United States Patent	12389222
Kind Code	B2
Date of Patent	August 12, 2025
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Communication apparatus, method of sharing, and program

Abstract

A communication apparatus includes a first notification unit, a second notification unit, a reception unit, and a sharing unit. The first notification unit provides first information containing information unique to the communication apparatus and information on a predetermined channel for use in sharing a communication parameter for wireless communication with a different communication apparatus. The second notification unit provides second information containing the information unique to the communication apparatus but not containing information on the predetermined channel. When the first information is provided, the reception unit waits to receive a predetermined signal containing information corresponding to the information unique to the communication apparatus without shifting to another channel. When the second information is provided, the reception unit waits to receive the predetermined signal using a plurality of channels. When the predetermined signal is provided, the sharing unit shares the communication parameter with the different communication apparatus.

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Appl. No.: **18/504074**

Filed: **November 07, 2023**

Prior Publication Data

Document Identifier	Publication Date
US 20240073688 A1	Feb. 29, 2024

Foreign Application Priority Data

JP	2015-144397	Jul. 21, 2015

Related U.S. Application Data

continuation parent-doc US 18046769 20221014 US 11843945 child-doc US 18504074
continuation parent-doc US 16216190 20181211 US 11503466 20221115 child-doc US 18046769
continuation parent-doc US 15210706 20160714 US 10178551 20190108 child-doc US 16216190

Publication Classification

Int. Cl.: **H04W12/06** (20210101); **H04W4/80** (20180101); **H04W12/50** (20210101); **H04W16/18** (20090101); **H04W72/02** (20090101); H04W8/00 (20090101); H04W12/77 (20210101); H04W84/12 (20090101); H04W84/18 (20090101)

U.S. Cl.:

CPC **H04W12/06** (20130101); **H04W4/80** (20180201); **H04W12/50** (20210101); **H04W16/18** (20130101); **H04W72/02** (20130101); H04W8/005 (20130101); H04W12/77 (20210101); H04W84/12 (20130101); H04W84/18 (20130101)

Field of Classification Search

CPC: H04W (12/06); H04W (12/50); H04W (72/02); H04W (4/80); H04W (16/18); H04W (12/77); H04W (84/18); H04W (8/005); H04W (84/12)

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) This application is a Continuation of U.S. application Ser. No. 18/046,769, filed Oct. 14, 2022; which is a Continuation of U.S. application Ser. No. 16/216,190, filed Dec. 11, 2018; now U.S. patent Ser. No. 11/503,466, issued Nov. 15, 2022; which is a Continuation of U.S. patent application Ser. No. 15/210,706, filed on Jul. 14, 2016, now U.S. patent Ser. No. 10/178,551, issued Jan. 8, 2019; which claims priority from Japanese Patent Application No. 2015-144397, filed Jul. 21, 2015, which is hereby incorporated by reference herein in its entirety.

BACKGROUND

Field

(1) Aspects of the present invention generally relate to a technique for sharing communication parameters.

Description of the Related Art

(2) In order for a communication apparatus to communicate with an access point by radio, the communication apparatus needs to set various communication parameters, such as an encryption method, an encryption key, an authentication method, and an authentication key. An example of a technique for setting such communication parameters is disclosed in U.S. Patent Application Publication No. 2006/0208088. In the technique disclosed in U.S. Patent Application Publication No. 2006/0208088, the access point displays a two-dimensional code containing information on the communication parameters. A communication apparatus captures an image of the two-dimensional code displayed on the access point and decodes the two-dimensional code to set the communication parameters.

(3) However, if the two-dimensional code containing information on communication parameters is displayed, as in U.S. Patent Application Publication No. 2006/0208088, the communication parameters could be acquired by an unintended apparatus. A conceivable method for preventing this from occurring would be for the communication apparatus to display, not a QR Code® containing information on the communication parameters, but information on an encryption key that encrypts the communication parameters in the QR Code®, while a different apparatus that has acquired the encryption key encrypts the communication parameters using the encryption key and provides the communication parameters to the communication apparatus by wireless communication.

(4) In this case, in order that the different communication apparatus can provide the communication parameters to the communication apparatus by wireless communication, the communication apparatus and the different apparatus need to communicate with each other over the same channel. The communication apparatus therefore needs to search for a channel that the different apparatus uses.

(5) This results in a significant time delay to share the communication parameters.

SUMMARY

(6) According to an aspect of the present invention, a communication apparatus includes a first notification unit, a second notification unit, a reception unit, and a sharing unit. The first notification unit is configured to provide a notification of first information containing information unique to the communication apparatus and information on a predetermined channel for use in sharing a communication parameter for wireless communication with a different communication apparatus. The second notification unit is configured to provide a notification of second information containing the information unique to the communication apparatus but not containing information on the predetermined channel. The reception unit is configured to, when the first information is provided, wait to receive a predetermined signal containing information corresponding to the information unique to the communication apparatus without shifting from the predetermined channel to another channel and configured to, when the second information is provided, wait to receive the predetermined signal from the different communication apparatus

using a plurality of channels. The sharing unit is configured to, when the reception unit receives the predetermined signal from the different communication apparatus, perform a process for sharing the communication parameter with the different communication apparatus.
(7) Further features of aspects of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a diagram illustrating the hardware configuration of a communication apparatus according to an embodiment of the present invention.
(2) FIG. **2** is a diagram illustrating the software functional block of a communication apparatus according to an embodiment of the present invention.
(3) FIG. **3** is a diagram illustrating a communication system according to an embodiment of the present invention.
(4) FIG. **4** is a flowchart illustrating the operation executed by a communication apparatus according to an embodiment of the present invention.
(5) FIG. **5** is a flowchart illustrating a sequence for connecting communication apparatuses according to an embodiment of the present invention.
(6) FIG. **6** is a flowchart illustrating a sequence for connecting communication apparatuses according to an embodiment of the present invention.
DESCRIPTION OF THE EMBODIMENTS
(7) A communication apparatus according to an embodiment of the present invention will be described hereinbelow with reference to the drawings. The following is an example in which a wireless LAN system based on the Institute of Electrical and Electronics Engineers, Inc. (IEEE) 802.11 series is used. This is provided for mere illustration purposes, and aspects of the present invention are applicable to a communication apparatus based on other wireless communication methods, such as Bluetooth® and ZigBee. Aspects of the present invention are also applicable to a communication apparatus based on a wired communication method, such as wired LAN.
(8) FIG. **3** illustrates a communication system according to this embodiment. The communication system illustrated in FIG. **3** includes communication apparatuses, such as a first camera **32**, a smartphone **33**, an access point (hereinafter referred to as “AP”) **34**, and a second camera **35**. A wireless network **31** is a wireless network that the AP **34** forms.
(9) Other examples of the communication apparatus includes, in addition to cameras and smartphones, various image capturing apparatuses, such as a video camera, and image input apparatuses, such as a scanner. Still other examples include image output apparatuses, such as a printer, a copying machine, and a projector. Still other examples include storage devices, such as a hard disk and a memory, and various information processing apparatuses, such as a personal computer (PC) and a mobile phone.
(10) In this embodiment, the AP **34** operates as an access point in an infrastructure mode defined by the IEEE 802.11 standard. In other words, the AP **34** operates as a base station that establishes a wireless network and transmits a beacon at predetermined regular intervals. The AP **34** can be a Group Owner (GO) having a function corresponding to an AP in Wi-Fi Direct® defined by Wi-Fi Alliance®. The GO also establishes a wireless network, as the AP does, and operates as a base station that transmits a beacon.
(11) The other communication apparatuses operate as stations (STAs) in the infrastructure mode defined by the IEEE 802.11 standard. The first camera **32**, the smartphone **33**, and the second camera **35** join the wireless network **31** that the AP **34** forms to wirelessly communicate with one another via the AP **34**.

(12) Referring next to FIG. **1**, the hardware configuration of each communication apparatus of the communication system shown in FIG. **3** will be described. FIG. **1** illustrates the whole of a communication apparatus **101**. A control unit **102** is used to control the whole of the communication apparatus **101** by implementing a control program stored in a storage unit **103**. Examples of the control unit **102** include a CPU and a microprocessor unit (MPU), which control the whole of the communication apparatus **101** by implementing the program stored in the storage unit **103**. The entire communication apparatus **101** can be controlled in cooperation with an operating system (OS) that the control unit **102** runs.
(13) The storage unit **103** stores the control program that control unit **102** executes, image data, and various pieces of information, such as communication parameters. The various operations described later are performed by the control unit **102** executing the control program stored in the storage unit **103**. Examples of the storage unit **103** include a read-only memory (ROM), a random-access memory (RAM), a hard disk drive (HDD), a flash memory, and a detachable SD card.
(14) A wireless unit **104** is used to perform wireless LAN communication based on the IEEE 802.11 series. The wireless unit **104** is formed of a wireless communication chip. A display unit **105** gives various displays and is capable of outputting visually recognizable information, like a liquid crystal display (LCD) and a light-emitting diode (LED), and outputting audio, like a speaker. The display unit **105** is capable of outputting at least one of visual information and audio information. For visual information, the display unit **105** includes a video RAM (VRAM) that holds image data corresponding to the visual information to be displayed. The display unit **105** performs such display control as to continuously display image data stored in the VRAM on a LCD or an LED.
(15) An image capturing unit **106** includes an image sensor and a lens and captures still images or moving images. The image capturing unit **106** captures an image of a QR Code®, for example. Although this embodiment shows an example in which a QR Code® is used. In some embodiments, another barcode, such as a two-dimensional code, is used.
(16) An antenna control unit **107** is used to control the output of an antenna **108**. The antenna **108** is capable of communication in 2.4 GHz band and 5 GHz band for wireless LAN communication. An input unit **109** is used for the user to do various inputs to operate the communication apparatus **101**. The input unit **109** stores information corresponding to the inputs in a memory, such as the storage unit **103**.
(17) FIG. **1** illustrates a mere example, and the communication apparatus **101** can have another hardware configuration. If the communication apparatus **101** is a printer, the communication apparatus **101** can include a printing unit in addition to the configuration shown in FIG. **1**. If the communication apparatus **101** is the AP **34**, the image capturing unit **106** is not needed.
(18) FIG. **2** illustrates a software functional block **201** implemented by the control unit **102** of the communication apparatus **101** reading a program stored in the storage unit **103**. At least part of the software functional block **201** illustrated in FIG. **2** can be implemented by hardware. With the hardware, a predetermined compiler is used to generate a dedicated circuit on a field programmable gate array (FPGA) from a program for implementing each function. The generated dedicated circuit can be used as a hardware module having the function of the software module. A gate array circuit can be formed, as the FPGA is, and can be implemented as hardware.
(19) A communication-parameter control unit **202** performs a communication-parameter sharing process for sharing communication parameters among the communication apparatuses **101**. In the communication-parameter sharing process, a providing apparatus provides communication parameters for wireless communication to a receiving apparatus. Examples of the communication parameters include wireless communication parameters necessary for wireless communication, such as a service set identifier (SSID), which is a network identifier, an encryption method, an encryption key, an authentication method, and an authentication key. Another example is a media access control (MAC) address, which is identification information unique to the communication

apparatus. Still other examples are a passphrase, an IP address for communication in an internet protocol (IP) layer, and information necessary for higher-level service. The communication-parameter control unit **202** communicates communication parameters encrypted using an encryption key, which is shared in advance using a public key, to share the communication parameters among the communication apparatuses **101**. This is provided for mere illustration purposes, and the communication-parameter control unit **202** can share the communication parameters by performing communication according to a procedure based on Wi-Fi® protected setup (WPS) defined by Wi-Fi Alliance® or Wi-Fi Direct®.

(20) A barcode reading unit **203** is used to analyze an image of a barcode, a two-dimensional code, or a QR Code® captured by the image capturing unit **106** to acquire coded information.

(21) A barcode-generation control unit **204** is used for control for generating a barcode, a two-dimensional code, or a QR Code® and for displaying the generated barcode, two-dimensional code, or QR Code® on the display unit **105**. A service control unit **205** is in an application layer. The application layer here refers to a service providing layer in an upper layer equal to or higher than the fifth layer in an open systems interconnection (OSI) reference model. In other words, the service control unit **205** executes a printing process, an image streaming process, a file transferring process, and so on by wireless communication using the wireless unit **104**.

(22) A packet receiving unit **206** and a packet transmitting unit **207** respectively control reception and transmission of all packets including a communication protocol in an upper layer. The packet receiving unit **206** and the packet transmitting unit **207** control the wireless unit **104** to receive and transmit packets from/to a different apparatus on the basis of the IEEE 802.11 standard.

(23) A station (STA)-function control unit **208** provides a STA function that operates as a station (STA) in the infrastructure mode defined by the IEEE 802.11 standard. The STA-function control unit **208** executes authentication and encryption processing and so on when operating as a STA. An access point (AP)-function control unit **209** provides an AP function that operates as an access point (AP) in the infrastructure mode defined by the IEEE 802.11 standard. The AP-point control unit **209** forms a wireless network and performs authentication and encryption processing on the STA and manages the STA. A data storage unit **210** controls writing and reading of software, communication parameters, and information, such as a barcode, in and from the storage unit **103**.

(24) The above functional block is provided for mere illustration purposes, and a plurality of functional blocks can constitute a single functional block, or one of the functional blocks can be divided into blocks for a plurality of functions. If the communication apparatus **101** is the AP **34**, the STA-function control unit **208** is not needed. If the communication apparatus **101** is the first camera **32**, the second camera **35**, or the smartphone **33**, which is operated as a STA, the AP-point control unit **209** is not needed.

(25) The operation of the communication system with the above configuration will be described. First, to set the wireless network **31**, setting of the AP **34** is performed using the smartphone **33**. Then, a setting process for allowing the first camera **32** and the second camera **35** to join the network of the AP **34** is performed using the smartphone **33**.

(26) FIG. **5** illustrates a sequence for connecting the smartphone **33** and the AP **34** during setting processing. In FIG. **5**, the smartphone **33** provides information for establishing the wireless network **31** to the AP **34**.

(27) The AP **34** displays a QR Code® containing information necessary for setting communication parameters on the display unit **105** of the AP **34** according to a user operation. When the AP **34** is instructed by the user to set communication parameters, the AP **34** displays a QR Code® containing information necessary for setting the communication parameters on the display unit **105** (F**501**).

(28) The information necessary for setting communication parameters is identification information unique to the AP **34**. The identification information is a public key or a certificate for use in encryption to share the communication parameters. The identification information can be a MAC

address or a universally unique identifier (UUID) that uniquely identifies a network device. The information necessary for setting the communication parameters can include an identifier indicating that the apparatus is a receiving apparatus that receives the communication parameters. The information necessary for setting the communication parameters can include identification information, such as a one type password using a QR Code®.

(29) The smartphone **33** reads the QR Code® displayed on the AP **34** using the image capturing unit **106** of the smartphone **33** (F**502**). The smartphone **33** decodes the read QR Code® to acquire information that the QR Code® indicates. The smartphone **33** determines whether the information acquired from the QR Code® is information necessary for setting the communication parameters.

(30) In this embodiment, a QR Code® containing information necessary for setting the communication parameters is displayed. The information can be provided using near-field communication (NFC). In other words, the information necessary for setting the communication parameters can be contained in the tag information of the NFC, and the information can be read using an NFC reader writer of a different apparatus. Instead of the NFC, Action Frame defined by Wi-Fi Alliance® or Bluetooth® communication can be used to provide the information. Alternatively, wireless communication based on IEEE 802.11ad or TransferJet® can be used. The information can be provided by wired communication over a cable, such as a universal serial bus (USB) and Ethernet®.

(31) The smartphone **33** that has acquired the public key or the like of the AP **34** serves as a communication-parameter providing apparatus and transmits a notification signal containing information corresponding to the identification information on the AP **34** to the AP **34** together with information on the smartphone **33** (F**503**). An example of the information corresponding to the identification information on the AP **34** is a hash value of the identification information, such as the public key of the AP **34**.

(32) The AP **34** that has acquired the information on the smartphone **33**, which is a communication parameter providing apparatus, starts an apparatus authentication process. The AP **34** transmits a start request signal for starting the authentication process to the smartphone **33** (F**504**).

(33) In response to receiving the apparatus-authentication start request signal from the AP **34**, the smartphone **33** transmits an apparatus-authentication request signal to the AP **34** (F**505**).

(34) Upon receiving the apparatus-authentication request signal, the AP **34** returns an apparatus-authentication response signal to the smartphone **33** (F**506**). Upon receiving the apparatus-authentication response signal, if authentication is completed, the smartphone **33** returns an apparatus-authentication confirmation signal to the AP **34** (F**507**). For the apparatus authentication executed from F**505** to F**507**, a challenge response method is employed. This is provided for mere illustration purposes, and another authentication method can be employed.

(35) Then, a communication-parameter sharing process is executed between the AP **34** and the smartphone **33** (F**508**). The communication-parameter sharing process at F**508** is based on WPS developed by Wi-Fi Alliance®. The communication-parameter sharing process can be based on, not the WPS, but Wi-Fi Direct® or AOSS. In this case, the communication parameters are provided from the smartphone **33** to the AP **34**. The AP **34** starts to transmit a beacon using the set communication parameters (F**509**).

(36) The AP **34** can establish the wireless network **31** according to the above connection sequence. For apparatus authentication, an example is described in which the AP **34** transmits an apparatus-authentication start notification to request the smartphone **33** to submit an apparatus authentication request. This is provided for mere illustration purposes, and F**503** and F**504** can be omitted, and the smartphone **33** can transmit the apparatus authentication request to the AP **34** immediately after reading the QR Code®.

(37) Referring next to FIG. **6**, a sequence for connecting the first camera **32** to the wireless network **31** that the AP **34** establishes will be described.

(38) In FIG. **6**, the smartphone **33** provides information for connecting the first camera **32** to the

wireless network **31** to the first camera **32**.
(39) The first camera **32** displays a QR Code® containing information necessary for setting the communication parameters on the display unit **105** of the first camera **32** according to a user operation. When the first camera **32** is instructed by the user to set communication parameters, the first camera **32** displays a QR Code® containing information necessary for setting the communication parameters on the display unit **105** (F**501**).
(40) The information necessary for setting communication parameters is identification information unique to the first camera **32**. The identification information is a public key or a certificate for use in encryption to share the communication parameters. The identification information can be a MAC address or UUID that uniquely identifies a network device. The information necessary for setting the communication parameters can include an identifier indicating that the apparatus is a receiving apparatus that receives the communication parameters. The information necessary for setting the communication parameters can include identification information, such as a one type password using a QR Code®.
(41) The smartphone **33** reads the QR Code® displayed on the first camera **32** using the image capturing unit **106** of the smartphone **33** (F**502**). The smartphone **33** decodes the read QR Code® to acquire information that the QR Code® indicates. The smartphone **33** determines whether the information acquired from the QR Code® is information necessary for setting the communication parameters.
(42) The smartphone **33** that has acquired the public key or the like of the first camera **32** serves as a communication-parameter providing apparatus and transmits a notification signal containing information corresponding to the identification information on the first camera **32** to the first camera **32** together with information on the smartphone **33** (F**503**). An example of the information corresponding to the identification information on the first camera **32** is a hash value of the identification information, such as the public key of the first camera **32**.
(43) The first camera **32** that has acquired the information on the smartphone **33**, which is a communication parameter providing apparatus, starts an apparatus authentication process. The first camera **32** transmits a start request signal for starting the authentication process to the smartphone **33** (F**504**).
(44) In response to receiving the apparatus-authentication start request signal from the first camera **32**, the smartphone **33** transmits an apparatus-authentication request signal to the first camera **32** (F**505**).
(45) Upon receiving the apparatus-authentication request signal, the first camera **32** returns an apparatus-authentication response signal to the smartphone **33** (F**506**). Upon receiving the apparatus-authentication response signal, if authentication is completed, the smartphone **33** returns an apparatus-authentication confirmation signal to the first camera **32** (F**507**). For the apparatus authentication executed from F**505** to F**507**, a challenge response method is employed. This is provided for mere illustration purposes, and another authentication method can be employed.
(46) Then, a communication-parameter sharing process is executed between the first camera **32** and the smartphone **33** (F**508**). The communication-parameter sharing process at F**508** is based on WPS developed by Wi-Fi Alliance®. The communication-parameter sharing process can be based on, not the WPS, but Wi-Fi Direct® or AOSS. In this case, the communication parameters are provided from the smartphone **33** to the first camera **32**.
(47) Then, the first camera **32** starts to connect to the AP **34** using the provided communication parameters (F**601**). Upon completion of the connecting process, the first camera **32** can communicates with the AP **34** wirelessly (F**602**). This enables the first camera **32** to communicate with the smartphone **33** wirelessly via the AP **34** (F**603**).
(48) The first camera **32** can connect to the wireless network **31** that the AP **34** establishes according to the above connection sequence. For apparatus authentication, an example is described in which the first camera **32** transmits an apparatus-authentication start notification to request the

smartphone **33** to submit an apparatus authentication request. This is provided for mere illustration purposes, and F**503** and F**504** can be omitted, and the smartphone **33** can transmit the apparatus authentication request to the first camera **32** immediately after reading the QR Code®.
(49) The second camera **35** can also connect to the wireless network **31** that the AP **34** establishes, as the first camera **32** does.
(50) Thus, the first camera **32** and the second camera **35** can connect to the wireless network **31** of the AP **34** according to the above connection sequence, so that mutual data communication can be executed via the AP **34**.
(51) Referring next to FIG. **4**, the process executed by the AP **34** in FIG. **5** and the process executed by the first camera **32** in FIG. **6** will be described. FIG. **4** is a flowchart illustrating the operation executed by the communication apparatus **101** (the AP **34** or the first camera **32**). The steps in the flowchart are implemented by the control unit **102** reading and executing the control program stored in the storage unit **103**.
(52) The process in the flowchart is executed when the communication apparatus **101** intends to share communication parameters with a different communication apparatus **101**. In this case, the different communication apparatus **101** is the smartphone **33** in FIGS. **5** and **6**. The flowchart is executed when an instruction to start a communication-parameter setting process is submitted by user operation. This is not intended to limit aspects of the invention. The operation in FIG. **4** can be periodically repeated. In this case, the operation can be repeated at fixed intervals or at random.
(53) When the communication-parameter setting process is started, the communication apparatus **101** determines whether the QR Code® contains information on a frequency channel (CH) (S**401**). The QR Code® contains no CH information in the case where, the information on the QR Code® cannot be changed, for example, in the case where the QR Code® is attached to an instruction manual or the casing of the communication apparatus **101**. If CH has not been set in advance by the user, it can be determined that the QR Code® does not contain CH information even if the QR Code® is to be displayed on the display unit **105**.
(54) In contrast, the QR Code® contains no CH information in the case where predetermined CH has been set in advance by the user. If the communication apparatus **101** has checked surrounding radio wave situation in advance and has found CH in which radio waves are least used, it can be determined that the QR Code® contains information on the found CH.
(55) If it is determined that the QR Code® does not contain CH information (No at S**401**), the communication apparatus **101** displays the QR Code® containing no CH information on the display unit **105** (S**402**). If the QR Code® is attached to an instruction manual or the communication apparatus **101**, this step can be omitted.
(56) Then, the communication apparatus **101** waits for a providing-apparatus information notification (F**503**) or a search signal, such as an apparatus-authentication request signal (F**505**), from a different communication apparatus **101** using a plurality of channels (S**403**). The plurality of channels are Channels 1 to 13 allocated to the 2.4 GHz band in the IEEE 802.11 series. The channels are not limited to such continuous channels; for example, discontinuous channels, such as Channels 1, 6, and 11.
(57) In contrast, if it is determined that the QR Code® contains CH information (Yes at S**401**), the communication apparatus **101** displays the QR Code® containing CH information on the display unit **105** (S**404**). The communication apparatus **101** waits for the providing-apparatus information notification (F**503**) or a search signal, such as the apparatus-authentication request signal (F**505**), from a different communication apparatus **101** using the channel corresponding to the CH information contained in the QR Code® (S**405**). At that time, the communication apparatus **101** waits for the search request signal only over a predetermined CH, not a plurality of channels, as at S**403**. This increases the possibility that a search request signal from a different communication apparatus **101** can be received more quickly.
(58) Thereafter, the communication apparatus **101** determines whether a search signal has been

received in a predetermined time (S**406**). If not, (No at S**406**), the communication apparatus **101** transmits a search signal for searching for another communication apparatus **101** (S**407**). In this case, the search signal is the authentication start notification signal (F**504**). The communication apparatus **101** transmits the authentication start notification signal over a plurality of channels (Channels 1 to 13) allocated to the 2.4 GHz band in the IEEE 802.11 series.

(59) If the QR Code® contains CH information, the authentication start notification signal can be transmitted only to the corresponding channel. The authentication start notification signal can be transmitted to not all of Channels 1 to 13 but discontinuous channels, such as Channels 1, 6, and 11.

(60) Thereafter, the communication apparatus **101** performs an apparatus authentication process with the different communication apparatus **101** (S**408**). In this case, the communication apparatus **101** performs an apparatus authentication process based on a challenge-response method. Upon completion of the authentication, the communication apparatus **101** executes a process for sharing the communication parameters with the different communication apparatus **101** (S**409**). In this case, the communication apparatus **101** communicates communication parameters encrypted using an encryption key, which is shared in advance using a public key, to share the communication parameters with the different communication apparatus **101**. This is provided for mere illustration purposes. In some embodiments, the communication apparatus **101** receives the communication parameters from the different communication apparatus **101** according to the procedure of WPS. Here, the communication parameters have been encoded using a key generated on the basis of a public key contained in the QR Code® displayed by the communication apparatus **101**. This allows the communication parameters to be shared without leaking to the third person.

(61) After sharing the communication parameters, the communication apparatus **101** determines the kind of operation of the communication apparatus **101** (S**410**). If the communication apparatus **101** operates as AP or GO in Wi-Fi Direct®, the communication apparatus **101** transmits a beacon and waits for connection from a STA or a client (CL) (S**412**). In contrast, if the communication apparatus **101** operates as STA or a client in Wi-Fi Direct®, the communication apparatus **101** searches for AP or GO and connects to the AP or GO (S**411**).

(62) Thus, this embodiment enables a camera to join, as STA, a wireless network established by an AP by the simple operation of photographing a QR Code® displayed on a smartphone or the camera. This enhances user convenience.

(63) In particular, if the QR Code® contains CH information, a communication apparatus and a different communication apparatus perform the searching process over a single channel without shifting to a plurality of channels, thus reducing the time taken for the searching process.

(64) Since control for channel shift in the searching process is changed according to whether the QR Code® contains CH information, an appropriate searching process can be performed in any cases. To enable a plurality of cameras to join a wireless network that an AP forms, it is only required that images of QR Codes® displayed on the plurality of cameras are taken in sequence by using smartphone, thus enhancing user convenience.

(65) The QR Codes® of the plurality of cameras can be photographed by a smartphone at different times, or alternatively, at the same time. In the former case, information on a first camera is acquired by photographing the QR Code® displayed on the first camera, and information on a second camera is acquired by photographing a QR Code® displayed on the second camera. That is, information on the individual cameras can be acquired from the individual photographed images.

(66) In the latter case, the user places the plurality of cameras, with their QR Codes® displayed thereon, and photographs the QR Codes® with a smartphone in such a manner that the plurality of QR Codes® are photographed by one shooting. This allows the plurality of QR Codes® contained in an image captured by the smartphone to be individually analyzed, thus allowing information regarding the individual cameras to be acquired. That is, information on the individual cameras is acquired from the captured single image.

(67) Another method for acquiring information on a plurality of cameras by photographing a QR Code® is creating one QR Code® containing information on the plurality of cameras and reading the QR Code® using a smartphone to acquire information on the plurality of cameras at one time. In this case, the information is shared in advance among the cameras using any method, and one of the cameras creates a QR Code® containing information on the other cameras. In some embodiments, the user designates other apparatuses (for example, cameras) whose information is to be contained in the QR Code® of any camera. The camera to which the user designation is input acquires the information from the designated other apparatuses and create a QR Code® containing the acquired information and information on the apparatus. Using such methods allows the smartphone to acquire information on a plurality of cameras by one photographing, further reducing the workload of the user.
(68) The QR Code® to be read is not limited to a QR Code® displayed on a display unit, but can also be a QR Code® attached to the casing of a communication apparatus in the form of a seal or a QR Code® written directly on the casing. Other examples include, but are not limited to, a QR Code® attached in the form of a seal to an instruction manual of a communication apparatus or to an item associated with a communication apparatus, such as a package including a corrugated box used as a package at the time of delivery, or a QR Code® written directly on the package. In addition to a QR Code®, a one-dimensional barcode or a two-dimensional code different from a QR Code® can be used. User-readable information can also be used instead of machine-readable information such as a QR Code®.
(69) In this embodiment, a communication apparatus notifies another apparatus of channel information in advance and waits to receive a predetermined signal when sharing communication parameters using the channel. This reduces the time taken to share the communication parameters.
Other Embodiments
(70) Embodiment(s) of the present invention can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a ‘non-transitory computer-readable storage medium’) to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer can comprise one or more processors (e.g., central processing unit (CPU), micro processing unit (MPU)) and can include a network of separate computers or separate processors to read out and execute the computer executable instructions. The computer executable instructions can be provided to the computer, for example, from a network or the storage medium. The storage medium can include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™), a flash memory device, a memory card, and the like.
(71) While aspects of the present invention have been described with reference to exemplary embodiments, it is to be understood that the aspects of the invention are not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

Claims

1. A communication apparatus comprising: at least one antenna; at least one processors; and at least one memory including instructions that, when executed by the at least one processors, cause the communication apparatus to: obtain first information that includes at least information of a public key that is unique to the communication apparatus and is used for share processing for sharing a communication parameter with another communication apparatus; determine, by analyzing the obtained first information, whether or not information indicating a predetermined channel is included in the obtained first information; perform processing to send a predetermined signal that comprises a hash value of the public key on the predetermined channel without shifting from the predetermined channel to another channel, upon condition that the information indicating the predetermined channel is determined to be included in the obtained first information, wherein the predetermined signal is wirelessly transmitted via the at least one antenna; perform processing to send the predetermined signal that comprises the hash value of the public key on a plurality of channels, upon condition that the information indicating the predetermined channel is determined to be not included in the obtained first information, wherein the predetermined signal is wirelessly transmitted via the at least one antenna, and the plurality of channels at least includes channel 2 and channel 3 of the 2.4 GHz band; transmit an authentication confirmation signal to the another communication apparatus in a case where a response signal to the predetermined signal is received from the another communication apparatus; execute the share processing with the another communication apparatus after transmitting the authentication confirmation signal; and in a case where the communication apparatus plays a role as a station, perform processing to connect to a network which is established by an access point, by using the communication parameter after the share processing.
2. The communication apparatus according to claim 1, wherein the at least one processors further causes the communication apparatus to: in a case where the communication apparatus plays a role as an access point, operate as the access point after the share processing.
3. The communication apparatus according to claim 1, wherein the at least one processors further causes the communication apparatus to: determine the role of the communication apparatus.
4. The communication apparatus according to claim 3, wherein the role of the communication apparatus is the role of the communication apparatus after the share processing.
5. The communication apparatus according to claim 1, wherein the communication apparatus transmits the communication parameter to the another communication apparatus in the share processing.
6. The communication apparatus according to claim 5, wherein the at least one processors further causes the communication apparatus to: notify the another communication apparatus that the communication apparatus is an apparatus which transmits the communication parameter.
7. The communication apparatus according to claim 1, wherein the at least one processors further causes the communication apparatus to: in a case where the communication apparatus plays a role as a group owner in Wi-Fi Direct, operate as a group owner after the share processing.
8. The communication apparatus according to claim 1, wherein a two-dimensional code includes the first information.
9. The communication apparatus according to claim 8, wherein the two-dimensional code further comprises a MAC address of the communication apparatus.
10. The communication apparatus according to claim 8, wherein the two-dimensional code is a QR (Quick Response) code.
11. The communication apparatus according to claim 1, wherein the first information is obtained by imaging the two-dimensional code displayed on the other communication apparatus.
12. The communication apparatus according to claim 1, wherein the communication parameter is encrypted using an encryption key, which is shared in advance using the public key.
13. The communication apparatus according to claim 1, wherein the share processing with the

another communication apparatus is not performed if authentication is not successful.
14. The communication apparatus according to claim 1, wherein the predetermined channel is a frequency channel, and the plurality of channels at least includes channel 1, channel 2, channel 3, channel 4, channel 5, channel 6, channel 7, channel 8, channel 9, channel 10, channel 11, channel 12 and channel 13 of the 2.4 GHz band.
15. The communication apparatus according to claim 1, wherein the communication parameter contains information on at least one of, for wireless communication, an encryption method, an encryption key, an authentication method, and an authentication key.
16. The communication apparatus according to claim 1, wherein the at least one processors further causes the communication apparatus to: in a case where the communication apparatus plays a role as a client in Wi-Fi Direct, connect to a group owner after the share processing.
17. A method for controlling a communication apparatus having at least one antenna, the method comprising: obtaining first information that includes at least information of a public key that is unique to a communication apparatus and is used for share processing for sharing a communication parameter with another communication apparatus; determining, by analyzing the obtained first information, whether or not information indicating a predetermined channel is included in the obtained first information; performing processing to send a predetermined signal that comprises a hash value of the public key on the predetermined channel without shifting from the predetermined channel to another channel, upon condition that the information indicating the predetermined channel is determined to be included in the obtained first information, wherein the predetermined signal is wirelessly transmitted via the at least one antenna; performing processing to send the predetermined signal that comprises the hash value of the public key on a plurality of channels, upon condition that the information indicating the predetermined channel is determined to be not included in the obtained first information, wherein the predetermined signal is wirelessly transmitted via the at least one antenna, and the plurality of channels at least includes channel 2 and channel 3 of the 2.4 GHz band; transmitting an authentication confirmation signal to the another communication apparatus in a case where a response signal to the predetermined signal is received from the another communication apparatus; executing the share processing with the another communication apparatus after transmitting the authentication confirmation signal; and in a case where the communication apparatus plays a role as a station, perform processing to connect to a network which is established by an access point, by using the communication parameter after the share processing.
18. A non-transitory computer-readable recording medium storing a program for causing a computer to execute a method for controlling a communication apparatus having at least one antenna, the method comprising: obtaining first information that includes at least information of a public key that is unique to a communication apparatus and is used for share processing for sharing a communication parameter with another communication apparatus; determining, by analyzing the obtained first information, whether or not information indicating a predetermined channel is included in the obtained first information; performing processing to send a predetermined signal that comprises a hash value of the public key on the predetermined channel without shifting from the predetermined channel to another channel, upon condition that the information indicating the predetermined channel is determined to be included in the obtained first information, wherein the predetermined signal is wirelessly transmitted via the at least one antenna; performing processing to send the predetermined signal that comprises the hash value of the public key on a plurality of channels, upon condition that the information indicating the predetermined channel is determined to be not included in the obtained first information, wherein the predetermined signal is wirelessly transmitted via the at least one antenna, and the plurality of channels at least includes channel 2 and channel 3 of the 2.4 GHz band; transmitting an authentication confirmation signal to the another communication apparatus in a case where a response signal to the predetermined signal is received from the another communication apparatus; executing the share processing with the another

communication apparatus after transmitting the authentication confirmation signal; and in a case where the communication apparatus plays a role as a station, perform processing to connect to a network which is established by an access point, by using the communication parameter after the share processing.