

DESCRIPTION
DEVICE, METHOD, AND RECORDING MEDIUM

TECHNICAL FIELD

5 [0001]

The present disclosure relates to a device, a method, and a recording medium.

BACKGROUND ART

10 [0002]

Radio access scheme for cellular mobile communication and radio network (hereinafter, also referred to as "long term evolution (LTE)", "LTE-advanced (LTE-A)", "LTE-advanced pro (LTE-A Pro)", "fifth generation (5G)", "new radio (NR)", "new radio access technology (NRAT)", "evolved universal terrestrial radio access (EUTRA)", or "further EUTRA (FEUTRA)", have been considered in the 3rd generation partnership project (3GPP). Note that, in the following description, the LTE includes the LTE-A, the LTE-A Pro, and the EUTRA, and the NR includes the NRAT and the FEUTRA. In the LTE and the NR, a base station device (base station) is also referred to as an evolved Node B (eNodeB), and a terminal device (mobile station, mobile station device, terminal) is also referred to as a user equipment (UE). The LTE and the NR are cellular communication systems in which a plurality of areas covered by the base station device is arranged in a cell. A single base station device may manage a plurality of cells.

25 [0003]

The NR is a radio access technology (RAT) different

from the LTE as a next-generation radio access scheme for the LTE. The NR is an access technology that can support various use cases including the enhanced mobile broadband (eMBB), the massive machine type communications (mMTC),
5 and the ultra reliable and low latency communications (URLLC). The NR is considered aiming at a technical framework corresponding to use scenarios, requirements, deployment scenarios, and the like in those use cases.
[0004]

10 For example, in the NR, a slicing technology is being considered for accommodating a plurality of forms of communication corresponding to various use cases such as low delay, high reliability, or high security in one network. According to the slicing technology, it is
15 possible to coexist logical networks called slices or network slices in one physical network. This makes it possible to efficiently provide a network in accordance with the requirements of the service used by the user.
[0005]

20 On the other hand, in order to secure frequency resources which are becoming increasingly severe in recent years, legislation and standardization of spectrum sharing are being promoted worldwide. For example, in the United States in recent years, citizens broadband
25 radio service (CBRS) utilizing a frequency sharing technology is legalized to aim to open the federal use band (3.55 to 3.70 GHz) overlapping the frequency band that is worldwide 3GPP band 42, 43 to the general public, and standardization thereof is accelerating. Note that,
30 at this point, it is assumed that LTE will be the mainstream as a radio access scheme to be operated.

[0006]

With regard to frequency sharing technology, many techniques have been developed for efficiently using frequency resources. For example, in Patent Document 1 below, a technology is disclosed in which, among frequency resources corresponding to position information, frequency resources according to communication demand are used by a user.

10 CITATION LIST

PATENT DOCUMENT

[0007]

Patent Document 1: Japanese Patent No. 5679033

15 SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008]

The frequency sharing technology and the slicing technology may be combined to operate a wireless communication system. In that case, it is assumed that a communication carrier provides the wireless communication service to a user while sharing frequency resources and resources of a network such as a core network with other communication carriers.

25 [0009]

Since network resources as well as frequency resources are limited, it is desirable to operate network resources efficiently in order to make various slices coexist. Moreover, it is desirable that efficient sharing of frequency resources and network resources be realized together.

[0010]

Thus, embodiments of the present disclosure provide a mechanism capable of sharing frequency resources and network resources while balancing each other.

SOLUTIONS TO PROBLEMS

[0011]

According to a first aspect of the present disclosure, there is provided a device including: a determination unit that determines one of a use setting of a frequency resource by a wireless communication device, and a use setting of a core network resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and a request unit that requests another device to determine a use setting of either the frequency resource or the core network resource that is not determined on a basis of a determination result of the use setting of the frequency resource or the core network resource by the determination unit, wherein when the determination unit determines the use setting of the core network resource, the request unit transmits to the another device information indicating the determined use setting of the core network resource with information indicating the wireless communication device in association with each other along with information indicating the use setting of the frequency resource recommended, wherein, in a case where a predetermined condition is satisfied, the determining step determines a change of one of the use setting of the frequency resource and the use setting of the core network resource, and the requesting step requests the another device to determine the change of the use setting of the resource that is not determined.

[0012]

Disclosed herein is a device including: an acquisition unit that acquires information indicating a determination result of one of a use setting of a frequency resource by a wireless communication device, and a use setting of a core network resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and a determination unit that determines

a use setting of either the frequency resource or the core network resource that is not determined on a basis of information acquired by the acquisition unit.

[0013]

According to a second aspect of the present disclosure, there is provided a method including: determining, by a processor, one of a use setting of a frequency resource by a wireless communication device, and a use setting of a core network resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and requesting another device to determine a use setting of either the frequency resource or the core network resource that is not determined on a basis of a determination result of the use setting of the frequency resource or the core network resource by the determining step, the request step transmitting to the another device information indicating the determined use setting of the core network resource with information indicating the wireless communication device in association with each other along with information indicating the use setting of the frequency resource recommended, wherein, in a case where a predetermined condition is satisfied, the determining step determines a change of one of the use setting of the frequency resource and the use setting of the core network resource, and the requesting step requests the another device to determine the change of the use setting of the resource that is not determined.

[0014]

Disclosed herein is a method including: acquiring information indicating a determination result of one of a use setting of a frequency resource by a wireless communication device, and a use setting of a core network resource by a logical network deployed on a physical network to which the wireless communication device connects for providing a wireless communication service by the wireless communication device; and determining, by a processor, a use setting of either the frequency resource or the core network resource that is not determined on a basis of information acquired.

[0015]

According to a third aspect of the present disclosure, there is provided a recording medium in which a program is recorded, the program causing a computer to function as: a determination unit that determines one of a use setting of a frequency resource by a wireless communication device, and a use setting of a core network resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and a request unit that requests another device to determine a use setting of either the frequency resource or the core network resource that is not determined on a basis of a determination result of the use setting of the frequency resource or the core network resource by the determination unit, wherein when the determination unit determines the use setting of the core network resource, the request unit transmits to the another device information indicating the determined use setting of the core network resource with information indicating the wireless communication device in association with each other along with information indicating the use setting of the frequency resource recommended, wherein, in a case where a predetermined condition is satisfied, the determining step determines a change of one of the use setting of the frequency resource and the use setting of the core network resource, and the requesting step requests the another device to determine the change of the use setting of the resource that is not determined.

[0016]

Disclosed herein is a recording medium in which a program is recorded, the program causing a computer to function as: an acquisition unit that acquires information indicating a determination result of one of a use setting of a frequency resource by a wireless communication device, and a use setting of a core network resource by a logical network deployed on a physical network to which the wireless communication device connects for providing a wireless communication service by the wireless communication device; and a determination unit that determines a use setting of either the frequency resource or the core network resource that is not determined on a basis of information acquired by the acquisition unit.

[0017]

According to embodiments of the present disclosure, one of the use setting of the frequency resource and the use setting of the network resource for providing the wireless communication service by the wireless communication device is first determined. Then, the use setting of the another resource is determined on the basis of determination result of the one resource. As a result, the use settings of the frequency resource or the network resource are determined on the basis of the determination result of the use setting each other. In this way, it is possible to determine the use settings of the frequency resource and network resource balanced with each other.

EFFECTS OF THE INVENTION

[0018]

As described above, according to embodiments of the present disclosure, there is provided is a mechanism capable of sharing frequency resources and network resources while balancing each other. Note that the effect described above is not necessarily limitative, and any of the effects shown in the present specification or other effects that can be understood from the present specification may be exhibited together with the effect described above, or instead of the effect described above.

BRIEF DESCRIPTION OF DRAWINGS

[0019]

Fig. 1 is a diagram showing an example of a system architecture according to an embodiment of the present disclosure.

Fig. 2 is a diagram showing an example of a system architecture according to the same embodiment.

Fig. 3 is a diagram for explaining balance between frequency resources and core network resources.

Fig. 4 is a block diagram showing an example of a configuration of a frequency resource manager according to the same embodiment.

Fig. 5 is a block diagram showing an example of a configuration of a core network resource manager

according to the same embodiment.

Fig. 6 is a diagram showing an example of a flow of determination processing of a use setting of a frequency resource in a first method performed in the system

5 according to the same embodiment.

Fig. 7 is a diagram showing an example of a flow of resource securing processing in the first method performed in the system according to the same embodiment.

Fig. 8 is a diagram showing an example of a flow of determination processing of a use setting of a core network resource in a second method performed in the system according to the same embodiment.

Fig. 9 is a diagram showing an example of a flow of determination processing of a use setting of a frequency resource in a second method performed in the system according to the same embodiment.

Fig. 10 is a block diagram showing an example of a schematic configuration of a server.

20 MODE FOR CARRYING OUT THE INVENTION

[0020]

Preferred embodiments of the present disclosure will be described in detail below with reference to the accompanying drawings. Note that, in the present specification and the drawings, the same reference numerals are given to the constituent elements having substantially the same functional configuration, and redundant explanations are omitted.

[0021]

30 Furthermore, in this specification and the drawings, constituent elements having substantially the same

functional configuration may be distinguished by attaching different alphabets after the same reference numerals. For example, a plurality of elements having substantially the same functional configuration is distinguished as wireless communication devices 100A, 100B, and 100C as necessary. However, in a case where it is not necessary to particularly distinguish each of a plurality of elements having substantially the same functional configuration, only the same reference numerals are attached. For example, in a case where it is not necessary to particularly distinguish the wireless communication devices 100A, 100B and 100C, each of the wireless communication devices 100A, 100B and 100C is simply referred to a wireless communication device 100.

[0022]

Note that the description will be given in the following order.

1. Introduction
 - 1.1. Frequency Sharing
 - 1.2. Slice
 - 1.3. Architecture
 - 1.4. Technical Issues
2. Configuration Example of Each Device
 - 2.1. Configuration Example of Frequency Resource Manager
 - 2.2. Configuration Example of Core Network Resource Manager
3. Technical Features
 - 3.1. Allocation Procedure of Wireless Communication Device
 - 3.2. Resource Use Setting Procedure

3.2.1. First Method

3.2.2. Second Method

3.3. Update of Use Setting

4. Application Example

5 5. Conclusion

[0023]

<<1. Introduction>>

<1.1. Frequency Sharing>

Since frequency resources are limited, technologies
10 for realizing efficient use of frequency resources are
being studied at various places. For example, in the
citizens broadband radio service (CBRS), which is
legalized for the 3,550 to 3,700 MHz band in the United
States, while three priorities are provided to protect
15 the existing system (incumbent system) to which the
highest priority is given, it is considered to assign a
channel (in other words, frequency band) to each of
wireless networks according to the priority.

[0024]

20 Furthermore, as a proposal for realizing efficient
use of frequency resources, a mechanism for making a
frequency band assigned to a certain wireless network to
be used by another wireless network is being considered.
For example, a mechanism is being considered in which,
25 among frequency channels allocated to a TV broadcast
system, a channel not used by the TV broadcast system
(also referred to as TV white space) is opened to another
system to use according to the area. Such a mechanism is
also referred to as secondary use of frequency. In
30 general, a system to which frequency channels are
preferentially allocated is called a primary system, and

a system that uses the frequency channel secondarily is called a secondary system.

[0025]

<1.2. Slice>

5 There are two features of NR. The first feature is to realize high-speed and large-capacity communication using a frequency band from 6 GHz to 100 GHz. The second feature is to efficiently accommodate a plurality of forms of communication for different use cases. Here,
10 the plurality of forms of communication includes high-speed and large-capacity communication (mobile broadband), low-delay communication (low latency), machine type communication (MTC), device to device (D2D), and the like. In the NR, it is considered to accommodate these
15 plurality of forms of communication in one network.

[0026]

 Although evolved packet core (EPC) is adopted in the LTE as a technology on a core network side connected to the RAN, New Core is being considered as a successor
20 to the EPC. The New Core is required to efficiently accommodate the above-described plurality of forms of communication and to keep CAPEX/OPEX (equipment installation cost, operation cost) low.

[0027]

25 In order to provide multiple forms of communication while keeping CAPEX/OPEX low, it is difficult to physically separate networks for each form of communication. Therefore, physically, operating a plurality of logical networks corresponding to a
30 plurality of forms of communication in a single network, and flexibly changing the capacity of the logical network

according to demand for communication amount for each communication form are being considered.

[0028]

For that, considered is implementing each node (in
5 other words, communication equipment) of the core network
as a virtual machine to virtually execute the operation
of the node according to the target communication form
for each logical network. This is because, for the
functions implemented by virtual machines, the functions
10 can be increased or decreased according to the increase
or decrease of the demand for communication, or to
increase or decrease the computer resources allocated for
each function. The functions implemented by the virtual
machine are connected with other functions and networked
15 by the virtual network technology. As such virtual
network technology, for example, there is a technology
called Open Flow in which a central controller
distributes rules of each switch and the switch operates
according to the rules distributed by the controller.
20 According to the Open Flow, flexible network operation
can be performed by freely switching switches connecting
functions implemented by the virtual machine.

[0029]

As described above, a technology that combines a
25 virtual machine and a virtual network technology such as
the Open Flow to provide logical networks (in other words,
pipes for communication) having different properties is
also referred to as slicing. For example, by combining a
virtual machine and an open flow switch, a core network
30 for low delay communication, a core network for the MTC,
and a core network for the D2D are realized on one

physical network. In other words, logically independent networks capable of providing different communication services are realized on one physical network. The logical network provided in the slicing technology is
5 also referred to as a slice or a network slice. The slicing technology can flexibly provide logical networks with different applications. Moreover, according to the slicing technology, the capacity of each slice can be flexibly changed by increasing or decreasing the
10 calculation resource allocated to the virtual machine or changing the switching.

[0030]

<1.3. Architecture>

The architecture of a system according to an
15 embodiment of the present disclosure will be described below with reference to Fig. 1.

[0031]

Fig. 1 is a diagram showing an example of the architecture of a system 1 according to an embodiment of
20 the present disclosure. As shown in Fig. 1, the system 1 includes a plurality of wireless communication devices 100 (100A to 100C), a core network 200, and a frequency monitor database 500.

[0032]

25 The wireless communication device 100 is a device that provides a wireless communication service to a user. For example, the wireless communication device 100 is a base station, operates a cell, transmits a downlink signal to a user terminal in a cell, and receives an
30 uplink signal. The wireless communication device 100 is operated on the basis of the frequency information

provided from the frequency monitor database 500. The wireless communication device 100 at least includes a control unit that controls wireless parameters such as a frequency to be used and transmission power, and an antenna unit that emits radio waves according to the wireless parameters controlled by the control unit. Note that the wireless communication device 100 may be configured as physically one device, or may be configured to be physically separated like a distributed antenna system (DAS) including a remote radio head (RRH) and a control device. Note that the wireless communication device 100 may also be referred to as infrastructure.

[0033]

The core network 200 is an example of a physical network to which the wireless communication device 100 is connected. For example, the core network 200 has a function of controlling communication between the wireless communication device 100 and a user terminal that enjoys the wireless communication service provided by the wireless communication device 100. Specifically, the core network 200 manages mobility of the user terminal, instructs handover, and relays transmission and reception of user data between the Internet and the user terminal. On the core network 200, one or more slices (in other words, logical networks) may be deployed. The resource of the core network 200 (in other words, network resource) is also referred to below as a core network resource. Specifically, the core network resource includes a computer resource of various devices forming the core network 200, a storage resource, a physical line resource between devices, or the like. The slice

operates using allocated core network resources.

[0034]

As shown in Fig. 1, the core network 200 includes a frequency resource manager 300 and a core network
5 resource manager 400. Each of the frequency resource manager 300 and the core network resource manager 400 may be configured as physically one device or may be deployed on a plurality of devices. Furthermore, the frequency resource manager 300 and the core network resource
10 manager 400 may be implemented logically separately in the same device.

[0035]

The frequency resource manager 300 accesses the frequency monitor database 500 to acquire information of
15 available frequency. Furthermore, the frequency resource manager 300 allocates available frequency to each wireless communication device 100 so that harmful interference is not given mutually among the plurality of wireless communication devices 100. Such frequency
20 utilization adjustment function can be provided by spectrum coordinator (SC) standardized by ETSI EN 303 145 and ETSI EN 303 387. Furthermore, such frequency utilization adjustment function may be provided by IEEE 802.19.1-2014 or IEEE P802.19.1a during standardization
25 work.

[0036]

The core network resource manager 400 controls the core network resource used for the operation of the slice deployed on the core network 200. The control of the
30 resource by the core network resource manager 400 is performed, for example, by increasing or decreasing the

calculation resources allocated to the virtual machine,
or changing the switching.

[0037]

The frequency monitor database 500 is an entity
5 that performs monitoring (management) related to
frequency sharing. The frequency monitor database 500
has a role of providing the wireless communication device
100 with a frequency that does not give harmful
interference and disturbance to the primary system and
10 the maximum transmission power associated with the
frequency in the frequency band in which frequency
sharing is performed, and permitting emission of radio
waves in the frequency band. For example, geolocation
database (GLDB) used in the TV band white space (TVWS)
15 and the spectrum access system (SAS) defined in 47C. F. R
Part 96 of the United States correspond to the frequency
monitor database 500.

[0038]

The example of the architecture of the system 1 has
20 been described above.

[0039]

Here, although only the relationship between the
entities is shown in Fig. 1, the system 1 may be shared
by a plurality of communication carriers. The
25 architecture in that case is described with reference to
Fig. 2.

[0040]

Fig. 2 is a diagram showing an example of the
architecture of the system 1 according to the present
30 embodiment. As shown in Fig. 2, in the system 1, in
addition to the configuration shown in Fig. 1, the core

network 200 includes an infrastructure manager 800, and a plurality of communication carrier devices 600 (600A to 600C) is connected to the core network 200.

[0041]

5 The communication carrier device 600 is a device operated by a communication carrier, accepts an input of various types of information from the communication carrier, and outputs information to the communication carrier. Here, the communication carrier in this
10 specification is an entity that provides wireless communication services. For example, the communication carrier may be a mobile Internet service provider (ISP) or a mobile virtual network operator (MVNO). Note that, in the following description, it is assumed that the
15 wireless communication device 100 and the core network 200 are operated by an entity logically different from the communication carrier. Of course, at the time of implementation, there may be a communication carrier that holds a part or all of the wireless communication device
20 100 or a part or all of the core network 200, or there may be a communication carrier that borrows part of resources from the communication carrier that holds the resources.

[0042]

25 As shown in Fig. 2, the wireless communication device 100 and the core network 200 are sharing targets. The wireless communication device 100 and the core network 200 may be shared by a plurality of carriers. For example, sharing of the core network 200 is realized
30 by providing slices for individual carriers. Furthermore, sharing of the wireless communication device 100 is

realized by allocating the wireless communication device 100 for each carrier. One wireless communication device 100 is typically allocated to one carrier. One wireless communication device 100 may be allocated to a plurality of carriers, in which case, for example, the frequencies used by the wireless communication device 100 may differ between the carriers.

[0043]

The infrastructure manager 800 is an entity that manages sharing of the infrastructure (in other words, the wireless communication device 100) by a plurality of communication carriers. The infrastructure manager 800 can automatically or dynamically allocate and manage. Even in a case where the infrastructure is shared by a plurality of communication carriers, the infrastructure manager 800 may not be provided if it is shared in a static manner. In a case where the infrastructure manager 800 does not exist, the wireless communication device 100 may be allocated to each communication carrier on the basis of an agreement between the communication carriers or between the communication carrier and the infrastructure provider.

[0044]

<1.4. Technical Issues>

Technical issues in a case where the wireless communication device 100 and the core network 200 are shared will be described below with reference to Fig. 3.

[0045]

Fig. 3 is a diagram for explaining balance between frequency resources and core network resources. Fig. 3 shows the amount of frequency resources and the amount of

core network resources used when the communication carrier provides the wireless communication service. In the case A, the core network resources and frequency resources are allocated to the communication carrier in appropriate amounts. In the case B, the amount of core network resources is small, and the frequency resources greatly exceed the appropriate amount. In such a case, congestion may occur in the core network 200 while simultaneous access by multiple wireless communication devices is possible in the wireless section. In the case C and case D, the opposite may occur.

[0046]

In the operation form in which the wireless communication device 100 and the core network 200 are shared, in a case where the frequency resources and the core network resources cannot be balanced as in the cases B to D, utilization efficiency of one or both of the resources may decrease significantly. This may cause unnecessary network operation costs.

[0047]

Thus, in the following, a mechanism capable of sharing frequency resources and core network resources while balancing each other is proposed. According to such a mechanism, unnecessary allocation of resources is reduced, and too little allocation is prevented, so that resource utilization efficiency can be improved.

[0048]

<<2. Configuration Example of Each Device>>

<2.1. Configuration Example of Frequency Resource Manager 300>

Subsequently, an example of a configuration of a

frequency resource manager 300 according to an embodiment of the present disclosure will be described with reference to Fig. 4. Fig. 4 is a block diagram showing an example of a configuration of the frequency resource manager 300 according to an embodiment of the present disclosure. Referring to Fig. 4, the frequency resource manager 300 includes a network communication unit 310, a storage unit 320, and a processing unit 330.

[0049]

10 (1) Network Communication Unit 310

The network communication unit 310 transmits and receives signals. For example, the network communication unit 310 communicates with the wireless communication device 100, the core network resource manager 400, the frequency monitor database 500, the communication carrier device 600, or the infrastructure manager 800.

[0050]

 (2) Storage Unit 320

The storage unit 320 temporarily or permanently stores programs for operation of the frequency resource manager 300 and various pieces of data.

[0051]

 (4) Processing Unit 330

The processing unit 330 provides various functions of the frequency resource manager 300. The processing unit 330 includes an acquisition unit 331, a determination unit 333, and a request unit 335. The acquisition unit 331 has a function of acquiring from the core network resource manager 400 a request for determining the use setting of the frequency resource. The determination unit 333 has a function of determining

the use setting of the frequency resource by the wireless communication device 100 for providing the wireless communication service by the wireless communication device 100. The request unit 335 has a function of
5 requesting the core network resource manager 400 to determine the use setting of the core network resource by the slice for providing the wireless communication service by the wireless communication device 100. Note that the processing unit 330 may further include other
10 components in addition to these components. In other words, the processing unit 330 may also perform operations other than the operations of these components.
[0052]

<2.2. Configuration Example of Core Network 15 Resource Manager 400>

Subsequently, an example of the configuration of the core network resource manager 400 according to an embodiment of the present disclosure will be described with reference to Fig. 5. Fig. 5 is a block diagram
20 showing an example of a configuration of the core network resource manager 400 according to an embodiment of the present disclosure. Referring to Fig. 5, the core network resource manager 400 includes a network communication unit 410, a storage unit 420, and a
25 processing unit 430.
[0053]

(1) Network Communication Unit 410

The network communication unit 410 transmits and receives signals. For example, the network communication
30 unit 410 communicates with the wireless communication device 100, the frequency resource manager 300, the

communication carrier device 600, or the infrastructure manager 800.

[0054]

(2) Storage Unit 420

5 The storage unit 420 temporarily or permanently stores programs for operation of the core network resource manager 400 and various pieces of data.

[0055]

(3) Processing Unit 430

10 The processing unit 430 provides various functions of the core network resource manager 400. The processing unit 430 includes an acquisition unit 431, a determination unit 433, and a request unit 435. The acquisition unit 431 has a function of acquiring from the
15 frequency resource manager 300 a request for determining the use setting of the core network resource. The determination unit 433 has a function of determining the use setting of the core network resource by the slice for providing the wireless communication service by the
20 wireless communication device 100. The request unit 435 has a function of requesting the frequency resource manager 300 to determine the use setting of the frequency resource by the wireless communication device 100 for providing the wireless communication service by the
25 wireless communication device 100. Note that the processing unit 430 may further include other components in addition to these components. In other words, the processing unit 430 may also perform operations other than the operations of these components.

30 [0056]

<<3. Technical Features>>

The sharing of the wireless communication device 100 and the core network 200 by a plurality of communication carriers is realized by an allocation procedure of the wireless communication device 100 and a resource use setting procedure. The resource use setting procedure includes a frequency resource use setting procedure and a use setting procedure of the core network resource, and the order thereof is arbitrary.

[0057]

10 <3.1. Allocation Procedure of Wireless Communication Device>

The communication carrier device 600 receives the allocation of the wireless communication device 100. For example, the infrastructure manager 800 may allocate the wireless communication device 100 to each carrier. Alternatively, the wireless communication device 100 may be allocated to each communication carrier on the basis of an agreement between the communication carriers or between the communication carrier and the infrastructure provider.

20 [0058]

<3.2. Resource Use Setting Procedure>

The system 1 allocates frequency resources and core network resources for providing the wireless communication service by the wireless communication device 100 to each communication carrier.

25 [0059]

Specifically, the frequency resource manager 300 determines the use setting of the frequency resource by the wireless communication device 100 for providing the wireless communication service by the wireless

30

communication device 100. The use setting of the frequency resource is a setting of the frequency resource which can be used by the wireless communication device 100 for providing the wireless communication service.

5 The wireless communication device 100 provides a wireless communication service using a part or all of the available frequency resources.

[0060]

On the other hand, the core network resource
10 manager 400 determines a use setting of a core network resource by a logical network (in other words, a slice) deployed on the core network 200 to which the wireless communication device 100 is connected for providing the wireless communication service by the wireless
15 communication device 100. The use setting of the core network resource is a setting of the core network resource which can be used by the slice in order to provide the wireless communication service by the wireless communication device 100. The slice associated
20 with (in other words, connected to) the wireless communication device 100 uses some or all of the available core network resources to support the provision of the wireless communication service by the wireless communication device 100.

25 [0061]

The frequency resource manager 300 and the core network resource manager 400 can determine the use setting of another resource on the basis of the determination result of one of the frequency resource and
30 the core network resource. Specifically, first, one of the frequency resource manager 300 or the core network

resource manager 400 determines one of the frequency resource and the core network resource, and requests the other to determine the use setting of the resource that is not determined on the basis of the determination
5 result. Then, the other requested determines the use setting of the requested resource.

[0062]

The use setting of any of the frequency resource and the core network resource may be determined first.

10 In the following, each method will be described in detail, considering the method in which the use setting of the frequency resource is determined first as a first method and the method in which the use setting of the core network resource is determined first as a second method.

15 [0063]

<3.2.1. First Method>

The first method is a method in which the use setting of the frequency resource is determined first, and then the use setting of the core network resource is
20 determined.

[0064]

(1) Frequency Resource Use Setting Procedure

The frequency resource manager 300 determines the use setting of the frequency resource by the wireless
25 communication device 100 for providing the wireless communication service by the wireless communication device 100. An example of the flow of this determination processing will be described below with reference to Fig. 6.

30 [0065]

Fig. 6 is a diagram showing an example of a flow of

determination processing of the use setting of the frequency resource in the first method performed in the system 1 according to the present embodiment. As shown in Fig. 6, the frequency resource manager 300, the frequency monitor database 500, and the communication carrier device 600 are involved in this sequence.

[0066]

First, the communication carrier device 600 transmits infrastructure information and license information to the frequency resource manager 300 (step S102). Next, the frequency resource manager 300 inquires the frequency monitor database 500 for information related to the available frequency (step S104). Next, the frequency resource manager 300 identifies information regarding the available frequency on the basis of the inquiry from the frequency resource manager 300 (step S106). Next, the frequency resource manager 300 transmits information related to the identified available frequency to the frequency resource manager 300 (step S108). Next, the frequency resource manager 300 determines the use setting of the frequency resource on the basis of the information related to the available frequency (step S110). Then, the frequency resource manager 300 sets up the wireless communication device 100 on the basis of the determined use setting of the frequency resource (step S112).

[0067]

An example of the flow of determination processing of the use setting of the frequency resource has been described above. The details will be described below.

[0068]

(1.1) Infrastructure Information

When securing the infrastructure (in other words, the wireless communication device 100), the communication carrier device 600 transmits infrastructure information, which is information associated with the secured infrastructure, to the frequency resource manager 300. An example of the information included in the infrastructure information will be described below.

[0069]

10 The infrastructure information may include installation position information which is information indicating the installation position of the wireless communication device 100. For example, the installation position information may include latitude, longitude, altitude, accuracy, indoor/outdoor identifiers or the like.

[0070]

20 The infrastructure information may include type authentication information which is authentication information associated with the wireless communication device 100. For example, the type authentication information may include information such as the federal communications commission (FCC) identification (ID), or the technical standard compliance certification.

25 [0071]

30 The infrastructure information may include device specific information which is information specific to the wireless communication device 100. For example, the device specific information may include a serial number, manufacturer information, or the like.

[0072]

The infrastructure information may include wireless interface information which is information associated with a wireless interface mounted on the wireless communication device 100. For example, the wireless interface information may include a wireless access technology name, a version of a corresponding standard, or the like.

[0073]

The infrastructure information may include corresponding frequency information which is information indicating a frequency to which the wireless communication device 100 corresponds (in other words, usable by the wireless communication device). For example, the corresponding frequency information may be a combination of center frequency and bandwidth. Furthermore, the corresponding frequency information may be a combination of the lower limit frequency and the upper limit frequency. Furthermore, the corresponding frequency information may be a band number or a channel number. Besides, the corresponding frequency information may take any form as long as the information indicates the frequency to which the wireless communication device 100 corresponds.

[0074]

The infrastructure information may include transmission spectrum mask information which is information associated with the spectrum transmitted by the wireless communication device 100. For example, the transmission spectrum mask information may include the maximum equivalent isotropic radiated power (EIRP), an adjacent channel leakage ratio (ACLR), or the like.

[0075]

The infrastructure information may include antenna information which is information associated with an antenna mounted on the wireless communication device 100.

5 For example, antenna information may include antenna gain, tilt angle, beam width, antenna type, directivity pattern, or the like.

[0076]

The infrastructure information may include
10 installer information which is information associated with an installer of the wireless communication device 100. For example, the installer information may include the installer's name, contact information, a unique ID, or the like.

15 [0077]

The infrastructure information may include operator information which is information associated with an operator of the wireless communication device 100. For example, the operator information may include the
20 operator's name, contact information, a unique ID, a call sign, or the like.

[0078]

An example of the information included in the infrastructure information has been described above.

25 Note that the infrastructure information may include, in addition to the information described above, information specified in laws and regulations of each country, and information defined in the wireless interface technical regulations.

30 [0079]

(1.2) License Information

In a case where the communication carrier has a frequency license, the communication carrier device 600 transmits, to the frequency resource manager 300, license information that is information associated with the frequency license that the communication carrier has. The frequency license may be a time-limited secondary license such as priority access license (PAL).

[0080]

(1.3) Inquiry of Information Related to Available Frequency

The frequency resource manager 300 inquires the frequency monitor database 500 for information related to the available frequency. Here, the frequency resource manager 300 makes an inquiry by transmitting the infrastructure information and license information acquired from the communication carrier device 600 to the frequency monitor database 500.

[0081]

(1.4) Identification of Information Related to Available Frequency

The frequency monitor database 500 identifies information related to the available frequency on the basis of an inquiry from the frequency resource manager 300. The information related to the available frequency is information indicating the frequency resources that can be used by the wireless communication device 100. For example, the frequency monitor database 500 is available with the frequency license owned by the communications carrier, and identifies the available frequency at the installation position of the infrastructure.

[0082]

(1.5) Information Related to Available Frequency

The frequency monitor database 500 transmits information related to the available frequency to the frequency resource manager 300. Then, the frequency resource manager 300 acquires information related to the available frequency from the frequency monitor database 500. The information related to the available frequency may include various pieces of information. An example of the information included in the information related to the available frequency will be described below.

[0083]

The information related to the available frequency includes information indicating the available frequency. For example, the available frequency may be specified as a combination of center frequency and bandwidth. Furthermore, the available frequency may be specified as a combination of the lower limit frequency and the upper limit frequency. Furthermore, the available frequency may be specified as a band number or a channel number.

[0084]

The information related to the available frequency may include an identifier indicating an allowable frequency use form. Examples of allowable frequency use form include a use that requires a frequency license (licensed use) and a use that does not require a frequency license (license-exempt).

[0085]

The information related to the available frequency may include information indicating legal regulations applied when using the frequency. For example, the

information indicating applicable laws and regulations may include FCC rule numbers (for example, 47 C. F. R Part 96, and 47 C. F. R Part 15, or the like).

Furthermore, the information indicating applicable laws and regulations may include ETSI European Norm, Harmonized Standard numbers, or the like. Besides, the information indicating the applicable laws and regulations may include any information indicating the laws and regulations applied when using the frequency.

10 [0086]

The information related to the available frequency may include information indicating transmission power that is allowed when using the frequency. For example, the information indicating the allowed transmission power may include information indicating the maximum allowable transmission power at the available frequency, and the maximum allowable EIRP.

[0087]

The information related to the available frequency may include information indicating an antenna setting that is allowed when using the frequency. For example, the information indicating the allowable antenna setting may include information indicating the installation height, the maximum allowable beam width, the tilt angle allowable range, the allowable antenna orientation, or the like.

[0088]

The information related to the available frequency may include information indicating the expiration date of the information related to the available frequency.

30 [0089]

(1.6) Determination of Frequency Resource Use
Setting

The frequency resource manager 300 determines the use setting of the frequency resource by the wireless communication device 100 for providing the wireless communication service by the wireless communication device 100. Specifically, the frequency resource manager 300 selects a wireless parameter to be used in each of the one or more wireless communication devices 100 on the basis of the information related to the available frequency. At that time, it is desirable that radio parameters be selected in consideration of interference to another wireless communication device 100 related to the wireless communication device 100 for which the wireless parameter is to be determined and interference from the another wireless communication device 100, in other words, in consideration of network coexistence. Note that the selection of the wireless parameter may be performed by the communication carrier device 600 or in cooperation with the communication carrier device 600.

[0090]

The radio parameter to be selected may be variously considered. For example, the selected wireless parameter may include frequency, transmission power, EIRP, installation position, antenna setting, and wireless interface information.

[0091]

The frequency resource manager 300 selects the radio parameter allowed by the frequency monitor database 500. For that purpose, the frequency resource manager 300 notifies the frequency monitor database 500 of the

selected radio parameter. Then, the frequency monitor database 500 determines whether or not the wireless parameter is allowable, and notifies the frequency resource manager 300 of the determination result. The frequency resource manager 300 may reselect the radio parameters until allowed.

[0092]

(1.7) Setup of Wireless Communication Device 100

The frequency resource manager 300 sets up the wireless communication device 100 using the wireless parameter allowed by the frequency monitor database 500. In other words, the frequency resource manager 300 performs setting for causing the wireless communication device 100 to use the selected parameter. The frequency resource manager 300 may set up the wireless communication device 100 directly or indirectly via the infrastructure manager 800.

[0093]

When setup of the wireless communication device 100 is completed, the wireless communication device 100 can generally start to emit radio waves. However, even though the wireless communication device 100 is physically connected to the core network 200, it is logically not connected. That is, since the wireless communication device 100 is not associated with the slice (in other words, not connected), provision of wireless communication service is still impossible.

[0094]

Therefore, as described below, the use setting of the core network resource and the setup of the core network 200 are performed.

[0095]

(2) Use Setting Procedure of Core Network Resource

The core network resource manager 400 determines the use setting of the core network resource for providing the wireless communication service by the wireless communication device 100. An example of the flow of this determination processing will be described below with reference to Fig. 7.

[0096]

Fig. 7 is a diagram showing an example of a flow of determination processing of a use setting of a core network resource in the first method performed in the system 1 according to the present embodiment. The frequency resource manager 300, the core network resource manager 400, and the communication carrier device 600 are involved in this sequence.

[0097]

First, the frequency resource manager 300 transmits, to the core network resource manager 400, a request for determining the use setting of the core network resource (step S202). Next, the core network resource manager 400 determines the use setting of the core network resources (step S204). Next, the core network resource manager 400 transmits information indicating whether or not the determination of the use setting of the core network resource is completed (Ack/Nack) to the frequency resource manager 300 (step S206). Next, the core network resource manager 400 sets up the core network 200 on the basis of the determined use setting of the core network resources (step S208). Then, the core network resource manager 400 transmits setup information to the

communication carrier device 600 (step S210).

[0098]

An example of the flow of determination processing of the use setting of the core network resource has been
5 described above. The details will be described below.

[0099]

(2.1) Request for Determination of Use Setting of Core Network Resource

After determining the use setting of the frequency
10 resource, the frequency resource manager 300 requests the core network resource manager 400 to determine the use setting of the core network resource.

[0100]

Specifically, the frequency resource manager 300
15 requests the core network resource determination by transmitting, to the core network resource manager 400, use setting information of the frequency resource indicating the determined use setting of the frequency resource. At this time, the frequency resource manager
20 300 transmits the use setting information of the frequency resource with the service information indicating the wireless communication service provided by the wireless communication device 100 in association with each other. The core network resource manager 400 can
25 determine an appropriate use setting of the core network resource by providing the use setting information of the frequency resource and the service information in association with each other. Specifically, the core network resource manager 400 can determine an amount of
30 resources that is balanced with the frequency resources used by the wireless communication device 100 and is

appropriate for the provided wireless communication service.

[0101]

For example, the use setting information of the
5 frequency resource may include the information related to the available frequency acquired from the frequency monitor database 500 and the information indicating the selected radio parameter.

[0102]

10 For example, the service information may include operator name, service type, and service deployment area information. Note that the operator name may be the ID of the operator. Furthermore, examples of the service type include high speed communication, low speed
15 communication, low delay communication, and public safety. Furthermore, the service deployment area information may include the ID of the infrastructure (in other words, the wireless communication device 100) that is desired to use for the deployment of the service, and geographic region
20 information such as a set of location coordinates or administrative division information.

[0103]

(2.2) Determination of Use Setting of Core Network Resource

25 The core network resource manager 400 acquires information (for example, use setting information of the frequency resources) transmitted from the frequency resource manager 300. Then, the core network resource manager 400 determines the use setting of the core
30 network resource by the slice for providing the wireless communication service by the wireless communication

device 100 on the basis of the acquired information. In other words, the core network resource manager 400 provides the slice to the wireless communication device 100 and the communication carrier at this timing.

5 [0104]

Typically, the core network resource manager 400 determines the amount of core network resources (for example, the amount of computer resources) available for use for providing the wireless communication service by the wireless communication device 100. The criteria for determining the amount of core network resources can be considered in various ways. An example will be described below.

[0105]

15 For example, the core network resource manager 400 may determine the amount of core network resources on the basis of an estimate value of the number of terminals that the wireless communication device 100 can accommodate. In this case, the core network resource manager 400 estimates the number of terminals accommodated in wireless communication device 100 on the basis of the wireless parameters, and provides a slice of the minimum required size for service provision to the estimated number of user terminals. Specifically, the core network resource manager 400 first calculates the coverage size and the number of cells from the frequency, the transmission power, and the antenna setting. Next, the core network resource manager 400 calculates the number of terminals that can be accommodated from the frequency width used by the cell and the frequency resource amount per a terminal required by the service

20
25
30

content that the communication carrier desires to provide (massive IoT, narrow-band IoT, enhanced mobile broadband (eMBB), or the like). Then, the core network resource manager 400 determines the amount of resources to be allocated to the slice to which the wireless communication device 100 is connected on the basis of the calculated number of terminals that can be accommodated. [0106]

For example, in a case where the wireless communication device 100 uses a plurality of frequencies, the core network resource manager 400 may provide, for each frequency, a slice of the minimum required size for providing the wireless communication service. In other words, a slice may be associated with each frequency used by the wireless communication device 100. Then, the core network resource manager 400 may determine the use setting of the core network resource by the slice associated with each of the plurality of frequencies used by the wireless communication device 100. [0107]

For example, in a case where carrier aggregation is used and a plurality of frequencies is bundled and used, the core network resource manager 400 may provide one slice for the plurality of frequencies bundled and used. In other words, a plurality of frequencies used by the wireless communication device 100 may be associated with one slice. Then, the core network resource manager 400 may determine the use setting of the core network resource by one slice associated with the plurality of frequencies used by the wireless communication device 100. [0108]

Note that determination of the use setting of the core network resource may include determination of various settings other than setting of resource amount. For example, the core network resource manager 400 may
5 determine, as one of use settings, a physical machine on which a virtual machine providing a slice operates. For example, the core network resource manager 400 can reduce the delay by operating a virtual machine that provides a slice for the wireless communication device 100 in a
10 physical machine near the wireless communication device 100.

[0109]

(2.3) Setup of Core Network

After determining the use setting of core network
15 resource, the core network resource manager 400 sets up the core network 200 for the communication carrier according to the determination result. At this time, the core network resource manager 400 also performs setup of the core network 200 and the wireless communication
20 device 100. Specifically, the core network resource manager 400 performs allocation and switching of calculation resources according to the determined use setting to control the resources of the slice, and associates (in other words, logically connects) the slice
25 with the wireless communication device 100.

[0110]

(2.4) Setup Information

After completing the setup of the core network 200,
the core network resource manager 400 generates setup
30 information and transmits the setup information to the communication carrier device 600.

[0111]

The setup information is information that associates the wireless communication device 100, the determined use setting of the frequency resource, and the determined use setting of the core network resource. More simply, the setup information is information that associates the wireless communication device 100, the frequency resource, and the slice. The setup information is generated and the communication carrier device 600 is notified so that the communication carrier can cause the wireless communication device 100 to provide a wireless communication service using frequency resources and core network resources. An example of the information included in the setup information will be described below.

15 [0112]

The setup information may include the ID of the wireless communication device 100 associated with the slice.

[0113]

20 The setup information may include use setting information of the core network resource. For example, the use setting information of the core network resource may include the ID of the slice connected to the wireless communication device 100, the resource size available to the slice, and the recommended use.

[0114]

The setup information may include the use setting information of the frequency resource. For example, the use setting information of the frequency resource may include the frequency used by the wireless communication device 100, transmission power, EIRP, installation

30

position, antenna setting, and wireless interface information.

[0115]

By the processing described above, when the setup
5 of the wireless communication device 100 and the core network 200 is completed, the wireless communication device 100 can start emitting a radio wave and start providing a wireless communication service.

[0116]

10 <3.2.2. Second Method>

The second method is a method in which the use setting of the core network resource is determined first, and then the use setting of the frequency resource is determined.

15 [0117]

(1) Use Setting Procedure of Core Network Resource

The core network resource manager 400 determines the use setting of the core network resource for providing the wireless communication service by the
20 wireless communication device 100. An example of the flow of this determination processing will be described below with reference to Fig. 8.

[0118]

Fig. 8 is a diagram showing an example of a flow of
25 determination processing of the use setting of the core network resource in the second method performed in the system 1 according to the present embodiment. As shown in Fig. 8, the core network resource manager 400 and the communication carrier device 600 are involved in this
30 sequence.

[0119]

First, the communication carrier device 600 transmits infrastructure information, license information and service information to the core network resource manager 400 (step S302). Next, the core network resource manager 400 determines the use setting of the core network resource (step S304). Next, the core network resource manager 400 sets up the core network 200 on the basis of the determined use setting of the core network resource (step S306).

10 [0120]

An example of the flow of determination processing of the use setting of the core network resource has been described above. The details will be described below.

[0121]

15 (1.1) Infrastructure Information

When securing the infrastructure (in other words, the wireless communication device 100), the communication carrier device 600 transmits infrastructure information, which is information associated with the secured infrastructure, to the core network resource manager 400. The infrastructure information is as described above, and thus the description thereof will not be repeated.

[0122]

(1.2) License Information

25 In a case where the communication carrier has a frequency license, the communication carrier device 600 transmits, to the core network resource manager 400, license information that is information associated with the frequency license that the communication carrier has. 30 The license information is as described above, and thus the description thereof will not be repeated.

[0123]

(1.3) Service Information

The communication carrier device 600 transmits, to the core network resource manager 400, service
5 information that the communication carrier desires to provide, in other words, the information associated with the wireless communication service provided by the wireless communication device 100. The information included in the service information is as described above,
10 and thus the description thereof will not be repeated.

[0124]

(1.4) Determination of Use Setting of Core Network Resource

The core network resource manager 400 determines
15 the use setting of the core network resource by the slice for providing the wireless communication service by the wireless communication device 100. Specifically, the core network resource manager 400 determines the use setting of the core network resource by the slice
20 connected to the wireless communication device 100 on the basis of the infrastructure information, the license information, and the information regarding the wireless communication service. In other words, the core network resource manager 400 provides the slice to the wireless
25 communication device 100 and the communication carrier at this timing.

[0125]

Typically, the core network resource manager 400 determines the amount of core network resources (for
30 example, the amount of computer resources) available for use for providing the wireless communication service by

the wireless communication device 100. The criteria for determining the amount of core network resources can be considered in various ways. An example will be described below.

5 [0126]

For example, the core network resource manager 400 may determine the amount of core network resources on the basis of an estimate value of the number of terminals that the wireless communication device 100 can
10 accommodate. In this case, the core network resource manager 400 estimates the number of terminals that can be accommodated by the wireless communication device 100 on the basis of the provided wireless communication service and the capabilities of the wireless communication device
15 100 to be used, and provides a network slice of the size required for service provision to the estimated number of terminals. Specifically, the core network resource manager 400 first calculates the coverage size and the number of cells that can be provided from the
20 capabilities of the wireless communication device 100. Next, the core network resource manager 400 calculates the number of terminals that can be accommodated by the wireless communication device 100 from the frequency resource amount required by the terminals in the wireless
25 communication service that the communication carrier desires to provide, and the calculated coverage size and number of cells. Then, the core network resource manager 400 determines the amount of resources to be allocated to the slice to which the wireless communication device 100
30 is connected on the basis of the calculated number of terminals that can be accommodated.

[0127]

For example, in a case where a plurality of wireless communication devices 100 simultaneously provides a wireless communication services to one user terminal, the core network resource manager 400 may determine that the plurality of wireless communication devices 100 accommodates one slice. In other words, a plurality of wireless communication devices 100 may be associated with one slice. Then, the core network resource manager 400 may determine the use setting of the core network resource by one slice associated with a plurality of wireless communication devices 100. Note that dual connectivity and coordinated multi-point (CoMP) are examples of the case where a plurality of wireless communication devices 100 simultaneously provides wireless communication services to one user terminal.

[0128]

(1.5) Core Network Setup

After determining the use setting of core network resource, the core network resource manager 400 sets up the core network 200 for the communication carrier according to the determination result. At this time, the core network resource manager 400 also performs setup of the core network 200 and the wireless communication device 100. Specifically, the core network resource manager 400 performs allocation and switching of calculation resources according to the determined use setting to control the resources of the slice, and associates (in other words, logically connects) the slice with the wireless communication device 100.

[0129]

(2) Frequency Resource Use Setting Procedure

The frequency resource manager 300 determines the use setting of the frequency resource by the wireless communication device 100 for providing the wireless communication service by the wireless communication device 100. An example of the flow of this determination processing will be described below with reference to Fig. 9.

[0130]

Fig. 9 is a diagram showing an example of a flow of determination processing of the use setting of the frequency resource in the second method performed in the system 1 according to the present embodiment. As shown in Fig. 9, the frequency resource manager 300, the core network resource manager 400, and the communication carrier device 600 are involved in this sequence.

[0131]

First, the core network resource manager 400 transmits, to the frequency resource manager 300, a request for determining the use setting of the frequency resource (step S402). Next, the frequency resource manager 300 determines the use setting of the frequency resource (step S404). Next, the frequency resource manager 300 transmits information indicating whether or not the determination of the use setting of the frequency resource is completed (Ack/Nack) to the core network resource manager 400 (step S406). Next, the frequency resource manager 300 sets up the wireless communication device 100 on the basis of the determined use setting of the frequency resource (step S408). Then, the frequency resource manager 300 transmits setup information to the

communication carrier device 600 (step S410).

[0132]

An example of the flow of determination processing of the use setting of the frequency resource has been
5 described above. The details will be described below.

[0133]

(2.1) Determination Request of Frequency Resource Use Setting

After determining the use setting of the core
10 network resource, the core network resource manager 400 requests the frequency resource manager 300 to determine the use setting of the frequency resource.

[0134]

Specifically, the core network resource manager 400
15 requests the determination of the frequency resource by transmitting, to the frequency resource manager 300, the use setting information of the core network resource indicating the determined use setting of the core network resource. At this time, the core network resource
20 manager 400 transmits the use setting information of the core network resource with the information indicating the wireless communication device 100 in association with each other. The frequency resource manager 300 can determine an appropriate use setting of the frequency
25 resource by providing the use setting information of the core network resource and the information indicating the wireless communication device 100 in association with each other. Specifically, the frequency resource manager 300 can determine an amount of resources that is balanced
30 with the core network resources used by the slice connected to the wireless communication device 100, and

is appropriate for the wireless communication service provided by the wireless communication device 100.

[0135]

For example, the use setting information of the
5 core network resource may include the ID of the slice,
the resource size available to the slice, and the
recommended use.

[0136]

For example, the information indicating the
10 wireless communication device 100 may include the ID of
the wireless communication device 100 and information
indicating the installation position.

[0137]

Moreover, the core network resource manager 400 may
15 transmit information indicating the recommended frequency
resource use setting to the frequency resource manager
300 when requesting the determination of the frequency
resource. For example, the information indicating the
use setting of the recommended frequency resource is
20 included in the information indicating the wireless
communication device 100 to be transmitted in association
with the use setting information of the core network
resource. This enables the frequency resource manager
300 to determine the use setting of the frequency
25 resource with reference to the recommended use setting.
The information indicating the use setting of the
recommended frequency resource may include, for example,
information indicating a recommended frequency bandwidth,
a recommended frequency, and a recommended transmission
30 power.

[0138]

(2.2) Determination of Frequency Resource Use
Setting

The frequency resource manager 300 acquires information (for example, use setting information of the core network resource) transmitted by the core network resource manager 400. Then, the frequency resource manager 300 determines the use setting of the frequency resource by the wireless communication device 100 for providing the wireless communication service by the wireless communication device 100 on the basis of the acquired information.

[0139]

Typically, the frequency resource manager 300 determines the amount of frequency resources (for example, the frequency bandwidth) available for use for providing the wireless communication service by the wireless communication device 100. Of course, the frequency resource manager 300 may also determine other radio parameters such as frequency and transmission power.

[0140]

A method similar to the first method is adopted as the method for determining the use setting of frequency resource. Specifically, the frequency resource manager 300 acquires infrastructure information and license information from the communication carrier device 600 or the core network resource manager 400. Next, the frequency resource manager 300 makes an inquiry to the frequency monitor database 500 to acquire information related to available frequency. Then, the frequency resource manager 300 selects a wireless parameter to be used in each of the one or more wireless communication

devices 100 on the basis of the information related to the available frequency.

[0141]

In particular, in the second method, the frequency resource manager 300 determines the use setting of the frequency resource on the basis of the information acquired from the core network resource manager 400 in addition to the information related to the available frequency. For example, the frequency resource manager 300 may calculate an estimated value of the number of terminals that can be accommodated by the slice on the basis of the use setting of the core network resource, and determine the amount of frequency resources on the basis of the estimated value. Specifically, first, the frequency resource manager 300 estimates the number of terminals that can be accommodated by the slice on the basis of the wireless communication service that the communication carrier desires to provide and the amount of core network resources used by the slice associated with the wireless communication device 100. Subsequently, the frequency resource manager 300 determines the frequency resource of the minimum required size to provide the size required to provide the service for the estimated number of terminals.

[0142]

(2.3) Setup of Wireless Communication Device 100

The frequency resource manager 300 sets up the wireless communication device 100 using the selected wireless parameter. The setup of the wireless communication device 100 is as described above in the first method.

[0143]

(2.4) Setup Information

After completing the setup of the frequency resource, the frequency resource manager 300 generates
5 setup information and transmits the setup information to the communication carrier device 600. The setup information is as described above in the first method.

[0144]

By the processing described above, when the setup
10 of the wireless communication device 100 and the core network 200 is completed, the wireless communication device 100 can start emitting a radio wave and start providing a wireless communication service.

[0145]

15 <3.3. Update of Use Setting>

One of the frequency resource manager 300 or the core network resource manager 400 determines the change of one of the use setting of the frequency resource or the use setting of the core network resource in a case
20 where a predetermined condition is satisfied, and requests the other to determine the change of the use setting of the resource that is not determined.

[0146]

- In a case where a change of the use setting of
25 the frequency resource is the starting point

For example, in a case where the predetermined condition is satisfied, the frequency resource manager 300 determines again the use setting of the frequency resource for providing the wireless communication service
30 by the wireless communication device 100. Then, the frequency resource manager 300 transmits, to the core

network resource manager 400, a request for determining the use setting of the core network resource on the basis of the determination result again. As a result, the core network resource manager 400 determines again the use
5 setting of the core network resource for providing the wireless communication service by the wireless communication device 100. The specific processing is similar to the first method described above.

[0147]

10 The predetermined condition includes, for example, that the frequency resource used so far has become unavailable for use by the primary system. Furthermore, the predetermined condition includes, for example, that there is a request from another communication carrier.
15 Even in a case where such a change in situation occurs, the system 1 can again determine the appropriate amount of frequency resources and core network resources that are balanced with each other.

[0148]

20 - In a case where a change of the use setting of the core network resource is the starting point

For example, in a case where a predetermined condition is satisfied, the core network resource manager 400 again determines the use setting of the core network
25 resource for providing the wireless communication service by the wireless communication device 100. Then, the core network resource manager 400 transmits, to the frequency resource manager 300, a request for determining the use setting of the frequency resource on the basis of the
30 determination result again. As a result, the frequency resource manager 300 determines again the use setting of

the frequency resource for providing the wireless communication service by the wireless communication device 100. The specific processing is similar to the second method described above.

5 [0149]

The predetermined condition includes, for example, that the core network 200 has undergone maintenance. Furthermore, the predetermined condition includes, for example, that there is a request from another communication carrier. Even in a case where such a change in situation occurs, the system 1 can again determine the appropriate amount of frequency resources and core network resources that are balanced with each other.

15 [0150]

<<4. Application Example>>

The technology according to the present disclosure can be applied to various products. For example, the frequency resource manager 300 and the frequency resource manager 300 may be realized as any type of server, such as a tower server, a rack server, or a blade server. Furthermore, the frequency resource manager 300 and the core network resource manager 400 may be control modules mounted on a server (for example, an integrated circuit module configured with one die, or a card or blade inserted in a slot of a blade server).

25 [0151]

Fig. 10 is a block diagram showing an example of a schematic configuration of the server 700 to which the technology according to the present disclosure may be applied. The server 700 includes a processor 701, a

30

memory 702, a storage 703, a network interface 704, and a bus 706.

[0152]

The processor 701 may be, for example, a central
5 processing unit (CPU) or a digital signal processor (DSP),
and controls various functions of the server 700. The
memory 702 includes a random access memory (RAM) and a
read only memory (ROM), and stores programs and data to
be executed by the processor 701. The storage 703 may
10 include a storage medium such as a semiconductor memory
or a hard disk.

[0153]

The network interface 704 is a wired communication
interface for connecting the server 700 to the wired
15 communication network 705. The wired communication
network 705 may be a core network such as evolved packet
core (EPC), or may be a packet data network (PDN) such as
the Internet.

[0154]

20 The bus 706 connects the processor 701, the memory
702, the storage 703, and the network interface 704 to
one another. The bus 706 may include two or more buses
of different speeds (for example, a high speed bus and a
low speed bus).

25 [0155]

In the server 700 shown in Fig. 10, one or more
components (the acquisition unit 331, the determination
unit 333, and/or the request unit 335) included in the
frequency resource manager 300 described above with
30 reference to Fig. 4, or one or more components (the
acquisition unit 431, the determination unit 433 and/or

the request unit 435) included in the core network resource manager 400 described above with reference to Fig. 5 may be implemented in the processor 701. As an example, a program for causing the processor to function
5 as the one or more components (in other words, a program for causing the processor to execute the operation of the one or more components) may be installed in the server 700, and the processor 701 may execute the program. As another example, the server 700 may include a module
10 including the processor 701 and the memory 702, and one or more components may be implemented in the module. In this case, the module may store a program for causing the processor to function as the one or more components in the memory 702, and execute the program by the processor
15 701. As described above, the server 700 or the module may be provided as a device including the one or more components, and a program for causing the processor to function as the one or more components may be provided. Furthermore, the readable recording medium in which the
20 program described above is recorded may be provided.
[0156]

Furthermore, in the server 700 shown in Fig. 10, for example, the network communication unit 310 described with reference to Fig. 4 or the network communication
25 unit 410 described next with reference to Fig. 5 may be implemented in the network interface 704. Furthermore, the storage unit 320 or the storage unit 420 may be implemented in the memory 702 and/or the storage 703.
[0157]

30 <<5. Conclusion>>

An embodiment of the present disclosure has been

described above in detail with reference to Figs. 1 to 10. As described above, one of the frequency resource manager 300 or the core network resource manager 400 according to the present embodiment determines one of the use setting
5 of the frequency resource by the wireless communication device 100, and the use setting of the network resource by the logical network deployed on the physical network to which the wireless communication device 100 is connected, for providing the wireless communication
10 service by the wireless communication device 100. Then, one of the frequency resource manager 300 or the core network resource manager 400 that has made determination above requests the other to determine the use setting of resources of which the determination is not made on the
15 basis of the determination result. Then, the other requested determines the use setting of the resource that has not been determined on the basis of the request. As a result, the use setting of the frequency resource or the core network resource is determined on the basis of
20 the determination result of the other use setting, and the use setting can be determined so that the frequency resource and the core network resource are balanced with each other. Accordingly, unnecessary allocation of resources is reduced, and too little allocation is
25 prevented, and resource utilization efficiency can be improved.

[0158]

While preferred embodiments of the present disclosure have been described above in detail with
30 reference to the accompanying drawings, the technical scope of the present disclosure is not limited to such

examples. It is obvious that various variations and modifications can be conceived within the scope of the technical idea described in the claims by a person having ordinary knowledge in the field of technology to which
5 the present disclosure belongs, and, of course, it is understood that these variations and modifications belong to the technical scope of present disclosure.

[0159]

Furthermore, the processing described using the
10 flowchart and the sequence diagram in the present specification may not necessarily be performed in the illustrated order. Some processing steps may be performed in parallel. Furthermore, additional processing steps may be employed and some processing
15 steps may be omitted.

[0160]

Furthermore, the effects described in the present specification are merely illustrative or exemplary, and are not limitative. That is, the technique according to
20 the present disclosure can exhibit other effects obvious to those skilled in the art from the description of the present specification together with the effects described above or instead of the effects described above.

[0161]

25 Note that the following configuration is also within the technical scope of the present disclosure.

(1)

A device including:

a determination unit that determines one of a use
30 setting of a frequency resource by a wireless communication device, and a use setting of a network

resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and

5 a request unit that requests another device to determine a use setting of a resource that is not determined on the basis of a determination result by the determination unit.

(2)

10 The device according to (1) described above, in which the determination unit determines the use setting of the frequency resource, and the request unit transmits information indicating the use setting of the frequency resource determined to
15 the another device.

(3)

 The device according to (2) described above, in which the request unit transmits the information indicating the use setting of the frequency resource
20 determined and information indicating the wireless communication service provided in association with each other to the another device.

(4)

 The device according to (2) or (3) described above,
25 in which the determination unit acquires information indicating the frequency resource that can be used by the wireless communication device from a frequency monitor database.

(5)

30 The device according to (1) described above, in which the determination unit determines the use

setting of the network resource, and

the request unit transmits information indicating the use setting of the network resource determined to the another device.

5 (6)

The device according to (5) described above, in which the request unit transmits the information indicating the use setting of the network resource determined and the information indicating the wireless
10 communication device in association with each other to the another device.

(7)

The device according to (6) described above, in which the request unit transmits, to the another device,
15 information indicating the use setting of the frequency resource recommended.

(8)

The device according to any of (1) to (7) described above,
20 in which the determination unit determines, in a case where a predetermined condition is satisfied, a change of one of the use setting of the frequency resource and the use setting of the network resource, and

the request unit requests the another device to
25 determine the change of the use setting of the resource of which change is not determined.

(9) A device including:

an acquisition unit that acquires information indicating a determination result of one of a use setting
30 of a frequency resource by a wireless communication device, and a use setting of a network resource by a

logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and

5 a determination unit that determines a use setting of a resource that is not determined on the basis of information acquired by the acquisition unit.

(10)

10 The device according to (9) described above, in which the determination unit determines an amount of resources that can be used for providing a wireless communication service by the wireless communication device.

(11)

15 The device according to (9) or (10) described above, in which the determination unit determines on the basis of an estimated value of a number of terminals that can be accommodated by the wireless communication device or the logical network.

20 (12)

 The device according to any one of (9) to (11) described above, in which the logical network is associated with each frequency used by the wireless communication device.

25 (13)

 The device according to any one of (9) to (11) described above, in which a plurality of frequencies used by the wireless communication device is associated with one of the logical networks.

30 (14)

 The device according to any one of (9) to (11)

described above, in which a plurality of the wireless communication devices is associated with one of the logical network.

(15)

5 The device according to any one of (9) to (14) described above, in which the determination unit generates information in which the wireless communication device, the use setting of the frequency resource determined, and the use setting of the network resource
10 determined are associated.

(16)

A method including:

 determining, by a processor, one of a use setting of a frequency resource by a wireless communication
15 device, and a use setting of a network resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and

20 requesting another device to determine a use setting of a resource that is not determined on the basis of a determination result.

(17)

A method including:

25 acquiring information indicating a determination result of one of a use setting of a frequency resource by a wireless communication device, and a use setting of a network resource by a logical network deployed on a physical network to which the wireless communication
30 device connects, for providing a wireless communication service by the wireless communication device; and

determining, by a processor, a use setting of a resource that is not determined on the basis of information acquired.

(18)

5 A recording medium in which a program is recorded, the program causing a computer to function as:

a determination unit that determines one of a use setting of a frequency resources by a wireless communication device, and a use setting of a network
10 resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and

a request unit that requests another device to
15 determine a use setting of a resource that is not determined on the basis of a determination result by the determination unit.

(19)

A recording medium in which a program is recorded,
20 the program causing a computer to function as:

an acquisition unit that acquires information indicating a determination result of one of a use setting of a frequency resource by a wireless communication device, and a use setting of a network resource by a
25 logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and

a determination unit that determines a use setting
30 of a resource that is not determined on the basis of information acquired by the acquisition unit.

REFERENCE SIGNS LIST

[0162]

	1	System
5	100	Wireless Communication Device
	200	Core Network
	300	Frequency Resource Manager
	310	Network Communication Unit
	320	Storage Unit
10	330	Processing Unit
	331	Acquisition Unit
	333	Determination Unit
	335	Request Unit
	400	Core Network Resource Manager
15	410	Network Communication Unit
	420	Storage Unit
	430	Processing Unit
	431	Acquisition Unit
	433	Determination Unit
20	435	Request Unit
	500	Frequency Monitor Database
	600	Communication Carrier Device
	800	Infrastructure Manager

CLAIMS

1. A device comprising:

a determination unit that determines one of a use setting of a frequency resource by a wireless communication device, and a use setting of a core network resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and

a request unit that requests another device to determine a use setting of either the frequency resource or the core network resource that is not determined on a basis of a determination result of the use setting of the frequency resource or the core network resource by the determination unit,

wherein when the determination unit determines the use setting of the core network resource, the request unit transmits to the another device information indicating the determined use setting of the core network resource with information indicating the wireless communication device in association with each other along with information indicating the use setting of the frequency resource recommended, and

wherein, in a case where a predetermined condition is satisfied, the determination unit determines a change of one of the use setting of the frequency resource and the use setting of the core network resource, and the request unit requests the another device to determine the change of the use setting of the resource that is not determined.

2. The device according to claim 1,

wherein when the determination unit determines the use setting of the frequency resource, the request unit transmits information indicating the use setting of the frequency resource determined to the another device.

3. The device according to claim 2, wherein the request unit transmits the information indicating the use setting of the frequency resource determined and information indicating the wireless communication service provided in association with each other to the another device.

4. The device according to claim 2, wherein the determination unit acquires information indicating the frequency resource that can be used by the wireless communication device from a frequency monitor database.

5. A method comprising:

determining, by a processor, one of a use setting of a frequency resource by a wireless communication device, and a use setting of a core network resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and

requesting another device to determine a use setting of either the frequency resource or the core network resource that is not determined on a basis of a determination result of the use setting of the frequency resource or the core network resource by the determining step, the request step

transmitting to the another device information indicating the determined use setting of the core network resource with information indicating the wireless communication device in association with each other along with information indicating the use setting of the frequency resource recommended,

wherein, in a case where a predetermined condition is satisfied, the determining step determines a change of one of the use setting of the frequency resource and the use setting of the core network resource, and the requesting step requests the another device to determine the change of the use setting of the resource that is not determined.

6. A recording medium in which a program is recorded, the program causing a computer to function as:

a determination unit that determines one of a use setting of a frequency resource by a wireless communication device, and a use setting of a core network resource by a logical network deployed on a physical network to which the wireless communication device connects, for providing a wireless communication service by the wireless communication device; and

a request unit that requests another device to determine a use setting of either the frequency resource or the core network resource that is not determined on a basis of a determination result of the use setting of the frequency resource or the core network resource by the determination unit,

wherein when the determination unit determines the use setting of the core network resource, the request unit transmits to the another device information indicating the

determined use setting of the core network resource with information indicating the wireless communication device in association with each other along with information indicating the use setting of the frequency resource recommended,

wherein, in a case where a predetermined condition is satisfied, the determination unit determines a change of one of the use setting of the frequency resource and the use setting of the core network resource, and the request unit requests the another device to determine the change of the use setting of the resource that is not determined.