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(54) **CONNECTION RELEASE METHOD AND APPARATUS FOR CLIENT COOPERATION IN WIRELESS COMMUNICATION SYSTEM**

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(57) **ABSTRACT**

Provided are a connection release method and apparatus for client cooperation in a wireless communication system. A source device and a base station exchange a release request message and a release response message at the stage of a connection release request. The source device releases connection with a cooperative device and then transmits a release report message, which includes the results of the connection release with the cooperative device, to the base station. The base station and the cooperative device are connected through a first system, and the source device and the cooperative device are connected through a second system.

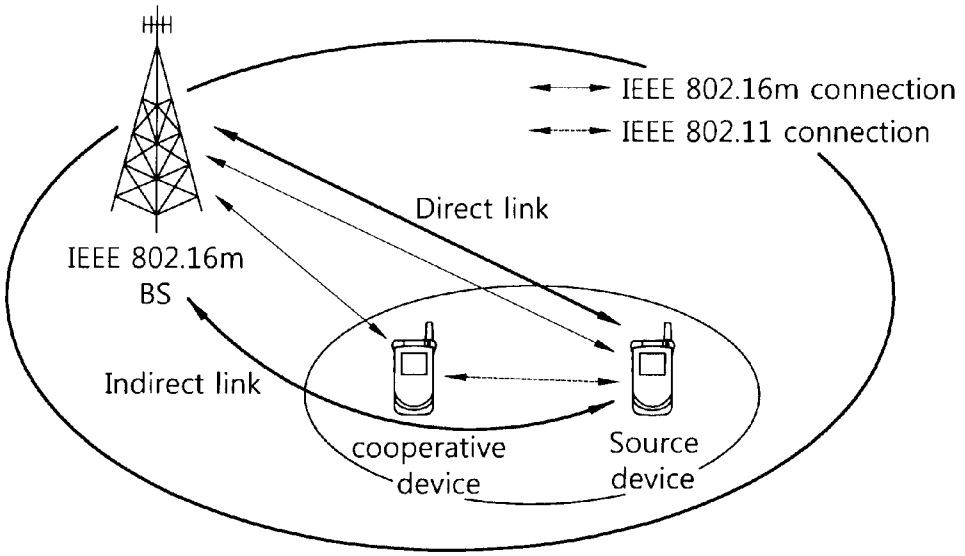


FIG. 1

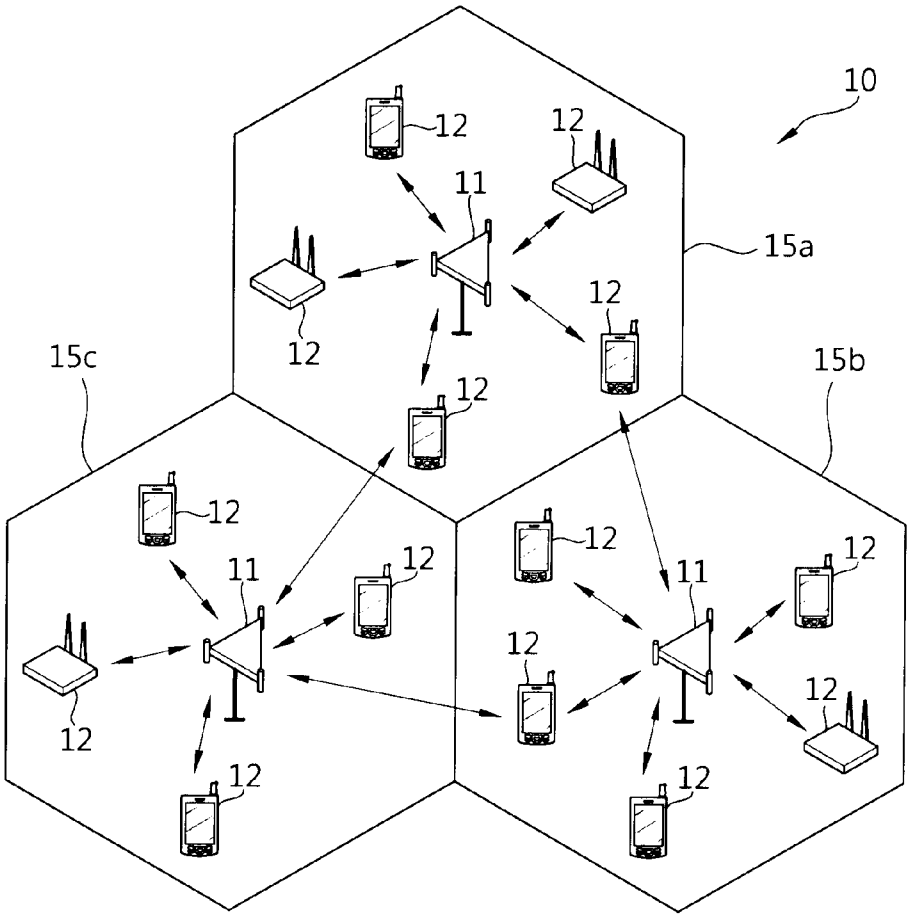


FIG. 2

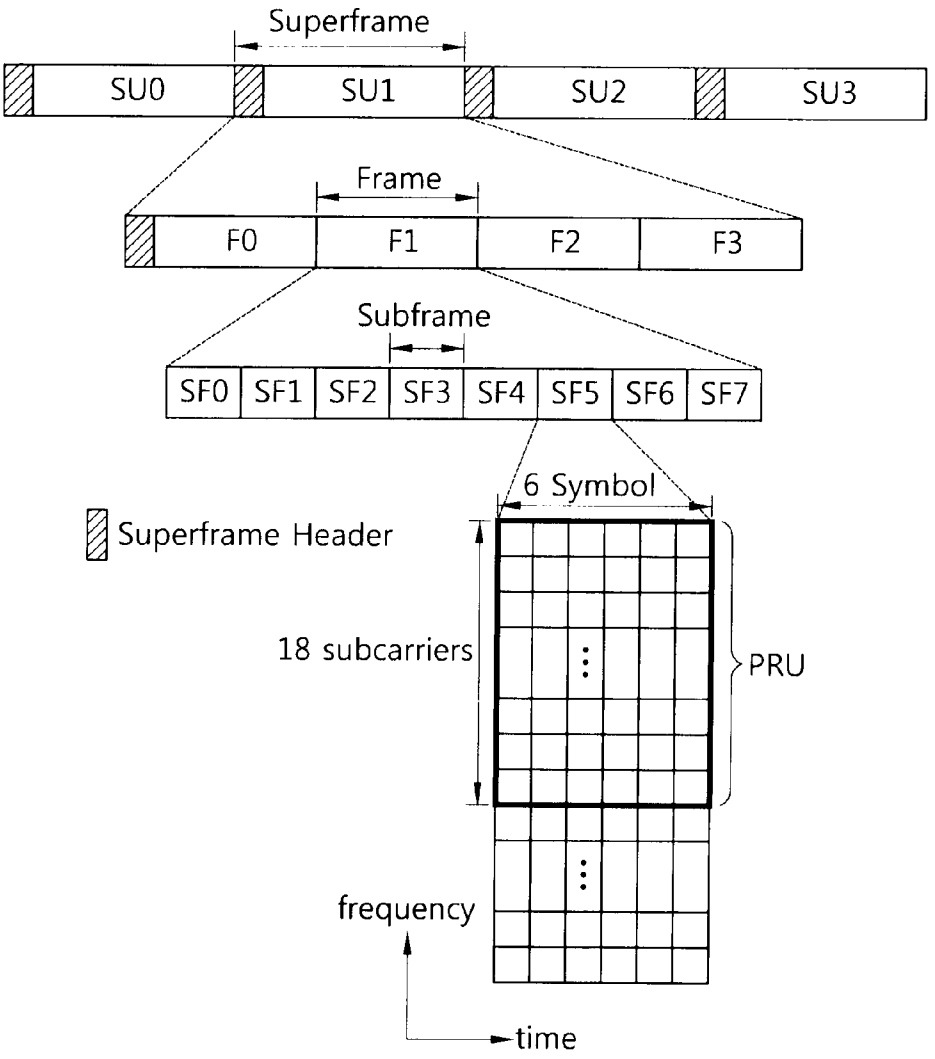

Superframe
SU0
SU1
SU2
SU3
Frame
F0
F1
F2
F3
Subframe
SF0
SF1
SF2
SF3
SF4
SF5
SF6
SF7
6 Symbol
Superframe Header
18 subcarriers
PRU
frequency
time

FIG. 3

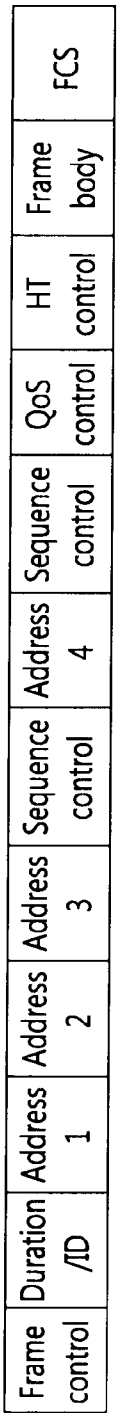

Frame control
Duration /ID
Address 1
Address 2
Address 3
Sequence control
Address 4
Sequence control
QoS control
HT control
Frame body
FCS

FIG. 4

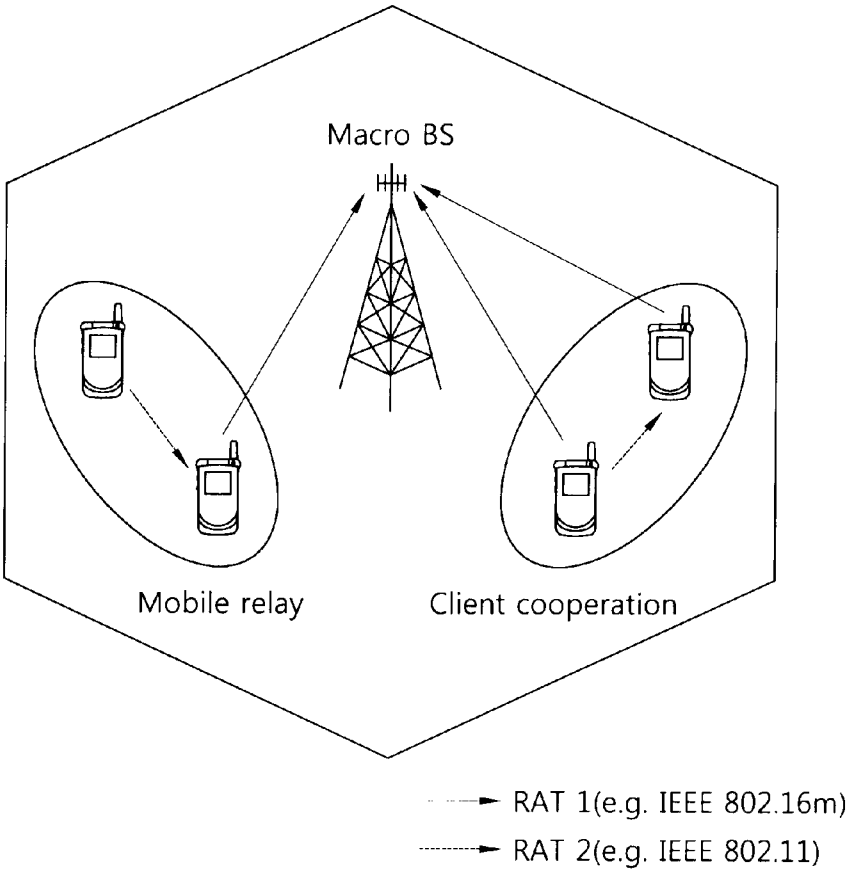

Macro BS
Mobile relay
Client cooperation
RAT 1(e.g. IEEE 802.16m)
RAT 2(e.g. IEEE 802.11)

FIG. 5

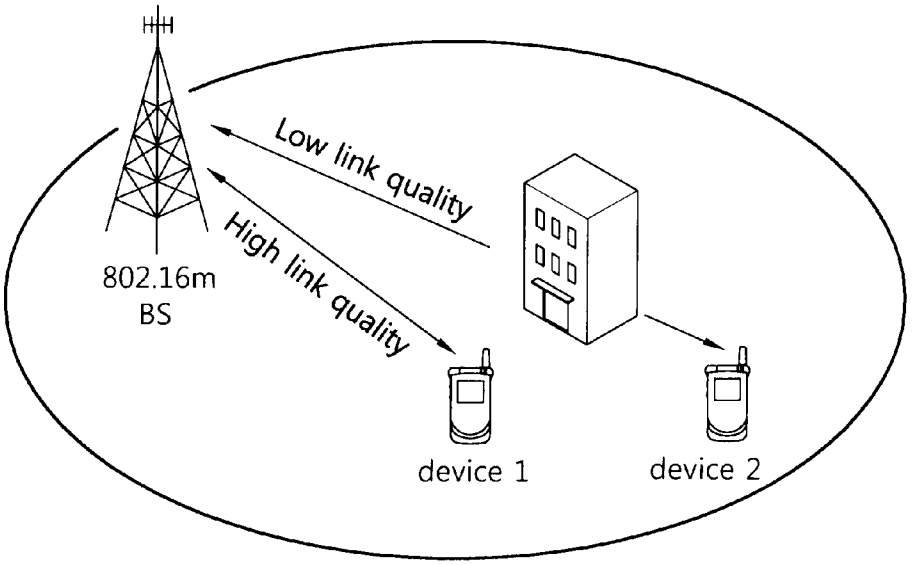

Low link quality
High link quality
802.16m
BS
device 1
device 2

FIG. 6

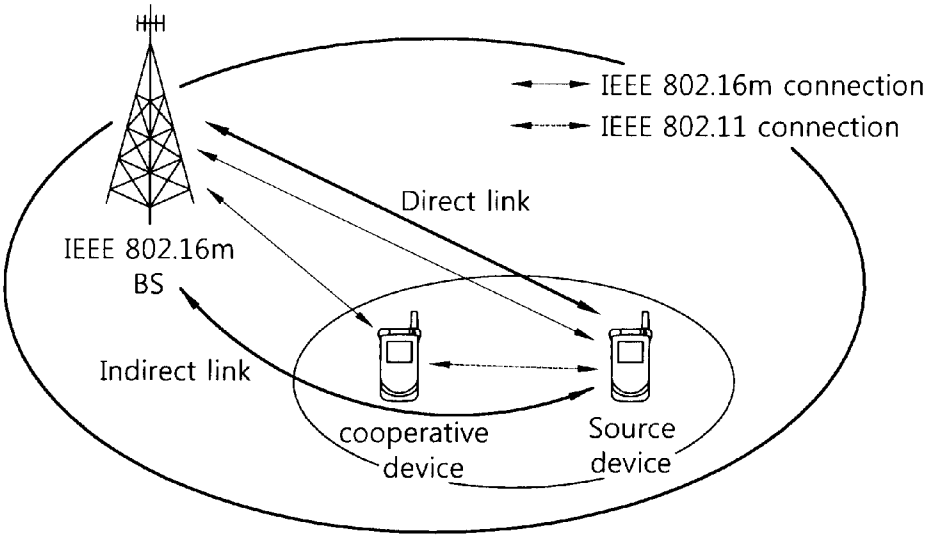

IEEE 802.16m connection
IEEE 802.11 connection
Direct link
IEEE 802.16m
BS
Indirect link
cooperative
device
Source
device

FIG. 7

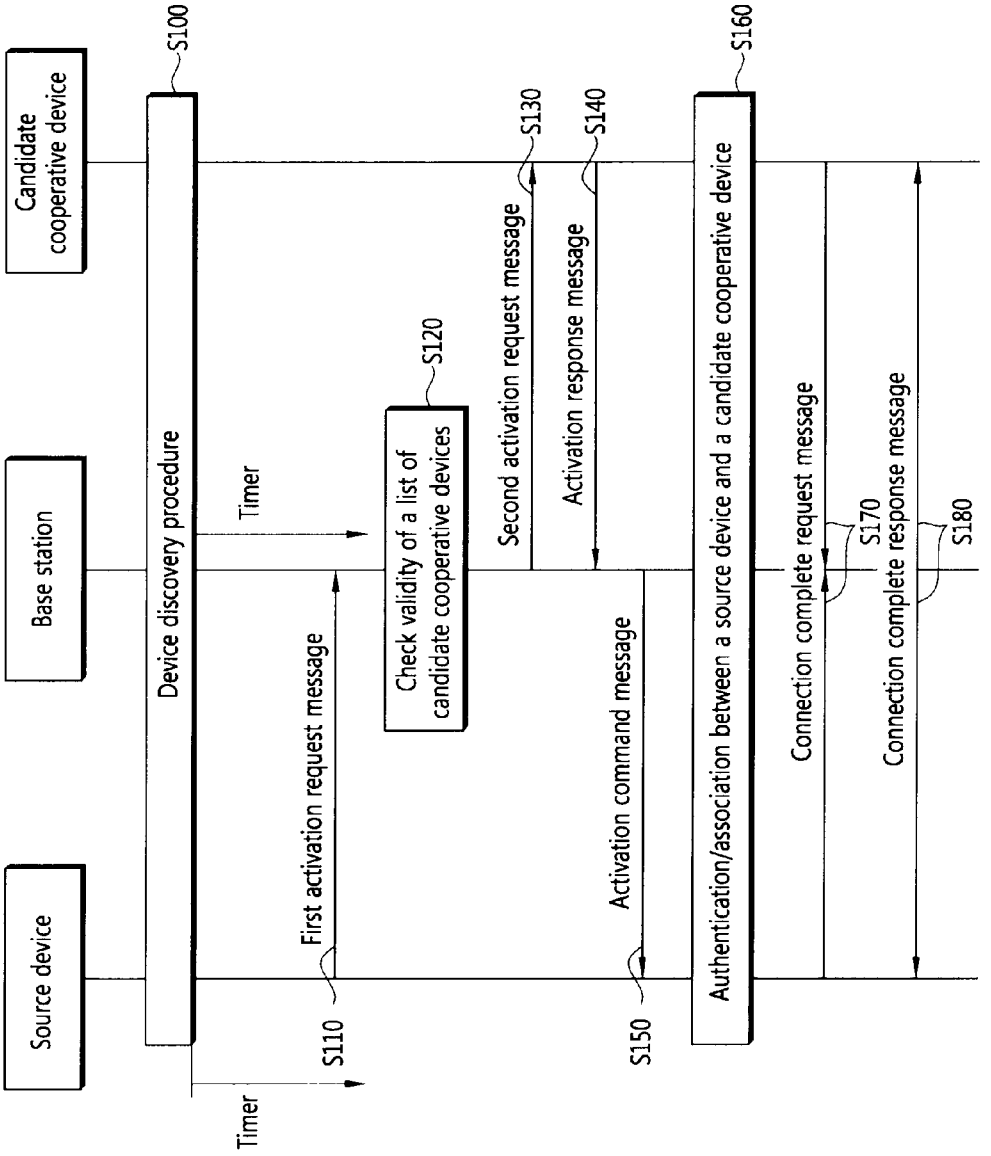

Source device
Base station
Candidate cooperative device
S100
Device discovery procedure
Timer
Timer
First activation request message
S110
S120
Check validity of a list of candidate cooperative devices
S130
Second activation request message
S140
Activation response message
Activation command message
S150
S160
Authentication/association between a source device and a candidate cooperative device
Connection complete request message
S170
Connection complete response message
S180

FIG. 8

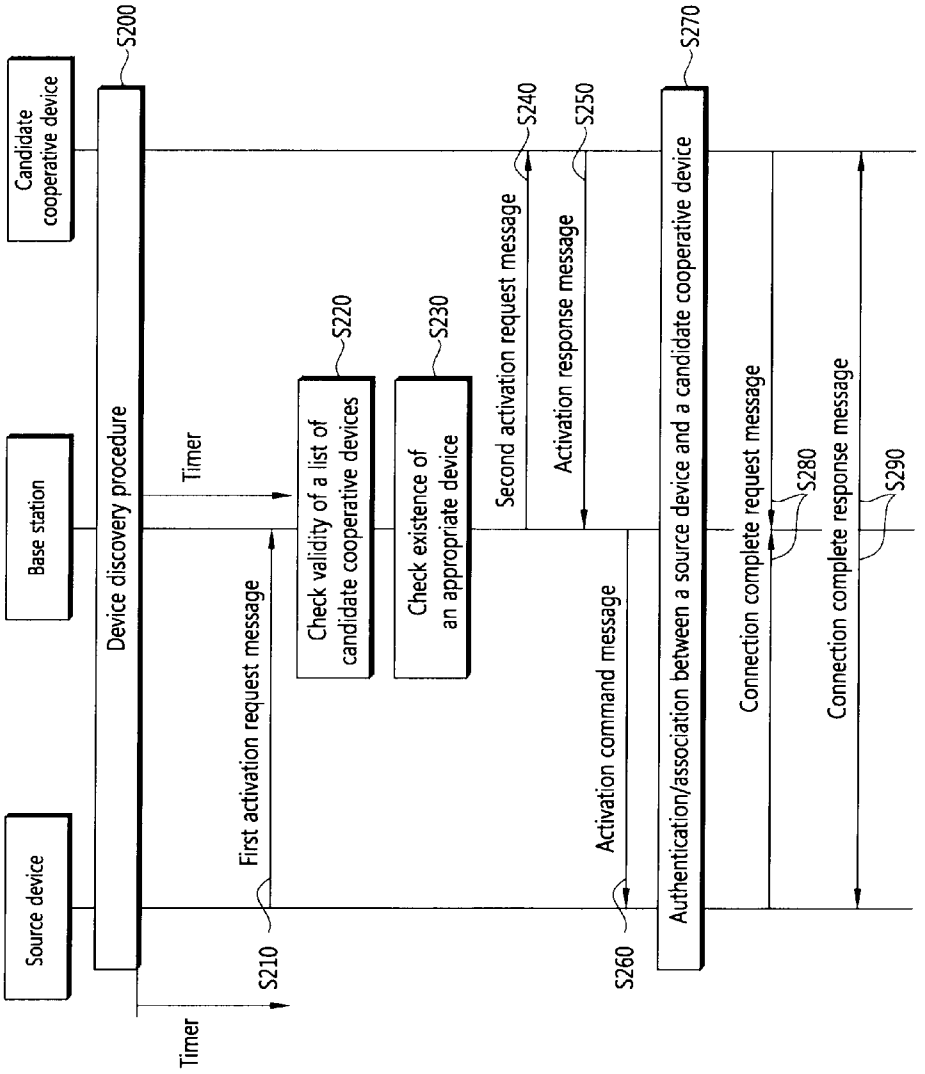

Source device
Base station
Candidate cooperative device
Device discovery procedure
S200
Timer
First activation request message
S210
Timer
Check validity of a list of candidate cooperative devices
S220
Check existence of an appropriate device
S230
Second activation request message
S240
Activation response message
S250
Activation command message
S260
Authentication/association between a source device and a candidate cooperative device
S270
Connection complete request message
S280
Connection complete response message
S290

FIG. 9

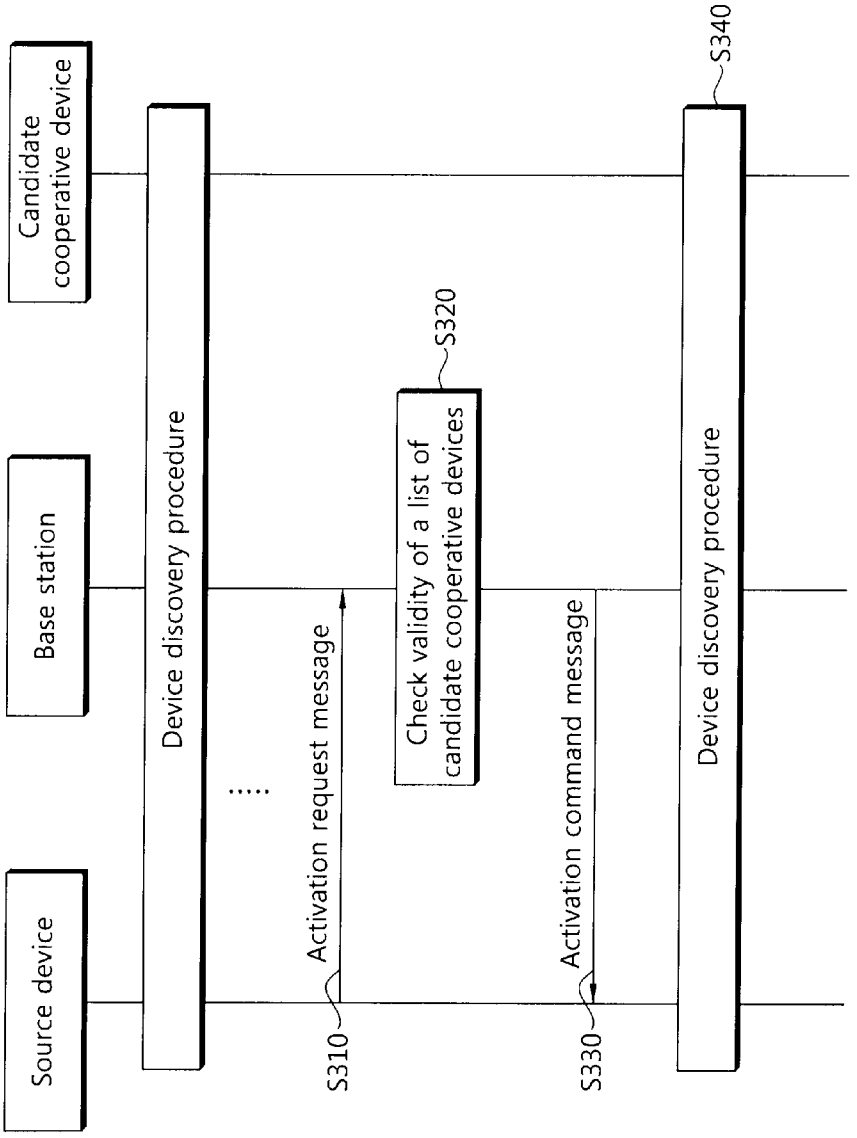

Source device
Base station
Candidate cooperative device
Device discovery procedure
Activation request message
S310
Check validity of a list of candidate cooperative devices
S320
Activation command message
S330
Device discovery procedure
S340

FIG. 10

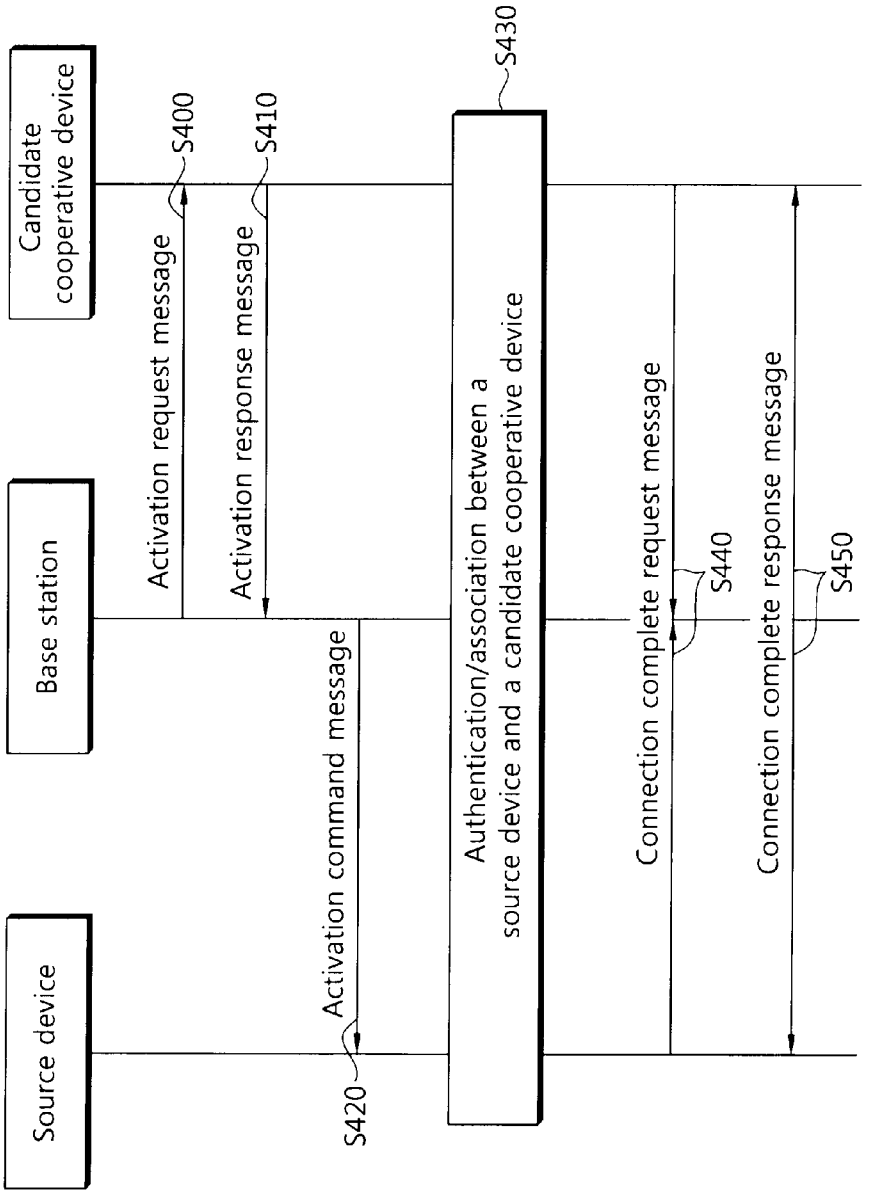

Source device
Base station
Candidate cooperative device
Activation request message
S400
Activation response message
S410
Activation command message
S420
Authentication/association between a source device and a candidate cooperative device
S430
Connection complete request message
S440
Connection complete response message
S450

FIG. 11

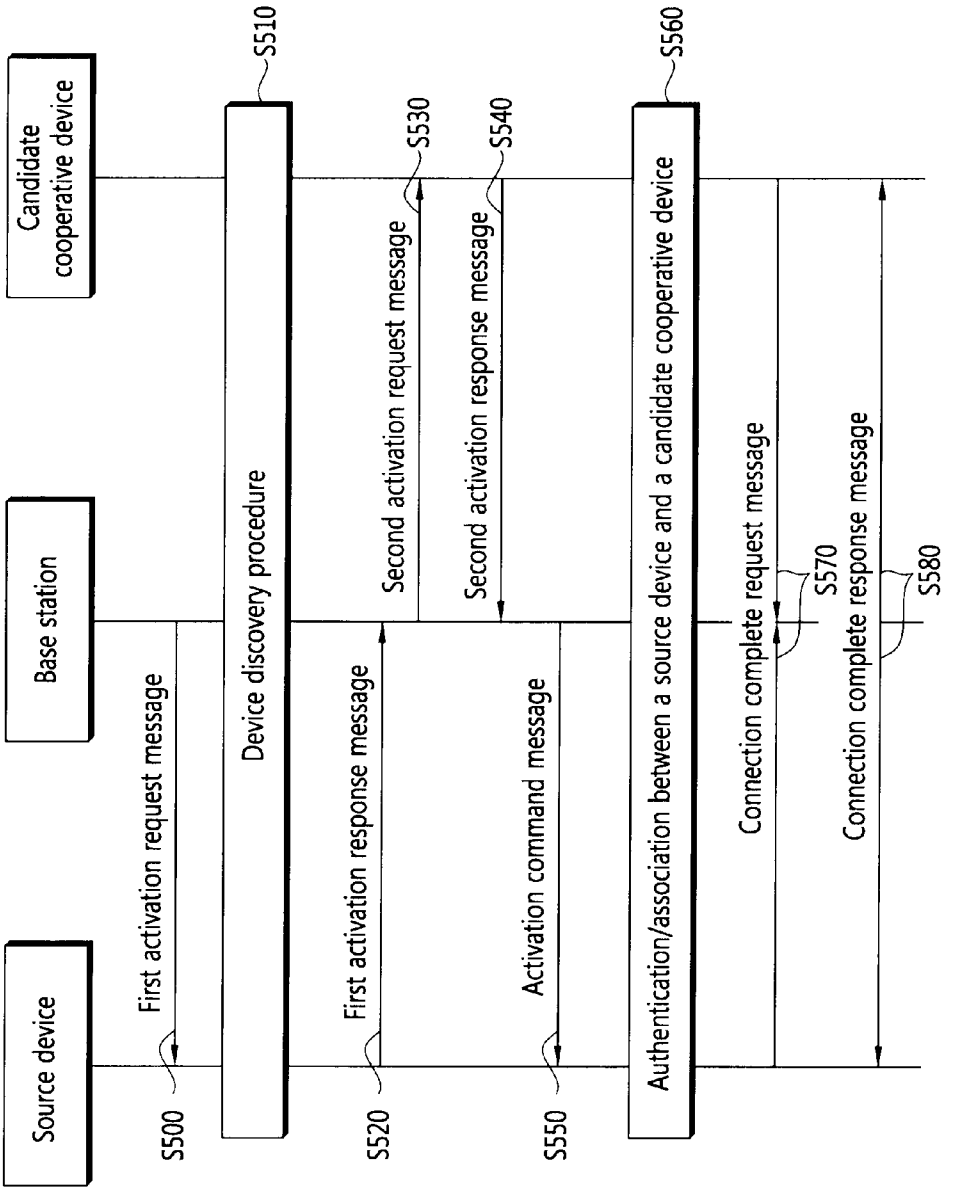

Source device
Base station
Candidate cooperative device
First activation request message
S500
Device discovery procedure
S510
First activation response message
S520
Second activation request message
S530
Second activation response message
S540
Activation command message
S550
Authentication/association between a source device and a candidate cooperative device
S560
Connection complete request message
S570
Connection complete response message
S580

FIG. 12

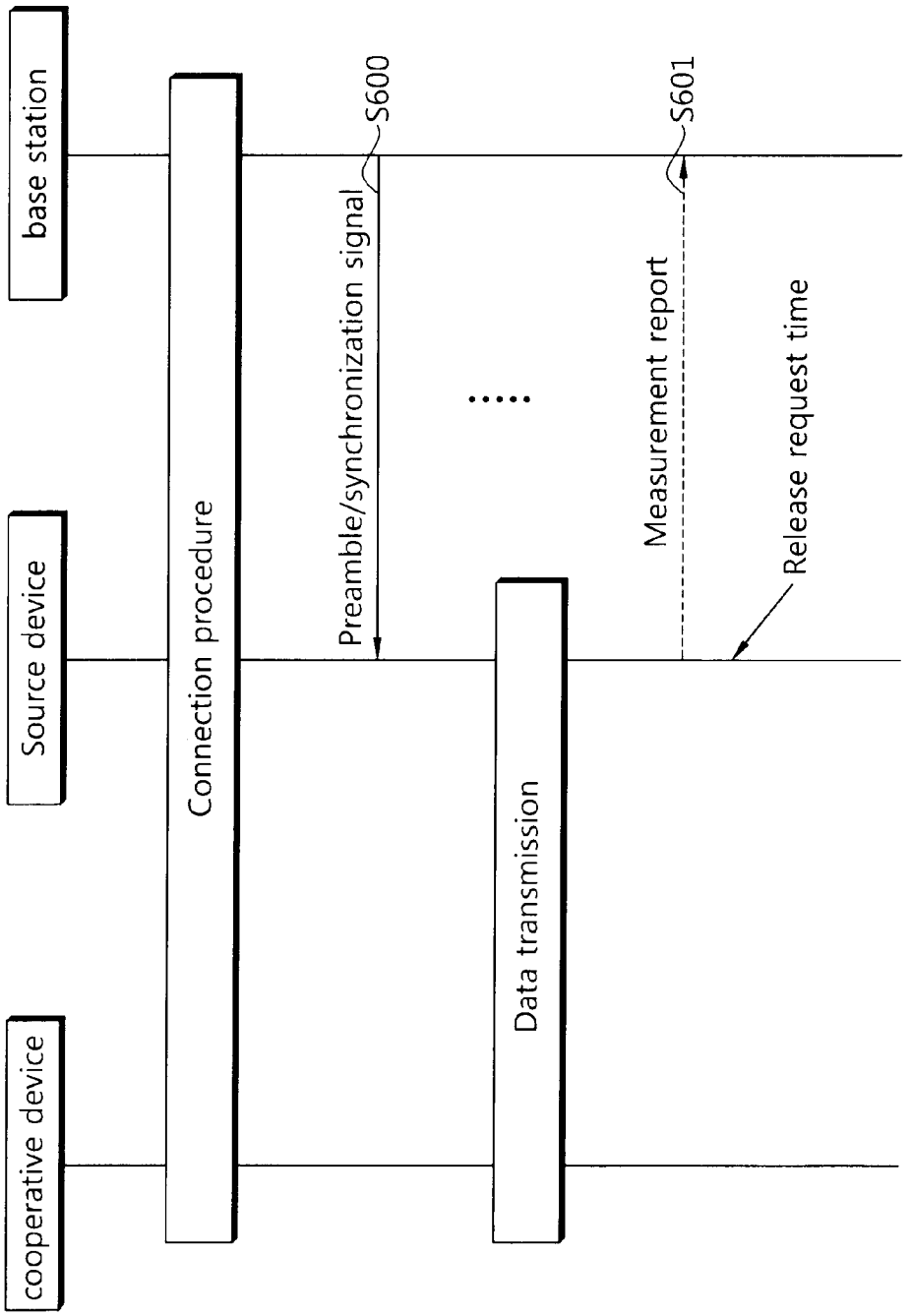

base station
Source device
cooperative device
Connection procedure
S600
Preamble/synchronization signal
S601
Measurement report
Release request time
Data transmission

FIG. 13

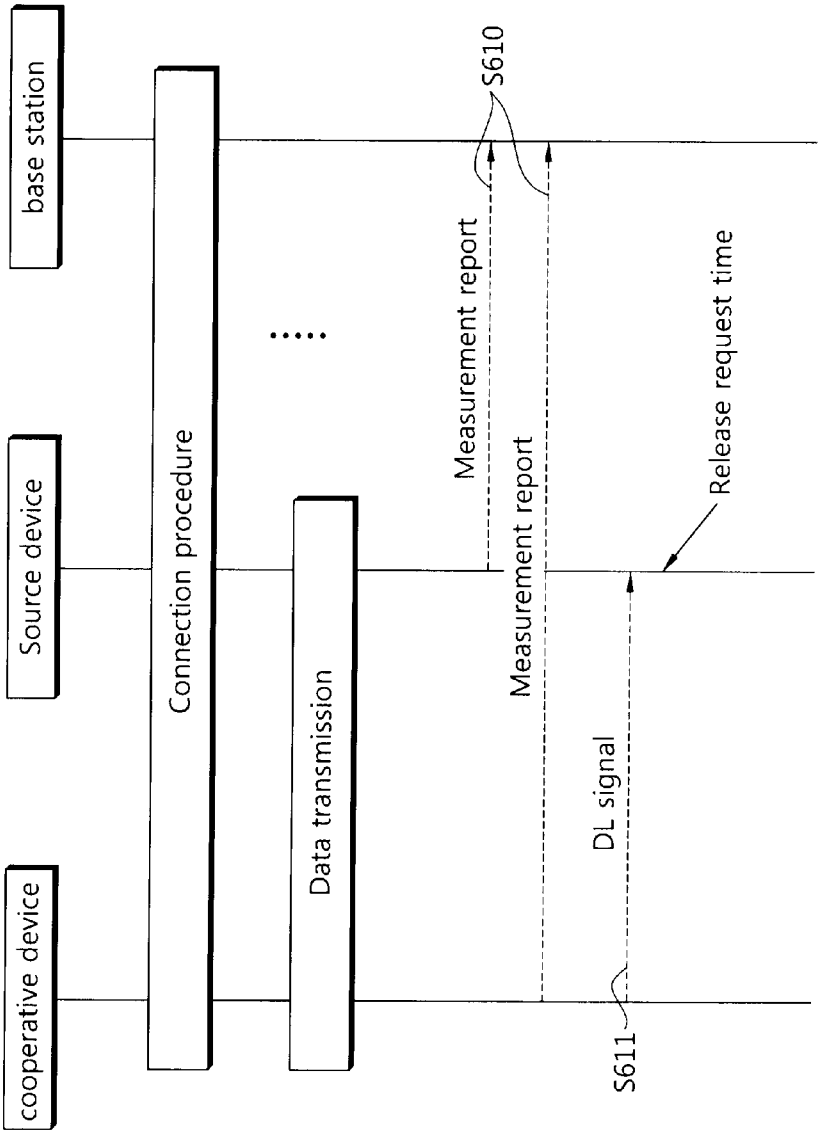

base station
Source device
cooperative device
Connection procedure
Data transmission
.....
S610
Measurement report
Measurement report
Release request time
DL signal
S611

FIG. 14

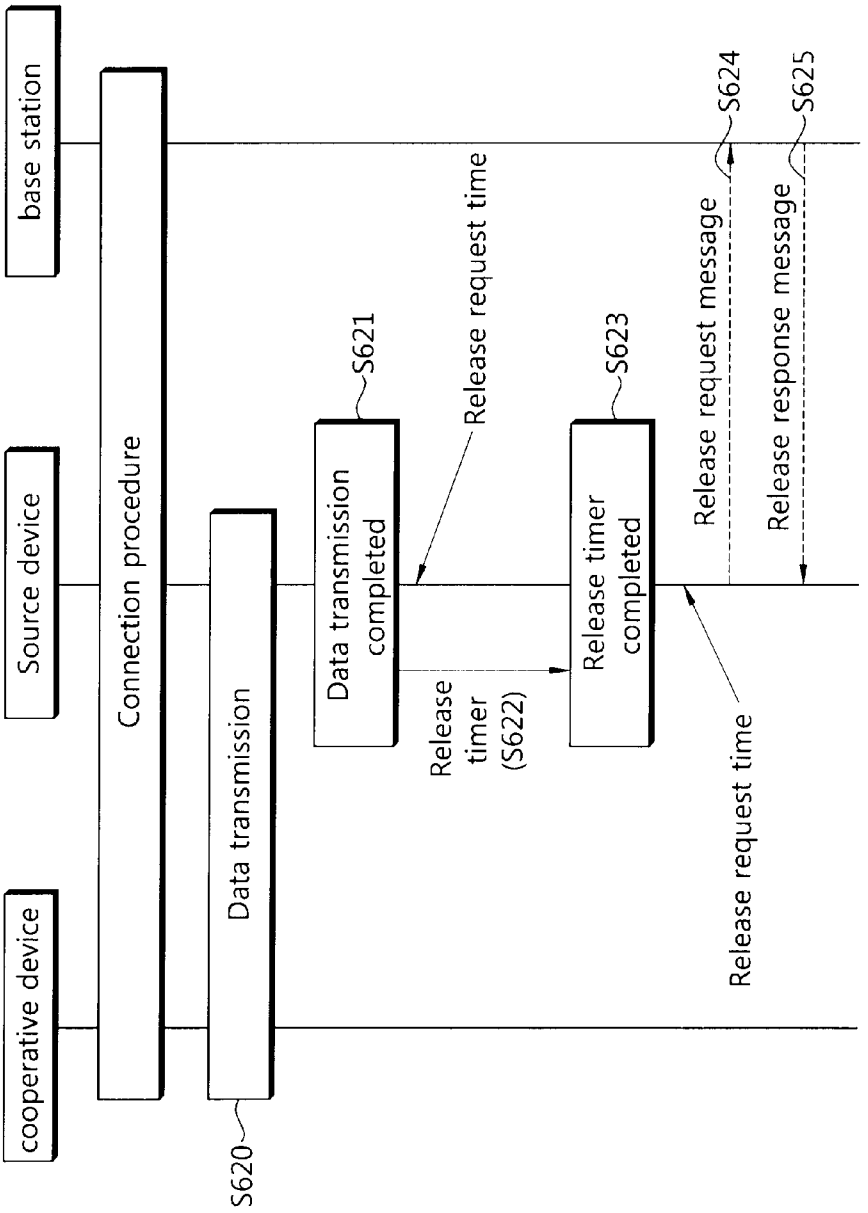

base station
Source device
cooperative device
Connection procedure
Data transmission
S620
Data transmission completed
S621
Release request time
Release timer (S622)
Release timer completed
S623
Release request message
S624
Release response message
S625
Release request time

FIG. 15

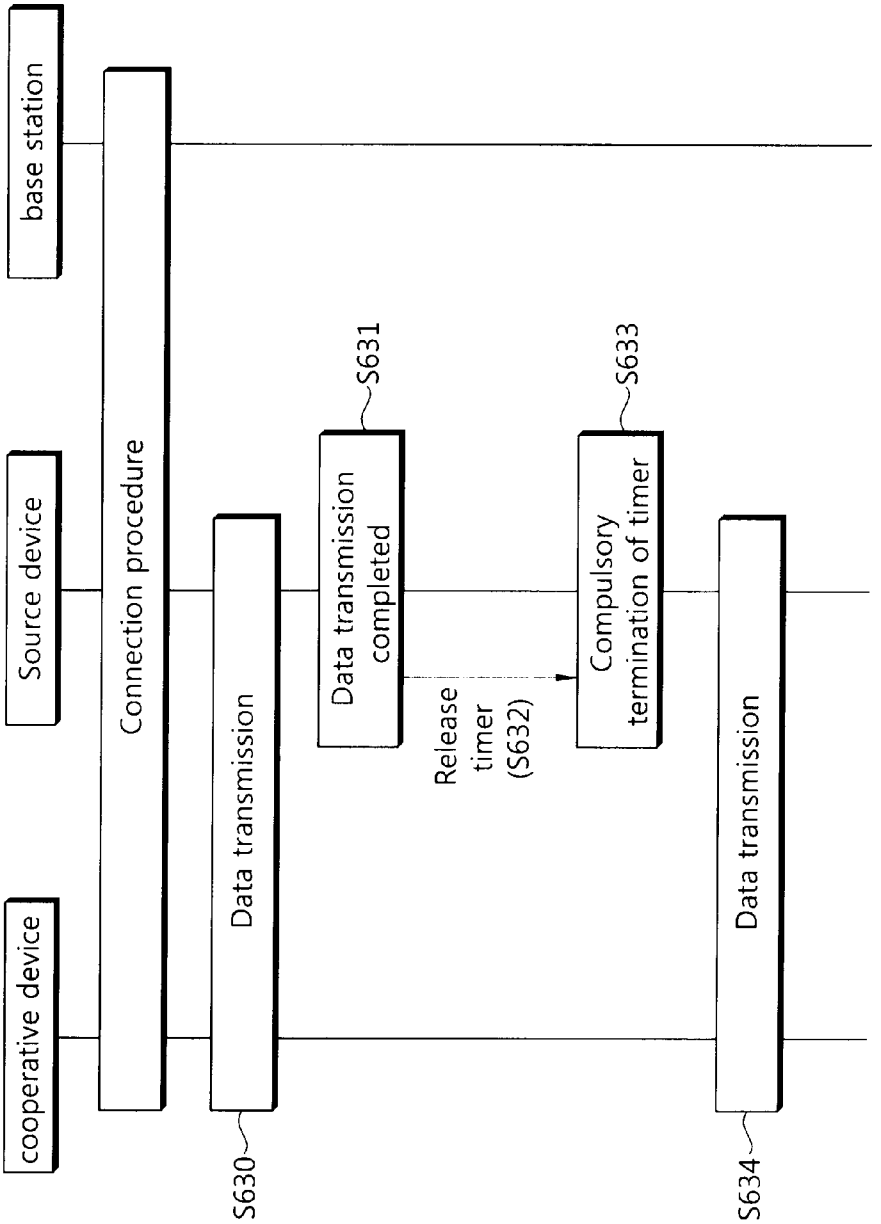

base station
Source device
cooperative device
Connection procedure
Data transmission
S630
Data transmission completed
S631
Release timer (S632)
Compulsory termination of timer
S633
Data transmission
S634

FIG. 16

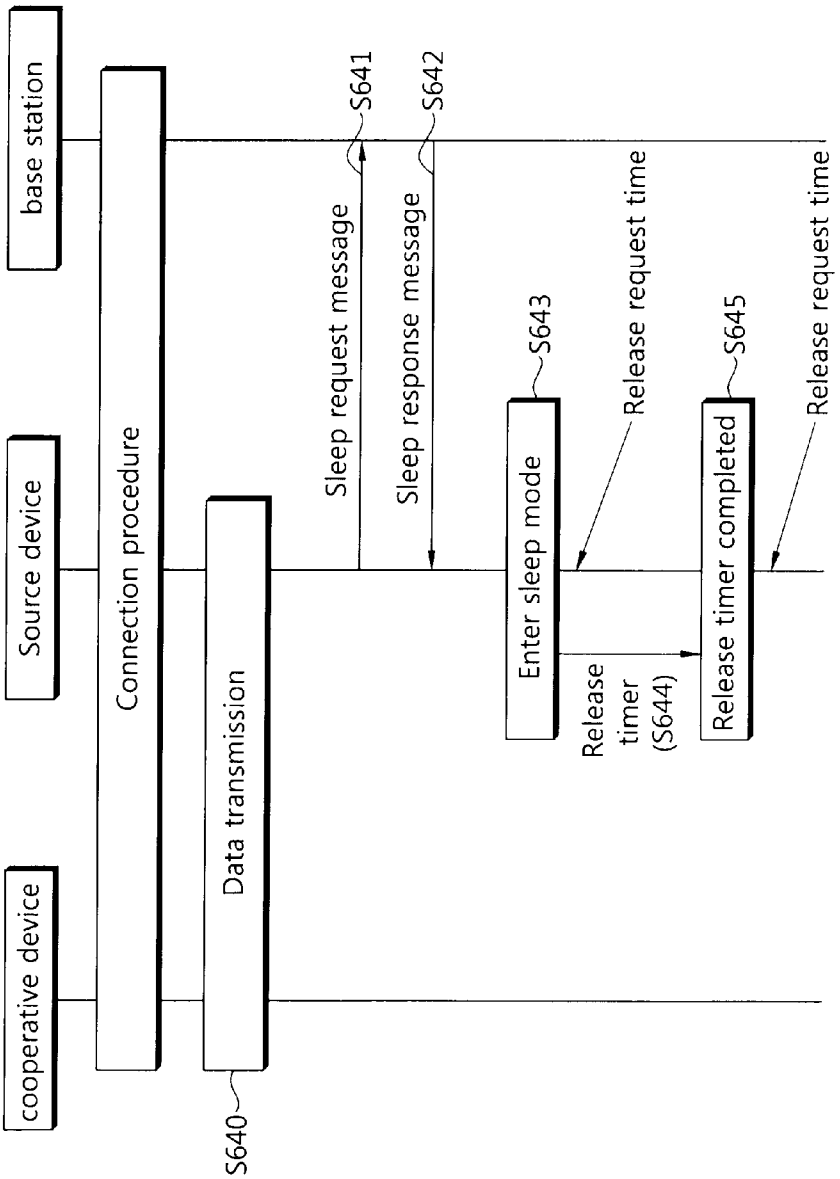

base station
Source device
cooperative device
Connection procedure
Data transmission
S640
Sleep request message
S641
Sleep response message
S642
Enter sleep mode
S643
Release request time
Release timer (S644)
Release timer completed
S645
Release request time

FIG. 17

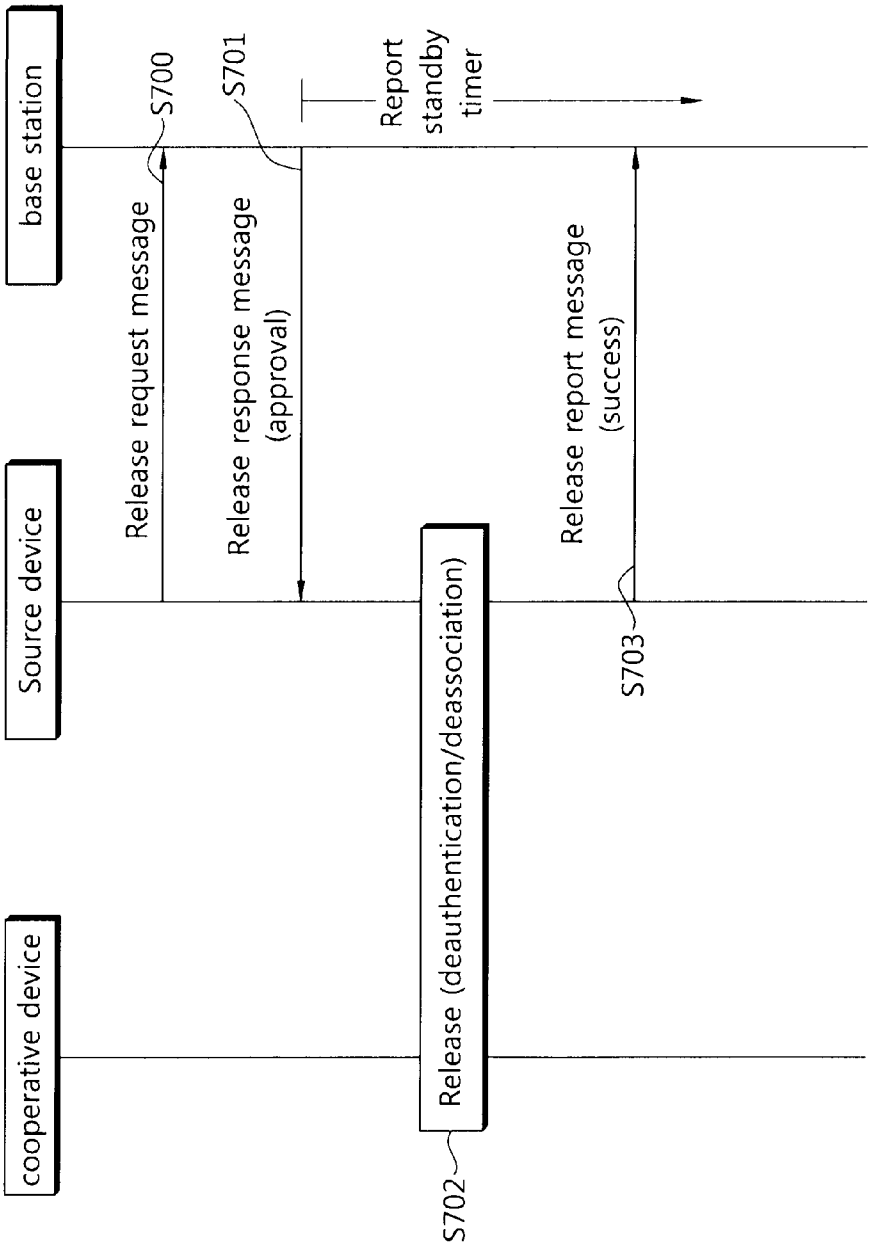

base station
Source device
cooperative device
S700
Release request message
S701
Release response message
(approval)
Report
standby
timer
Release report message
(success)
S703
Release (deauthentication/deassociation)
S702

FIG. 18

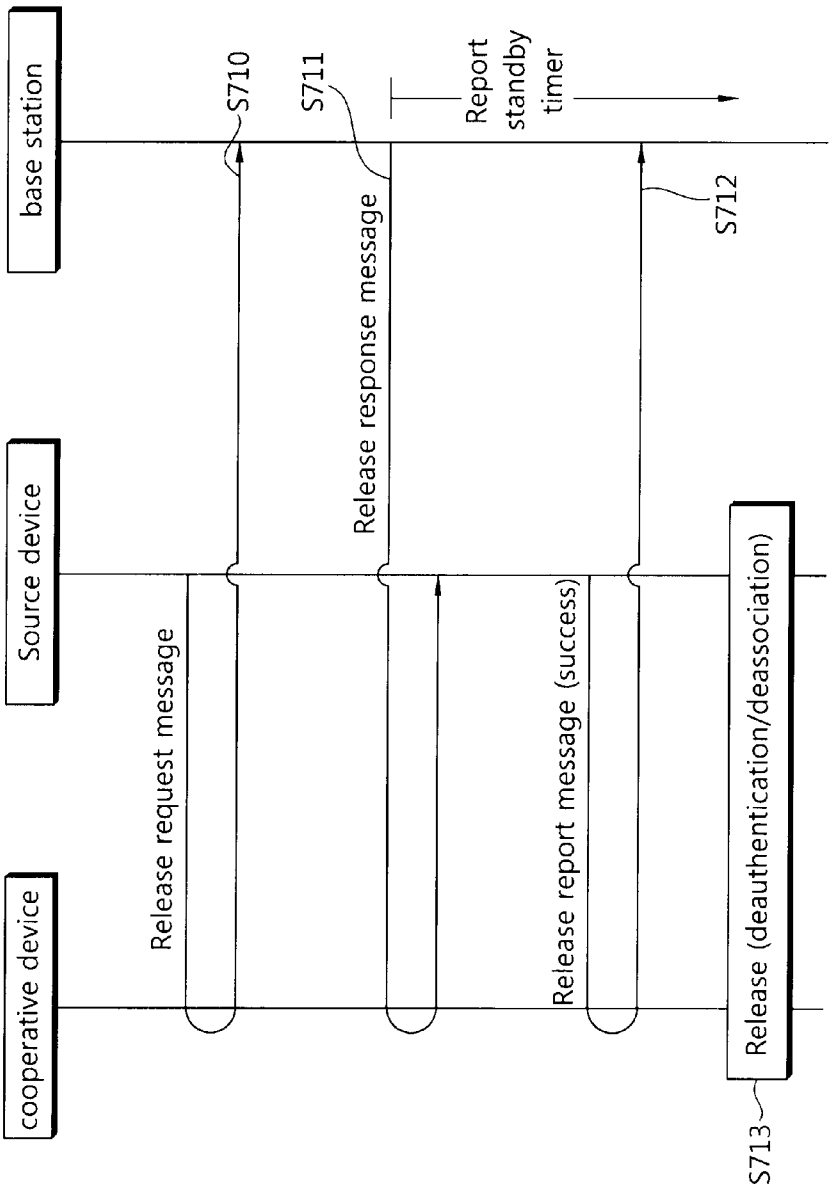

base station
Source device
cooperative device
S710
S711
Release response message
Report standby timer
S712
Release request message
Release report message (success)
Release (deauthentication/deassociation)
S713

FIG. 19

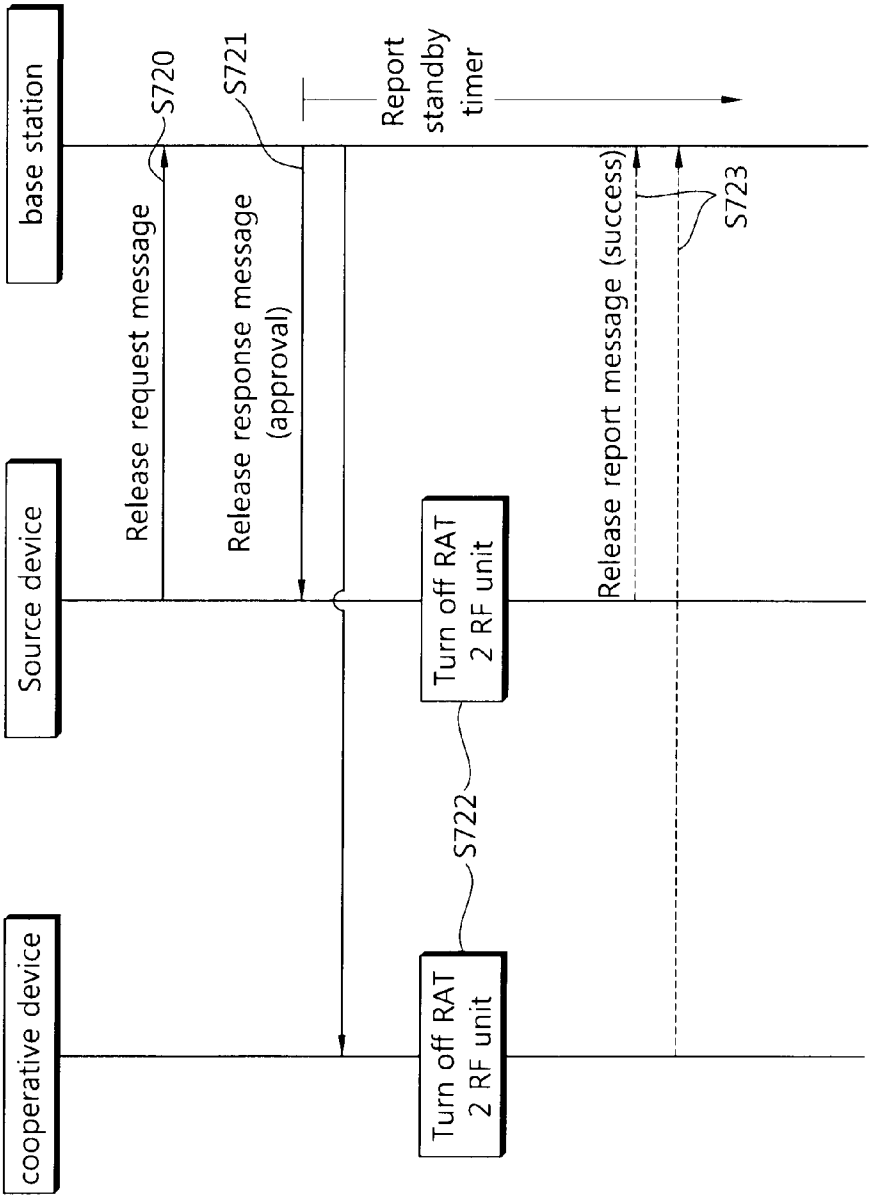

base station
Source device
cooperative device
S720
S721
Report standby timer
Release request message
Release response message (approval)
Release report message (success)
S723
Turn off RAT 2 RF unit
S722
Turn off RAT 2 RF unit

FIG. 20

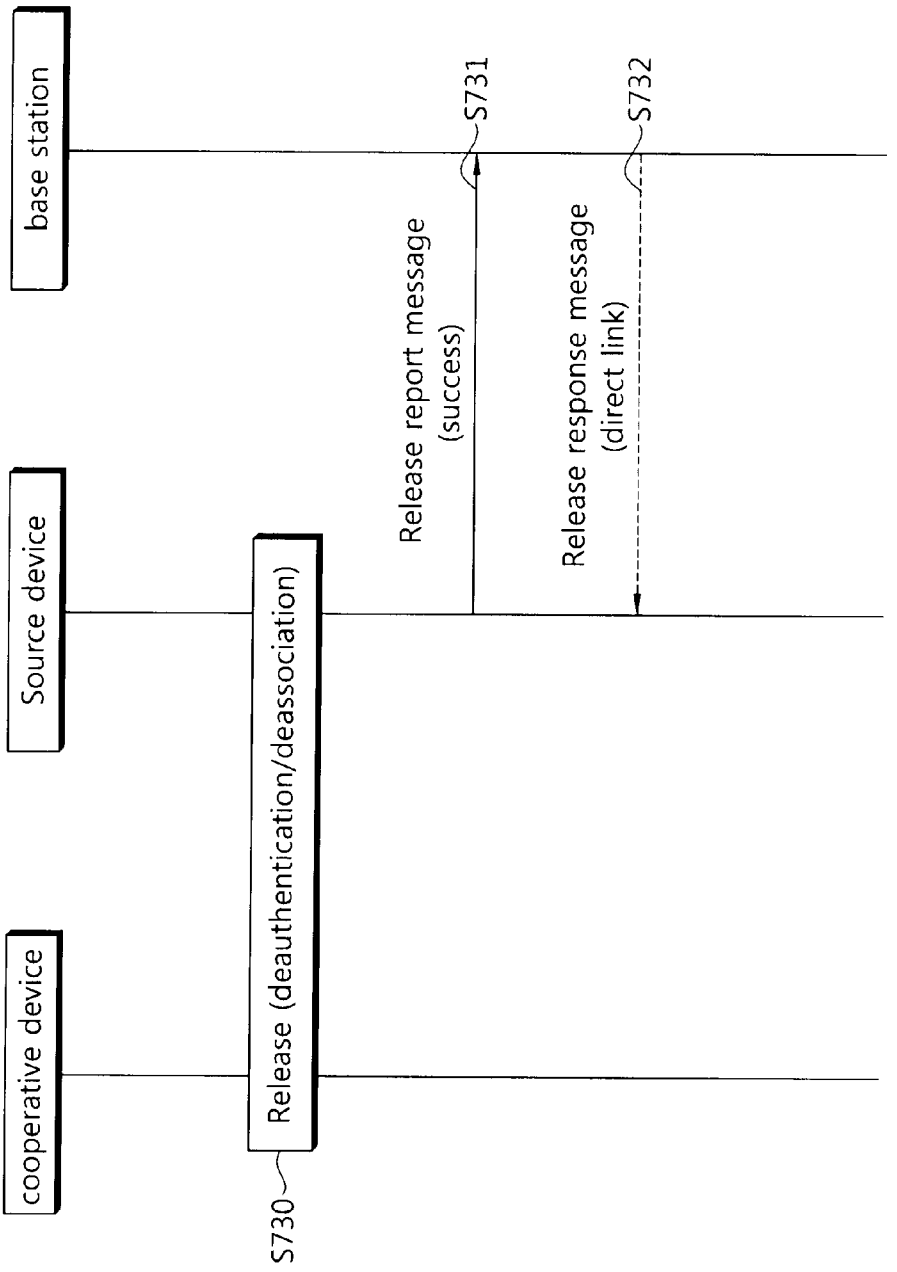

base station
Source device
cooperative device
Release (deauthentication/deassociation)
S730
S731
S732
Release report message
(success)
Release response message
(direct link)

FIG. 21

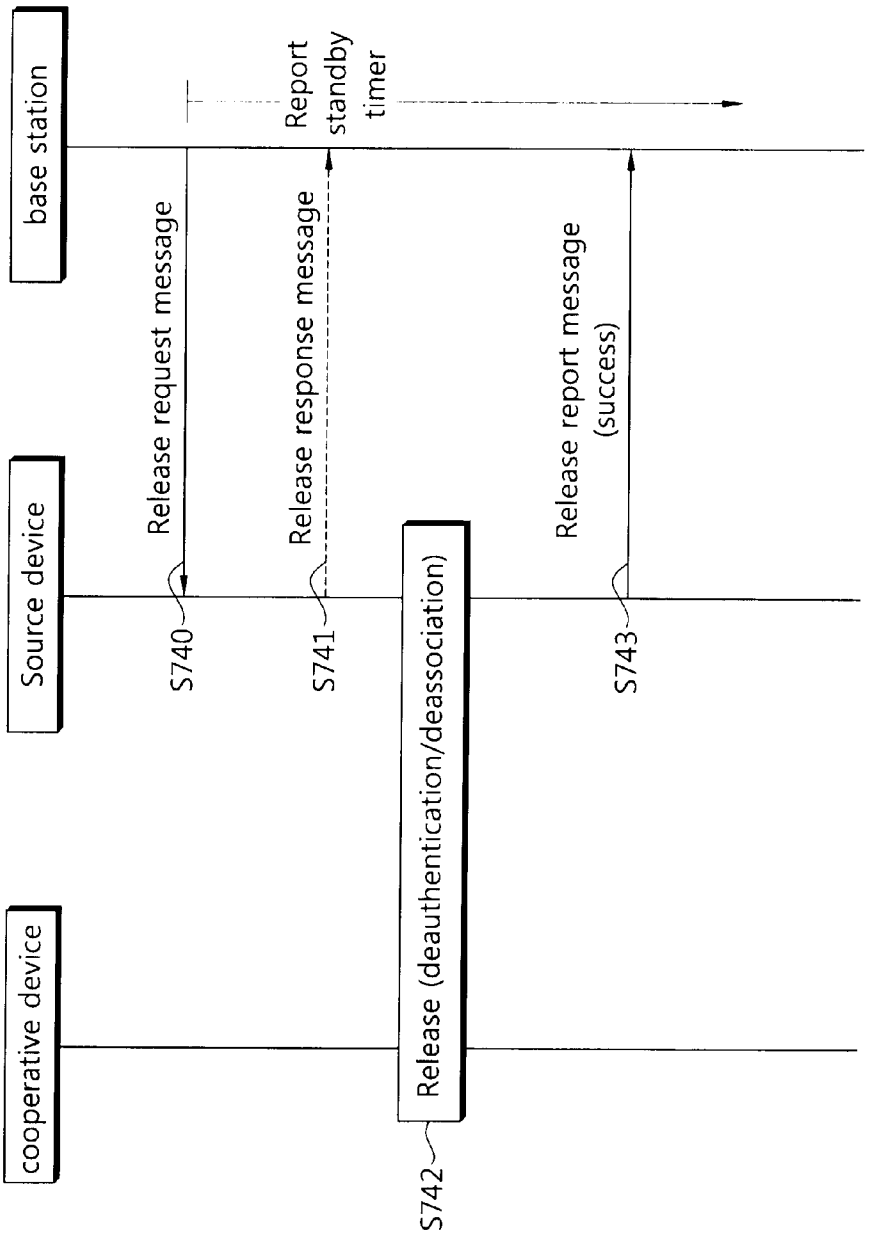

base station
Source device
cooperative device
Report standby timer
Release request message
Release response message
Release report message (success)
Release (deauthentication/deassociation)
S740
S741
S742
S743

FIG. 22

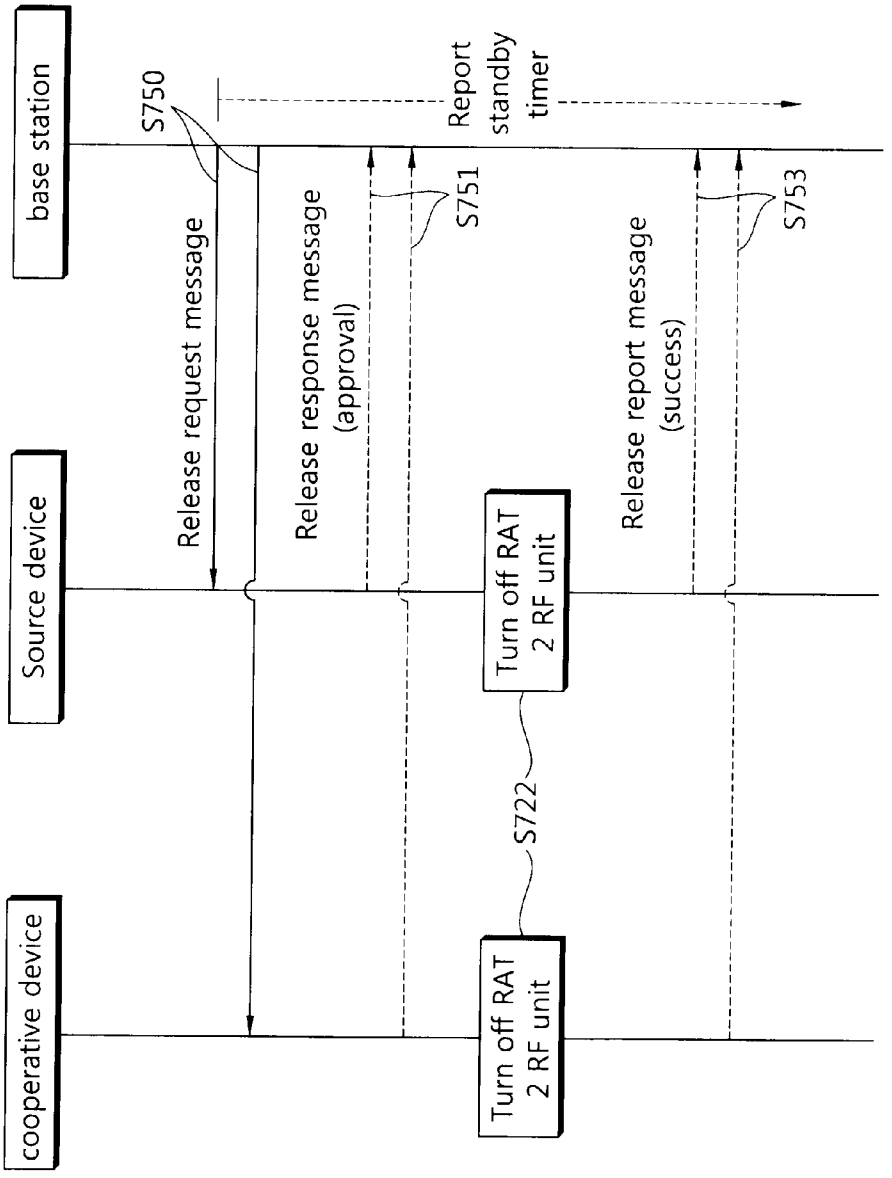

base station
Source device
cooperative device
S750
Release request message
Release response message (approval)
S751
Report standby timer
Release report message (success)
S753
Turn off RAT 2 RF unit
S722
Turn off RAT 2 RF unit

FIG. 23

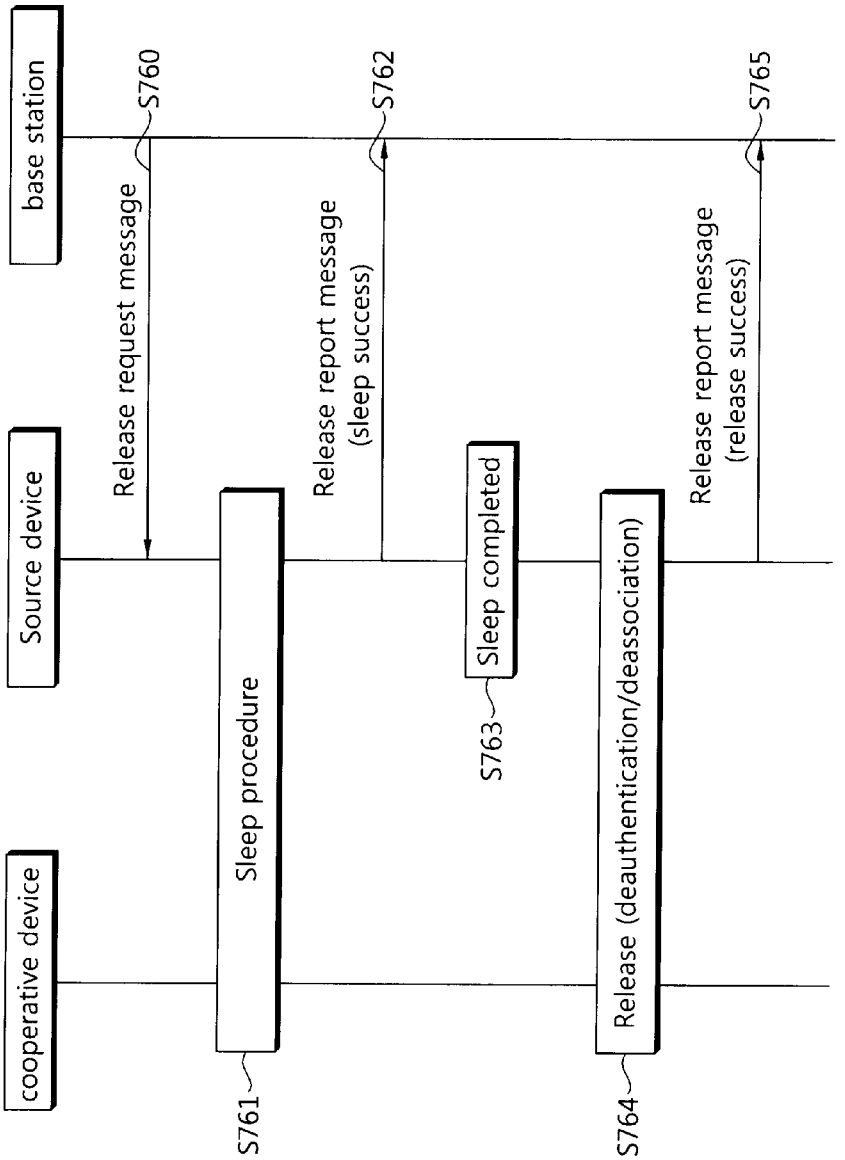
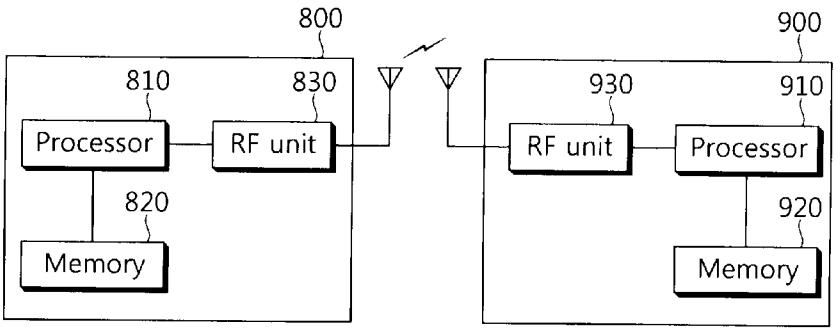

base station
Source device
cooperative device
S760
Release request message
S761
Sleep procedure
S762
Release report message
(sleep success)
S763
Sleep completed
S764
Release (deauthentication/deassociation)
S765
Release report message
(release success)

FIG. 24


800
900
810
830
930
910
Processor
RF unit
RF unit
Processor
820
920
Memory
Memory

CONNECTION RELEASE METHOD AND APPARATUS FOR CLIENT COOPERATION IN WIRELESS COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to wireless communications, and more particularly, a method and apparatus for releasing a connection for client cooperation in a wireless communication system.

[0003] 2. Related Art

[0004] In next generation multimedia mobile communication systems, which have been actively studied in recent years, there is a demand for a system capable of processing and transmitting a variety of information (e.g., video and radio data) in addition to the early-stage voice service. Further, a 3rd generation wireless communication system is followed by a 4th generation wireless communication which is currently being developed aiming at supporting a high-speed data service of 1 gigabits per second (Gbps) in downlink and 500 megabits per second (Mbps) in uplink. The wireless communication system is designed for the purpose of providing reliable communication to a plurality of users irrespective of their locations and mobility. However, a wireless channel has an abnormal characteristic such as a fading phenomenon caused by a path loss, noise, and multipath, an inter-symbol interference (ISI), a Doppler effect caused by mobility of a user equipment, etc. Therefore, various techniques have been developed to overcome the abnormal characteristic of the wireless channel and to increase reliability of wireless communication.

[0005] Meanwhile, with the advent of a ubiquitous environment, there is a rapid increase in a demand for receiving a seamless service anytime anywhere by using equipments. In order to satisfy such a demand, a client cooperation technique may be introduced in a wireless communication system. The client cooperation technique refers to a technique by which a specific device helps transmission of another device. That is one device may directly communicate with a base station (BS) or may indirectly communication with the BS by the aid of another device. The client cooperation technique has an effect of lower power consumption, throughput enhancement, etc.

[0006] The client cooperation technique can be more effectively used in a multi-radio access technology (RAT) device. The multi-RAT device refers to a device that can operate in a plurality of communication systems. For example, the multi-RAT device can operate both in institute of electrical and electronics engineers (IEEE) 802.16m and IEEE 802.11. To provide an easiness access to the BS anytime anywhere and to maintain effective performance, the multi-RAT device can use a multi-RAT client cooperation technique (i.e., improved tethering) in a heterogeneous network.

[0007] A base station may search for a device capable of performing client cooperation to perform a client cooperation technology, and a source device, being connected to a searched device, may communicate with the base station through client cooperation. Depending on situations, communication employing client cooperation technology may not be needed. In this case, a connection between the source device and the searched device needs to be released.

[0008] A method for releasing a connection between a source device and a cooperative device for client cooperation in an efficient manner is required.

SUMMARY OF THE INVENTION

[0009] The present invention provides a method and apparatus for releasing a connection for client cooperation in a wireless communication system. In releasing a connection between a source device and a cooperative device for client cooperation, the present invention provides a method for determining a time point at which release of a connection is requested. Also, the present invention provides operations of a source device, a cooperative device, and a base station in a connection release procedure.

[0010] In an aspect, a method for releasing, by a source device, a connection for client cooperation in a wireless communication system is provided. The method includes transmitting a release request message to a base station at connection release request time, receiving a release response message from the base station as a response to the release request message, releasing a connection to a cooperative device, and transmitting a release report message including a result of releasing the connection to the cooperative device to the base station. The base station and the cooperative device are connected to each other through a first system, and the source device and the cooperative device are connected to each other through a second system.

[0011] The base station and the source device may be connected to each other through the first system.

[0012] The method may further include determining whether to transmit the release request message through the first system or through the second system.

[0013] The connection release request time may correspond to time at which a connection state between the base station and the source device through the first system exceeds a predetermined threshold.

[0014] The connection release request time may correspond to time at which a connection state between the source device and the cooperative device through the second system falls below a predetermined threshold.

[0015] The connection release request time may correspond to time at which data transmission between the source device and the cooperative device through the second system is completed.

[0016] The connection release request time may correspond to time at which data transmission between the source device and the cooperative device through the second system is completed, and a release timer starting after completion of the data transmission expires.

[0017] The connection release request time may correspond to time at which the source device enters sleep mode.

[0018] The connection release request time may correspond to time at which the source device enters sleep mode, and a release timer starting after entrance to the sleep mode is completed.

[0019] Releasing the connection to the cooperative device may include performing de-authentication and de-association with the cooperative device.

[0020] Releasing the connection to the cooperative device may include turning off power of a radio frequency (RF) for the second system.

[0021] The first system may be one of institute of electrical and electronics engineers (IEEE) 802.16, IEEE 802.16m, IEEE 802.20, evolved-UMTS terrestrial radio access (E-UTRA), 3^{rd} generation partnership project (3GPP) long-term evolution (LTE), or 3GPP LTE-A (advanced), and the second system may be IEEE 802.11.

[0022] The method may further include searching for at least one candidate cooperative device for the source device, receiving an activation command including a result of an activation request from the base station, and connecting to a selected cooperative device among the at least one candidate cooperative device through the second system.

[0023] In another aspect, a method for releasing, by a base station, a connection for client cooperation in a wireless communication system is provided. The method includes transmitting a release request message to a source device or a cooperative device at connection release request time, receiving a release response message from the source device or the cooperative device as a response to the release request message, and receiving a release report message including a result of connection release from the source device or the cooperative device. The base station and the cooperative device are connected to each other through a first system, and the source device and the cooperative device are connection to each other through a second system.

[0024] The method may further include starting a report standby timer after transmitting the release request message.

[0025] A source device for client cooperation in a wireless communication system is provided. The source device includes a radio frequency (RF) unit for transmitting or receiving a radio signal, and a processor connected to the RF unit, and configured to transmit a release request message to a base station at connection release request time, receive a release response message from the base station as a response to the release request message, release a connection to a cooperative device, and transmit a release report message including a result of releasing the connection to the cooperative device to the base station. The base station and the cooperative device are connected to each other through a first system, and the source device and the cooperative device are connected to each other through a second system.

[0026] A connection between a source device and a cooperative device can be released in an effective manner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] FIG. **1** shows a wireless communication system.

[0028] FIG. **2** shows an example of a frame structure of IEEE 802.16m.

[0029] FIG. **3** shows an example of a frame structure of IEEE 802.11.

[0030] FIG. **4** shows an example of implementing a client cooperation technique.

[0031] FIG. **5** shows another example of implementing a client cooperation technique.

[0032] FIG. **6** shows another example of implementing a client cooperation technique.

[0033] FIG. **7** shows an example of a method for setting a connection according to an embodiment of the present invention.

[0034] FIG. **8** shows an example of a method for setting a connection according to another embodiment of the present invention.

[0035] FIG. **9** shows an example of a method for setting a connection according to another embodiment of the present invention.

[0036] FIG. **10** shows an example of a method for setting a connection according to another embodiment of the present invention.

[0037] FIG. **11** shows an example of a method for setting a connection according to another embodiment of the present invention.

[0038] FIG. **12** shows an example of connection release request time according to an embodiment of the proposed connection release method.

[0039] FIG. **13** shows another example of connection release request time according to an embodiment of the proposed connection release method.

[0040] FIG. **14** shows another example of connection release request time according to an embodiment of the proposed connection release method.

[0041] FIG. **15** shows another example of connection release request time according to an embodiment of the proposed connection release method.

[0042] FIG. **16** shows another example of connection release request time according to an embodiment of the proposed connection release method.

[0043] FIG. **17** shows an embodiment of the proposed connection release method.

[0044] FIG. **18** shows another embodiment of the proposed connection release method.

[0045] FIG. **19** shows another embodiment of the proposed connection release method.

[0046] FIG. **20** shows another embodiment of the proposed connection release method.

[0047] FIG. **21** shows another embodiment of the proposed connection release method.

[0048] FIG. **22** shows another embodiment of the proposed connection release method.

[0049] FIG. **23** shows another embodiment of the proposed connection release method.

[0050] FIG. **24** is a block diagram showing wireless communication system to implement an embodiment of the present invention.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0051] A technology below can be used in a variety of wireless communication systems, such as code division multiple access (CDMA), frequency division multiple access (FDMA), time division multiple access (TDMA). orthogonal frequency division multiple access (OFDMA), and single carrier frequency division multiple access (SC-FDMA). CDMA can be implemented using radio technology, such as universal terrestrial radio access (UTRA) or CDMA2000. TDMA can be implemented using radio technology, such as global system for mobile communications (GSM)/general packet radio service (GPRS)/enhanced data rates for GSM evolution (EDGE). OFDMA can be implemented using radio technology, such as IEEE 802.11(Wi-H), IEEE 802.16 (WiMAX), IEEE 802-20, or Evolved UTRA (E-UTRA). IEEE 802.16m is the evolution of IEEE 802.16e, and it provides a backward compatibility with an IEEE 802.16e-based system. UTRA is part of a universal mobile telecommunications system (UMTS). 3rd generation partnership project (3GPP) long term evolution (LTE) is part of evolved UMTS (E-UMTS) using evolved-UMTS terrestrial radio access (E-UTRA), and it adopts OFDMA in downlink (DL) and SC-FDMA in uplink (UL). LTE-A (advanced) is the evolution of 3GPP LTE.

[0052] IEEE 802.16m and IEEE 802.11 are chiefly described as an example in order to clarify the description, but

[0053] FIG. **1** shows a wireless communication system.

[0054] Referring to FIG. **1**, the wireless communication system **10** includes one or more base stations (BSs) **11**. The BSs **11** provide communication services to respective geographical areas (in general called 'cells') **15***a*, **15***b*, and **15***c*. Each of the cells can be divided into a number of areas (called 'sectors'). A user equipment (UE) **12** can be fixed or mobile and may be referred to as another terminology, such as a mobile station (MS), a mobile terminal (MT), a user terminal (UT), a subscriber station (SS), a wireless device, a personal digital assistant (PDA), a wireless modem, or a handheld device. In general, the **13**S **11** refers to a fixed station that communicates with the UEs **12**, and it may be referred to as another terminology, such as an evolved-NodeB (eNB), a base transceiver system (BTS), or an access point.

[0055] The UE generally belongs to one cell. A cell to which a UE belongs is called a serving cell. A BS providing the serving cell with communication services is called a serving BS. A wireless communication system is a cellular system, and so it includes other cells neighboring a serving cell. Other cells neighboring the serving cell are called neighbor cells. A BS providing the neighbor cells with communication services is called as a neighbor BS. The serving cell and the neighbor cells are relatively determined on the basis of a UE.

[0056] This technology can be used in the downlink (DL) or the uplink (UL). In general, DL refers to communication from the BS **11** to the UE **12**, and UL refers to communication from the UE **12** to the BS **11**. In the DL, a transmitter may be part of the BS **11** and a receiver may be part of the UE **12**. In the UL, a transmitter may be part of the UE **12** and a receiver may be part of the BS **11**.

[0057] FIG. **2** shows an example of a frame structure of IEEE 802.16m.

[0058] Referring to FIG. **2**, a superframe (SF) includes a superframe header (SFH) and four frames F**0**, F**1**, F**2**, and F**3**. Each frame may have the same length in the SF. Although it is shown that each SF has a length of 20 milliseconds (ms) and each frame has a length of 5 ms, the present invention is not limited thereto. A length of the SF, the number of frames included in the SF, the number of SFs included in the frame, or the like can change variously. The number of SFs included in the frame may change variously according to a channel bandwidth and a cyclic prefix (CP) length.

[0059] One frame includes 8 subframes SF**0**, SF**1**, SF**2**, SF**3**, SF**4**, SFS, SF**6**, and SF**7**. Each subframe can be used for uplink or downlink transmission. One subframe includes a plurality of orthogonal frequency division multiplexing (OFDM) symbols in a time domain, and includes a plurality of subcarriers in a frequency domain. An OFDM symbol is for representing one symbol period, and can be referred to as other terminologies such as an OFDM symbol, an SC-FDMA symbol, etc., according to a multiple access scheme. The subframe can consist of 5, 6, 7, or 9 OFDMA symbols. However, this is for exemplary purposes only, and thus the number of OFDMA symbols included in the subframe is not limited thereto. The number of OFDMA symbols included in the subframe may change variously according to a channel bandwidth and a CP length. A subframe type may be defined according to the number of OFDMA symbols included in the subframe. For example, it can be defined such that a type-1 subframe includes **6** OFDMA symbols, a type-2 subframe includes 7 OFDMA symbols, a type-3 subframe includes 5 OFDMA symbols, and a type-4 subframe includes 9 OFDMA symbols. One frame may include subframes each having the same type. Alternatively, one frame may include subframes each having a different type. That is, the number of OFDMA symbols included in each subframe may be identical or different in one frame. Alternatively, the number of OFDMA symbols included in at least one subframe of one frame may be different from the number of OFDMA symbols of the remaining subframes of the frame.

[0060] Time division duplex (TDD) or frequency division duplex (FDD) may be applied to the frame. In the TDD, each subframe is used in uplink or downlink transmission at the same frequency and at a different time. That is, subframes included in a TDD frame are divided into an uplink subframe and a downlink subframe in the time domain. A switching point refers to a point where a transmission direction is changed from an uplink region to a downlink region or from a downlink region to an uplink region. In the TDD, the number of the switching points in each frame may be two. In the FDD, each subframe is used in uplink or downlink transmission at the same time and at a different frequency. That is, subframes included in an FDD frame are divided into an uplink subframe and a downlink subframe in the frequency domain. Uplink transmission and downlink transmission occupy different frequency bands and can be simultaneously performed.

[0061] One OFDMA symbol includes a plurality of subcarriers. The number of subcarriers is determined by a fast Fourier transform (FFT) size. The subcarrier can be classified into a data subcarrier for data transmission, a pilot subcarrier for various estimations, and a null subcarrier for a guard band and a direct current (DC) carrier. The OFDMA symbol is characterized by parameters BW. N_{used}, n, G, etc. The parameter BW denotes a nominal channel bandwidth. The parameter N_{used} denotes the number of used subcarriers (including the DC subcarrier). The parameter n denotes a sampling factor. The parameter n is combined with the parameters BW and N_{used} to determine a subcarrier spacing and a useful symbol time. The parameter G denotes a ratio of a cyclic prefix (CP) time and a useful time.

[0062] Table 1 below shows an orthogonal frequency division multiple access (OFDMA) parameter.

TABLE 1

Channel bandwidth, BW(MHz)			5	7	8.75	10	20
Sampling factor, n			28/25	8/7	8/7	28/25	28/25
Sampling frequency, F_s(MHz)			5.6	8	10	11.2	22.4
FFT size, N_{FFT}			512	1024	1024	1024	2048
Subcarrier spacing, Δf(kHz)			10.94	7.81	9.77	10.94	10.94
Useful symbol time T_b(μs)			91.4	128	102.4	91.4	91.4
G = 1/8		Symbol time, T_s(μs)	102.857	144	115.2	102.857	102.857
	FDD	Number of OFDMA symbols per 5 ms frame	48	34	43	48	48
		Idle time(μs)	62.857	104	46.40	62.857	62.857

TABLE 1-continued

	TDD	Number of OFDMA symbols per 5 ms frame	47	33	42	47	47
		TTG + RTG(μs)	165.714	248	161.6	165.714	165.714
G = 1/16	Symbol time, T_s(μs)		97.143	136	108.8	97.143	97.143
	FDD	Number of OFDMA symbols per 5 ms frame	51	36	45	51	51
		Idle time(μs)	45.71	104	104	45.71	45.71
	TDD	Number of OFDMA symbols per 5 ms frame	50	35	44	50	50
		TTG + RTG(μs)	142.853	240	212.8	142.853	142.853
G = 1/4	Symbol time, T_s(μs)		114.286	160	128	114.286	114.286
	FDD	Number of OFDMA symbols per 5 ms frame	43	31	39	43	43
		Idle time(μs)	85.694	40	8	85.694	85.694
	TDD	Number of OFDMA symbols per 5 ms frame	42	30	38	42	42
		TTG + RTG(μs)	199.98	200	136	199.98	199.98
Number of Guard subcarriers		Left	40	80	80	80	160
		Right	39	79	79	79	159
Number of used subcarriers			433	865	865	865	1729
Number of PRU in type-1 subframe			24	48	48	48	96

[0063] In Table 1, N_{FFT} denotes a smallest power of 2 greater than N_{used}. A sampling factor is defined as F_s=floor (n·BW/8000)×8000. A subcarrier spacing is defined as $\Delta f = F_s / NFFT$. A useful symbol time is defined as $T_b = 1/\Delta f$. A CP time is defined as $T_g = G \cdot T_b$. An OFDMA symbol time is defined as $T_s = T_b + T_g$. A sampling time is defined as T_b / N_{FFT}.

[0064] FIG. **3** shows an example of a frame structure of IEEE 802.11.

[0065] A frame of IEEE 802.11 includes a set of fields in a fixed order. Referring to FIG. **3**, the frame of IEEE 802.11 includes a frame control field, a duration/ID field, an address **1** field, an address **2** field, an address **3** field, a sequence control field, an address **4** field, a quality of service (QoS) control field, an HT control field, a frame body field, and a frame check sequence (FCS) field. Among the fields listed above, the frame control field, the duration/ID field, the address **1** field, and the FCS field constitute a minimum IEEE 802.11 frame format, and may be included in all IEEE 802.11 frames. The address **2** field, the address **3** field, the sequence control field, the address **4** field, the QoS control field, the HT control field, and the frame body field may be included only in a specific frame type.

[0066] The frame control field may include various subfields. The duration/ID field may be 16 bits in length. The address field may include a basic service set identifier (BSSID), a source address (SA), a destination address (DA), a transmitting STA address (TA), and a receiving STA address (RA). In the address field, different fields may be used for other purposes according to a frame type. The sequence control field can be used when fragments are reassembled or when an overlapping frame is discarded. The sequence control field may be 16 bits, and may include two subfields indicating a sequence number and a fragment number. The FCS field can be used to check an error of a frame received by a station. The FCS field may be a 32-bit field including a 32-bit cyclic redundancy check (CRC). An FCS can be calculated across the frame body field and all fields of a media access control (MAC) header.

[0067] The frame body field may include information specified for an individual frame type and subtype. That is, the frame body field carries high-level data from one station to another station. The frame body field can also be called a data field. The frame body field can be variously changed in length. A minimum length of the frame body field may be zero octet. A maximum length of the frame body field may be determined by a total sum of a maximum length of a MAC service data unit (MSDU), a length of a mesh control field, and an overhead for encryption or a total sum of a maximum length of an aggregated MSDU (A-MSDU) and an overhead for encryption. The data frame includes high-level protocol data of the frame body field. The data frame may always include the frame control field, the duration/ID field, the address **1** field, the address **2** field, the address **3** field, the sequence control field, the frame body field, and the FCS field. A presence of an address **4** field may be determined by a configuration of a 'To DS' subfield and a 'From DS' subfield in the frame control field. Another data frame type can be categorized according to a function.

[0068] A management frame may always include the frame control field, the duration/ID field, the address **1** field, the address **2** field, the address **3** field, the sequence control field, the frame body field, and the FCS field. Data included in the frame body field generally uses a fixed-length field called a fixed field and a variable-length field called an information element. The information element is a variable-length data unit.

[0069] The management frame can be used for various purposes according to a subtype. That is, a frame body field of a different subtype includes different information. A beacon frame reports an existence of a network, and takes an important role of network maintenance. The beacon frame corresponds to a parameter which allows a mobile station to participate in the network. In addition, the beacon frame is periodically transmitted so that the mobile station can scan and recognize the network. A probe request frame is used to scan an IEEE 802.11 network in which the mobile station exists. A probe response frame is a response for the probe

request frame. An authentication request is used so that the mobile station requests an access point to perform authentication. An authentication response frame is a response for the authentication request frame. A deauthentication frame is used to finish an authentication relation. An association request frame is transmitted so that the mobile station participates in the network when the mobile station recognizes the compatible network and is authenticated. An association response frame is a response for the association request frame. A deassociation frame is used to finish an association relation.

[0070] Three states may exist according to an authentication and association procedure in IEEE 802.11. Table 2 below shows the three states of IEEE 802.11.

TABLE 2

	Authentication	Association
State 1	X	X
State 2	○	X
State 3	○	○

[0071] To transmit a data frame, a device must perform the authentication and association procedure with respect to a network. In Table 2, a procedure of transitioning from the state 1 to the state 2 can be called the authentication procedure. The authentication procedure can be performed in such a manner that one device acquires information of a different device and authenticates the different device. The information of the different device can be acquired by using two methods, i.e., a passive scanning method for acquiring information of a different node by receiving a beacon frame and an active scanning method for acquiring the information of the different device by transmitting a probe request message and receiving a probe response message received in response thereto. The authentication procedure can be complete by exchanging an authentication request frame and an authentication response frame.

[0072] In Table 2, a procedure of transitioning from the state 2 to the state 3 can be called the association procedure. The association procedure can be complete when two devices exchange the association request frame and the association response frame upon completion of the authentication procedure. An association ID can be allocated by the association procedure.

[0073] A client cooperation technique may be introduced in a wireless communication system. One device may directly communicate with a base station (BS) or may indirectly communication with the BS by the aid of another device. Hereinafter, a source device refers to a device which communicates with the BS through a connection with another device. A cooperative device refers to a relay entity which helps the source device to communicate with the BS. The client cooperation technique has an effect of lower power consumption. In terms of a device, a path-loss can be decreased by the client cooperation technique, thereby being able to decrease transmit power. In terms of a network, total network power consumption can be decreased. In addition, the client cooperation technique has an effect of throughput enhancement. In terms of a device, a source device can use a good-quality link between a cooperative device and a BS and between BSs. In addition, an antenna extension gain can be obtained. In terms of the network, network capacity can be increased by using client clustering based on frequency reuse without an additional infrastructure.

[0074] FIG. **4** shows an example of implementing a client cooperation technique.

[0075] Referring to FIG. **4**, in the client cooperation technique, a source device can directly communicate with a macro BS, or can communicate with the macro BS via a cooperative device. The cooperative device may directly communicate with the macro BS, or can help communication of the source device. This is different from a mobile relay in a sense that the source device can directly communicate with the macro BS. In this case, each device and the macro BS can communicate by using a first radio access technology (RAT), and the source device and the cooperative device can communicate by using a second RAT. The first RAT may be a radio technology such as IEEE 802.16 (WiMAX), IEEE 802.16m or IEEE 802.20, etc. Alternatively, the first RAT may be a radio technology such as E-UTRA, 3GPP LTE or 3GPP LTE-A, etc. The second RAT may be IEEE 802.11.

[0076] FIG. **5** shows another example of implementing a client cooperation technique.

[0077] The client cooperation technique can be more effectively used in a multi-RAT device. The multi-RAT device refers to a device that can operate in a plurality of communication systems. For example, the multi-RAT device can operate both in IEEE 802.16m and IEEE 802.11. When the multi-RAT device uses the client cooperation technique, the multi-RAT device can communicate with an IEEE 802.16m BS by using a plurality of RATs. For example, as shown in FIG. **5**, if channel quality is poor between a second device and a BS or if the second device located in a shadow area cannot receive a signal from the BS, the first device can be used as a cooperative device to communicate with the BS. In this case, each device and the BS can communicate by using the first RAT, and the source device and the cooperative device can communicate by using the second RAT. The first RAT may be a radio technique such as IEEE 802.16, IEEE 802.16m, IEEE 802.20, E-UTRA, 3GPP LTE or 3GPP LTE-A, etc. The second RAT may be IEEE 802.11.

[0078] FIG. **6** shows another example of implementing a client cooperation technique.

[0079] A source device and a macro BS (e.g., IEEE 802.16m BS) can be connected through a direct link, and can be connected through an indirect link by using a cooperative device. In this case, each device and the BS can be connected by using IEEE 802.16m, and the source device and the cooperative device can be connected by using IEEE 802.11.

[0080] In what follows, a method for connecting multi-RAT devices to each other and releasing connection between the multi-RAT devices to perform a client cooperation technology will be described. Hereinafter, it is assumed that a multi-RAT device attempting to connect to a first RAT base station through client cooperation is denoted as a source device while a device that may be connected to the source device through a second RAT for client cooperation is denoted as a candidate cooperative device. When a candidate cooperative device is connected to a source device through the second RAT and performs client cooperation, the candidate cooperative device may be a cooperative device of client cooperation. In what follows, it is assumed that the first RAT is the IEEE 802.16m, and the second RAT is the IEEE 802.11, but the present invention is not limited to thereto.

[0081] Before details of a connection procedure for multi-RAT devices, a device discovery procedure is described first. A device discovery procedure may be carried out before a connection procedure. Through the device discovery procedure, a base station and/or a source device may search for a candidate cooperative device which may function as a cooperative device for client cooperation. In general, the device discovery procedure may be performed by exchanging a beacon message or a probe request/response message.

[0082] The base station searches for a candidate cooperative device and informs the source device of a list including one or more candidate cooperative devices. The list may include information such as a device identifier (ID), a media access control (MAC) address, a beacon interval, and so on. Also, the base station may inform the source device of a candidate cooperative device deemed relatively suitable for performing client cooperation with the source device. Such a kind of device may be called a recommended candidate cooperative device. In other words, recommended cooperative devices may form a subset of a list including at least candidate cooperative devices. A recommended device may be determined based on a total number of source devices, speed of source devices, and so on.

[0083] A source device may utilize information about candidate cooperative devices or recommended cooperative devices provided by a base station. The source device may transmit a unicast probe request message to each of candidate cooperative devices or recommended cooperative devices and may perform a subsequent procedure. The source device may ignore a beacon message transmitted from a different device other than each of candidate cooperative devices or recommended cooperative devices.

[0084] In what follows, a connection procedure between a source device and a candidate cooperative device will be described. The connection procedure may be initiated by a source device or a base station. If the connection procedure is initiated by a source device, the source device may request a base station to start the connection procedure and set up a connection to a candidate cooperative device which can support client cooperation. If the connection procedure is initiated by a base station, the base station may request a source device to start the connection procedure, and the source device may set up a connection to a candidate cooperative device which can support client cooperation. In general, the device discovery procedure may be carried out by exchanging an authentication request/response message or an association request/response message.

[0085] 1) First of all, a case where the connection procedure is initiated by a source device is described.

[0086] FIG. **7** shows an example of a method for setting a connection according to an embodiment of the present invention.

[0087] In step S**100**, at least one candidate cooperative device is discovered as a result of a device discovery procedure. Once the device discovery procedure is completed, a list holding timer within the base station and the source device starts. While the list holding timer is operating, the list of candidate cooperative devices within each of the base station and the source device is retained.

[0088] In step S**110**, the source device transmits a first activation request message to the base station. The first activation request message may include the following parameters.

[0089] A list of candidate cooperative devices maintained by the source device: this list may be included in the first activation request message only when the list holding timer expires, or the list of candidate cooperative devices is changed. The list of candidate cooperative devices maintained by the source device may be changed when the source device reconfirms the candidate cooperative devices independently.

[0090] A list of neighbor devices maintained by the source device: this list may be a list of neighbor devices discovered by the source device without assistance of the base station. In other words, the list may be a list of devices not identified as a candidate cooperative device.

[0091] The latest timestamp of a list of candidate cooperative devices maintained by the source device: this parameter indicates one particular time point at which the list of candidate cooperative devices is updated.

[0092] Information on location of the source device: this information may be included if the source device's location has been changed. The information on location of the source device may include at least one of absolute location of the source device or relative location of a neighbor IEEE 802.11 access point (AP).

[0093] Indication of whether to maintain an IEEE 802.16m connection: this parameter indicates whether to maintain a connection between the source device and the base station if a connection between the source device and the candidate cooperative devices is established, and thus client cooperation is carried out.

[0094] Referring to FIG. **7** again, in step S**120**, upon receiving the first activation request message from the source device, the base station determines whether the list of candidate cooperative devices is valid.

[0095] Validity of a list of candidate cooperative devices may be indicated by a list valid period timer within the base station and the source device. In other words, the list valid period timer indicates a time period during which a device discovery result is valid. Valid time of a list may be the same or different for each candidate cooperative device. If the valid time for each list of candidate cooperative devices is the same for each candidate cooperative device, the valid time may assume one from among the minimum value, average value, and maximum value of valid time of multiple lists of candidate cooperative devices. If each valid time of the lists of candidate cooperative devices is different from each other for the respective candidate cooperative devices, the valid time may be determined based on moving speed of the source device and/or each candidate cooperative device transmitted from the base station, or the valid time may be transmitted explicitly from the base station.

[0096] If it is determined that the list of candidate cooperative devices is valid, the base station may select candidate cooperative devices appropriate for client cooperation. At this time, the base station may select candidate cooperative devices appropriate for client cooperation based on the list of candidate cooperative devices received from the source device (if the list is included in the first activation request message), information on at least one candidate cooperative device within the list of candidate cooperative devices maintained by the base station (if the list holding timer is in operation), or information on location of the source device, etc. Also, the base station may select candidate cooperative devices appropriate for client cooperation based on a total number of source devices, speed of source devices, etc.

[0097] Meanwhile, separately from the list valid period timer, a list holding timer may be defined. A list holding timer indicates holding time during which the base station stores a search result for a particular candidate cooperative device, namely a list of candidate cooperative devices and information of neighbor APs of a particular source device. The holding time may be defined by a predetermined value or may be delivered to the source device by the base station. If the holding time is delivered to the source device, the holding time may be determined based on moving speed, link quality, etc., of the source device. The source device and the base station start the list holding timer at the time when the list of candidate cooperative devices is updated and/or communicated. At this time, if the list holding timer is already in operation, the corresponding timer is reconfigured and starts over. Similarly, if the list holding timer expires, the base station may delete a search result for the corresponding source device and information on the corresponding source device.

[0098] In step S**130**, the base station transmits a second activation request message to the selected candidate cooperative device. In step S**140**, the base station receives from the selected candidate cooperative device an activation response message as a response to the second activation request message. By exchanging the second activation request message and the activation response message, the base station may negotiate the selected candidate cooperative device about an activation time point of radio frequency (RF) for multi-RAT client cooperation, capability of performing client cooperation, etc.

[0099] In step S**150**, the base station transmits an activation command message to the source device. The base station may inform the source device of decisions made between the base station and the candidate cooperative device through the activation command message. In other words, the activation command message may include a result of the activation request of the source device. If the result of the activation request of the source device is successful, the activation command message may include the following parameters.

[0100] Multi-RAT information of a candidate cooperative device capable of performing client cooperation: this information may include the MAC address of the candidate cooperative device, type and version of a system type which allows operation of the candidate cooperative device, security association, etc.

[0101] Multi-RAT random access time: for example, this may be a frame offset or a frame number.

[0102] Indication of whether to maintain IEEE 802.16m connection: this parameter indicates whether to continuously maintain a connection between the source device and the base station if a connection between the source device and the candidate cooperative device is completed and thus client cooperation is performed. If the IEEE 802.16m connection between the source device and the base station is not maintained, the activation command message may include action time which indicates absolute time and/or relative time at which a data and a control signal are transmitted through a multi-RAT connection, and disconnection time which indicates absolute time and/or relative time at which the IEEE 802.16m connection is terminated.

[0103] Upon receiving the activation command message, in step S**160**, the source device may perform an authentication and an association procedure for the candidate cooperative device.

[0104] In step S**170**, the source device and the candidate cooperative device may each transmit a connection complete request message for client cooperation to the base station. Through the connection complete request message, a result of the performing the authentication and the association procedure may be transmitted. Also, the connection complete request message transmitted by the source device may include the parameter indicating whether to maintain the IEEE 802.16m connection.

[0105] In step S**180**, the base station transmits a connection complete response message for client cooperation to each of the source device and the candidate cooperative device. The connection complete response message may include an address to be used for multi-RAT client cooperation, security information of the IEEE 802.16m, etc. The address may correspond to a local ID dedicated to client cooperation or a local ID of the source device. The connection compete response message may include a parameter indicating whether to maintain the IEEE 802.16m connection.

[0106] Meanwhile, the base station may receive the connection complete request message from one or more candidate cooperative devices. Then the base station may select one candidate cooperative device and transmit the connection complete response message thereto. Also, in case of device-to-device direct communication, the corresponding device and base station may select a plurality of devices and set up a connection with each of the devices.

[0107] FIG. **8** shows an example of a method for setting a connection according to another embodiment of the present invention.

[0108] In step S**200**, at least one candidate cooperative device is discovered from the device discovery procedure. In step S**210**, the source device transmits a first activation request message to the base station. As described above in FIG. **7**, the first activation request message may include a list of candidate cooperative devices maintained by the source device, a list of neighbor devices maintained by the source device, the latest timestamp of the list of candidate cooperative devices maintained by the source device, information on location of the source device, indication of whether to maintain IEEE 802.16m connection, etc. In step S**220**, upon receiving the first activation request message from the source device, the base station determines whether the list of candidate cooperative devices is valid.

[0109] The base station may determine that the list of candidate cooperative devices is not valid. Then, in step S**230**, the base station may check existence of other devices appropriate for client cooperation. For example, if the base station receives a list of neighbor devices maintained by the source device through the first activation request message, the base station may determine whether a device belonging to the corresponding list is appropriate as a cooperative device. According to the checking result, the base station may select a candidate cooperative device appropriate for client cooperation. Similarly, if the base station receives information on location of the source device through the first activation request message, the base station may select a candidate cooperative device for client cooperation based on the absolute location and/or relative location of the source device.

[0110] In step S**240**, the base station transmits a second activation request message to the selected candidate cooperative device. In step S**250**, the base station receives an activation response message as a response to the second activation request message from the selected candidate cooperative device. By exchanging the second activation request message and the activation response message, the base station may negotiate the selected candidate cooperative device about activation time of RF for multi-RAT client cooperation, capability of performing client cooperation, etc. In step S**260**, the base station transmits an activation command message to the source device. The activation command message may include a result of the activation request of the source device. If the result of the activation request of the source device is successful, the activation command message may include parameters such as multi-RAT information of the candidate cooperative device capable of performing client cooperation, multi-RAT random access time, an indicator of whether to maintain the IEEE 802.16m connection, etc., as described above in FIG. **7**.

[0111] Upon receiving an activation command message, in step S**270**, the source device may perform an authentication and an association procedure for the candidate cooperative device. In step S**280**, the source device and the candidate cooperative device may each transmit a connection complete request message for client cooperation to the base station. Through the connection complete request message, a result of performing the authentication and the association procedure may be transmitted. In step S**290**, the base station a connection complete response message for client cooperation to each of the source device and the candidate cooperative device. The connection complete request message may include and address used for multi-RAT client cooperation, security information of the IEEE 802.16m, a parameter indicating whether to maintain the IEEE 802.16m connection, etc.

[0112] FIG. **9** shows an example of a method for setting a connection according to another embodiment of the present invention.

[0113] In step S**300**, as a result of the device discovery procedure, at least one candidate cooperative device is discovered. In step S**310**, the source device transmits the first activation request message to the base station. As described above in FIG. **7**, the first activation request message may include such parameters as a list of candidate cooperative devices maintained by the source device, a list of neighbor device maintained by the source device, the latest timestamp of the list of candidate cooperative devices maintained by the source device, information about location of the source device, an indicator of whether to maintain the IEEE 802.16m connection, etc. In step S**320**, upon receiving the first activation request message from the source device, the base station determines whether the list of candidate cooperative devices is valid.

[0114] The base station may determine that the list of candidate cooperative devices is not valid. Also, the base station may not be able to perform a connection procedure since no device appropriate for client cooperation is available. In this case, in step S**330**, the base station transmits an activation command message to the source device. The activation command message may indicate a failure of the activation request from the source device. Also, the activation command message may include a cause of the failure (e.g., no valid list or no newly updated list) and an action code (re-execution of the device discovery procedure). In step S**340**, upon receiving the activation command message, the source device may perform the device discovery procedure again.

[0115] 1) In what follows, the case where the connection procedure is initiated by the base station is described. The base station may communicate the source device by performing client cooperation by taking account of low link quality between the base station and the source device and other similar reasons. The method for setting a connection described above in FIGS. **7** to **9** may be applied similarly to the case where the connection procedure is initiated by the base station.

[0116] FIG. **10** shows an example of a method for setting a connection according to another embodiment of the present invention.

[0117] Once the list of candidate cooperative devices is validated, the base station may select candidate cooperative devices appropriate for client cooperation. At this time, the base station may select candidate cooperative devices appropriate for client cooperation based on speed, timestamp, and location information, etc., of the source device.

[0118] In step S**400**, the base station transmits an activation request message to the selected candidate cooperative device. In step S**410**, the base station receives from the selected candidate cooperative device an activation response message as a response to the activation request message. By exchanging the activation request message and the activation response message, the base station may negotiate the candidate cooperative device about an activation time point of RF for multi-RAT client cooperation, capability of performing client cooperation, etc. In step S**420**, the base station transmits an activation command message to the source device. The activation command message may include a result of the activation request of the source device. If the result of the activation request of the source device is successful, the activation command message may include such parameters as multi-RAT information of a candidate cooperative device capable of performing client cooperation, multi-RAT arbitrary connection time, an indicator of whether to maintain IEEE 802.16m connection. etc.

[0119] Upon receiving the activation command message, in step S**430**, the source device may perform an authentication and an association procedure for the candidate cooperative device. In step S**440**, the source device and the candidate cooperative device may each transmit a connection complete request message for client cooperation to the base station. Through the connection complete request message, a result of performing the authentication and the association procedure may be transmitted. In step S**450**, the base station transmits a connection complete response message for client cooperation to each of the source device and the candidate cooperative device. The connection complete response message may include an address to be used for multi-RAT client cooperation, security information of the IEEE 802.16m, an indicator of whether to maintain the IEEE 802.16m connection, etc.

[0120] FIG. **11** shows an example of a method for setting a connection according to another embodiment of the present invention.

[0121] The base station may determine that the list of candidate cooperative devices is not valid. In step S**500**, the base station transmits a first activation request message to the source device.

[0122] Upon receiving the first activation request message, in step S**510**, the source device performs the device discovery procedure. In step S**520**, the source device transmits the first

activation response message to the base station as a response to the first activation request message. At this time, the first activation response message may include such parameters as a list of candidate cooperative devices maintained by the source device, a list of neighbor devices maintained by the source device, the latest timestamp of the list of candidate cooperative devices maintained by the source device, information on location of the source device, an indicator of whether to maintain the IEEE 802.16m, etc.

[0123] Similarly, the source device may transmit the first activation response message including information for generating a list of candidate cooperative devices directly to the base station without performing the device discovery procedure. The information for generating the list of candidate cooperative devices may include location information of the source device.

[0124] Upon receiving the first activation response message from the source device, the base station may select a candidate cooperative device appropriate for client cooperation. In step **S530**, the base station transmits a second activation request message to the selected candidate cooperative device. In step **S540**, the base station receives a second activation response message as a response to the second activation request message from the selected candidate cooperative device. By exchanging the second activation request message and the second activation response message, the base station may negotiate consult the candidate cooperative device about an activation time point of RF for multi-RAT client cooperation, capability of performing client cooperation, etc. In step **S550**, the base station transmits an activation command message to the source device. The activation command message may include a result of the activation request of the source device. If the result of the activation request of the source device is successful, the activation command message may include such parameters as multi-RAT information of a candidate cooperative device capable of performing client cooperation, multi-RAT arbitrary connection time, an indicator of whether to maintain the IEEE 802.16m. etc.

[0125] Upon receiving an activation command message, in step **S560**, the source device may perform an authentication and an association procedure for the candidate cooperative device. In step **S570**, the source device and the candidate cooperative device may each transmit a connection complete request message for client cooperation to the base station. Through the connection complete request message, a result of performing the authentication and the association procedure may be transmitted. In step **S580**, the base station a connection complete response message for client cooperation to each of the source device and the candidate cooperative device. The connection complete request message may include and address used for multi-RAT client cooperation, security information of the IEEE 802.16m, a parameter indicating whether to maintain the IEEE 802.16m connection, etc.

[0126] In what follows, a procedure for releasing a second RAT connection between a source device and a cooperative device connected to each other through a client cooperation technology will be described. First, a time point at which release of the second RAT connection between the source device and the cooperative device is requested will be described.

[0127] FIG. **12** shows an example of connection release request time according to an embodiment of the proposed connection release method.

[0128] If first RAT connection quality between the source device and the base station is improved, maintaining a second RAT between the source device and the cooperative device is no longer needed. Therefore, release of the second RAT connection may be requested. In other words, if reception power for the first RAT exceeds a threshold during a reference period predefined or negotiated, the source device and/or the base station may determine that connection quality of the first RAT has been improved, and the source device and/or the base station may request connection release of the second RAT. At this time, the reference period or the threshold may be determined through a capability negotiation procedure for client cooperation or by consultation between the base station and the source device during the connection procedure.

[0129] Referring to FIG. **12**, in step **S600**, the base station transmits a DL signal to the source device. The DL signal may correspond to either a preamble or a synchronization signal. The source device, based on the DL signal, may determine whether connection quality of the first RAT has been improved. Also, the DL signal at this stage may be the signal transmitted from a serving base station or a neighbor base station. In step **S601**, the source device may transmit a measurement report to the base station. The base station, based on the reception power of UL data or the measurement report, etc., transmitted from the source device, may determine whether connection quality of the first RAT has been improved. The connection release request time may be determined as the time point at which it is determined that connection quality of the first RAT has been improved.

[0130] FIG. **13** shows another example of connection release request time according to an embodiment of the proposed connection release method.

[0131] Since maintaining the current second RAT is no longer required if connection quality of the second RAT is degraded, connection release of the second RAT may be requested. In other words, if reception power for the second RAT is lower than a threshold during a reference period predetermined or negotiated, the source device, the cooperative device, and the base station may determine that connection quality of the second RAT has been degraded. The source device, the cooperative device, and the base station may request connection release of the second RAT. At this time, the reference period or the threshold may be determined through the capability negotiation procedure for client cooperation or consultation between the base station and the cooperative device during the connection procedure.

[0132] Referring to FIG. **13**, in step **S610**, the source device and the cooperative device may transmit a measurement report to the base station. The base station, based on the reception power of UL data or the measurement report, etc., transmitted from the source device or the cooperative device, may determine whether connection quality of the second RAT has been degraded. Also, in step **S610**, the cooperative device may transmit a DL signal to the source device. The DL signal may be a beacon message, a probe response message, etc. The source device, based on the DL signal, may determine whether connection quality of the second RAT has been degraded. The connection release request time may be determined as the time point at which it is determined that connection quality of the second RAT has been degraded.

[0133] Similarly, the connection release request time may be determined as the time point at which data transmission through the second RAT is completed. For example, if the last data within a transmission buffer is transmitted, the transmit-

ter may determine that data transmission has been completed and may request connection release of the second RAT. Likewise, if the last data within the transmission buffer is transmitted and a reception success message for the transmitted data is received, the transmitter may determine that data transmission has been completed and may request connection release of the second RAT.

[0134] FIG. **14** shows another example of connection release request time according to an embodiment of the proposed connection release method.

[0135] Referring to FIG. **14**, in step S**620**, the source device and the cooperative device transmit data to each other. In step S**621**, data transmission is completed. This moment may be the connection release request time.

[0136] Similarly when the data transmission is completed, a release timer starts in step S**622**. At this time, the value of the release timer may be determined by the capability negotiation procedure for client cooperation or through consultation between the base station and the cooperative device during the connection procedure. In step S**623**, the release timer expires. If no data transmission is carried out until the release timer expires, the expiration of the release timer may act as the connection release request time. In step S**624**, the source device transmits the release request message to the base station. In step S**625**, the base station transmits a release response message, which is a response to the release request message, to the source device. At this time, the release response message may accept release of the second RAT or reject the release thereof. For example, if there is remaining data to be transmitted by the base station to the source device, the release request of the source device may be rejected.

[0137] FIG. **15** shows another example of connection release request time according to an embodiment of the proposed connection release method.

[0138] Referring to FIG. **15**, in step S**630**, the source device and the cooperative device transmit data to each other. In step S**631**, data transmission is completed. This moment can be the connection release request time. Similarly, when the data transmission is completed, the release timer starts in step S**632**. At this time, the value of the release timer may be determined by the capability negotiation procedure for client cooperation or through consultation between the base station and the cooperative device during the connection procedure. In step S**633**, the release timer is forced to be terminated. In step S**634**, the source device and the cooperative device resume data transmission. In other words, if data transmission is resumed before the release timer expires, the release timer is forced to be terminated and made to be inactive.

[0139] In another case, the connection release request time may correspond to the moment the source device enters a sleep mode or an idle mode for the second RAT connection.

[0140] FIG. **16** shows another example of connection release request time according to an embodiment of the proposed connection release method.

[0141] Referring to FIG. **16**, in step S**640**, the source device and the cooperative device transmit data to each other. In step S**641**, the source device transmits a sleep request message to the base station, and in step S**642**, the base station transmits a sleep response message to the source device as a response to the sleep request message. The sleep request message and the sleep response message may be transmitted through a Release-REQ message and Release-RSP message, newly defined respectively for connection release of client cooperation. In another case, the sleep request message and the sleep response message may use existing messages if the source device enters the sleep mode for the first RAT connection. For example, if the first RAT is the IEEE 802.16m, the sleep request message and the sleep response message may use a deregistration release request (DREG-REQ) message and a deregistration release response (DREG-RSP) message.

[0142] In step S**643**, the source device enters the sleep mode. This moment may correspond to the connection release request time.

[0143] In another case, after the source device enters the sleep mode, the release timer starts in step S**644**. At this time, the value of the release timer may be determined by the capability negotiation procedure for client cooperation or through consultation between the base station and the cooperative device during the connection procedure. The value of the release timer may be determined by sleep mode-related interval such as time unit (for example, ms) and sleep cycle, or the number of windows. For example, the value of the release timer may be defined as the last subframe of a second listening window. In step S**645**, the release timer expires. This moment may correspond to the connection release request time. In step S**624**, the source device transmits a release request message to the base station.

[0144] In what follows, operations of each device during the procedure for releasing a second RAT connection between the source device and the cooperative device connected to each other through client cooperation technology will be described. The connection release procedure may be initiated by the source device, the cooperative device, or the base station.

[0145] 1) First, a case where the connection release procedure is initiated by the source device or the cooperative device will be described.

[0146] FIG. **17** shows an embodiment of the proposed connection release method. FIG. **17** shows a case where the source device and the base station are connected by a direct link of first RAT.

[0147] In step S**700**, the source device transmits a release request message to the base station, and in step S**701**, the base station transmits a request response message to the source device as a response to the release request message. The release response message may include an approval to the release request. As shown in FIG. **17**, in case a direct link of first RAT exists between the source device and the base station, the source device may determine through which of the direct link of the first RAT and an indirect link of a second RAT the release request message is to be transmitted.

[0148] If the release response message includes an approval to the release request of the source device, in step S**702**, the source device and the cooperative device release connection of the second RAT. For example, if the second RAT is the IEEE 802.11, de-authentication and de-association may be performed. In step S**703**, the source device transmits a release report message to the base station. The source device may report a result of releasing connection of the second RAT to the cooperative device through the release report message.

[0149] If the release response message includes rejection of the release request from the source device, the source device does not perform connection release of the second RAT. The release response message may include reasons of the rejection of the connection release request. Also, the release response message may include an action field of the source device for a direct link of the first RAT to the source device.

[0150] Meanwhile, a report standby timer may start after the base station transmits a release response message. If a result of performing the connection release procedure for the second RAT of the source device and the cooperative device is not received before the report standby timer expires, the base station may perform a connection release procedure initiated by the base station to be described later.

[0151] FIG. **18** shows another embodiment of the proposed connection release method.

[0152] In step S**710**, the source device transmits a release request message to the base station, and in step S**711**, the base station transmits a release response message to the source device as a response to the release request message. The release response message may include an approval to the release request. If a direct link of first RAT exists between the source device and the base station, the source device m,ay determine through which of the direct link of the first RAT and the indirect link of the second RAT the release request message is to be transmitted. FIG. **18** shows a case where the release request message is transmitted through an indirect connection. If the direct link of the first RAT does not exist between the source device and the base station, the source device may transmit a release request message through the indirect link of the second RAT, or the cooperative device may transmit the release request message directly to the base station at the connection release request time. In this case, which device transmits the release request may be determined by the connection setting procedure.

[0153] If the release response message includes an approval to the release request of the source device, the source device transmits a release report message to the base station in step S**712**. The source device may report the result of the second RAT connection release related to the cooperative device to the base station through the release report message. In step S**713**, the source device and the cooperative device release the connection of the second RAT. For example, if the second RAT is the IEEE 802.11, de-authentication and de-association may be performed. Meanwhile, the report standby timer may start after the base station transmits the release response message. If a result of the second RAT connection release procedure of the source device and the cooperative device is not received before the report standby timer expires, the base station may perform a connection release procedure initiated by the base station to be described later.

[0154] FIG. **19** shows another embodiment of the proposed connection release method.

[0155] In step S**720**, the source device transmits a release request message to the base station, and in step S**721**, the base station transmits a release response message to the source device and the cooperative device as a response to the release request message. The release response message may include an approval to the release request.

[0156] If the release response message includes an approval to the release request of the source device, in step S**722**, the source device does not perform a separate connection release procedure and does not monitor the second RAT any longer. For example, by turning off the RF for the second RAT within the source device, monitoring of the second RAT may be suspended. Accordingly, the cooperative device determines that the connection of the cooperative device to the source device has been released without performing a separate connection release procedure with the source device. The cooperative device may determine that no additional device capable of supporting the client cooperation technology is available. Therefore, the second RAT is no longer monitored.

[0157] In step S**723**, the source device and the cooperative device may transmit a release report message to the base station. The source device and the cooperative device may report the result of the second RAT connection release related to the cooperative device to the base station through the release report message. Meanwhile, the report standby timer may start after the base station transmits the release response message. If a result of the second RAT-based connection release procedure of the source device and the cooperative device is not received before the report standby timer expires, the base station may perform a connection release procedure initiated by the base station to be described later. Transmission of the release report message and the operation of the report standby timer in step S**723**, as shown in FIG. **19**, may not be essential operations.

[0158] FIG. **20** shows another embodiment of the proposed connection release method.

[0159] In step S**730**, the source device and the cooperative device release the connection of the second RAT. For example, if the second RAT is the IEEE 802.11, de-authentication and de-association may be performed. In step S**731**, the source device transmits a release report message to the base station. The source device may report a result of releasing a connection of the second RAT to the cooperative device through the release report message. The release report message may be transmitted by the device which has started the connection release procedure. In other words, the source device may transmit the release report message if the source device has started the connection release procedure, whereas the release report message may be transmitted by the cooperative device if the cooperative device has started the connection release procedure. In step S**732**, the base station may transmit the release response message to the source device. The release response message may include an action field of the source device for a direct link of the first RAT to the source device.

[0160] 2) In what follows, a case where the connection release procedure is initiated by the base station will be described.

[0161] FIG. **21** shows another embodiment of the proposed connection release method.

[0162] In step S**740**, the base station transmits the release request message to the source device. If a direct link of the first RAT is established between the source device and the base station, the base station may determine to which device (source device or cooperative device) the release request message is transmitted through which connection (first RAT or second RAT). Also, if a direct link of the first RAT does not exist between the source device and the cooperative device, the base station may determine to which of the source device or the cooperative device the release request message is transmitted. Also, the release request message may include an action field of the source device for a direct link of the first RAT to the source device.

[0163] Meanwhile, the release request of the base station may be a forced release request of the second RAT or an optional release request. If the release request of the base station is forced, the source device has to perform the release procedure of the second RAT connection to the cooperative device unconditionally. If the release request of the base station is forced, the source device transmits a release response message to the base station as a response to the

release request message in step S741. The release response message may include an approval to the release request or acknowledgement (ACK) indicating successful reception of the release request message.

[0164] If the release request of the base station is optional, the source device may determine whether to perform selectively the release procedure of the second RAT connection to the cooperative device. If the source device determines to release the second RAT connection, the source device may transmit the release response message to the base station as a response to the release request message in step S741. The release response message may include an approval to the release request of the base station. If the source device determines not to release the second RAT connection, the release response message may include rejection of the release request and/or reasons of the rejection. At this time, the source device does not perform the connection release procedure. Meanwhile, if the release request is operated based on hybrid automatic repeat request (HARQ) or ARQ, the base station may wait for a response when ACKs for all the packets are received. If the base station fails to receive the release response message, the base station may determine implicitly that the release request has been accepted or rejected.

[0165] If the release request of the base station is forced, or the release request of the base station is selective and the source device accepts the release request of the second RAT connection, the source device and the cooperative device release the second RAT connection in step S742. For example, if the second RAT is the IEEE 802.11, de-authentication and de-association may be performed. In step S743, the source device transmits a release report message to the base station. The source device may report a result of releasing connection of the second RAT to the cooperative device through the release report message.

[0166] Meanwhile, a report standby timer may start after the base station transmits a release response message. If a result of performing the connection release procedure for the second RAT of the source device and the cooperative device is not received before the report standby timer expires, the base station may transmit the release request message again. Similarly, if the release request is rejected by the source device before the report standby timer expires, the base station may stop the report standby timer and transmit the release request message again.

[0167] FIG. 22 shows another embodiment of the proposed connection release method.

[0168] In step S750, the base station transmits the release request message to the source device and the cooperative device. Release request of the base station may be forced or optional. In step S751, the source device and the cooperative device may transmit the release response message to the base station as a response to the release request message. The release response message may include an approval to the release request of the base station.

[0169] In step S752, the source device does not perform a separate connection release procedure and do not monitor the second RAT any longer. For example, by turning off the RF for the second RAT within the source device, monitoring of the second RAT may be suspended. Accordingly, the cooperative device determines that the connection of the cooperative device to the source device has been released without performing a separate connection release procedure with the source device. The cooperative device may determine that no additional device capable of supporting the client cooperation technology is available. Therefore, the second RAT is no longer monitored. In step S753, the source device and the cooperative device may transmit a release report message to the base station. The source device and the cooperative device may report the result of the second RAT connection release to the cooperative device to the base station through the release report message.

[0170] Meanwhile, instead of immediately performing the release procedure as a response to the release request of the base station, a procedure for power saving may be performed.

[0171] FIG. 23 shows another embodiment of the proposed connection release method.

[0172] In step S760, the base station transmits a release request message to the source device. In step S761, the source device and the cooperative device enters the sleep mode. In step S762, the source device transmits a release report message to the base station as a response to the release request message. The source device may inform the base station through the release report message that the source device has successfully entered the sleep mode. Data transmission may be performed immediately in the sleep mode within a predetermined time period without a separate authentication and/or an association procedure.

[0173] In step S763, without separate data transmission, sleep mode for the source device and the cooperative device is terminated. It is not until the moment that the connection release procedure is performed. In step S764, the source device and the cooperative device releases the connection of the second RAT. In step S765, the source device transmits the release report message to the base station. The source device may report a result of releasing connection of the second RAT to the cooperative device through the release report message.

[0174] Meanwhile, in the connection release procedure described above, the source device, the cooperative device, and the base station may store information of their partner device for which connection release is attempted. The information may include location, MAC address, authentication-related information, information on a beacon frame body of the partner device. The cooperative device may store information on the source device. Information on the partner device may be stored for a predetermined time period or for a time period negotiated with the base station. The time period during which the information is stored may be determined based on absolute time and/or movement speed of each device, etc. Also, the time period during which the information is stored may be transmitted through the release request/response message. If it is required again to perform client cooperation within the time period during which the information is stored after the connection release procedure is completed, a connection procedure for the partner device may be performed base on the stored information of the partner device. The base station may first of all recommend the partner device to the source device as the cooperative device, and accordingly the connection procedure may be simplified.

[0175] FIG. 24 is a block diagram showing wireless communication system to implement an embodiment of the present invention.

[0176] A BS 800 includes a processor 810, a memory 820, and a radio frequency (RF) unit 830. The processor 810 may be configured to implement proposed functions, procedures, and/or methods in this description. Layers of the radio interface protocol may be implemented in the processor 810. The memory 820 is operatively coupled with the processor 810 and stores a variety of information to operate the processor

810. The RF unit **830** is operatively coupled with the processor **810**, and transmits and/or receives a radio signal.

[0177] A UE **900** may include a processor **910**, a memory **920** and a RF unit **930**. The processor **910** may be configured to implement proposed functions, procedures and/or methods described in this description. Layers of the radio interface protocol may be implemented in the processor **910**. The memory **920** is operatively coupled with the processor **910** and stores a variety of information to operate the processor **910**. The RF unit **930** is operatively coupled with the processor **910**, and transmits and/or receives a radio signal.

[0178] The processors **810**, **910** may include application-specific integrated circuit (ASIC), other chipset, logic circuit and/or data processing device. The memories **820**, **920** may include read-only memory (ROM), random access memory (RAM), flash memory, memory card, storage medium and/or other storage device. The RF units **830**, **930** may include baseband circuitry to process radio frequency signals. When the embodiments are implemented in software, the techniques described herein can be implemented with modules (e.g.. procedures, functions, and so on) that perform the functions described herein. The modules can be stored in memories **820**, **920** and executed by processors **810**. **910**. The memories **820**, **920** can be implemented within the processors **810**, **910** or external to the processors **810**. **910** in which case those can be communicatively coupled to the processors **810**, **910** via various means as is known in the art.

[0179] In view of the exemplary systems described herein, methodologies that may be implemented in accordance with the disclosed subject matter have been described with reference to several flow diagrams. While for purposed of simplicity, the methodologies are shown and described as a series of steps or blocks, it is to be understood and appreciated that the claimed subject matter is not limited by the order of the steps or blocks, as some steps may occur in different orders or concurrently with other steps from what is depicted and described herein. Moreover, one skilled in the art would understand that the steps illustrated in the flow diagram are not exclusive and other steps may be included or one or more of the steps in the example flow diagram may be deleted without affecting the scope and spirit of the present disclosure.

[0180] What has been described above includes examples of the various aspects. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing the various aspects, but one of ordinary skill in the art may recognize that many further combinations and permutations are possible. Accordingly, the subject specification is intended to embrace all such alternations, modifications and variations that fall within the spirit and scope of the appended claims.

What is claimed is:

1. A method for releasing, by a source device, a connection for client cooperation in a wireless communication system, the method comprising:

transmitting a release request message to a base station at connection release request time;

receiving a release response message from the base station as a response to the release request message;

releasing a connection to a cooperative device; and

transmitting a release report message including a result of releasing the connection to the cooperative device to the base station,

wherein the base station and the cooperative device are connected to each other through a first system, and

wherein the source device and the cooperative device are connected to each other through a second system.

2. The method of claim **1**, wherein the base station and the source device are connected to each other through the first system.

3. The method of claim **2**, further comprising:

determining whether to transmit the release request message through the first system or through the second system.

4. The method of claim **2**, wherein the connection release request time corresponds to time at which a connection state between the base station and the source device through the first system exceeds a predetermined threshold.

5. The method of claim **1**, wherein the connection release request time corresponds to time at which a connection state between the source device and the cooperative device through the second system falls below a predetermined threshold.

6. The method of claim **1**, wherein the connection release request time corresponds to time at which data transmission between the source device and the cooperative device through the second system is completed.

7. The method of claim **6**, wherein the connection release request time corresponds to time at which data transmission between the source device and the cooperative device through the second system is completed, and a release timer starting after completion of the data transmission expires.

8. The method of claim **1**, wherein the connection release request time corresponds to time at which the source device enters sleep mode.

9. The method of claim **8**, wherein the connection release request time corresponds to time at which the source device enters sleep mode, and a release timer starting after entrance to the sleep mode is completed.

10. The method of claim **1**, wherein releasing the connection to the cooperative device includes performing de-authentication and de-association with the cooperative device.

11. The method of claim **1**, wherein releasing the connection to the cooperative device includes turning off power of a radio frequency (RF) for the second system.

12. The method of claim **1**, wherein the first system is one of institute of electrical and electronics engineers (IEEE) 802.16, IEEE 802.16m, IEEE 802.20, evolved-UMTS terrestrial radio access (E-UTRA), 3^{rd} generation partnership project (3GPP) long-term evolution (LTE), or 3GPP LTE-A (advanced), and the second system is IEEE 802.11.

13. The method of claim **1**, further comprising:

searching for at least one candidate cooperative device for the source device;

receiving an activation command including a result of an activation request from the base station; and

connecting to a selected cooperative device among the at least one candidate cooperative device through the second system.

14. A method for releasing, by a base station, a connection for client cooperation in a wireless communication system, the method comprising:

transmitting a release request message to a source device or a cooperative device at connection release request time;

receiving a release response message from the source device or the cooperative device as a response to the release request message; and

receiving a release report message including a result of connection release from the source device or the cooperative device,

wherein the base station and the cooperative device are connected to each other through a first system, and

wherein the source device and the cooperative device are connection to each other through a second system.

15. The method of claim **14**, further comprising

starting a report standby timer after transmitting the release request message.

16. A source device for client cooperation in a wireless communication system, the source device comprising:

a radio frequency (RF) unit for transmitting or receiving a radio signal; and

a processor connected to the RF unit, and configured to:

transmit a release request message to a base station at connection release request time;

receive a release response message from the base station as a response to the release request message;

release a connection to a cooperative device; and

transmit a release report message including a result of releasing the connection to the cooperative device to the base station,

wherein the base station and the cooperative device are connected to each other through a first system, and

wherein the source device and the cooperative device are connected to each other through a second system.

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