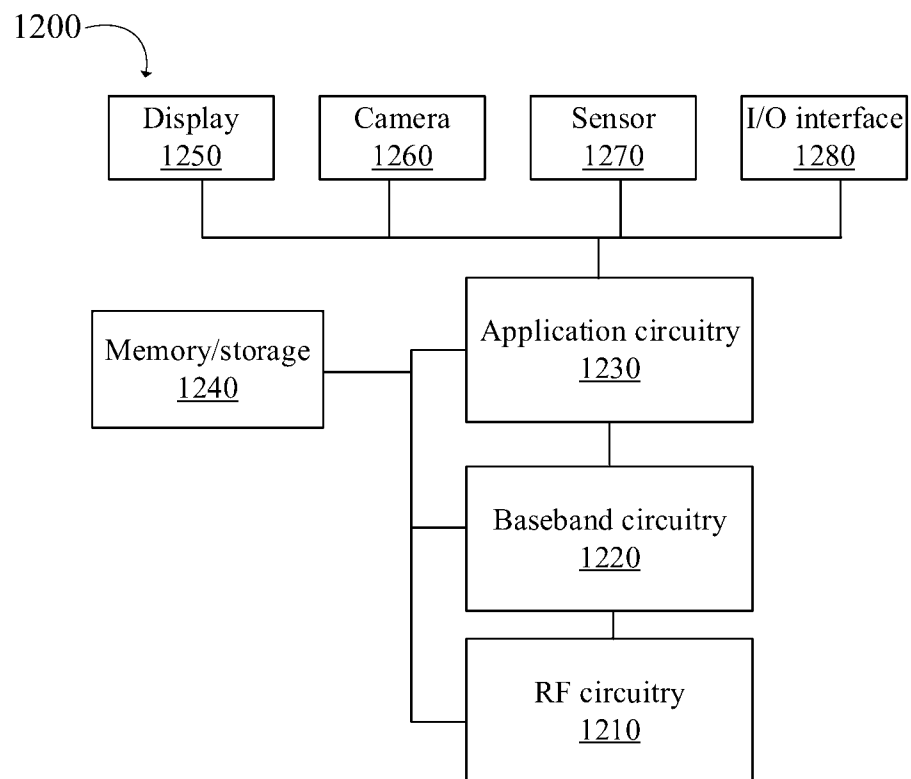


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/139893

A. CLASSIFICATION OF SUBJECT MATTER

H04W4/30(2018.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

IPC: H04W, H04B

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

3GPP,CNABS,CNTXT,ENTXTC,VEN,USTXT,CNKI:IoT,AIoT, ambient internet of things, NAS, non-access stratum, ASF, AIoT service function, AMF, mobility management function, UDM, unified data management, signaling

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2020323020 A1 (NOKIA TECHNOLOGIES OY) 08 October 2020 (2020-10-08) abstract and description, paragraphs [0057]-[0108]	1-3, 5, 6, 14
A	US 2020323020 A1 (NOKIA TECHNOLOGIES OY) 08 October 2020 (2020-10-08) the whole document	4, 7-13
A	CN 110808830 A (UNIV NANJING POST & TELECOM etc.) 18 February 2020 (2020-02-18) the whole document	1-14
A	CN 116941260 A (BEIJING XIAOMI MOBILE SOFTWARE CO., LTD.) 24 October 2023 (2023-10-24) the whole document	1-14
A	vivo. "S1-230174_ AIoT_update for use case 12" <i>3GPP tsq_sa\wg1_serv; pCR Title: Update of Use case 5.12; S1-230174</i> , 10 February 2023 (2023-02-10), the whole document	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

26 August 2024

Date of mailing of the international search report

06 September 2024

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2023/139893

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
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				JP	7317139	B2	28 July 2023
				BR	112021019604	A2	30 November 2021
				US	11166337	B2	02 November 2021
				EP	3949669	A1	09 February 2022
				EP	3949669	A4	04 January 2023
				WO	2020201624	A1	08 October 2020
				US	2022022278	A1	20 January 2022
				IN	202147049676	A	26 November 2021
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				VN	83489	A	25 January 2022
				IN	535065	B	03 May 2024
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CN	116941260	A	24 October 2023	None			