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(54) **INFORMATION PROCESSING DEVICE, INFORMATION PROCESSING METHOD, TERMINAL DEVICE, AND SYSTEM**

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(57) **ABSTRACT**

An information processing device of the present disclosure includes a control unit. The control unit acquires first information regarding a terminal device from a core network (CN) via a service based interface (SBI). The control unit acquires second information including at least one of measurement information measured based on the first information or terminal-related information acquired from the terminal device directly or via the SBI. The control unit specifies the terminal device from the second information or by associating the first information and the second information with each other. The control unit notifies a client device of at least one of the first information or the second information in association with the specified terminal device.

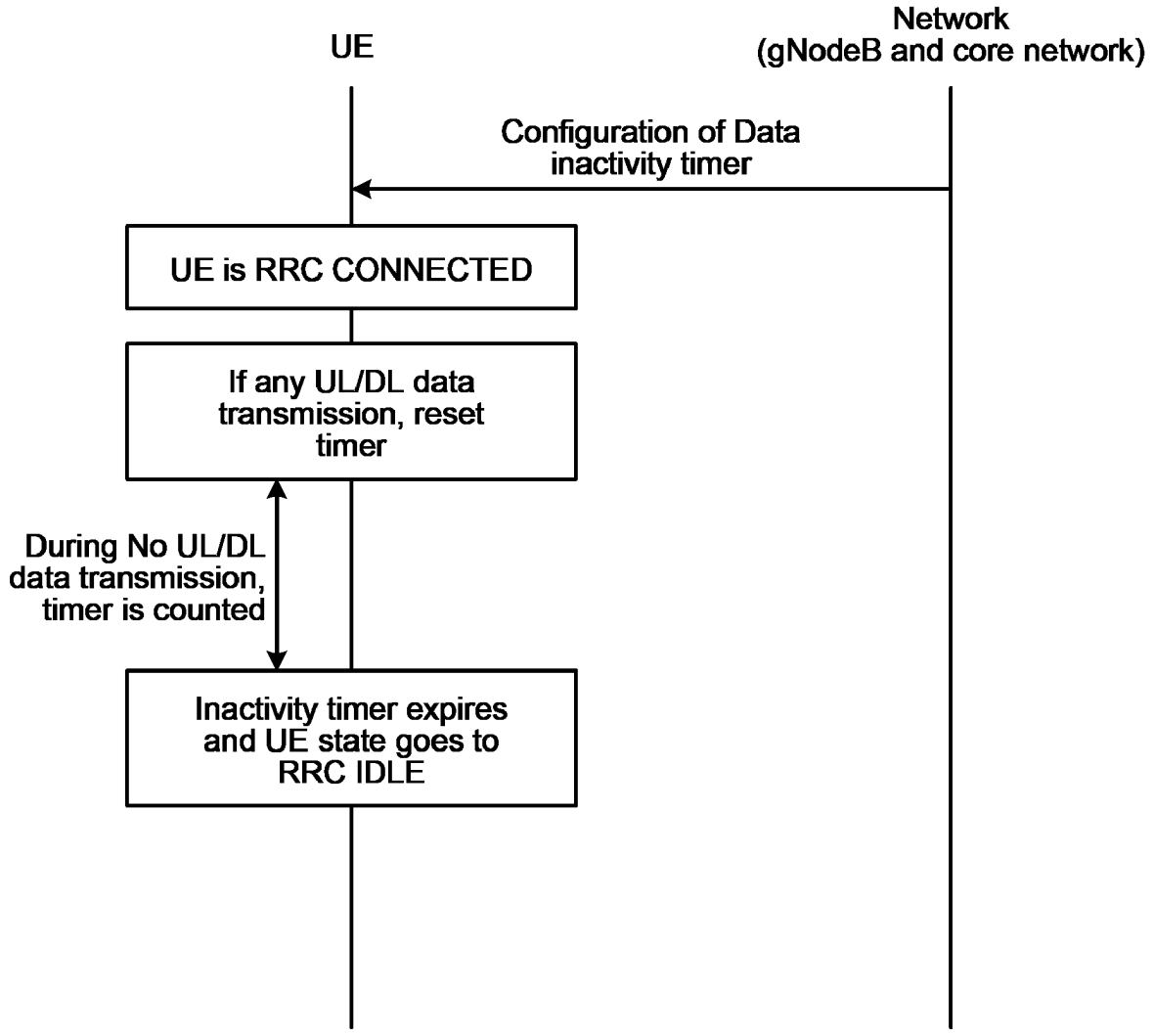


FIG.1

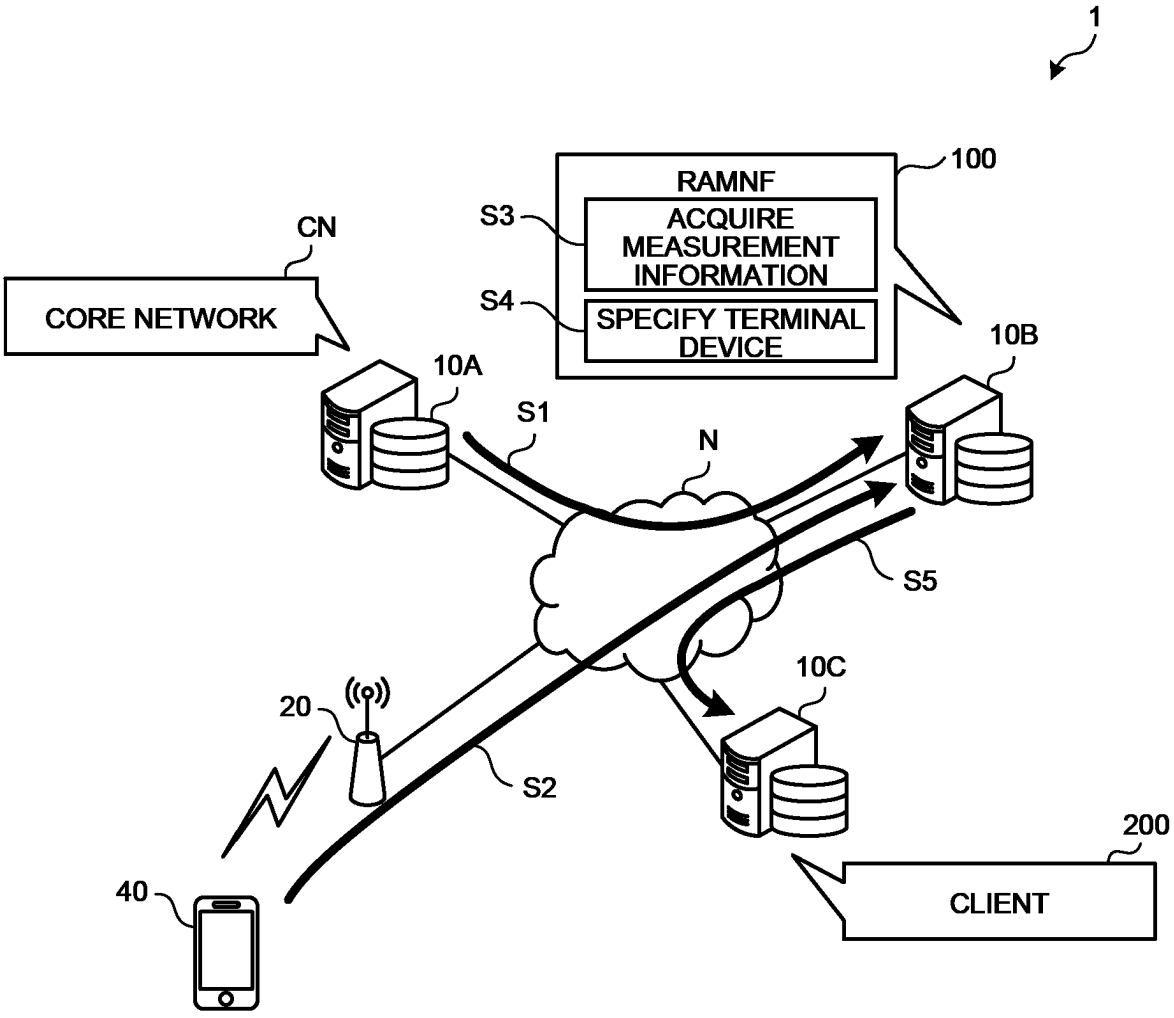

1
100
RAMNF
S3
ACQUIRE MEASUREMENT INFORMATION
S4
SPECIFY TERMINAL DEVICE
CN
CORE NETWORK
10A
10B
S1
N
S5
10C
20
S2
200
CLIENT
40

FIG.2

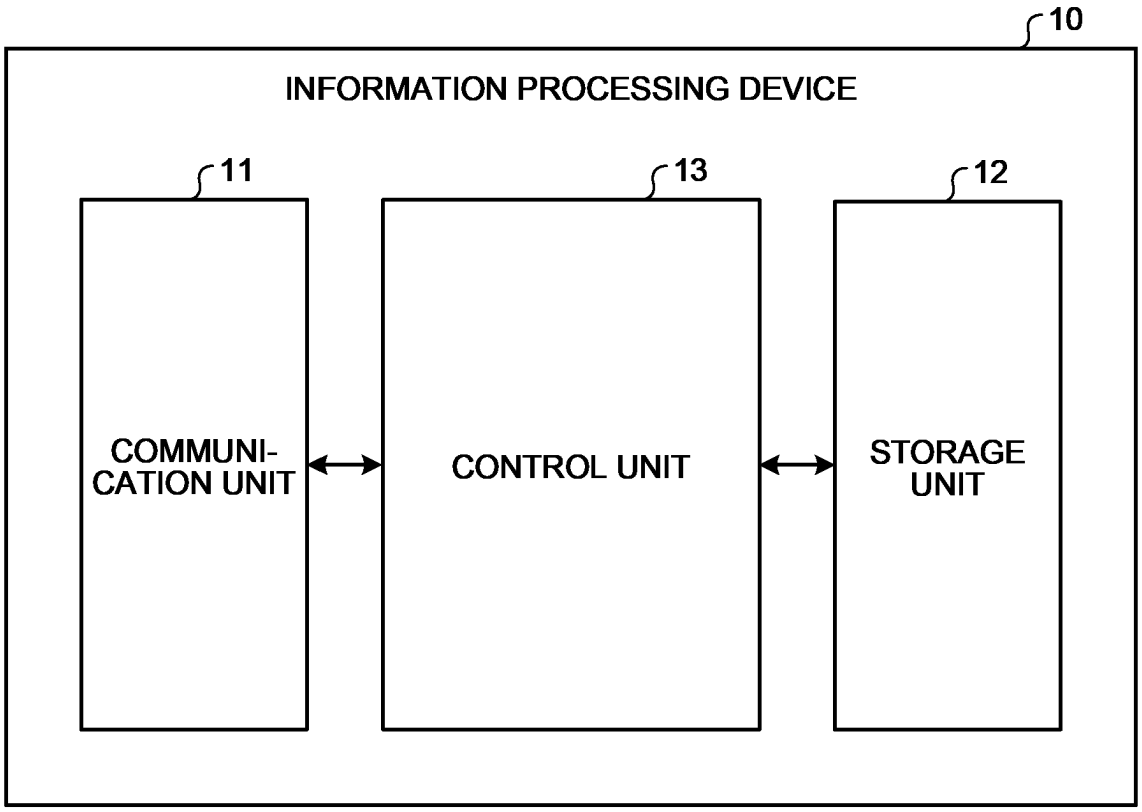

10
INFORMATION PROCESSING DEVICE
11
13
12
COMMUNI-
CATION UNIT
CONTROL UNIT
STORAGE
UNIT

FIG.3

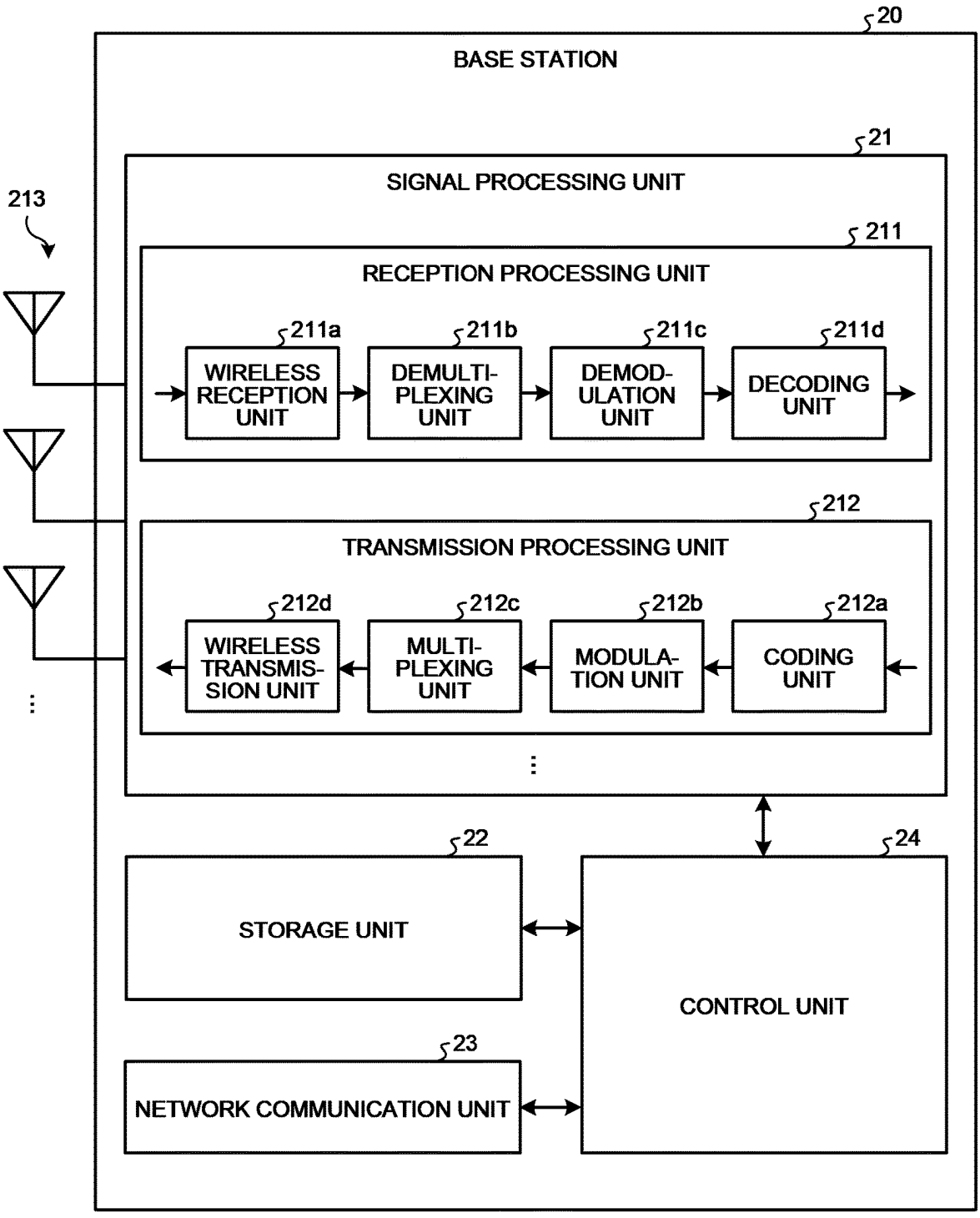

20
BASE STATION
21
SIGNAL PROCESSING UNIT
213
211
RECEPTION PROCESSING UNIT
211a
WIRELESS RECEPTION UNIT
211b
DEMULTI-PLEXING UNIT
211c
DEMOD-ULATION UNIT
211d
DECODING UNIT
212
TRANSMISSION PROCESSING UNIT
212d
WIRELESS TRANSMIS-SION UNIT
212c
MULTI-PLEXING UNIT
212b
MODULA-TION UNIT
212a
CODING UNIT
22
STORAGE UNIT
24
CONTROL UNIT
23
NETWORK COMMUNICATION UNIT

FIG.4

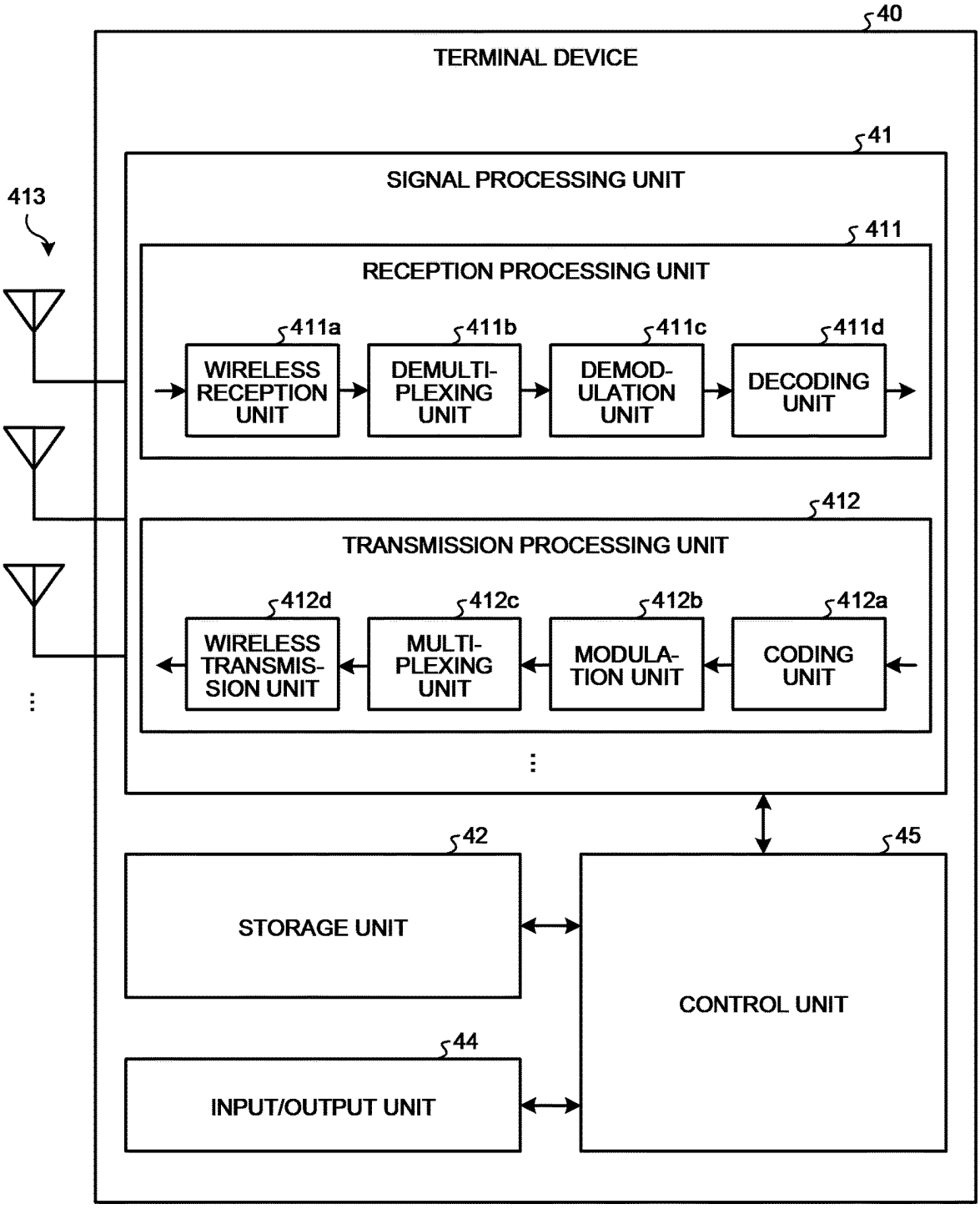

40
TERMINAL DEVICE
41
SIGNAL PROCESSING UNIT
413
411
RECEPTION PROCESSING UNIT
411a
WIRELESS RECEPTION UNIT
411b
DEMULTI-PLEXING UNIT
411c
DEMOD-ULATION UNIT
411d
DECODING UNIT
412
TRANSMISSION PROCESSING UNIT
412d
WIRELESS TRANSMIS-SION UNIT
412c
MULTI-PLEXING UNIT
412b
MODULA-TION UNIT
412a
CODING UNIT
42
STORAGE UNIT
45
CONTROL UNIT
44
INPUT/OUTPUT UNIT

FIG.5

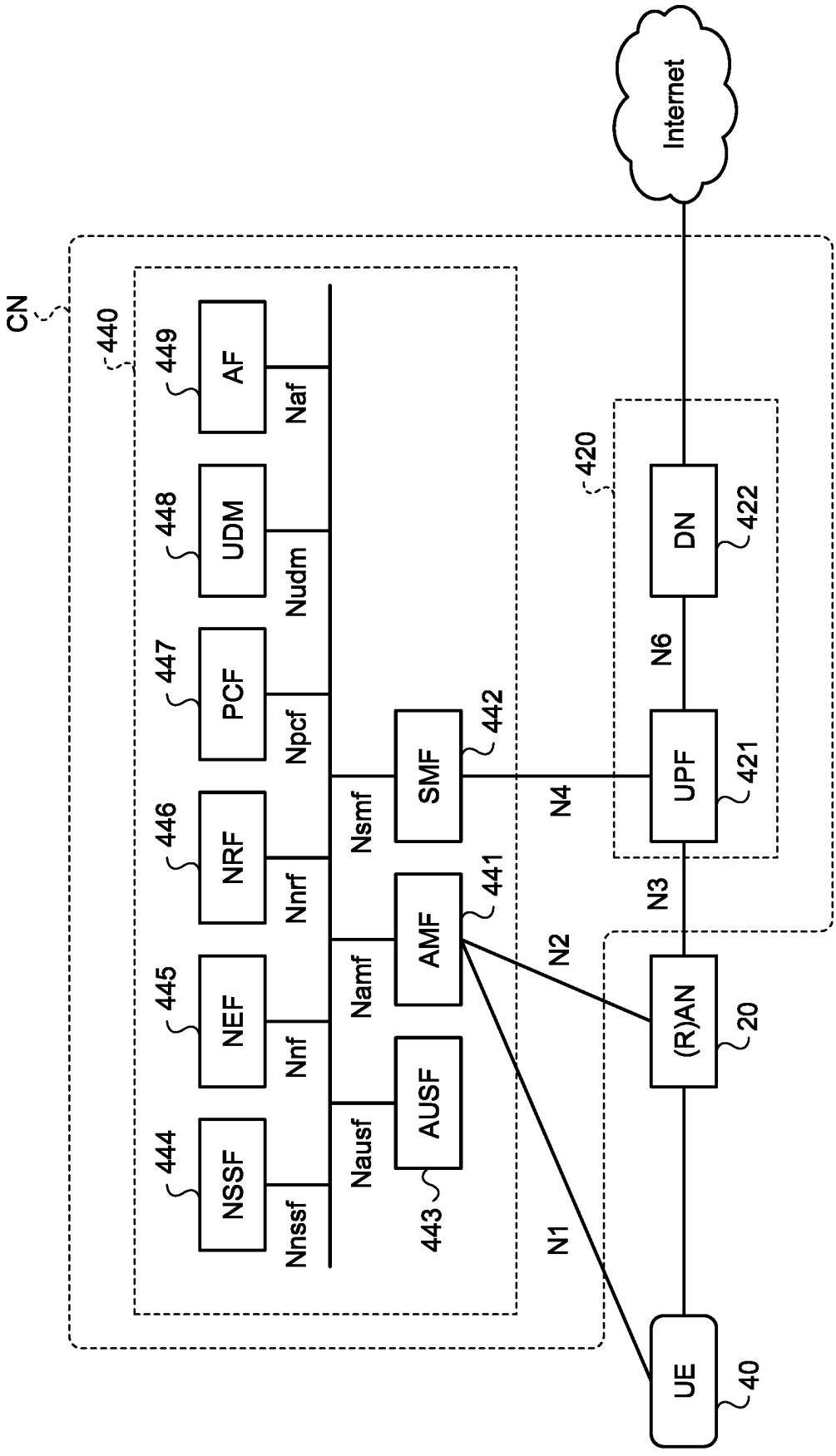

Internet
CN
440
449
AF
Naf
448
UDM
Nudm
447
PCF
Npcf
446
NRF
Nnrf
445
NEF
Nnf
444
NSSF
Nnssf
Nausf
AUSF
443
Namf
AMF
441
Nsmf
SMF
442
N4
420
DN
422
N6
UPF
421
N3
N2
(R)AN
20
N1
UE
40

FIG.6

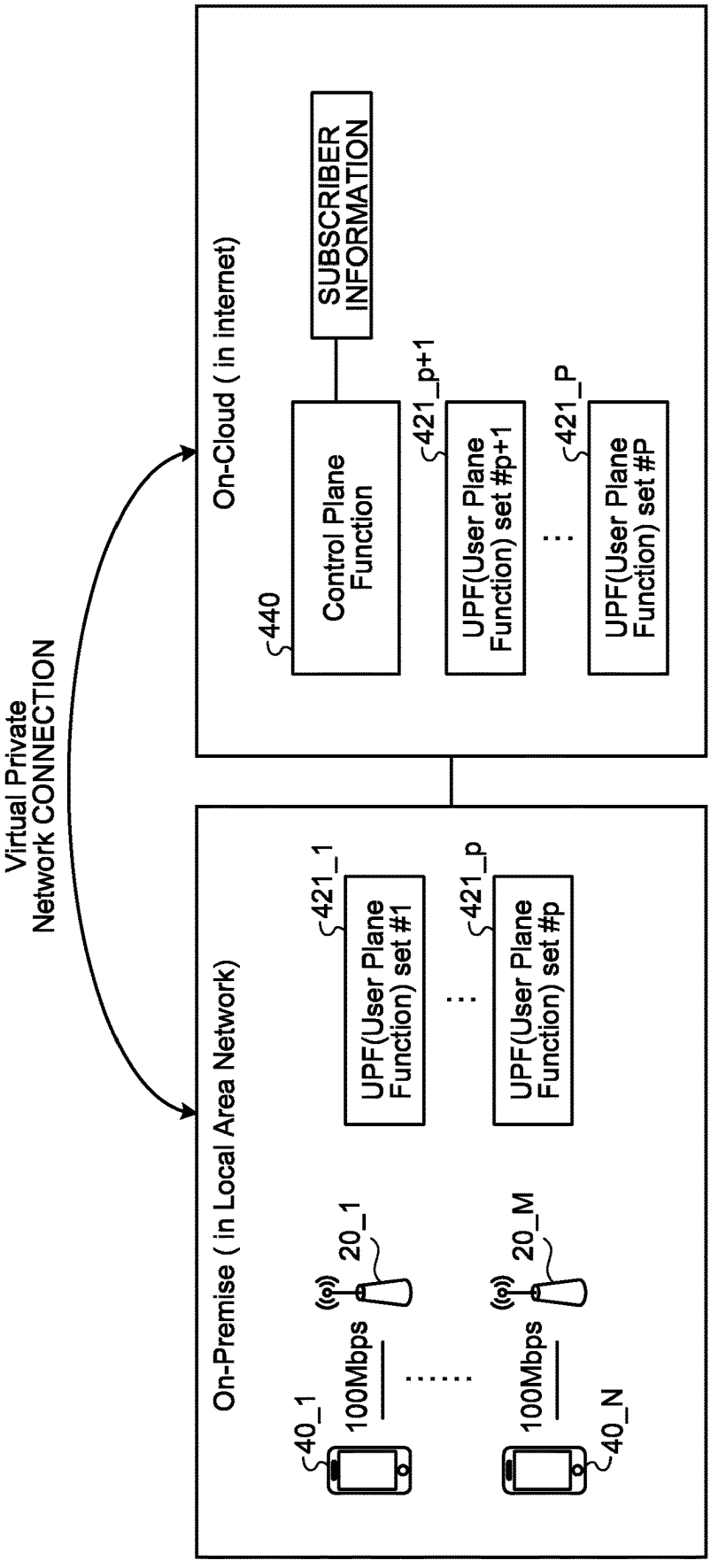

Virtual Private
Network CONNECTION
On-Cloud (in internet)
SUBSCRIBER
INFORMATION
Control Plane
Function
440
421_p+1
UPF(User Plane
Function) set #p+1
421_P
UPF(User Plane
Function) set #P
On-Premise (in Local Area Network)
421_1
UPF(User Plane
Function) set #1
421_p
UPF(User Plane
Function) set #p
20_1
20_M
100Mbps
100Mbps
40_1
40_N

FIG.7

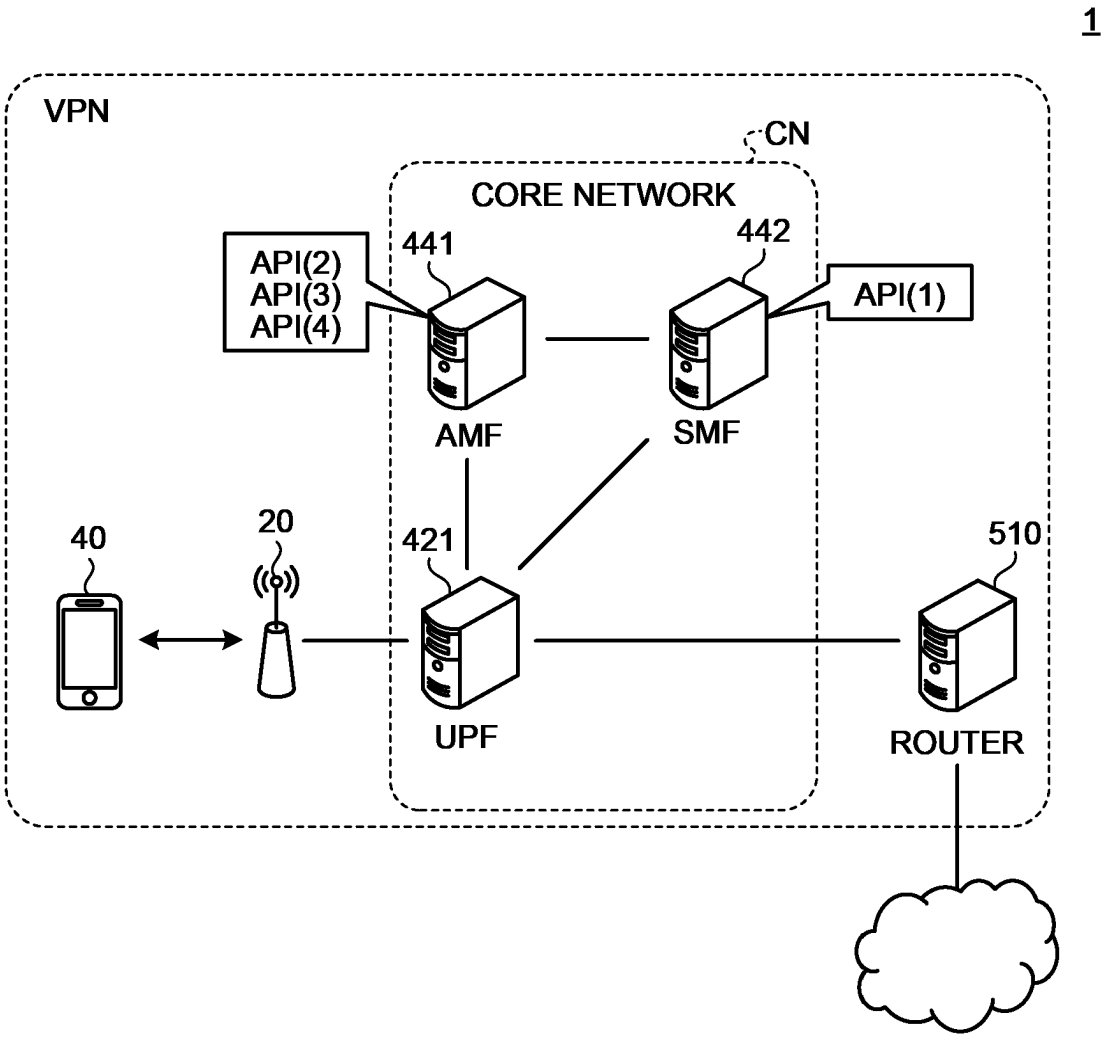

1
VPN
CN
CORE NETWORK
441
442
API(2)
API(3)
API(4)
API(1)
AMF
SMF
40
20
421
510
UPF
ROUTER

FIG.8

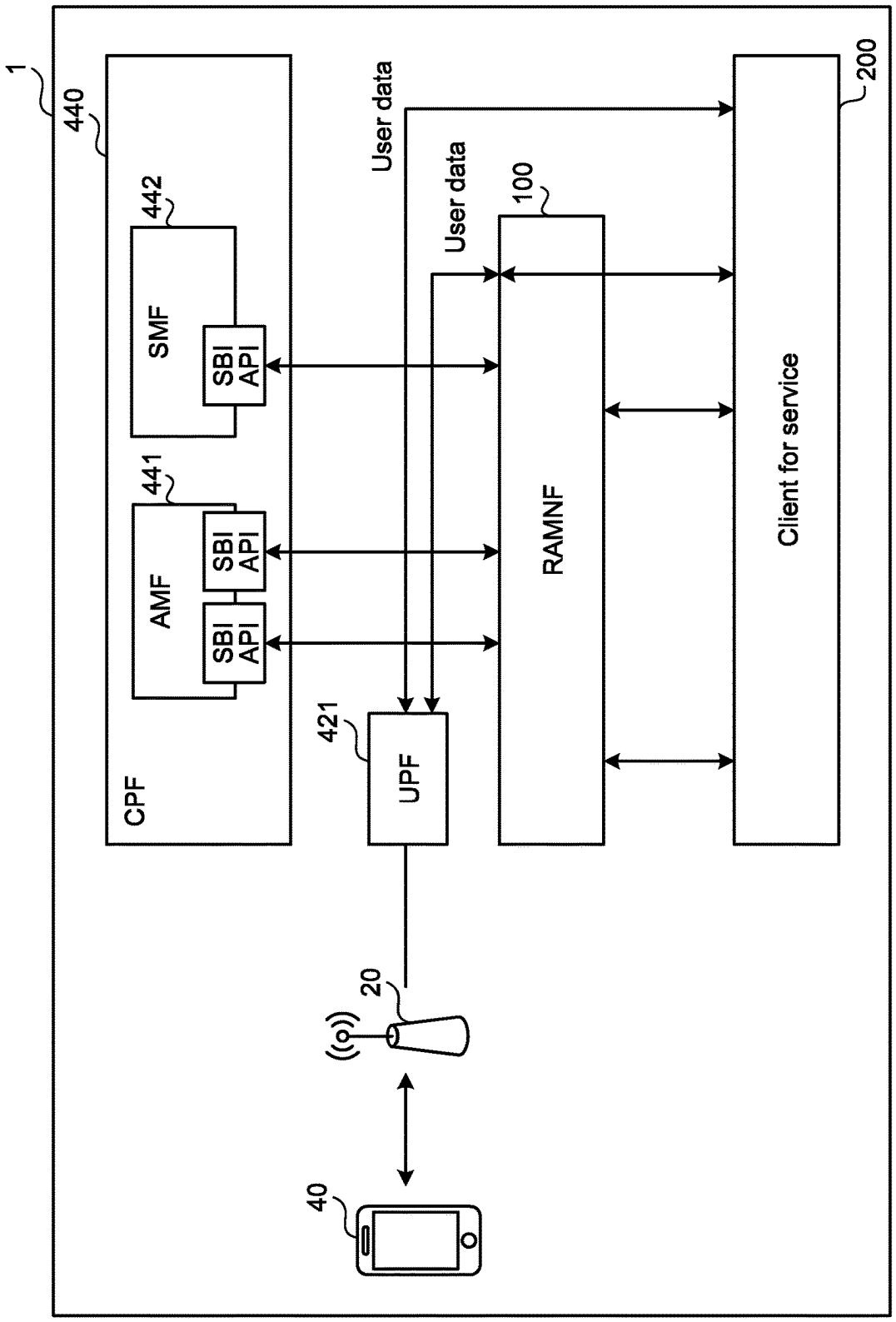

1
440
442
SMF
SBI API
441
AMF
SBI API
SBI API
CPF
421
UPF
User data
User data
100
RAMNF
200
Client for service
20
40

FIG.9

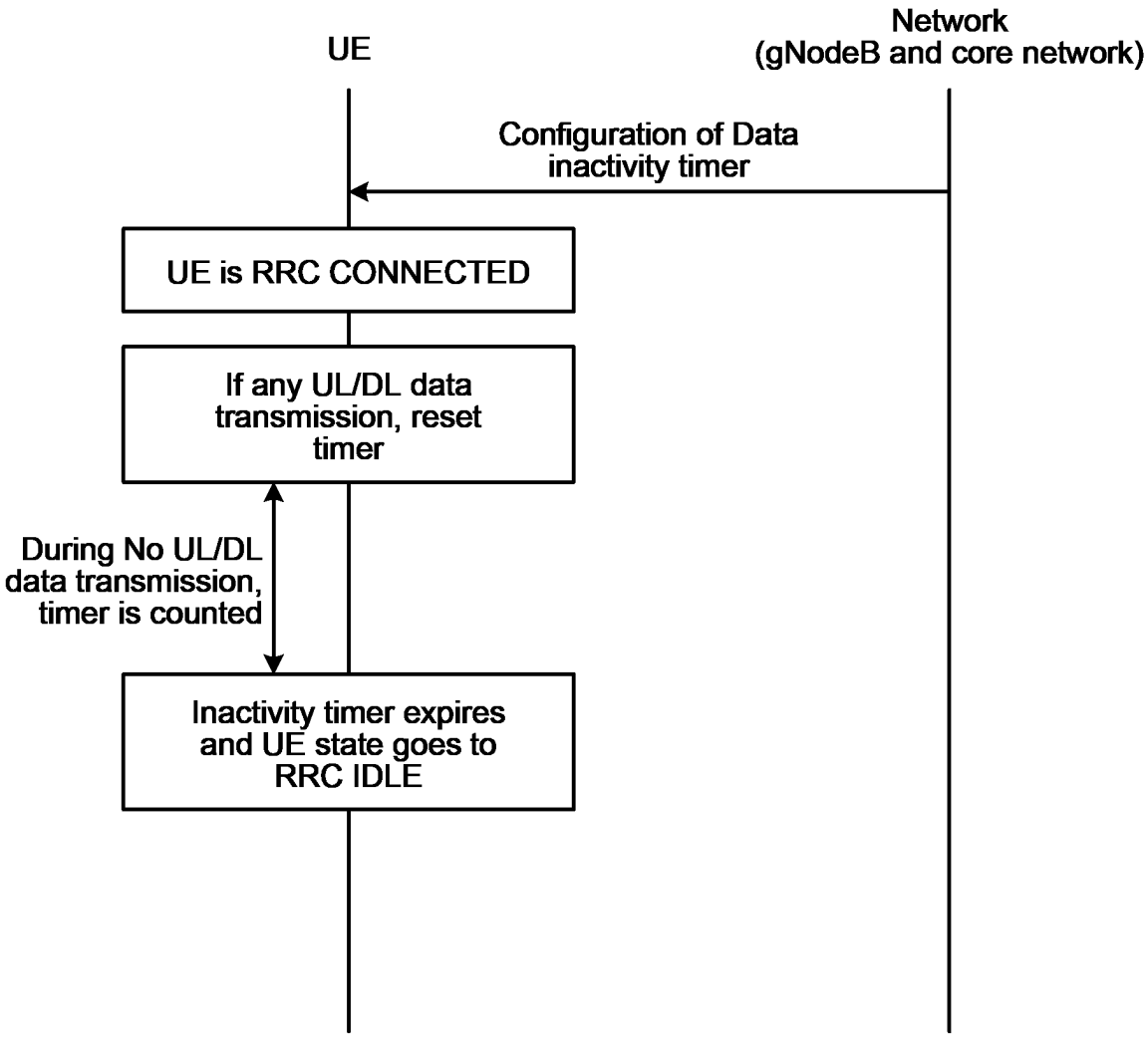

UE
Network
(gNodeB and core network)
Configuration of Data inactivity timer
UE is RRC CONNECTED
If any UL/DL data transmission, reset timer
During No UL/DL data transmission, timer is counted
Inactivity timer expires and UE state goes to RRC IDLE

FIG.10

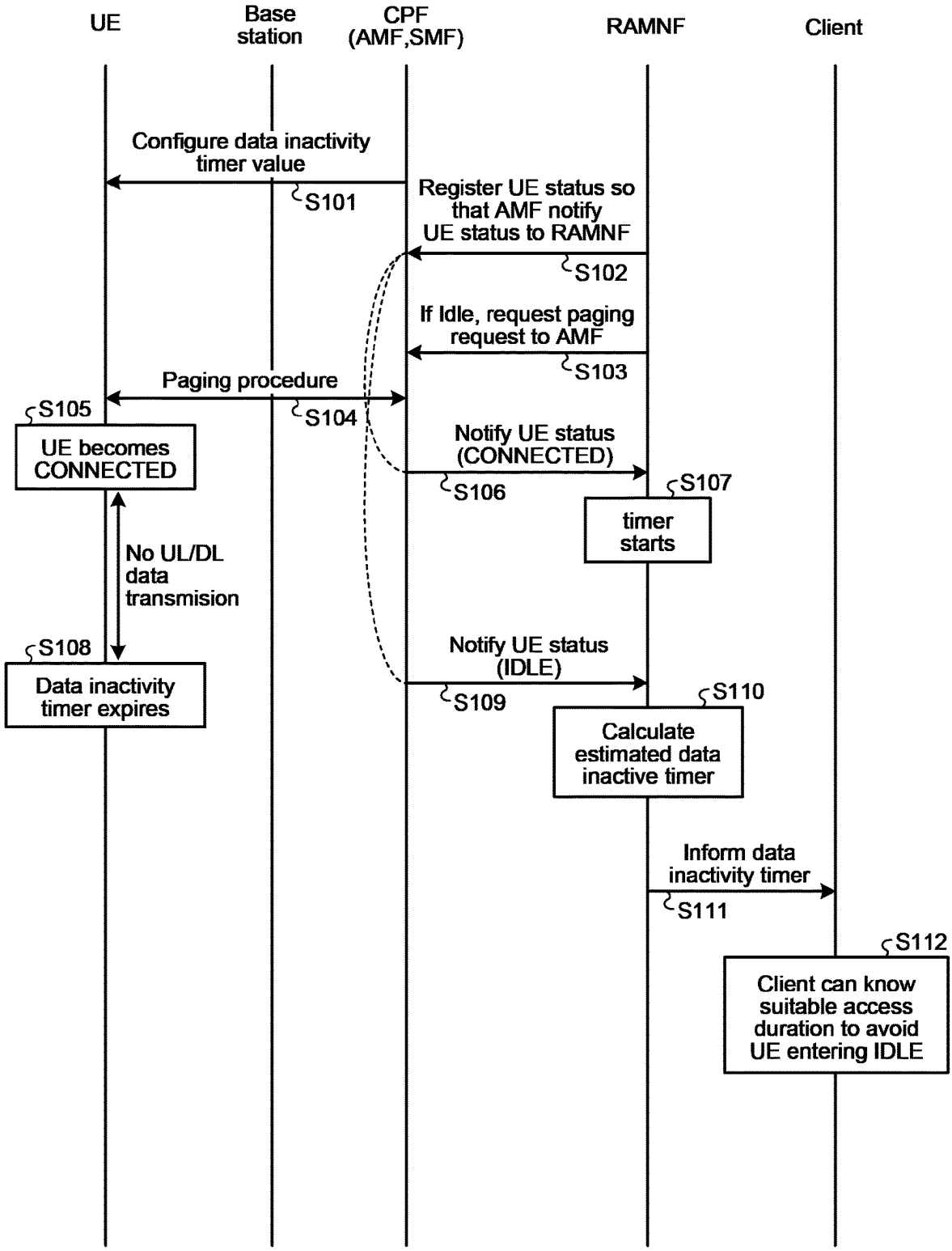

UE
Base station
CPF (AMF,SMF)
RAMNF
Client
Configure data inactivity timer value
S101
Register UE status so that AMF notify UE status to RAMNF
S102
If Idle, request paging request to AMF
S103
Paging procedure
S104
S105
UE becomes CONNECTED
Notify UE status (CONNECTED)
S106
S107
timer starts
No UL/DL data transmision
S108
Data inactivity timer expires
Notify UE status (IDLE)
S109
S110
Calculate estimated data inactive timer
Inform data inactivity timer
S111
S112
Client can know suitable access duration to avoid UE entering IDLE

FIG.11

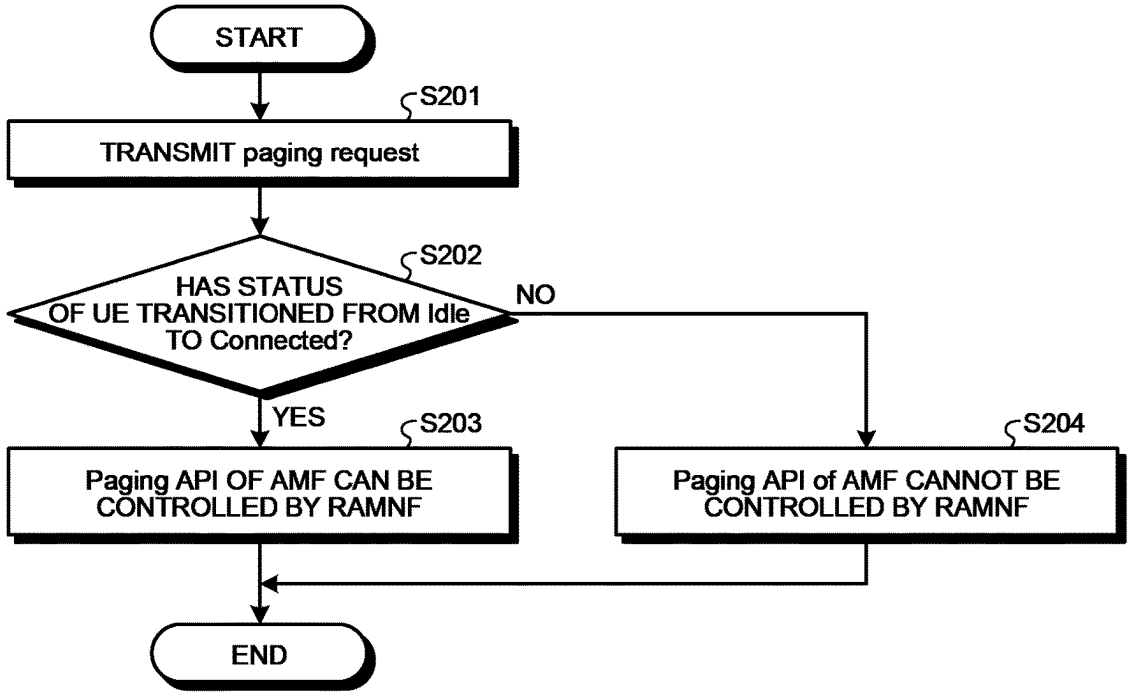

START
S201
TRANSMIT paging request
S202
HAS STATUS OF UE TRANSITIONED FROM Idle TO Connected?
NO
YES
S203
Paging API OF AMF CAN BE CONTROLLED BY RAMNF
S204
Paging API of AMF CANNOT BE CONTROLLED BY RAMNF
END

FIG.12

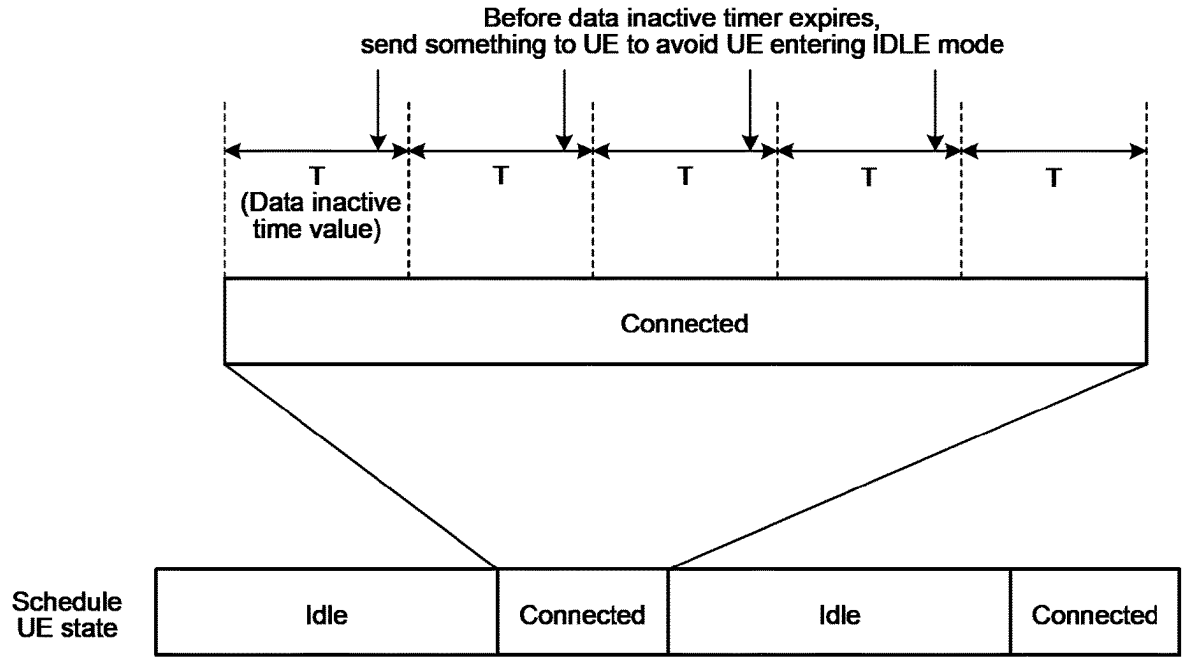

Before data inactive timer expires,
send something to UE to avoid UE entering IDLE mode
T
(Data inactive time value)
T
T
T
T
Connected
Schedule UE state
Idle
Connected
Idle
Connected

FIG.13

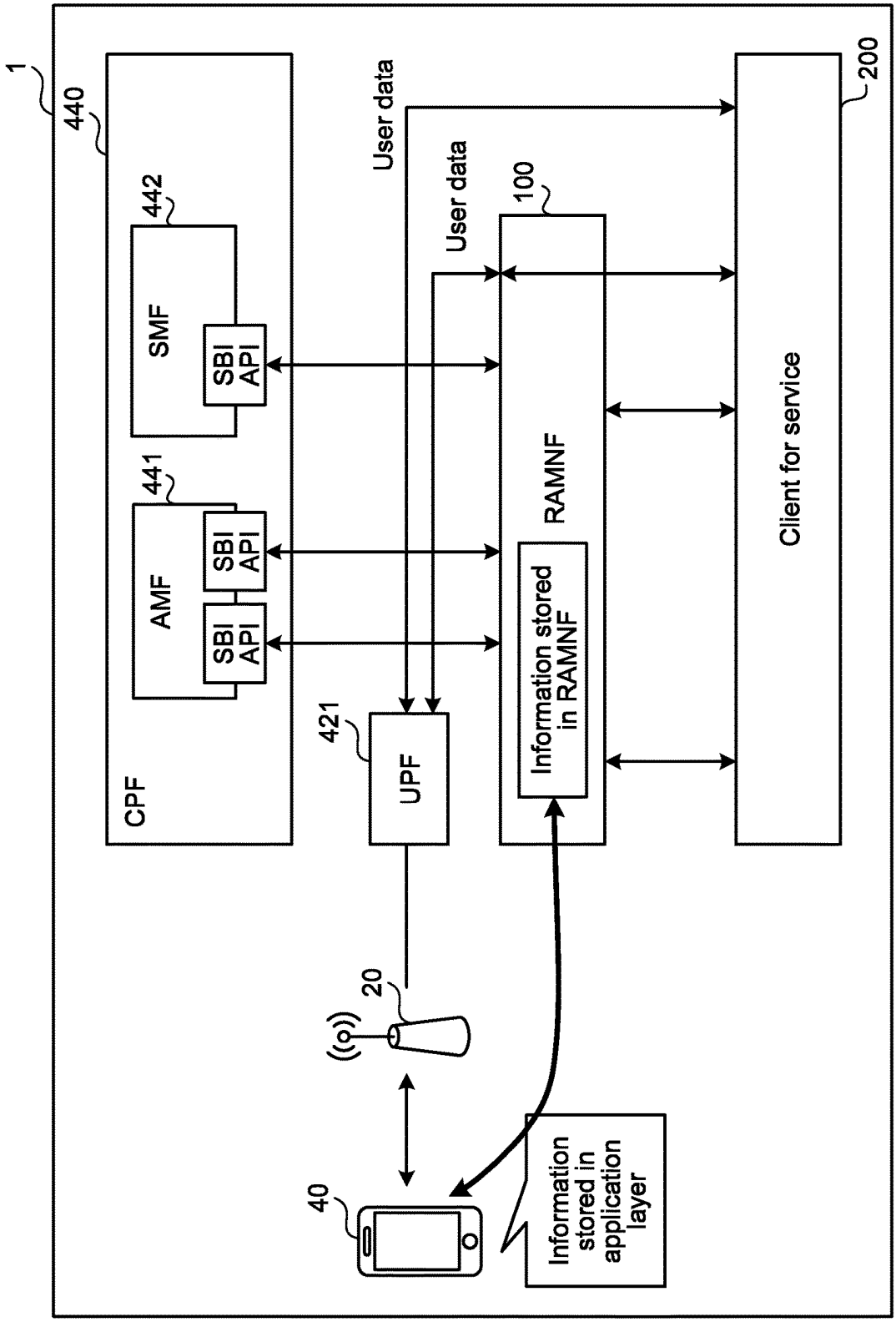

1
440
442
SMF
SBI API
441
AMF
SBI API
SBI API
CPF
User data
User data
100
RAMNF
Information stored in RAMNF
421
UPF
200
Client for service
20
40
Information stored in application layer

FIG.14

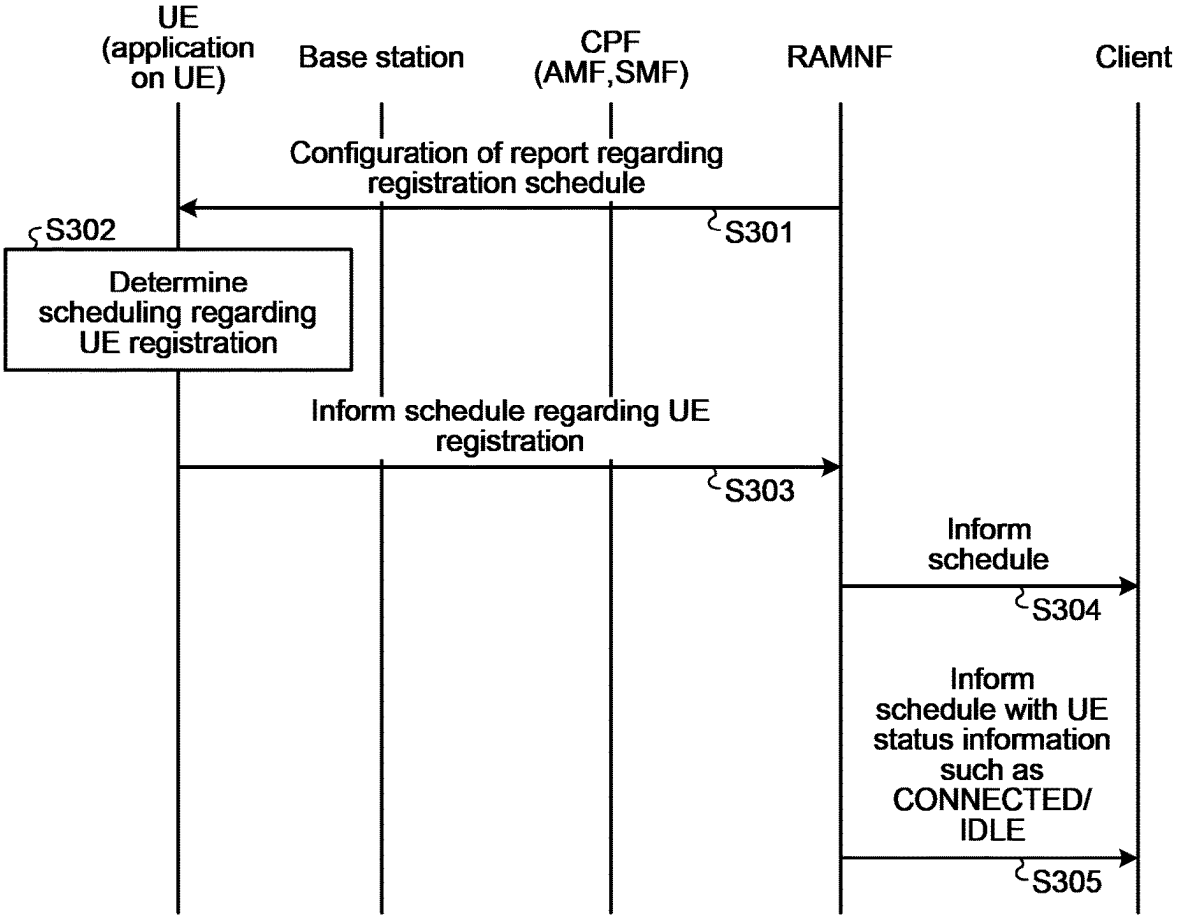

UE (application on UE)
Base station
CPF (AMF,SMF)
RAMNF
Client
Configuration of report regarding registration schedule
S301
S302
Determine scheduling regarding UE registration
Inform schedule regarding UE registration
S303
Inform schedule
S304
Inform schedule with UE status information such as CONNECTED/ IDLE
S305

FIG.15

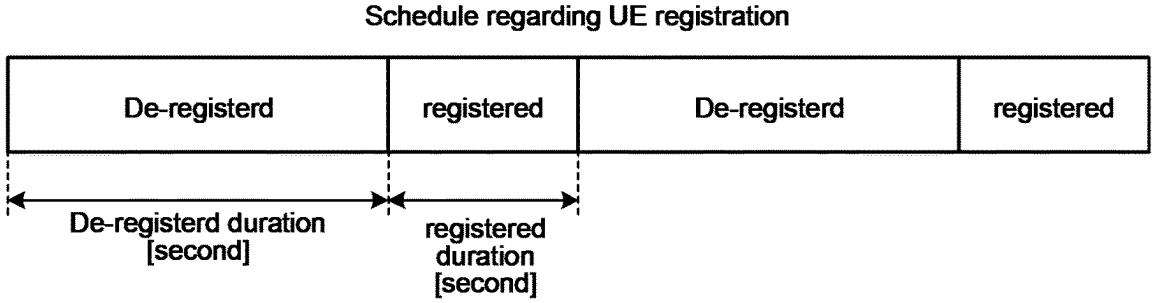

Schedule regarding UE registration
De-registerd
registered
De-registerd
registered
De-registerd duration [second]
registered duration [second]

FIG.16

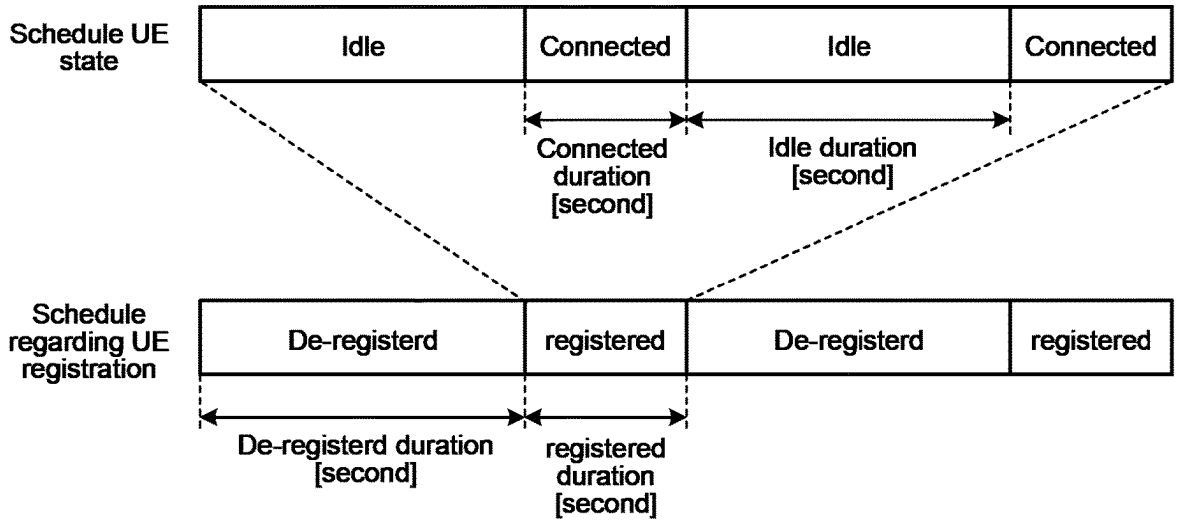

Schedule UE state
Idle
Connected
Idle
Connected
Connected duration [second]
Idle duration [second]
Schedule regarding UE registration
De-registerd
registered
De-registerd
registered
De-registerd duration [second]
registered duration [second]

FIG.17

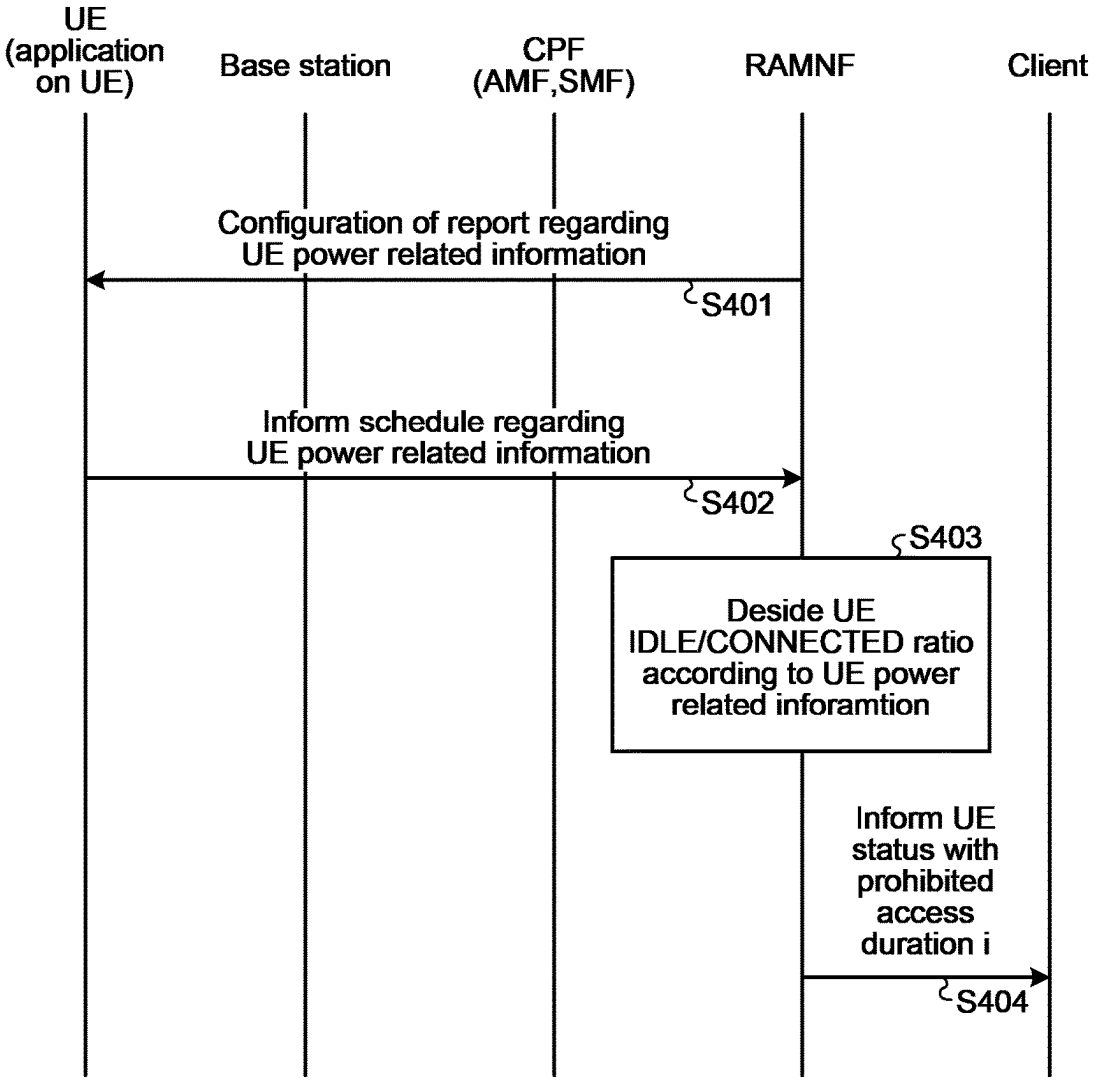

UE (application on UE)
Base station
CPF (AMF,SMF)
RAMNF
Client
Configuration of report regarding UE power related information
S401
Inform schedule regarding UE power related information
S402
S403
Deside UE IDLE/CONNECTED ratio according to UE power related inforamtion
Inform UE status with prohibited access duration i
S404

FIG.18

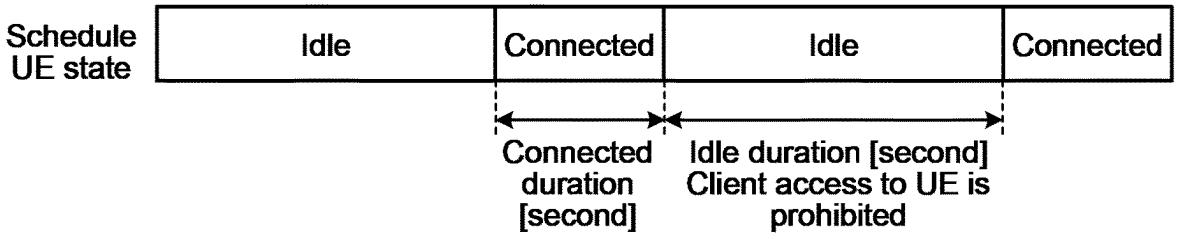

Schedule UE state
Idle
Connected
Idle
Connected
Connected duration [second]
Idle duration [second] Client access to UE is prohibited

FIG.19

CRITICALITY OF BATTERY	HIGH: BATTERY CAPACITY IS LOW MEDIUM: BATTERY CAPACITY IS HIGH LOW: CONNECTED TO POWER SUPPLY.	
REMAINING BATTERY LEVEL	HIGH: REMAINING BATTERY LEVEL IS HIGH MEDIUM: REMAINING BATTERY LEVEL IS MEDIUM LOW: REMAINING BATTERY LEVEL IS LOW	
EXPECTED CHARGE VALUE	AFTER X HOURS	TIME WHEN CHARGING IS EXPECTED TO BE PERFORMED NEXT

FIG.20

CURRENT TERMINAL LOCATION INFORMATION	MAKE NOTIFICATION OF CURRENT TERMINAL LOCATION INFORMATION	
PAST TERMINAL LOCATION INFORMATION	MAKE NOTIFICATION OF LOCATION THROUGH WHICH TERMINAL HAS PASSED IN PAST WITHIN CERTAIN TIME	PAST TERMINAL LOCATION INFORMATION IS USED WHEN IT IS DESIRED TO OBTAIN INFORMATION OF CERTAIN LOCATION, AND IT IS DESIRED TO ACCESS UE THAT HAS PASSED THROUGH CERTAIN LOCATION IN PAST WHEN CURRENTLY THERE IS NO UE IN CERTAIN LOCATION
FUTURE TERMINAL LOCATION INFORMATION	MAKE NOTIFICATION OF POSSIBLE TERMINAL LOCATION INFORMATION	FUTURE TERMINAL LOCATION INFORMATION IS USEFUL WHEN SEARCHING FOR AND ACCESSING UE THAT CAN GO TO THAT LOCATION

FIG.21

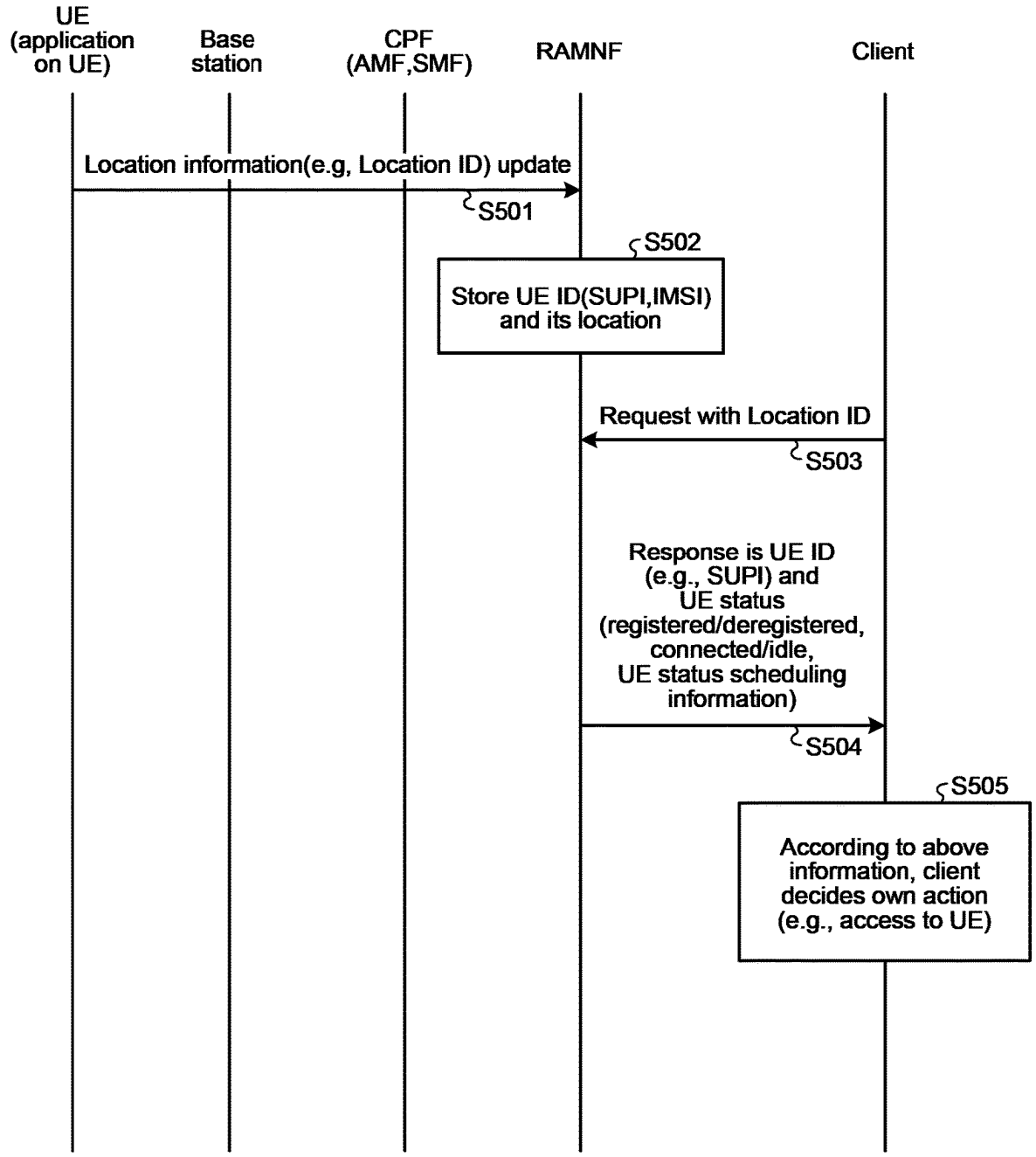

UE (application on UE)
Base station
CPF (AMF,SMF)
RAMNF
Client
Location information(e.g, Location ID) update
S501
S502
Store UE ID(SUPI,IMSI) and its location
Request with Location ID
S503
Response is UE ID (e.g., SUPI) and UE status (registered/deregistered, connected/idle, UE status scheduling information)
S504
S505
According to above information, client decides own action (e.g., access to UE)

FIG.22

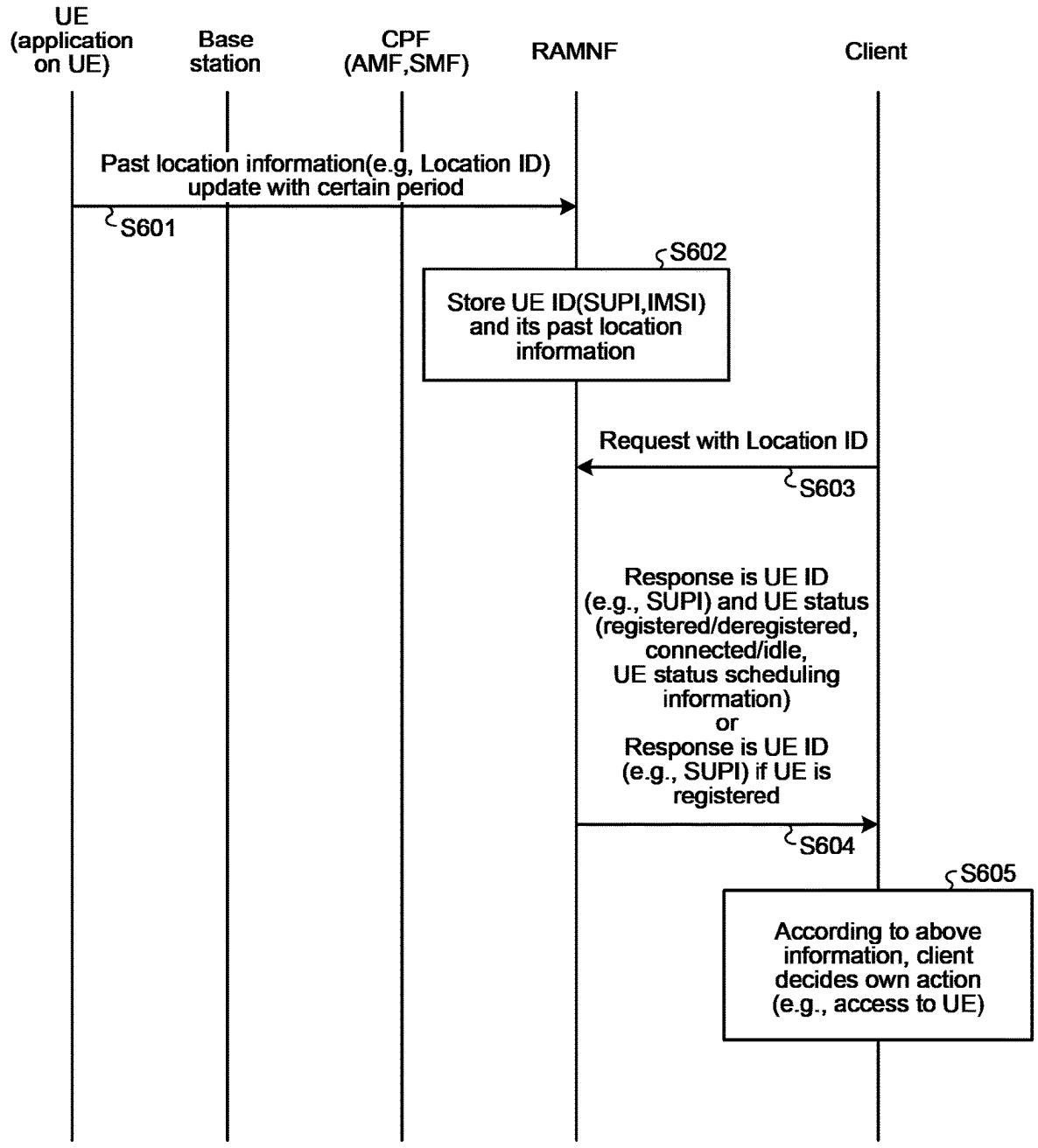

UE
(application on UE)
Base station
CPF
(AMF,SMF)
RAMNF
Client
Past location information(e.g, Location ID) update with certain period
S601
S602
Store UE ID(SUPI,IMSI) and its past location information
Request with Location ID
S603
Response is UE ID (e.g., SUPI) and UE status (registered/deregistered, connected/idle, UE status scheduling information) or Response is UE ID (e.g., SUPI) if UE is registered
S604
S605
According to above information, client decides own action (e.g., access to UE)

FIG.23

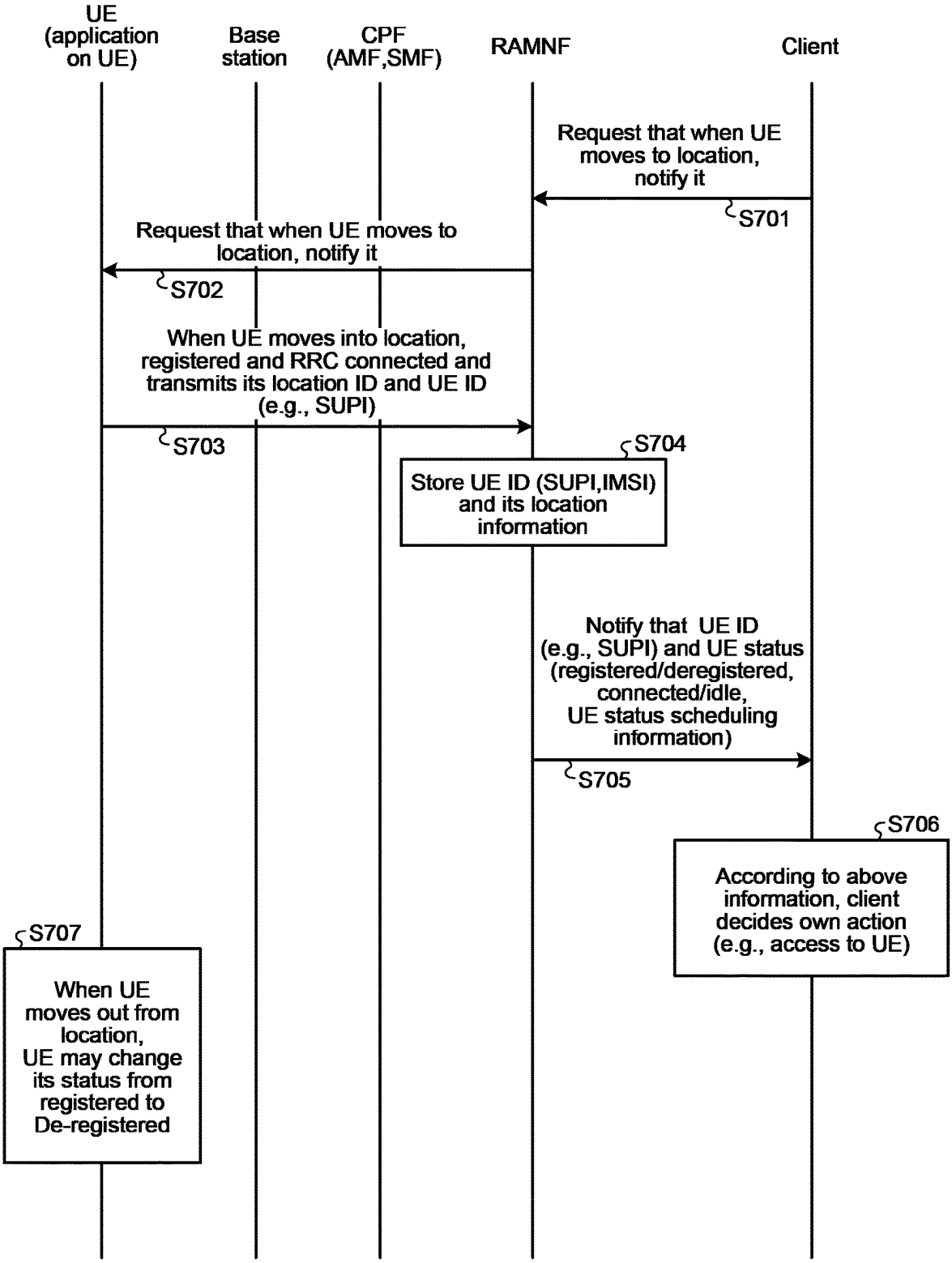

UE (application on UE)
Base station
CPF (AMF,SMF)
RAMNF
Client
Request that when UE moves to location, notify it
S701
Request that when UE moves to location, notify it
S702
When UE moves into location, registered and RRC connected and transmits its location ID and UE ID (e.g., SUPI)
S703
S704
Store UE ID (SUPI,IMSI) and its location information
Notify that UE ID (e.g., SUPI) and UE status (registered/deregistered, connected/idle, UE status scheduling information)
S705
S706
According to above information, client decides own action (e.g., access to UE)
S707
When UE moves out from location, UE may change its status from registered to De-registered

FIG.24

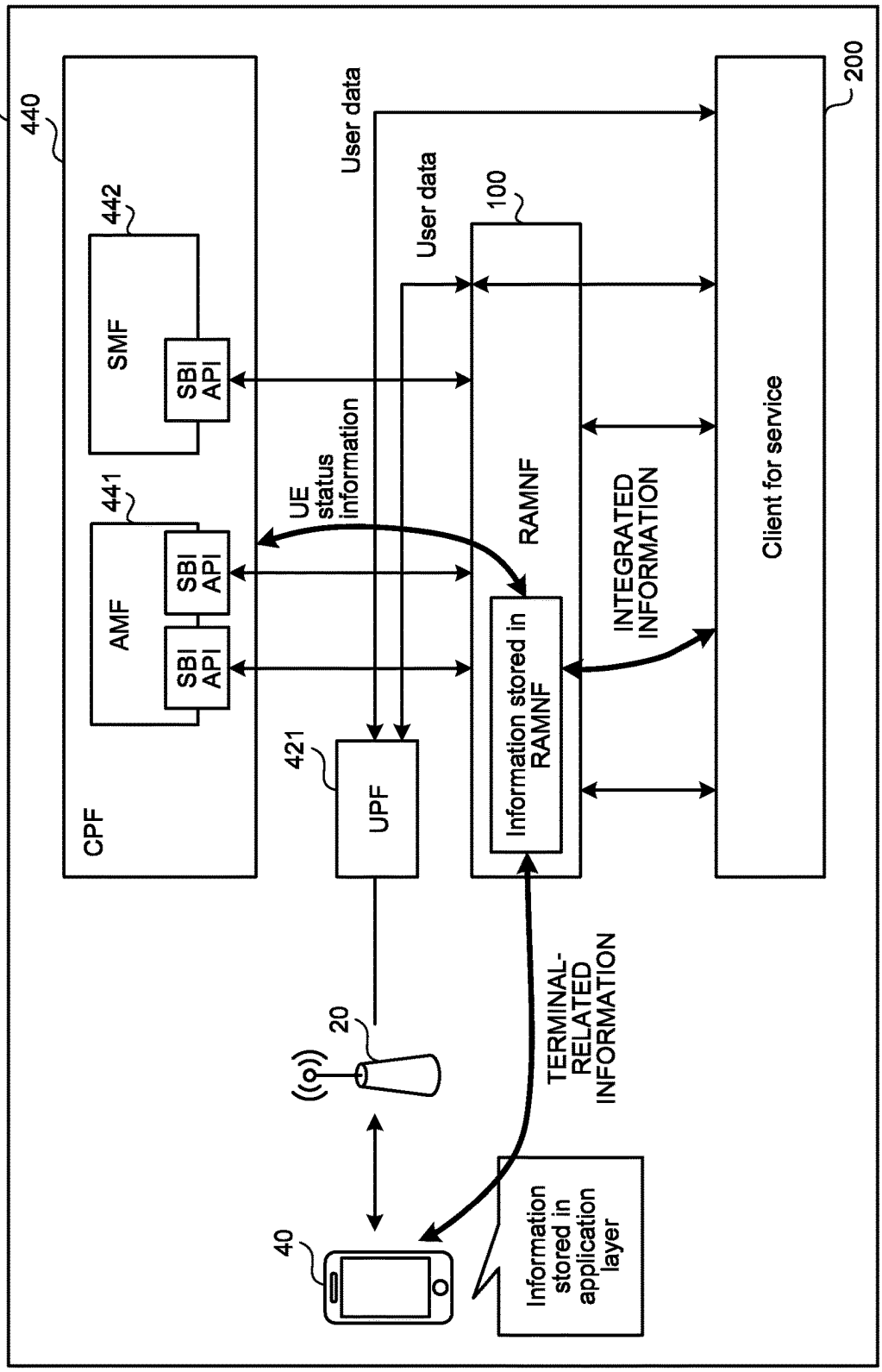

1
440
CPF
442
SMF
SBI API
441
AMF
SBI API
SBI API
User data
User data
UE status information
100
RAMNF
Information stored in RAMNF
INTEGRATED INFORMATION
200
Client for service
421
UPF
20
TERMINAL-RELATED INFORMATION
40
Information stored in application layer

FIG.25

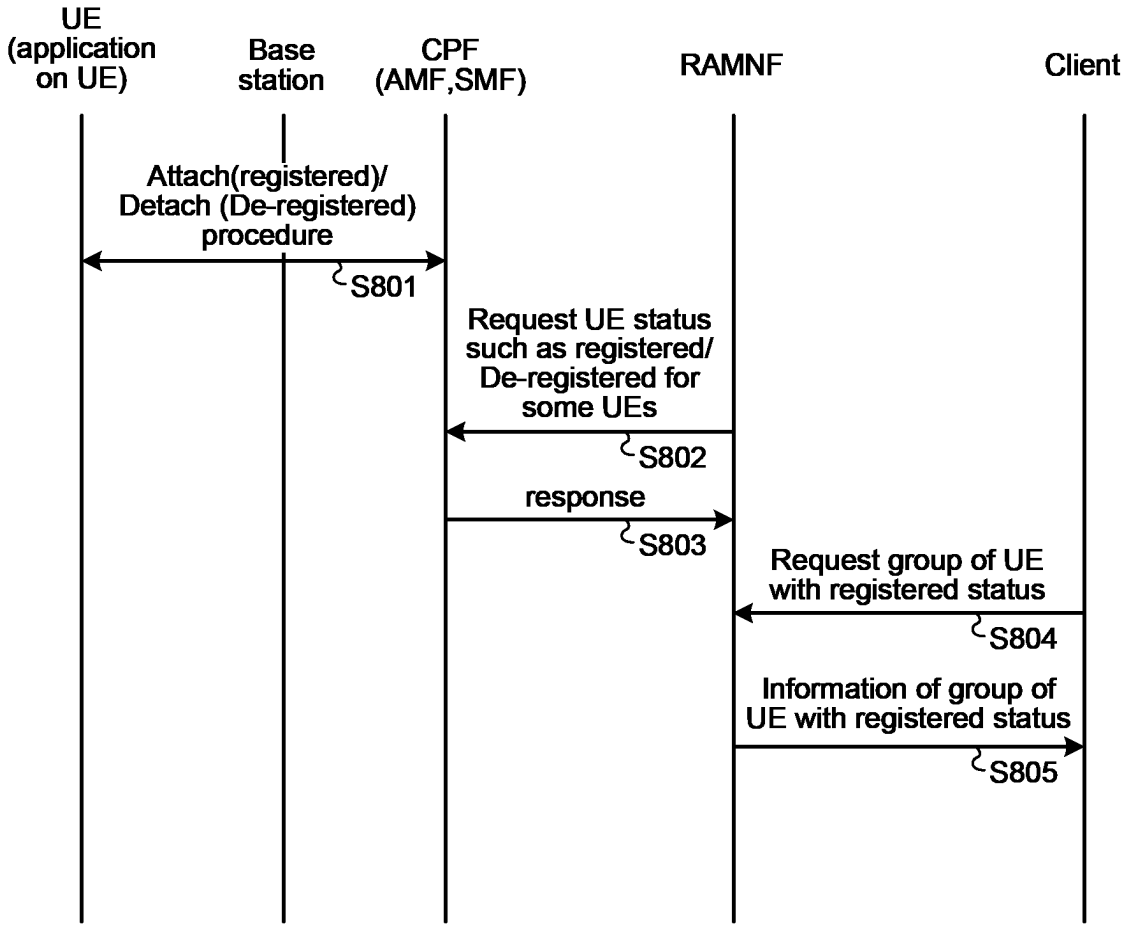


FIG.26

ID	UE ID(SUPI)
1	2
2	3
3	5
4	7

FIG.27

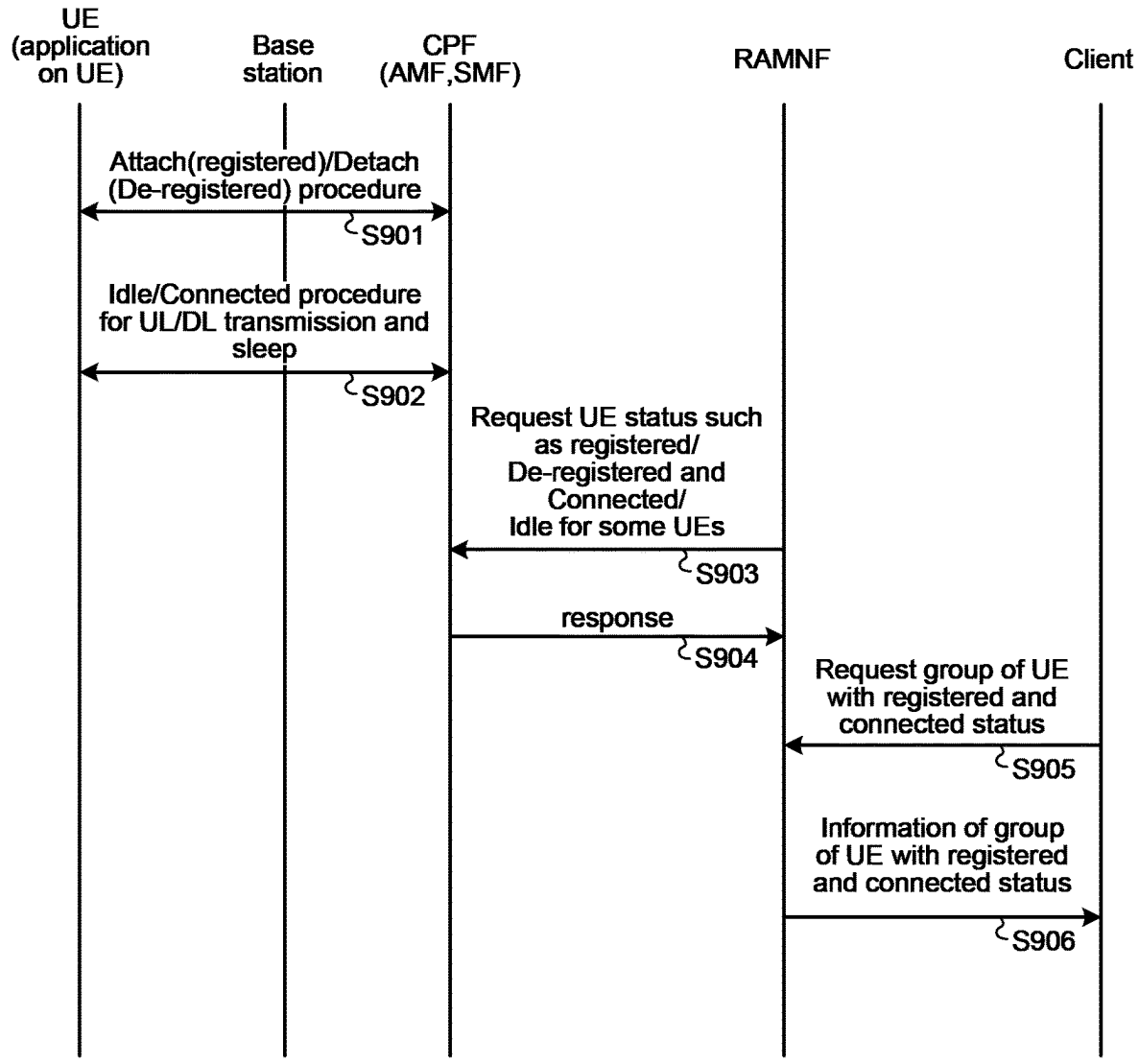

UE (application on UE)
Base station
CPF (AMF,SMF)
RAMNF
Client
Attach(registered)/Detach (De-registered) procedure
S901
Idle/Connected procedure for UL/DL transmission and sleep
S902
Request UE status such as registered/ De-registered and Connected/ Idle for some UEs
S903
response
S904
Request group of UE with registered and connected status
S905
Information of group of UE with registered and connected status
S906

FIG.28

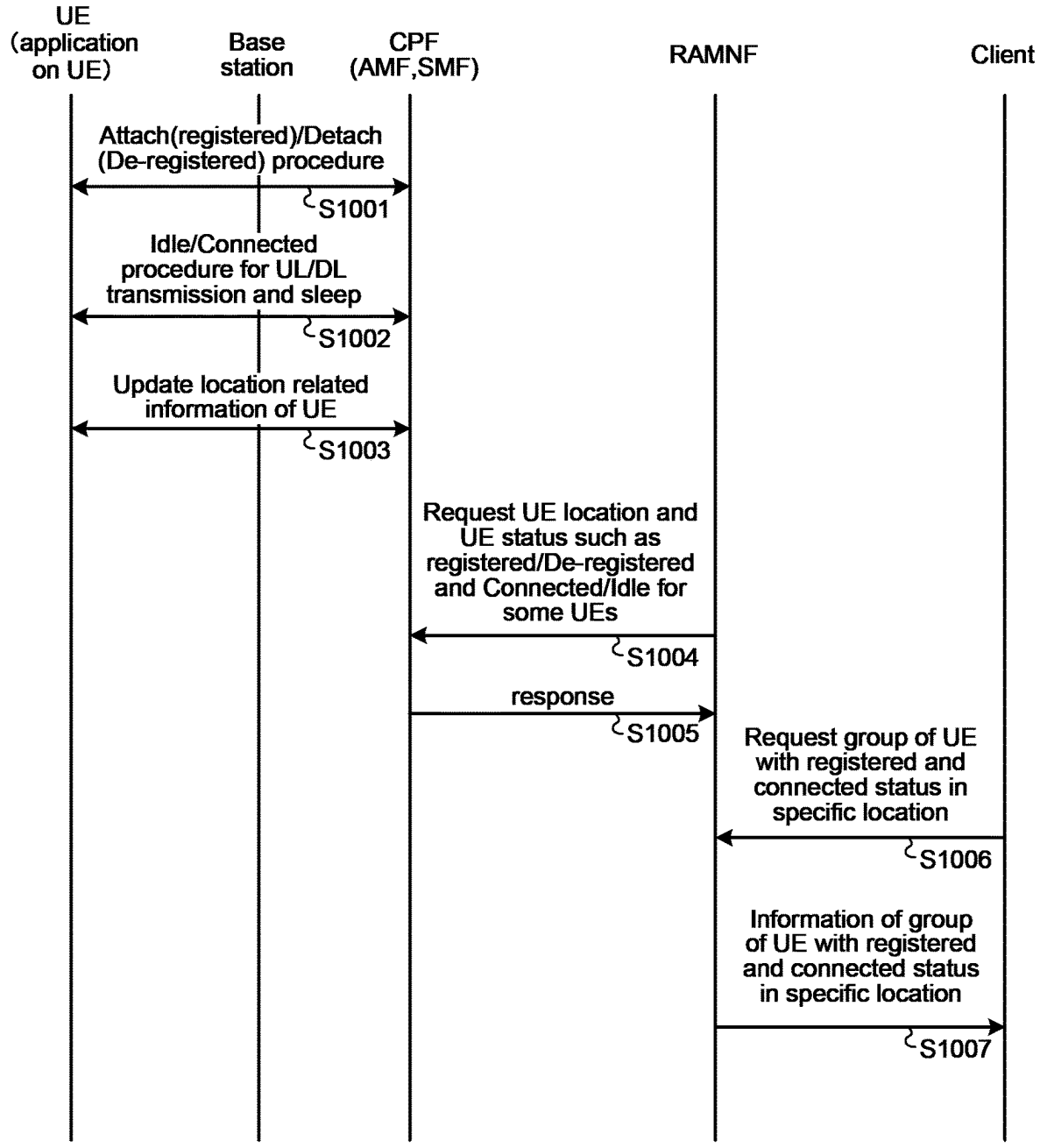

UE (application on UE)
Base station
CPF (AMF,SMF)
RAMNF
Client
Attach(registered)/Detach (De-registered) procedure
S1001
Idle/Connected procedure for UL/DL transmission and sleep
S1002
Update location related information of UE
S1003
Request UE location and UE status such as registered/De-registered and Connected/Idle for some UEs
S1004
response
S1005
Request group of UE with registered and connected status in specific location
S1006
Information of group of UE with registered and connected status in specific location
S1007

FIG.29

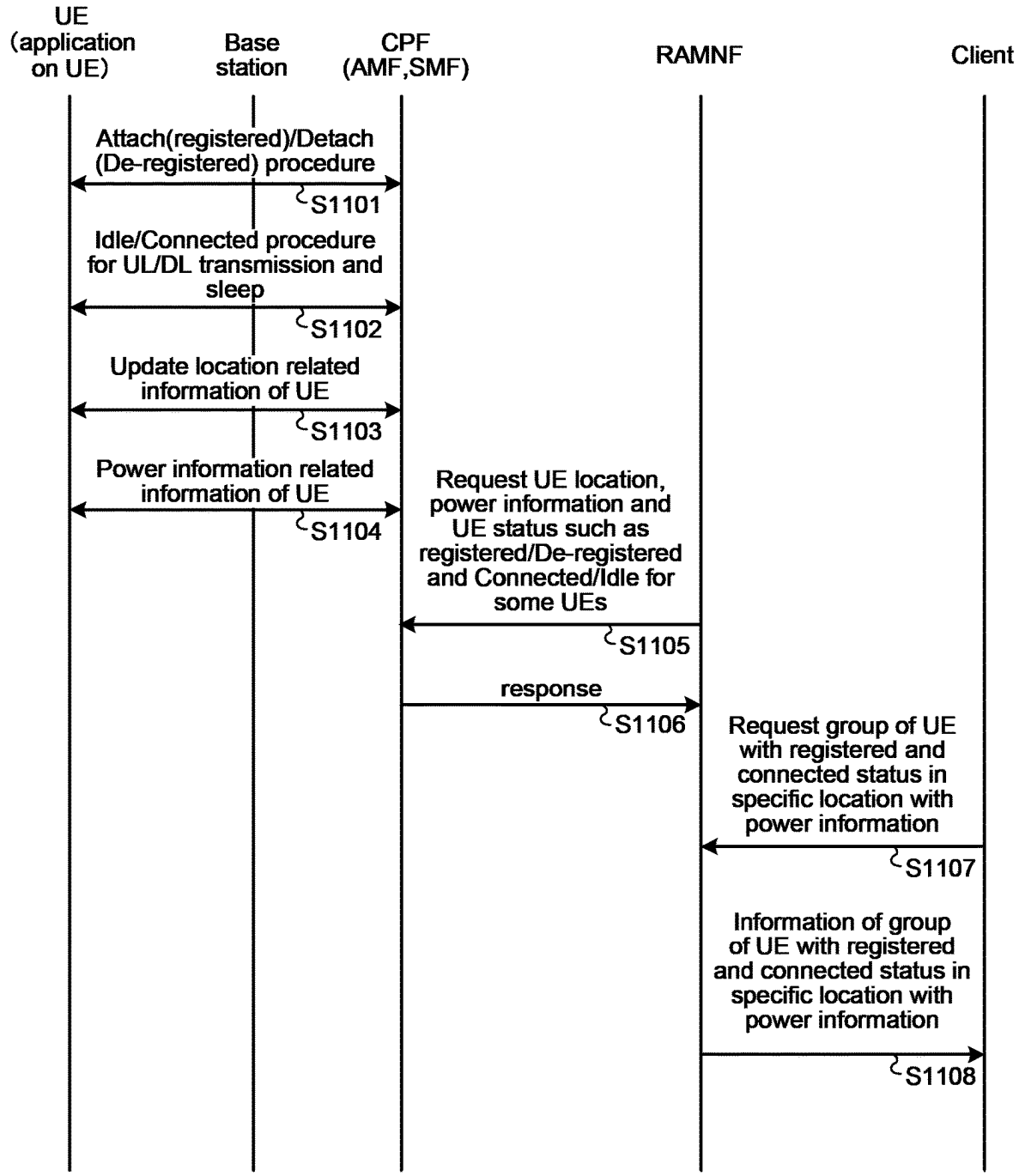

UE (application on UE)
Base station
CPF (AMF,SMF)
RAMNF
Client
Attach(registered)/Detach (De-registered) procedure
S1101
Idle/Connected procedure for UL/DL transmission and sleep
S1102
Update location related information of UE
S1103
Power information related information of UE
S1104
Request UE location, power information and UE status such as registered/De-registered and Connected/Idle for some UEs
S1105
response
S1106
Request group of UE with registered and connected status in specific location with power information
S1107
Information of group of UE with registered and connected status in specific location with power information
S1108

FIG.30

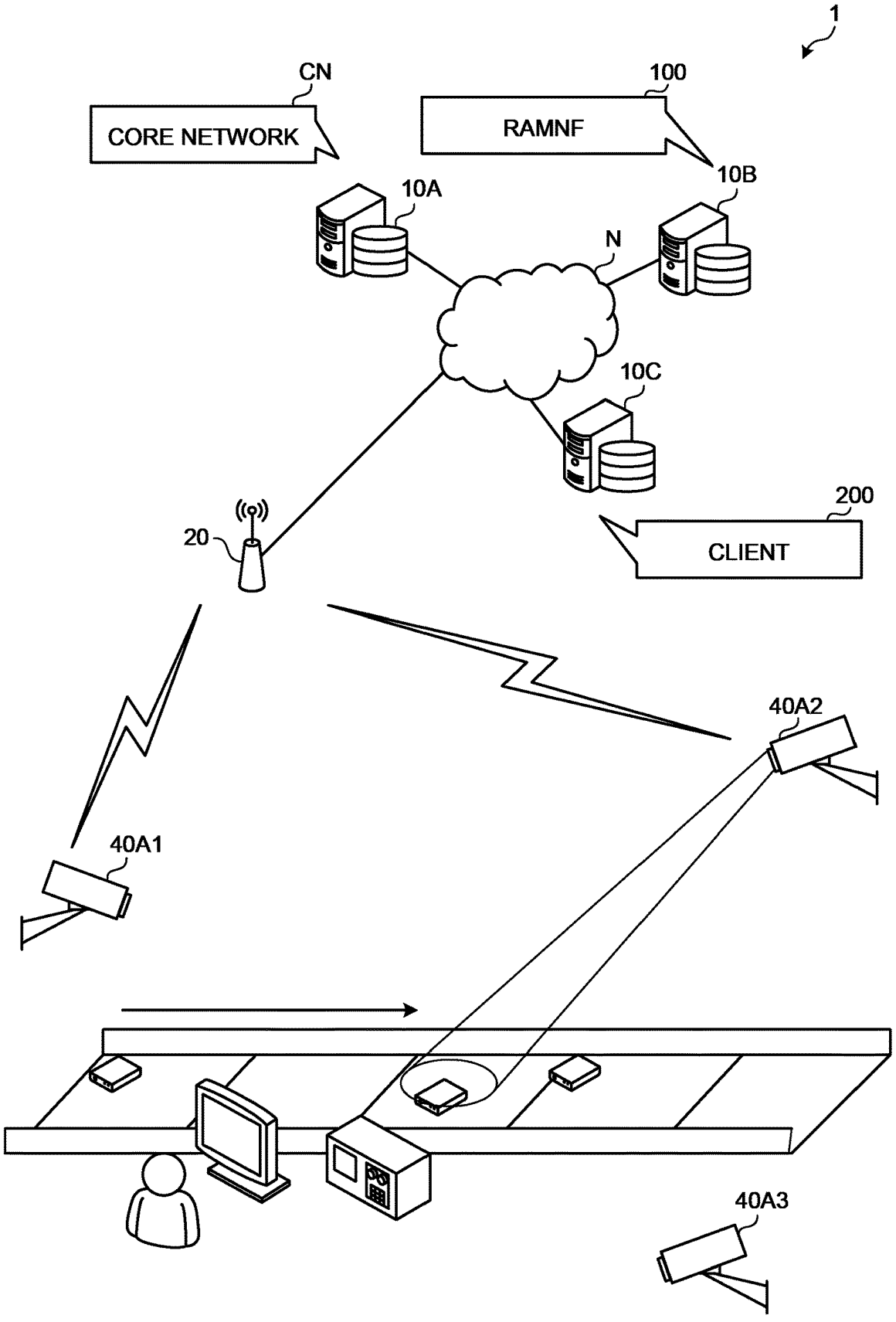
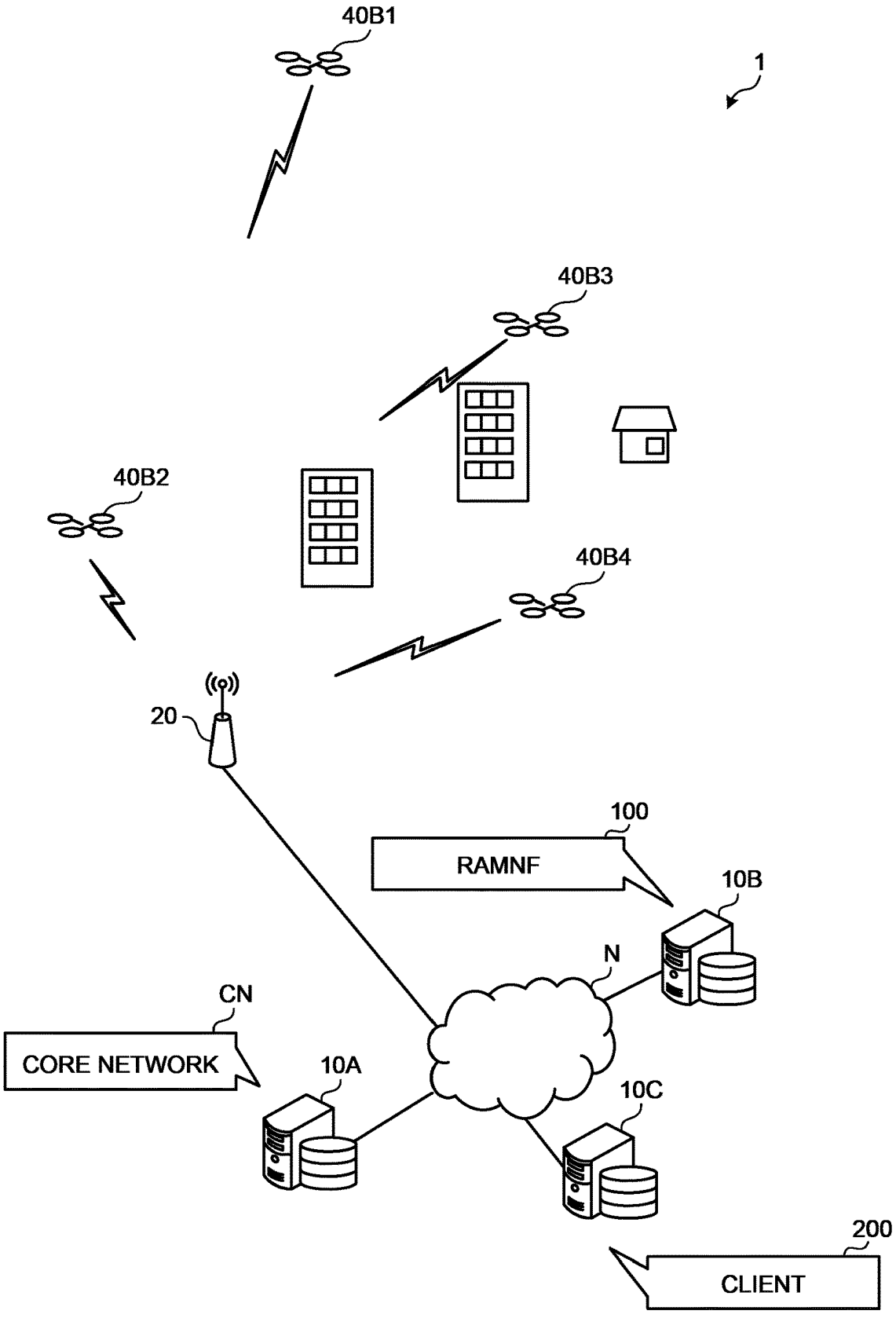

1
CN
CORE NETWORK
100
RAMNF
10A
10B
N
10C
200
CLIENT
20
40A1
40A2
40A3

FIG.31


40B1
1
40B3
40B2
40B4
20
100
RAMNF
10B
N
CN
CORE NETWORK
10A
10C
200
CLIENT

INFORMATION PROCESSING DEVICE, INFORMATION PROCESSING METHOD, TERMINAL DEVICE, AND SYSTEM

TECHNICAL FIELD

[0001] The present disclosure relates to an information processing device, an information processing method, a terminal device, and a system.

BACKGROUND ART

[0002] In recent years, in cellular wireless communication, a new technology has been introduced in order to cope with diversification of communication services. For example, a technology in which a mobile network discloses a status of communication with a terminal to an application function (AF) of a third party so that the AF establishes a protocol data unit (PDU) session according to network capability has been known.

[0003] In addition, a technology in which a terminal device (user equipment (UE)) determines whether or not to transmit PDU-session-related signaling based on area-restriction-related information has been known.

CITATION LIST

Patent Literature

[0004] PTL 1: JP 2021-513269 T

[0005] PTL 2: JP 2021-532675 T

SUMMARY OF INVENTION

Technical Problem

[0006] In the above-described technology, the AF acquires data from each network function (NF) of the mobile network. However, it is difficult to say that the AF can sufficiently acquire data regarding the terminal device.

[0007] For example, in a case where the terminal device is an Internet of Things (IoT) terminal, a client (an example of the AF) that performs communication with the terminal device can more appropriately communicate with the terminal device by using the data regarding the terminal device. As described above, it is desirable that the client more appropriately communicate with the terminal device by acquiring the data regarding the terminal device.

[0008] Therefore, the present disclosure provides a mechanism capable of more appropriately communicating with a terminal device.

[0009] It should be noted that the above-mentioned problem or purpose is only one of a plurality of problems or purposes that can be solved or achieved by a plurality of embodiments disclosed in the present specification.

Solution to Problem

[0010] An information processing device of the present disclosure includes a control unit. The control unit acquires first information regarding a terminal device from a core network via a service based interface (SBI). The control unit acquires second information including at least one of measurement information measured based on the first information or terminal-related information acquired from the terminal device directly or via the SBI. The control unit specifies the terminal device from the second information or by associating the first information and the second information with each other. The control unit notifies a client device of at least one of the first information or the second information in association with the specified terminal device.

BRIEF DESCRIPTION OF DRAWINGS

[0011] FIG. **1** is a diagram for describing an outline of an information processing system according to an embodiment of the present disclosure.

[0012] FIG. **2** is a diagram illustrating an example of a configuration of an information processing device according to an embodiment of the present disclosure.

[0013] FIG. **3** is a diagram illustrating an example of a configuration of a base station according to an embodiment of the present disclosure.

[0014] FIG. **4** is a diagram illustrating an example of a configuration of a terminal device according to an embodiment of the present disclosure.

[0015] FIG. **5** is a diagram illustrating an example of a 5G architecture.

[0016] FIG. **6** is a diagram for describing an example of a configuration of a private 5G network according to an embodiment of the present disclosure.

[0017] FIG. **7** is a diagram for describing an application programming interface (API) according to an embodiment of the present disclosure.

[0018] FIG. **8** is a diagram illustrating an example of the information processing system according to an embodiment of the present disclosure.

[0019] FIG. **9** is a sequence diagram illustrating an example of setting of an idle transition time by the base station.

[0020] FIG. **10** is a sequence diagram illustrating an example of a flow of first information processing according to a first embodiment of the present disclosure.

[0021] FIG. **11** is a flowchart illustrating an example of a flow of confirmation processing according to the first embodiment of the present disclosure.

[0022] FIG. **12** is a diagram for describing an example of scheduling of a user equipment (UE) status by a reachability management network function (RAMNF) according to the first embodiment of the present disclosure.

[0023] FIG. **13** is a diagram illustrating an example of an information processing system according to a second embodiment of the present disclosure.

[0024] FIG. **14** is a sequence diagram illustrating an example of a flow of registration schedule information provision processing according to the second embodiment of the present disclosure.

[0025] FIG. **15** is a diagram illustrating an example of a registration schedule according to the second embodiment of the present disclosure.

[0026] FIG. **16** is a diagram illustrating an example of a schedule regarding registration according to the second embodiment of the present disclosure.

[0027] FIG. **17** is a sequence diagram illustrating an example of a flow of power information provision processing according to the second embodiment of the present disclosure.

[0028] FIG. **18** is a diagram illustrating an example of a connection schedule according to the second embodiment of the present disclosure.

[0029] FIG. **19** is a table illustrating power information according to the second embodiment of the present disclosure.

[0030] FIG. **20** is a table illustrating an example of terminal location information according to the second embodiment of the present disclosure.

[0031] FIG. **21** is a sequence diagram illustrating an example of a flow of current terminal location information provision processing according to the second embodiment of the present disclosure.

[0032] FIG. **22** is a sequence diagram illustrating an example of a flow of past terminal location information provision processing according to the second embodiment of the present disclosure.

[0033] FIG. **23** is a sequence diagram illustrating an example of a flow of future terminal location information provision processing according to the second embodiment of the present disclosure.

[0034] FIG. **24** is a diagram for describing an example of integration of information by a RAMNF according to the second embodiment of the present disclosure.

[0035] FIG. **25** is a sequence diagram illustrating an example of a flow of provision processing according to a registration condition according to a third embodiment of the present disclosure.

[0036] FIG. **26** is a table illustrating an example of group information according to the third embodiment of the present disclosure.

[0037] FIG. **27** is a sequence diagram illustrating another example of the flow of the provision processing according to the registration condition according to the third embodiment of the present disclosure.

[0038] FIG. **28** is a sequence diagram illustrating an example of a flow of provision processing according to a location condition according to the third embodiment of the present disclosure.

[0039] FIG. **29** is a sequence diagram illustrating an example of a flow of provision processing according to a power condition according to the third embodiment of the present disclosure.

[0040] FIG. **30** is a diagram illustrating an example of an information processing system according to a first application example of the present disclosure.

[0041] FIG. **31** is a diagram illustrating an example of an information processing system according to a second application example of the present disclosure.

DESCRIPTION OF EMBODIMENTS

[0042] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the appended drawings. Note that, in the present specification and the drawings, components having substantially the same functional configuration are provided with the same reference signs, so that an overlapping description of these components is omitted.

[0043] In addition, in the present specification and drawings, similar components of embodiments may be distinguished by adding different alphabets or numerals after the same reference sign. However, in a case where it is not necessary to particularly distinguish each of similar components, only the same reference sign is assigned. Each of one or more embodiments (including examples, modified examples, and application examples) described below can be implemented independently. On the other hand, at least some of the plurality of embodiments described below may be implemented in combination with at least some of other embodiments as appropriate. These plurality of embodiments may include novel characteristics different from each other. Therefore, these plurality of embodiments can contribute to achieve or solving different purposes or problems, and can exert different effects.

1. Introduction

1.1. Problem

[0044] In recent years, a technology related to a service using a 5G network has attracted attention. The 5G network and the service using the 5G network basically operate independently. Therefore, it is hard to say that a service side sufficiently uses information of a network side.

[0045] The service side can obtain some pieces of information of the network side by using a 5G application programming interface (API), but it cannot be said that sufficient information has been obtained. In addition, it cannot be said that the service side has sufficiently notified the network side of a request for information desired to be acquired.

[0046] For example, the service side can more appropriately perform communication with a terminal device by acquiring information regarding the terminal device that performs communication via the network. For example, the service side can select a terminal device corresponding to a service, such as a terminal device whose remaining power is equal to or more than a predetermined value or a terminal device located in a specific area, to perform communication by acquiring a power status and more detailed location information of the terminal device.

[0047] In this manner, a mechanism capable of more appropriately performing communication with the terminal device on the service side is required.

1.2. Overview of Proposed Technology

[0048] FIG. **1** is a diagram for describing an outline of an information processing system **1** according to an embodiment of the present disclosure. The information processing system **1** illustrated in FIG. **1** includes information processing devices **10**A to **10**C, a base station **20**, and a terminal device **40**.

[0049] The information processing device **10**A is, for example, a server device that implements a function of a core network CN (an example of a network). Here, one information processing device **10**A implements the function of the core network CN, but a plurality of information processing devices **10** may implement the function of the core network CN in cooperation with each other.

[0050] The information processing device **10**B is, for example, a server device that implements a function of a reachability management network function (RAMNF) **100**. The RAMNF **100** is a platform that notifies a service-side client **200** of information of the core network CN. Note that FIG. **1** illustrates a case where the RAMNF **100** is an NF (AF) different from the core network CN, but the RAMNF **100** may be implemented as an NF in the core network CN.

[0051] The information processing device **10**C is, for example, a server device (client device) that implements the function of the server-side client **200**. The client **200** provides a predetermined service to a user by, for example,

performing communication with the terminal device **40** or controlling the terminal device **40**.

[0052] The base station **20** is a wireless communication device that performs wireless communication with the terminal device **40**. The base station **20** is a type of communication device. The base station **20** is a type of information processing device.

[0053] The terminal device **40** is a wireless communication device that performs wireless communication with the base station **20**. The terminal device **40** is, for example, a mobile phone, a smart device (smartphone or tablet PC), a personal digital assistant (PDA), or a personal computer. For example, the terminal device **40** may be a machine to machine (M2M) device or an Internet of Things (IoT) device. Furthermore, the terminal device **40** may be a head mounted display, VR goggles, or the like. The terminal device **40** may be a mobile body such as a vehicle (automobile) or a drone.

[0054] For example, in a case where the terminal device **40** is a mobile phone, the client **200** provides a predetermined service to the user who uses the terminal device **40**. Furthermore, in a case where the terminal device **40** is an M2M device, an IoT device, or the like, the client **200** acquires data from the terminal device **40** or controls the terminal device **40**, thereby providing a predetermined service to the user.

[0055] As illustrated in FIG. **1**, the RAMNF **100** acquires first information regarding the terminal device **40** from the core network CN via a service based interface (SBI) (Step S**1**). The first information includes, for example, registration information (for example, registered/de-registered, connected/idle, or the like) regarding registration of the terminal device **40**.

[0056] The RAMNF **100** acquires terminal-related information acquired from the terminal device **40** directly or via the SBI (Step S**2**). The RAMNF **100** acquires measurement information measured based on the first information (Step S**3**). Note that the RAMNF **100** may acquire at least one of the terminal-related information or the measurement information. Hereinafter, the measurement information and/or the terminal-related information are also collectively referred to as second information.

[0057] The measurement information includes information regarding a transition interval of registration of the terminal device **40** calculated based on the registration information. The terminal-related information includes, for example, information included in an application layer of the terminal device **40**. More specifically, the terminal-related information includes, for example, at least one of schedule information regarding a registration schedule, power information regarding power consumption of the terminal device **40**, and location information regarding a location of the terminal device **40**.

[0058] The RAMNF **100** specifies the terminal device **40** from the second information or by associating the first information and the second information with each other (Step S**4**). The RAMNF **100** specifies the terminal device **40** by using, for example, the second information and/or information (for example, a UE ID such as an international mobile subscriber identity (IMSI) or a subscription permanent identifier (SUPI)) for specifying the terminal device **40** included in the first information. The RAMNF **100** notifies the client **200** of at least one of the first information or the second information in association with the specified terminal device **40** (Step S**5**).

[0059] As a result, the client **200** can acquire more detailed information of the terminal device **40**, and can more appropriately communicate with the terminal device **40**. For example, the client **200** can select a terminal device **40** located in a predetermined area to perform communication, or can select a terminal device **40** with sufficient power remaining to perform communication.

2. Configuration of Communication System

2.1. Example of Configuration of Information Processing Device

[0060] The information processing device **10** is an information processing device (computer) connected to a network N (see FIG. **1**). For example, the information processing device **10** is an information processing device that implements at least a part of the function of the core network CN. For example, the information processing device **10** is an information processing device that implements at least a part of the function of the RAMNF **100**. For example, the information processing device **10** is an information processing device that implements at least a part of the function of the client **200**.

[0061] FIG. **2** is a diagram illustrating an example of a configuration of the information processing device **10** according to an embodiment of the present disclosure. The information processing device **10** includes a communication unit **11**, a storage unit **12**, and a control unit **13**. Note that the configuration illustrated in FIG. **2** is a functional configuration, and a hardware configuration may be different from this. Furthermore, the functions of the information processing device **10** may be statically or dynamically distributed to and implemented in a plurality of physically separated components. For example, the information processing device **10** may be implemented by a plurality of server devices.

[0062] The communication unit **11** is a communication interface for performing communication with another device. The communication unit **11** may be a network interface or may be an equipment connection interface. For example, the communication unit **11** may be a local area network (LAN) interface such as a network interface card (NIC), or may be a universal serial bus (USB) interface including a USB host controller, a USB port, and the like. Further, the communication unit **11** may be a wired interface or a wireless interface. The communication unit **11** functions as communication means of the information processing device **10**. The communication unit **11** communicates with another information processing device **10**, the base station **20**, and the like under the control of the control unit **13**.

[0063] The storage unit **12** is a storage device, from which data can be read and in which data can be written, such as a dynamic random access memory (DRAM), a static random access memory (SRAM), a flash memory, or a hard disk. The storage unit **12** functions as storage means of the information processing device **10**.

[0064] The control unit **13** is a controller that controls each unit of the information processing device **10**. The control unit **13** is implemented by, for example, a processor such as a central processing unit (CPU), a micro processing unit (MPU), or a graphics processing unit (GPU). For example,

the control unit **13** is implemented in a manner in which the processor executes various programs stored in the storage device inside the information processing device **10** by using a random access memory (RAM) or the like as a work area. Note that the control unit **13** may be implemented by an integrated circuit such as an application specific integrated circuit (ASIC) or a field programmable gate array (FPGA). The CPU, the MPU, the GPU, the ASIC, and the FPGA can all be regarded as the controller.

2.2. Example of Configuration of Base Station

[0065] The base station **20** is a communication device that operates a cell and provides a wireless communication service to one or more terminal devices **40** located inside the coverage of the cell. The cell can be operated according to any wireless communication scheme such as LTE or New Radio (NR). The base station **20** is connected to the core network CN. The core network CN is connected to a packet data network via a gateway device.

[0066] Note that the base station **20** may include a set of a plurality of physical or logical devices. For example, in an embodiment of the present disclosure, the base station **20** is classified into a plurality of devices including a baseband unit (BBU) and a radio unit (RU), and may be interpreted as a set of these plurality of devices. In addition or instead, in the embodiments of the present disclosure, the base station **20** may be either or both of the BBU and the RU. The BBU and the RU may be connected by a predetermined interface (for example, eCPRI). In addition or instead, the RU may be referred to as a remote radio unit (RRU) or a Radio DoT (RD). In addition or instead, the RU may correspond to a gNB distributed unit (gNB-DU) described below. In addition or instead, the BBU may correspond to a gNB-CU described below. Instead, the RU may be connected to the gNB-DU described below. In addition, the BBU may correspond to a combination of the gNB-CU and the gNB-DU described below. In addition or instead, the RU may be a device integrally formed with an antenna. An antenna of the base station **20** (for example, the antenna integrally formed with the RU) may adopt an advanced antenna system and support MIMO (for example, FD-MIMO) or beamforming. In the advanced antenna system, the antenna of the base station **20** (for example, the antenna integrally formed with the RU) may include, for example, 64 transmission antenna ports and 64 reception antenna ports.

[0067] Further, a plurality of base stations **20** may be connected to each other. One or more base stations **20** may be included in the radio access network (RAN). That is, the base station **20** may be simply referred to as a RAN, a RAN node, an access network (AN), or an AN node. The RAN in the LTE is referred to as an enhanced universal terrestrial RAN (EUTRAN). The RAN in the NR is referred to as an NGRAN. The RAN in W-CDMA (UMTS) is referred to as a UTRAN. The base station **20** in the LTE is referred to as an evolved node B (eNodeB) or an eNB. That is, the EUTRAN includes one or more eNodeBs (eNBs). Further, the base station **20** in the NR is referred to as a gNodeB or a gNB. That is, the NGRAN includes one or more gNBs. Further, the EUTRAN may include a gNB (ng-eNB) connected to the core network (EPC) in the communication system (EPS) of the LTE. Similarly, the NGRAN may include a gNB connected to the core network (5GC) in the 5G communication system (5GS). In addition or instead, in a case where the base station **20** is an eNB, a gNB, or the like, the base station may be referred to as 3GPP access. In addition or instead, in a case where the base station **20** is a wireless access point (e.g., an access point of WiFi (registered trademark)), the base station **20** may be referred to as non-3GPP access. In addition or instead, the base station **20** may be an optical feeder device which is called a remote radio head (RRH). In addition or instead, in a case where the base station **20** is a gNB, the base station **20** may be referred to as a combination of a gNB central unit (CU) and a gNB distributed unit (DU) described above or any of them. The gNB central unit (CU) hosts a plurality of higher layers (for example, radio resource control (RRC), service data adaptation protocol (SDAP), and PDCP) of the access stratum for communication with the UE. On the other hand, the gNB-DU hosts a plurality of lower layers (for example, RLC, MAC, and PHY) of the access stratum. That is, among messages and information to be described later, RRC signaling (for example, various system information blocks (SIB) including a master information block (MIB) and an SIB1, an RRCSetup message, and an RRCReconfiguration message) may be generated by the gNB CU, while a downlink control indicator (DCI) and various physical channels (for example, a PDCCH and a PBCH) to be described later may be generated by the gNB-DU. Alternatively, in the RRC signaling, for example, some configurations (configuration information) such as IE: cellGroupConfig may be generated by the gNB-DU, and the remaining configurations may be generated by the gNB-CU. These configurations (configuration information) may be transmitted and received by an F1 interface to be described later. The base station **20** may be configured to be able to perform communication with another base station **20**. For example, in a case where a plurality of base stations **20** are eNBs or a combination of eNBs and gn-eNBs, the base stations **20** may be connected by an X2 interface. In addition or instead, in a case where a plurality of base stations **20** are eNBs or a combination of gn-eNBs and gNBs, the devices may be connected by an Xn interface. In addition or instead, in a case where a plurality of base stations **20** are a combination of gNB CUs and gNB DUs, the devices may be connected by the above-described F1 interface. The messages/information (RRC signaling, DCI information, or physical channel) to be described later may be communicated between a plurality of base stations **20** (for example, via the X2, Xn, or F1 interface).

[0068] Further, as described above, the base station **20** may be configured to manage a plurality of cells. A cell provided by the base station **20** is called a serving cell. The serving cell includes a primary cell (PCell) and a secondary cell (SCell). In a case where Dual Connectivity (for example, EUTRA-EUTRA Dual Connectivity, EUTRA-NR Dual Connectivity (ENDC), EUTRA-NR Dual Connectivity with 5GC, NREUTRA Dual Connectivity (NEDC), or NR-NR Dual Connectivity) is provided to the UE (for example, terminal device **40**), the PCell and zero or one or more SCells provided by a master node (MN) are referred to as a master cell group. Further, the serving cell may include a primary secondary cell or a primary SCG Cell (PSCell). That is, in a case where the Dual Connectivity is provided to the UE, the PSCell and zero or one or more SCells provided by a secondary node (SN) are referred to as a secondary cell group (SCG). Unless specially configured (for example, physical uplink control channel (PUCCH) on SCell), the PUCCH is transmitted by the PCell and the PSCell, not by the SCell. Radio link failure is detected in the

PCell and the PSCell, and is not detected (does not have to be detected) in the SCell. Since the PCell and the PSCell have a special role in the serving cell(s) as described above, they are also called special cells (SpCells). One downlink component carrier and one uplink component carrier may be associated with one cell. Further, a system bandwidth corresponding to one cell may be divided into a plurality of bandwidth parts. In this case, one or more bandwidth parts (BWPs) may be set in the UE and one bandwidth part may be used in the UE as an active BWP. Further, radio resources (for example, a frequency band, numerology (subcarrier spacing), and slot configuration) that can be used by the terminal device **40** may be different for each cell, each component carrier, or each BWP.

[0069] FIG. **3** is a diagram illustrating an example of a configuration of the base station **20** according to an embodiment of the present disclosure. The base station **20** is a communication device (wireless system) that performs wireless communication with the terminal device **40**. The base station **20** is a type of information processing device.

[0070] The base station **20** includes a signal processing unit **21**, a storage unit **22**, a network communication unit **23**, and a control unit **24**. Note that the configuration illustrated in FIG. **3** is a functional configuration, and a hardware configuration may be different from this. Further, the functions of the base station **20** may be distributed to and implemented in a plurality of physically separated devices.

[0071] The signal processing unit **21** is a wireless communication interface that performs wireless communication with other communication devices (for example, the terminal device **40** and another base station **20**). The signal processing unit **21** is a wireless transceiver that operates under the control of the control unit **24**. The signal processing unit **21** may support a plurality of radio access schemes. For example, the signal processing unit **21** may support both NR and LTE. The signal processing unit **21** may support another cellular communication scheme such as W-CDMA or cdma2000. Further, the signal processing unit **21** may support a wireless LAN communication scheme in addition to the cellular communication scheme. It is a matter of course that the signal processing unit **21** may only support one radio access scheme.

[0072] The signal processing unit **21** includes a reception processing unit **211**, a transmission processing unit **212**, and an antenna **213**. The signal processing unit **21** may include a plurality of reception processing units **211**, a plurality of transmission processing units **212**, and a plurality of antennas **213**. Note that, in a case where the signal processing unit **21** supports a plurality of radio access schemes, each unit of the signal processing unit **21** can be individually configured for each radio access scheme. For example, in a case where the base station **20** supports NR and LTE, the reception processing unit **211** and the transmission processing unit **212** may be individually configured for each of NR and LTE.

[0073] The reception processing unit **211** processes an uplink signal received via the antenna **213**. The reception processing unit **211** includes a wireless reception unit **211***a*, a demultiplexing unit **211***b*, a demodulation unit **211***c*, and a decoding unit **211***d*.

[0074] The wireless reception unit **211***a* performs, on the uplink signal, down-conversion, removal of an unnecessary frequency component, a control of an amplification level, quadrature demodulation, conversion into a digital signal, removal of a guard interval, extraction of a frequency domain signal by fast Fourier transform, and the like. For example, it is assumed that the radio access scheme of the base station **20** is a cellular communication scheme such as LTE. At this time, the demultiplexing unit **211***b* separates an uplink channel such as a physical uplink shared channel (PUSCH) or physical uplink control channel (PUCCH) and an uplink reference signal from a signal output from the wireless reception unit **211***a*. The demodulation unit **211***c* performs demodulation of a reception signal for a modulation symbol of the uplink channel by using a modulation scheme such as binary phase shift keying (BPSK) or quadrature phase shift keying (QPSK). The modulation scheme used by the demodulation unit **211***c* may be multi-level QAM such as 16-quadrature amplitude modulation (QAM), 64-QAM, or 256-QAM. The decoding unit **211***d* performs decoding processing on a coded bit of the demodulated uplink channel. Decoded uplink data and uplink control information are output to the control unit **24**.

[0075] The transmission processing unit **212** performs transmission processing of downlink control information and downlink data. The transmission processing unit **212** includes a coding unit **212***a*, a modulation unit **212***b*, a multiplexing unit **212***c*, and a wireless transmission unit **212***d*.

[0076] The coding unit **212***a* codes the downlink control information and the downlink data input from the control unit **24** by using a coding method such as block coding, convolutional coding, or turbo coding. The modulation unit **212***b* modulates the coded bit output from the coding unit **212***a* by a predetermined modulation scheme such as BPSK, QPSK, 16-QAM, 64-QAM, or 256-QAM. The multiplexing unit **212***c* multiplexes a modulation symbol of each channel and a downlink reference signal, and maps them to a predetermined resource element. The wireless transmission unit **212***d* performs various kinds of signal processing on a signal from the multiplexing unit **212***c*. For example, the wireless transmission unit **212***d* performs processing such as conversion into the time domain by fast Fourier transform, addition of a guard interval, generation of a baseband digital signal, conversion into an analog signal, quadrature modulation, up-conversion, removal of extra frequency components, or power amplification. A signal generated by the transmission processing unit **212** is transmitted from the antenna **213**.

[0077] The storage unit **22** is a storage device, from which data can be read and in which data can be written, such as a DRAM, an SRAM, a flash memory, or a hard disk. The storage unit **22** functions as a storage means of the base station **20**.

[0078] The network communication unit **23** is a communication interface for communicating with other devices (for example, another base station **20**). For example, the network communication unit **23** is a local area network (LAN) interface such as a network interface card (NIC). The network communication unit **23** may be a universal serial bus (USB) interface including a USB host controller, a USB port, and the like. Further, the network communication unit **23** may be a wired interface or a wireless interface. The network communication unit **23** functions as a network communication means of the base station **20**. The network communication unit **23** performs communication with another device under the control of the control unit **24**.

[0079] The control unit **24** is a controller that controls each unit of the base station **20**. The control unit **24** is imple-

mented by, for example, a processor such as a central processing unit (CPU) or a micro processing unit (MPU). For example, the control unit **24** is implemented in a manner in which the processor executes various programs stored in the storage device inside the base station **20** by using a random access memory (RAM) or the like as a work area. Note that the control unit **24** may be implemented by an integrated circuit such as an application specific integrated circuit (ASIC) or a field programmable gate array (FPGA). The CPU, the MPU, the ASIC, and the FPGA can all be regarded as the controller.

2.3. Example of Configuration of Terminal Device

[0080] The terminal device **40** is a communication device that performs wireless communication with the base station **20** under the control of the base station **20**.

[0081] The terminal device **40** is a wireless communication device that performs wireless communication with other devices. The terminal device **40** is, for example, a sensor or a camera device having a communication function, a mobile phone, a smart device (smartphone or tablet PC), a personal digital assistant (PDA), or a personal computer. The terminal device **40** may be a head mounted display having a function of wirelessly transmitting and receiving data, VR goggles, or the like. The terminal device **40** may be a mobile body such as an automobile or a drone.

[0082] For example, the terminal device **40** performs wireless communication with another terminal device **40** under the control of the base station **20** or autonomously. In this case, the terminal device **40** transmits a sidelink signal to another terminal device **40** and receives a sidelink signal from another terminal device **40** in PC5 link. Transmission and reception of the sidelink signal by the terminal device **40** will be collectively referred to as sidelink communication. When performing the sidelink communication, the terminal device **40** may be able to use automatic retransmission technology such as hybrid automatic repeat request (HARQ).

[0083] The terminal device **40** may be capable of non-orthogonal multiple access (NOMA) communication with the base station **20**. The terminal device **40** may also be able to perform the NOMA communication for communication (sidelink) with another terminal device **40**. Furthermore, the terminal device **40** may be able to perform low power wide area (LPWA) communication with another communication device (for example, the base station **20** and another terminal device **40**). In addition, wireless communication used by the terminal device **40** may be wireless communication using millimeter waves or terahertz waves. Note that the wireless communication (including the sidelink communication) used by the terminal device **40** may be wireless communication using radio waves or may be (optical) wireless communication using infrared rays or visible light.

[0084] FIG. **4** is a diagram illustrating an example of the configuration of the terminal device **40** according to an embodiment of the present disclosure. The terminal device **40** is a communication device (wireless system) that performs wireless communication with the base station **20**. The terminal device **40** is a type of information processing device.

[0085] The terminal device **40** includes a signal processing unit **41**, a storage unit **42**, an input/output unit **44**, and a control unit **45**. Note that the configuration illustrated in FIG. **4** is a functional configuration, and a hardware configuration may be different from this. Further, the functions of the terminal device **40** may be distributed to and implemented in a plurality of physically separated components.

[0086] The signal processing unit **41** is a wireless communication interface that performs wireless communication with other communication devices (for example, the base station **20** and another terminal device **40**). The signal processing unit **41** is a wireless transceiver that operates under the control of the control unit **45**. The signal processing unit **41** supports one or more radio access schemes. For example, the signal processing unit **41** supports both NR and LTE. The signal processing unit **41** may support another radio access scheme such as W-CDMA or cdma2000.

[0087] The signal processing unit **41** includes a reception processing unit **411**, a transmission processing unit **412**, and an antenna **413**. The signal processing unit **41** may include a plurality of reception processing units **411**, a plurality of transmission processing units **412**, and a plurality of antennas **413**. Note that, in a case where the signal processing unit **41** supports a plurality of radio access schemes, each unit of the signal processing unit **41** can be individually configured for each radio access scheme. For example, the reception processing unit **411** and the transmission processing unit **412** may be individually configured for each of LTE and NR. The configurations of the reception processing unit **411** and the transmission processing unit **412** are similar to those of the reception processing unit **211** and the transmission processing unit **212** of the base station **20**.

[0088] The storage unit **42** is a storage device, from which data can be read and in which data can be written, such as a DRAM, an SRAM, a flash memory, or a hard disk. The storage unit **42** functions as storage means of the terminal device **40**.

[0089] The input/output unit **44** is a user interface for exchanging information with the user. For example, the input/output unit **44** is an operation device for the user to perform various operations, such as a keyboard, a mouse, an operation key, or a touch panel. Alternatively, the input/output unit **44** is a display device such as a liquid crystal display or an organic electroluminescence (EL) display. The input/output unit **44** may be an audio device such as a speaker or a buzzer. Further, the input/output unit **44** may be a lighting device such as a light emitting diode (LED) lamp. The input/output unit **44** functions as input/output means (input means, output means, operation means, or notification means) of the terminal device **40**.

[0090] The control unit **45** is a controller that controls each unit of the terminal device **40**. The control unit **45** is implemented by, for example, a processor such as a CPU or an MPU. For example, the control unit **45** is implemented in a manner in which the processor executes various programs stored in the storage device inside the terminal device **40** by using a RAM or the like as a work area. Note that the control unit **45** may be implemented by an integrated circuit such as an ASIC or a FPGA. The CPU, the MPU, the ASIC, and the FPGA can all be regarded as the controller.

3. Network Architecture

[0091] The configuration of the information processing system **1** has been described above. Next, a network architecture applicable to the information processing system **1** of the present embodiment will be described. An architecture of a fifth generation mobile communication system (5G) will be described below as an example of the core network CN

of the information processing system **1**. The 5G architecture described herein is described, for example, in 3GPP TS23.501.

[0092] FIG. **5** is a diagram illustrating an example of the 5G architecture. The core network CN of 5G is also referred to as 5G core/next generation core (5GC/NGC). Hereinafter, the core network CN of 5G is also referred to as the 5GC/NGC. The core network CN is connected to a user equipment (UE) **40** via a (R)AN **20**. The UE **40** is, for example, the terminal device **40**.

[0093] The (R)AN **20** has a function of enabling connection to a radio access network (RAN) and connection to an access network (AN) other than the RAN. The (R)AN **20** includes the base station **20** called a gNB or an ng-eNB.

[0094] The core network CN mainly performs connection permission and session management when the UE **40** is connected to the network. The core network CN can include a user plane function group **420** and a control plane function group **440**.

[0095] The user plane function group **420** includes a user plane function (UPF) **421** and a data network (DN) **422**. The UPF **421** has a user plane processing function. The UPF **421** has a function of routing/forwarding data handled in user plane. The DN **422** is, for example, an entity that provides access to a service unique to an operator such as a mobile network operator (MNO), and has a function of providing Internet connection providing access to a service of a third party. As described above, the user plane function group **420** plays a role of a gateway serving as a boundary between the core network CN and the Internet.

[0096] The control plane function group **440** includes an access management function (AMF) **441**, a session management function (SMF) **442**, an authentication server function (AUSF) **443**, a network slice selection function (NSSF) **444**, a network exposure function (NEF) **445**, a network repository function (NRF) **446**, a policy control function (PCF) **447**, a unified data management (UDM) **448**, and an application function (AF) **449**.

[0097] The AMF **441** has functions such as registration processing, connection management, and mobility management for the UE **40**. The SMF **442** has functions such as session management and IP assignment and management for the UE **40**. The AUSF **443** has an authentication function. The NSSF **444** has a function related to selection of a network slice. The NEF **445** has a function of providing network function capabilities and events to a third party, the AF **449**, and an edge computing function.

[0098] The NRF **446** has a function of finding a network function and holding a profile of the network function. The PCF **447** has a policy control function. The UDM **448** has functions of generating 3GPP AKA authentication information and processing a user ID. The AF **449** has a function of interacting with the core network CN to provide a service.

[0099] For example, the control plane function group **440** acquires information from the UDM **448** in which subscriber information of the UE **40** is stored, and determines whether or not the UE **40** may be connected to the network. The control plane function group **440** uses contract information of the UE **40** included in the information acquired from the UDM **448** and a key for encryption for such determination. In addition, the control plane function group **440** generates the key for encryption and the like.

[0100] That is, the control plane function group **440** determines whether or not connection to the network can be made according to whether or not information of the UE **40** associated with a subscriber number called international mobile subscriber identity (IMSI) is stored in the UDM **448**, for example. Note that the IMSI is stored in, for example, a subscriber identity module (SIM) card in the UE **40**.

[0101] Here, Namf is a service-based interface provided by the AMF **441**, and Nsmf is a service-based interface provided by the SMF **442**. In addition, Nnef is a service-based interface provided by the NEF **445**, and Npcf is a service-based interface provided by the PCF **447**. Nudm is a service-based interface provided by the UDM **448**, and Naf is a service-based interface provided by the AF **449**. Nnrf is a service-based interface provided by the NRF **446**, and Nnssf is a service-based interface provided by the NSSF **444**. Nausf is a service-based interface provided by the AUSF **443**. Each of the network functions (NF) exchanges information with another NF via each service-based interface.

[0102] In addition, N1 illustrated in FIG. **5** is a reference point between the UE **40** and the AMF **441**, and N2 is a reference point between the (R)AN **20** and the AMF **441**. N4 is a reference point between the SMF **442** and the UPF **421**, and information is exchanged between the network functions (NFs).

[0103] As described above, in the core network CN, an interface that transmits information and controls functions via an application programming interface (API) called a service-based interface (SBI) is prepared.

[0104] The API specifies a resource and enables GET (resource acquisition), POST (resource creation and data addition), PUT (resource creation and resource update), DELETE (resource deletion), and the like for the resource. Such a function is generally used, for example, in the technical field related to the web.

[0105] For example, the AMF **441**, the SMF **442**, and the UDM **448** illustrated in FIG. **5** transmit and receive information with each other by using the API in a case of establishing a communication session. Hitherto, it has not been assumed that an application (for example, the AF **449**) uses such an API. However, as the AF **449** uses such an API, the AF **449** can use information of a 5G cellular network, and it is considered that a function of the application can be further evolved.

[0106] Note that it is difficult for the AF **449** to use the API used by the AMF **441**, the SMF **442**, and the UDM **448** in a public network. However, in a case of a non-public private 5G network, it is considered that the system can include, for example, a modification of the API of the core network CN so that the AF **449** can use such an API.

(Private 5G)

[0107] Here, an example of the non-public private 5G network will be described. FIG. **6** is a diagram for describing an example of a configuration of the private 5G network according to an embodiment of the present disclosure.

[0108] Currently, a local area network (LAN) is arranged in many offices and homes. The LAN includes, for example, an Ethernet cable, a router, or the like. The LAN is connected to the Internet by using a service of an Internet service provider (ISP). The LAN and a cloud are connected via, for example, a virtual private network (VPN). In the VPN, a packet is basically routed by a private IP address. In

a case where a packet is transmitted outside the VPN, the packet is transmitted outside the VPN via a gateway router (not illustrated).

[0109] The private 5G is operated by placing the cellular base station **20** in the LAN. That is, in the private 5G, a plurality of base stations **20_1** to **20**_M (M is a natural number), a plurality of UEs **40_1** to **40**_N (N is a natural number), and some functions of the core network CN are arranged in the LAN. In addition, the remaining functions of the core network CN are arranged, for example, in a data center of the cloud of the Internet line.

[0110] In the example of FIG. **6**, UPFs **421_1** to **421**_*p* (p is a natural number, and p≤P) are arranged in the LAN. UPFs **421**_*p*+1 to **421**_P (P is a natural number) are arranged in the cloud of the Internet line. Note that, here, the UPF **421** is arranged in the LAN or/and the cloud, but instead of this, the user plane function group **420** may be arranged in the LAN or/and the cloud.

[0111] In addition, the control plane function group **440** (hereinafter, also referred to as CPF **440**) is arranged in the Cloud of the Internet line.

[0112] As described above, in the private 5G, the base station **20** and the UE **40** are arranged in an office, a factory, or a private residence where the LAN is arranged. Meanwhile, the core network CN that controls the base station **20** may be arranged in the LAN or may be arranged in the data center of the cloud in the Internet. Note that FIG. **6** is an example, and at least some functions of the CPF **440** may be arranged in the LAN. In addition, all the UPFs **421** may be arranged in the LAN, or may be arranged in the cloud.

[0113] A private IP address is assigned to the base station **20** and the core network CN. The base station **20** and the core network CN are arranged in an environment in which the base station **20** and the core network CN can communicate with each other. For example, by using a technology such as the VPN, the base station **20** and the core network CN can communicate with each other using the private IP address.

[0114] That is, a network connecting the base station **20** and the core network CN can be treated as a private network.

[0115] Note that the UPFs **421_1** to **421**_*p* arranged in the LAN exist in the LAN when the CPF **440** is started or when the operation of the core network CN is started. On the other hand, the UPFs **421**_*p*+1 to **421**_P arranged in the cloud do not exist in the Cloud when the CPF **440** is started or when the operation of the core network CN is started. The UPFs **421**_p+1 to **421**_P are, for example, a function that is started after the CPF **440** is started or after the operation of the core network CN is started.

[0116] In summary, the private 5G may be a non-public network. In practice, there is a high possibility that the UE **40**, the base station **20**, the core network CN, and the application having the client function are arranged inside the VPN. The UE **40** and the base station **20** are arranged in the LAN. The core network CN and the application may be arranged in either the LAN or the cloud of the Internet.

(API)

[0117] Here, an example of the API will be described. FIG. **7** is a diagram for describing the API according to an embodiment of the present disclosure. API(1) to API(4) described here are described in 3GPP TS23.502.

[0118] As described above, the UE **40**, the base station **20**, and the core network CN are arranged in the virtual LAN (VPN **500**). The base station **20** and the core network CN communicate with a network outside the VPN (for example, the Internet) via a gateway router **510**.

API(1)

[0119] API(1) is an API with which the SMF **442** makes a notification of the fact that the UE **40** registered in advance transitions from a power-off state to a power-on state and is attached to the network, and an IP address acquired at that time.

[0120] The SMF **442** notifies the NF when the UE **40** of the registered IMSI obtains the IP address, by using API(1).

API(2)

[0121] The UE **40** enters an idle mode in a case where communication is not performed, and transitions to a connected mode in a case where communication is performed. API(2) is an API with which the AMF **441** makes a notification of whether the UE **40** is in the idle mode or the connected mode.

API(3)

[0122] API(3) is an API for broadcasting, from the base station **20**, a message (paging message) for instructing the UE **40** to transition from the idle mode to the connected mode. API(3) can be used, for example, when a packet addressed to the UE **40** in the idle mode arrives at the UPF **421**.

API(4)

[0123] API(4) is an API with which the AMF **441** provides the location information of the UE **40**. The AMF **441** may use the API(4) to inform which tracking area the UE **40** is in, which cell the UE **40** belongs to, and the fact that the UE **40** enters a specific region when the UE **40** enters the specific region.

[0124] Note that the location information obtained by using API(4) is, for example, information with lower accuracy than location information obtained by the global positioning system (GPS). For example, the location information obtained by the GPS is information in units of longitude and latitude, whereas the location information obtained by using API(4) is, for example, information in units of cells of the base stations **20**.

[0125] For example, the location information obtained by the GPS is location information of the application layer of the UE **40** on which the GPS is mounted. On the other hand, the location information obtained by API(4) is location information provided from 3GPP RAN **1** by the AMF **441**. An API(API(4)) for acquiring location information of 3GPP RAN **1** is provided in the AMF **441**.

[0126] Note that an example of the UE **40** of FIG. **5** is the terminal device **40** of the present embodiment. An example of the (R)AN **20** is the base station **20** of the present embodiment. Furthermore, the information processing device **10** illustrated in FIG. **2** is an example of a device having each function of the core network CN, for example.

4. Technical Features

4.1. RAMNF

4.1.1. Outline of RAMNF

[0127] Here, in the conventional 5G, the network function (NF) of the core network CN uses an API of a 5G service based interface. In the present embodiment, as a platform called the RAMNF **100** is provided, the service and the application, that is, the client **200** and the terminal device **40** can more easily obtain the information of the core network CN. As a result, the service provided by the client **200** can be further evolved.

[0128] FIG. **8** is a diagram illustrating an example of the information processing system **1** according to an embodiment of the present disclosure. As illustrated in FIG. **8**, the client **200** for the service transmits and receives user data with the UPF **421** via the RAMNF **100** or directly. In addition, the client **200** communicates with the CPF **440** via the RAMNF **100**. The RAMNF **100** performs communication with the AMF **441** and the SMF **442** via an SBI API.

[0129] For example, the service-side client **200** inquires of the RAMNF **100** about a status of a target terminal device **40** (that is, a terminal device **40** with which communication is to be performed) before communicating with the terminal device **40**.

[0130] In a case where a result of the inquiry indicates that the terminal device **40** is deregistered (a state in which the IP address is not assigned), the client **200** does not perform communication with the terminal device **40**. As a result, the client **200** can refrain from transmitting an unnecessary packet.

[0131] Furthermore, even in a case where the terminal device **40** is registered (a state in which the IP address is assigned), when the terminal device **40** is in the idle status, the client **200** can be prevented from performing communication with the terminal device **40**.

[0132] When a packet is transmitted to the terminal device **40** in the idle status, paging is automatically transmitted to the terminal device **40**, and the terminal device **40** is activated (transitions to the connected status). For example, in a case where the terminal device **40** is a low power consumption type device, the client **200** can refrain from transmitting a packet to the terminal device **40** in the idle status and transmit a packet to the terminal device **40** in the connected status. As a result, the client **200** can prevent the terminal device **40** from being unnecessarily activated, and the power consumption of the terminal device **40** can be further reduced.

[0133] Furthermore, in a case where the terminal device **40** is not a low power consumption type device, the client **200** can transmit a packet to the terminal device **40** in the idle status. At this time, for example, it is assumed that the client **200** transmits the paging message to the terminal device **40** in advance by using the API of the AMF **441** via the RAMNF **100** before transmitting the packet.

[0134] For example, in a normal cellular system, the client **200** transmits a packet to the terminal device **40** in the idle status without causing the terminal device **40** transition to the connected status. In this case, after the packet arrives at the UPF **421**, the paging message for causing the terminal device **40** to transition to the connected status is transmitted. Therefore, in a normal cellular system, a large delay occurs when a packet is transmitted to the terminal device **40** in the idle status.

[0135] On the other hand, as described above, as the RAMNF **100** is used, the client **200** according to the present embodiment can make the status of the terminal device **40** transition to the connected status before actually transmitting a packet to the terminal device **40**. As a result, the client **200** can further reduce a packet delay time.

4.1.2. Problem of RAMNF

[0136] It is considered that there is an increasing demand for obtaining more detailed information of the network (for example, the core network CN) by the client **200** providing the service. This is because a service quality that is higher than before (for example, low delay and low power consumption) is expected by cooperation between the network and the service.

[0137] As described above, in order for the RAMNF **100** to transmit more detailed information of the network to the client **200**, the RAMNF **100** is required to collect more detailed information of the network.

[0138] Here, the network includes, for example, at least one of the following statuses.

[0139] Status of base station **20**

[0140] Status of core network CN

[0141] Status of terminal device **40**

[0142] Traffic status

[0143] Status of capability of at least one of base station **20**, core network CN, or terminal device **40**

[0144] A mechanism for collecting more detailed information regarding these Statuses is required.

[0145] Next, the RAMNF **100** can be required to more efficiently deliver information regarding the network to the client **200**. For example, the RAMNF **100** transmits information regarding a plurality of terminal devices **40** as a group to the client **200**, so that the client **200** can more appropriately grasp the information of the network in some cases.

[0146] Finally, there may be a case where the client **200** desires to control the status of the network in more detail. This is because it may be more beneficial for the service if the network operates as desired by the client **200**.

[0147] As described above, it is desirable that the RAMNF **100** further has the following functions.

[0148] (1) Function of collecting more detailed information of network

[0149] (2) Function of providing information of network to client **200** in easy-to-understand manner

[0150] (3) Function for performing control by client **200** in more detail

[0151] Hereinafter, more detailed problems and solutions for implementing these functions will be described. Note that, since (1) and (2) can operate integrally, the problems and solutions of (1) and (2) can be simultaneously described.

4.2. First Embodiment

4.2.1. First Problem

[0152] It is desirable that the client **200** can know a time after which the terminal device **40** transitions from the connected mode (status) to the idle mode (status) if no communication is performed. That is, it cannot be said that

the client **200** can properly grasp the information of the network. In other words, it is desirable to enable the RAMNF **100** to collect more detailed registration information regarding the registration of the terminal device **40**.

[0153] As the API of the 5G SBI, for example, the API of paging (a function of calling the terminal device **40** in the idle mode) of the AMF **441**, is used, the RAMNF **100** can instruct the terminal device **40** in the idle mode to transition to the connected mode.

[0154] Here, the idle mode means an RRC idle status, and means a state in which a wireless section between the terminal device **40** and the base station **20** is disconnected. In addition, the connected mode means an RRC connected status, and means a state in which the wireless section between the terminal device **40** and the base station **20** is connected.

[0155] The RAMNF **100** can cause the terminal device **40** transition to the connected mode by activating the API of the AMF **441** in response to a request from the client **200**. As a result, the RAMNF **100** can cause a counterpart terminal device **40** with which the client **200** desires to communicate to transition to the connected mode in advance at a timing when the client **200** starts communication.

[0156] It is desirable to enable the RAMNF **100** to know a time after which the terminal device **40** transitions to the idle mode after transitioning to the connected mode once. That is, it is desirable that the RAMNF **100** can know idle transition time information indicating a time until the terminal device **40** transitions from the connected mode to the idle mode.

[0157] For example, in a case where the RAMNF **100** cannot know the idle transition time information, the RAMNF **100** needs to acquire the registration information regarding the registration of the terminal device **40** by using the API of the AMF **441** before the client **200** transmits a packet. Here, the registration information includes information indicating the status of the terminal device **40** (for example, whether the terminal device **40** is in the connected mode or the idle mode).

[0158] In a case where the terminal device **40** is in the idle mode, the RAMNF **100** needs to perform paging control by using the API of the AMF **441** to cause the terminal device **40** to transition to the connected mode.

[0159] An idle transition time is different for each terminal device **40**. For example, some of the terminal devices **40** transition to the idle mode in about one second, and some of the terminal devices **40** transition to the idle mode in about six seconds. In such a state where the idle transition time is uncertain, it cannot be said that the RAMNF **100** transmits appropriate information of the network to the client **200**.

[0160] The idle transition time (idle return time) is configured by the base station **20** according to the capability of the terminal device **40**. FIG. **9** is a sequence diagram illustrating an example of configuration of the idle transition time by the base station **20**. The sequence illustrated in FIG. **9** is described in, for example, Section 5.19 of 3GPP TS38.321 or Section 5.3.9 of TS38.331.

[0161] As illustrated in FIG. **9**, the base station **20** configures a time during which the terminal device **40** transitions to the idle mode (data inactivity timer) according to the capability of the terminal device **40**. From this, it is considered that the idle transition time is a value configured according to both the terminal device **40** and the base station **20**. However, it is difficult for the RAMNF **100** to acquire information regarding the configuration performed by the base station **20** (for example, information regarding the data inactivity timer) from all the base stations **20**, and it is thus not easy to acquire the idle transition time information.

4.2.2. Example of Solution for First Problem

[0162] FIG. **10** is a sequence diagram illustrating an example of a flow of first information processing according to a first embodiment of the present disclosure. The first information processing illustrated in FIG. **10** is performed by the information processing system **1**.

[0163] As illustrated in FIG. **10**, the CPF **440** (for example, the AMF **441**) on a network side configures a data inactive timer value for the UE **40** (terminal device **40**) (Step S**101**).

[0164] The AMF **441** configures the value (data inactive timer value) in consideration of the specification of the UE **40** and the specification of the base station **20**. The data inactive timer value is, for example, a value such as one second or six seconds.

[0165] In a case where there is no transmission/reception of uplink (UL) or/and downlink (DL) data between the UE **40** and the base station **20** for a period of this value, the UE **40** transitions from the connected mode to the idle mode.

[0166] Note that, although the AMF **441** configures the data inactive timer value here, the configuration may be performed by the base station **20**.

[0167] Next, the RAMNF **100** performs UE status registration for notifying the RAMNF **100** of a status of the UE **40** (UE status) from the AMF **441** to the AMF **441** (Step S**102**).

[0168] The RAMNF **100** registers the UE **40** so that the AMF **441** is notified when there is a change in status of the UE **40**, such as when the UE **40** transitions from the connected mode to the idle mode or when the UE transitions from the idle mode to the connected mode. For example, an ID (for example, subscription permanent identifier (SUPI)) of the UE **40** can be used for this registration.

[0169] If the UE **40** is in the idle mode, the RAMNF **100** requests the AMF **441** for a paging request (Step S**103**). The RAMNF **100** requests the AMF **441** to transmit paging to the UE **40** by using the API of the SBI of the AMF **441**.

[0170] A paging procedure is performed between the AMF **441** of the CPF **440** and the UE **40** (Step S**104**). Accordingly, the UE **40** becomes connected (Step S**105**).

[0171] The AMF **441** of the CPF **440** notifies the RAMNF **100** of the status of the UE **40** (UE status) (Step S**106**). Here, the AMF **441** makes a notification that the status of the UE **40** is the connected status. Since the RAMNF **100** has performed the UE status registration with respect to the AMF **441** in Step S**102**, the AMF **441** notifies the RAMNF **100** of a change in status of the UE **40** (here, transition from the idle mode to the connected mode).

[0172] Upon receiving the notification, the RAMNF **100** starts a timer (Step S**107**). That is, the RAMNF **100** starts time measurement by the timer.

[0173] As illustrated in FIG. **10**, when the data inactive timer expires with no UL/DL data transmission (Step S**108**), the UE **40** transitions from the connected mode to the idle mode.

[0174] Since both the UE **40** and the AMF **441** have the data inactive timer, the AMF **441** knows that the UE **40** has

transitioned to the idle mode. In this case, the AMF **441** notifies the RAMNF **100** of the status of the UE **40** (Step S**109**).

[0175] Here, the AMF **441** notifies that the status of the UE **40** is the Idle status. Since the RAMNF **100** has performed the UE status registration with respect to the AMF **441** in Step S**102**, the AMF **441** notifies the RAMNF **100** of a change in status of the UE **40** (here, transition from the idle mode to the connected mode).

[0176] The RAMNF **100** that has received the notification stops the timer started in Step S**107**, and calculates the estimated data inactive timer based on a measurement time of the timer (Step S**110**). For example, the RAMNF **100** estimates the measurement time of the timer as the idle transition time until the UE **40** transitions to the idle status.

[0177] In this manner, the RAMNF **100** acquires the first information (here, the registration information regarding the registration (for example, UE status) of the UE **40**). The RAMNF **100** calculates information regarding a transition interval of the registration (an example of the measurement time, here, the idle transition time information) based on the acquired first information.

[0178] Note that, here, the AMF **441** makes a notification of the UE status based on the UE status registration by the RAMNF **100**, but a method by which the RAMNF **100** acquires the UE status is not limited thereto.

[0179] For example, the RAMNF **100** may transmit a request for knowing the status of the UE **40** to the AMF **441** periodically (for example, every 0.5 seconds). In this case, the RAMNF **100** calculates the idle transition time information based on the change in status of the UE **40** included in a response from the AMF **441**.

[0180] The RAMNF **100** notifies the client **200** of the data inactive timer (Step S**111**). For example, the RAMNF **100** notifies the client **200** of the idle transition time calculated in Step S**110** as the data inactive timer.

[0181] The client **200** can know a suitable access duration to avoid the UE **40** from entering the Idle mode (Step S**112**). That is, in a case of continuously transmitting data to the UE **40**, if the client **200** transmits the data at an interval shorter than the idle transition time, the data can be transmitted to the UE **40** in the connected mode before the UE **40** transitions to the idle mode.

[0182] When the UE **40** enters the idle mode, the client **200** needs to transmit data after, for example, transmitting paging to cause the UE **40** to transition from the idle mode to the connected mode. Therefore, when the UE **40** enters the idle mode, a delay of several 100 ms may occur before the client **200** transmits data.

[0183] As described above, the client **200** can transmit data before the UE **40** enters the idle mode by knowing the idle transition time, and can thus further reduce a delay that occurs in data transmission.

[0184] Note that, in FIG. **10**, the RAMNF **100** measures the data inactive timer by performing the operation one time (an operation from the start to the end of timer measurement), but the number of times the operation is performed may be two times or more. That is, the RAMNF **100** may calculate the idle transition time (for example, an average value) by repeatedly performing the operation from Step S**103** to Step S**110** (for example, 10 times).

[0185] For example, in the UE **40**, various applications are operating, and in a case where transmission and reception are required in the application, the UE **40** side returns to the wireless section of the network (transition to the connected mode). Therefore, the RAMNF **100** can calculate a more accurate idle transition time by calculating the idle transition time based on the time measured by repeatedly performing the operation a plurality of times.

[0186] Here, a supplementary description of a special case will be provided. It is conceivable that there is a base station **20** that cannot awake the UE **40** by the paging API among the base stations **20**. For example, the capability of the small base station **20** and the small core network CN used for the private network may be simplified. In this case, even in a case where the RAMNF **100** activates the paging API of the AMF **441**, it is conceivable that the UE **40** does not transition from the idle mode to the connected mode. Therefore, the RAMNF **100** performs confirmation processing of confirming whether or not the status of the UE **40** transitions by paging.

[0187] FIG. **11** is a flowchart illustrating an example of a flow of the confirmation processing according to the first embodiment of the present disclosure. The confirmation processing illustrated in FIG. **11** is performed by the RAMNF **100**, for example, before the measurement of the idle transition time.

[0188] As illustrated in FIG. **11**, the RAMNF **100** transmits a paging request to the AMF **441** (Step S**201**). For example, in a case where the UE **40** is in the idle mode, the RAMNF **100** transmits the paging request to the AMF **441**.

[0189] Thereafter, the RAMNF **100** determines whether or not the status of the UE **40** has transitioned from the idle mode to the connected mode (Step S**202**). The RAMNF **100** determines the status of the UE **40** based on the notification from the AMF **441**.

[0190] In a case where the status of the UE **40** has transitioned from the idle mode to the connected mode (Step S**202**; Yes), the RAMNF **100** determines that the paging API of the AMF **441** can be controlled by the RAMNF **100** (Step S**203**), and ends the processing.

[0191] On the other hand, in a case where the status of the UE **40** has not transitioned from the idle mode to the connected mode (Step S**202**; No), the RAMNF **100** determines that the paging API of the AMF **441** cannot be controlled by the RAMNF **100** (Step S**204**), and ends the processing.

[0192] The RAMNF **100** can disclose, to the client **200**, the result of the confirmation processing, that is, whether or not the paging API of the AMF **441** can be controlled by the RAMNF **100**.

[0193] Here, FIG. **12** is a diagram for describing an example of scheduling of the status of the UE **40** by the RAMNF **100** according to the first embodiment of the present disclosure. As described above, the RAMNF **100** calculates the idle transition time. In FIG. **12**, the RAMNF **100** calculates (acquires) a time T as the idle transition time (data inactive time value).

[0194] The RAMNF **100** transmits something data to the UE **40** to avoid the UE **40** from entering the idle mode before the data inactive timer expires. As a result, the RAMNF **100** can control the status of the UE **40**. In the example of FIG. **12**, the RAMNF **100** schedules the status of the UE **40** in such a way that the UE **40** repeatedly switches between the idle mode and the connected mode at predetermined intervals. The RAMNF **100** notifies the client **200** of the schedule of the status of the UE **40**.

[0195] As described above, the RAMNF **100** communicates with the UE **40** before a timing at which the UE **40** transitions to the idle status based on the idle transition time (an example of the measurement information). As a result, the RAMNF **100** controls a time during which the UE **40** is in the idle mode and a time during which the UE is in the connected mode in a planned manner. In addition, the RAMNF **100** notifies the client **200** of a schedule (plan) of the registration (idle/connected) of the UE **40**.

[0196] The client **200** can access the UE **40** in a case where the UE **40** is in the connected mode by using the notified schedule from the RAMNF **100**. As a result, the client **200** can access the UE **40** with a lower delay.

[0197] As described above, the RAMNF **100** can prevent the UE **40** from transitioning to the idle mode by transmitting a signal from the network side before the UE **40** transitions to the idle mode, and can control the registration status of the UE **40**. Note that the signal transmitted from the network side at this time may be any signal or a signal having a small data amount. In this way, as the network side transmits a small signal, an increase in network traffic can be suppressed.

[0198] Note that the RAMNF **100** may be defined as a new network function (NF) of the core network CN, and the function of the RAMNF **100** may be implemented as a new function in the existing AMF **441**, SMF **442**, and location management function (LMF).

[0199] As described above, the RAMNF **100** can acquire the idle transition time of the UE **40** that is the information of the network, and can provide the idle transition time to the client **200**.

[0200] As a result, the client **200** can know how long the signal need to be continuously transmitted to the UE **40** so that the UE **40** can continue the communication without transitioning to the idle mode. The client **200** can continue to transmit the signal so that the UE **40** does not transition to the idle mode, which can achieve lower-delay communication.

[0201] The RAMNF **100** notifies the client **200** of the schedule of idle/connected status of the UE **40**. At this time, by acquiring the idle transition time, the RAMNF **100** can reduce the number of times the paging control necessary for keeping the schedule is performed and the number of times of awaking the UE **40** by transmitting data. That is, the RAMNF **100** can keep the schedule of idle/connected status of the UE **40** by minimum paging control and data transmission based on the idle transition time.

[0202] As a result, the RAMNF **100** can save communication resources of the UE **40** and the core network CN and computer resources. In particular, the RAMNF **100** can suppress power consumption of the UE **40**. As described above, the RAMNF **100** can efficiently manage the schedule of the registration (idle/connected) of the UE **40**.

4.3. Second Embodiment

4.3.1. Second Problem

[0203] It is desirable that the RAMNF **100** can correctly provide, to the client **200**, information grasped by the application layer of the UE **40** among the pieces of information regarding the status of the network of the UE **40**. In addition, it is desirable that the RAMNF **100** can provide the information to the client **200** in cooperation with other network information (for example, the first information obtained via the SBI).

[0204] As described above, the RAMNF **100** can acquire the information regarding the network of the UE **40** to some extent via the AMF **441** of the core network CN or the API of the SBI of the SMF **442**.

[0205] The information regarding the network of the UE **40** (first information) acquired in this manner includes, for example, information indicating whether the UE **40** is in the idle mode or the connected mode, information indicating whether the UE **40** is registered or de-registered, and the like.

[0206] It is desirable that the RAMNF **100** can acquire information regarding behavior that cannot be known unless it is the application layer of the UE **40** (hereinafter, also described as the terminal-related information).

[0207] The terminal-related information includes, for example, at least one of the schedule information regarding the schedule of the registration (registered/de-registered), the power information regarding the power consumption of the UE **40**, or the location information regarding the location of the UE **40**. Note that the location information here is not location information of the UE **40** estimated from a reference signal of 5G, but high-accuracy location information using wireless information of the GPS, wireless LAN, or Bluetooth (registered trademark).

[0208] In addition, it is desirable that the RAMNF **100** can provide the acquired terminal-related information to the client **200**. At this time, it is further desirable that the RAMNF **100** can combine the first information (network information) acquired via the AMF **441** or the SMF **442** and the terminal-related information known by the application layer and provide the pieces of information to the client **200** as one piece of information.

[0209] As the RAMNF **100** combines the first information and the terminal-related information and provides the first information and the terminal-related information as one piece of information to the client **200**, the service and the network can be combined, and a valuable new service can be provided. Therefore, it is required to provide such information obtained by combining the first information and the terminal-related information.

4.3.2. Example of Solution for Second Problem

[0210] FIG. **13** is a diagram illustrating an example of an information processing system **1** according to a second embodiment of the present disclosure. The information processing system **1** illustrated in FIG. **13** is the same as the information processing system **1** illustrated in FIG. **8** except that the terminal-related information is transmitted and received between the RAMNF **100** and the UE **40**.

[0211] In the information processing system **1** illustrated in FIG. **13**, the RAMNF **100** is notified of information (terminal-related information) stored in the application layer of the UE **40**, and similar information is also stored in the RAMNF **100**.

[0212] The terminal-related information includes, for example, at least one of the schedule information regarding a registration schedule, the power information regarding the power consumption of the UE **40**, or the location information regarding the location of the UE **40**. Hereinafter, details of an example of the terminal-related information will be described.

(Registration (Registered/De-Registered) Schedule Information)

[0213] Detachment of the UE **40** means that the UE **40** is completely separated from the network, and at that time, the IP address assigned to the UE **40** by the SMF **442** of the core network CN becomes invalid. On the other hand, when the UE **40** is attached to the network, the SMF **442** assigns the IP address to the UE **40**.

[0214] Then, when the UE **40** transitions from the idle mode to the connected mode, the wireless section is connected, and the UE **40** can perform communication. That is, the UE needs to be in the registered status in order for the UE **40** to be connected.

[0215] In a case where the UE **40** is registered and is in the idle status, the IP address is assigned to the UE **40**, but the UE **40** cannot perform communication. In a case where the UE **40** is de-registered, since the IP address is not assigned to the UE **40**, the UE **40** is in a state in which communication completely cannot be performed.

[0216] Here, in a case where the UE **40** is a low power consumption device such as a case where the UE **40** is an IoT device, it is conceivable that the UE **40** is in the registered status only when necessary for battery saving. That is, it is conceivable that the UE **40** performs a plan (schedule) in which the registered status and the de-registered status are repeated at a constant cycle on the application layer. In this case, the UE **40** repeats attachment and detachment, that is, the registered status and the de-registered status according to the schedule.

[0217] The RAMNF **100** can provide the schedule information to the client **200** by grasping the cycle as the schedule information.

[0218] Hitherto, it has not been assumed that application-level information such as the schedule information is transmitted and received between an application installed in a client server (client **200**) and an application installed in the UE **40**.

[0219] As described above, the RAMNF **100** is a platform that mediates between the network and the service. In the present embodiment, the application-level information is provided to the client **200** via the RAMNF **100**. The RAMNF **100** can provide, to the client **200**, the application-level information together with other information of the network.

(Power Information)

[0220] The RAMNF **100** can provide, to the client **200**, the power information regarding a battery of the UE **40** in addition to the schedule information as the terminal-related information (terminal application information) of the UE **40**. This is because the power information of the UE **40** affects the schedule information of the connected/idle status of the UE **40** and the information of the registered/de-registered status (for example, the schedule information).

[0221] Hereinafter, the connected/idle schedule information is also referred to as connection schedule information. The registered/de-registered schedule information is also described as registration schedule information. In a case where the connection schedule information and the registration schedule information are not distinguished from each other, the connection schedule information and the registration schedule information are simply described as schedule information (the schedule information regarding the registration schedule).

[0222] As described above, the schedule regarding registration of the UE **40** affects the power consumption of the UE **40**. The RAMNF **100** can not only receive the power information from the UE **40** but also request a registration schedule based on the power information. As described above, when the RAMNF **100** makes the registration schedule request, the RAMNF **100** (or the client **200**) can access the UE **40** in more detailed consideration of care for the power consumption of the UE **40**. In this manner, the power information can be used for controlling the schedule and accessing the UE **40**.

(Location Information)

[0223] Examples of other information included in the terminal-related information include the location information regarding the location of the UE **40**. The UE **40** can provide the location information to the client **200** or the like via the RAMNF **100**.

[0224] In 5G, the AMF **441** can acquire information regarding the location of the UE **40**. The AMF **441** can provide the acquired information to other NFs or the like by using the API. However, the location information of the UE **40** handled by the AMF **441** is location information acquired using a positioning technology of 3GPP (registered trademark). The location information is, for example, information estimated based on information such as an estimated arrival time of radio waves from the base station **20** and an estimated arrival direction of the radio waves.

[0225] As described above, the location information that can be provided by the AMF **441** is location information obtained by the 3GPP technology.

[0226] On the other hand, the location information acquired by the RAMNF **100** from the UE **40** is location information measured by the GPS of the application layer of the UE **40** or location information acquired using radio waves of Bluetooth (registered trademark) or Wi-Fi (registered trademark). That is, the location information is information measured using equipment mounted on the UE **40**. The location information is location information that is not collected by the AMF **441**. The location information that the AMF **441** does not grasp may be more accurate than the location information collected by the AMF **441**.

[0227] Hereinafter, the location information that can be provided by the AMF **441** may be referred to as cellular location information, and the location information acquired by the RAMNF **100** from the UE **40** may be referred to as terminal location information to distinguish these pieces of location information.

[0228] As described above, the RAMNF **100** acquires various pieces of terminal-related information with high accuracy from the UE **40**. The terminal-related information may be related to the first information collected by the RAMNF **100** via the conventional SBI. For example, the terminal location information included in the terminal-related information and the information regarding the registered/de-registered status obtained from the AMF **441**.

[0229] When the UE **40** reaches a certain location, the status may change from the deregistered status to the registered status. For example, it is assumed that an automatic conveyance robot moving in a factory carries a part to a predetermined location and arrives at a predetermined loca-

tion. For example, once the automatic conveyance robot arrives at the predetermined location, the automatic conveyance robot is attached to the network and is registered, and thus can perform communication.

[0230] Since the client **200** knows in advance the information that the automatic conveyance robot is registered when arriving at the predetermined location, for example, it is possible to set up a system on the premise that communication becomes possible when the automatic conveyance robot is located at a specific location.

[0231] Note that the terminal-related information is not limited to the registration schedule information, the power information, and the location information described above. The terminal-related information may include, for example, the following information.

- **[0232]** Whether or not data exists in a monitoring camera
- **[0233]** Whether or not a failure has been detected at a factory
- **[0234]** Whether or not a conveyance robot of a factory has entered a specific area
- **[0235]** Whether or not a drone has entered a specific area
- **[0236]** Whether or not a moving speed or speed of a drone has reached a certain value or whether the speed has become a certain value or less
- **[0237]** Whether or not a drone has detected another drone
- **[0238]** Whether or not an automatic conveyance robot has stopped for collision avoidance
- **[0239]** Detection of earthquake and fire
- **[0240]** Whether or not a specific session of an application has started
- **[0241]** An expected duration of an application

[0242] Such terminal-related information regarding various applications can also be collected by the RAMNF **100**. The RAMNF **100** can collect these pieces of terminal-related information and notify the client **200** of the terminal-related information in combination with the first information included in the RAMNF **100**.

[0243] As described above, the RAMNF **100** according to the present embodiment acquires, from the UE **40**, information (terminal-related information) that the normal core network CN does not grasp, and provides the information to the client **200** together with the first information acquired via the SBI.

[0244] Hereinafter, an example of information provision processing performed by the RAMNF **100** for each piece of terminal-related information will be described.

(Registration Schedule Information Provision Processing)

[0245] FIG. **14** is a sequence diagram illustrating an example of a flow of registration schedule information provision processing according to the second embodiment of the present disclosure. Note that the UE **40** that performs a part of the provision processing may be the application of the UE **40**.

[0246] As illustrated in FIG. **14**, the RAMNF **100** notifies the UE **40** of configuration of a report of the registration schedule (registration schedule information) (Step S**301**).

[0247] The UE **40** determines the schedule regarding the registration of the UE **40** (Step S**302**), and notifies the RAMNF **100** of the schedule regarding the registration (Step S**303**).

[0248] Here, FIG. **15** is a diagram illustrating an example of the registration schedule according to the second embodiment of the present disclosure. As illustrated in FIG. **15**, the UE **40** notifies the RAMNF **100** of the registration schedule information including a de-registered duration (second) and a registered duration (second).

[0249] Note that FIG. **15** illustrates the registration schedule in which a certain de-registered duration (second) and a certain registered duration (second) are alternately repeated, but the registration schedule is not limited thereto. For example, the RAMNF **100** may be notified of a registration schedule having different de-registered durations (second) and/or registered durations (second) each time.

[0250] The description returns to FIG. **14**. The RAMNF **100** informs the client **200** of a schedule (Step S**304**). This schedule may be, for example, the registration schedule acquired by the RAMNF **100** from the UE **40** in Step S**303**.

[0251] In addition, the RAMNF **100** informs the client **200** of a schedule including the status information of the UE **40** such as the connected/idle status (Step S**305**). This schedule may be the schedule information regarding the registration including the registered/de-registered status and the connected/idle status of the UE **40**.

[0252] Here, FIG. **16** is a diagram illustrating an example of the schedule regarding the registration according to the second embodiment of the present disclosure. As illustrated in FIG. **16**, the RAMNF **100** notifies the RAMNF **100** of the schedule information including the de-registered duration (second) and the registered duration (second). At this time, the RAMNF **100** makes a notification of the schedule information including the information regarding a connected duration (second) and an idle duration (second) in the registered status.

[0253] In this manner, the RAMNF **100** integrates the registration schedule information and the connection schedule information, and notifies the client **200** of the integrated information as one piece of schedule information.

[0254] As described above, as the UE **40** accesses the RAMNF **100**, the registration schedule information of the UE **40** is transmitted (shared) between the application of the UE **40** and the application of the RAMNF **100**.

[0255] As a member of the NF of the core network CN, the RAMNF **100** provides information to the client **200** by combining the terminal-related information regarding the application of the UE **40** and the first information regarding the status of the network.

[0256] In a case where there is a change in registration schedule, the UE **40** accesses the RAMNF **100** and notifies the RAMNF **100** that there is a change.

[0257] Here, the registration schedule information of the UE **40** is the terminal-related information known (managed) by the application of the UE **40**. The connection schedule information of the UE **40** is information that can be controlled by the RAMNF **100**, that is, information that can be created by the RAMNF **100**. The RAMNF **100** can provide, to the client **200**, the registration schedule information and the connection schedule information by acquiring the registration schedule information of the UE **40**.

[0258] That is, the client **200** can grasp at which time the UE **40** is registered and at which time the UE is connected in the registered duration. Therefore, the client **200** can access the UE **40** while the UE **40** is in the connected status.

[0259] In a case where the client **200** inadvertently accesses the UE **40**, there is a possibility that the UE **40** is

de-registered and the IP address is not assigned to the UE **40**. Alternatively, in a case where the client **200** accesses the UE **40** when the UE **40** is in the idle status, the paging message is sent to the UE **40**, and there is a possibility that the power consumption of the UE **40** increases.

[0260] The power consumption of the UE **40** can be suppressed by the client **200** accessing the UE **40** at a connected time of the UE **40** determined in advance based on the schedule information.

[0261] Note that the RAMNF **100** may notify the client **200** of a time during which the UE **40** is RRC connected (connection schedule information) alone as the registration schedule information provision processing. For example, the RAMNF **100** may notify the client **200** of the connection schedule information and the registration schedule information. Also in this case, the connection schedule information and the registration schedule information are notified in association with each other, so that the client **200** can use the registration schedule information and the connection schedule information provided from the UE **40** as integrated schedule information.

[0262] As described above, also in a case where the RAMNF **100** makes a notification of each of the connection schedule information and the registration schedule information, it can be said that the connection schedule information and the registration schedule information are notified in association with each other, so that these pieces of information are integrated (combined) and notified.

[0263] As described above, the RAMNF **100** combines the connection schedule information and the registration schedule information and provides the combined information as the integrated schedule information of the UE **40** to the client **200**. As a result, the client **200** can know in advance at which time access to the UE **40** is to be made to communicate with the UE **40**.

[0264] In a case where the UE **40** is an IoT device, it is conceivable that the number of UEs **40** accessed by the client **200** increases. In addition, it is conceivable that a number of clients **200** for services access one UE **40**. As described above, even in a case where there is a possibility that many communications occur between the client **200** and the UE **40**, the client **200** can access the UE **40** that is in the connected status, so that it is possible to reduce useless communications with the UE **40**. As a result, low power consumption of the network and/or the UE **40** is achieved.

[0265] Note that, in the second embodiment of the present disclosure, communication between the UE **40** and the RAMNF **100** can be directly performed between the UE **40** and the RAMNF **100** via the base station **20**. Alternatively, the RAMNF **100** may communicate with the UE **40** via the SBI by another NF of the core network such as the AMF **441**. As described above, a communication path of the RAMNF **100** and the UE **40** is not particularly limited. The same applies to other embodiments.

(Power Information Provision Processing)

[0266] FIG. **17** is a sequence diagram illustrating an example of a flow of power information provision processing according to the second embodiment of the present disclosure. Note that the UE **40** that performs a part of the provision processing may be the application of the UE **40**.

[0267] As illustrated in FIG. **17**, the RAMNF **100** notifies the UE **40** of configuration of a report of UE power related information (power information) (Step S**401**). The UE **40** informs the RAMNF **100** of the UE power related information of the UE **40** (Step S**402**).

[0268] The RAMNF **100** decides a connected/idle ratio of the UE **40** according to the UE power related information (Step S**403**). The RAMNF **100** informs the client **200** of the UE status including a prohibited access duration i based on the decided connected/idle ratio, for example (Step S**404**).

[0269] Here, FIG. **18** is a diagram illustrating an example of the connection schedule according to the second embodiment of the present disclosure. As illustrated in FIG. **18**, the UE **40** notifies the RAMNF **100** of the connection schedule information (a schedule UE state) including the connected duration (second) and the idle duration (second).

[0270] In this manner, the RAMNF **100** makes a notification of the connection schedule information illustrated in FIG. **18** as the UE status, for example. In this case, in the idle duration, the client **200** is prohibited from accessing the UE **40**. That is, the idle duration corresponds to the prohibited access duration i.

[0271] As described above, in the power information provision processing, the power information of the UE **40** is transmitted (shared) between the application of the UE **40** and the application of the RAMNF **100** by accessing the RAMNF **100** from the UE **40**.

[0272] Here, FIG. **19** is a table illustrating the power information according to the second embodiment of the present disclosure. As illustrated in FIG. **19**, the power information can include a criticality of the battery, a remaining battery level, an expected charge value, and the like.

[0273] The criticality of the battery is information indicating the capacity of the battery. For example, in a case where the battery capacity is low, the criticality of the battery is "high", and in a case where the battery capacity is high, the criticality of the battery is "medium". In addition, in a case where the UE **40** is connected to a power supply, the criticality of the battery is "low" regardless of the battery capacity.

[0274] The remaining battery level is information indicating the remaining battery level. The expected charge value is information indicating a time when charging is expected to be performed next, and can be represented by, for example, a time when charging is performed, such as after X hours. The expected charge value can be determined by the UE **40** based on, for example, a previous charge time, a charge cycle, or the like.

[0275] Here, it is assumed that the criticality of the battery and the remaining battery level are expressed in three stages of "high", "medium", and "low", but the representation of the criticality of the battery and the remaining battery level is not limited thereto. For example, the criticality of the battery and the remaining battery level may be expressed in two stages of "high" and "low", or may be expressed in four or more stages. Further, the criticality of the battery and the remaining battery level may be represented by a numerical value or a ratio such as a percentage.

[0276] For example, the RAMNF **100** that has acquired such power information provides, to the client **200**, the terminal-related information (for example, power information) of the UE **40** and the first information (for example, the registration information) regarding the status of the network together as a member of the NF of the core network CN.

[0277] When there is a change in power information such as when there is a large change in remaining battery level,

the UE **40** accesses the RAMNF **100** and makes a notification of the latest power information.

[0278] As described above, the RAMNF **100** acquires information managed by the application layer of the UE **40**, such as the power information. As a result, the RAMNF **100** can decide the connected/idle ratio according to the power information. Furthermore, the RAMNF **100** can decide the prohibited access duration of the UE **40** based on the decided ratio, and provide the connection schedule information including the prohibited access duration to the client **200**.

[0279] The client **200** can access the UE **40** while avoiding the prohibited access duration (for example, the idle duration), and can implement low power consumption of the UE **40**. For example, the client determines a UE **40** to access based on the terminal-related information (for example, power information) of the UE **40** and the first information (for example, the registration information) regarding the status of the network. As a result, the client **200** can access a UE **40** while avoiding the UE **40** with a low remaining battery level, for example.

(Terminal Location Information Provision Processing)

[0280] The RAMNF **100** collects terminal location information of the UE **40**. At this time, the RAMNF **100** can collect at least one of current terminal location information, past terminal location information, or and future terminal location information.

[0281] FIG. **20** is a table illustrating an example of the terminal location information according to the second embodiment of the present disclosure. As illustrated in FIG. **20**, the RAMNF **100** collects, for example, the current terminal location information, the past terminal location information, and the future terminal location information.

[0282] The current terminal location information is information regarding a current terminal location. The RAMNF **100** collects the current terminal location information and notifies the client **200** of the terminal location information.

[0283] The past terminal location information is information indicating a location through which the UE **40** has passed within a certain time in the past. The RAMNF **100** collects the past terminal location information and notifies the client **200** of the terminal location information. At this time, the RAMNF **100** can makes a notification of the past terminal location information as group information. The group information is described in detail in a third embodiment.

[0284] For example, it is assumed that the client **200** desires to acquire information of a certain location. At this time, when there is no UE **40** located at the location at the current time, the client **200** can acquire the information of the location by accessing the UE **40** that was located at the location in the past. In this way, the past terminal location information is used when the client **200** desires to access the UE **40** that has passed through a specific location in the past.

[0285] The future terminal location information is information indicating a possible location where the UE **40** may go. The RAMNF **100** collects the future terminal location information and notifies the client **200** of the terminal location information.

[0286] The future terminal location information is information useful when the client **200** searches for and accesses a UE **40** that can go to that location (for example, a specific location).

[0287] As described above, the RAMNF **100** according to the present embodiment separately collects the past terminal location information, the current terminal location information, and the future terminal location information and notifies the client **200** of the pieces of terminal location information. Hereinafter, an example of processing of providing each of the past terminal location information, the current terminal location information, and the future terminal location information will be described.

(Current Terminal Location Information Provision Processing)

[0288] FIG. **21** is a sequence diagram illustrating an example of a flow of the current terminal location information provision processing according to the second embodiment of the present disclosure. Note that the UE **40** that performs a part of the provision processing may be the application of the UE **40**.

[0289] The UE **40** updates the terminal location information (location information) represented by, for example, a location ID (Step S**501**). The UE **40** updates the terminal location information by notifying the RAMNF **100** of the current terminal location information.

[0290] The RAMNF **100** stores the ID (for example, SUPI or international mobile subscriber identity (IMSI)) of the UE **40** and the location of the UE **40** (Step S**502**). The RAMNF **100** stores the ID of the UE **40** and the terminal location information acquired in Step S**501** in association with each other.

[0291] Next, upon receiving a request including the location ID from the client **200** (Step S**503**), the RAMNF **100** responds to the client **200** with the ID of the UE **40** (for example, SUPI) and the UE status of the UE **40** (Step S**504**). That is, the RAMNF **100** responds to the client **200** by associating the ID of the UE **40** located in an area corresponding to the location ID with the status of the UE **40**. The UE status includes, for example, information indicating whether the UE **40** is registered or deregistered and whether the UE **40** is in the connected status or the idle status, and UE status schedule information.

[0292] The client **200** determines its own action such as accessing the UE **40** according to the above-described information (information in which the ID and the status of the UE **40** are associated with each other) (Step S**505**).

[0293] In this way, the current terminal location information is useful for the client **200** that desires to access the UE **40** at a specific location. The RAMNF **100** notifies the client **200** of the registered UE **40** that is located in a specific area designated by the client **200**, for example.

[0294] In this way, the RAMNF **100** may provide information to the client **200** by combining the current terminal location information and the first information regarding the network. The client **200** can know whether or not the UE **40** in a specific area is accessible. That is, the client **200** can acquire information regarding an accessible UE **40** in a specific area.

[0295] This specific area is, for example, a mesh-like area of 10 m square. In this manner, it is assumed that a resolution of the area is determined in advance.

[0296] When the UE **40** moves to a location, the UE **40** notifies (updates) the RAMNF **100** that the UE **40** has transitioned to the registered status and the connected status and has moved to the location. After the notification, the UE **40** may transition to the idle status.

[0297] In this manner, the UE **40** registers the current terminal location information in the RAMNF **100**.

[0298] The registration of the terminal location information here is different from a conventional tracking update in that the terminal location information is updated based on the terminal location information of the application layer of the UE **40**. An area targeted by the conventional tracking update is an area bound by a plurality of base stations **20** and is a very large area compared to an area targeted by terminal location information. In addition, the conventional tracking update is performed using a 5G radio technology.

[0299] On the other hand, the registration of the terminal location information according to the present embodiment is updated based on the terminal location information of the application layer of the UE **40** as described above. As described above, the terminal location information is information targeted for a narrow area such as 10 m square.

[0300] Furthermore, in the present embodiment, the RAMNF **100** acquires the terminal location information from the UE **40** directly or via the SBI. In this respect, the tracking update is different from a tracking update that acquires the location information from the core network CN.

[0301] As described above, the client **200** makes an inquiry about the UE **40** in a specific location (area) to the RAMNF **100**. At this time, the client **200** can designate the specific location by using the location ID.

[0302] The RAMNF **100** can respond to the client **200** by associating the ID (the IMSI, the SUPI, or the like) of the UE **40** in the area corresponding to the location ID with the UE status (for example, whether or not the UE **40** is registered). At this time, the RAMNF **100** may transmit, to the client **200**, a response including the connection schedule information and the registration schedule information described in the first embodiment.

[0303] In addition, in a case where a plurality of UEs **40** exist in the area corresponding to the location ID, the RAMNF **100** may respond to the client **200** with the plurality of UEs **40** as the group information. The group information is described in detail in a third embodiment.

(Past Terminal Location Information Provision Processing)

[0304] FIG. **22** is a sequence diagram illustrating an example of a flow of past terminal location information provision processing according to the second embodiment of the present disclosure. Note that the UE **40** that performs a part of the provision processing may be the application of the UE **40**.

[0305] The UE **40** updates the past terminal location information (location information) represented by, for example, a location ID or the like with a certain period (Step S**601**). The UE **40** updates the past terminal location information by notifying the RAMNF **100** of the past terminal location information together with the period.

[0306] The RAMNF **100** stores the ID (for example, SUPI or international mobile subscriber identity (IMSI)) of the UE **40** and the past location information of the UE **40** (Step S**602**). The RAMNF **100** stores the ID of the UE **40** and the past terminal location information acquired in Step S**501** in association with each other.

[0307] Next, the RAMNF **100** receives a request including a location ID from the client **200** (Step S**603**). The RAMNF **100** responds to the client **200** with the ID (for example, SUPI) of the UE **40** and the UE status of the UE **40**, or responds to the client **200** with the ID (for example, SUPI) of the UE **40** in a case where the UE **40** is registered (Step S**604**).

[0308] That is, the RAMNF **100** responds to the client **200** by associating the ID of the UE **40** that stayed in the area corresponding to the location ID in the past with the status (UE status) of the UE **40**. Alternatively, the RAMNF **100** responds to the client **200** with the ID of the UE **40** that stayed in the area corresponding to the location ID for a predetermined period in the past among the registered UEs **40**. The UE status includes, for example, information indicating whether the UE **40** is registered or deregistered and whether the UE **40** is in the connected status or the idle status, and UE status schedule information.

[0309] The client **200** decides its own action such as accessing the UE **40** according to the above information (information in which the ID and the status of the UE **40** are associated with each other) (Step S**605**).

[0310] In this manner, the past terminal location information is useful for the client **200** that desires to access the UE **40** that was in a specific location in the past. The number of specific locations may be plural, and the specific location may also be a trajectory.

[0311] For example, it is assumed that, while staying (or moving) in a specific location, the UE **40** accumulates area information depending on the location such as a temperature and humidity of the location (area). The past terminal location information is useful, for example, for the client **200** that desires to acquire the area information.

[0312] In this manner, the RAMNF **100** can provide information to the client **200** by combining the past terminal location information and the first information regarding the network. The client **200** can know whether or not a UE **40** that was in a specific area in the past is accessible (registered or/and connected). That is, the client **200** can acquire information regarding an accessible (registered or/and connected) UE **40** that was in a specific area.

[0313] For example, the UE **40** notifies the RAMNF **100** of information regarding a location where the UE **40** stayed (has passed) as the past terminal location information at a constant cycle, for example, every day or every several hours. The RAMNF **100** accumulates the past terminal location information together with the ID of the UE **40**.

[0314] The client **200** inquires of the RAMNF **100** about information of a UE **40** that has passed through a specific location.

[0315] For example, the RAMNF **100** transmits a response by associating information (the ID of the UE **40**) identifying the UE **40** that has passed through the specific location and the status (UE status) of the UE **40** with each other.

[0316] Alternatively, for example, the RAMNF **100** may respond to the client **200** with information of a UE **40** that is currently registered from among UEs **40** that have passed through the specific location. As a result, the client **200** can access the UE **40** that has passed through the specific location and acquire the area information.

[0317] Alternatively, when the UE **40** that has passed through the specific location is registered, the client **200** may register with the RAMNF **100** so that the client **200** is notified of the information regarding the UE **40**.

[0318] In this case, when detecting that the UE **40** that has passed through the specific location is registered, the RAMNF **100** notifies the client **200** of the information regarding the UE **40**. Alternatively, the RAMNF **100** may

make a notification to the client **200** when the UE **40** that has passed through the specific location is registered and connected.

[0319] The area of the past terminal location information may be the same as or different from that of the current terminal location information. It is sufficient if the target area of the past terminal location information is an area narrower (with higher accuracy) than the area of the location information acquirable from the network side.

(Future Terminal Location Information Provision Processing)

[0320] FIG. **23** is a sequence diagram illustrating an example of a flow of future terminal location information provision processing according to the second embodiment of the present disclosure. Note that the UE **40** that performs a part of the provision processing may be the application of the UE **40**.

[0321] As illustrated in FIG. **23**, in a case where the UE **40** has moved to a certain location, the client **200** requests the RAMNF **100** to make a notification of the fact (Step S**701**).

[0322] In a case where the UE **40** has moved to a certain location, the RAMNF **100** requests the UE **40** to make a notification of the fact (Step S**702**).

[0323] When the UE **40** has moved to the location designated by the request, the UE **40** is registered and RRC connected and transmits the location ID and the UE ID (for example, SUPI) to the RAMNF **100** (Step S**703**).

[0324] The RAMNF **100** stores the ID (for example, SUPI or international mobile subscriber identity (IMSI)) of the UE **40** and the location information of the UE **40** (Step S**704**).

[0325] The RAMNF **100** notifies the client **200** of the ID (for example, SUPI) of the UE **40** and the UE status of the UE **40** (Step S**705**). The UE status includes, for example, information indicating whether the UE **40** is registered or deregistered and whether the UE **40** is in the connected status or the idle status, and UE status schedule information.

[0326] The client **200** decides its own action such as accessing the UE **40** according to the above information (information in which the ID and the status of the UE **40** are associated with each other) (Step S**706**).

[0327] Furthermore, in a case where the UE has moved out from the location designated in the request, the UE **40** can change its own status from the registered status to the deregistered status (Step S**707**).

[0328] As described above, the future terminal location information is information indicating that the UE **40** is likely to move to a specific location in the future. The client **200** makes a request the UE **40** via the RAMNF **100** in such a way that the UE **40** is registered when the UE **40** arrives at the location.

[0329] In addition, the client **200** registers with the RAMNF **100** in such a way as to be notified when the UE **40** has moved to the specific location.

[0330] In a case where the UE **40** has moved to the specified location, the UE is registered. In addition, the UE **40** is connected and notifies the RAMNF **100** of arrival at the location. Note that the UE **40** can transition to the idle status after a certain period elapses after the notification.

[0331] Upon receiving the notification from the UE **40**, the RAMNF **100** notifies the client **200** that the UE **40** has arrived at the designated location. The UE **40** is registered when arriving at the designated location. Therefore, the client **200** can acquire information such as the area information by accessing the UE **40** that has arrived at the designated location. For example, the client **200** can perform an operation such as causing the UE **40** to transmit the temperature of the designated location.

[0332] In a case where the UE **40** has moved out from the designated location, the UE transitions from the registered status to the de-registered status. The RAMNF **100** detects that the UE **40** has transitioned to the de-registered status, thereby being able to know that the UE **40** has moved out from the designated location. The RAMNF **100** may notify the client **200** that the UE **40** has left the designated location.

[0333] As described above, the RAMNF **100** according to the present embodiment collects the past terminal location information, the current terminal location information, and the future terminal location information. The cellular location information provided by the AMF **441** is current location information having low accuracy and including no past or future information. In this respect, the terminal location information according to the present embodiment is different from the cellular location information.

[0334] Furthermore, the RAMNF **100** combines the first information (for example, the registration information) regarding the network and the terminal location information and provides the combined information to the client **200**. As a result, the client **200** can know the past or/and current location of the UE **40**, and further can know whether or not the UE **40** is accessible. In addition, the client **200** can access a UE **40** that arrives at a specific location in the future. As a result, the client **200** can access the UE **40** at an appropriate time.

[0335] As described above, the RAMNF **100** can integrate the terminal-related information in the application layer level of the UE **40** and the information of the UE status acquired via the SBI API (an example of the first information) and provide the integrated information to the client **200**.

[0336] FIG. **24** is a diagram for describing an example of integration of information by the RAMNF **100** according to the second embodiment of the present disclosure.

[0337] The RAMNF **100** acquires the terminal-related information directly from the UE **40** or via the SBI. In addition, the RAMNF **100** acquires the UE status information from the CPF **440** of the core network CN via the SBI API. The RAMNF **100** notifies the client **200** of information obtained by integrating the terminal-related information and the UE status information.

[0338] By acquiring the terminal-related information and the UE status information, the RAMNF **100** can change a plan of the schedule of the UE status and the like based on, for example, the power information of the UE **40**. In addition, the RAMNF **100** can optimize a time for accessing the UE **40** based on the terminal location information of the UE **40** and the UE status information by acquiring the terminal-related information and the UE status information.

[0339] As described above, the RAMNF **100** integrates (combines) information of different layers such as the information of the application layer of the UE **40** and the information regarding the network of the core network CN, and provides the integrated information to the client **200**. As a result, the service and the network are combined, and the client **200** can provide a valuable new service.

4.4. Third Embodiment

4.4.1. Third Problem

[0340] As described above, the RAMNF **100** provides, to the client **200**, the information of the network, for example, the UE status that is the network information of the UE **40**. The UE status includes information indicating whether the UE **40** is registered or deregistered, and information indicating whether the UE is in the connected status or the idle status.

[0341] Here, in each of the embodiments described above, the client **200** makes an inquiry to the RAMNF **100** for each UE **40** and acquires the UE status of each UE **40**.

[0342] For example, in a case where the number of UEs **40** targeted by the client **200** is large, the communication between the client **200** and the RAMNF **100** increases. In particular, in a case where the client **200** provides an IoT service, it is assumed that the number of UEs **40** that perform communication increases.

[0343] Furthermore, for example, in a case where the UE **40** targeted by the client **200** is not clearly determined, it is difficult for the client **200** to make an inquiry to the RAMNF **100**. This is because an ID (for example, IMSI or SUPI) for specifying the UE **40** is used when the client **200** makes an inquiry to the RAMNF **100** in each of the embodiments described above. Note that the ID for specifying the UE **40** may be any information that can specify the UE **40**, and is not limited to the IMSI or SUPI.

4.4.2. Example of Solution for Third Problem

[0344] Therefore, in the present embodiment, the RAMNF **100** notifies the client **200** of the group information (group based network information) including at least one piece of information regarding the UE **40** that satisfies a condition designated by the client **200**.

[0345] The condition designated by the client **200** includes at least one of a registration condition that designates the registration status of the UE **40**, a power condition that designates a power consumption status of the UE **40**, and a location condition that designates the location of the UE **40**.

(Provision Processing According to Registration Condition)

[0346] FIG. **25** is a sequence diagram illustrating an example of a flow of provision processing according to the registration condition according to the third embodiment of the present disclosure. Here, the RAMNF **100** acquires the group information of the UE **40** in the registered status in response to an instruction from the client **200**. That is, here, it is assumed that the registration condition designated by the client **200** is the registered status.

[0347] As illustrated in FIG. **25**, the UE **40** performs an attach (registered)/detach procedure with the CPF **440** (Step S**801**). Although the attach (registered)/detach (de-registered) procedure by one UE **40** is illustrated here, the CPF **440** can perform the attach (registered)/detach procedure with a plurality of UEs **40**.

[0348] The RAMNF **100** inquires of the CPF **440** about the UE status such as the registered/de-registered status for some UEs **40** (Step S**802**), and obtains a response from the CPF **440** (Step S**803**).

[0349] The client **200** inquires of the RAMNF **100** about the group of the UE **40** in the registered status (Step S**804**).

[0350] The RAMNF **100** transmits, as a response to the client **200**, the group information of the UE **40** in the registered status (Step S**805**).

[0351] Here, FIG. **26** is a table illustrating an example of the group information according to the third embodiment of the present disclosure. The group information illustrated in FIG. **26** is the group information of the UE **40** in the registered status.

[0352] As illustrated in FIG. **26**, the group information includes an ID and a UE ID. The UE ID is, for example, an SUPI. Alternatively, the UE ID is not particularly limited as long as the UE ID is information specifying the UE **40** such as an IMSI.

[0353] The RAMNF **100** notifies the client **200** of information regarding at least one UE **40** in the registered status as the group information.

[0354] In this manner, the RAMNF **100** receives a request for the ID of the registered UE **40** from the client **200**.

[0355] The RAMNF **100** notifies the client **200** of the UE ID of the registered UE **40** as the group information. The RAMNF **100** detects the group of the UE **40** corresponding to the registration condition (here, the UE **40** in the registered status) designated by the client **200** from all pieces of information that has been grasped and creates the group information.

[0356] Note that at least one RAMNF **100** can be arranged in one private network. The RAMNF **100** uses all the UEs **40** belonging to one private network as a population parameter, searches for the UE **40** corresponding to the condition from among them, and provides information to the client **200**.

[0357] Note that the registration condition is not limited to whether the UE **40** is registered or de-registered. For example, the client **200** can request the RAMNF **100** for the group information by designating the idle status or the connected status as the registration condition.

[0358] FIG. **27** is a sequence diagram illustrating another example of the flow of the provision processing according to the registration condition according to the third embodiment of the present disclosure. Here, the RAMNF **100** acquires the group information of the UE **40** in the registered status and the connected status in response to an instruction from the client **200**. That is, here, it is assumed that the registration condition designated by the client **200** is the registered status and the connected status.

[0359] As illustrated in FIG. **27**, the UE **40** performs an attach (registered)/detach procedure with the CPF **440** (Step S**901**). Although the attach (registered)/detach (de-registered) procedure by one UE **40** is illustrated here, the CPF **440** can perform the attach (registered)/detach procedure with a plurality of UEs **40**.

[0360] The UE **40** performs the idle/connected procedure with the CPF **440** (Step S**902**). The idle/connected procedure is processing for the UE **40** to perform UL/DL communication or transition to a sleep status. Although the idle/connected procedure by one UE **40** is illustrated here, the CPF **440** can perform the idle/connected procedure with a plurality of UEs **40**.

[0361] The RAMNF **100** inquires of the CPF **440** about the UE status such as the registered/de-registered status and the idle/connected status for some UEs **40** (Step S**903**), and obtains a response from the CPF **440** (Step S**904**).

[0362] The client **200** inquires of the RAMNF **100** about the group of the UE **40** that is in the registered status and in the connected status (Step S**905**).

[0363] The RAMNF **100** transmits, as a response to the client **200**, the group information of the UE **40** in the registered status and the connected status (Step S**906**).

[0364] In this manner, the RAMNF **100** receives a request for the ID of the UE **40** that is in the registered status and the connected status from the client **200**.

[0365] The RAMNF **100** notifies the client **200** of the UE ID of the UE **40** that is in the registered status and the connected status as the group information. The RAMNF **100** detects the group of the UE **40** corresponding to the registration condition (here, the UE **40** in the registered status and the connected status) designated by the client **200** from all pieces of information that has been grasped and creates the group information.

[0366] Note that at least one RAMNF **100** can be arranged in one private network. The RAMNF **100** uses all the UEs **40** belonging to one private network as a population parameter, searches for the UE **40** corresponding to the condition from among them, and provides information to the client **200**.

[0367] Note that the registration condition is not limited to the UE **40** in the connected status. For example, the client **200** may request the RAMNF **100** for the group information by designating the UE **40** in the idle status.

(Provision Processing According to Location Condition)

[0368] FIG. **28** is a sequence diagram illustrating an example of a flow of provision processing according to the location condition according to the third embodiment of the present disclosure. Here, the RAMNF **100** acquires the group information of the UE **40** in the registered status and the connected status in a designated area in response to an instruction from the client **200**. That is, here, it is assumed that the registration condition designated by the client **200** is the registered status and the connected status, and the location condition is the current cellular location information.

[0369] As illustrated in FIG. **28**, the UE **40** performs an attach (registered)/detach procedure with the CPF **440** (Step S**1001**). Although the attach (registered)/detach (de-registered) procedure by one UE **40** is illustrated here, the CPF **440** can perform the attach (registered)/detach procedure with a plurality of UEs **40**.

[0370] The UE **40** performs the idle/connected procedure with the CPF **440** (Step S**1002**). The idle/connected procedure is processing for the UE **40** to perform UL/DL communication or transition to a sleep status. Although the idle/connected procedure by one UE **40** is illustrated here, the CPF **440** can perform the idle/connected procedure with a plurality of UEs **40**.

[0371] The UE **40** updates information regarding the location of the UE **40** (for example, the cellular location information) for the CPF **440** (Step S**1003**). Although the update of the location information by one UE **40** is described here, the CPF **440** can update the location information with a plurality of UEs **40**.

[0372] The RAMNF **100** inquires of the CPF **440** about the UE status such as the registered/de-registered status and the idle/connected status for some UEs **40** and the location information of the UE **40** (Step S**1004**). The RAMNF **100** obtains a response from the CPF **440** (Step S**1005**).

[0373] The client **200** inquires of the RAMNF **100** about the group of the UE **40** that is in the registered status and the connected status and is located in a specific location (Step S**1006**).

[0374] The RAMNF **100** transmits, as a response to the client **200**, the group information of the UE **40** that is in the registered status and the connected status and is located in the specific location (Step S**1007**).

[0375] In this manner, the RAMNF **100** receives a request for the ID of the UE **40** that is in a specific area and is in the registered status and the connected status from the client **200**.

[0376] The RAMNF **100** notifies the client **200** of the UE ID of the UE **40** that is in the specific area and is in the registered status and the connected status as the group information. The RAMNF **100** detects the group of the UE **40** corresponding to the registration condition (here, the UE **40** that is in the specific area and is in the registered status and the connected status) designated by the client **200** from all pieces of information that has been grasped and creates the group information.

[0377] Note that at least one RAMNF **100** can be arranged in one private network. The RAMNF **100** uses all the UEs **40** belonging to one private network as a population parameter, searches for the UE **40** corresponding to the condition from among them, and provides information to the client **200**.

[0378] Note that the location condition is not limited to the condition that designates the cellular location information collected by the CPF **440**. For example, the client **200** can request the RAMNF **100** for the group information by designating the terminal location information collected by the RAMNF **100** as the location condition.

[0379] Furthermore, the client **200** can request the RAMNF **100** for the group information by designating not only the current location information but also, for example, the past or future terminal location information as the location condition.

[0380] For example, the client **200** may register with the RAMNF **100** to be notified when a specific UE **40** enters a particular location. Further, in the present embodiment, the client **200** may register with the RAMNF **100** to be notified of information (for example, the UE ID) regarding the UE **40** that has entered a specific location on condition that the UE **40** has entered the specific location without specifying the UE **40**.

(Provision Processing According to Power Condition)

[0381] FIG. **29** is a sequence diagram illustrating an example of a flow of provision processing according to the power condition according to the third embodiment of the present disclosure. Here, the RAMNF **100** acquires the group information of the UE **40** that has a remaining battery level equal to or higher than a certain level and is in the registered status and the connected status in a designated area in response to an instruction from the client **200**. That is, here, it is assumed that the registration condition designated by the client **200** is the registered status and the connected status. It is assumed that the location condition is the current cellular location information. It is assumed that the power condition is that the remaining battery level is equal to or higher than a certain level.

[0382] As illustrated in FIG. **29**, the UE **40** performs an attach (registered)/detach procedure with the CPF **440** (Step

S1101). Although the attach (registered)/detach (de-registered) procedure by one UE **40** is illustrated here, the CPF **440** can perform the attach (registered)/detach procedure with a plurality of UEs **40**.

[0383] The UE **40** performs the idle/connected procedure with the CPF **440** (Step S1102). The idle/connected procedure is processing for the UE **40** to perform UL/DL communication or transition to a sleep status. Although the idle/connected procedure by one UE **40** is illustrated here, the CPF **440** can perform the idle/connected procedure with a plurality of UEs **40**.

[0384] The UE **40** updates information regarding the location of the UE **40** (for example, the cellular location information) for the CPF **440** (Step S1103). Although the update of the location information by one UE **40** is described here, the CPF **440** can update the location information with a plurality of UEs **40**.

[0385] The UE **40** notifies the CPF **440** of the information (for example, the power information) of the UE **40** regarding the power of the UE **40** (Step S1104). Although the notification of the power information by one UE **40** is illustrated here, the CPF **440** can receive a notification of the power information from a plurality of UEs **40**.

[0386] The RAMNF **100** inquires of the CPF **440** about the UE status such as the registered/de-registered status and the idle/connected status for some UEs **40**, the location information of the UE **40**, and the power information (Step S1105). The RAMNF **100** obtains a response from the CPF **440** (Step S1106).

[0387] The client **200** inquires of the RAMNF **100** about the group of the UE **40** that is in the registered status and the connected status, is located in a specific location, and has predetermined power information (Step S1107). For example, the client **200** inquires of the RAMNF **100** about the group of the UE **40** that is in the registered status and the connected status, is located in a specific location, and has a remaining battery level that is equal to or higher than a certain value.

[0388] The RAMNF **100** transmits, as a response to the client **200**, the group information of the UE **40** that is in the registered status and the connected status, is located in the specific location, and has predetermined power information (Step S1108). For example, the client **200** transmits, as a response to the RAMNF **100**, the group information of the UE **40** that is in the registered status and the connected status, is located in a specific location, and has a remaining battery level that is equal to or higher than a certain value.

[0389] In this manner, the RAMNF **100** receives a request for the ID of the UE **40** that is in a specific power status (for example, the remaining battery level is equal to or higher than a certain level), is in a specific area, and is in the registered status and the connected status from the client **200**.

[0390] The RAMNF **100** notifies the client **200** of the UE ID of the UE **40** that is in a specific power status, is in a specific area, and is in the registered status and the connected status as the group information. The RAMNF **100** detects the group of the UE **40** corresponding to the registration condition (here, the UE **40** that is in the specific area, is in the registered status and the connected status, and is in a specific power status) designated by the client **200** from all pieces of information that has been grasped and creates the group information.

[0391] Note that at least one RAMNF **100** can be arranged in one private network. The RAMNF **100** uses all the UEs **40** belonging to one private network as a population parameter, searches for the UE **40** corresponding to the condition from among them, and provides information to the client **200**.

[0392] As described above, the RAMNF **100** according to the present embodiment provides, to the client **200**, at least one UE **40** that satisfies the condition designated by the client **200** as the group information. As a result, the client **200** can receive one or more candidates for the UE **40** that satisfy the condition. The client **200** may access all the UEs **40** included in the group information, or may select and access a UE **40** from among them.

[0393] The client **200** can acquire information (for example, the registration information) regarding the status of the UE **40**, which is one of the network information (first information), as the group. As a result, signaling between the client **200** and the RAMNF **100** is reduced according to the number of UEs **40** included in the group information as compared with a case where the UE **40** is designated to acquire the information.

[0394] As a result, the operation of the client **200** is simplified, and the client **200** can avoid a congested status of the network.

5. Application Example

[0395] Next, a case where the information processing system **1** according to an embodiment is applied will be described. Note that an application example of the information processing system **1** according to the third embodiment will be described below, but the first and second embodiments can be similarly applied to each case.

5.1. First Application Example

[0396] FIG. **30** is a diagram illustrating an example of the information processing system **1** according to a first application example of the present disclosure. FIG. **30** illustrates a case where the information processing system **1** is applied to a factory. Here, the UE **40** is a camera arranged in the factory.

[0397] FIG. **30** illustrates a case where three cameras **40A1** to **40A3** are arranged, but the number of cameras is not limited to three, and may be two or less, or four or more.

[0398] For example, the client **200** providing a management service for the factory makes an inquiry to the RAMNF **100** in order to know group information of the cameras that are arranged in a specific area in the factory (location condition) and are in the registered status (registration condition).

[0399] In the RAMNF **100**, for example, it is assumed that the cameras **40A1** and **40A2** are the UEs **40** that satisfy the condition designated by the client **200**. The RAMNF **100** responds to the client **200** with the group information including IDs (for example, the UE IDs) for specifying the cameras **40A1** and **40A2**.

[0400] The client **200** that has received the group information accesses the camera **40A2**, for example, and requests the camera **40A2** to upload information (alternatively, the currently captured image) captured by the camera **40A2**.

[0401] As described above, the client **200** can acquire the group information regarding the UE **40** satisfying the condition from the RAMNF **100** by designating the condition.

5.2. Second Application Example

[0402] FIG. **31** is a diagram illustrating an example of the information processing system **1** according to a second application example of the present disclosure. FIG. **31** illustrates a case where the information processing system **1** is applied to a drone system. Here, the UE **40** is a drone.

[0403] FIG. **31** illustrates a case where four drones **40**B**1** to **40**B**4** are flying, but the number of drones is not limited to four, and may be three or less or five or more. For example, the number of drones may be several hundred.

[0404] For example, the client **200** providing a management service for the drones makes an inquiry to the RAMNF **100** in order to know group information of the drones that have passed through a specific area and performed image capturing. At this time, in order to immediately access the drone, the client **200** designates a drone that is currently in the registered status and makes an inquiry about the group information. That is, the client **200** makes an inquiry to the RAMNF **100** by using the past terminal location information (having passed through the specific area in the past) as the location condition and using the current registered status as the registration condition.

[0405] In the RAMNF **100**, for example, it is assumed that the drones **40**B**2** and **40**B**4** are the UEs **40** that satisfy the conditions designated by the client **200**. The RAMNF **100** responds to the client **200** with the group information including IDs (for example, the UE IDs) for specifying the drones **40**B**2** and **40**B**4**.

[0406] The client **200** that has received the group information accesses the drone **40**B**2**, for example, and requests the drone **40**B**2** to upload information captured by the drone **40**B**2** in the specific area.

[0407] As described above, the client **200** can acquire the group information regarding the UE **40** satisfying the condition from the RAMNF **100** by designating the condition. At this time, the client **200** can designate the past terminal location information and acquire the group information.

5.3. Third Application Example

[0408] A case where the information processing system **1** is applied to a temperature measurement system will be described. Here, the UE **40** is a temperature sensor arranged in a region. A large number of temperature sensors may be arranged in the region. In addition, there may be a plurality of regions in which the temperature sensors are arranged. A battery of such a temperature sensor is often difficult to be replaced, and it is thus desired to suppress power consumption as much as possible.

[0409] Therefore, the client **200** that manages the temperature sensor makes an inquiry to the RAMNF **100** in order to know group information of the temperature sensors in the RRC connected status. At this time, the client **200** may designate a region and make an inquiry.

[0410] The RAMNF **100** responds to the client **200** with the group information including IDs (for example, the UE IDs) for specifying the temperature sensors that satisfy the condition (being in the RRC connected status).

[0411] The client **200** that has received the group information selects, for example, a predetermined number (for example, five) of temperature sensors among the temperature sensors included in the group information in such a way that the positions of the temperature sensors are distributed. The client **200** accesses the selected temperature sensors and acquires temperature information.

[0412] As a result, the client **200** can access a temperature sensor in the RRC connected status, and does not need to activate the temperature sensors in the RRC idle status. In addition, the client **200** can access a temperature sensor at a desired location among the temperature sensors in the RRC connected status, and can acquire desired temperature information.

6. Other Embodiments

[0413] The above-described embodiments and application examples show only examples, and various modifications and applications are possible.

[0414] For example, a control device that controls the information processing device **10**, the base station **20**, and the terminal device **40** of the above-described embodiments may be implemented by a dedicated computer system or may be implemented by a general-purpose computer system.

[0415] For example, a communication program for performing the above-described operations is stored in a computer-readable recording medium such as an optical disk, a semiconductor memory, a magnetic tape, or a flexible disk, and distributed. Then, for example, the control device is implemented by installing the program in a computer and performing the above-described processing. At this time, the control device may be a device (for example, a personal computer) outside the information processing device **10**, the base station **20**, and the terminal device **40**. Furthermore, the control device may be a device (for example, the control units **13**, **24**, and **45**) inside the information processing device **10**, the terminal device **40**, and the base station **20**.

[0416] Further, the communication program may be stored in a disk device included in a server device on a network such as the Internet, and be downloaded to a computer. Further, the functions described above may be implemented by cooperation between an operating system (OS) and application software. In this case, the part other than the OS may be stored in a medium and distributed, or the part other than the OS may be stored in a server device and downloaded to a computer.

[0417] Further, among the respective processing described in the above-described embodiments, all or some of the processing described as being automatically performed can be manually performed. Alternatively, all or some of the processing described as being manually performed can be automatically performed by a known method. In addition, the processing procedures, specific names, information including various data and parameters illustrated in the specification and drawings can be arbitrarily changed unless otherwise specified. For example, various pieces of information illustrated in the drawings are not limited to those illustrated in the drawings.

[0418] Further, each illustrated component of each device is functionally conceptual, and does not necessarily have to be configured physically as illustrated in the drawings. That is, the specific modes of distribution/integration of the respective devices are not limited to those illustrated in the drawings. All or some of the devices can be functionally or physically distributed/integrated in any arbitrary unit, depending on various loads or the usage status. Note that this configuration by distribution and integration may be dynamically made.

[0419] Further, the above-described embodiments can be appropriately combined as long as the processing contents do not contradict each other. Further, the order of the steps illustrated in the sequence diagram of the above-described embodiments can be changed as appropriate.

[0420] Furthermore, for example, the present embodiment can be implemented as any component included in the device or system, for example, a processor as a system large scale integration (LSI) or the like, a module using a plurality of processors or the like, a unit using a plurality of modules or the like, a set obtained by further adding other functions to a unit, or the like (that is, some components of the device).

[0421] Note that, in the present embodiment, the system means a set of a plurality of components (devices, modules (parts), and the like), and it does not matter whether or not all the components are in the same housing. Therefore, a plurality of devices housed in separate housings and connected via a network and one device in which a plurality of modules are housed in one housing are both systems.

[0422] Furthermore, for example, the present embodiment can adopt a configuration of cloud computing in which one function is shared and processed by a plurality of devices in cooperation via a network.

7. Conclusion

[0423] Although the embodiments of the present disclosure have been described above, the technical scope of the present disclosure is not limited to the above-described embodiments, and various modifications can be made without departing from the scope of the present disclosure. Moreover, components of different embodiments and modified examples may be appropriately combined.

[0424] Further, the effects in each embodiment described in the present specification are merely examples. The effects of the present disclosure are not limited thereto, and other effects may be obtained.

[0425] Note that the present technology can also have the following configurations.

[0426] (1)

[0427] An information processing device comprising:

[0428] a control unit that

[0429] acquires first information regarding a terminal device from a core network via a service based interface (SBI),

[0430] acquires second information including at least one of measurement information measured based on the first information or terminal-related information acquired from the terminal device directly or via the SBI,

[0431] specifies the terminal device from the second information or by associating the first information and the second information with each other, and

[0432] notifies a client device of at least one of the first information or the second information in association with the specified terminal device.

[0433] (2)

[0434] The information processing device according to (1), wherein the terminal-related information includes information included in an application layer of the terminal device.

[0435] (3)

[0436] The information processing device according to (1) or (2), wherein the terminal-related information includes at least one of schedule information regarding a registration schedule, power information regarding power consumption of the terminal device, or location information regarding a location of the terminal device.

[0437] (4)

[0438] The information processing device according to (3), wherein the location information is measured using equipment mounted on the terminal device.

[0439] (5)

[0440] The information processing device according to (3) or (4), wherein

[0441] the location information includes at least one of current location information, past location information, or future location information.

[0442] (6)

[0443] The information processing device according to any one of (3) to (5), wherein

[0444] the first information includes registration information regarding registration of the terminal device, and

[0445] the client device determines the terminal device to access based on the power information and the registration information.

[0446] (7)

[0447] The information processing device according to any one of (3) to (6), wherein

[0448] the first information includes registration information regarding registration of the terminal device, and

[0449] the client device determines the terminal device to access based on the location information and the registration information.

[0450] (8)

[0451] The information processing device according to any one of (1) to (7), wherein the control unit notifies the client device of group information including at least one piece of information regarding the terminal device that satisfies a condition designated by the client device.

[0452] (9)

[0453] The information processing device according to (8), wherein the condition includes at least one of a registration condition that designates a registration status of the terminal device, a power condition that designates a power consumption status of the terminal device, or a location condition that designates a location of the terminal device.

[0454] (10)

[0455] The information processing device according to (9), wherein the location condition includes a condition that designates at least one of a current location, a past location, or a future location of the terminal device.

[0456] (11)

[0457] The information processing device according to any one of (1) to (10), wherein

[0458] the first information includes registration information regarding registration of the terminal device, and

[0459] the measurement information includes information regarding a transition interval of registration of the terminal device calculated based on the registration information.

[0460] (12)

[0461] The information processing device according to (11), wherein the measurement information includes information regarding an idle transition time until the terminal device transitions to an idle status.

[0462] (13)
[0463] The information processing device according to (12), wherein the client device communicates with the terminal device before a timing at which the terminal device transitions to the idle status based on the measurement information.
[0464] (14)
[0465] An information processing method comprising:
[0466] acquiring first information regarding a terminal device from a core network via a service based interface (SBI);
[0467] acquiring second information including at least one of measurement information measured based on the first information or terminal-related information acquired from the terminal device directly or via the SBI;
[0468] specifying the terminal device from the second information or by associating the first information and the second information with each other; and
[0469] notifying a client device of at least one of the first information or the second information in association with the specified terminal device.
[0470] (15)
[0471] A terminal device comprising:
[0472] a control unit that notifies an information processing device of terminal-related information directly or via a service based interface (SBI), wherein
[0473] the information processing device
[0474] acquires first information regarding the terminal device from a core network via the SBI,
[0475] specifies the terminal device from the terminal-related information or by associating the first information and the terminal-related information with each other, and
[0476] notifies a client device of at least one of the first information or the terminal-related information in association with the specified terminal device
[0477] (16)
[0478] A system comprising: a first information processing device; a second information processing device that functions as a network function of a core network; and a terminal device, wherein
[0479] the first information processing device comprises a control unit that
[0480] acquires first information regarding the terminal device from the second information processing device via a service based interface (SBI),
[0481] acquires second information including at least one of measurement information measured based on the first information or terminal-related information acquired from the terminal device directly or via the SBI,
[0482] specifies the terminal device from the second information or by associating the first information and the second information with each other, and
[0483] notifies a client device of at least one of the first information or the second information in association with the specified terminal device.

REFERENCE SIGNS LIST

[0484] **1** Information processing system
[0485] **10** Information processing device
[0486] **11** Communication unit
[0487] **12**, **22**, **42** Storage unit
[0488] **13**, **24**, **45** Control unit
[0489] **20** Base station
[0490] **21**, **41** Signal processing unit
[0491] **23** Network communication unit
[0492] **40** Terminal device
[0493] **44** Input/output unit

1. An information processing device, comprising:
one or more network interfaces; and
circuitry configured to:
acquire, using the one or more network interfaces, first information regarding a terminal device from a core network via a service based interface (SBI),
acquire, using the one or more network interfaces, second information including terminal-related information acquired from the terminal device directly or via the SBI, the terminal-related information being application layer information of the terminal device,
specify the terminal device from the second information or by associating the first information and the second information with each other, and
notify a client device of the first information and the second information in association with the specified terminal device.

2. The information processing device according to claim **1**, wherein the terminal-related information is behavior information of the terminal device that originates from the application layer of the terminal device.

3. The information processing device according to claim **1**, wherein the terminal-related information includes at least one of schedule information regarding a registration schedule, power information regarding power consumption of the terminal device, or location information regarding a location of the terminal device.

4. The information processing device according to claim **3**, wherein the location information is measured using equipment mounted on the terminal device.

5. The information processing device according to claim **3**, wherein
the location information includes at least one of current location information, past location information, or future location information.

6. The information processing device according to claim **3**, wherein
the first information includes registration information regarding registration of the terminal device, and
the terminal device is accessed by the client device based on the power information and the registration information.

7. The information processing device according to claim **3**, wherein
the first information includes registration information regarding registration of the terminal device, and
the terminal device is accessed by the client device based on the location information and the registration information.

8. The information processing device according to claim **1**, wherein the circuitry is further configured to
notify the client device of group information including at least one piece of information regarding the terminal device that satisfies a condition designated by the client device.

9. The information processing device according to claim **8**, wherein the condition includes at least one of a registration condition that designates a registration status of the

terminal device, a power condition that designates a power consumption status of the terminal device, or a location condition that designates a location of the terminal device.

10. The information processing device according to claim **9**, wherein the location condition includes a condition that designates at least one of a current location, a past location, or a future location of the terminal device.

11. The information processing device according to claim **1**, wherein

the first information includes registration information regarding registration of the terminal device, and

the measurement information includes information regarding a transition interval of registration of the terminal device calculated based on the registration information.

12. The information processing device according to claim **11**, wherein the measurement information includes information regarding an idle transition time until the terminal device transitions to an idle status.

13. The information processing device according to claim **12**, wherein the terminal device receives communication from the client device before a timing at which the terminal device transitions to the idle status based on the measurement information.

14. An information processing method, comprising:

acquiring, using one or more network interfaces, first information regarding a terminal device from a core network via a service based interface (SBI);

acquiring, using the one or more network interfaces, second information including terminal-related information acquired from the terminal device directly or via the SBI, the terminal-related information being application layer information of the terminal device;

specifying the terminal device from the second information or by associating the first information and the second information with each other; and

notifying a client device of the first information and the second information in association with the specified terminal device.

15. A terminal device, comprising:

circuitry configured to

notify a core network of first information via a service based interface (SBI), and

notify an information processing device of second information including terminal-related information directly or via the SBI, the terminal-related information being application layer information of the terminal device.

16. A system, comprising:

a first information processing device;

a second information processing device that functions as a network function of a core network; and

a terminal device, wherein

the first information processing device includes one or more network interfaces and circuitry configured to

acquire, using the one or more network interfaces, first information regarding the terminal device from the second information processing device via a service based interface (SBI),

acquire, using the one or more network interfaces, second information including terminal-related information acquired from the terminal device directly or via the SBI, the terminal-related information being application layer information of the terminal device,

specify the terminal device from the second information or by associating the first information and the second information with each other, and

notify a client device of the first information and the second information in association with the specified terminal device.

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