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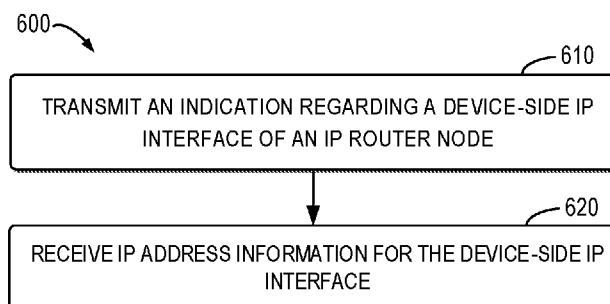


Fig. 6

(57) Abstract: Embodiments of the present disclosure relate to external IP interface management in an IP router node. According to one aspect of the present disclosure, a device transmits, to a first core network element, an indication regarding a device-side IP interface of an IP router node. Then the device receives, from the first core network element or a second core network element, IP address information for the device-side IP interface. In this way, external IP interface at device-side is achieved.



EXTERNAL IP INTERFACE MANAGEMENT IN 5GS IP ROUTER NODE

FIELD

[0001] Embodiments of the present disclosure generally relate to the field of telecommunication and in particular, to a method, device, apparatus and computer readable medium for external Internet Protocol (IP) interface management in the fifth generation (5G) system (5GS) as an IP router node.

BACKGROUND

[0002] As known, 5GS may operate as a deterministic networking (DetNet) node in a DetNet domain and define generic enablers for time-sensitive networking (TSN) and native time-sensitive communication (TSC). 5GS as one of the DetNet nodes in the DetNet domain is required to expose all its external visible interfaces to a DetNet controller. At user equipment (UE) side, when a device with a device-side TSN translator (DS-TT) joins a 5GS DetNet node, a DS-TT side interface of the device becomes an external IP interface of the 5GS DetNet node. However, management on such external IP interface of the 5GS DetNet node is still incomplete and needs to be further developed.

SUMMARY

[0003] In general, example embodiments of the present disclosure provide a solution for external IP interface management in a 5GS IP router node.

[0004] In a first aspect, there is provided a device. The device comprises at least one processor; and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the device to: transmit, to a first core network element, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and receive, from the first core network element or a second core network element, Internet Protocol address information for the device-side Internet Protocol interface.

[0005] In a second aspect, there is provided a first core network element. The first core network element comprises at least one processor; and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the first core network element to:

receive, from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and transmit, to the device, Internet Protocol address information of the device-side Internet Protocol interface.

[0006] In a third aspect, there is provided a first core network element. The first core network element comprises at least one processor; and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the first core network element to: receive, from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and transmit, to a second core network element, an interface number for the device-side Internet Protocol interface and an identity of the Internet Protocol router node for allocation of Internet Protocol address information of the device-side Internet Protocol interface.

[0007] In a fourth aspect, there is provided a second core network element. The second core network element comprises at least one processor; and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the second core network element to: receive, from a first core network element, an interface number for a device-side Internet Protocol interface of an Internet Protocol router node and an identity of the Internet Protocol router node, the interface number corresponding to a protocol data unit session; and transmit, to a device, Internet Protocol address information for the device-side Internet Protocol interface.

[0008] In a fifth aspect, there is provided a second core network element. The second core network element comprises at least one processor; and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the second core network element to: receive, from a first core network element, Internet Protocol address information for a device-side Internet Protocol interface of an Internet Protocol router node and an interface number of the device-side Internet Protocol interface corresponding to a protocol data unit session; generate information of the Internet Protocol router node, the information comprising the identity of the Internet Protocol router node, the interface number and the Internet Protocol address information; and expose the information of the Internet Protocol router node to a controller.

[0009] In a sixth aspect, there is provided a third core network element. The third core network element comprises at least one processor; and at least one memory including computer program code; the at least one memory and the computer program code are configured to, with the at least one processor, cause the third core network element to:
5 receive, from a first core network element or from a second core network element, a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for a device-side Internet Protocol interface of an Internet Protocol router node; and transmit, to the first core network element or to the second core network element, the at least one of the Internet Protocol address information or Internet
10 Protocol configuration information.

[0010] In a seventh aspect, there is provided a method for communication. The method comprises: transmitting, at a device and to a first core network element, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and receiving, from the first core network element or a second core network element, Internet
15 Protocol address information for the device-side Internet Protocol interface.

[0011] In an eighth aspect, there is provided a method for communication. The method comprises: receiving, at a first core network element and from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and transmitting, to the device, Internet Protocol address information of the device-side Internet
20 Protocol interface.

[0012] In a ninth aspect, there is provided a method for communication. The method comprises: receiving, at a first core network element and from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and transmitting, to a second core network element, an interface number for the device-side
25 Internet Protocol interface, an identity of the Internet Protocol router node and an identity of a protocol data unit session for the second core network element to allocate Internet Protocol address information of the device-side Internet Protocol interface.

[0013] In a tenth aspect, there is provided a method for communication. The method comprises: receiving, at a second core network element and from a first core network
30 element, an interface number for a device-side Internet Protocol interface of an Internet Protocol router node and an identity of the Internet Protocol router node, the interface number corresponding to a protocol data unit session; and transmitting, to the first core

network element, Internet Protocol address information for the device-side Internet Protocol interface.

[0014] In an eleventh aspect, there is provided a method for communication. The method comprises: receiving, at a second core network element and from a first core network element, Internet Protocol address information for a device-side Internet Protocol interface of an Internet Protocol router node and an interface number of the device-side Internet Protocol interface corresponding to a protocol data unit session; generating information of the Internet Protocol router node, the information comprising the identity of the Internet Protocol router node, the interface number and the Internet Protocol address information; and exposing the information of the Internet Protocol router node to a controller.

[0015] In a twelfth aspect, there is provided a method for communication. The method comprises: receiving, at a third core network element and from a first core network element or from a second core network element via the first core network element, a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for a device-side Internet Protocol interface of an Internet Protocol router node; and transmitting, to the first core network element or to the second core network element via the first core network element, the at least one of the Internet Protocol address information or Internet Protocol configuration information.

[0016] In a thirteenth aspect, there is provided apparatus for communication. The method comprises: means for transmitting, at a device and to a first core network element, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and means for receiving, from the first core network element or a second core network element, Internet Protocol address information for the device-side Internet Protocol interface.

[0017] In a fourteenth aspect, there is provided apparatus for communication. The method comprises: means for receiving, at a first core network element and from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and means for transmitting, to the device, Internet Protocol address information of the device-side Internet Protocol interface.

[0018] In a fifteenth aspect, there is provided apparatus for communication. The method comprises: means for receiving, at a first core network element and from a device, an

indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and means for transmitting, to a second core network element, an interface number for the device-side Internet Protocol interface, an identity of the Internet Protocol router node and an identity of a protocol data unit session for the second core network element to allocate Internet Protocol address information of the device-side Internet Protocol interface.

[0019] In a sixteenth aspect, there is provided apparatus for communication. The method comprises: means for receiving, at a second core network element and from a first core network element, an interface number for a device-side Internet Protocol interface of an Internet Protocol router node and an identity of the Internet Protocol router node, the interface number corresponding to a protocol data unit session; and means for transmitting, to the first core network element, Internet Protocol address information for the device-side Internet Protocol interface.

[0020] In a seventeenth aspect, there is provided apparatus for communication. The method comprises: means for receiving, at a second core network element and from a first core network element, Internet Protocol address information for a device-side Internet Protocol interface of an Internet Protocol router node and an interface number of the device-side Internet Protocol interface corresponding to a protocol data unit session; means for generating information of the Internet Protocol router node, the information comprising the identity of the Internet Protocol router node, the interface number and the Internet Protocol address information; and means for exposing the information of the Internet Protocol router node to a controller.

[0021] In a nineteenth aspect, there is provided apparatus for communication. The method comprises: means for receiving, at a third core network element and from a first core network element or from a second core network element via the first core network element, a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for a device-side Internet Protocol interface of an Internet Protocol router node; and means for transmitting, to the first core network element or to the second core network element via the first core network element, the at least one of the Internet Protocol address information or Internet Protocol configuration information.

[0022] In a twentieth aspect, there is provided a non-transitory computer readable medium comprising program instructions for causing an apparatus to perform the method according

to any of the seventh to twelfth aspects.

[0023] It is to be understood that the summary section is not intended to identify key or essential features of embodiments of the present disclosure, nor is it intended to be used to limit the scope of the present disclosure. Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Some example embodiments will now be described with reference to the accompanying drawings, where:

[0025] Fig. 1 illustrates an example DetNet architecture in which embodiments of the present disclosure may be implemented;

[0026] Fig. 2 illustrates an example 5GS DetNet node architecture in which embodiments of the present disclosure may be implemented;

[0027] Fig. 3A illustrates an example IP architecture model for a device acting as a device-side IP interface of a 5GS DetNet node in which embodiments of the present disclosure may be implemented;

[0028] Fig. 3B illustrates an example IP architecture model for a device acting as a network-side IP interface of a 5GS DetNet node in which embodiments of the present disclosure may be implemented;

[0029] Fig. 4 illustrates a diagram illustrating a process of communication according to some embodiments of the present disclosure;

[0030] Fig. 5 illustrates a diagram illustrating another process of communication according to some embodiments of the present disclosure;

[0031] Fig. 6 illustrates a flowchart of an example method implemented at a device according to some embodiments of the present disclosure;

[0032] Fig. 7 illustrates a flowchart of an example method implemented at a first core network element according to some embodiments of the present disclosure;

[0033] Fig. 8 illustrates a flowchart of an example method implemented at a first core network element according to some embodiments of the present disclosure;

[0034] Fig. 9 illustrates a flowchart of an example method implemented at a second core

network element according to some embodiments of the present disclosure;

[0035] Fig. 10 illustrates a flowchart of an example method implemented at a second core network element according to some embodiments of the present disclosure;

5 [0036] Fig. 11 illustrates a flowchart of another example method implemented at a third core network element according to some embodiments of the present disclosure;

[0037] Fig. 12 illustrates a simplified block diagram of a device that is suitable for implementing embodiments of the present disclosure; and

[0038] Fig. 13 illustrates a block diagram of an example computer readable medium in accordance with some embodiments of the present disclosure.

10 [0039] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

15 [0040] Principle of the present disclosure will now be described with reference to some example embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein can be implemented in various manners other than the ones described below.

20 [0041] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

25 [0042] References in the present disclosure to “one embodiment,” “an embodiment,” “an example embodiment,” and the like indicate that the embodiment described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or
30 characteristic in connection with other embodiments whether or not explicitly described.

[0043] It shall be understood that although the terms “first” and “second” etc. may be

used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the listed terms.

[0044] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including”, when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[0045] As used in this application, the term “circuitry” may refer to one or more or all of the following:

(a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and

(b) combinations of hardware circuits and software, such as (as applicable):

(i) a combination of analog and/or digital hardware circuit(s) with software/firmware and

(ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and

(c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.

[0046] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their)

accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

5 **[0047]** As used herein, the term “communication network” refers to a network following any suitable communication standards, such as Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT) and so on. Furthermore, the communications between a terminal device and a network device in the
10 communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G), the future sixth generation (6G) communication protocols, and/or any other protocols either currently known or to be developed in the future. Embodiments
15 of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will of course also be future type communication technologies and systems with which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned system.

20 **[0048]** As used herein, the term “network device” refers to a node in a communication network via which a terminal device accesses the network and receives services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a NR next generation NodeB (also referred to as a gNB), a Remote Radio Unit (RRU), a radio header (RH), a remote
25 radio head (RRH), a relay, a low power node such as a femto, a pico, and so forth, depending on the applied terminology and technology. An radio access network (RAN) split architecture comprises a gNB-CU (centralized unit, hosting radio resource control (RRC), service data adaptation protocol (SDAP) and packet data convergence protocol (PDCP) layers) controlling a plurality of gNB-DUs (distributed unit, hosting radio link
30 control (RLC), medium access control (MAC) and physical (PHY) layers).

[0049] The term “terminal device” refers to any end device that may be capable of wireless communication. By way of example rather than limitation, a terminal device may also be referred to as a communication device, user equipment (UE), a Subscriber Station

(SS), a Portable Subscriber Station, a Mobile Station (MS), or an Access Terminal (AT). The terminal device may include, but not limited to, a mobile phone, a cellular phone, a smart phone, voice over IP (VoIP) phones, wireless local loop phones, a tablet, a wearable terminal device, a personal digital assistant (PDA), portable computers, desktop computer, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, vehicle-mounted wireless terminal devices, wireless endpoints, mobile stations, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), USB dongles, smart devices, wireless customer-premises equipment (CPE), an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device and applications (e.g., remote surgery), an industrial device and applications (e.g., a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. In the following description, the terms “terminal device”, “communication device”, “terminal”, “user equipment” and “UE” may be used interchangeably.

[0050] Although functionalities described herein can be performed, in various example embodiments, in a fixed and/or a wireless network node, in other example embodiments, functionalities may be implemented in a user equipment apparatus (such as a cell phone or tablet computer or laptop computer or desktop computer or mobile IoT device or fixed IoT device). This user equipment apparatus can, for example, be furnished with corresponding capabilities as described in connection with the fixed and/or the wireless network node(s), as appropriate. The user equipment apparatus may be the user equipment and/or or a control device, such as a chipset or processor, configured to control the user equipment when installed therein. Examples of such functionalities include the bootstrapping server function and/or the home subscriber server, which may be implemented in the user equipment apparatus by providing the user equipment apparatus with software configured to cause the user equipment apparatus to perform from the point of view of these functions/nodes.

[0051] Since Release 16, the third generation partnership project (3GPP) has been considering how to define technical building blocks in cellular networks for delivery of reliable and predictable network services defined by other standardization groups, e.g., Institute of Electrical and Electronics Engineers (IEEE) TSN.

[0052] In 3GPP Release 16, integration of layer-2 (L2) Ethernet TSN features into 5GS

was introduced as an essential part of ultra-reliable and low latency communication (URLLC). 5GS bridge utilizes a fully centralized configuration model. In this model, TSN application function (TSN AF) discovers ingress/egress port (DS-TT: Device-side TSN translator, or NW-TT: Network-Side TSN translator) capabilities, configures them and gets notifications about configuration updates from them via a port management information container (PMIC) and/or a user plane node management information container (UMIC).

[0053] In 3GPP Release 17, generalized time sensitive communication (TSC) support was introduced to provide deterministic transmission capability without relying on TSN specific functions. Since then, 5GS has defined generic enablers for TSC and native TSC. A time sensitive communication and time synchronization function (TSCTSF) is introduced to take care of time synchronization, individual quality of service (QoS) parameters, and TSC assistance container (TSCAC) determination. TSCTSF discovers ingress/egress port (DS-TT or NW-TT) capabilities, configures them and get notifications about configuration updates from them. TSCTSF is able to communicate with DS-TTs and NW-TTs with PMICs and UMICs similarly to TSN AF, depending on their supported capabilities and configuration data models.

[0054] As mentioned above, at UE side, when a device with a DS-TT joins a 5GS DetNet node, a DS-TT side interface of the device becomes an IP interface of the 5GS DetNet node. However, management on such DS-TT side interface of the device is still incomplete and needs to be further developed.

[0055] In view of this, embodiments of the present disclosure provide a solution of external IP interface management in a 5GS IP router node. In the context of the present disclosure, an external IP interface in a 5GS IP router node comprises a DS-TT side interface (for convenience, also referred to as a device-side IP interface) and/or a NW-TT side interface (for convenience, also referred to as a network-side IP interface).

[0056] In the solution, there is provided a method to enable 5G core network (5GC) functions operated as one 5GS IP router node. The method is designed to configure and discovery IP management information of an external IP interface of a 5GS IP router node. The IP management information may comprise IP address information and IP configuration information.

[0057] In one aspect, a core network element may configure respective IP address

information and IP configuration information to a device-side IP interface or a network-side IP interface. That is, the core network element serves as “management owner” for IP management. In another aspect, a core network element may learn respective IP address information and IP configuration information of a device-side IP interface or a network-side IP interface. That is, the core network element serves as “management learner” for IP management. It is possible to use both modes for different external IP interfaces within the same IP router node.

[0058] In some embodiments, a device transmits indication regarding an external IP interface of an IP router node to a core network element and receives IP address information from the core network element. In this way, an external IP interface at a device-side may be managed.

[0059] In some embodiments, a core network element allocates IP address information for an external IP interface of an IP router node, generates information of the IP router node and exposes the information of the IP router node to an IP router controller. In this way, a core network element may be enabled as an owner for management of an external IP interface of an IP router node.

[0060] In some embodiments, a core network element learns at least IP address information and an interface number for an external IP interface of an IP router node, and bind the interface number to at least the IP address information. In this way, a core network element may be enabled as a learner for management of an external IP interface of an IP router node.

[0061] In some embodiments, a core network element stores subscription information of a device in association with at least one of a pair of an identity of an IP router node and an interface number of an external Internet Protocol interface, IP address information of the external Internet Protocol interface, or IP configuration information of the external Internet Protocol interface. In this way, a core network element may support management of an external IP interface of an IP router node.

[0062] Principles and implementations of the present disclosure will be described in detail below with reference to the figures. For illustration, the following description will be given by taking a DetNet architecture as an example of an IP router architecture. It is to be understood that embodiments of the present disclosure also apply to any suitable IP router architectures.

EXAMPLE OF COMMUNICATION ENVIRONMENT

[0063] Fig. 1 illustrates an example DetNet architecture 100 in which embodiments of the present disclosure may be implemented. The DetNet architecture 100 is a reference architecture of DetNet network with a centralized controller plane. As shown in Fig. 1, the DetNet architecture 100 may comprise DetNet end systems 110-1 and 110-2 (for convenience, may also be collectively referred to as a DetNet end system 110 herein). The DetNet end system 110 may be a robot in factory or any other suitable terminals.

[0064] The DetNet architecture 100 may also comprise DetNet nodes 120-1, 120-2 and 120-3 (for convenience, may also be collectively referred to as a DetNet node 120 herein).

[0065] As shown in Fig. 1, the DetNet architecture 100 may further comprise a DetNet controller 130. The DetNet controller 130 may be connected to a database (DB) 140. The DetNet controller 130 may collect topology and capability and resource availability information from DetNet nodes 120. With this information and ability to configure explicit routes and reserve resources along the routes, the DetNet controller may calculate and setup an end-to-end (E2E) deterministic path for DetNet traffic flows according to requests from applications.

[0066] It is to be understood that Fig. 1 is merely an example, and the DetNet architecture 100 may comprise any other suitable type or number of elements.

[0067] Communications in the DetNet architecture 100 may be implemented according to any proper communication protocol(s), comprising, but not limited to, cellular communication protocols of the first generation (1G), the second generation (2G), the third generation (3G), the fourth generation (4G), the fifth generation (5G) or the future sixth generation (6G) wireless local network communication protocols, and/or any other protocols currently known or to be developed in the future. Moreover, the communication may utilize any proper wireless communication technology, comprising but not limited to: Code Division Multiple Access (CDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Frequency Division Duplex (FDD), Time Division Duplex (TDD), Multiple-Input Multiple-Output (MIMO), Orthogonal Frequency Division Multiple (OFDM), Discrete Fourier Transform spread OFDM (DFT-s-OFDM) and/or any other technologies currently known or to be developed in the future.

[0068] For 3GPP Release 18, one study item is to study whether and how to enable 3GPP support for DetNet such that a mapping is provided between the central DetNet controller

entity and the 5GS. The study considers 5GS acting as a one of the DetNet nodes in the Figure 1 in the DetNet domain.

[0069] The Release 18 study has the following architecture assumptions (not all assumptions are listed below): IP based DetNet traffic is carried in protocol data unit (PDU) sessions of IP type; mapping functionality for DetNet is realized in the TSCTSF; solutions should reuse functionality of a TSC framework defined in Release 17 where applicable; and granularity of a 5GS DetNet node is per user plane function (UPF) for each network instance; and solutions shall not have any 5G access network (AN) and UE impacts.

[0070] The 5GS is extended to support the following: UE is part of a 5GS logical DetNet Node, and thus is not a DetNet node or end system on its own.

[0071] The 5GS has already defined various ways to configure UE's IP address information and 5GC internal IP routing information related to the UE. The 5GC and the UE support the following IP address allocation mechanisms:

- During a PDU session establishment procedure, a session management function (SMF) sends an IP address to UE via non-access-stratum (NAS) session management (SM) signaling or via IPv6 router advertisement. IPv4 address allocation and/or IPv4 parameter configuration via DHCPv4 may also be used once a PDU session is established.
- IPv6 prefix allocation shall be supported via IPv6 Stateless Auto-configuration, if IPv6 is supported. IPv6 parameter configuration via Stateless DHCPv6 may also be supported.

[0072] In addition, for the residential gateway (GW) implementation, following address configuration mechanisms are specified: IPv6 address allocation using DHCPv6 may be supported for allocating individual IPv6 address(es) for a PDU session; and IPv6 prefix delegation using DHCPv6 may be supported for allocating additional IPv6 prefixes for a PDU session.

[0073] To support IP routes behind UE, framed routing mechanism has been specified by 3GPP. 3GPP has defined a mechanism called "framed routing" that allows 5GC to be configured with IP prefixes/subnets that should be forwarded to UE in addition to UE's own or delegated prefixes. The framed route information may be provided to the SMF by a data network-authentication authorization accounting (DN-AAA) server or unified data management (UDM) who stores the information. The SMF configures them in the UPF using normal packet detection rules (PDR)/forwarding action rules (FAR). Framed routes do not cover the routing or forwarding by the UE acting as a router, but that part needs to be

separately configured in the UE router itself.

[0074] Fig. 2 illustrates an example 5GS DetNet node architecture 200 in which embodiments of the present disclosure may be implemented. As shown in Fig. 2, a 5GS DetNet node 210 may comprise a UE/DS-TT module 211, a radio access network (RAN) 212 and a plurality of core network elements such as a UPF/NW-TT module 213, a SMF 214, an access management function (AMF) 215, a UDM 216, a TSCTSF 217, a policy control function (PCF) 218 and a network exposure function (NEF) 219. The TSCTSF may be connected to a DetNet controller 220 via the NEF 219. It is to be understood that Fig. 2 is merely an example, and the architecture 200 and the 5GS DetNet node 210 may also comprise any other suitable more or less elements.

[0075] As shown in Fig. 2, the UE/DS-TT module 211 may provide an external IP interface #2 of the 5GS DetNet node 210 towards DetNet node or DetNet end system 201. The UPF/NW-TT module 213 may provide an external IP interface #3 of the 5GS DetNet node 210 towards DetNet node or DetNet end system 202.

[0076] In the context of the present disclosure, the interface #2 may also be referred to as a device-side IP interface, and the interface #3 may also be referred to as a network-side IP interface. The device-side IP interface and the network-side IP interface may also be collectively referred to as external IP interfaces of a DetNet node.

[0077] In some embodiments, the UE/DS-TT module 211 may comprise a device (e.g., a terminal device) and a DS-TT and the DS-TT may provide the interface #2. In some embodiments, the device may be not accompanied by a DS-TT. That is, the UE/DS-TT module 211 may only comprise the device. In this case, the device provides the interface #2 by itself.

[0078] In some embodiments, the UPF/NW-TT module 213 may comprise a UPF and a NW-TT and the NW-TT may provide the interface #3. In some embodiments, a UPF may be not accompanied by a NW-TT. That is, the UPF/NW-TT module 213 may only comprise a UPF. In this case, the UPF provides the interface #3 by itself.

[0079] The granularity of a 5GS DetNet node is per UPF for each network instance. Thus, a 5GS DetNet node comprises a single UPF and one or more devices. Each device may be accompanied by one or more DS-TTs that provide a 5GS DetNet Node with IP interfaces to an external DetNet network. The UPF may be accompanied by one or more NW-TTs and has a set of IP interfaces that also connect the 5GS DetNet Node to the

external DetNet Network. For simplicity, only one device-side or network-side IP interface is shown in Fig. 2 and it is to be understood that multiple device-side or network-side IP interfaces may also be feasible.

[0080] Inside the 5GS DetNet node 210, the TSCTSF 217 is responsible for an interaction with the DetNet controller 220. The DetNet controller 220 needs IP topology and routing information of each DetNet node within the DetNet domain as inputs to calculate paths for DetNet traffic flows. Thus, DetNet integration into 5GS puts new requirements on 5GS, especially on TSCTSF and TT functionalities.

[0081] For IP address management, 5GS as one of DetNet nodes in the DetNet domain shall expose all its external visible interfaces to a DetNet controller. In a device side, when a device joins a 5GS DetNet node, its device-side IP interface becomes an external IP interface of the 5GS DetNet node. The device-side interface, as an IP router interface, may need at least an IP address and IP prefix/subnet information.

[0082] Although current 3GPP specifications support various ways to configure UE's IP address information, these mechanisms are meant to configure the terminal device's 3GPP access network (e.g., 5G AN) side IP interface, i.e. an interface#1 as shown in Fig. 2, not the interface #2. IPv6 prefix delegation may be used to provide additional prefixes besides the prefixes allocated to the interface#1 for a network behind the terminal device. However, how the terminal device uses the delegated prefixes or forms its own IP addresses from them is not explicitly defined. In this case, it is required to know exactly which prefixes are taken for a device-side IP interface and which IPv6 addresses the device-side IP interface uses. IPv6 prefix delegation also works only for IPv6 but not for IPv4. For UPF/NW-TT module, if UPF or NW-TT provides multiple network-side IP interfaces, these interfaces may need separate configurations.

[0083] After external IP interfaces obtain their IP address information, the TSCTSF needs to be aware of the IP address information for all the external IP interfaces of a 5GS DetNet node.

[0084] For IP interface properties, the external IP interfaces may have some basic properties such as which IP routing protocol(s) or algorithm(s) and L2 technology they support, what the IP parameters relevant to the IP routing protocol(s) or algorithm(s), what L2/MAC addresses they have or what their bitrate is. The TSCTSF responsible for the 5GS DetNet Node needs to learn these properties and may also need to configure at least

part of these properties.

[0085] In view of this, it is to be addressed how 5GS network functions and terminal device and/or DS-TT/NW-TT in general operate as a DetNet node from IP interface addressing and management and IP routing and packet forwarding perspective. Further, how to allocate IP address for an external IP interface of a DetNet node is to be solved. In addition, it is to be addressed how to learn or configure IP parameters of the external IP interface and how to make the TSCTSF be aware of the IP address and IP parameters of the external IP interface.

[0086] 3GPP Release 17 defines how TSCTSF and DS-TT/NW-TT can exchange management information containers for TSC, including both UMIC and PMIC. However, current 3GPP defined UMIC and PMIC for TSC focus on Ethernet layer information, and IP layer information is not defined.

[0087] Embodiments of the present disclosure provide a solution of external IP interface management in a DetNet node to solve the above and other potential issues. More details will be described below in connection with Figs. 3A to 5.

EXAMPLE IMPLEMENTATION OF IP ARCHITECTURE MODEL

[0088] Fig. 3A illustrates an example IP architecture model 300A for a device acting as a device-side IP interface of a 5GS DetNet node in which embodiments of the present disclosure may be implemented. For the purpose of discussion, the model 300A will be described with reference to Fig. 2. The model 300A may be implemented at the UE/DS-TT module 211.

[0089] As shown in Fig. 3A, the UE/DS-TT module 211 may consist of a device 310 and a DS-TT 311. The device 310 may provide a 5G IP interface 320 (i.e., the interface #1 as shown in Fig.2), and the DS-TT 311 may provide a 5GS DetNet node IP interface 321 (i.e., the interface #2 as shown in Fig. 2). The 5GS DetNet node IP interface 321 corresponds to a device-side IP interface of a DetNet node. In some embodiments, the device 310 may be a terminal device.

[0090] The 5G IP interface 320 is an “ordinary” 5G AN IP interface of the device 310, and the device 310 may be connected to a data network via a UPF. An IP address of the 5G IP interface 320 is allocated or configured by existing means such as NAS SM signaling, IPv6 router advertisement message or dynamic host configuration protocol (DHCP) message. From perspective of a 5GS DetNet node, the 5G IP interface 320 is not an externally visible

interface but is mainly just used for packet forwarding within the 5GS DetNet Node.

[0091] The 5GS DetNet node IP interface 321 is an externally visible interface of the 5GS DetNet Node. In principle, the 5GS DetNet node IP interface 321 may be any type of interface that supports IP and DetNet compliant IP QoS, but in practice the 5GS DetNet node IP interface 321 is most often an Ethernet interface.

[0092] Alternatively, the UE/DS-TT module 211 may only consist of the device 310 and does not comprise the DS-TT 311. In this case, the device 310 may provide both the 5G IP interface 320 and the 5GS DetNet node IP interface 321 on its own.

[0093] Fig. 3B illustrates an example IP architecture model 300B for a device acting as a network-side IP interface of a 5GS DetNet node in which embodiments of the present disclosure may be implemented. For the purpose of discussion, the model 300B will be described with reference to Fig. 2. The model 300B may be implemented at the UPF/NW-TT module 213.

[0094] As shown in Fig. 3B, the UPF/NW-TT module 213 may consist of a UPF 330 and a NW-TT 331. The NW-TT 331 may provide a 5GS DetNet node IP interface 340 (i.e., the interface #3 as shown in Fig. 2). The 5GS DetNet node IP interface 340 corresponds to a network-side IP interface of a DetNet node.

[0095] The 5GS DetNet node IP interface 340 is an externally visible interface of the 5GS DetNet Node. In principle, the 5GS DetNet node IP interface 340 may be any type of interface that supports IP and DetNet compliant IP QoS, but in practice the 5GS DetNet node IP interface 340 is most often an Ethernet interface.

[0096] Alternatively, the UPF/NW-TT module 213 may only consist of the UPF 330 and does not comprise the NW-TT 331. In this case, the UPF 330 may provide the 5GS DetNet node IP interface 340 on its own.

[0097] Embodiments of the present disclosure are intended to provide IP management for an externally visible interface (i.e., the 5GS DetNet node IP interface 321 or 340) of a 5GS IP router node (for example, a 5GS DetNet node). Externally visible means that for instance adjacent DetNet nodes would see the interface as a next hop interface for IP traffic such as DetNet traffic flows, or an interface that matters to a DetNet controller for understanding network topology or routing.

[0098] In one solution, the IP management may be implemented with a TSCTSF as an

owner and a SMF as a learner. In another solution, the IP management may be implemented with a TSCTSF as a learner and a SMF as an owner. What is common to both solutions is that they allow 5GC to detect a new external IP interface or a list of external IP interfaces and configure IP address information and/or IP configuration information to the detected external IP interface(s). Further, the TSCTSF is allowed to be aware of and up-to-date with the IP address information and/or IP configuration information, so that the TSCTSF can expose the IP address information and/or IP configuration information to the DetNet controller or any other IP software defined network (SDN) controller.

[0099] In some embodiments, the IP address information may comprise an IP address and a prefix length. For example, the IP address information may comprise an IP address and subnet mask for IPv4. As another example, the IP address information may comprise one or more IP prefixes and an interface identity (ID) for IPv6. For example, the full IP address of an external IP interface may be concatenation of the prefix and the interface ID. It is to be understood that these are merely examples and the IP address information may adopt any other suitable forms.

[00100] In the context of the present disclosure, the IP configuration information may refer to additional IP or lower layer information of the interface. In some embodiments, the IP configuration information may comprise IP routing protocol(s) or algorithm(s) applied to the interface and IP parameters configured to the IP routing protocol(s) or algorithm(s). In some embodiments, the IP configuration information may comprise a maximum transmission unit (MTU) size of the interface. In some embodiments, the IP configuration information may comprise a configuration on how duplicate address detection should be performed or a neighbor/address resolution protocol (ARP) cache of the interface. For example, the IP configuration information may comprise lower layer information such as the L2 technology type (e.g., Ethernet), bitrate and address (e.g., MAC address). As another example, the IP configuration information may comprise cost and/or priority of IP links. It is to be understood that these are merely examples and the IP configuration information may comprise any other suitable information.

[00101] The IP configuration information may be read-only or read-and-write for the TSCTSF depending on the implementation. For example, the lower layer information such as the L2 technology type (e.g., Ethernet), bitrate and address (e.g., MAC address) may be read-only for the TSCTSF because they stem from the interface hardware and are

not changeable by configuration. As another example, IP routing protocol(s) or algorithm(s) applied to the interface and IP parameters configured to the IP routing protocol(s) or algorithm(s) may be “read and write” for the TSCTSF. As another example, parameters such as cost and/or priority of IP links may be “read and write” for the TSCTSF.

5 It is to be understood that these are merely examples and are not intended for limitation.

[00102] For illustration, some example embodiments of external IP interface management will be described in details with reference to Figs. 4 and 5.

EXAMPLE IMPLEMENTATION OF EXTERNAL IP INTERFACE MANAGEMENT WITH TSCTSF AS OWNER

10 [00103] Fig. 4 illustrates a diagram illustrating a process 400 of communication according to some embodiments of the present disclosure. For the purpose of discussion, the model 400 will be described with reference to Fig. 2. It is assumed that the device 310 is accompanied by the DS-TT 311, and the UPF 330 is accompanied by the NW-TT 331. The TSCTSF 217 serves as a management owner, and the SMF 214 serves as a
15 management learner. UPF 330 is preconfigured with interface numbers of external IP interfaces of a 5GS DetNet node and a list of 5GS DetNet node IDs. It is to be understood that an order and the number of the steps in Fig. 4 are merely for illustration, and are not intended for limitation.

[00104] As shown in Fig. 4, at step 401, the device 310 transmits, to a first core network
20 element (e.g., the SMF 214), an indication regarding a device-side IP interface of a DetNet node. The indication may be implemented in any suitable ways.

[00105] In some embodiments, the device 310 may transmit the indication in a PDU session establishment request. For example, the device 310 may transmit the indication in a NAS SM message via AMF (not shown).

25 [00106] In some alternative embodiments, the device 310 may transmit the indication in a DHCP request after PDU session establishment. In some embodiments, the DHCP request may comprise an identifier specific to the device-side IP interface as the indication.

[00107] In some embodiments for IPv4, the identifier may be a DHCP client ID specific to the device-side IP interface. In some embodiments, the DHCP client ID may be allocated
30 by the SMF 214 in NAS SM PDU session establishment signaling during the PDU session establishment. In some alternative embodiments, the DHCP client ID may be predefined. In this case, the device 310 may indicate the DHCP client ID to the SMF 214 in NAS SM

PDU session establishment signaling during the PDU session establishment.

[00108] In some embodiments for IPv6, the identifier may be an IA_PD identifier of an IA_PD option specific to the device-side IP interface. For example, when the device 310 requests IPv6 prefix for the DetNet interface from the SMF 214 with the IPv6 Prefix Delegation. The device 310 acts as a "Requesting Router" and inserts DetNet interface specific IA_PD option(s) into a DHCPv6 Solicit message sent to the SMF 214. In some embodiments, the IA_PD identifier may be allocated by the SMF 214 in NAS SM PDU session establishment signaling during the PDU session establishment. In some alternative embodiments, the IA_PD identifier may be predefined. In this case, the device 310 may indicate the IA_PD identifier to the SMF 214 in NAS SM PDU session establishment signaling during the PDU session establishment.

[00109] Upon reception of the indication, at step 402, the SMF 214 determines that a new device-side IP interface is detected. In some embodiments where the indication is transmitted in a PDU session establishment request, the SMF 214 is able to identify that the PDU session is established for the purpose of joining a 5GS DetNet node. In some embodiments where the indication is transmitted in a DHCP request, the SMF 214 may associate the DHCP request to the specific device-side IP interface.

[00110] At step 403, the SMF 214 requests a fourth core network element (e.g., the UPF 330) to allocate an interface number for the device-side IP interface. For the first joining device-side IP interface to the 5GS DetNet node, the UPF 330 may also feedback a 5GS DetNet Node ID to the SMF 214.

[00111] At step 404, the SMF 214 transmits the interface number, the 5GS DetNet Node ID and a PDU session ID to a second core network element (e.g., the TSCTSF 217) via a PCF (not shown).

[00112] At step 405, the TSCTSF 217 determines IP address information for the device-side IP interface. In some embodiments, the TSCTSF 217 is preconfigured with a set of IP address information for a set of device-side IP interfaces. In this case, as shown by step 405-1, the TSCTSF 217 may determine, from the set of IP address information, the IP address information for the device-side IP interface.

[00113] In some alternative embodiments, as shown by step 405-2, the TSCTSF 217 may transmit, to the SMF 214, a request (for convenience, also referred to as a second request herein) for obtaining at least one of IP address information or IP configuration information

for the device-side IP interface. The SMF 214 may transmit, to a third core network element (e.g., the UDM 216), a request (for convenience, also referred to as a first request herein) for obtaining the at least one of IP address information or IP configuration information for the device-side IP interface. Then the SMF 214 may receive, from the UDM 216, the at least one of IP address information or IP configuration information for the device-side IP interface, and transmit the at least one of IP address information or IP configuration information for the device-side IP interface to the TSCTSF 217.

[00114] In some embodiments, the first request may be transmitted by the SMF 214 on its own initiative. In some embodiments, the first request may be transmitted by the SMF 214 in response to receiving the second request.

[00115] In some embodiments, each of the first request and the second request may comprise an ID of the device 310 as a key. For example, the information may be requested with UE ID if mapping between UE ID and the DetNet Node ID/interface number is known already when the information is stored in the UDM 216.

[00116] In some embodiments, each of the first request and the second request may comprise a pair of the 5GS DetNet node ID and an interface number of the device-side IP interface as a key. In some embodiments, the SMF 214 may derive, from a generic public subscription identifier (GPSI) of the device 310, the pair of the identity of the 5GS DetNet node and the interface number of the device-side IP interface. GPSI is within the subscription data of the device 310. The device 310 may have multiple GPSIs associated to the same UE ID (e.g., International Mobile Subscriber Identity (IMSI)). For example, the information may be requested with GPSI by a specific locally meaningful mapping from a GPSI associated to the UE ID to the pair of {DetNet Node ID and interface number}.

[00117] In some alternative embodiments, as shown in step 405-3, the TSCTSF 217 may transmit, to the UDM 216, a request for obtaining at least one of IP address information or IP configuration information for the device-side IP interface. In some embodiments, the request may comprise an ID of the device 310 as a key. In some embodiments, the request may comprise a pair of the 5GS DetNet node ID and an interface number of the device-side IP interface as a key. In this regard, the request may be implemented similar with the first request or the second request, and thus other details are omitted here for concise. Then the TSCTSF 217 may receive the at least one of IP address information or IP configuration

information for the device-side IP interface from the UDM 216.

[00118] The information stored in the UDM 216 or DN-AAA server (not shown) may be considered as an extension of the current Framed Route information stored there according to earlier 3GPP releases. This information would have to be augmented by two additional mandatory pieces of information for the prefixes that are meant for the device-side IP interface of the UE: an indicator that the prefix is targeted for the device-side IP interface of the UE; and an IP interface ID by which a full IP address can be formed from the prefix. Optionally, the information may also comprise other IP configuration parameters (such as the MTU size) designated for the device-side IP interface.

[00119] By above means, the TSCTSF uses the received augmented information to learn the IP address information, i.e., IP prefixes and addresses (IP interface IDs) that are designated for the device-side interface.

[00120] In some alternative embodiments, after receiving the request from the TSCTSF 217, the SMF 214 may request the information from the UDM 216 or DN-AAA server (not shown) by using DHCP to ask for the IP configuration information of the device-side IP interface. For example, the SMF 214 may use the pair of {DetNet Node ID and interface number} in a DHCP query. The SMF 214 may pass the information received from the DHCP server to the TSCTSF 217.

[00121] At step 406, the DS-TT 311 transmits, to the TSCTSF 217, IP management capability of the device-side IP interface. In some embodiments, the DS-TT 311 may transmit the IP management capability via a PMIC. In some embodiments where there is no DS-TT, the device 310 may transmit the IP management capability of the device-side IP interface to the TSCTSF 217.

[00122] At step 406', the NW-TT 331 may transmit, to the TSCTSF 217, IP management capability of the network-side IP interface. In some embodiments, the NW-TT 331 may transmit the IP management capability via a PMIC or UMIC. In some embodiments for transmission via PMIC, the PMIC may carry information of one port or interface. In some embodiments for transmission via UMIC, the UMIC may carry information of one or more ports or interfaces. In some embodiments where there is no NW-TT, the UPF 330 may transmit the IP management capability of the network-side IP interface to the TSCTSF 217 via N4 session level message.

[00123] In some embodiments, the DS-TT 311 or the NW-TT 331 may transmit types of

supported IP routing protocols or algorithms to the TSCTSF 217 as the IP management capability. For example, the IP management capability may indicate that the DS-TT 311 may support routing protocols: open shortest path first (OSPF) protocol and intermediate system-to-intermediate system (IS-IS) protocol.

5 [00124] At step 407, the TSCTSF 217 may update IP configuration information of the device-side IP interface based on the IP management capability of the device-side IP interface if needed. The TSCTSF 217 may update IP configuration information of the network-side IP interface based on the IP management capability of the network-side IP interface if needed.

10 [00125] In some embodiments where the IP management capability indicates that the DS-TT 311 or NW-TT 331 may support OSPF and IS-IS protocols, the TSCTSF 217 may configure, in the updated IP configuration information, the type of routing protocol or algorithm and parameters of the routing protocol or algorithm applied in the interface. For example, the parameters may comprise at least one of the following: Hello Interval (number
15 of seconds that the interface sends out OSPF hello packets to the network), cost of the interface, retransmit interval (configure the number of seconds that elapse before the interface resends a link state advertisement (LSA) to a neighbor that did not respond to the original LSA), etc..

[00126] At step 408, the TSCTSF 217 may bind the interface number to the IP address
20 information corresponding to a PDU session. For example, the TSCTSF 217 may build up binding information of the interface number and the IP address information of the interface corresponding to the PDU session. If IP address of the device with the interface is known by the TSCTSF 217, the TSCTSF 217 may also include the IP address of the device in the binding information. In this way, it is ensured to transmit PMIC to the
25 correct interface.

[00127] As another example, IPv6 interface ID determination may be done based on a MAC address of the DS-TT 311. The MAC address may be transmitted to the TSCTSF 217 during the PDU session establishment procedure. In this case, the TSCTSF 217 may provide the IPv6 prefix to the interface. If a full IP address is provided, the TSCTSF 217
30 may provide the IPv6 prefix based on the MAC address.

[00128] The TSCTSF 217 also maintains the up-to-date information of the IP address information and IP configuration information provided to each interface or interface

number.

[00129] At step 409, the TSCTSF 217 may transmit the IP address information to the DS-TT 311. In some embodiments, the TSCTSF 217 may also transmit the IP configuration information. In some embodiments, the TSCTSF 217 may transmit at least one of the IP address information or the IP configuration information via a PMIC. For example, if IP configuration information can be written, the TSCTSF 217 may transmit the IP address information and may also transmit any other “read-and-write” parameters of IP configuration information to the DS-TT 311 via a PMIC.

[00130] In some embodiments where there is no DS-TT, the TSCTSF 217 may transmit at least one of the IP address information or the IP configuration information via a NAS SM message.

[00131] At step 409', the TSCTSF 217 may determine IP address information of the network-side IP interface and transmit it to the NW-TT 331. In some embodiments, the TSCTSF 217 may also transmit the IP configuration information of the network-side IP interface. In some embodiments, the TSCTSF 217 may transmit at least one of the IP address information or the IP configuration information of the network-side IP interface via a PMIC or UMIC. For example, if IP configuration information can be written, the TSCTSF 217 may transmit the IP address information and may also transmit any other “read-and-write” parameters of IP configuration information to the NW-TT 331 via a PMIC or UMIC. In some embodiments where there is no NW-TT, the TSCTSF 217 may transmit at least one of the IP address information or the IP configuration information via a SM policy association modification procedure.

[00132] At step 410, the TSCTSF 217 may transmit the IP address information associated with the DS-TT to the SMF 214 and the SMF 214 may transmit the IP address information to the UPF 330. In this way, the TSCTSF 217 may ensure that the UPF 330 starts to forward IP packets to that IP address information to the PDU session associated with the DS-TT 311. For example, the TSCTSF 217 informs the SMF 214 that an IPv4 address or IPv6 prefix should be associated with the PDU session. The SMF 214 may configure the IP address information to the UPF 330 via PDR.

[00133] At step 411, the TSCTSF 217 may generate information of the DetNet node. The information may comprise the DetNet node ID, the interface number and the IP address information and/or IP configuration information of the IP interface(s) of the DetNet node.

In some embodiments, the information of the DetNet node may comprise an interface number and IP address information of each external IP interface in a same DetNet node.

[00134] At step 412, the TSCTSF 217 may expose the information of the DetNet node to a controller (e.g., the DetNet controller 220). In some embodiments, the information of the DetNet node may be exchanged by any means such as YANG data models and NETCONF/RESTCONF protocols, the Path Computation Element Protocol, or master information block (MIB) data models and simple network management protocol (SNMP). The present disclosure does not limit this aspect.

[00135] With the process 400, external IP interface management may be achieved for an IP router node.

EXAMPLE IMPLEMENTATION OF EXTERNAL IP INTERFACE MANAGEMENT WITH TSCTSF AS LEARNER

[00136] Fig. 5 illustrates a diagram illustrating a process 500 of communication according to some embodiments of the present disclosure. For the purpose of discussion, the model 500 will be described with reference to Figs. 2, 3A and 3B. It is assumed that the device 310 is accompanied by the DS-TT 311, and the UPF 330 is accompanied by the NW-TT 331. The TSCTSF 217 serves as a management learner, and the SMF 214 serves as a management owner. UPF 330 is preconfigured with interface numbers of external IP interfaces of a 5GS DetNet node and a list of 5GS DetNet node IDs. It is to be understood that an order and the number of the steps in Fig. 5 are merely for illustration, and are not intended for limitation.

[00137] As shown in Fig. 5, at step 501, the device 310 transmits, to a first core network element (e.g., the SMF 214), an indication regarding a device-side IP interface of a DetNet node. The indication may be implemented in any suitable ways.

[00138] In some embodiments, the device 310 may transmit the indication in a PDU session establishment request. For example, the device 310 may transmit the indication in a NAS SM message via AMF (not shown). In some embodiments, the PDU session establish request may further comprise a protocol configuration option (PCO) value indicating a configuration of the device-side IP interface. In some embodiments, the PCO value may comprise a MAC address or IP interface ID of the DS-TT 311.

[00139] In some alternative embodiments, the device 310 may transmit the indication in a DHCP request after PDU session establishment. In some embodiments, the DHCP request

may comprise an identifier specific to the device-side IP interface as the indication.

[00140] The operation in the step 501 is similar with that in the step 401 in Fig. 4, and thus other details are omitted here for concise.

[00141] Upon reception of the indication, at step 502, the SMF 214 determines that a new device-side IP interface is detected. In some embodiments where the indication is transmitted in a PDU session establishment request, the SMF 214 is able to identify that the PDU session is established for the purpose of joining a 5GS DetNet node. In some embodiments where the indication is transmitted in a DHCP request, the SMF 214 may associate the DHCP request to the specific device-side IP interface.

[00142] At step 503, the SMF 214 may request a fourth core network element (e.g., the UPF 330) to allocate an interface number for the device-side IP interface. For the first joining device-side IP interface to the 5GS DetNet node, the UPF 330 may also feedback a 5GS DetNet Node ID to the SMF 214.

[00143] At step 504, the SMF 214 may determine IP address information of the device-side IP interface. In some embodiments, the SMF 214 may select an IP address and prefix length for the device-side IP interface from an IP pool. In some embodiments, an index of the IP pool may be obtained from UPF, PCF or UDM. It is to be understood that any other suitable ways are also feasible.

[00144] At step 505, the SMF 214 may bind the interface number to the IP address information and the PDU session ID. For example, the SMF 214 may build up binding information of the interface number, the IP address information, and the PDU session ID. If IP address of the device associated with the interface is known by the SMF, the SMF also include the IP address of the device in the binding information.

[00145] At step 506, the SMF 214 may receive IP management capability of the device-side IP interface from the device 310, for example, via a NAS SM message.

[00146] At step 506', the SMF 214 may receive IP management capability of the network-side IP interface from the UPF 330.

[00147] At step 507, the SMF 214 may update IP configuration information of the device-side IP interface based on the IP management capability of the device-side IP interface if needed. The SMF 214 may update IP configuration information of the network-side IP interface based on the IP management capability of the network-side IP

interface if needed.

[00148] At step 508, the SMF 214 may transmit the IP address information to the device 310. In some embodiments, the SMF 214 may also transmit the IP configuration information. In some embodiments, the SMF 214 may transmit at least one of the IP address information or the IP configuration information via a NAS SM message.

[00149] For example, if the PDU session establishment request comprises the PCO value specific to the device-side IP interface, the SMF 214 may respond with that PCO value including IP prefix and/or IP configuration information for the device-side IP interface. As another example, if the device 310 provides a MAC address or IP interface ID of the device-side IP interface in the PCO, the SMF 214 may take them into account when determining an IPv6 address for the device-side IP interface.

[00150] In some embodiments, the SMF 214 may transmit at least one of the IP address information or the IP configuration information via a DHCP message. For example, the SMF 214 may allocate IPv4 address and/or IPv6 prefix for the device-side IP interface, construct a DHCP server message and send the allocated address/prefix to the device 310. The device 310 may pass the IP address/prefix to the device-side IP interface.

[00151] At step 508', the SMF 214 may determine IP address information of the network-side IP interface and transmit it to the UPF 330. In some embodiments, the SMF 214 may also transmit, to the UPF 330, the IP configuration information of the network-side IP interface. In some embodiments, the SMF 214 may transmit at least one of the IP address information or the IP configuration information of the network-side IP interface.

[00152] At step 509, the SMF 214 may transmit the IP address information of the external IP interfaces to the TSCTSF 217. In some embodiments, the SMF 214 may also transmit the IP configuration information of the external IP interfaces to the TSCTSF 217.

[00153] At step 510, the TSCTSF 217 may receive, from the DS-TT 311, IP management capability and IP configuration information of the device-side IP interface, for example, via a PMIC.

[00154] At step 510', the TSCTSF 217 may receive, from the NW-TT 331, IP management capability and IP configuration information of the network-side IP interface, for example, via a PMIC or UMIC. In some embodiments for reception via PMIC, the PMIC may carry information of one port or interface. In some embodiments for reception via UMIC,

the UMIC may carry information of one or more ports or interfaces.

[00155] At step 511, the TSCTSF 217 may learn the interface number and the IP address information corresponding to the PDU session for the device-side IP interface, and bind the interface number to the IP address information corresponding to the PDU session. In some embodiments, the TSCTSF 217 may also learn an interface number and IP address information for each external IP interface, and bind the interface number to the IP address information for each external IP interface. If IP address of the device associated with the external IP interface is known by the TSCTSF 217, the TSCTSF 217 may also include the IP address of the device in the binding information.

[00156] At step 512, the TSCTSF 217 may generate information of the DetNet node. The information may comprise the DetNet node ID, the interface number and the IP address information and/or the IP configuration information of IP interface(s) of the DetNet node. In some embodiments, the information of the DetNet node may comprise an interface number and IP address information of each external IP interface in a same DetNet node.

[00157] At step 513, the TSCTSF 217 may expose the information of the DetNet node to a controller (e.g., the DetNet controller 220). In some embodiments, the information of the DetNet node may be exchanged by any means such as YANG data models and NETCONF/RESTCONF protocols, the Path Computation Element Protocol, or MIB data models and SNMP. The present disclosure does not limit this aspect.

[00158] With the process 500, external IP interface management may also be achieved for an IP router node.

[00159] It is to be understood that Figs. 4 and 5 are merely examples and are not intended for limitation. The operations in the processes 400 and 500 may be implemented in any suitable combination.

EXAMPLE IMPLEMENTATION OF METHODS

[00160] Corresponding to the above processes, example embodiments of the present disclosure also provide methods of communication. Fig. 6 illustrates a flowchart of an example method 600 implemented at a device according to some embodiments of the present disclosure. For the purpose of discussion, the method 600 will be described with reference to Fig. 2.

[00161] At block 610, a device (for example, the UE/DS-TT module 211) transmits, to a

first core network element (for example, the SMF 214), an indication regarding a device-side IP interface of an IP router node.

[00162] In some embodiments, the UE/DS-TT module 211 may transmit the indication in a PDU establishment request. In some embodiments, the PDU establishment request may further comprise a PCO value indicating a configuration of the device-side IP interface.

[00163] In some embodiments, the UE/DS-TT module 211 may transmit the indication in a DHCP request. In some embodiments, the DHCP request may comprise an identifier specific to the device-side Internet Protocol interface as the indication.

[00164] At block 620, the UE/DS-TT module 211 receives, from the SMF 214 or a second core network element (for example, the TSCTSF 217), IP address information for the device-side IP interface. In some embodiments, the UE/DS-TT module 211 may receive the IP address information via a PMIC or a NAS SM message.

[00165] In some embodiments, the UE/DS-TT module 211 may transmit, to the SMF 214 or the TSCTSF 217, IP management capability of the device-side IP interface. In some embodiments, the UE/DS-TT module 211 may transmit the IP management capability via a PMIC or a NAS SM message. Then the UE/DS-TT module 211 may receive, from the SMF 214 or the TSCTSF 217, IP configuration information updated based on the IP management capability.

[00166] In this way, an external IP interface at a UE/DS-TT module can be managed.

[00167] Fig. 7 illustrates a flowchart of an example method 700 implemented at a core network element according to some embodiments of the present disclosure. For the purpose of discussion, the method 700 will be described with reference to Fig. 2.

[00168] At block 710, a first core network element (for example, the SMF 214) receives, from a device (for example, the UE/DS-TT module 211), an indication regarding a device-side IP interface of an IP router node.

[00169] In some embodiments, the SMF 214 may receive the indication in a PDU establishment request. In some embodiments, the PDU establishment request may further comprise a PCO value indicating a configuration of the device-side IP interface.

[00170] In some embodiments, the SMF 214 may transmit the indication in a DHCP request. In some embodiments, the DHCP request may comprise an identifier specific to the device-side Internet Protocol interface as the indication.

[00171] At block 720, the SMF 214 transmits, to the UE/DS-TT module 211, IP address information of the device-side IP interface. In some embodiments, the UE/DS-TT module 211 may transmit the IP address information via a NAS SM message.

[00172] In some embodiments, the SMF 214 may receive, from the UE/DS-TT module 211, IP management capability of the device-side IP interface. In some embodiments, the SMF 214 may receive the IP management capability via a PMIC or a NAS SM message. Then the SMF 214 may transmit, to the UE/DS-TT module 211, IP configuration information updated based on the IP management capability.

[00173] In some embodiments, the SMF 214 may transmit the IP address information to a second core network element (for example, the TSCTSF 217). In some embodiments, the SMF 214 may also transmit IP configuration information for the device-side IP interface to the TSCTSF 217.

[00174] In some embodiments, the SMF 214 may determine an interface number for the device-side IP interface and an identity of a PDU session associated with the device-side IP interface, and bind the interface number to the IP address information and the identity of the PDU session. In some embodiments, if IP address information of the device 310 is available, the SMF 214 may bind the interface number to the IP address information of the device 310, the IP address information of the device-side IP interface and the identity of the PDU session.

[00175] In this way, a core network element may be enabled as an owner for management of an external IP interface of an IP router node.

[00176] Fig. 8 illustrates a flowchart of an example method 800 implemented at a core network element according to some embodiments of the present disclosure. For the purpose of discussion, the method 800 will be described with reference to Fig. 2.

[00177] At block 810, a first core network element (for example, the SMF 214) receives, from a device (for example, the UE/DS-TT module 211), an indication regarding a device-side IP interface of an IP router node.

[00178] In some embodiments, the SMF 214 may receive the indication in a PDU establishment request. In some embodiments, the PDU establishment request may further comprise a PCO value indicating a configuration of the device-side IP interface.

[00179] In some embodiments, the SMF 214 may transmit the indication in a DHCP

request. In some embodiments, the DHCP request may comprise an identifier specific to the device-side Internet Protocol interface as the indication.

[00180] At block 820, the SMF 214 transmits, to a second core network element (for example, the TSCTSF 217), an interface number for the device-side IP interface and an identity of the IP router node for allocation of IP address information of the device-side IP interface.

[00181] In some embodiments, the SMF 214 may transmit, to a third core network element (for example, the UDM 216), a first request for obtaining at least one of IP address information or IP configuration information for the device-side IP interface. The SMF 214 may receive, from the UDM 216, the at least one of the IP address information or IP configuration information, and transmit it to the TSCTSF 217. In some embodiments, the SMF 214 may transmit the first request in response to receiving, from the TSCTSF 217, a second request for obtaining the at least one of IP address information or IP configuration information for the device-side IP interface.

[00182] In some embodiments, the first request and the second request comprise at least one of an identity of the device or a pair of an identity of the IP router node and an interface number of the device-side IP interface. In some embodiments, the SMF 214 may derive, from a GPSI of the device, the pair of the identity of the IP router node and the interface number of the device-side IP interface.

[00183] In some embodiments, the SMF 214 may receive, from the UE/DS-TT module 211, IP management capability of the device-side IP interface, and transmit the IP management capability of the device-side IP interface to the TSCTSF 217. Then the SMF 214 may receive, from the TSCTSF 217, IP configuration information updated based on the IP management capability.

[00184] In this way, a core network element may be enabled as a learner for management of an external IP interface of an IP router node.

[00185] Fig. 9 illustrates a flowchart of an example method 900 implemented at a core network element according to some embodiments of the present disclosure. For the purpose of discussion, the method 900 will be described with reference to Fig. 2.

[00186] At block 910, a second core network element (for example, the TSCTSF 217) receives, from a first core network element (for example, the SMF 214), an interface number for a device-side IP interface of an IP router node and an identity of the IP router

node, the interface number corresponding to a protocol data unit session.

[00187] At block 920, the TSCTSF 217 transmits, to a device (for example, the UE/DS-TT 210), IP address information for the device-side IP interface.

5 [00188] In some embodiments, the TSCTSF 217 may determine, from a preconfigured set of Internet Protocol address information for a set of device-side Internet Protocol interfaces, the Internet Protocol address information for the device-side Internet Protocol interface.

[00189] In some embodiments, the TSCTSF 217 may transmit, to the SMF 214 or to a third core network element (e.g., UDM 216), a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for the
10 device-side Internet Protocol interface. The TSCTSF 217 may receive the Internet Protocol address information from the SMF 214 or UDM 216.

[00190] In some embodiments, the request comprises at least one of an identity of the device or a pair of the identity of the Internet Protocol router node and the interface number of the device-side Internet Protocol interface.

15 [00191] In some embodiments, the TSCTSF 217 may receive, from a device (for example, UE/DS-TT module 211 or UPF/NW-TT module 213), Internet Protocol management capability of an external Internet Protocol interface via a port management information container, a user plane node management information container or a non-access-stratum message. The TSCTSF 217 may transmit, to the device, Internet Protocol configuration
20 information updated based on the Internet Protocol management capability via a port management information container, a user plane node management information container or a non-access-stratum message.

[00192] In some embodiments, the TSCTSF 217 may bind the interface number to the IP address information corresponding to the PDU session. In some embodiments, if IP
25 address information of the device 310 is available, the TSCTSF 217 may bind the interface number to the IP address information of the device-side IP interface corresponding to the PDU session and the IP address information of the device 310.

[00193] In some embodiments, the TSCTSF 217 may receive, from the UPF/NW-TT 213, an interface number of a network-side IP interface of the IP router node and at least one of
30 IP address information or IP configuration information of the network-side IP interface. The TSCTSF 217 may bind the interface number of the network-side IP interface to the at least one of the IP address information or IP configuration information of the network-side

IP interface.

[00194] In some embodiments, the TSCTSF 217 may generate information of the IP router node. The information comprises: the identity of the IP router node; the interface number and at least one of the IP address information or IP configuration information for the device-side IP interface; and the interface number and at least one of the IP address information or IP configuration information for the network-side IP interface. Then the TSCTSF 217 may expose the information of the IP router node to a controller.

[00195] In this way, a core network element may also be enabled as an owner for management of an external IP interface of an IP router node.

[00196] Fig. 10 illustrates a flowchart of an example method 1000 implemented at a core network element according to some embodiments of the present disclosure. For the purpose of discussion, the method 1000 will be described with reference to Fig. 2.

[00197] At block 1010, a second core network element (for example, the TSCTSF 217) receives, from a first core network element (for example, the SMF 214), Internet Protocol address information for a device-side IP interface of an IP router node, and an interface number of the device-side IP interface corresponding to a PDU session.

[00198] In some embodiments, if IP address information of the device 310 is available, the TSCTSF 217 may bind the interface number to the IP address information of the device-side IP interface corresponding to the PDU session and the IP address information of the device 310.

[00199] In some embodiments, the TSCTSF 217 may receive, from the UPF/NW-TT 213, an interface number of a network-side IP interface of the IP router node and at least one of IP address information or IP configuration information of the network-side IP interface. The TSCTSF 217 may bind the interface number of the network-side IP interface to the at least one of the IP address information or IP configuration information of the network-side IP interface.

[00200] At block 1011, the TSCTSF 217 generates information of the Internet Protocol router node. The information comprises: the identity of the IP router node; the interface number and at least one of the IP address information or IP configuration information for the device-side IP interface; and the interface number and at least one of the IP address information or IP configuration information for the network-side IP interface.

[00201] At block 1012, the TSCTSF 217 exposes the information of the IP router node to a controller.

[00202] In some embodiments, the TSCTSF 217 may receive, from a device (for example, UE/DS-TT module 211 or UPF/NW-TT module 213), at least one of Internet Protocol address information or Internet Protocol configuration information for an external IP interface via a port management information container, a user plane node management information container or a non-access-stratum message.

[00203] In this way, a core network element may also be enabled as a learner for management of an external IP interface of an IP router node.

[00204] Fig. 11 illustrates a flowchart of an example method 1100 implemented at a core network element according to some embodiments of the present disclosure. For the purpose of discussion, the method 1100 will be described with reference to Fig. 2.

[00205] At block 1110, a third core network element (for example, the UDM 216) receive, from a first core network element (for example, the SMF 214) or from a second core network element (for example, TSCTSF 217), a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for a device-side Internet Protocol interface of an Internet Protocol router node.

[00206] At block 1120, the UDM 216 transmits, to the SMF 214 or to the TSCTSF 217, the at least one of the Internet Protocol address information or Internet Protocol configuration information.

[00207] In some embodiments, the request comprises at least one of an identity of a device or a pair of an identity of the Internet Protocol router node and an interface number of the device-side Internet Protocol interface.

[00208] In some embodiments, the UDM 216 stores subscription information of a device in association with at least one of a pair of an identity of the Internet Protocol router node and an interface number of the device-side Internet Protocol interface, the Internet Protocol address information, or the Internet Protocol configuration information.

[00209] In this way, a core network element may support management of an external IP interface of an IP router node.

[00210] It is to be noted that the operations of the methods described above may correspond to that of the processes 400 and 500 described above, and thus other details are

not repeated here for concise.

EXAMPLE IMPLEMENTATION OF APPARATUS AND DEVICES

[00211] Example embodiments of the present disclosure also provide the corresponding apparatus. In some embodiments, an apparatus capable of performing one of the methods
5 600 to 1100 may comprise means for performing the respective steps of the one of the methods 600 to 1100. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00212] Fig. 12 is a simplified block diagram of a device 1200 that is suitable for implementing embodiments of the present disclosure. The device 1200 may be provided
10 to implement the communication device, for example the devices 310, the DS-TT 311, the NW-TT 331, or the core network elements as shown in Fig. 2. As shown, the device 1200 includes one or more processors 1210, one or more memories 1220 coupled to the processor 1210, and one or more communication modules 1240 coupled to the processor 1210.

[00213] The communication module 1240 is for bidirectional communications. The communication module 1240 has at least one antenna to facilitate communication. The communication interface may represent any interface that is necessary for communication with other network elements.

[00214] The processor 1210 may be of any type suitable to the local technical network and
20 may include one or more of the following: general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 1200 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00215] The memory 1220 may include one or more non-volatile memories and one or more volatile memories. Examples of the non-volatile memories include, but are not limited to, a Read Only Memory (ROM) 1224, an electrically programmable read only memory (EPROM), a flash memory, a hard disk, a compact disc (CD), a digital video disk (DVD), and other magnetic storage and/or optical storage. Examples of the volatile
30 memories include, but are not limited to, a random access memory (RAM) 1222 and other volatile memories that will not last in the power-down duration.

[00216] A computer program 1230 includes computer executable instructions that are

executed by the associated processor 1210. The program 1230 may be stored in the ROM 1220. The processor 1210 may perform any suitable actions and processing by loading the program 1230 into the RAM 1220.

[00217] The embodiments of the present disclosure may be implemented by means of the program 1230 so that the device 1200 may perform any process of the disclosure as discussed with reference to Figs. 4 to 11. The embodiments of the present disclosure may also be implemented by hardware or by a combination of software and hardware.

[00218] In some embodiments, the program 1230 may be tangibly contained in a computer readable medium which may be included in the device 1200 (such as in the memory 1220) or other storage devices that are accessible by the device 1200. The device 1200 may load the program 1230 from the computer readable medium to the RAM 1222 for execution. The computer readable medium may include any types of tangible non-volatile storage, such as ROM, EPROM, a flash memory, a hard disk, CD, DVD, and the like. Fig. 13 shows an example of the computer readable medium 1300 in form of CD or DVD. The computer readable medium has the program 1230 stored thereon.

[00219] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. While various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representations, it is to be understood that the block, apparatus, system, technique or method described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00220] The present disclosure also provides at least one computer program product tangibly stored on a non-transitory computer readable storage medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target real or virtual processor, to carry out the method 600 to 1100 as described above with reference to Figs. 6-11. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data

types. The functionality of the program modules may be combined or split between program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed device, program modules may be located in both local and remote storage media.

5 [00221] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. These program codes may be provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program codes, when executed by the processor or controller, cause the functions/operations specified in
10 the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[00222] In the context of the present disclosure, the computer program codes or related data may be carried by any suitable carrier to enable the device, apparatus or processor to
15 perform various processes and operations as described above. Examples of the carrier include a signal, computer readable medium, and the like.

[00223] The computer readable medium may be a computer readable signal medium or a computer readable storage medium. A computer readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor
20 system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the computer readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only
25 memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[00224] In summary, Embodiments of the present disclosure may provide the following solutions:

Clause 1. A device comprising:

30 at least one processor; and

at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at least one processor, cause the device to:

transmit, to a first core network element, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

5 receive, from the first core network element or a second core network element, Internet Protocol address information for the device-side Internet Protocol interface.

Clause 2. The device of Clause 1, wherein the device is caused to transmit the indication by:

10 transmitting the indication in a protocol data unit session establishment request; or
transmitting the indication in a dynamic host configuration protocol request.

Clause 3. The device of Clause 2, wherein the protocol data unit session establishment request further comprises a protocol configuration option value indicating a
15 configuration of the device-side Internet Protocol interface.

Clause 4. The device of Clause 2, wherein the dynamic host configuration protocol request comprises an identifier specific to the device-side Internet Protocol interface as the indication.

20

Clause 5. The device of Clause 1, wherein the device is further caused to:

transmit, to the first core network element or the second core network element, Internet Protocol management capability of the device-side Internet Protocol interface; and

receive, from the first core network element or the second core network element,
25 Internet Protocol configuration information updated based on the Internet Protocol management capability.

Clause 6. The device of Clause 5, wherein the device is caused to transmit the Internet Protocol management capability by:

transmitting the Internet Protocol management capability via a port management information container, a user plane node management information container or a non-access stratum session management message.

5 Clause 7. The device of Clause 1, wherein the device is caused to receive the Internet Protocol address information by:

receiving the Internet Protocol address information via a port management information container, a user plane node management information container or a non-access stratum session management message.

10

Clause 8. The device of Clause 1, wherein the device is a terminal device, the first core network element is a session management function, and the second core network element is a time sensitive communication and time synchronization function.

15 Clause 9. A first core network element comprising:

at least one processor; and

at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at least one processor, cause the first core network element to:

20 receive, from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

transmit, to the device, Internet Protocol address information of the device-side Internet Protocol interface.

25 Clause 10. The first core network element of Clause 9, wherein the first core network element is caused to receive the indication by:

receiving the indication in a protocol data unit session establishment request; or

receiving the indication in a dynamic host configuration protocol request.

Clause 11. The first core network element of Clause 9, wherein the first core network element is further caused to:

receive, from the device, Internet Protocol management capability of the device-side Internet Protocol interface; and

5 transmit, to the device, Internet Protocol configuration information updated based on the Internet Protocol management capability.

Clause 12. The first core network element of Clause 9, wherein the first core network element is further caused to:

10 transmit the Internet Protocol address information to a second core network element.

Clause 13. The first core network element of Clause 12, wherein the first core network element is further caused to:

15 transmit, to the second core network element, Internet Protocol configuration information for the device-side Internet Protocol interface.

Clause 14. The first core network element of Clause 9, wherein the first core network element is further caused to:

20 determine an interface number for the device-side Internet Protocol interface and an identity of a protocol data unit session associated with the device-side Internet Protocol interface; and

bind the interface number to the Internet Protocol address information and the identity of the protocol data unit session.

25

Clause 15. A first core network element comprising:

at least one processor; and

at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at

least one processor, cause the first core network element to:

receive, from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

transmit, to a second core network element, an interface number for the device-side
5 Internet Protocol interface and an identity of the Internet Protocol router node for allocation of Internet Protocol address information of the device-side Internet Protocol interface.

Clause 16. The first core network element of Clause 15, wherein the first core network element is further caused to:

10 transmit, to a third core network element, a first request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for the device-side Internet Protocol interface;

receive, from the third core network element, the at least one of the Internet Protocol address information or Internet Protocol configuration information; and

15 transmit, to the second core network element, the at least one of the Internet Protocol address information or Internet Protocol configuration information.

Clause 17. The first core network element of Clause 16, wherein the first core network element is caused to transmit the first request by:

20 transmitting the first request in response to receiving, from the second core network element, a second request for obtaining the at least one of Internet Protocol address information or Internet Protocol configuration information for the device-side Internet Protocol interface.

25 Clause 18. The first core network element of Clause 17, wherein the first request and the second request comprise at least one of an identity of the device or a pair of an identity of the Internet Protocol router node and an interface number of the device-side Internet Protocol interface.

30 Clause 19. The first core network element of Clause 18, wherein the first core

network element is further caused to:

derive, from a generic public subscription identifier of the device, the pair of the identity of the Internet Protocol router node and the interface number of the device-side Internet Protocol interface.

5

Clause 20. The first core network element of Clause 15, wherein the first core network element is further caused to:

receive, from the device, Internet Protocol management capability of the device-side Internet Protocol interface;

10 transmit the Internet Protocol management capability of the device-side Internet Protocol interface to the second core network element; and

receive, from the second core network element, Internet Protocol configuration information updated based on the Internet Protocol management capability.

15 Clause 21. A second core network element comprising:

at least one processor; and

at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at least one processor, cause the second core network element to:

20 receive, from a first core network element, an interface number for a device-side Internet Protocol interface of an Internet Protocol router node and an identity of the Internet Protocol router node, the interface number corresponding to a protocol data unit session; and

transmit, to a device, Internet Protocol address information for the device-side
25 Internet Protocol interface.

Clause 22. The second core network element of Clause 21, wherein the second core network element is further caused to:

determine, from a preconfigured set of Internet Protocol address information for a

set of device-side Internet Protocol interfaces, the Internet Protocol address information for the device-side Internet Protocol interface.

Clause 23. The second core network element of Clause 22, wherein the second core
5 network element is further caused to:

transmit, to the first core network element or to a third core network element, a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for the device-side Internet Protocol interface; and

receive the Internet Protocol address information from the first core network
10 element or the third core network element.

Clause 24. The second core network element of Clause 23, wherein the request comprises at least one of an identity of the device or a pair of the identity of the Internet Protocol router node and the interface number of the device-side Internet Protocol interface.

Clause 25. The second core network element of Clause 21, wherein the second core
15 network element is further caused to:

receive, from a device, Internet Protocol management capability of an external Internet Protocol interface via a port management information container, a user plane node
20 management information container or a non-access-stratum message; and

transmit, to the device, Internet Protocol configuration information updated based on the Internet Protocol management capability via a port management information container, a user plane node management information container or a non-access-stratum message.

Clause 26. The second core network element of Clause 21, wherein the second core
25 network element is further caused to:

bind the interface number to the Internet Protocol address information corresponding to the protocol data unit session.

Clause 27. The second core network element of Clause 21, wherein the second core network element is further caused to:

generate information of the Internet Protocol router node, the information comprising the identity of the Internet Protocol router node, the interface number and the Internet Protocol address information; and

expose the information of the Internet Protocol router node to a controller.

Clause 28. A second core network element comprising:

at least one processor; and

at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at least one processor, cause the second core network element to:

receive, from a first core network element, Internet Protocol address information for a device-side Internet Protocol interface of an Internet Protocol router node and an interface number of the device-side Internet Protocol interface corresponding to a protocol data unit session;

generate information of the Internet Protocol router node, the information comprising the identity of the Internet Protocol router node, the interface number and the Internet Protocol address information; and

expose the information of the Internet Protocol router node to a controller.

Clause 29. The second core network element of Clause 28, wherein the second core network element is further caused to:

receive, from a device, at least one of Internet Protocol address information or Internet Protocol configuration information for an external IP interface via a port management information container, a user plane node management information container or a non-access-stratum message.

Clause 30. A third core network element comprising:

at least one processor; and

at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at least one processor, cause the third core network element to:

5 receive, from a first core network element or from a second core network element, a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for a device-side Internet Protocol interface of an Internet Protocol router node; and

10 transmit, to the first core network element or to the second core network element, the at least one of the Internet Protocol address information or Internet Protocol configuration information.

Clause 31. The third core network element of Clause 30, wherein the request comprises at least one of an identity of a device or a pair of an identity of the Internet Protocol router node and an interface number of the device-side Internet Protocol interface.

Clause 32. The third core network element of Clause 30, wherein the third core network element is further caused to:

20 store subscription information of a device in association with at least one of a pair of an identity of the Internet Protocol router node and an interface number of the device-side Internet Protocol interface, the Internet Protocol address information, or the Internet Protocol configuration information.

Clause 33. A method of communication, comprising:

25 transmitting, at a device and to a first core network element, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

receiving, from the first core network element or a second core network element, Internet Protocol address information for the device-side Internet Protocol interface.

30 Clause 34. A method of communication, comprising:

receiving, at a first core network element and from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

transmitting, to the device, Internet Protocol address information of the device-side Internet Protocol interface.

5

Clause 35. A method of communication, comprising:

receiving, at a first core network element and from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

transmitting, to a second core network element, an interface number for the device-side Internet Protocol interface, an identity of the Internet Protocol router node and an identity of a protocol data unit session for the second core network element to allocate Internet Protocol address information of the device-side Internet Protocol interface.

10

Clause 36. A method of communication, comprising:

receiving, at a second core network element and from a first core network element, an interface number for a device-side Internet Protocol interface of an Internet Protocol router node and an identity of the Internet Protocol router node, the interface number corresponding to a protocol data unit session; and

15

transmitting, to the first core network element, Internet Protocol address information for the device-side Internet Protocol interface.

20

Clause 37. A method of communication, comprising:

receiving, at a second core network element and from a first core network element, Internet Protocol address information for a device-side Internet Protocol interface of an Internet Protocol router node and an interface number of the device-side Internet Protocol interface corresponding to a protocol data unit session;

25

generating information of the Internet Protocol router node, the information comprising the identity of the Internet Protocol router node, the interface number and the Internet Protocol address information; and

exposing the information of the Internet Protocol router node to a controller.

30

Clause 38. A method of communication, comprising:

receiving, at a third core network element and from a first core network element or from a second core network element via the first core network element, a request for
5 obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for a device-side Internet Protocol interface of an Internet Protocol router node; and

transmitting, to the first core network element or to the second core network element via the first core network element, the at least one of the Internet Protocol address
10 information or Internet Protocol configuration information.

Clause 39. An apparatus of communication, comprising:

means for transmitting, at a device and to a first core network element, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

15 means for receiving, from the first core network element or a second core network element, Internet Protocol address information for the device-side Internet Protocol interface.

Clause 40. An apparatus of communication, comprising:

20 means for receiving, at a first core network element and from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

means for transmitting, to the device, Internet Protocol address information of the device-side Internet Protocol interface.

25 Clause 41. An apparatus of communication, comprising:

means for receiving, at a first core network element and from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

means for transmitting, to a second core network element, an interface number for the device-side Internet Protocol interface, an identity of the Internet Protocol router node
30 and an identity of a protocol data unit session for the second core network element to

allocate Internet Protocol address information of the device-side Internet Protocol interface.

Clause 42. An apparatus of communication, comprising:

means for receiving, at a second core network element and from a first core network
5 element, an interface number for a device-side Internet Protocol interface of an Internet
Protocol router node and an identity of the Internet Protocol router node, the interface
number corresponding to a protocol data unit session; and

means for transmitting, to the first core network element, Internet Protocol address
information for the device-side Internet Protocol interface.

10

Clause 43. An apparatus of communication, comprising:

means for receiving, at a second core network element and from a first core network
element, Internet Protocol address information for a device-side Internet Protocol interface
of an Internet Protocol router node and an interface number of the device-side Internet
15 Protocol interface corresponding to a protocol data unit session;

means for generating information of the Internet Protocol router node, the
information comprising the identity of the Internet Protocol router node, the interface
number and the Internet Protocol address information; and

means for exposing the information of the Internet Protocol router node to a
20 controller.

Clause 44. An apparatus of communication, comprising:

means for receiving, at a third core network element and from a first core network
element or from a second core network element via the first core network element, a
25 request for obtaining at least one of Internet Protocol address information or Internet
Protocol configuration information for a device-side Internet Protocol interface of an
Internet Protocol router node; and

means for transmitting, to the first core network element or to the second core
network element via the first core network element, the at least one of the Internet Protocol
30 address information or Internet Protocol configuration information.

Clause 45. A non-transitory computer readable medium comprising program instructions for causing an apparatus to perform the method according to any of Claims 33 to 38.

5 [00225] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in
10 the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather as descriptions of features that may be specific to particular embodiments. Certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment may also be implemented
15 in multiple embodiments separately or in any suitable sub-combination.

[00226] Although the present disclosure has been described in languages specific to structural features and/or methodological acts, it is to be understood that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are
20 disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. A device comprising:

at least one processor; and

at least one memory including computer program code,

5 the at least one memory and the computer program code configured to, with the at least one processor, cause the device to:

transmit, to a first core network element, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

10 receive, from the first core network element or a second core network element, Internet Protocol address information for the device-side Internet Protocol interface.

2. The device of claim 1, wherein the device is caused to transmit the indication by: transmitting the indication in a protocol data unit session establishment request; or transmitting the indication in a dynamic host configuration protocol request.

15

3. The device of claim 2, wherein the protocol data unit session establishment request further comprises a protocol configuration option value indicating a configuration of the device-side Internet Protocol interface.

20

4. The device of claim 2, wherein the dynamic host configuration protocol request comprises an identifier specific to the device-side Internet Protocol interface as the indication.

5. The device of claim 1, wherein the device is further caused to:

25

transmit, to the first core network element or the second core network element, Internet Protocol management capability of the device-side Internet Protocol interface; and

receive, from the first core network element or the second core network element, Internet Protocol configuration information updated based on the Internet Protocol management capability.

30

6. The device of claim 5, wherein the device is caused to transmit the Internet Protocol management capability by transmitting the Internet Protocol management capability via a port management information container, a user plane node management

information container or a non-access stratum session management message; and

wherein the device is caused to receive the Internet Protocol configuration information by receiving the Internet Protocol configuration information via a port management information container, a user plane node management information container
5 or a non-access stratum session management message.

7. The device of claim 1, wherein the device is caused to receive the Internet Protocol address information by:

receiving the Internet Protocol address information via a port management
10 information container, a user plane node management information container or a non-access stratum session management message.

8. The device of claim 1, wherein the device is a terminal device or a terminal device with a device-side time-sensitive networking translator, the first core network
15 element is a session management function, and the second core network element is a time sensitive communication and time synchronization function.

9. A first core network element comprising:

at least one processor; and

20 at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at least one processor, cause the first core network element to:

receive, from a device, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

25 transmit, to the device, Internet Protocol address information of the device-side Internet Protocol interface.

10. The first core network element of claim 9, wherein the first core network element is caused to receive the indication by:

30 receiving the indication in a protocol data unit session establishment request; or

receiving the indication in a dynamic host configuration protocol request.

11. The first core network element of claim 9, wherein the first core network element is further caused to:

receive, from the device, Internet Protocol management capability of the device-side Internet Protocol interface; and

transmit, to the device, Internet Protocol configuration information updated based on the Internet Protocol management capability.

5

12. The first core network element of claim 9, wherein the first core network element is further caused to:

transmit the Internet Protocol address information to a second core network element.

10

13. The first core network element of claim 12, wherein the first core network element is further caused to:

transmit, to the second core network element, Internet Protocol configuration information for the device-side Internet Protocol interface.

15

14. The first core network element of claim 9, wherein the first core network element is further caused to:

determine an interface number for the device-side Internet Protocol interface and an identity of a protocol data unit session associated with the device-side Internet Protocol interface; and

20

bind the interface number to the Internet Protocol address information and the identity of the protocol data unit session.

15. The first core network element of claim 14, wherein the first core network element is caused to bind the interface number by:

25

in accordance with a determination that Internet Protocol address information of the device is available, binding the interface number to the Internet Protocol address information of the device-side Internet Protocol interface, the Internet Protocol address information of the device, and the identity of the protocol data unit session associated to the interface number.

30

16. A second core network element comprising:

at least one processor; and

at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at

least one processor, cause the second core network element to:

receive, from a first core network element, an interface number for a device-side Internet Protocol interface of an Internet Protocol router node and an identity of the Internet Protocol router node, the interface number corresponding to a protocol data unit session;

5 and

transmit, to a device, Internet Protocol address information for the device-side Internet Protocol interface.

10 17. The second core network element of claim 16, wherein the second core network element is further caused to:

determine, from a preconfigured set of Internet Protocol address information for a set of device-side Internet Protocol interfaces, the Internet Protocol address information for the device-side Internet Protocol interface.

15 18. The second core network element of claim 16, wherein the second core network element is further caused to:

transmit, to the first core network element or to a third core network element, a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for the device-side Internet Protocol interface; and

20 receive the Internet Protocol address information from the first core network element or the third core network element.

19. The second core network element of claim 18, wherein the request comprises at least one of an identity of the device or a pair of the identity of the Internet Protocol router node and the interface number of the device-side Internet Protocol interface.

20. The second core network element of claim 16, wherein the second core network element is further caused to:

30 receive, from the device, Internet Protocol management capability of the device-side Internet Protocol interface via a port management information container, a user plane node management information container or a non-access-stratum message; and

transmit, to the device, Internet Protocol configuration information updated based on the Internet Protocol management capability via a port management information container, a user plane node management information container or a non-access-stratum

message.

21. The second core network element of claim 16, wherein the second core network element is further caused to:

5 bind the interface number to the Internet Protocol address information corresponding to the protocol data unit session.

22. The second core network element of claim 21, wherein the second core network element is caused to bind the interface number by:

10 in accordance with a determination that Internet Protocol address information of the device is available, binding the interface number to the Internet Protocol address information of the device-side Internet Protocol interface and the Internet Protocol address information of the device.

15 23. The second core network element of claim 21, wherein the second core network element is further caused to:

 receive, from a further device, an interface number of a network-side Internet Protocol interface of the Internet Protocol router node, and at least one of Internet Protocol address information or Internet Protocol configuration information of the network-side
20 Internet Protocol interface; and

 bind the interface number of the network-side Internet Protocol interface to the at least one of the Internet Protocol address information or Internet Protocol configuration information of the network-side Internet Protocol interface.

25 24. The second core network element of claim 23, wherein the second core network element is further caused to:

 generate information of the Internet Protocol router node comprising:

 the identity of the Internet Protocol router node,

 the interface number and at least one of the Internet Protocol address
30 information or Internet Protocol configuration information for the device-side Internet Protocol interface, and

 the interface number and at least one of the Internet Protocol address information or Internet Protocol configuration information for the network-side Internet Protocol interface; and

expose the information of the Internet Protocol router node to a controller.

25. A third core network element comprising:

at least one processor; and

5 at least one memory including computer program code,

the at least one memory and the computer program code configured to, with the at least one processor, cause the third core network element to:

10 receive, from a first core network element or from a second core network element, a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for a device-side Internet Protocol interface of an Internet Protocol router node; and

transmit, to the first core network element or to the second core network element, the at least one of the Internet Protocol address information or Internet Protocol configuration information.

15

26. The third core network element of claim 25, wherein the request comprises at least one of an identity of a device or a pair of an identity of the Internet Protocol router node and an interface number of the device-side Internet Protocol interface.

20

27. The third core network element of claim 25, wherein the third core network element is further caused to:

25 store subscription information of a device in association with at least one of a pair of an identity of the Internet Protocol router node and an interface number of the device-side Internet Protocol interface, the Internet Protocol address information, or the Internet Protocol configuration information.

28. A method of communication comprising:

transmitting, at a device and to a first core network element, an indication regarding a device-side Internet Protocol interface of an Internet Protocol router node; and

30 receiving, from the first core network element or a second core network element, Internet Protocol address information for the device-side Internet Protocol interface.

29. The method of claim 28, wherein transmitting the indication comprises:

transmitting the indication in a protocol data unit session establishment request; or

transmitting the indication in a dynamic host configuration protocol request.

30. The method of claim 28, further comprising:

transmitting, to the first core network element or the second core network element,

5 Internet Protocol management capability of the device-side Internet Protocol interface; and

receiving, from the first core network element or the second core network element,
Internet Protocol configuration information updated based on the Internet Protocol
management capability.

10 31. The method of claim 30, wherein transmitting the Internet Protocol management
capability comprises transmitting the Internet Protocol management capability via a port
management information container, a user plane node management information container
or a non-access stratum session management message; and

wherein receiving the Internet Protocol configuration information comprises
15 receiving the Internet Protocol configuration information via a port management
information container, a user plane node management information container or a non-access
stratum session management message.

20 32. The method of claim 28, wherein receiving the Internet Protocol address
information comprises:

receiving the Internet Protocol address information via a port management
information container, a user plane node management information container or a non-access
stratum session management message.

25 33. A method of communication comprising:

receiving, at a first core network element and from a device, an indication regarding
a device-side Internet Protocol interface of an Internet Protocol router node; and

transmitting, to the device, Internet Protocol address information of the device-side
Internet Protocol interface.

30

34. The method of claim 33, wherein receiving the indication comprises:

receiving the indication in a protocol data unit session establishment request; or

receiving the indication in a dynamic host configuration protocol request.

35. The method of claim 33, further comprising:

receiving, from the device, Internet Protocol management capability of the device-side Internet Protocol interface; and

transmitting, to the device, Internet Protocol configuration information updated
5 based on the Internet Protocol management capability.

36. The method of claim 33, further comprising:

transmitting the Internet Protocol address information to a second core network element.

10

37. A method of communication, comprising:

receiving, at a second core network element and from a first core network element, an interface number for a device-side Internet Protocol interface of an Internet Protocol router node and an identity of the Internet Protocol router node, the interface number
15 corresponding to a protocol data unit session; and

transmitting, to a device, Internet Protocol address information for the device-side Internet Protocol interface.

38. The method of claim 37, further comprising:

determining, from a preconfigured set of Internet Protocol address information for a set of device-side Internet Protocol interfaces, the Internet Protocol address information for the device-side Internet Protocol interface.

20

39. The method of claim 37, further comprising:

transmitting, to the first core network element or to a third core network element, a request for obtaining at least one of Internet Protocol address information or Internet Protocol configuration information for the device-side Internet Protocol interface; and

25

receiving the Internet Protocol address information from the first core network element or the third core network element.

30

40. The method of claim 39, wherein the request comprises at least one of an identity of the device or a pair of the identity of the Internet Protocol router node and the interface number of the device-side Internet Protocol interface.

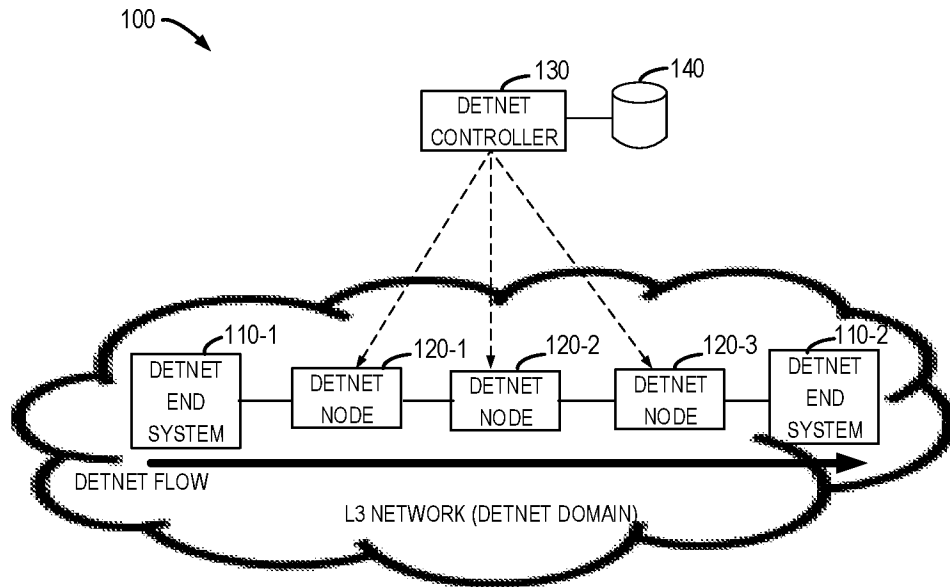


Fig. 1

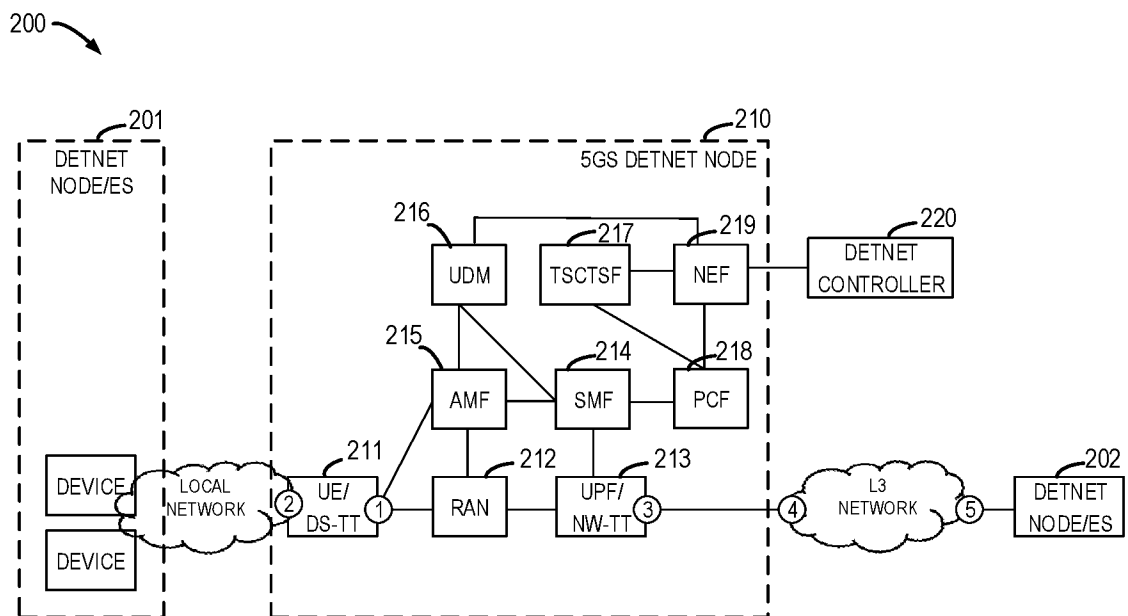


Fig. 2

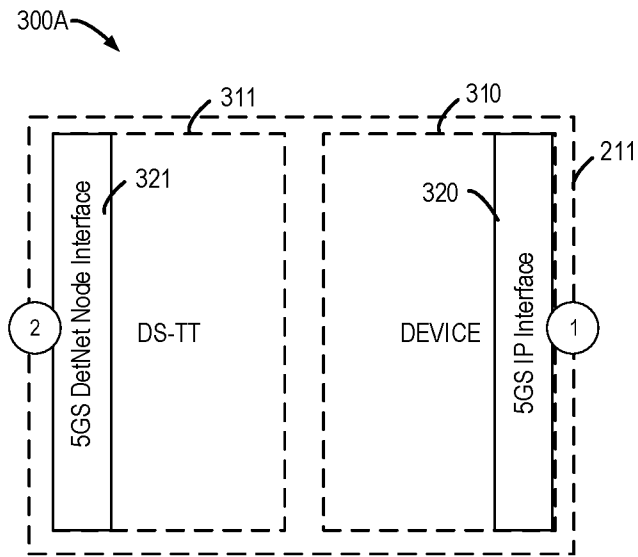


Fig. 3A

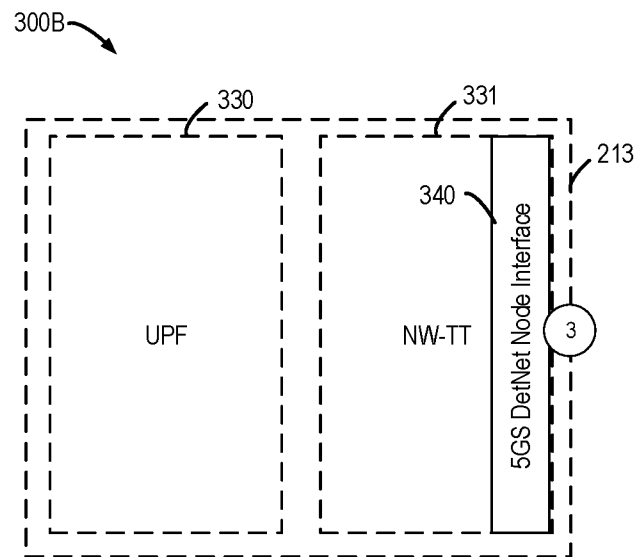


Fig. 3B

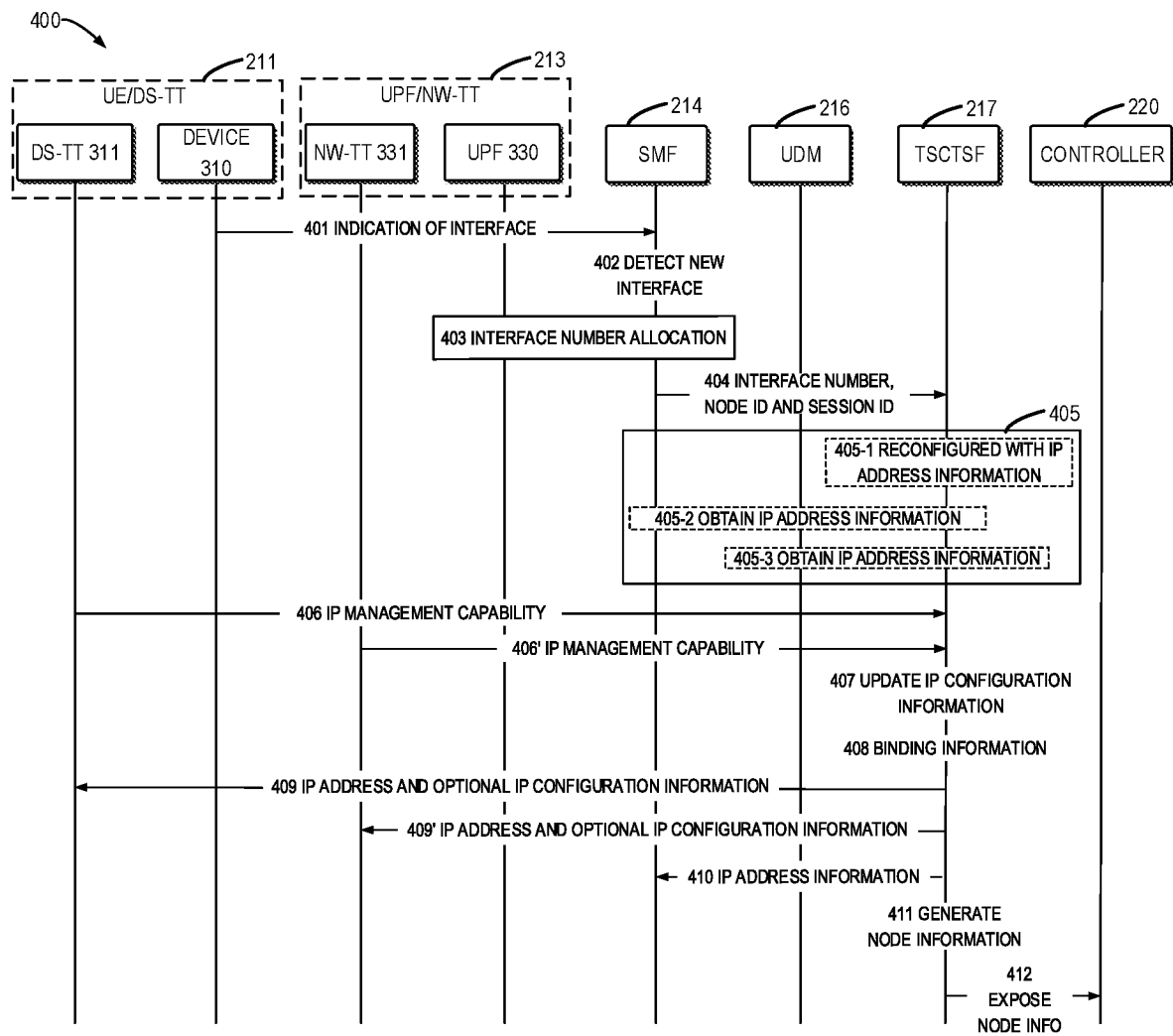


Fig. 4

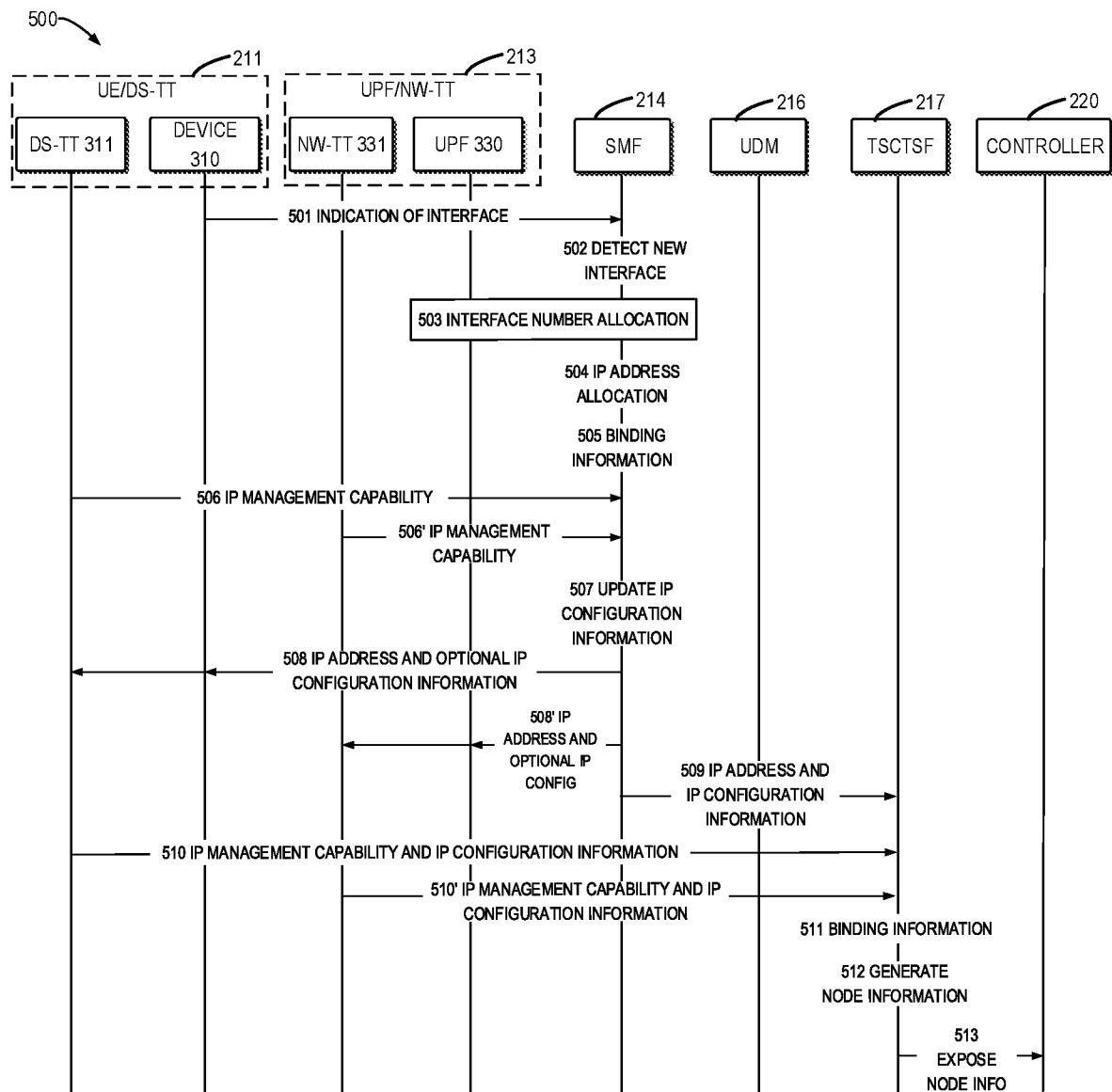


Fig. 5

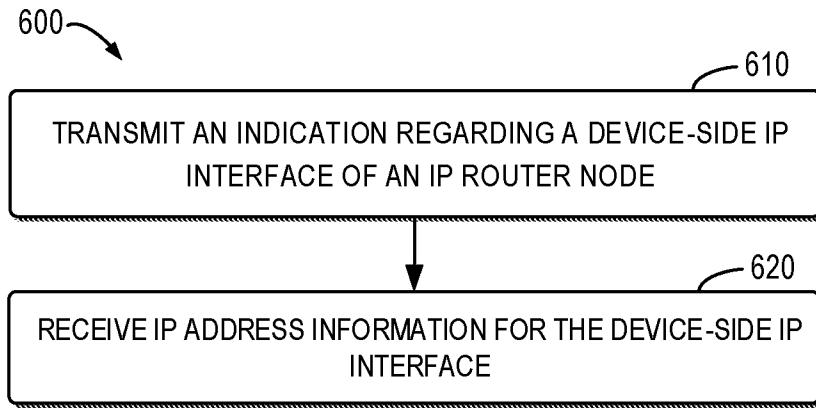


Fig. 6

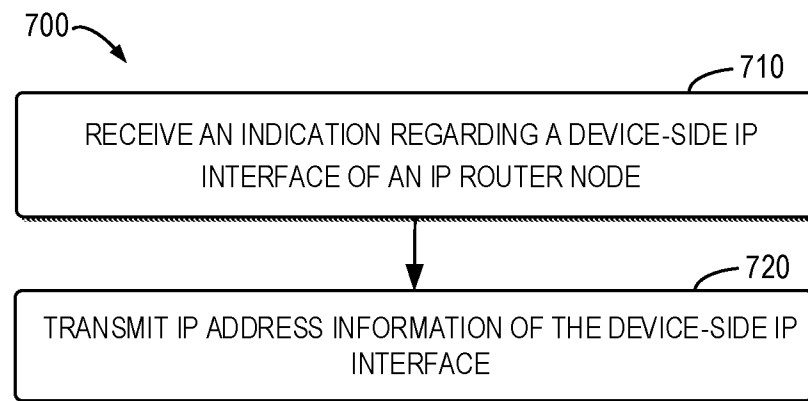


Fig. 7

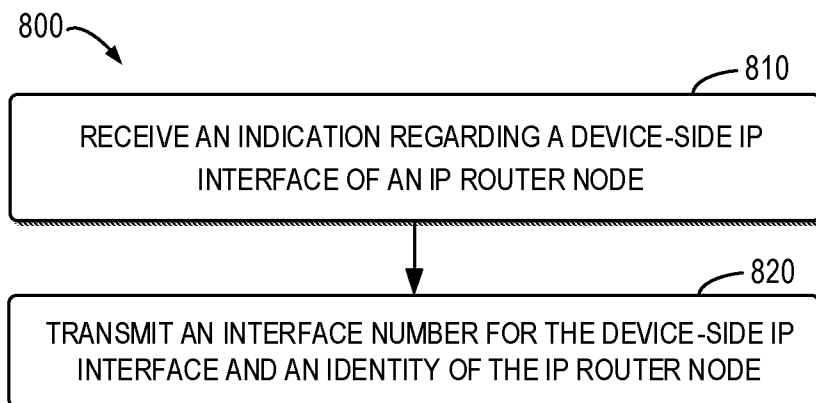


Fig. 8

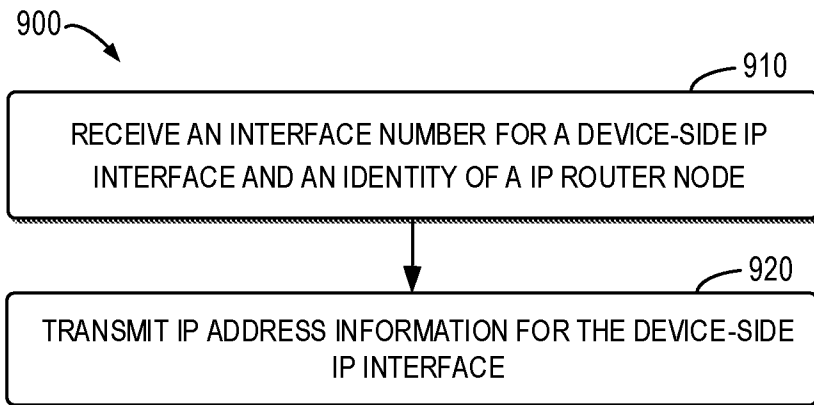


Fig. 9

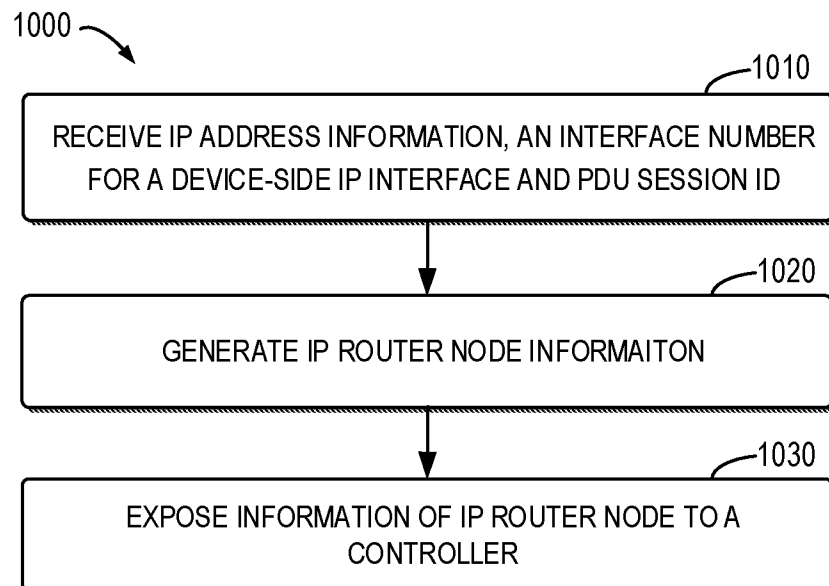


Fig. 10

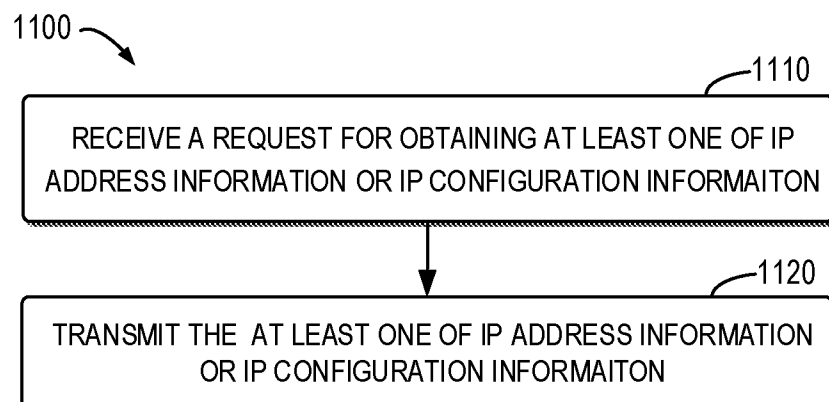


Fig. 11

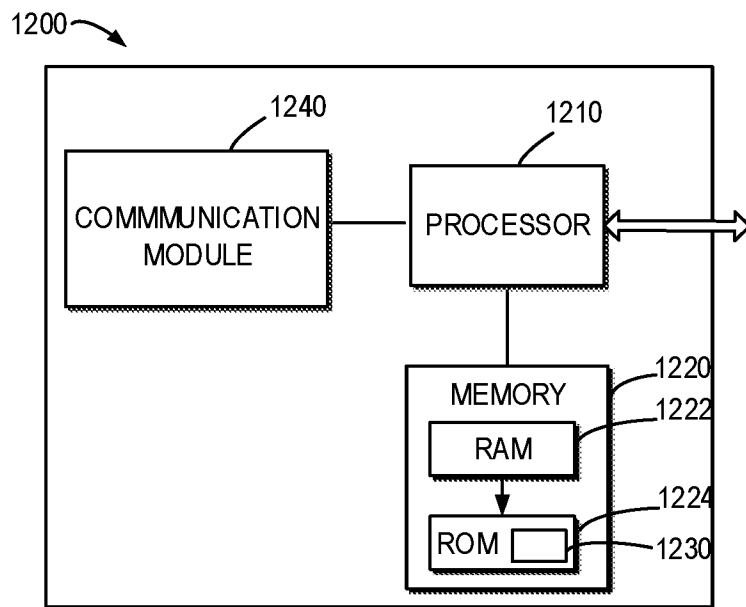


Fig. 12

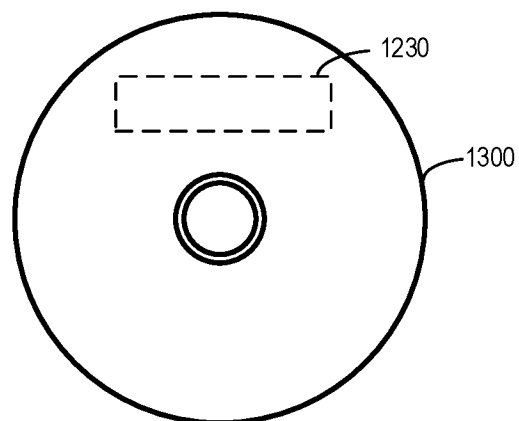


Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/091030

A. CLASSIFICATION OF SUBJECT MATTER

H04W 92/02(2009.01)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)

H04W; H04L

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

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

CNKI,CNPAT,WPI,EPODOC,3GPP: DetNet, device-side, IP, DS-TT, internet protocol, interface, TSN, 5GC, 5GS, rout+, indication, core network, UE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2022020020 A1 (INTEL CORPORATION) 27 January 2022 (2022-01-27) description, paragraphs [0021]-[0155]	1-40
A	US 2022030530 A1 (TELEFONAKTIEBOLAGET LM ERICSSON PUBL) 27 January 2022 (2022-01-27) the whole document	1-40
A	US 2020351973 A1 (NOKIA TECHNOLOGIES OY) 05 November 2020 (2020-11-05) the whole document	1-40
A	ZTE. "RFCs related to DHCPv6 are obsoleted by RFC 8415" 3GPP TSG-CT WG1 Meeting #126-e C1-205904, 23 October 2020 (2020-10-23), the whole document	1-40
A	CN 105612508 A (HUAWEI TECHNOLOGIES CO., LTD.) 25 May 2016 (2016-05-25) the whole document	1-40

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"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

08 December 2022

Date of mailing of the international search report

19 December 2022

Name and mailing address of the ISA/CN

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Telephone No. 86-(10)-53961731

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2022/091030

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2022020020	A1	27 January 2022	None			
US	2022030530	A1	27 January 2022	WO	2020111994	A1	04 June 2020
				EP	3888275	A1	06 October 2021
				TW	202029720	A	01 August 2020
US	2020351973	A1	05 November 2020	CN	114073043	A	18 February 2022
				WO	2020224958	A1	12 November 2020
				EP	3963840	A1	09 March 2022
				IN	202147055360	A	10 December 2021
CN	105612508	A	25 May 2016	US	2015103780	A1	16 April 2015
				EP	3055782	A1	17 August 2016
				WO	2015054589	A1	16 April 2015