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(54) **BASE STATION AND TERMINAL APPARATUS**

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CPC *H04W 76/15* (2018.02)

(57) **ABSTRACT**

A base station (**10**) of an embodiment includes a first wireless signal processing unit, a second wireless signal processing unit, and a link management unit (**120**). The first wireless signal processing unit is configured to be able to transmit and receive wireless signals using the first band. The second wireless signal processing unit is configured to be able to transmit and receive wireless signals using a second band that is different from the first band. The link management unit manages a link state of the first wireless signal processing unit and a link state of the second wireless signal processing unit. If each of the first wireless signal processing unit and the second wireless signal processing unit has established a link by executing association processing with the same terminal apparatus, upon receiving a multi-link request from the terminal apparatus, the link management unit establishes a multi-link with the terminal apparatus using the first wireless signal processing unit and the second wireless signal processing unit.

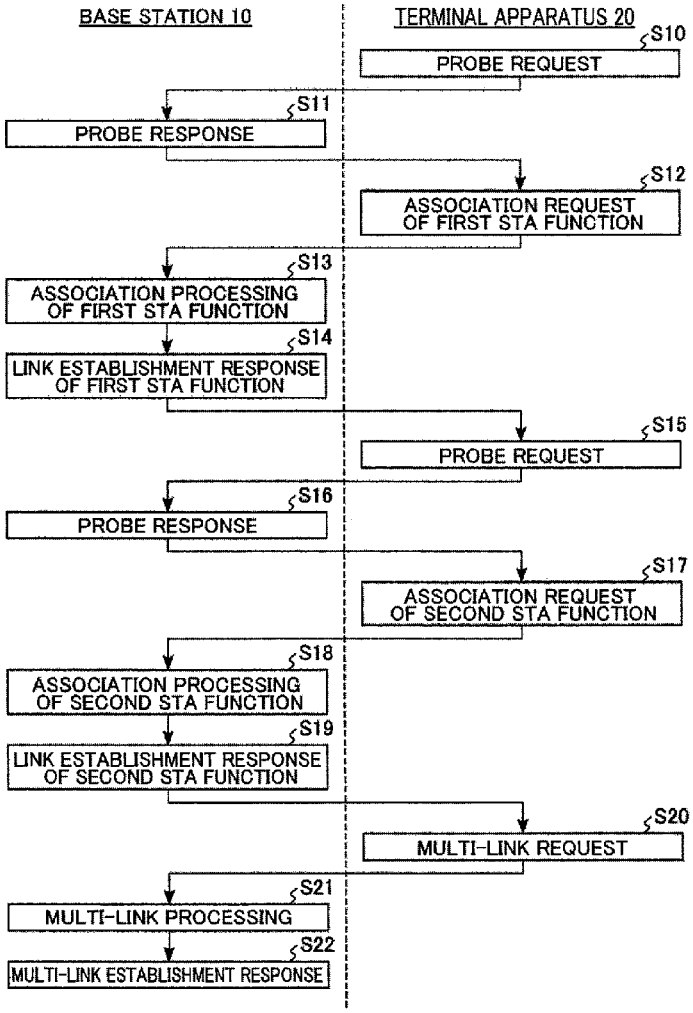


Fig. 1

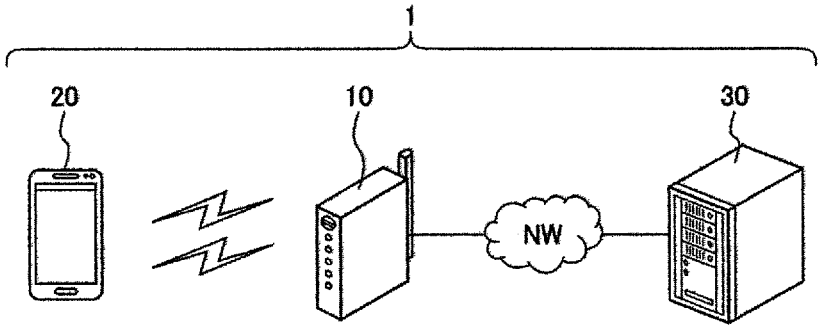


Fig. 2

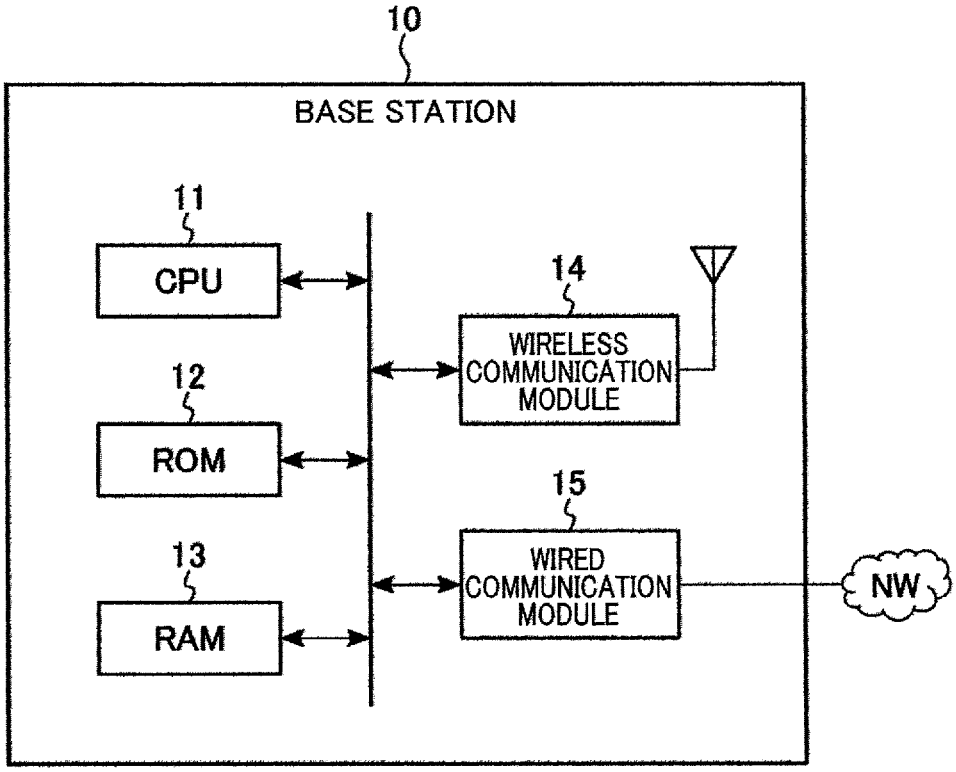
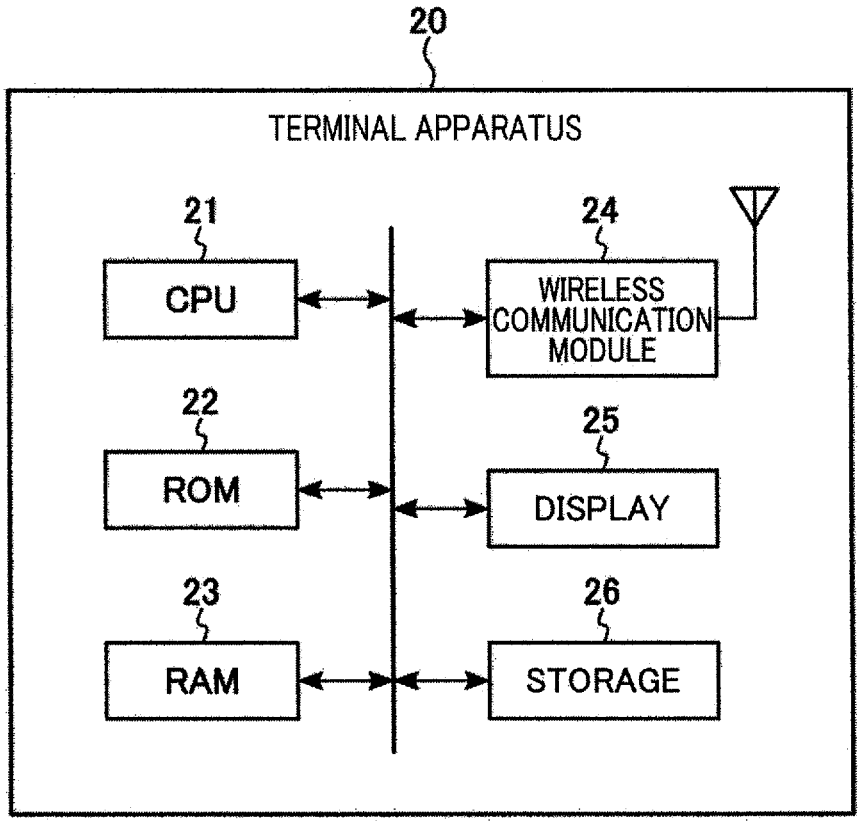

10
BASE STATION
11
CPU
12
ROM
13
RAM
14
WIRELESS COMMUNICATION MODULE
15
WIRED COMMUNICATION MODULE
NW

Fig. 3


20
TERMINAL APPARATUS
21
CPU
22
ROM
23
RAM
24
WIRELESS COMMUNICATION MODULE
25
DISPLAY
26
STORAGE

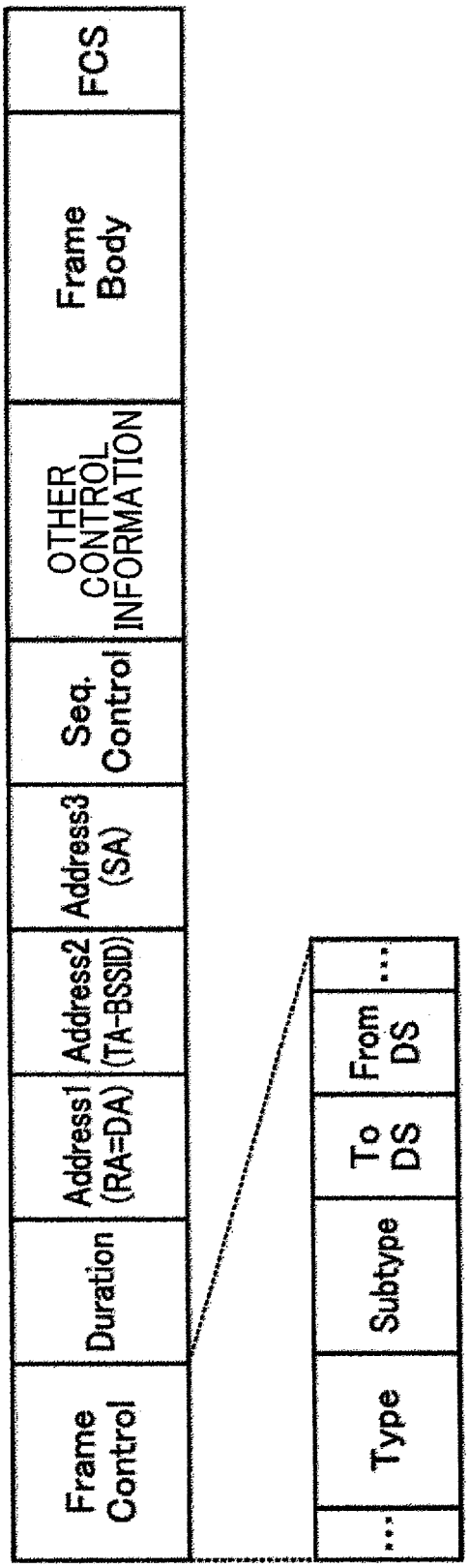

Frame Control
Duration
Address1 (RA=DA)
Address2 (TA-BSSID)
Address3 (SA)
Seq. Control
OTHER CONTROL INFORMATION
Frame Body
FCS
...
Type
Subtype
To DS
From DS
...

Fig. 4

Fig. 5

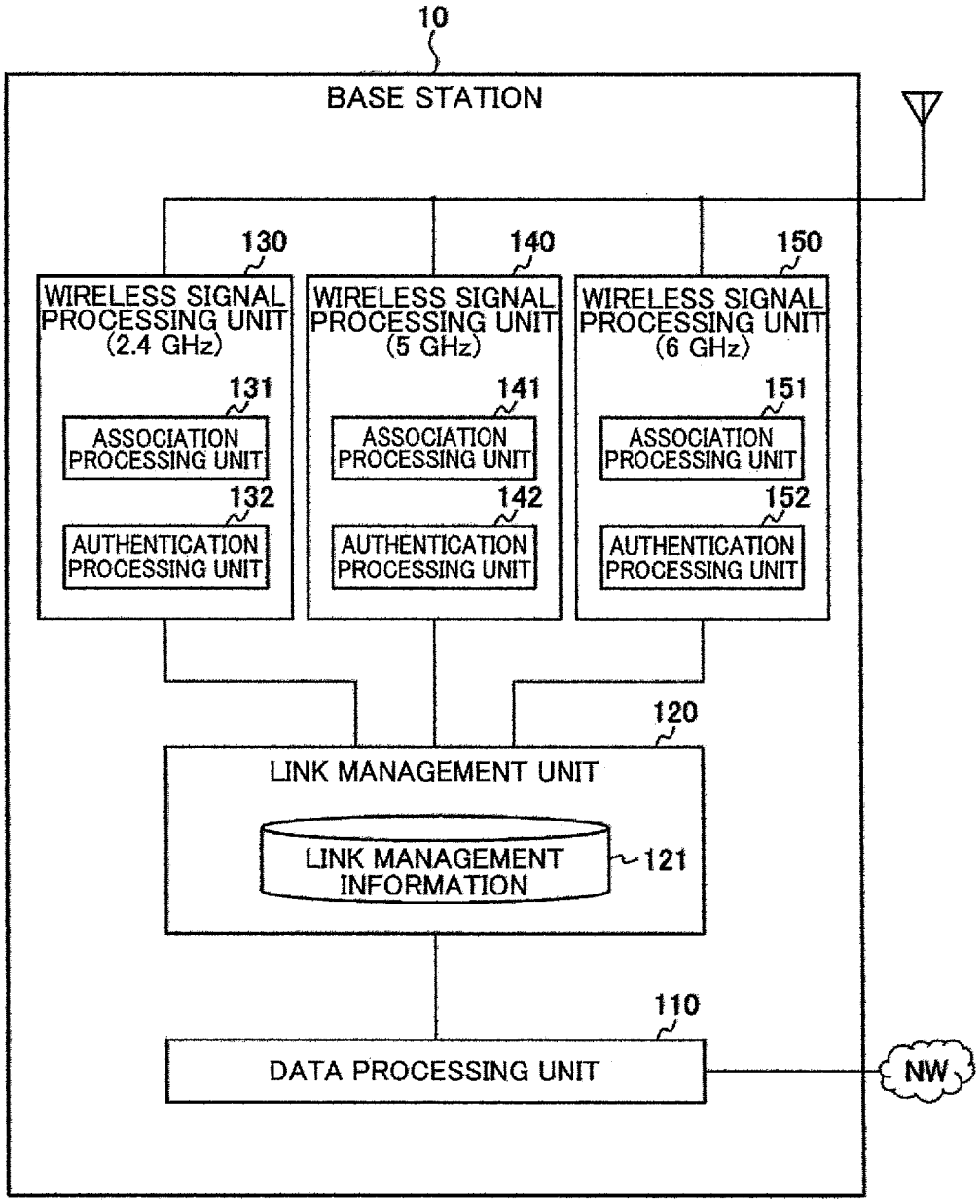

10
BASE STATION
130
WIRELESS SIGNAL PROCESSING UNIT (2.4 GHz)
131
ASSOCIATION PROCESSING UNIT
132
AUTHENTICATION PROCESSING UNIT
140
WIRELESS SIGNAL PROCESSING UNIT (5 GHz)
141
ASSOCIATION PROCESSING UNIT
142
AUTHENTICATION PROCESSING UNIT
150
WIRELESS SIGNAL PROCESSING UNIT (6 GHz)
151
ASSOCIATION PROCESSING UNIT
152
AUTHENTICATION PROCESSING UNIT
120
LINK MANAGEMENT UNIT
LINK MANAGEMENT INFORMATION
121
110
DATA PROCESSING UNIT
NW

Fig. 6

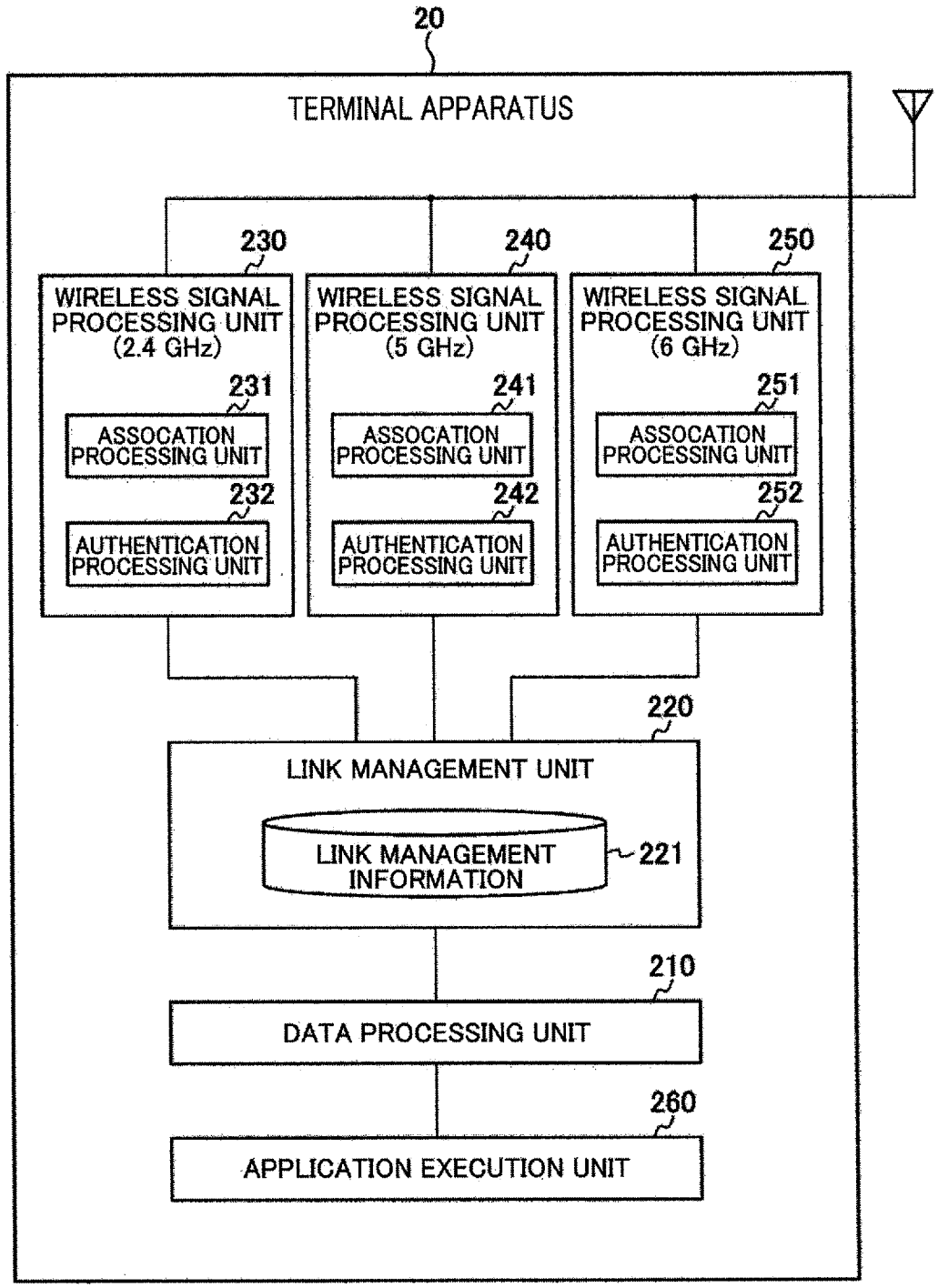

20
TERMINAL APPARATUS
230
240
250
WIRELESS SIGNAL PROCESSING UNIT (2.4 GHz)
WIRELESS SIGNAL PROCESSING UNIT (5 GHz)
WIRELESS SIGNAL PROCESSING UNIT (6 GHz)
231
241
251
ASSOCATION PROCESSING UNIT
ASSOCATION PROCESSING UNIT
ASSOCATION PROCESSING UNIT
232
242
252
AUTHENTICATION PROCESSING UNIT
AUTHENTICATION PROCESSING UNIT
AUTHENTICATION PROCESSING UNIT
220
LINK MANAGEMENT UNIT
LINK MANAGEMENT INFORMATION
221
210
DATA PROCESSING UNIT
260
APPLICATION EXECUTION UNIT

Fig. 7

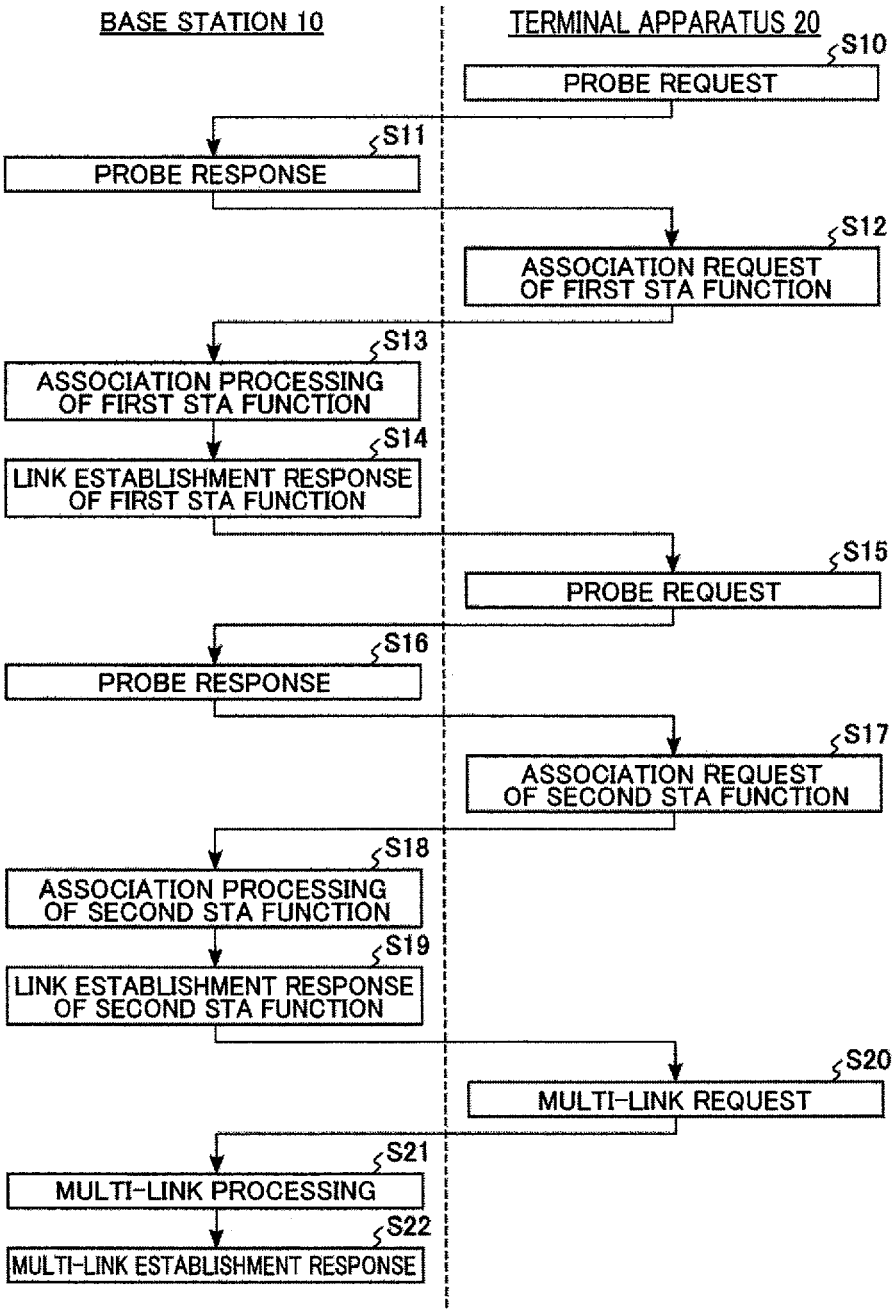

BASE STATION 10
TERMINAL APPARATUS 20
S10
PROBE REQUEST
S11
PROBE RESPONSE
S12
ASSOCIATION REQUEST OF FIRST STA FUNCTION
S13
ASSOCIATION PROCESSING OF FIRST STA FUNCTION
S14
LINK ESTABLISHMENT RESPONSE OF FIRST STA FUNCTION
S15
PROBE REQUEST
S16
PROBE RESPONSE
S17
ASSOCIATION REQUEST OF SECOND STA FUNCTION
S18
ASSOCIATION PROCESSING OF SECOND STA FUNCTION
S19
LINK ESTABLISHMENT RESPONSE OF SECOND STA FUNCTION
S20
MULTI-LINK REQUEST
S21
MULTI-LINK PROCESSING
S22
MULTI-LINK ESTABLISHMENT RESPONSE

Fig. 8

STA FUNCTION	FREQUENCY BAND	LINK DESTINATION ID	MULTI-LINK	TID
STA1	6GHz	XX	○	#1,#2
STA2	5GHz	XX	○	#1,#3
STA3	2.4GHz	–	–	–

Fig. 9

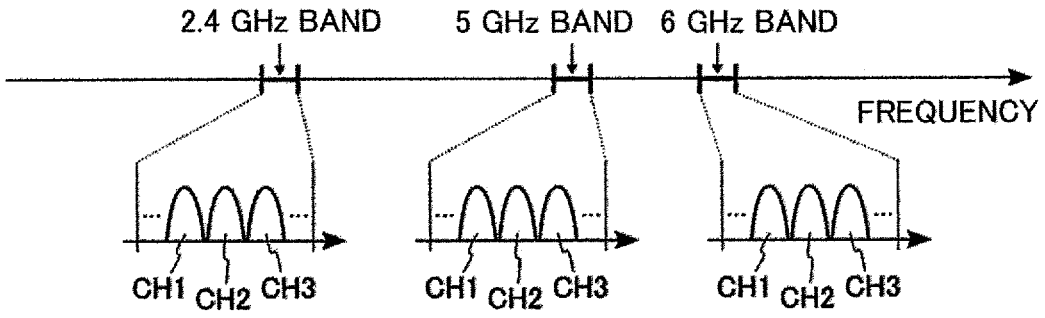

2.4 GHz BAND
5 GHz BAND
6 GHz BAND
FREQUENCY
CH1
CH2
CH3
CH1
CH2
CH3
CH1
CH2
CH3

Fig. 10

STA FUNCTION	FREQUENCY BAND	CHANNEL ID	LINK DESTINATION ID	MULTI-LINK	TID
STA1	6 GHz BAND	CH1	–	–	–
		CH2	XX	○	#1,#2
		CH3	–	–	–
STA2	6 GHz BAND	CH1	–	–	–
		CH2	–	–	–
		CH3	XX	○	#1,#3

BASE STATION AND TERMINAL APPARATUS

TECHNICAL FIELD

[0001] An embodiment relates to a base station and a terminal apparatus.

BACKGROUND ART

[0002] A wireless LAN (Local Area Network) is known as a wireless system for wirelessly connecting a base station and a terminal apparatus.

CITATION LIST

Non-Patent Literature

[0003] NPL 1: IEEE Std 802.11-2016, "FIG. 4-25 Establishing the IEEE 802.11 association" and "11.3 STA authentication and association", 7 Dec. 2016

SUMMARY OF THE INVENTION

Technical Problem

[0004] A problem to be solved is to improve the speed and stability of wireless communication.

Means for Solving the Problem

[0005] A base station of an embodiment includes a first wireless signal processing unit, a second wireless signal processing unit, and a link management unit. The first wireless signal processing unit is configured to be able to transmit and receive a wireless signal using a first band. The second wireless signal processing unit is configured to be able to transmit and receive a wireless signal using a second band that is different from the first band. The link management unit manages the link state of the first wireless signal processing unit and the link state of the second wireless signal processing unit. If each of the first wireless signal processing unit and the second wireless signal processing unit has established a link by executing association processing with the same terminal apparatus, upon receiving a request for a multi-link from the terminal apparatus, the link management unit establishes a multi-link with the terminal apparatus using the first wireless signal processing unit and the second wireless signal processing unit.

Advantageous Effects of the Invention

[0006] The base station of the embodiment can improve the speed and stability of wireless communication.

BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. **1** is a conceptual diagram showing an example of an overall configuration of a wireless system according to an embodiment.

[0008] FIG. **2** is a block diagram showing an example of a configuration of a base station included in the wireless system according to the embodiment.

[0009] FIG. **3** is a block diagram showing an example of a configuration of a terminal apparatus included in the wireless system according to the embodiment.

[0010] FIG. **4** is a conceptual diagram showing a specific example of a format of a wireless frame in the wireless system according to the embodiment.

[0011] FIG. **5** is a block diagram showing an example of functions of the base station included in the wireless system according to the embodiment.

[0012] FIG. **6** is a block diagram showing an example of functions of the terminal apparatus included in the wireless system according to the embodiment.

[0013] FIG. **7** is a flowchart showing an example of an operation in the wireless system according to the embodiment.

[0014] FIG. **8** is a table showing an example of link management information in the wireless system according to the embodiment.

[0015] FIG. **9** is a conceptual diagram showing an example of a band to be used for wireless communication in a wireless system according to a modified example of the embodiment.

[0016] FIG. **10** is a table showing an example of link management information in the wireless system according to a modified example of the embodiment.

DESCRIPTION OF EMBODIMENTS

[0017] Hereinafter, embodiments will be described with reference to the drawings. Each embodiment illustrates an apparatus or method for embodying the technical idea of the invention. The drawings are schematic or conceptual, and the dimensions and ratios of each drawing are not necessarily the same as the actual ones. The technical idea of the present invention is not specified by the shape, structure, arrangement, and the like of the constituent elements.

[0018] In the following description, components having substantially the same function and configuration are denoted by the same reference numerals. Letters following numerals in reference signs are used to distinguish between elements that are referred to by reference signs including the same letters and have the same configuration. If there is no need to distinguish between elements that are indicated by reference signs including the same numerals, these elements are referred to by reference signs including only the same numerals.

<1> First Embodiment

[0019] A wireless system **1** according to a first embodiment will be described hereinafter.

[0020] <1-1> Configuration of Wireless System **1**

[0021] FIG. **1** shows an example of a configuration of the wireless system **1** according to the first embodiment. As shown in FIG. **1**, the wireless system **1** includes, for example, a base station **10**, a terminal apparatus **20**, and a server **30**.

[0022] The base station **10** is connected to a network NW and is used as an access point of a wireless LAN. For example, the base station **10** can wirelessly distribute data received from the network NW to the terminal apparatus **20**. Also, the base station **10** can be connected to the terminal apparatus **20** using one type of band or a plurality of types of bands. In the present specification, a wireless connection between the base station **10** and the terminal apparatus **20** using a plurality of types of bands is referred to as a "multi-link". Communication between the base station **10** and the terminal apparatus **20** is based on, for example, the IEEE 802.11 standard.

[0023] The terminal apparatus **20** is, for example, a wireless terminal such as a smartphone or a tablet PC. The

terminal apparatus **20** can transmit and receive data to and from a server **30** on the network NW via the base station **10**, which is connected wirelessly. Note that the terminal apparatus **20** may be another electronic device such as a desktop computer or a laptop computer. The terminal apparatus **20** can be a device that can communicate with at least the base station **10** and can execute later-described operations.

[0024] The server **30** can hold various types of information, and for example, holds data of content for the terminal apparatus **20**. The server **30** is connected to, for example, the network NW by wire, and is configured to be able to communicate with the base station **10** via the network NW. Note that the server **30** is be able to communicate with at least the base station **10**. That is, communication between the base station **10** and the server **30** may be by wire or wireless.

[0025] <1-1-1> Configuration of Base Station **10**

[0026] FIG. **2** shows an example of a configuration of the base station **10** included in the wireless system **1** according to the first embodiment. As shown in FIG. **2**, the base station **10** includes, for example, a CPU (Central Processing Unit) **11**, a ROM (Read Only Memory) **12**, a RAM (Random Access Memory) **13**, a wireless communication module **14**, and a wired communication module **15**.

[0027] The CPU **11** is a circuit that can execute various programs, and controls the overall operation of the base station **10**. The ROM **12** is a non-volatile semiconductor memory, and holds a program, control data, and the like for controlling the base station **10**. The RAM **13** is, for example, a volatile semiconductor memory and is used as a work region of the CPU **11**. The wireless communication module **14** is a circuit used for transmitting and receiving data by a wireless signal, and is connected to an antenna. Also, the wireless communication module **14** includes, for example, a plurality of communication modules respectively corresponding to a plurality of frequency bands. The wired communication module **15** is a circuit used for transmitting and receiving data by a wired signal, and is connected to the network NW.

[0028] <1-1-2> Configuration of Terminal Apparatus **20**

[0029] FIG. **3** shows an example of a configuration of the terminal apparatus **20** included in the wireless system **1** according to the first embodiment. As shown in FIG. **3**, the terminal apparatus **20** includes, for example, a CPU **21**, a ROM **22**, a RAM **23**, a wireless communication module **24**, a display **25**, and a storage **26**.

[0030] The CPU **21** is a circuit that can execute various programs, and controls the overall operation of the terminal apparatus **20**. The ROM **22** is a non-volatile semiconductor memory, and holds a program, control data, and the like for controlling the terminal apparatus **20**. The RAM **23** is, for example, a volatile semiconductor memory and is used as a work region of the CPU **21**. The wireless communication module **24** is a circuit used for transmitting and receiving data by a wireless signal, and is connected to an antenna. Also, the wireless communication module **24** includes, for example, a plurality of communication modules that respectively correspond to a plurality of frequency bands. The display **25** displays, for example, a GUI (Graphical User Interface) corresponding to application software. The display **25** may include a function of an input interface of the terminal apparatus **20**. The storage **26** is a non-volatile storage device, and holds, for example, system software and the like of the terminal apparatus **20**.

[0031] <1-2> Operation of Wireless System **1**

[0032] The wireless system **1** according to the first embodiment executes data communication based on an OSI (Open Systems Interconnection) reference model. In the OSI reference model, the communication function is divided into 7 layers (first layer: physical layer, second layer: data link layer, third layer: network layer, fourth layer: transport layer, fifth layer: session layer, sixth layer: presentation layer, seventh layer: application layer). The data link layer includes, for example, an LLC (Logical Link Control) layer and a MAC (Media Access Control) layer. In the present specification, the third to seventh layers are referred to as "upper layers" using the data link layer as a reference.

[0033] <1-2-1> Format of Wireless Frame

[0034] FIG. **4** shows a specific example of a format of a wireless frame in the wireless system **1** according to the first embodiment. As shown in FIG. **4**, the wireless frame includes, for example, a Frame Control field, a Duration field, an Address1 field, an Address2 field, an Address3 field, a Sequence Control field, other control information field, a Frame Body field, and an FCS (Frame Check Sequence) field. The Frame Control field to the other control information field correspond to, for example, a MAC header included in a MAC frame. The Frame Body field corresponds to, for example, a MAC payload contained in the MAC frame. The FCS field is information added in order to detect a frame error.

[0035] The Frame Control field indicates various types of control information and includes, for example, a Type value, a Subtype value, a To DS (To Distribution System) value, and a From DS value.

[0036] The Type value and Subtype value indicate the frame type of the wireless frame. For example, the Type value "00" indicates that the wireless frame is a management frame. The Type value "01" indicates that the wireless frame is a control frame. The Type value "10" indicates that the wireless frame is a data frame. Also, the content of the wireless frame changes depending on the combination of the Type value and the Subtype value.

[0037] The meaning of the To DS value and From DS value differs depending on the combination. For example, "00 (To DS/From DS)" indicates that the data is between terminal apparatuses in the same IBSS. "10" indicates that the data frame is directed to the DS (Distribution System) from the outside. "01" indicates that the data frame is to go out of the DS. "11" is used when forming a mesh network.

[0038] The Duration field indicates a scheduled period of using the wireless line. The Address field is used to indicate the BSSID, the transmission source address, the destination address, the sender terminal apparatus address, and the recipient terminal apparatus address.

[0039] The Sequence Control field shows the sequence number of the MAC frame and the fragment number for the fragment. The Frame Body field includes information corresponding to the type of the frame, and for example, in the case of a data frame, data is stored therein. FCS stores the error detection code of the MAC header and Frame Body, and is used to determine whether or not there is an error.

[0040] <1-2-2> Functional Configuration of Wireless System **1**

[0041] In the wireless system **1** according to the first embodiment, the base station **10** establishes a multi-link with the terminal apparatus **20** based on a request from the terminal apparatus **20** for which a plurality of links have

been established. Note that although the establishment of the multi-link between the base station **10** and the terminal apparatus **20** may also be triggered by the base station **10**, in the present specification, a case will be described in which the multi-link is established based on a request from the terminal apparatus **20**. In this specification, an operation for establishing a multi-link between the base station **10** and the terminal apparatus **20** is referred to as "multi-link processing". First, the respective functional configurations of the base station **10** and the terminal apparatus **20** related to the multi-link processing of the wireless system **1** according to the first embodiment will be described sequentially.

[0042] (Functional Configuration of Base Station **10**)

[0043] FIG. **5** shows an example of the functional configuration of the base station **10** in the wireless system **1** according to the first embodiment. As shown in FIG. **5**, the base station **10** can function as, for example, a data processing unit **110**, a link management unit **120**, and wireless signal processing units **130**, **140**, and **150**.

[0044] The data processing unit **110** can execute the processing of the LLC layer and the processing of the upper layer on the input data. For example, the data processing unit **110** outputs the data input from the server **30** via the network NW to the link management unit **120**. Also, the data processing unit **110** transmits the data input from the link management unit **120** to the server **30** via the network NW.

[0045] The link management unit **120** can execute, for example, some of the processing of the MAC layer on the input data. Also, the link management unit **120** manages the link with the terminal apparatus **20** based on notifications from the wireless signal processing units **130**, **140**, and **150**. The link management unit **120** includes link management information **121**. The link management information **121** is stored in, for example, the RAM **13**, and includes information on the terminal apparatus **20** that is wirelessly connected to the base station **10**.

[0046] Also, if it is detected that a plurality of links have been established for the same terminal apparatus **20** in the link management information **121**, the link management unit **120** establishes a multi-link in response to request from the link management unit **220** of the terminal apparatus **20**.

[0047] Each of the wireless signal processing units **130**, **140**, and **150** can execute, for example, part of the processing of the MAC layer and the processing of the first layer on the input data or the wireless signal. That is, each of the wireless signal processing units **130**, **140**, and **150** performs transmission and reception of data between the base station **10** and the terminal apparatus **20** using wireless communication. The wireless signal processing unit **130** handles wireless signals in the 2.4 GHz band. The wireless signal processing unit **140** handles wireless signals in the 5 GHz band. The wireless signal processing unit **150** handles wireless signals in the 6 GHz band. The wireless signal processing units **130**, **140**, and **150** may or may not share the antenna of the base station **10**.

[0048] For example, each of the wireless signal processing units **130**, **140**, and **150** generates a wireless frame using the data input from the link management unit **120**. Then, each of the wireless signal processing units **130**, **140**, and **150** converts the wireless frame into a wireless signal and distributes the wireless signal via the antenna of the base station **10**. Also, each of the wireless signal processing units **130**, **140**, and **150** converts the wireless signal received via the antenna of the base station **10** into a wireless frame and outputs the data included in the wireless frame to the link management unit **120**.

[0049] Also, the wireless signal processing unit **130** includes an association processing unit **131** and an authentication processing unit **132**. Also, the wireless signal processing unit **140** includes an association processing unit **141** and an authentication processing unit **142**. Also, the wireless signal processing unit **150** includes an association processing unit **151** and an authentication processing unit **152**. Each of the association processing units **131**, **141**, and **151** executes a protocol related to association if a connection request from the terminal apparatus **20** is received. Each of the authentication processing units **132**, **142**, and **152** executes a protocol related to authentication following the connection request.

[0050] (Functional Configuration of Terminal Apparatus **20**)

[0051] FIG. **6** shows an example of the functional configuration of the terminal apparatus **20** in the wireless system **1** according to the first embodiment. As shown in FIG. **6**, the terminal apparatus **20** can function as, for example, a data processing unit **210**, a link management unit **220**, wireless signal processing units **230**, **240**, and **250**, and an application execution unit **260**.

[0052] The data processing unit **210** can execute the processing of the LLC layer and the processing of the upper layer on the input data. For example, the data processing unit **210** outputs the data input from the application execution unit **260** to the link management unit **220**. Also, the data processing unit **210** outputs the data input from the link management unit **220** to the application execution unit **260**.

[0053] The link management unit **220** can execute, for example, some of the processing of the MAC layer on the input data. Also, the link management unit **220** manages the link with the base station **10** based on notifications from the wireless signal processing units **230**, **240**, and **250**. The link management unit **220** includes link management information **221**. The link management information **221** is stored in, for example, the RAM **23**, and includes information on the base station **10** to which the terminal apparatus **20** is connected. The link management information **221** includes information similar to, for example, the link management information **121**.

[0054] Also, if it is detected that a plurality of links for the same base station **10** have been established in the link management information **221**, the link management unit **220** requests the base station **10** to establish a multi-link.

[0055] Each of the wireless signal processing units **230**, **240**, and **250** can execute, for example, some of the processing of the MAC layer and the processing of the first layer on the input data or the wireless signal. That is, each of the wireless signal processing units **230**, **240**, and **250** performs transmission and reception of data between the base station **10** and the terminal apparatus **20** using wireless communication. The wireless signal processing unit **230** handles wireless signals in the 2.4 GHz band. The wireless signal processing unit **240** handles wireless signals in the 5 GHz band. The wireless signal processing unit **250** handles wireless signals in the 6 GHz band. The wireless signal processing units **230**, **240**, and **250** may or may not share the antenna of the terminal apparatus **20**.

[0056] For example, each of the wireless signal processing units **230**, **240**, and **250** generates a wireless frame using the

data input from the link management unit **220**. Then, each of the wireless signal processing units **230**, **240**, and **250** converts the wireless frame into a wireless signal and distributes the wireless signal via the antenna of the terminal apparatus **20**. Also, each of the wireless signal processing units **230**, **240**, and **250** converts the wireless signal received via the antenna of the terminal apparatus **20** into a wireless frame, and outputs the data included in the wireless frame to the link management unit **220**.

[0057] Also, the wireless signal processing unit **230** includes an association processing unit **231** and an authentication processing unit **232**. The wireless signal processing unit **240** includes an association processing unit **241** and an authentication processing unit **242**. The wireless signal processing unit **250** includes an association processing unit **251** and an authentication processing unit **252**. Each of the association processing units **231**, **241**, and **251** executes a protocol related to association if a connection request from the base station **10** is received. Each of the authentication processing units **232**, **242**, and **252** executes a protocol related to authentication following the connection request.

[0058] The application execution unit **260** executes an application that can use the data input from the data processing unit **210**. For example, the application execution unit **260** can display information on the application on the display **25**. Also, the application execution unit **260** can operate based on operation of the input interface.

[0059] In the functional configuration of the wireless system **1** according to the first embodiment described above, the wireless signal processing units **130**, **140**, and **150** of the base station **10** are configured to be able to connect to the wireless signal processing units **230**, **240**, and **250** of the terminal apparatus **20**, respectively. Specifically, the wireless signal processing units **130** and **230** can be wirelessly connected using the 2.4 GHz band. The wireless signal processing units **140** and **240** can be wirelessly connected using the 5 GHz band. The wireless signal processing units **150** and **250** can be wirelessly connected using the 6 GHz band. Each wireless signal processing unit may be referred to as an "STA function". That is, the wireless system **1** according to the first embodiment includes a plurality of STA functions.

[0060] <1-2-3> Details of Multi-Link Processing

[0061] In the multi-link processing of the first embodiment, the terminal apparatus **20** requests the base station **10** to establish a multi-link after a connection using a plurality of STA functions is established between the base station **10** and the terminal apparatus **20**. An example of a flow of multi-link processing in the wireless system **1** according to the first embodiment will be described hereinafter.

[0062] FIG. **7** is a flowchart showing an example of multi-link processing in the wireless system **1** according to the first embodiment. As shown in FIG. **7**, in the multi-link processing in the first embodiment, for example, the processing of steps S**10** to S**22** is executed sequentially.

[0063] Specifically, first, in the processing of step S**10**, the terminal apparatus **20** (e.g., STA1) transmits a probe request to the base station **10**. The probe request is a signal for confirming whether or not the base station **10** is present in the surrounding area of the terminal apparatus **20**. The Frame Control field of the probe request includes, for example, "00/0100 (Type value/Subtype value)". Upon receiving the probe request, the base station **10** executes the processing of step S**11**.

[0064] In the processing of step S**11**, the base station **10** transmits a probe response to the terminal apparatus **20**. The probe response is a signal used by the base station **10** to respond to a probe request from the terminal apparatus **20**. The Frame Control field of the probe response includes, for example, "00/0101 (Type value/Subtype value)". Upon receiving the probe request, the terminal apparatus **20** executes the processing of step S**12**.

[0065] In the processing of step S**12**, the terminal apparatus **20** transmits an association request for a first STA function to the base station **10**. The Frame Control field of the association request includes, for example, "00/0000 (Type value/Subtype value)". Upon receiving the association request for the first STA function, the link management unit **120** of the base station **10** executes the processing of step S**13**.

[0066] In the processing of step S**13**, the link management unit **120** of the base station **10** executes the association processing for the first STA function. Then, in the processing of step S**14**, the base station **10** transmits a link establishment response for the first STA function to the terminal apparatus **20**. The Frame Control field of the link establishment response includes, for example, "00/0001 (Type value/Subtype value)". Accordingly, a link (wireless connection) using the first STA function is established between the base station **10** and the terminal apparatus **20**.

[0067] On the other hand, in the processing of step S**15**, the terminal apparatus **20** (e.g., STA2) transmits a probe request to the base station **10**. Upon doing so, in the processing of step S**16**, the base station **10** transmits a probe response to the terminal apparatus **20**. Upon receiving the probe request, the terminal apparatus **20** executes the processing of step S**17**.

[0068] In the processing of step S**17**, the terminal apparatus **20** transmits an association request for a second STA function to the base station **10**. Upon receiving the association request, the link management unit **120** of the base station **10** executes the processing of step S**18**.

[0069] In the processing of step S**18**, the link management unit **120** of the base station **10** executes the association processing for the second STA function. Then, in the processing of step S**19**, the base station **10** transmits a link establishment response for the second STA function to the terminal apparatus **20**. Accordingly, a link using the second STA function is established between the base station **10** and the terminal apparatus **20**.

[0070] At this time, a link using the first STA function and a link using the second STA function are established between the base station **10** and the terminal apparatus **20**. If the link management unit **220** of the terminal apparatus **20** recognizes that a plurality of links for the same base station **10** have been established using a plurality of STA functions, the link management unit **220** executes the processing of step S**20**.

[0071] In the processing of step S**20**, the terminal apparatus **20** transmits a multi-link request to the base station **10**. The multi-link request is a signal for requesting the base station **10** to establish a multi-link using a plurality of links if a plurality of links using a plurality of STA functions have been established between the base station **10** and the terminal apparatus **20**. The Frame Control field of the multi-link request includes, for example, "00/xxxx (Type value/Subtype value (xxxx is a predetermined numeric value))". Upon

receiving the multi-link request, the link management unit **120** of the base station **10** executes the processing of step S**21**.

[0072] In the processing of step S**20**, the link management unit **120** of the base station **10** executes the multi-link processing. A multi-link using a plurality of links established between the base station **10** and the terminal apparatus **20** is established through this multi-link processing. When the multi-link is established, in the processing of step S**21**, the base station **10** transmits a multi-link establishment response to the terminal apparatus **20**. As a result, the terminal apparatus **20** recognizes that a multi-link has been established with the base station **10**. As a result, the multi-link processing of the wireless system **1** according to the first embodiment is complete, and data communication using the multi-link is possible between the base station **10** and the terminal apparatus **20**.

[0073] Note that in the above-described processing, the link management unit **120** of the base station **10** updates the link management information **121** as appropriate. Similarly, the link management unit **220** of the terminal apparatus **20** updates the link management information **221** as appropriate. For example, the link management units **120** and **220** sequentially update the link management information when a link or a multi-link is established.

[0074] FIG. **8** shows an example of the link management information **121** in the wireless system **1** according to the first embodiment. As shown in FIG. **8**, the link management information **121** includes, for example, information on the STA function, frequency, link destination ID, presence/absence of a multi-link, and traffic ID (TID). The link destination ID in the link management information **121** corresponds to, for example, the identifier of the terminal apparatus **20**. On the other hand, the link destination ID in the link management information **221** corresponds to, for example, the identifier of the base station **10**. In this example, "STA1" corresponds to the STA function that uses the 6 GHz frequency band. "STA2" corresponds to the STA function that uses the 5 GHz frequency band. "STA3" corresponds to the STA function that uses the 2.4 GHz frequency band.

[0075] Also, in this example, a multi-link using "STA1" and "STA2" has been established. When the multi-link is established, each of the link management units **120** and **220** transmits the data input from the upper layer using the link of at least one STA function associated with the multi-link. The link management units **120** and **220** may associate the traffic and the STA function with each other based on the type of traffic.

[0076] For example, the link management unit **220** of the terminal apparatus **20** determines the association between the traffic and the STA function, and sends a request to the link management unit **120** of the base station **10**. Then, the base station **10** confirms the association between the traffic and the STA function by responding to the request. Also, one STA function may be associated with one type of traffic, or a plurality of STA functions may be associated with one type of traffic. In this example, "STA1" is associated with "TID #1" and "TID #2". "STA2" is associated with "TID #1" and "TID #3".

[0077] In this manner, when a plurality of STA functions are associated with one type of traffic, data is transmitted in parallel by the plurality of STA functions. When one type of traffic is transmitted in parallel, it is necessary to distribute and sort the data between the link management unit **120** of the base station **10** and the link management unit **220** of the terminal apparatus **20**. The distribution of the data is executed by the link management unit on the transmitting side, and the link management unit on the transmitting side adds a flag indicating the multi-link and an identification number to the wireless frame. The sorting of the data is executed by the link management unit on the receiving side.

[0078] <1-3> Effect of Embodiment

[0079] With the wireless system **1** according to the first embodiment described above, a method for using content distributed wirelessly can be made easier. Detailed effects of the wireless system **1** according to the first embodiment will be described hereinafter.

[0080] Base stations and terminal apparatuses that use a wireless LAN include a plurality of STA functions provided for each band used, for example, 2.4 GHz, 5 GHz, and 6 GHz, in some cases. In such a wireless system, for example, by selecting one STA function among a plurality of STA functions, a wireless connection is established and data communication between the base station and the terminal apparatus is performed. At this time, in the wireless system, the unselected STA function is not used even if there is a base station corresponding to the band of the STA function.

[0081] In contrast to this, the wireless system **1** according to the first embodiment utilizes a plurality of STA functions provided in each of the base station **10** and the terminal apparatus **20** to establish a multi-link between the base station **10** and the terminal apparatus **20**. Stated briefly, the base station **10** includes a link management unit **120**, and the terminal apparatus **20** has a link management unit **220**.

[0082] Then, when the link management unit **220** of the terminal apparatus **20** recognizes that a plurality of links have been established with the same base station **10**, the link management unit **220** transmits a multi-link request to the base station **10**. Upon doing so, the link management unit **120** of the base station **10** establishes a multi-link based on the received multi-link request. In this manner, the multi-link of the wireless system **1** according to the embodiment is established due to the terminal apparatus **20** requesting a multi-link to the base station **10** based on a plurality of links that have already been established.

[0083] As described above, the multi-link in the wireless system **1** according to the first embodiment is established due to the terminal apparatus **20** requesting the multi-link to the base station **10**. In data communication through a multi-link, a plurality of bands can be used together, and the functions of the wireless LAN device can be fully utilized. As a result, the wireless system **1** according to the first embodiment can realize efficient communication and can improve the communication speed.

[0084] Also, the wireless system **1** according to the first embodiment can continue communication using another STA function even if the connection through one STA function is canceled in the multi-link state. Furthermore, the wireless system **1** according to the first embodiment can also use a multi-link to communicate between the link management unit **120** of the base station **10** and the link management unit **220** of the terminal apparatus **20** while performing link aggregation processing and switching. As a result, the wireless system **1** according to the first embodiment can also improve the communication stability.

<2> Second Embodiment

[0085] The wireless system **1** according to a second embodiment has, for example, the same configuration as that of the first embodiment. Also, the wireless system **1** according to the second embodiment establishes the same multi-link as the first embodiment using a plurality of channels included in the same frequency band. Points in which the wireless system **1** according to the second embodiment differs from the first embodiment will be described hereinafter.

[0086] <2-1> Band Used for Wireless Communication

[0087] FIG. **9** shows an example of a frequency band used for wireless communication in the wireless system **1** according to the second embodiment. As shown in FIG. **9**, in wireless communication, for example, the 2.4 GHz band, the 5 GHz band, and the 6 GHz band are used. Each frequency band includes a plurality of channels. In this example, it is assumed that each of the 2.4 GHz band, 5 GHz band, and 6 GHz band includes at least three channels CH1, CH2, and CH3. Communication using each channel CH is realized by the associated STA function.

[0088] <2-2> Multi-Link Processing

[0089] The wireless system **1** according to the second embodiment establishes the same multi-link as in the first embodiment using a plurality of channels CH included in the same frequency band. The multi-link processing in the second embodiment is the same as the multi-link processing described in the first embodiment in which the band used for the multi-link is changed to a plurality of channels CH included in the same frequency band.

[0090] FIG. **10** shows an example of the link management information **121** in the wireless system **1** according to the second embodiment. As shown in FIG. **10**, the link management information **121** in the second embodiment has a configuration in which information related to the channel ID for each frequency band is added to the link management information **121** in the first embodiment. Also, in this example, the same multi-link as in the first embodiment is established using the channel CH2 of "STA1" corresponding to the 6 GHz frequency band and the channel CH3 of "STA2" corresponding to the 6 GHz frequency band.

[0091] <2-3> Effect of Second Embodiment

[0092] As described above, the same frequency band may be used for each STA function of the base station **10** and the terminal apparatus **20**. Also, the multi-link between the base station **10** and the terminal apparatus **20** may be established by a plurality of STA functions using the same frequency band. Specifically, a plurality of STA functions may form a multi-link using, for example, different channels CH in the 5 GHz band. Even in such a case, the wireless system **1** according to the second embodiment can realize efficient communication and improve communication stability, similarly to the first embodiment.

<3> Other Modified Examples, etc.

[0093] In the above-described embodiment, a case was illustrated in which only the association processing was executed in the establishment of the link of each STA function, but there is no limitation to this. The wireless system **1** may also apply various options to the multi-link processing. For example, authentication processing, notification of a candidate link, or the like may be executed during the establishment of the link. In this manner, the option to be used in the establishment of the link can be selected as appropriate.

[0094] In the above-described embodiment, a case was illustrated in which the association processing unit and the authentication processing unit are provided in each wireless signal processing unit, but there is no limitation to this. For example, the link management unit **120** of the base station **10** may include the association processing unit and the authentication processing unit and the link management unit **220** of the terminal apparatus **20** may include the association processing unit and the authentication processing unit. In this case, each of the link management units **120** and **220** executes the association and authentication of each wireless signal processing unit.

[0095] In the above-described embodiment, each STA function may notify the corresponding link management unit when the link cannot be maintained due to movement of the terminal apparatus **20** or the like. Also, the link management unit **220** of the terminal apparatus **20** may change the multi-link state with the link management unit **120** of the base station **10** based on a notification from an STA function. Specifically, for example, the link management unit **220** of the terminal apparatus **20** and the link management unit **120** of the base station **10** may change the STA function used in the multi-link as appropriate. If the multi-link status is changed, the link management units **120** and **220** update the link management information **121** and **221** respectively. Also, the link management units **120** and **220** may update the association between the traffic and the STA function according to an increase or decrease in the number of links.

[0096] The configuration of the wireless system **1** according to the first embodiment is merely an example, and other configurations may be used. For example, although a case was illustrated in which each of the base station **10** and the terminal apparatus **20** has three STA functions (wireless signal processing units), the present invention is not limited to this. The base station **10** may include at least two wireless signal processing units. Similarly, the terminal apparatus **20** may include at least two wireless signal processing units. Also, the number of channels that can be processed by each STA function can be set as appropriate according to the frequency band used. Each of the wireless communication modules **14** and **24** may support wireless communication in a plurality of frequency bands using a plurality of communication modules, or may support wireless communication in a plurality of frequency bands using a single communication module. If the operation described in the above-described embodiment can be executed, the arrangement of the association processing unit and the authentication processing unit can be changed as appropriate.

[0097] Also, the functional configurations of the base station **10** and the terminal apparatus **20** in the wireless system **1** according to the first embodiment are merely examples. The functional configuration of the base station **10** and the terminal apparatus **20** may have other names and groupings as long as the operations described in each embodiment can be executed. For example, in the base station **10**, the data processing unit **110** and the link management unit **120** may be collectively referred to as a data processing unit. Similarly, in the terminal apparatus **20**, the data processing unit **210** and the link management unit **220** may be collectively referred to as a data processing unit.

[0098] Also, in the wireless system **1** according to the first embodiment, the CPU included in each of the base station **10** and the terminal apparatus **20** may be another circuit. For example, an MPU (Micro Processing Unit) or the like may be used instead of the CPU. Also, each of the processes described in each embodiment may be realized using dedicated hardware. The wireless system **1** according to each embodiment may include both processes executed by software and processes executed by hardware, or may include only one of them.

[0099] In each embodiment, the flowchart used to describe the operations is merely an example. The multi-link processing is an operation of establishing a multi-link based on at least the request of the terminal apparatus **20**, and the order of the processing may be changed within a possible range, or other processing may be added. Also, the format of the wireless frame described in the above embodiment is merely an example. The wireless system **1** may use another wireless frame format as long as it is possible to execute the multi-link processing described in each embodiment.

[0100] In the present specification, "connection" corresponds to a state in which communication of data is possible. The "connection request" corresponds to the terminal apparatus **20** requesting connection with the base station **10** in order to communicate with the network NW. Each of the "association processing" and the "authentication processing" corresponds to processing for assigning the terminal apparatus **20** to the base station **10**.

[0101] Although several embodiments of the present invention have been described, these embodiments are presented as examples and are not intended to limit the scope of the invention. These novel embodiments can be implemented in various other embodiments, and various omissions, replacements, and changes can be made thereto without departing from the gist of the invention. These embodiments and modifications thereof are included in the scope and gist of the invention, as well as in the scope of the invention described in the claims and the range of equivalency thereof.

REFERENCE SIGNS LIST

[0102] **1** Wireless system
[0103] **10** Base station
[0104] **20** Terminal apparatus
[0105] **30** Server
[0106] **11**, **21** CPU
[0107] **12**, **22** ROM
[0108] **13**, **23** RAM
[0109] **14**, **24** Wireless communication module
[0110] **15** Wired communication module
[0111] **25** Display
[0112] **26** Storage
[0113] **110**, **210** Data processing unit
[0114] **120**, **220** Link management unit
[0115] **121**, **221** Link management information
[0116] **122**, **131**, **141**, **151**, **222**, **231**, **241**, **251** Association processing unit
[0117] **123**, **132**, **142**, **152**, **223**, **232**, **242**, **252** Authentication processing unit
[0118] **130**, **140**, **150**, **230**, **240**, **250** Wireless signal processing unit

1. A base station comprising:
a first wireless signal processing unit configured to transmit and receive a wireless signal using a first channel;
a second wireless signal processing unit configured to transmit and receive a wireless signal using a second channel different from the first channel; and
a link management unit configured to manage a link state of the transmitting and receiving using the first channel and a link state of the transmitting and receiving using the second channel,
wherein if each of the first wireless signal processing unit and the second wireless signal processing unit has established a link by executing association processing with the same terminal apparatus, upon receiving a multi-link request from the terminal apparatus, the link management unit establishes a multi-link with the terminal apparatus using the first wireless signal processing unit and the second wireless signal processing unit.

2. The base station according to claim **1**, wherein the first channel and the second channel are included in mutually different frequency bands.

3. The base station according to claim **1**, wherein the first channel and the second channel are included in the same frequency band.

4. A terminal apparatus comprising:
a first wireless signal processing unit configured to transmit and receive a wireless signal using a first channel;
a second wireless signal processing unit configured to transmit and receive a wireless signal using a second channel different from the first channel; and
a link management unit configured to manage a link state of the first wireless signal processing unit and a link state of the second wireless signal processing unit,
wherein if each of the first wireless signal processing unit and the second wireless signal processing unit has established a link by executing association processing with the same terminal apparatus, upon receiving a multi-link request from the terminal apparatus, the link management unit establishes a multi-link with the terminal apparatus using the first wireless signal processing unit and the second wireless signal processing unit.

5. The terminal apparatus according to claim **4**, wherein the first channel and the second channel are included in mutually different frequency bands.

6. The terminal apparatus according to claim **4**, wherein the first channel and the second channel are included in the same frequency band.

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