ELECTRONIC DEVICE SUPPORTING DEVICE DISCOVERY ON BASIS OF D2D COMMUNICATION AND OPERATION METHOD OF ELECTRONIC DEVICE

Abstract

An electronic device is provided. The electronic device includes a first communication circuit configured to support device-to-device (D2D) communication, a second communication circuit configured to support out-of-band (OOB) communication, memory storing one or more computer programs, and one or more processors communicatively coupled to the first communication circuit, the second communication circuit, and the memory, wherein the one or more computer programs include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to, based on detecting initiation of a service, configure a discovery protocol for each of multiple frequency bands related to discovering, using the first communication circuit, an external electronic device for which the service is to be performed, transmit a discovery mode start message through the second communication circuit, discover at least one external electronic device through the first communication circuit based on a protocol corresponding to each of the multiple frequency bands, determine one of the discovered at least one external electronic device as a service target device, and perform a connection procedure with the external electronic device determined as the service target device.

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Related U.S. Application Data

Publication Classification

Int. Cl.: **H04W8/00** (20090101); **H04W8/22** (20090101); **H04W76/14** (20180101)

U.S. Cl.:

CPC **H04W8/005** (20130101); **H04W8/22** (20130101); **H04W76/14** (20180201);

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION(S) [0001] This application is a continuation application, claiming priority under 35 U.S.C. § 365 (c), of an International application No. PCT/KR2023/015986, filed on Oct. 17, 2023, which is based on and claims the benefit of a Korean patent application number 10-2022-0145218, filed on Nov. 3, 2022, in the Korean Intellectual Property Office, and of a Korean patent application number 10-2022-0185996, filed on Dec. 27, 2022, in the Korean Intellectual Property Office, the disclosure of each of which is incorporated by reference herein in its entirety.

BACKGROUND
1. Field
[0002] The disclosure relates to a method for supporting device discovery based on wireless fidelity (Wi-Fi) peer-to-peer (P2P) between electronic devices supporting wireless fidelity (Wi-Fi), and an electronic device supporting the same.
2. Description of Related Art
[0003] With the development of digital technology, various types of electronic devices, such as mobile communication terminals, smartphones, tablet personal computers (PCs), notebooks, wearable devices, digital cameras, personal computers, or Internet of Things (IoT) devices, are widely used. In order to support and enhance functions of such electronic devices, hardware parts and/or software parts of the electronic devices are continuously being developed.
[0004] Recently, various types of proximity services utilizing low-power discovery technology are being developed. For example, proximity services (or proximity communication services), in which nearby electronic devices can quickly exchange data through a proximity network, are being developed. The proximity services may include a low-power proximity service using a Bluetooth low energy (BLE) beacon, a low-power proximity service based on a low-power short-range communication technology (e.g., neighbor awareness networking (NAN) or Wi-Fi aware) (hereinafter, referred to as "NAN") based on wireless fidelity (Wi-Fi), or a proximity service based on Wi-Fi direct.
[0005] According to an embodiment, based on the various technologies described above, an electronic device may provide a proximity service (e.g., a device-to-device (D2D) service) by directly establishing a communication connection (e.g., configuring a proximity network) with an external electronic device in proximity to the electronic device.
[0006] According to an embodiment, representative communication technologies recently used in proximity services may be, for example, Wi-Fi Direct technology and NAN technology. According to an embodiment, Wi-Fi Direct (or Wi-Fi peer-to-peer (P2P)) technology may refer to a

technology that provides a direct connection between electronic devices which support Wi-Fi by using a Wi-Fi interface without an access point (AP) which is a medium of an infrastructure network. According to an embodiment, NAN technology may refer to a technology in which electronic devices within an NAN cluster synchronize their time clocks and exchange beacons and service discovery frames (SDFs) within the same discovery window (DW) interval.

[0007] Currently, an electronic device may basically support Wi-Fi Direct technology, and may selectively support NAN technology depending on the implementation of the electronic device. Therefore, the existing proximity service enables an electronic device to perform data communication by performing device discovery and connection based on Wi-Fi Direct technology or NAN technology depending on the support capability of an external electronic device (e.g., a target device for proximity services). For example, in the case of an electronic device, a Wi-Fi Direct function and an NAN function cannot be activated simultaneously during device discovery. Therefore, conventionally, an electronic device discovers an external electronic device through specified other communication (e.g., Bluetooth low energy (BLE) communication), and then, depending on the support capability of the external electronic device discovered through the other communication, uses Wi-Fi Direct technology or NAN technology to establish a communication connection, so as to provide a proximity service (e.g., D2D service). For example, conventionally, an electronic device may discover external electronic devices, based on BLE, determine to switch to NAN or Wi-Fi Direct depending on the support capability of the discovered external electronic devices, and then perform a discovery procedure again.

[0008] Therefore, the existing method of utilizing BLE for discovery may cause a degradation in discovery speed due to performing redundant device discovery processes such as a BLE-based discovery and an NAN or Wi-Fi Direct-based discovery based on a result of the discovery. In addition, since the method of utilizing BLE for discovery requires maintaining a BLE operation even after switching to Wi-Fi Direct or NAN, conflict (or interference) (coexistence) with BLE may occur even in a D2D operation that uses about 2.4 GHz band.

[0009] The above information is presented as background information only to assist with an understanding of the disclosure. No determination has been made, and no assertion is made, as to whether any of the above might be applicable as prior art with regard to the disclosure.

SUMMARY

[0010] Aspects of the disclosure are to address at least the above-mentioned problems and/or disadvantages and to provide at least the advantages described below. Accordingly, an aspect of the disclosure is to provide a method capable of supporting fast device discovery based on Wi-Fi peer-to-peer (P2P) between electronic devices supporting Wi-Fi and, an electronic device supporting the same.

[0011] Another aspect of the disclosure is to provide a method capable of supporting efficient and fast device discovery by using multiple bands to simultaneously use Wi-Fi device-to-device (D2D) technologies (e.g., low-power short-range communication technology based on neighbor awareness networking (NAN) (or Wi-Fi aware) and Wi-Fi Direct technology), and an electronic device supporting the same.

[0012] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

[0013] In accordance with an aspect of the disclosure, an electronic device is provided. The electronic device includes a first communication circuit configured to support device-to-device (D2D) communication, a second communication circuit configured to support out-of-band (OOB) communication, memory storing one or more computer programs, and one or more processors communicatively coupled to the first communication circuit, the second communication circuit, and the memory, wherein the one or more computer programs include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to, based on detecting initiation of a service, configure a discovery protocol

for each of multiple frequency bands related to discovering, using the first communication circuit, an external electronic device for which the service is to be performed, transmit a discovery mode start message through the second communication circuit, discover at least one external electronic device through the first communication circuit, based on a protocol corresponding to each of the multiple frequency bands, determine one of the discovered at least one external electronic device as a service target device, and perform a connection procedure with the external electronic device determined as the service target device.

[0014] In accordance with another aspect of the disclosure, an operation method performed by an electronic device is provided. The method includes based on detecting initiation of a service, configuring a discovery protocol for each of multiple frequency bands related to discovering, using a first communication circuit configured to support device-to-device (D2D) communication, an external electronic device for which the service is to be performed, transmitting a discovery mode start message through a second communication circuit configured to support out-of-band (OOB) communication, discovering at least one external electronic device through the first communication circuit, based on a protocol corresponding to each of the multiple frequency bands, determining one of the at least one discovered external electronic device as a service target device, and performing a connection procedure with the external electronic device determined as the service target device.

[0015] In accordance with another aspect of the disclosure, one or more non-transitory computer-readable storage media storing one or more computer programs including computer-executable instructions that, when executed by one or more processors of an electronic device individually or collectively, cause the electronic device to perform operations is provided. The operations include, based on detecting initiation of a service, configuring a discovery protocol for each of multiple frequency bands related to discovering, using a first communication circuit configured to support device-to-device (D2D) communication, an external electronic device for which the service is to be performed, transmitting a discovery mode start message through a second communication circuit configured to support out-of-band (OOB) communication, discovering at least one external electronic device through the first communication circuit, based on a protocol corresponding to each of the multiple frequency bands, determining one of the at least one discovered external electronic device as a service target device, and performing a connection procedure with the external electronic device determined as the service target device.

[0016] According to an electronic device, an operation method thereof, and a recording medium according to an embodiment of the disclosure, a Wi-Fi P2P-based device discovery speed for a proximity service (e.g., a D2D service) can be improved by simultaneously using different frequency bands (or radio bands). According to an embodiment, the usability of a D2D service can be improved by improving the device discovery speed. According to an embodiment, a device discovery and communication connection may be supported regardless of the support capability of an external electronic device while improving the device discovery speed through simultaneous discovery of external electronic devices based on multiple frequency bands.

[0017] Other aspects, advantages, and salient features of the disclosure will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses various embodiments of the disclosure.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The above and other aspects, features, and advantages of certain embodiments of the disclosure will be more apparent from the following description taken in conjunction with the accompanying drawings, in which:

[0019] FIG. **1** is a block diagram illustrating an example electronic device in a network

environment according to an embodiment of the disclosure;

[0020] FIG. **2** is a diagram illustrating an example in which electronic devices are connected in a P2P group according to an embodiment of the disclosure;

[0021] FIG. **3** is a diagram illustrating an example in which a first electronic device and a second electronic device are connected through Wi-Fi Direct according to an embodiment of the disclosure of the disclosure;

[0022] FIG. **4** is a diagram illustrating an example in which electronic devices are connected in an NAN cluster according to an embodiment of the disclosure;

[0023] FIG. **5** is a diagram illustrating an example of a protocol for transmitting a signal by an electronic device included in an NAN cluster according to an embodiment of the disclosure;

[0024] FIG. **6** is a diagram illustrating an example of data transmission and/or reception within an NAN cluster according to an embodiment of the disclosure;

[0025] FIG. **7** is a diagram schematically illustrating a configuration of an electronic device according to an embodiment of the disclosure;

[0026] FIG. **8** is a diagram illustrating an example in which an electronic device performs device discovery for an external electronic device according to an embodiment of the disclosure;

[0027] FIG. **9** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure;

[0028] FIG. **10** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure;

[0029] FIG. **11** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure;

[0030] FIG. **12** is a diagram illustrating an example in which electronic devices operate based on a first discovery procedure according to an embodiment of the disclosure;

[0031] FIG. **13** is a diagram illustrating an example in which electronic devices operate based on a first discovery procedure according to an embodiment of the disclosure;

[0032] FIG. **14** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure;

[0033] FIG. **15** is a diagram illustrating an example in which electronic devices operate based on a second discovery procedure according to an embodiment of the disclosure;

[0034] FIG. **16** is a diagram illustrating an example in which electronic devices operate based on a first discovery procedure according to an embodiment of the disclosure; and

[0035] FIG. **17** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure.

[0036] The same reference numerals are used to represent the same elements throughout the drawings.

DETAILED DESCRIPTION

[0037] The following description with reference to the accompanying drawings is provided to assist in a comprehensive understanding of various embodiments of the disclosure as defined by the claims and their equivalents. It includes various specific details to assist in that understanding but these are to be regarded as merely exemplary. Accordingly, those of ordinary skill in the art will recognize that various changes and modifications of the various embodiments described herein can be made without departing from the scope and spirit of the disclosure. In addition, descriptions of well-known functions and constructions may be omitted for clarity and conciseness.

[0038] The terms and words used in the following description and claims are not limited to the bibliographical meanings, but, are merely used by the inventor to enable a clear and consistent understanding of the disclosure. Accordingly, it should be apparent to those skilled in the art that the following description of various embodiments of the disclosure is provided for illustration purpose only and not for the purpose of limiting the disclosure as defined by the appended claims and their equivalents.

[0039] It is to be understood that the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a component surface" includes reference to one or more of such surfaces.

[0040] It should be appreciated that the blocks in each flowchart and combinations of the flowcharts may be performed by one or more computer programs which include instructions. The entirety of the one or more computer programs may be stored in a single memory device or the one or more computer programs may be divided with different portions stored in different multiple memory devices.

[0041] Any of the functions or operations described herein can be processed by one processor or a combination of processors. The one processor or the combination of processors is circuitry performing processing and includes circuitry like an application processor (AP, e.g. a central processing unit (CPU)), a communication processor (CP, e.g., a modem), a graphics processing unit (GPU), a neural processing unit (NPU) (e.g., an artificial intelligence (AI) chip), a Wi-Fi chip, a Bluetooth® chip, a global positioning system (GPS) chip, a near field communication (NFC) chip, connectivity chips, a sensor controller, a touch controller, a finger-print sensor controller, a display driver integrated circuit (IC), an audio CODEC chip, a universal serial bus (USB) controller, a camera controller, an image processing IC, a microprocessor unit (MPU), a system on chip (SoC), an IC, or the like.

[0042] FIG. **1** is a block diagram illustrating an example electronic device **101** in a network environment **100** according to an embodiment of the disclosure.

[0043] Referring to FIG. **1**, the electronic device **101** in the network environment **100** may communicate with an electronic device **102** via a first network **198** (e.g., a short-range wireless communication network), or at least one of an electronic device **104** or a server **108** via a second network **199** (e.g., a long-range wireless communication network). According to an embodiment, the electronic device **101** may communicate with the electronic device **104** via the server **108**. According to an embodiment, the electronic device **101** may include a processor **120**, memory **130**, an input module **150**, a sound output module **155**, a display module **160**, an audio module **170**, a sensor module **176**, an interface **177**, a connecting terminal **178**, a haptic module **179**, a camera module **180**, a power management module **188**, a battery **189**, a communication module **190**, a subscriber identification module (SIM) **196**, or an antenna module **197**. In various embodiments, at least one of the components (e.g., the connecting terminal **178**) may be omitted from the electronic device **101**, or one or more other components may be added in the electronic device **101**. In various embodiments, some of the components (e.g., the sensor module **176**, the camera module **180**, or the antenna module **197**) may be implemented as a single component (e.g., the display module **160**).

[0044] The processor **120** may execute, for example, software (e.g., a program **140**) to control at least one other component (e.g., a hardware or software component) of the electronic device **101** coupled with the processor **120**, and may perform various data processing or computation. According to an embodiment, as at least part of the data processing or computation, the processor **120** may store a command or data received from another component (e.g., the sensor module **176** or the communication module **190**) in volatile memory **132**, process the command or the data stored in the volatile memory **132**, and store resulting data in non-volatile memory **134**. According to an embodiment, the processor **120** may include a main processor **121** (e.g., a central processing unit (CPU) or an application processor (AP)), or an auxiliary processor **123** (e.g., a graphics processing unit (GPU), a neural processing unit (NPU), an image signal processor (ISP), a sensor hub processor, or a communication processor (CP)) that is operable independently from, or in conjunction with, the main processor **121**. For example, when the electronic device **101** includes the main processor **121** and the auxiliary processor **123**, the auxiliary processor **123** may be adapted to consume less power than the main processor **121**, or to be specific to a specified function. The auxiliary processor **123** may be implemented as separate from, or as part of the main processor **121**.

[0045] The auxiliary processor **123** may control at least some of functions or states related to at least one component (e.g., the display module **160**, the sensor module **176**, or the communication module **190**) among the components of the electronic device **101**, instead of the main processor **121** while the main processor **121** is in an inactive (e.g., sleep) state, or together with the main processor **121** while the main processor **121** is in an active state (e.g., executing an application). According to an embodiment, the auxiliary processor **123** (e.g., an image signal processor or a communication processor) may be implemented as part of another component (e.g., the camera module **180** or the communication module **190**) functionally related to the auxiliary processor **123**. According to an embodiment, the auxiliary processor **123** (e.g., the neural processing unit) may include a hardware structure specified for artificial intelligence model processing. An artificial intelligence model may be generated by machine learning. Such learning may be performed, e.g., by the electronic device **101** where the artificial intelligence is performed or via a separate server (e.g., the server **108**). Learning algorithms may include, but are not limited to, e.g., supervised learning, unsupervised learning, semi-supervised learning, or reinforcement learning. The artificial intelligence model may include a plurality of artificial neural network layers. The artificial neural network may be a deep neural network (DNN), a convolutional neural network (CNN), a recurrent neural network (RNN), a restricted boltzmann machine (RBM), a deep belief network (DBN), a bidirectional recurrent deep neural network (BRDNN), deep Q-network or a combination of two or more thereof but is not limited thereto. The artificial intelligence model may, additionally or alternatively, include a software structure other than the hardware structure.

[0046] The memory **130** may store various data used by at least one component (e.g., the processor **120** or the sensor module **176**) of the electronic device **101**. The various data may include, for example, software (e.g., the program **140**) and input data or output data for a command related thereto. The memory **130** may include the volatile memory **132** or the non-volatile memory **134**.

[0047] The program **140** may be stored in the memory **130** as software, and may include, for example, an operating system (OS) **142**, middleware **144**, or an application **146**.

[0048] The input module **150** may receive a command or data to be used by another component (e.g., the processor **120**) of the electronic device **101**, from the outside (e.g., a user) of the electronic device **101**. The input module **150** may include, for example, a microphone, a mouse, a keyboard, a key (e.g., a button), or a digital pen (e.g., a stylus pen).

[0049] The sound output module **155** may output sound signals to the outside of the electronic device **101**. The sound output module **155** may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record. The receiver may be used for receiving incoming calls. According to an embodiment, the receiver may be implemented as separate from, or as part of the speaker.

[0050] The display module **160** may visually provide information to the outside (e.g., a user) of the electronic device **101**. The display module **160** may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display module **160** may include a touch sensor adapted to detect a touch, or a pressure sensor adapted to measure the intensity of force incurred by the touch.

[0051] The audio module **170** may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module **170** may obtain the sound via the input module **150**, or output the sound via the sound output module **155** or a headphone of an external electronic device (e.g., an electronic device **102**) directly (e.g., wiredly) or wirelessly coupled with the electronic device **101**.

[0052] The sensor module **176** may detect an operational state (e.g., power or temperature) of the electronic device **101** or an environmental state (e.g., a state of a user) external to the electronic device **101**, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module **176** may include, for example, a gesture sensor, a

gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

[0053] The interface **177** may support one or more specified protocols to be used for the electronic device **101** to be coupled with the external electronic device (e.g., the electronic device **102**) directly (e.g., wiredly) or wirelessly. According to an embodiment, the interface **177** may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

[0054] A connecting terminal **178** may include a connector via which the electronic device **101** may be physically connected with the external electronic device (e.g., the electronic device **102**). According to an embodiment, the connecting terminal **178** may include, for example, a HDMI connector, a USB connector, a SD card connector, or an audio connector (e.g., a headphone connector).

[0055] The haptic module **179** may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or electrical stimulus which may be recognized by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module **179** may include, for example, a motor, a piezoelectric element, or an electric stimulator.

[0056] The camera module **180** may capture a still image or moving images. According to an embodiment, the camera module **180** may include one or more lenses, image sensors, image signal processors, or flashes.

[0057] The power management module **188** may manage power supplied to the electronic device **101**. According to an embodiment, the power management module **188** may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

[0058] The battery **189** may supply power to at least one component of the electronic device **101**. According to an embodiment, the battery **189** may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

[0059] The communication module **190** may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device **101** and the external electronic device (e.g., the electronic device **102**, the electronic device **104**, or the server **108**) and performing communication via the established communication channel. The communication module **190** may include one or more communication processors that are operable independently from the processor **120** (e.g., the application processor (AP)) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module **190** may include a wireless communication module **192** (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module **194** (e.g., a local area network (LAN) communication module or a power line communication (PLC) module). A corresponding one of these communication modules may communicate with the external electronic device via the first network **198** (e.g., a short-range communication network, such as Bluetooth™, wireless-fidelity (Wi-Fi) direct, or infrared data association (IrDA)) or the second network **199** (e.g., a long-range communication network, such as a legacy cellular network, a fifth generation (5G) network, a next-generation communication network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module **192** may identify and authenticate the electronic device **101** in a communication network, such as the first network **198** or the second network **199**, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the subscriber identification module **196**.

[0060] The wireless communication module **192** may support a 5G network, after a fourth generation (4G) network, and next-generation communication technology, e.g., new radio (NR)

access technology. The NR access technology may support enhanced mobile broadband (eMBB), massive machine type communications (mMTC), or ultra-reliable and low-latency communications (URLLC). The wireless communication module **192** may support a high-frequency band (e.g., the millimeter wave (mmWave) band) to achieve, e.g., a high data transmission rate. The wireless communication module **192** may support various technologies for securing performance on a high-frequency band, such as, e.g., beamforming, massive multiple-input and multiple-output (massive MIMO), full dimensional MIMO (FD-MIMO), array antenna, analog beam-forming, or large scale antenna. The wireless communication module **192** may support various requirements specified in the electronic device **101**, an external electronic device (e.g., the electronic device **104**), or a network system (e.g., the second network **199**). According to an embodiment, the wireless communication module **192** may support a peak data rate (e.g., 20 Gbps or more) for implementing eMBB, loss coverage (e.g., 164 dB or less) for implementing mMTC, or U-plane latency (e.g., 0.5 ms or less for each of downlink (DL) and uplink (UL), or a round trip of 1 ms or less) for implementing URLLC.

[0061] The antenna module **197** may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device **101**. According to an embodiment, the antenna module **197** may include an antenna including a radiating element including a conductive material or a conductive pattern formed in or on a substrate (e.g., a printed circuit board (PCB)). According to an embodiment, the antenna module **197** may include a plurality of antennas (e.g., array antennas). In such a case, at least one antenna appropriate for a communication scheme used in the communication network, such as the first network **198** or the second network **199**, may be selected, for example, by the communication module **190** (e.g., the wireless communication module **192**) from the plurality of antennas. The signal or the power may then be transmitted or received between the communication module **190** and the external electronic device via the selected at least one antenna. According to an embodiment, another component (e.g., a radio frequency integrated circuit (RFIC)) other than the radiating element may be additionally formed as part of the antenna module **197**.

[0062] According to various embodiments, the antenna module **197** may form a mmWave antenna module. According to an embodiment, the mmWave antenna module may include a printed circuit board, a RFIC disposed on a first surface (e.g., the bottom surface) of the printed circuit board, or adjacent to the first surface and capable of supporting a designated high-frequency band (e.g., the mmWave band), and a plurality of antennas (e.g., array antennas) disposed on a second surface (e.g., the top or a side surface) of the printed circuit board, or adjacent to the second surface and capable of transmitting or receiving signals of the designated high-frequency band.

[0063] At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

[0064] According to an embodiment, commands or data may be transmitted or received between the electronic device **101** and the external electronic device **104** via the server **108** coupled with the second network **199**. Each of the electronic devices **102** or **104** may be a device of a same type as, or a different type, from the electronic device **101**. According to an embodiment, all or some of operations to be executed at the electronic device **101** may be executed at one or more of the external electronic devices **102** or **104** or the server **108**. For example, if the electronic device **101** should perform a function or a service automatically, or in response to a request from a user or another device, the electronic device **101**, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic

device **101**. The electronic device **101** may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, mobile edge computing (MEC), or client-server computing technology may be used, for example. The electronic device **101** may provide ultra low-latency services using, e.g., distributed computing or mobile edge computing. In an embodiment, the external electronic device **104** may include an internet-of-things (IoT) device. The server **108** may be an intelligent server using machine learning and/or a neural network. According to an embodiment, the external electronic device **104** or the server **108** may be included in the second network **199**. The electronic device **101** may be applied to intelligent services (e.g., smart home, smart city, smart car, or healthcare) based on 5G communication technology or IoT-related technology.

[0065] The electronic device according to various embodiments may be one of various types of electronic devices. The electronic devices may include, for example, a portable communication device (e.g., a smartphone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, a home appliance, or the like. According to an embodiment of the disclosure, the electronic devices are not limited to those described above.

[0066] It should be appreciated that various embodiments of the disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or replacements for a corresponding embodiment. As used herein, each of such phrases as "A or B," "at least one of A and B," "at least one of A or B," "A, B, or C," "at least one of A, B, and C," and "at least one of A, B, or C," may include any one of, or all possible combinations of the items enumerated together in a corresponding one of the phrases. As used herein, such terms as "1st" and "2nd," or "first" and "second" may be used to simply distinguish a corresponding component from another, and does not limit the components in other aspect (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term "operatively" or "communicatively", as "coupled with," "coupled to," "connected with," or "connected to" another element (e.g., a second element), the element may be coupled with the other element directly (e.g., wiredly), wirelessly, or via a third element.

[0067] As used in connection with various embodiments of the disclosure, the term "module" may include a unit implemented in hardware, software, or firmware, or any combination thereof, and may interchangeably be used with other terms, for example, "logic," "logic block," "part," or "circuitry". A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of an application-specific integrated circuit (ASIC).

[0068] Various embodiments as set forth herein may be implemented as software (e.g., the program **140**) including one or more instructions that are stored in a storage medium (e.g., internal memory **136** or external memory **138**) that is readable by a machine (e.g., the electronic device **101**). For example, a processor (e.g., the processor **120**) of the machine (e.g., the electronic device **101**) may invoke at least one of the one or more instructions stored in the storage medium, and execute it, with or without using one or more other components under the control of the processor. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include a code generated by a complier or a code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Wherein, the "non-transitory" storage medium is a tangible device, and may not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium.

[0069] According to an embodiment, a method according to various embodiments of the disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product may be

distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloaded or uploaded) online via an application store (e.g., PlayStore™), or between two user devices (e.g., smart phones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer's server, a server of the application store, or a relay server.

[0070] According to various embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities, and some of the multiple entities may be separately disposed in different components. According to various embodiments, one or more of the above-described components may be omitted, or one or more other components may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, according to various embodiments, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to various embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

[0071] In the disclosure, a method for supporting device discovery based on Wi-Fi device-to-device (D2D) technology between electronic devices supporting Wi-Fi and an electronic device supporting the same are disclosed. According to an embodiment, the Wi-Fi D2D technology may include Wi-Fi Direct technology and neighbor awareness networking (NAN) (or Wi-Fi aware)-based low-power short-range communication technology (hereinafter, referred to as "NAN technology"). According to an embodiment, the Wi-Fi Direct technology and NAN technology will be described.

[0072] FIG. **2** is a diagram illustrating an example in which electronic devices are connected in a P2P group according to an embodiment of the disclosure.

[0073] According to an embodiment, Wi-Fi Direct (or Wi-Fi peer-to-peer (Wi-Fi P2P)) technology may refer to a technology that utilizes a Wi-Fi interface to provide a direct connection between electronic devices (e.g., Wi-Fi terminals) without an access point (AP), which is a medium of an infrastructure network.

[0074] Referring to FIG. **2**, a connection using Wi-Fi Direct between electronic devices (e.g., a first electronic device **210** and a second electronic device **220**) may be referred to as a P2P group **200**. For example, the electronic devices (e.g., the first electronic device **210** and the second electronic device **220**) may include the electronic device **101** of FIG. **1** or may include the same components as the electronic device **101**.

[0075] According to an embodiment, the first electronic device **210** and the second electronic device **220** within the P2P group **200** may be directly connected through short-range wireless communication without going through separate entities (e.g., an access point (AP)). For example, the first electronic device **210** may perform direct wireless communication with the second electronic device **220** through short-range wireless communication. According to an embodiment, the second electronic device **220** may perform direct wireless communication with the first electronic device **210** through short-range wireless communication. The short-range wireless communication may refer to a communication scheme which can be supported by both the first electronic device **210** and the second electronic device **220**. For example, the wireless communication may be Wi-Fi communication.

[0076] In an embodiment, short-range wireless communication used by the first electronic device **210** to exchange data may use various frequency bands including a first frequency band (e.g., about 2.4 GHz band), a second frequency band (e.g., about 5 GHz band), and/or a third frequency band (e.g., about 6 GHz band). For example, the first electronic device **210** may establish a channel included in one frequency band among multiple frequency bands, and exchange data by using the

established channel.

[0077] According to an embodiment, the first electronic device **210** may serve as a base station which provides wireless communication to at least one electronic device (e.g., the second electronic device **220**) located within a communication radius. According to an embodiment, the second electronic device **220** may serve as a station (STA).

[0078] According to an embodiment, when assuming a 1:1 connection between the first electronic device **210** and the second electronic device **220**, one electronic device (e.g., the first electronic device **210**) may operate as a group owner (GO), and another electronic device (or peer device) (e.g., the second electronic device **220**) may operate as a client. According to an embodiment, the group owner (e.g., the first electronic device **210**) may perform a role (or function) like an AP of WLAN, and the client (e.g., the second electronic device **220**) may perform a role like a station (STA) of the WLAN. In an embodiment, the roles of the electronic devices **210** and **220** within the P2P group **200** may be determined through a P2P protocol according to a Wi-Fi Direct connection procedure (e.g., Group Owner Negotiation). An example of this is illustrated in FIG. **3**.

[0079] According to an embodiment, a connection between the electronic devices **210** and **220** in the P2P group **200** can be not only a 1:1 connection but also a 1:N connection (where N is a natural number greater than or equal to 2), and the number of acceptable clients may be determined according to the capability of the group owner (e.g., the first electronic device **210**).

[0080] FIG. **3** is a diagram illustrating an example in which a first electronic device and a second electronic device are connected through Wi-Fi Direct according to an embodiment of the disclosure.

[0081] Referring to FIG. **3**, FIG. **3** illustrates messages exchanged during negotiation for determining a group owner (GO) performed while a first electronic device (e.g., the first electronic device **210** of FIG. **2**) and a second electronic device (e.g., the second electronic device **220** of FIG. **2**) are connected through short-range wireless communication (e.g., Wi-Fi Direct).

[0082] In operation **301**, the first electronic device **210** may transmit a GO negotiation request message to the second electronic device **220**.

[0083] According to an embodiment, the first electronic device **210** may discover an external electronic device (e.g., the second electronic device **220**) to be connected through short-range wireless communication in a discovery procedure, and transmit a GO negotiation request message to the discovered second electronic device **220**.

[0084] According to an embodiment, the GO negotiation request message may include P2P information element (IE) information and Wi-Fi simple configuration information element (WSC IE) information. The P2P IE information may include a GO intent and operating channel attribute information which are available for determining a GO. The operating channel attribute information may include preferred channel information which is information related to a channel preferred by the first electronic device **210** among channels which may be established between the first electronic device **210** and the second electronic device **220**, and/or preferred frequency band information which is information related to a frequency band preferred by the first electronic device **210**. The preferred channel information may be included in a channel number field of an operating channel attribute field. The preferred frequency band information may be included in an operating class field of the operating channel attribute field.

[0085] In operation **303**, the second electronic device **220** may transmit a GO negotiation response message to the first electronic device **210**.

[0086] According to an embodiment, the GO negotiation response message may include P2P IE information and WSC IE information. The P2P IE information may include a GO intent and operating channel attribute information which are available for determining a GO. The operating channel attribute information may include preferred channel information which is information related to a channel preferred by the second electronic device **220** among channels which may be established between the first electronic device **210** and the second electronic device **220**, and/or

preferred frequency band information which is information related to a frequency band preferred by the second electronic device **220**. The preferred channel information may be included in a channel number field of an operating channel attribute field. The preferred frequency band information may be included in an operating class field of the operating channel attribute field.

[0087] According to an embodiment, the first electronic device **210** may receive the GO negotiation response message and compare a GO intent included in the GO negotiation response message with a GO intent included in the GO negotiation request message. According to an embodiment, based on the comparison of the GO intents, an electronic device (e.g., the first electronic device **210**) having transmitted a GO intent having a larger value may become a group owner (GO), and an electronic device (e.g., the second electronic device **220**) having transmitted a GO intent having a smaller value may become a GC (group client). The GO may operate as a host in a short-range wireless communication system (e.g., the P2P group **200**), and the GC may operate as a client in the short-range wireless communication system (e.g., the P2P group **200**). For convenience of explanation, it is assumed that the first electronic device **210** performs the role of a GO.

[0088] The first electronic device **210** may select a channel to be used for a connection between the first electronic device **210** and the second electronic device **220**, based on a preferred channel of the first electronic device **210**, a preferred frequency band of the first electronic device **210**, a preferred channel of the second electronic device **220**, and/or a preferred frequency band of the second electronic device **220**.

[0089] In operation **305**, the first electronic device **210** may transmit a GO negotiation confirmation message (e.g., GO negotiation confirmation) to the second electronic device **220**. According to an embodiment, the GO negotiation confirmation message may include information on the selected channel.

[0090] Referring to the above-described embodiment, in discovering an electronic device (e.g., the second electronic device **220**) to be connected through a Wi-Fi Direct scheme, the first electronic device **210** may discover various electronic devices (e.g., the second electronic device **220**) which support Wi-Fi Direct regardless of an AP (not shown).

[0091] According to an embodiment, a communication scheme in which the first electronic device **210** and the second electronic device **220** are directly connected without going through separate entities may be defined as a D2D communication scheme. For example, the D2D communication scheme may refer to a communication scheme in which required data is exchanged without going through an access point (AP) in a process of setting up (or establishing) a communication channel between the first electronic device **210** and the second electronic device **220**. According to an embodiment, the D2D communication scheme may include, for example, a Wi-Fi direct scheme as exemplified in FIGS. **2** and **3** and an NAN scheme as exemplified in FIG. **4**.

[0092] FIG. **4** is a diagram illustrating an example in which electronic devices are connected in an NAN cluster according to an embodiment of the disclosure.

[0093] According to an embodiment, FIG. **4** may illustrate an example of a configuration of a neighbor awareness networking (NAN) cluster **400** for a proximity network. In the following description, the cluster **400** may refer to a set of electronic devices **410**, **420**, **430**, or **440** constituting a proximity network so as to allow the respective electronic devices (or NAN devices) (e.g., the electronic device **101** of FIG. **1**) **410**, **420**, **430**, or **440** to mutually transmit and/or receive data. For example, the cluster **400** may be referred to as an NAN cluster according to the NAN specification (or standard).

[0094] Referring to FIG. **4**, the cluster **400** may include the multiple electronic devices **410**, **420**, **430**, or **440**. The electronic devices **410**, **420**, **430**, or **440** included within the cluster **400** may transmit and/or receive a beacon (or discovery beacon) and/or a service discovery frame (SDF) (hereinafter, referred to as an "SDF") within a synchronized time duration (or communication interval) (e.g., a discovery window (DW)).

[0095] The electronic devices **410**, **420**, **430**, or **440** included within the cluster **400** may have their time clocks synchronized with each other. For example, the electronic devices **410**, **420**, **430**, and **440** may be synchronized to the time clock of one electronic device (e.g., the electronic device **410**) and may exchange beacons and SDFs with each other in the same discovery window (DW).

[0096] According to an embodiment, an electronic device supporting a low-power short-range communication technology based on NAN may broadcast a discovery signal (e.g., a beacon) for discovering another electronic device at every preconfigured first cycle (e.g., about 100 msec) and perform scanning at every preconfigured second cycle (e.g., about 10 msec) to receive the discovery signal broadcasted from the other electronic device.

[0097] According to an embodiment, the electronic devices **410**, **420**, **430**, and **440** may detect at least one other electronic device located around the electronic devices, based on the discovery signal received through the scanning, and perform NAN cluster synchronization with the detected at least one other electronic device. In an embodiment, the NAN cluster synchronization may include an operation of receiving time clock information of an electronic device representing an NAN cluster so that electronic devices included in the NAN cluster transmit and/or receive data through the same channel and/or during the same time period.

[0098] For example, as illustrated in FIG. **4**, each of the multiple electronic devices **410**, **420**, **430**, or **440** may transmit a beacon and receive beacons from the other electronic devices **410**, **420**, **430**, or **440**, so as to form one cluster **400** that operates according to a synchronized time clock, and the electronic devices **410**, **420**, **430**, or **440** within the cluster **400** may perform NAN cluster synchronization.

[0099] According to an embodiment, the NAN cluster synchronization may be performed with reference to a time and a channel of an electronic device having the highest master preference within the cluster **400**. For example, the electronic devices **410**, **420**, **430**, or **440** within the cluster **400** formed through discovery may exchange a signal regarding master preference information indicating a preference for operating as an anchor master, and may determine an electronic device having the highest master preference as an anchor master (or master electronic device) through the exchanged signal.

[0100] According to an embodiment, the anchor master may refer to an electronic device which serves as a reference for time and channel synchronization of the electronic devices **410**, **420**, **430**, or **440** within the cluster **400**. The anchor master may be changed based on a master preference of the electronic device. Each of the time and channel synchronized electronic devices **410**, **420**, **430**, or **440** may transmit a beacon and an SDF and receive beacons and SDFs from the other electronic devices within the cluster **400**, within a discovery window (or discovery interval) that is repeated according to a preconfigured cycle.

[0101] According to an embodiment, a beacon may be transmitted and/or received periodically during each discovery window to continuously maintain time and channel synchronization of the electronic devices **410**, **420**, **430**, or **440** within the cluster **400**. According to an embodiment, an SDF may be transmitted and/or received in a discovery window as needed to provide a service to the discovered electronic devices **410**, **420**, **430**, or **440**. According to an embodiment, an electronic device operating as an anchor master among the time and channel synchronized electronic devices **410**, **420**, **430**, or **440** may transmit a beacon to detect a new electronic device during an interval between discovery windows.

[0102] According to an embodiment, each of the electronic devices **410**, **420**, **430**, or **440** within the cluster **400** may operate in an active state only during a discovery window, and operate in a low-power state (e.g., a sleep state) during the remaining interval other than the discovery window, thereby reducing current consumption.

[0103] For example, a discovery window corresponds to a time (e.g., milliseconds) during which an electronic device is in an active state (or awake state), where a large amount of current consumption occurs, while the electronic device may remain in a sleep state during the remaining

interval other than the discovery window, thereby enabling low-power discovery.

[0104] According to an embodiment, the electronic devices **410**, **420**, **430**, or **440** within the cluster **400** may be simultaneously activated at a start time point (e.g., DW start) of a synchronized discovery window, and simultaneously switched to a sleep state at an end time point (e.g., DW end) of the discovery window.

[0105] According to an embodiment, the electronic devices **410**, **420**, **430**, or **440** included within the cluster **400** may perform discovery, synchronization, and data exchange operations by using a protocol illustrated in FIG. **5**, which will be described later.

[0106] FIG. **5** is a diagram illustrating an example of a protocol for transmitting a signal by an electronic device included in an NAN cluster according to an embodiment of the disclosure.

[0107] For example, FIG. **5** may represent an example diagram for a discovery window according to an embodiment. FIG. **5** illustrates an example in which electronic devices included in one cluster transmit a signal through a specific channel (e.g., channel No. 6 (Ch6)) based on the NAN standard.

[0108] Referring to FIG. **5**, electronic devices included in one cluster may transmit a synchronization beacon **510** and an SDF **520** in a synchronized discovery window (DW) **525**. A discovery beacon **530** may be transmitted by at least one electronic device in another interval **540** (e.g., an interval between discovery windows) other than the discovery window **525**. According to an embodiment, the electronic devices may transmit the synchronization beacon **510** and the SDF **520** on a contention basis. For example, the synchronization beacon **510** and the SDF **520** may be transmitted based on contention among respective electronic devices (e.g., the electronic devices **410**, **420**, **430**, and **440** of FIG. **4**) belonging to a cluster (e.g., the cluster **400** of FIG. **4**).

[0109] According to an embodiment, the discovery window **525** may be an interval during which a corresponding electronic device is activated from a sleep state, which is a power-saving mode, to a wake-up state for data exchange between the respective electronic devices. For example, the discovery window **525** may be divided into time units (TUs) in milliseconds. According to an embodiment, the discovery window **525** for transmitting and/or receiving the synchronization beacon **510** and the SDF **520** may occupy 16 time units (TUs) (16 TUs), and may have a cycle (or interval) that is repeated with 512 time units (512 TUs).

[0110] According to an embodiment, the discovery beacon **530** may indicate a signal transmitted so that other electronic devices which have not joined the cluster can discover the cluster. For example, the discovery beacon **530** is a signal for notifying the existence of the cluster, and electronic devices which have not joined the cluster may perform a passive scan to receive the discovery beacon **530**, thereby discovering and joining the cluster.

[0111] According to an embodiment, the discovery beacon **530** may include information necessary for synchronizing with the cluster. For example, the discovery beacon **530** may include at least one of a frame control (FC) field indicating a function (e.g., a beacon) of a signal, a broadcast address, a media access control (MAC) address of a transmission electronic device, a cluster identifier (ID), a sequence control field, a time stamp for a beacon frame, a beacon interval indicating a transmission interval of the discovery beacon **530**, or capability information regarding a transmission electronic device transmitting the discovery beacon **530**.

[0112] According to an embodiment, the discovery beacon **530** may include at least one proximity network (or cluster)-related information element (IE). In an embodiment, proximity network-related information may be referred to as attribute information.

[0113] According to an embodiment, the synchronization beacon **510** may indicate a signal for maintaining synchronization between synchronized electronic devices within a cluster. The synchronization beacon **510** may be transmitted by a synchronization device among the electronic devices within the cluster. For example, the synchronization device may include an anchor master electronic device, a master electronic device, or a non-master sync device as defined in the NAN standard.

[0114] According to an embodiment, the discovery beacon **530** may include information necessary for the electronic devices within the cluster to synchronize. For example, the synchronization beacon **510** may include at least one of an FC field indicating a function (e.g., a beacon) of a signal, a broadcast address, a MAC address of a transmission electronic device, a cluster identifier, a sequence control field, a time stamp for a beacon frame, a beacon interval indicating an interval between start points of the discovery window **525**, or capability information for a transmission electronic device. According to an embodiment, the discovery beacon **530** may include at least one proximity network (or cluster)-related information element. For example, the proximity network-related information may include contents for a service provided through a proximity network.

[0115] According to an embodiment, the SDF **520** may represent a signal for exchanging data through the proximity network. According to an embodiment, the SDF **520** represents a vendor specific public action frame and may include various fields. For example, the SDF **520** may include a category or an action field, and may include at least one proximity network-related information.

[0116] As described above, the synchronization beacon **510**, the SDF **520**, and the discovery beacon **530** may include the proximity network-related information. In an embodiment, the proximity network-related information may include an identifier indicating the type of information, the length of the information, and a body field that is corresponding information. According to an embodiment, the corresponding information may include at least one of master indication information, cluster information, service identifier list information, service descriptor information, connection capability information, wireless LAN infrastructure information, peer-to-peer (P2P) operation information, independent basic service set (IBSS) information, mesh information, additional proximity network service discovery information, further availability map information, country code information, ranging information, cluster discovery information, or vendor specific information.

[0117] FIG. **6** is a diagram illustrating an example of data transmission and/or reception within an NAN cluster according to an embodiment of the disclosure.

[0118] For example, FIG. **6** illustrates an example in which a first electronic device **610**, a second electronic device **620**, and a third electronic device **630** form one cluster through a wireless short-range communication technology, and each of the electronic devices **610**, **620**, or **630** may transmit and/or receive a beacon and/or an SDF to/from one another. According to an embodiment, in FIG. **6**, an example may be given in which the first electronic device **610** among the electronic devices **610**, **620**, or **630** configuring a cluster serves as a master electronic device.

[0119] Referring to FIG. **6**, the first electronic device **610** may transmit a beacon and an SDF within a discovery window **650**. According to an embodiment, the first electronic device **610** may broadcast a beacon and an SDF in each discovery window **650** that is repeated at every predetermined interval (e.g., an interval **660**).

[0120] According to an embodiment, the second electronic device **620** and the third electronic device **630** may receive the beacon and the SDF transmitted by the first electronic device **610**. According to an embodiment, each of the second electronic device **620** and the third electronic device **630** may receive the beacon and the SDF broadcasted from the first electronic device **610** in each discovery window **650**.

[0121] According to an embodiment, the beacon transmitted within the discovery window **650** may indicate a synchronization beacon and may include information for maintaining synchronization between the electronic devices **610**, **620**, or **630**. For example, the second electronic device **620** and/or the third electronic device **630** may perform NAN cluster synchronization, based on time clock information of the first electronic device **610** included in the beacon transmitted by the first electronic device **610** operating as a master. For example, the second electronic device **620** and/or the third electronic device **630** may be synchronized so that the discovery window **650** may be activated at the same time.

[0122] According to an embodiment, in an interval (e.g., the interval **660**) other than the discovery

window **650**, the electronic devices **610**, **620**, or **630** may maintain a sleep state to reduce current consumption. For example, the electronic devices **610**, **620**, or **630** may operate in a wake state only in an interval of the discovery window **650**, based on a synchronized time clock, so as to reduce current consumption.

[0123] In an embodiment of the disclosure, a method capable of supporting fast device discovery based on Wi-Fi P2P between electronic devices supporting Wi-Fi, and an electronic device supporting the same are provided. According to an embodiment, the electronic device **101** can improve the speed of device discovery, based on Wi-Fi D2D technology (e.g., a low-power short-range communication technology based on NAN (e.g., NAN technology) and Wi-Fi Direct technology). According to an embodiment, the electronic device **101** may use multiple bands (multi-band) (or multiple frequency bands (multi-frequency band)) to simultaneously use NAN technology and Wi-Fi Direct technology, so as to support device discovery.

[0124] According to an embodiment, the electronic device **101** may be connected to an external electronic device through various types of short-range wireless communication. For example, the electronic device **101** may transmit data (e.g., content) to the external electronic device or receive data from the external electronic device, and perform a service based on the data.

[0125] According to an embodiment, the electronic device **101** may be connected to the external electronic device through a first communication scheme (or a first protocol) or a second communication scheme (or a second protocol) of the short-range wireless communication. In an embodiment, the first communication scheme and the second communication scheme may include device-to-device communication (D2D) in the short-range wireless communication. According to an example, the first communication scheme may include NAN-based short-range wireless communication (hereinafter, referred to as "NAN technology" or "NAN communication"), and the second communication scheme may include Wi-Fi Direct-based short-range wireless communication (hereinafter, referred to as "Wi-Fi Direct technology" or "Wi-Fi Direct communication").

[0126] According to an embodiment, the electronic device **101** may be connected to the external electronic device through a third communication scheme of the short-range wireless communication. In an embodiment, the third communication scheme may include BLE-based short-range wireless communication in the short-range wireless communication.

[0127] According to an embodiment, when the external electronic device supports both the NAN technology of the first communication scheme and the Wi-Fi Direct technology of the second communication scheme, the electronic device **101** may be connected to the external electronic device through at least one of the first communication scheme or the second communication scheme of the short-range wireless communication. According to an embodiment, when the external electronic device does not support the NAN technology of the first communication scheme, the electronic device **101** may be connected to the external electronic device through the Wi-Fi Direct technology of the second communication scheme in the short-range wireless communication. According to an embodiment, the electronic device **101** may perform device discovery with the external electronic device, based on different frequency bands (e.g., multiple frequency bands) according to the first communication scheme and/or the second communication scheme.

[0128] Hereinafter, the electronic device **101** and its operation in various embodiments will be described.

[0129] FIG. **7** is a diagram schematically illustrating a configuration of an electronic device according to an embodiment of the disclosure.

[0130] Referring to FIG. **7**, the electronic device **101** according to an embodiment of the disclosure may include a first communication circuit **710**, a second communication circuit **740**, the memory **130**, and/or the processor **120**. According to an embodiment, the electronic device **101** may include all or at least a part of the components of the electronic device **101** as described in the description

part referring to FIG. **1**.

[0131] According to an embodiment, the first communication circuit **710** may correspond to the wireless communication module **192** as illustrated in FIG. **1**. According to an embodiment, the first communication circuit **710** may support various communication schemes based on multiple bands (multi-band) (or multiple frequency bands (multi-frequency band)). According to an embodiment, the first communication circuit **710** may connect to and communicate with an external electronic device through a first communication scheme and/or a second communication scheme of short-range wireless communication. In an embodiment, the first communication scheme and the second communication scheme may include device-to-device communication (e.g., D2D communication) in the short-range wireless communication. According to an embodiment, the first communication scheme of the short-range wireless communication may include an NAN communication scheme. According to an embodiment, the second communication scheme of the short-range wireless communication may include a Wi-Fi Direct communication scheme.

[0132] According to an embodiment, the first communication circuit **710** may include various circuit structures used for modulation and/or demodulation of a signal within the electronic device **101**. For example, the first communication circuit **710** may modulate a signal of a baseband into a signal of a radio frequency (RF) band so as to be output through an antenna (not shown), or demodulate a signal of an RF band received through the antenna into a signal of a baseband to transmit the demodulated signal to the processor **120**.

[0133] According to an embodiment, the first communication circuit **710** may transmit or receive various data to or from the external electronic device through a frequency band (e.g., about 2.4 GHz band, about 5 GHz band, and/or about 6 GHz band) supported by the short-range wireless communication. According to an embodiment, the short-range wireless communication may include Wi-Fi communication defined in Institute of Electrical and Electronics Engineers (IEEE) 802.11 WLAN.

[0134] According to an embodiment, the first communication circuit **710** may include multiple cores (e.g., baseband cores) for various frequency bands supported by the short-range wireless communication. For example, the first communication circuit **710** may include a first core **720** for a first baseband (e.g., about 5 GHz band) and a second core **730** for a second baseband (e.g., about 2.4 GHz band). In an embodiment, an example of two basebands and baseband cores (e.g., the first core **720** and the second core **730**) corresponding thereto is described, but the number of baseband cores and supported basebands are not limited thereto. For example, the first communication circuit **710** may include a third core for a third baseband (e.g., about 6 GHz band), or may be implemented to support the third baseband in the first core **720** or the second core **730**.

[0135] According to an embodiment, the first communication circuit **710** may support multiple frequency bands (or basebands) (e.g., dual bands), based on the first core **720** and the second core **730**, and may support different frequency bands simultaneously without antenna switching. For example, the first communication circuit **710** may support dual Wi-Fi (e.g., real simultaneous dual band (RSDB) or dual band simultaneous (DBS)). According to an embodiment, the first communication circuit **710** may support different topologies simultaneously through the first core **720** and the second core **730** for supporting multiple frequency bands, and thus support data communication simultaneously in the multiple frequency bands (e.g., dual bands). According to an embodiment, the first communication circuit **710** may support fast device discovery based on Wi-Fi P2P, based on dual Wi-Fi in a discovery procedure for discovering an external electronic device.

[0136] According to an embodiment, the first communication circuit **710** may connect to and communicate with various external electronic devices through the first communication scheme and/or the second communication scheme, based on the control of the processor **120**. According to an embodiment, the first communication circuit **710** may be connected to an external electronic device through the first communication scheme while being simultaneously connected to another external electronic device through the second communication scheme.

[0137] According to an embodiment, the second communication circuit **740** may correspond to the wireless communication module **192** as illustrated in FIG. **1**. According to an embodiment, the second communication circuit **740** may support a third communication scheme based on out-of-band (OOB). According to an embodiment, the second communication circuit **740** may connect to and communicate with an external electronic device through the third communication scheme of the short-range wireless communication. In an embodiment, the third communication scheme may include Bluetooth or Bluetooth low energy (BLE).

[0138] According to an embodiment, the second communication circuit **740** may transmit or receive data to or from the external electronic device through a specified frequency band (e.g., about 2.4 GHz band) supported by the short-range wireless communication. According to an embodiment, the second communication circuit **740** may establish short-range wireless communication with the external electronic device, and perform data communication with the external electronic device.

[0139] According to an embodiment, the memory **130** may correspond to the memory **130** of FIG. **1**. According to an embodiment, the memory **130** may store various data used by the electronic device **101**. In an embodiment, the data may include input data or output data for an application (e.g., the program **140** of FIG. **1**) and a command related to the application. In an embodiment, the data may include configuration information (or allocation information) regarding a preferred frequency band and a preferred channel (e.g., a discovery (or configuration) channel) for each communication scheme. In an embodiment, the data may include service-specific characteristic information capable of identifying service characteristics of a D2D service. In an embodiment, the data may include mapping information regarding a communication scheme assigned (or mapped) to each piece of service-specific characteristic information.

[0140] According to an embodiment, the memory **130** may store instructions that, when executed, cause the processor **120** to operate. For example, the application may be stored as software (e.g., the program **140** of FIG. **1**) in the memory **130** and may be executable by the processor **120**. According to an embodiment, the application may be various applications capable of providing various functions or services (e.g., a D2D service) in the electronic device **101**.

[0141] According to an embodiment, the processor **120** may perform an application layer processing function requested by a user of the electronic device **101**. According to an embodiment, the processor **120** may provide control and commands of functions for various blocks of the electronic device **101**. According to an embodiment, the processor **120** may perform an operation or data processing related to control and/or communication of each component of the electronic device **101**. For example, the processor **120** may include at least some of the configurations and/or the functions of the processor **120** of FIG. **1**. The processor **120** may be operatively connected to, for example, the components of the electronic device **101**. The processor **120** may load commands or data received from other components of the electronic device **101** into the memory **130**, process the commands or the data stored in the memory **130**, and store resulting data.

[0142] According to an embodiment, the processor **120** may be an application processor (AP). According to an embodiment, the processor **120** may be a system semiconductor responsible for an operation and a multimedia driving function of the electronic device **101**. According to an embodiment, the processor **120** may be configured in the form of a system-on-chip (SoC), and may include a technology-intensive semiconductor chip which integrates multiple semiconductor technologies into one and implements system blocks into one chip. According to an embodiment, the system blocks of the processor **120** may include, for example, a graphics processing unit (GPU), an image signal processor (ISP), a central processing unit (CPU), a neural processing unit (NPU), a digital signal processor, a modem, connectivity, and/or a security block.

[0143] According to an embodiment, the modem may perform a role of enabling various communication functions to be used in the electronic device **101**. For example, the modem may support communication such as call and data transmission and reception while transmitting and

receiving a signal to and from a base station. According to an embodiment, the modem may include an integrated modem (e.g., a cellular modem, an LTE modem, a 5G modem, a 5G-Advanced modem, and a sixth generation (6G) modem) which supports communication technologies such as LTE and second generation (2G) to 5G. According to an embodiment, the modem may include an AI modem to which an AI algorithm is applied.

[0144] In an embodiment, the connectivity may support wireless data transmission based on IEEE 802.11. According to an embodiment, the connectivity may support a communication service based on IEEE 802.11 (e.g., Wi-Fi) and/or 802.15 (e.g., Bluetooth, ZigBee, or UWB). For example, the connectivity may support a communication service targeting an unspecified number of people in a localized area such as indoors by using an unlicensed band.

[0145] According to an embodiment, the processor **120** may be a communication processor (CP) which receives data transmitted by the application processor and generates a packet for transmitting the received data to an external electronic device. For example, the processor **120** may be defined as a processor included in a communication module (e.g., the wireless communication module **192** of FIG. **1**). According to an embodiment, the processor **120** may be implemented by being integrated with the first communication circuit **710** into one physical chip.

[0146] According to an embodiment of the disclosure, the processor **120** may include processing circuitry and/or executable program elements. According to an embodiment, the processor **120** may control (or process) an operation related to supporting a D2D service capable of exchanging data by directly connecting to an external electronic device adjacent to the periphery of the electronic device **101**, based on the processing circuitry and/or the executable program elements. According to an embodiment, the processor **120** may control (or process) an operation related to supporting device discovery simultaneously in multiple frequency bands based on the first communication scheme (e.g., NAN communication) and/or the second communication scheme (e.g., Wi-Fi Direct communication) according to activation (or initiation) of a service using short-range wireless communication.

[0147] According to an embodiment, the processor **120** may detect initiation of the service. According to an embodiment, the processor **120** may perform an operation of configuring, based on detecting the initiation of the service, a discovery protocol for each of multiple frequency bands related to discovering, using the first communication circuit **710**, an external electronic device for which the service is to be performed. According to an embodiment, the processor **120** may perform an operation of transmitting a discovery mode start message including configuration information regarding the configured discovery protocol by using OOB through the second communication circuit **740**. According to an embodiment, the processor **120** may perform an operation of discovering external electronic devices through the first communication circuit **710**, based on a protocol corresponding to each of the multiple frequency bands. According to an embodiment, the processor **120** may perform an operation of determining a service target device among at least one discovered external electronic device. According to an embodiment, the processor **120** may perform a connection procedure with the determined external electronic device.

[0148] According to an embodiment, a detailed operation of the processor **120** of the electronic device **101** is described with reference to the drawings described below.

[0149] According to an embodiment, the operations performed by the processor **120** may be implemented as a recording medium (or computer program product). For example, the recording medium may include a non-transitory computer-readable recording medium on which a program for executing various operations performed by the processor **120** is recorded.

[0150] The embodiments described in this disclosure may be implemented in a recording medium readable by a computer or a similar device by using software, hardware, or a combination thereof. In terms of hardware implementation, operations described in an embodiment may be implemented using at least one of application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field

programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, and/or other electrical units for performing functions.

[0151] In an embodiment, the recording medium (or computer program product) may include a computer-readable recording medium having recorded thereon a program for executing an operation of configuring, based on detecting initiation of a service, a discovery protocol for each of multiple frequency bands related to discovering, using the first communication circuit **710** configured to support device-to-device (D2D) communication, an external electronic device for which the service is to be performed, an operation of transmitting a discovery mode start message including configuration information regarding the configured discovery protocol by using out-of-band (OOB) through the second communication circuit **740** configured to support OOB communication, an operation of discovering external electronic devices through the first communication circuit **710**, based on a protocol corresponding to each of the multiple frequency bands, an operation of determining a service target device among at least one discovered external electronic device, and an operation of performing a connection procedure with the determined external electronic device.

[0152] FIG. **8** is a diagram illustrating an example in which an electronic device performs device discovery for an external electronic device according to an embodiment of the disclosure.

[0153] According to an embodiment, FIG. **8** may illustrate an example in which the electronic device **101** (e.g., the first electronic device **610** of FIG. **6**) discovers a first external electronic device **810** (e.g., the second electronic device **620** of FIG. **6**) and a second external electronic device **820** (e.g., the second electronic device **620** of FIG. **6**), based on different multiple frequency bands based on a first communication scheme and/or a second communication scheme.

[0154] According to an embodiment, it may be assumed that the electronic device **101** is an electronic device capable of supporting both the first communication scheme (or a first protocol) and the second communication scheme (or a second protocol). According to an embodiment, it may be assumed that the first external electronic device **810** is an electronic device capable of supporting both the first communication scheme and the second communication scheme. According to an embodiment, it may be assumed that the second external electronic device **820** is an electronic device which does not support the first communication scheme and is capable of supporting the second communication scheme.

[0155] Referring to FIG. **8**, in operation **801**, the electronic device **101** may detect initiation of a service. According to an embodiment, the electronic device **101** may receive, from a user, a user input (e.g., a request to execute an application capable of performing a service by using short-range wireless communication) for initiating a D2D service (e.g., a Wi-Fi P2P-based service) based on a connection with an external electronic device. According to an embodiment, the electronic device **101** may determine initiation of the service, based on receiving the user input. In an embodiment, the service using short-range wireless communication may include various Wi-Fi P2P-based services such as a content transmission service which transmits data (or content) temporarily or non-temporarily stored in the electronic device **101** to the external electronic device, a device-to-device continuity service, or a device-to-device screen sharing service. For example, the service using the short-range wireless communication may include various D2D services which can be provided based on a direct connection between the electronic device **101** and the external electronic device.

[0156] In operation **803**, the electronic device **101** may configure, based on detecting the initiation of the service, multiple channels (e.g., a discovery channel or a configuration channel), based on each of a first frequency band and a second frequency band. According to an embodiment, the electronic device **101** may activate, based on detecting the initiation of the service, an interface for the first communication scheme (or the first protocol) and the second communication scheme (or the second protocol) through the first communication circuit **710** (e.g., the first communication circuit **710** of FIG. **7**). For example, the electronic device **101** may control the first communication

circuit **710** to activate the short-range wireless communication in response to the activation of the service using the short-range wireless communication. According to an embodiment, the electronic device **101** may control the first communication circuit **710** to activate the short-range wireless communication when an application capable of performing the service using the short-range wireless communication is executed, or when the application capable of performing the service using the short-range wireless communication requests to perform the service using the short-range wireless communication.

[0157] According to an embodiment, the electronic device **101** may activate an interface of the first communication scheme and an interface of the second communication scheme for device-to-device communication in the short-range wireless communication, and discover an external electronic device to be connected to the electronic device **101**, based on each of the first communication scheme and the second communication scheme. According to an embodiment, the first communication scheme of the short-range wireless communication may include an NAN communication scheme. According to an embodiment, the second communication scheme of the short-range wireless communication may include a Wi-Fi Direct communication scheme. According to an embodiment, the electronic device **101** may configure a first frequency band (e.g., about 5 GHz band) and a discovery channel to be used for device discovery based on a P2P protocol, based on the first core **720** of the first communication circuit **710**. According to an embodiment, the electronic device **101** may configure a second frequency band (e.g., about 2.4 GHz band) and a discovery channel to be used for device discovery based on the P2P protocol, based on the second core **730** of the first communication circuit **710**.

[0158] In operations **805** and **807**, the electronic device **101** may transmit (e.g., broadcast) a discovery mode start message by using the second communication circuit **740**. In an embodiment, operations **805** and **807** may be performed in parallel or substantially simultaneously. According to an embodiment, the discovery mode start message may include configuration information regarding multiple frequency bands that the electronic device **101** supports for the short-range wireless communication.

[0159] According to an embodiment, the configuration information regarding the multiple frequency bands may include configuration information regarding a frequency band and a discovery channel corresponding to each of heterogeneous communication schemes, such as the first communication scheme and the second communication scheme. For example, the discovery mode start message may include information (or first protocol information) on a first frequency band related to the first communication scheme and a channel allocated (or configured) in the first frequency band, and information (or second protocol information) on a second frequency band related to the second communication scheme and a channel allocated (or configured) in the second frequency band. For example, the configuration information may include band information and channel information related to the multiple frequency bands according to heterogeneous protocols.

[0160] According to an embodiment, the configuration information regarding the multiple frequency bands may include configuration information regarding frequency bands and discovery channels respectively corresponding to dual bands in a homogeneous communication scheme (e.g., the second communication scheme). For example, the discovery mode start message may include information on a first frequency band related to one communication scheme and a channel allocated (or configured) in the first frequency band, and information on a second frequency band and a channel allocated (or configured) in the second frequency band. For example, the configuration information may include band information and channel information related to the multiple frequency bands according to a homogeneous protocol.

[0161] According to an embodiment, the electronic device **101** may control the second communication circuit **740** (e.g., the second communication circuit **740** of FIG. **7**) to broadcast, through a third communication scheme, the discovery mode start message including configuration information for simultaneously discovering at least one external electronic device supporting the

first communication scheme and/or the second communication scheme. According to an embodiment, the electronic device **101** may transmit the discovery mode start message to external electronic devices (e.g., the first external electronic device **810** and the second external electronic device **820**) located around the electronic device **101** by using the second communication circuit **740**, based on out-of-band (OOB).

[0162] In operations **809** and **811**, the first external electronic device **810** and the second external electronic device **820** may receive the discovery mode start message transmitted (e.g., broadcasted) by the electronic device **101** by using the third communication scheme. According to an embodiment, the first external electronic device **810** and the second external electronic device **820** may receive the discovery mode start message transmitted by the electronic device **101** through the OOB. According to an embodiment, the first external electronic device **810** and the second external electronic device **820** may determine that reception of the discovery mode start message is a trigger for activating a D2D service. According to an embodiment, the first external electronic device **810** and the second external electronic device **820** may identify the configuration information included in the discovery mode start message. According to an embodiment, the first external electronic device **810** and the second external electronic device **820** may determine a communication scheme (or protocol) and/or a frequency band to be used for discovery of the electronic device **101**, based on the configuration information.

[0163] According to an embodiment, in the example of FIG. **8**, it may be assumed that the first external electronic device **810** is an electronic device capable of supporting both the first communication scheme and the second communication scheme. According to an embodiment, when the first external electronic device **810** receives the discovery mode start message from the electronic device **101** through the OOB, the first external electronic device **810** may identify that the electronic device **101** supports the first communication scheme (e.g., the first protocol), based on the configuration information.

[0164] According to an embodiment, in operation **809**, the first external electronic device **810** may determine the first communication scheme as the communication scheme to be used for discovery of the electronic device **101**. For example, the first external electronic device **810** may configure a first frequency band and/or a first discovery channel in response to the determination of the first communication scheme. According to an embodiment, the first external electronic device **810** may determine one of the first communication scheme or the second communication scheme, based on whether the discovery mode start message transmitted by the electronic device **101** includes information related to the first communication scheme, and perform discovery with the electronic device **101**, based on the determined communication scheme.

[0165] According to an embodiment, the first external electronic device **810** may determine the first communication scheme (e.g., the NAN communication scheme) having relatively high performance (or new technology) when supporting the first communication scheme and the second communication scheme. According to an embodiment, the first external electronic device **810** may determine the first communication scheme or the second communication scheme according to various states of the first external electronic device **810**. According to an embodiment, the first external electronic device **810** may determine the second communication scheme according to a state of the first external electronic device **810**, even in a state where priority is designated to the first communication scheme. For example, the first external electronic device **810** may determine a communication scheme for discovery and connection as the second communication scheme when the second communication scheme is activated or when the second communication scheme is already in use.

[0166] According to an embodiment, in the example of FIG. **8**, it may be assumed that the second external electronic device **820** is an electronic device which does not support the first communication scheme and is capable of supporting the second communication scheme. According to an embodiment, when the second external electronic device **820** receives the discovery mode

start message from the electronic device **101** through the OOB, the second external electronic device **820** may identify that the electronic device **101** supports the second communication scheme (e.g., the second protocol), based on the configuration information.

[0167] According to an embodiment, in operation **811**, the second external electronic device **820** may determine the second communication scheme as the communication scheme to be used for discovery of the electronic device **101**. For example, the second external electronic device **820** may configure a second frequency band and/or a second discovery channel in response to the determination of the second communication scheme. According to an embodiment, the second external electronic device **820** may determine the second communication scheme, based on whether the discovery mode start message transmitted by the electronic device **101** includes information related to the second communication scheme, and perform discovery with the electronic device **101**, based on the determined second communication scheme.

[0168] According to an embodiment, operations **809** and **811** may be performed substantially simultaneously.

[0169] In operations **813** and **815**, the electronic device **101** may perform discovery, based on a communication scheme (e.g., a protocol) corresponding to each of the first external electronic device **810** and the second external electronic device **820**.

[0170] According to an embodiment, the electronic device **101** may control the first communication circuit **710** to receive signals of various frequency bands in order to discover an external electronic device to be connected through the first communication scheme or the second communication scheme. According to an embodiment, the electronic device **101** may control the first communication circuit **710** (e.g., the first core **720**) to receive a signal of the first frequency band, and control the first communication circuit **710** (e.g., the second core **730**) to receive a signal of the second frequency band different from the first frequency band.

[0171] According to an embodiment, in operation **813**, the electronic device **101** may discover the first external electronic device **810** based on the first communication scheme. According to an embodiment, although FIG. **8** illustrates the first external electronic device **810**, the electronic device **101** according to an embodiment may discover at least one external electronic device supporting the first communication scheme, based on the first communication scheme.

[0172] According to an embodiment, in operation **815**, the electronic device **101** may discover the second external electronic device **820** based on the second communication scheme. According to an embodiment, although FIG. **8** illustrates the second external electronic device **820**, the electronic device **101** according to an embodiment may discover at least one external electronic device supporting the second communication scheme, based on the second communication scheme.

[0173] According to an embodiment, FIG. **8** illustrates that the electronic device **101** discovers external electronic devices (e.g., the first external electronic device **810** and the second external electronic device **820**), but the disclosure is not limited thereto. For example, an operation of performing discovery in a channel of a frequency band synchronized between the electronic device **101** and the external electronic devices (e.g., the first external electronic device **810** and the second external electronic device **820**) may include a scheme in which the electronic device **101** proactively transmits a discovery request message and receives a response message corresponding thereto from the external electronic devices as in the example of FIG. **8**. For example, the operation of performing discovery in the channel of the frequency band synchronized between the electronic device **101** and the external electronic devices (e.g., the first external electronic device **810** and the second external electronic device **820**) may include a scheme in which the external electronic devices transmit a discovery request message in a synchronized channel, and the electronic device **101** transmits a response message corresponding to the discovery request message to the external electronic devices while listening in the synchronized channel.

[0174] In operation **817**, the electronic device **101** may generate a discovery list. According to an embodiment, the electronic device **101** may generate a discovery list, based on at least one external

electronic device (e.g., the first external electronic device **810**) discovered based on the first communication scheme and at least one external electronic device (e.g., the second external electronic device **820**) discovered based on the second communication scheme.

[0175] According to an embodiment, the electronic device **101** may determine (or select) an external electronic device to be connected from among the at least one external electronic device according to the discovery list. According to an embodiment, when the external electronic device to be connected is determined, the electronic device **101** may perform a connection with the determined external electronic device through the communication scheme used for discovery of the external electronic device. According to an embodiment, when the determined external electronic device is the first external electronic device **810**, the electronic device **101** may control the first communication circuit **710** to perform a connection with the first external electronic device **810** through the first communication scheme used for discovery of the first external electronic device **810**. According to an embodiment, when the determined external electronic device is the second external electronic device **820**, the electronic device **101** may control the first communication circuit **710** to perform a connection with the second external electronic device **820** through the second communication scheme used for discovery of the second external electronic device **820**.

[0176] The electronic device **101** according to an embodiment of the disclosure may include a first communication circuit (e.g., the wireless communication module **192** of FIG. **1** and/or the first communication circuit **710** of FIG. **7**) configured to support device-to-device (D2D) communication, a second communication circuit (e.g., the wireless communication module **192** of FIG. **1** and/or the second communication circuit **740** of FIG. **7**) configured to support out-of-band (OOB) communication, and at least one processor (e.g., the processor **120** of FIG. **1** and/or FIG. **7**) operatively connected to the first communication circuit and the second communication circuit.

[0177] According to an embodiment, the at least one processor **120** may detect initiation of a service. According to an embodiment, the at least one processor **120** may operate to configure, based on detecting the initiation of the service, a discovery protocol for each of multiple frequency bands related to discovering, using the first communication circuit, an external electronic device for which the service is to be performed. According to an embodiment, the at least one processor **120** may operate to transmit a discovery mode start message through the second communication circuit. According to an embodiment, the at least one processor **120** may operate to discover at least one external electronic device through the first communication circuit, based on a protocol corresponding to each of the multiple frequency bands. According to an embodiment, the at least one processor **120** may operate to determine one of the at least one discovered external electronic device as a service target device. According to an embodiment, the at least one processor **120** may operate to perform a connection procedure with the external electronic device determined as the service target device.

[0178] According to an embodiment, the service may include a D2D service which can be provided based on a direct connection with the external electronic device determined as the service target device.

[0179] According to an embodiment, the discovery mode start message may include configuration information regarding the discovery protocol.

[0180] According to an embodiment, the configuration information may include information on different frequency bands related to a first protocol for simultaneously discovering the at least one external electronic device and/or a second protocol different from the first protocol.

[0181] According to an embodiment, the at least one processor **120** may operate to transmit the discovery mode start message including the configuration information regarding the configured discovery protocol by using OOB communication through the second communication circuit.

[0182] According to an embodiment, the at least one processor **120** may operate to configure multiple discovery channels, based on each of a first frequency band and a second frequency band different from the first frequency band, based on heterogeneous protocols or a homogeneous

protocol.

[0183] According to an embodiment, the at least one processor **120** may operate to perform discovery with at least one first external electronic device, based on a first protocol, and to perform discovery with at least one second external electronic device, based on a second protocol.

[0184] According to an embodiment, the at least one processor **120** may operate to discover, based on a first frequency band according to a first protocol, at least one first external electronic device having determined a discovery mode in the first frequency band, and to discover, based on a second frequency band according to a second protocol different from the first protocol, at least one second external electronic device having determined a discovery mode in the second frequency band.

[0185] According to an embodiment, the at least one processor **120** may operate to discover, based on a first frequency band according to a specified protocol, at least one first external electronic device having determined a discovery mode in the first frequency band, and to discover, based on a second frequency band according to the specified protocol, at least one second external electronic device having determined a discovery mode in the second frequency band.

[0186] According to an embodiment, the at least one processor **120** may operate to generate a discovery list related to at least one external electronic device discovered based on the multiple frequency bands, and to determine at least one external electronic device to be connected for the service as the service target device, based on the discovery list.

[0187] According to an embodiment, the at least one processor **120** may operate to perform a direct connection with the external electronic device determined as the service target device, based on a protocol used to discover the external electronic device determined as the service target device.

[0188] According to an embodiment, when the external electronic device determined as the service target device is a first external electronic device supporting a first protocol, the at least one processor **120** may operate to perform a connection procedure with the first external electronic device through the first protocol used for discovery of the first external electronic device. According to an embodiment, when the external electronic device determined as the service target device is a second external electronic device supporting a second protocol, the at least one processor **120** may operate to perform a connection procedure with the second external electronic device through the second protocol used for discovery of the second external electronic device.

[0189] Hereinafter, an operation method of the electronic device **101** according to various embodiments will be described in detail. The operations performed by the electronic device **101** according to various embodiments may be executed by the processor **120** including various processing circuitry and/or executable program elements of the electronic device **101**. According to an embodiment, the operations performed by the electronic device **101** may be executed by instructions which are stored in the memory **130** and, when executed, cause the processor **120** to operate.

[0190] FIG. **9** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure.

[0191] According to an embodiment, FIG. **9** may illustrate an example of supporting device discovery for an external electronic device to be connected to a D2D service based on multiple frequency bands in the electronic device **101** according to an embodiment.

[0192] In the electronic device **101** according to an embodiment of the disclosure, a device discovery method based on multiple frequency bands may be performed, for example, according to the flowchart illustrated in FIG. **9**. The flowchart illustrated in FIG. **9** is merely a flowchart according to an embodiment of the device discovery method of the electronic device **101**, and the order of at least some operations may be changed, performed in parallel, or performed as independent operations, or at least some other operations may be performed complementarily to the at least some operations. According to an embodiment of the disclosure, operations **901** to **911** may be performed in at least one processor **120** of the electronic device **101**.

[0193] According to an embodiment, the operations described in FIG. **9** may be performed

heuristically, for example, in combination with the operations described in FIGS. **2** to **8**, or may be performed heuristically as detailed operations of at least some of the described operations.

[0194] Referring to FIG. **9**, an operation method (e.g., an operation method for supporting device discovery based on multiple frequency bands) performed by the electronic device **101** according to an embodiment may include an operation of detecting initiation of a service in operation **901**, configuring a discovery protocol for each of multiple frequency bands in operation **903**, transmitting a discovery mode start message including configuration information by using OOB in operation **905**, discovering external electronic devices, based on a corresponding protocol in each of multiple discovery channels for the frequency bands in operation **907**, selecting a service target device from among at least one discovered external electronic device in operation **909**, and performing a connection procedure with the selected external electronic device in operation **911**.

[0195] Referring to FIG. **9**, in operation **901**, the processor **120** of the electronic device **101** may perform an operation of detecting initiation of a service. According to an embodiment, the electronic device **101** may receive, from a user, a user input (e.g., a request to execute an application capable of performing a service by using short-range wireless communication) for initiating a D2D service (e.g., a Wi-Fi P2P-based service) based on a connection with an external electronic device. According to an embodiment, the electronic device **101** may determine initiation of the service, based on receiving the user input. In an embodiment, the service using short-range wireless communication may include various Wi-Fi P2P-based services such as a content transmission service which transmits data (or content) temporarily or non-temporarily stored in the electronic device **101** to the external electronic device, a device-to-device continuity service, or a device-to-device screen sharing service. For example, the service using the short-range wireless communication may include various D2D services which can be provided based on a direct connection between the electronic device **101** and the external electronic device.

[0196] In operation **903**, the processor **120** may perform an operation of configuring a discovery protocol for each of multiple frequency bands. According to an embodiment, the processor **120** may configure, based on detecting the initiation of the service, a discovery protocol for each of the multiple frequency bands related to discovering, using the first communication circuit, an external electronic device for which the service is to be performed. According to an embodiment, the processor **120** may configure, based on detecting the initiation of the service, multiple channels (e.g., a discovery channel or a configuration channel), based on each of a first frequency band and a second frequency band.

[0197] According to an embodiment, the processor **120** may activate, based on detecting the initiation of the service, an interface for a first communication scheme (or a first protocol) and a second communication scheme (or a second protocol) through the first communication circuit **710** (e.g., the first communication circuit **710** of FIG. **7**). For example, the processor **120** may control the first communication circuit **710** to activate the short-range wireless communication in response to the activation of the service using the short-range wireless communication. According to an embodiment, the electronic device **101** may control the first communication circuit **710** to activate the short-range wireless communication when an application capable of performing the service using the short-range wireless communication is executed, or when the application capable of performing the service using the short-range wireless communication requests to perform the service using the short-range wireless communication.

[0198] In operation **905**, the processor **120** may perform an operation of transmitting (e.g., broadcasting) a discovery mode start message including configuration information (e.g., configuration information regarding the configured discovery protocol) by using OOB. According to an embodiment, the discovery mode start message may include configuration information regarding the first communication scheme and the second communication scheme through which the electronic device **101** supports the short-range wireless communication. For example, the discovery mode start message may include information on different frequency bands related to the

first communication scheme and/or the second communication scheme. According to an embodiment, the discovery mode start message may include information on the first frequency band and a channel allocated (or configured) in the first frequency band, and information on the second frequency band different from the first frequency band and a channel allocated (or configured) in the second frequency band.

[0199] According to an embodiment, the processor **120** may control the second communication circuit **740** (e.g., the second communication circuit **740** of FIG. **7**) to broadcast the discovery mode start message including configuration information for simultaneously discovering at least one external electronic device supporting the first communication scheme (or the first protocol) and/or the second communication scheme (or the second protocol). According to an embodiment, the processor **120** may transmit the discovery mode start message to external electronic devices (e.g., the first external electronic device **810** and the second external electronic device **820** of FIG. **8**) located around the electronic device **101** by using the second communication circuit **740**, based on the OOB.

[0200] In operation **907**, the processor **120** may perform an operation of discovering external electronic devices, based on a corresponding protocol in each of multiple discovery channels for the frequency bands. According to an embodiment, the processor **120** may perform discovery, based on a communication scheme (e.g., a protocol) corresponding to each of the first external electronic device **810** and the second external electronic device **820**. According to an embodiment, the processor **120** may control the first communication circuit **710** to receive signals of various frequency bands in order to discover an external electronic device to be connected through the first communication scheme or the second communication scheme. According to an embodiment, the processor **120** may control the first communication circuit **710** (e.g., the first core **720**) to receive a signal of the first frequency band, and control the first communication circuit **710** (e.g., the second core **730**) to receive a signal of the second frequency band different from the first frequency band.

[0201] According to an embodiment, the processor **120** may discover at least one first external electronic device having determined (or configured) a discovery mode by using the first communication scheme, based on the first communication scheme. For example, the processor **120** may operate to discover the first external electronic device, based on the first protocol in a first discovery channel of the first frequency band, based on discovery configuration. According to an embodiment, the processor **120** may discover at least one second external electronic device having determined a discovery mode by using the second communication scheme, based on the second communication scheme. For example, the processor **120** may operate to discover the second external electronic device, based on the second protocol in a second discovery channel of the second frequency band, based on discovery configuration.

[0202] In operation **909**, the processor **120** may perform an operation of selecting a service target device from among at least one discovered external electronic device. According to an embodiment, the processor **120** may generate a discovery list related to at least one external electronic device discovered respectively through the multiple discovery channels of the multiple frequency bands according to the first communication scheme and the second communication scheme. According to an embodiment, the processor **120** may generate a discovery list, based on at least one external electronic device (e.g., the first external electronic device **810**) discovered based on the first communication scheme and at least one external electronic device (e.g., the second external electronic device **820**) discovered based on the second communication scheme.

[0203] According to an embodiment, the processor **120** may determine (or select) a at least one external electronic device to be connected for the service from the at least one external electronic device according to the discovery list. According to an embodiment, the processor **120** may determine an external electronic device supporting relatively high performance (e.g., the first communication scheme) among the at least one external electronic device in the discovery list as the service target device. According to an embodiment, the processor **120** may determine an

external electronic device having priority as the service target device, based on a previous connection history (e.g., the number of connections with an external electronic device which has been previously connected) among the at least one external electronic device in the discovery list. According to an embodiment, the processor **120** may provide (e.g., display) the discovery list through a display (e.g., the display module **160** of FIG. **1**), receive a user input (e.g., a user input of selecting (e.g., touching) an item of an external electronic device) based on the displayed discovery list, and determine an external electronic device corresponding to an item of an external electronic device selected according to the user input as the service target device.

[0204] In operation **911**, the processor **120** may perform a connection procedure for a connection with the selected external electronic device. According to an embodiment, when the external electronic device to be connected is determined, the processor **120** may perform a connection with the determined external electronic device through the communication scheme used for discovery of the external electronic device. According to an embodiment, when the service target device is determined, the processor **120** may operate to perform a direct connection with the corresponding external electronic device, based on the communication scheme (or protocol) used for discovery of the service target device.

[0205] According to an embodiment, when the determined external electronic device is a first external electronic device supporting the first communication scheme, the processor **120** may perform a connection procedure with the first external electronic device through the first communication scheme used for discovery of the first external electronic device. According to an embodiment, when the determined external electronic device is a second external electronic device supporting the second communication scheme, the processor **120** may perform a connection procedure with the second external electronic device through the second communication scheme used for discovery of the second external electronic device. According to an embodiment, a description is given with reference to the drawings below in relation to performing a connection procedure with a corresponding external electronic device based on multiple frequency bands according to a first communication scheme and/or a second communication scheme.

[0206] FIG. **10** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure.

[0207] According to an embodiment, FIG. **10** may illustrate an example of supporting device discovery for an external electronic device to be connected to a D2D service based on multiple frequency bands in the electronic device **101** according to an embodiment.

[0208] In the electronic device **101** according to an embodiment of the disclosure, a device discovery method based on multiple frequency bands may be performed, for example, according to the flowchart illustrated in FIG. **10**. The flowchart illustrated in FIG. **10** is merely a flowchart according to an embodiment of the device discovery method of the electronic device **101**, and the order of at least some operations may be changed, performed in parallel, or performed as independent operations, or at least some other operations may be performed complementarily to the at least some operations. According to an embodiment of the disclosure, operations **1001** to **1013** may be performed in at least one processor **120** of the electronic device **101**.

[0209] According to an embodiment, the operations described in FIG. **10** may be performed heuristically, for example, in combination with the operations described in FIGS. **2** to **9**, or may be performed heuristically as detailed operations of at least some of the described operations.

[0210] Referring to FIG. **10**, an operation method (e.g., an operation method for supporting device discovery based on multiple frequency bands) performed by the electronic device **101** according to an embodiment may include an operation of detecting initiation of a service in operation **1001**, determining a situation for determining a discovery mode in operation **1003**, determining whether a specified communication scheme is supportable, based on the determination of the situation in operation **1005**, activating a function (or an interface) for a first communication scheme and a second communication scheme, based on determining that the specified communication scheme is

supported in operation **1007**, performing a first discovery procedure, based on multiple discovery channels corresponding to a first frequency band of the first communication scheme and a second frequency band of the second communication scheme, respectively in operation **1009**, activating a function (or an interface) for the second communication scheme, based on determining that the specified communication scheme is not supported in operation **1011**, and performing a second discovery procedure, based on multiple discovery channels corresponding to a third frequency band and a fourth frequency band of the second communication scheme, respectively in operation **1013**.

[0211] Referring to FIG. **10**, in operation **1001**, the processor **120** of the electronic device **101** may perform an operation of detecting initiation of a service. According to an embodiment, the electronic device **101** may receive, from a user, a user input (e.g., a request to execute an application capable of performing a service by using short-range wireless communication) for initiating a D2D service, based on a connection with an external electronic device. According to an embodiment, the electronic device **101** may determine initiation of the service, based on receiving the user input.

[0212] In operation **1003**, the processor **120** may perform an operation for determining a situation for determining a discovery mode. According to an embodiment, the processor **120** may determine a situation such as a service characteristic (e.g., an attribute or capability) of a service requested to be executed, an operation state of the first communication circuit **710**, and/or a preferred connection scheme used for the service with the external electronic device. According to an embodiment, the processor **120** may determine a discovery mode (e.g., a discovery mode based on a first discovery procedure or a second discovery procedure), at least based on the determined situation.

[0213] In operation **1005**, the processor **120** may perform an operation of determining whether a specified communication scheme (e.g., a first communication scheme) is supportable, based on the determination of the situation. According to an embodiment, the processor **120** may determine whether support through the first communication scheme (or a first protocol) is possible for the service. According to an embodiment, the processor **120** may determine whether the service supports the specified communication scheme (e.g., the first communication scheme), based on the service characteristic of the service requested to be executed.

[0214] In an embodiment, the processor **120** may also determine whether the specified communication scheme is available, based on whether a communication scheme currently being used is activated, based on the first communication circuit **710**. For example, the processor **120** may assign priority to a second communication scheme for the service connection when the second communication scheme is being used by the first communication circuit **710**, and may determine that the specified communication scheme is not supportable.

[0215] In operation **1007**, the processor **120** may perform an operation of activating a function for the first communication scheme and the second communication scheme, based on determining in operation **1005** that the specified communication scheme (e.g., the first protocol) is supported (e.g., "Yes" in operation **1005**). According to an embodiment, the processor **120** may activate an interface for the first communication scheme (or the first protocol) and the second communication scheme (or a second protocol) through the first communication circuit **710** (e.g., the first communication circuit **710** of FIG. **7**). For example, the processor **120** may control the first communication circuit **710** to activate short-range wireless communication based on NAN. For example, the processor **120** may control the first communication circuit **710** to activate short-range wireless communication based on Wi-Fi Direct. According to an embodiment, the processor **120** may control activation of the first core **720** and the second core **730** of the first communication circuit **710** to perform device discovery, based on multiple discovery channels for multiple frequency bands according to the first communication scheme and the second communication scheme.

[0216] In operation **1009**, the processor **120** may perform an operation of performing a first

discovery procedure based on multiple discovery channels corresponding to a first frequency band of the first communication scheme and a second frequency band of the second communication scheme, respectively. According to an embodiment, the processor **120** may discover at least one first external electronic device having determined (or configured) a discovery mode by using the first communication scheme, based on the first communication scheme. For example, the processor **120** may operate to discover the first external electronic device, based on the first protocol in a first discovery channel of the first frequency band, based on discovery configuration. According to an embodiment, the processor **120** may discover at least one second external electronic device having determined a discovery mode by using the second communication scheme, based on the second communication scheme. For example, the processor **120** may operate to discover the second external electronic device, based on the second protocol in a second discovery channel of the second frequency band, based on discovery configuration. The first discovery procedure according to an embodiment is described with reference to the drawings described below.

[0217] In operation **1011**, the processor **120** may perform an operation of activating a function for the second communication scheme, based on determining in operation **1005** that the specified communication scheme (e.g., the first protocol) is not supported (e.g., "No" in operation **1005**). According to an embodiment, the processor **120** may activate an interface for the second communication scheme (or the second protocol) through the first communication circuit **710** (e.g., the first communication circuit **710** of FIG. **7**). For example, the processor **120** may control the first communication circuit **710** to activate short-range wireless communication based on Wi-Fi Direct. According to an embodiment, the processor **120** may control activation of the first core **720** and the second core **730** of the first communication circuit **710** to perform device discovery, based on multiple discovery channels for multiple frequency bands according to the second communication scheme.

[0218] In operation **1013**, the processor **120** may perform an operation of performing a second discovery procedure based on multiple discovery channels respectively corresponding to dual frequency bands (e.g., a third frequency band and a fourth frequency band) of the second communication scheme. According to an embodiment, the processor **120** may discover at least one external electronic device having determined (or configured) a discovery mode by using the second communication scheme, based on the second communication scheme. For example, the processor **120** may operate to discover the first external electronic device, based on the second protocol in a third discovery channel of the third frequency band of the second communication scheme, based on discovery configuration. For example, the processor **120** may operate to discover the second external electronic device, based on the second protocol in a fourth discovery channel of the fourth frequency band of the second communication scheme, based on discovery configuration. The second discovery procedure according to an embodiment is described with reference to the drawings described below.

[0219] The electronic device **101** according to an embodiment of the disclosure may support Wi-Fi P2P-based device discovery in device discovery. According to an embodiment, the electronic device **101** can improve discovery speed according to the device discovery by simultaneously using multiple frequency bands. According to an embodiment, the electronic device **101** may perform the device discovery by simultaneously activating NAN technology and Wi-Fi Direct technology, which are heterogeneous Wi-Fi P2P technologies, in different frequency bands. According to an embodiment, the electronic device **101** can improve the discovery speed by being configured to utilize all the multiple frequency bands even when performing external electronic device discovery based on Wi-Fi Direct.

[0220] According to an embodiment, the electronic device **101** may simultaneously support different frequency bands without performance degradation, such as dual Wi-Fi (e.g., RSDB or DBS). According to an embodiment, the electronic device **101** may discover external electronic devices by utilizing both the NAN technology and the Wi-Fi Direct technology. According to an

embodiment, the electronic device **101** may simultaneously discover external electronic devices supporting corresponding protocols based on respective protocols by simultaneously utilizing the NAN technology and the Wi-Fi Direct technology.

[0221] According to an embodiment, the electronic device **101** may configure the first frequency band (e.g., about 5 GHz band) and the first discovery channel in the first frequency band for discovery based on the first protocol. According to an embodiment, the electronic device **101** may configure the second frequency band (e.g., about 2.4 GHz band) and the second discovery channel in the second frequency band for discovery based on the second protocol. According to an embodiment, the electronic device **101** may be synchronized to discover an external electronic device in different frequency bands according to a situation in two P2P protocols (e.g., the first protocol and the second protocol). For example, the electronic device **101** can prevent conflict between two protocols by using different frequency bands in heterogeneous protocols, and can improve discovery speed by independently performing discovery for each protocol.

[0222] According to an embodiment, the electronic device **101** may configure the third frequency band (e.g., a frequency band identical to or different from the first frequency band) and the third discovery channel (e.g., a discovery channel identical to or different from the first discovery channel) in the third frequency band for discovery based on the second protocol. According to an embodiment, the electronic device **101** may configure the fourth frequency band (e.g., a frequency band identical to or different from the second frequency band) and the fourth discovery channel (e.g., a discovery channel identical to or different from the second discovery channel) in the fourth frequency band for discovery based on the second protocol. According to an embodiment, the electronic device **101** may be synchronized to discover an external electronic device in different frequency bands according to a situation in one P2P protocol (e.g., the second protocol). For example, the electronic device **101** may use different frequency bands in a homogeneous protocol to independently perform discovery for each frequency band, so as to improve discovery speed.

[0223] FIG. **11** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure.

[0224] According to an embodiment, FIG. **11** may illustrate an example of supporting device discovery and connection of an external electronic device for a D2D service based on a first discovery procedure in the electronic device **101** according to an embodiment.

[0225] In the electronic device **101** according to an embodiment of the disclosure, a device discovery method based on multiple frequency bands may be performed, for example, according to the flowchart illustrated in FIG. **11**. The flowchart illustrated in FIG. **11** is merely a flowchart according to an embodiment of the device discovery method of the electronic device **101**, and the order of at least some operations may be changed, performed in parallel, or performed as independent operations, or at least some other operations may be performed complementarily to the at least some operations. According to an embodiment of the disclosure, operations **1101** to **1117** may be performed in at least one processor **120** of the electronic device **101**.

[0226] According to an embodiment, the operations described in FIG. **11** may be performed heuristically, for example, in combination with the operations described in FIGS. **2** to **10**, or may be performed heuristically as detailed operations of at least some of the described operations.

[0227] Referring to FIG. **11**, an operation method (e.g., an operation method according to a first discovery procedure for supporting device discovery based on multiple discovery channels for multiple frequency bands) performed by the electronic device **101** according to an embodiment may include an operation of determining a first discovery procedure in operation **1101**, determining a first frequency band and a first discovery channel to be used for discovery based on a first communication scheme in operation **1103**, determining a second frequency band and a second discovery channel to be used for discovery based on a second communication scheme in operation **1105**, transmitting a discovery mode start message including configuration information for simultaneous discovery of external electronic devices in operation **107**, discovering a first external

electronic device based on a first protocol in the first discovery channel of the first frequency band in operation **1109**, discovering a second ternal electronic device based on a second protocol in the second discovery channel of the second frequency band in operation **1111**, generating a discovery list including the first external electronic device and the second external electronic device in operation **1113**, selecting a service target device from the discovery list in operation **1115**, and performing a connection procedure based on the protocol used to discover the selected external electronic device in operation **1117**.

[0228] Referring to FIG. **11**, in operation **1101**, the processor **120** of the electronic device **101** may determine a first discovery procedure. According to an embodiment, the processor **120** may determine the first discovery procedure, based on the operation described in the description part referring to FIG. **10** described above.

[0229] In operation **1103**, the processor **120** may perform an operation of determining a first frequency band and a first discovery channel to be used for discovery based on a first communication scheme. According to an embodiment, the processor **120** may determine a frequency band and a discovery channel in which NAN technology, which is a first protocol, is to be used when a D2D service is requested.

[0230] In operation **1105**, the processor **120** may perform an operation of determining a second frequency band and a second discovery channel to be used for discovery based on a second communication scheme. According to an embodiment, the processor **120** may determine a frequency band and a discovery channel in which Wi-Fi Direct technology, which is a second protocol, is to be used when a D2D service is requested.

[0231] According to an embodiment, operations **1103** and **1105** are not limited to the illustrated order and may be performed in parallel, substantially simultaneously, or heuristically. According to an embodiment, a description is made with reference to the drawings described below in relation to determining (or configuring) multiple frequency bands based on NAN and Wi-Fi Direct.

[0232] In operation **1107**, the processor **120** may perform an operation of transmitting a discovery mode start message including configuration information for simultaneous discovery of external electronic devices. In an embodiment, the processor **120** may broadcast the discovery mode start message including the configuration information through OOB by using the second communication circuit **740** (e.g., the second communication circuit **740** of FIG. **7**).

[0233] In operation **1109**, the processor **120** may perform an operation of discovering a first external electronic device, based on the first protocol in the first discovery channel of the first frequency band.

[0234] In operation **1111**, the processor **120** may perform an operation of discovering a second external electronic device, based on the second protocol in the second discovery channel of the second frequency band.

[0235] According to an embodiment, operations **1109** and **1111** are not limited to the illustrated order and may be performed in parallel, substantially simultaneously, or heuristically. According to an embodiment, the following is described in relation to an operation of discovering external electronic devices in multiple discovery channels of multiple frequency bands by using the NAN technology which is the first protocol, and the Wi-Fi Direct technology which is the second protocol.

[0236] In operation **1113**, the processor **120** may perform an operation of generating a discovery list including the first external electronic device and the second external electronic device.

[0237] In operation **1115**, the processor **120** may perform an operation of selecting a service target device from the discovery list. According to an embodiment, the processor **120** may determine (or select) an external electronic device to be connected from among at least one external electronic device included in the discovery list. According to an embodiment, the processor **120** may determine an external electronic device supporting relatively high performance (e.g., the first communication scheme) among the at least one external electronic device in the discovery list as

the service target device. According to an embodiment, the processor **120** may determine an external electronic device having priority as the service target device, based on a previous connection history (e.g., the number of connections with an external electronic device which has been previously connected) among the at least one external electronic device in the discovery list. According to an embodiment, the processor **120** may provide (e.g., display) the discovery list through a display (e.g., the display module **160** of FIG. **1**), receive a user input (e.g., a user input of selecting (e.g., touching) an item of an external electronic device) based on the displayed discovery list, and determine an external electronic device corresponding to an item of an external electronic device selected according to the user input as the service target device.

[0238] In operation **1117**, the processor **120** may perform a connection procedure based on the protocol used to discover the selected external electronic device.

[0239] FIG. **12** is a diagram illustrating an example in which electronic devices operate based on a first discovery procedure according to an embodiment of the disclosure.

[0240] FIG. **13** is a diagram illustrating an example in which electronic devices operate based on a first discovery procedure according to an embodiment of the disclosure.

[0241] According to an embodiment, FIGS. **12** and **13** may illustrate an example of a Wi-Fi P2P discovery method performed based on a first discovery procedure between electronic devices according to an embodiment. For example, FIGS. **12** and **13** may illustrate an example of an operation in which the electronic device **101** simultaneously discovers external electronic devices supporting multiple protocols by simultaneously using multiple frequency bands according to an embodiment. According to an embodiment, FIGS. **12** and **13** may illustrate an example of an operation in which the electronic device **101** simultaneously performs NAN discovery and Wi-Fi Direct discovery by using multiple frequency bands based on heterogeneous protocols.

[0242] Referring to FIG. **12**, in operation **1201**, the electronic device **101** may initiate a service in response to a D2D service request. For example, the electronic device **101** may start various Wi-Fi P2P-based service scenarios. The electronic device **101** and an external electronic device (e.g., the first external electronic device **810** and the second external electronic device **820**) according to an embodiment may perform a Wi-Fi P2P connection and perform data communication through Wi-Fi P2P discovery between each other. For example, a service may be initiated based on a service request in various application fields such as a device-to-device content transmission service, a device-to-device continuity service, or a device-to-device screen sharing service.

[0243] In operation **1203**, the electronic device **101** may activate an interface for supporting a first communication scheme (e.g., short-range wireless communication based on NAN) and an interface for supporting a second communication scheme (e.g., short-range wireless communication based on Wi-Fi Direct). According to an embodiment, when a D2D service is requested, the electronic device **101** may determine a frequency band and a discovery channel in which NAN technology, which is a first protocol, is to be used, and determine a frequency band and a discovery channel in which Wi-Fi Direct technology, which is a second protocol, is to be used. According to an embodiment, the electronic device **101** may simultaneously support different frequency bands such as dual Wi-Fi (e.g., RSDB or DBS). According to an embodiment, the electronic device **101** may be used to discover external electronic devices in different frequency bands based on the NAN technology and the Wi-Fi Direct technology. According to an embodiment, the electronic device **101** may simultaneously discover external electronic devices supporting protocols corresponding to the NAN technology and the Wi-Fi Direct technology by simultaneously utilizing both the technologies.

[0244] According to an embodiment, the electronic device **101** may configure a first frequency band (e.g., about 5 GHz band) and a first discovery channel in the first frequency band for discovery based on the first protocol. According to an embodiment, the electronic device **101** may configure a second frequency band (e.g., about 2.4 GHz band) and a second discovery channel in the second frequency band for discovery based on the second protocol. According to an

embodiment, the electronic device **101** may be synchronized to discover the external electronic devices **810** and **820** in different frequency bands according to a situation in two P2P protocols (e.g., the first protocol and the second protocol). For example, the electronic device **101** can prevent conflict between two protocols by using different frequency bands in heterogeneous protocols, and can improve discovery speed by independently performing discovery for each protocol.

[0245] In operations **1205** and **1207**, the electronic device **101** may include discovery configuration information of the two P2P protocols (e.g., the first protocol and the second protocol) determined by the electronic device **101** in a discovery mode start message to broadcast the message to the external electronic devices **810** and **820** through OOB such as BLE.

[0246] According to an embodiment, the first external electronic device **810** may receive the discovery mode start message including the configuration information from the electronic device **101** through the OOB. According to an embodiment, the first external electronic device **810** may determine a communication scheme which is supportable by the first external electronic device **810**, based on the configuration information of the discovery mode start message. In an embodiment, the first external electronic device **810** may be a device capable of supporting both the first communication scheme (e.g., short-range wireless communication based on NAN) and the second communication scheme (e.g., short-range wireless communication based on Wi-Fi Direct).

[0247] According to an embodiment, in operation **1209**, the first external electronic device **810** may activate the interface for the first communication scheme (e.g., short-range wireless communication based on NAN). For example, the first external electronic device **810** may determine the first frequency band (e.g., about 5 GHz band) in which the NAN technology, which is the first protocol, is to be used. According to an embodiment, FIG. **12** may illustrate an example in which the first external electronic device **810** determines to utilize the NAN technology. According to an embodiment, the first external electronic device **810** may determine a higher-performance NAN technology, and may also determine the Wi-Fi Direct technology depending on a state of the first external electronic device **810**. For example, the first external electronic device **810** may determine discovery and connection based on Wi-Fi Direct when Wi-Fi Direct is already being used.

[0248] According to an embodiment, in the examples of FIGS. **12** and **13**, the electronic device **101** and the first external electronic device **810** may activate an interface for short-range wireless communication based on NAN by using the first frequency band (e.g., about 5 GHz band) as configured by the electronic device **101**.

[0249] According to an embodiment, the second external electronic device **820** may receive the discovery mode start message including the configuration information from the electronic device **101** through the OOB. According to an embodiment, the second external electronic device **820** may determine a communication scheme which is supportable by the second external electronic device **820**, based on the configuration information of the discovery mode start message. In an embodiment, the second external electronic device **820** may be a device which does not support the first communication scheme and is capable of supporting the second communication scheme, or a device which is capable of supporting both the first communication scheme and the second communication scheme but has priority applied to the second communication scheme.

[0250] According to an embodiment, in operation **1211**, the second external electronic device **820** may activate the interface for the second communication scheme (e.g., short-range wireless communication based on Wi-Fi Direct). For example, the second external electronic device **820** may determine the second frequency band (e.g., about 2.4 GHz band) in which the Wi-Fi Direct technology, which is the second protocol, is to be used.

[0251] In operation **1213**, the electronic device **101** may discover the first external electronic device **810** in the first discovery channel of the first frequency band, based on the first protocol. According to an embodiment, the electronic device **101** may exchange an SDF with the first external electronic device **810**, based on the first frequency band (e.g., about 5 GHz band).

[0252] According to an embodiment, FIG. **13** may illustrate an example in which the electronic device **101** determines the first frequency band (e.g., about 5 GHz band) as a utilization frequency band of the first protocol (e.g., NAN technology) and determines the second frequency band (e.g., about 2.4 GHz band) as a utilization frequency band of the second protocol (e.g., Wi-Fi Direct technology). The disclosure is not limited thereto, and the second frequency band (e.g., about 2.4 GHz band) may be utilized as the utilization frequency band of the first protocol, and the first frequency band (e.g., about 5 GHz band) may be utilized as the utilization frequency band of the second protocol.

[0253] According to an embodiment, as illustrated in FIG. **13**, when the first protocol is utilized in the first frequency band (e.g., about 5 GHz band), the electronic device **101** may not use an NAN DW which basically operates on channel No. 6 of the second frequency band (e.g., about 2.4 GHz band). According to an embodiment, the electronic device **101** may operate to synchronize with the external electronic devices **810** and **820** by utilizing channel No. 149, which is a social channel of the first frequency band (e.g., about 5 GHz band).

[0254] According to an embodiment, the electronic device **101** may utilize a DW on channel No. 149 and utilize an interval between DWs to quickly exchange an SDF and perform discovery. According to an embodiment, a method of utilizing an interval between DWs for discovery may utilize an instant mode or an unsynchronous discovery mode defined in the standard.

[0255] According to an embodiment, the electronic device **101** may transmit channel information regarding a discovery channel for performing discovery by utilizing the interval between the DWs to the external electronic devices **810** and **820** through the discovery mode start message. According to an embodiment, in FIG. **13**, channel No. 36, which is a different channel from channel No. 149, may be assumed. In an embodiment, channel No. 36 may be, for example, a channel through which the electronic device **101** is connected to an access point (AP). For example, when the electronic device **101** is connected to the access point (AP), channel information (e.g., channel No. 36) connected to the access point (AP) may be utilized to minimize channel movement and maximize discovery speed, and FIG. **13** may illustrate an example of this. According to an embodiment, the electronic device **101** may also continuously utilize channel No. 149, which is a DW channel, as a discovery channel.

[0256] According to an embodiment, the electronic device **101** may activate an interface (e.g., the first core **720**) for the first protocol (e.g., NAN technology) in the first frequency band (e.g., about 5 GHz band) and periodically perform a passive scan operation on channel No. 149 for NAN cluster synchronization.

[0257] According to an embodiment, although not illustrated in FIG. **13**, the first external electronic device **810** may also perform a passive scan operation for NAN synchronization when performing discovery by utilizing the first frequency band based on the first protocol.

[0258] According to an embodiment, the first external electronic device **810** may transmit an SDF publish message by using an interval (e.g., an NAN discovery interval) between DWs in a discovery channel (e.g., channel No. 36) of the first frequency band (e.g., about 5 GHz band). According to an embodiment, the electronic device **101** may receive a command message from the first external electronic device **810**, obtain information (e.g., a protocol determined by the first external electronic device **810**) on the first external electronic device **810**, and perform discovery with the first external electronic device **810** based on the first protocol.

[0259] According to an embodiment, although not illustrated in FIG. **13**, a discovery method in which the electronic device **101** first transmits an SDF subscribe message and the first external electronic device **810** responds with an SDF publish message in response thereto is also possible.

[0260] In operation **1215**, the electronic device **101** may discover the second external electronic device **820** in the second discovery channel of the second frequency band, based on the second protocol. According to an embodiment, the electronic device **101** may exchange a probe message with the second external electronic device **820** based on the second frequency band (e.g., about 2.4

GHz band).

[0261] According to an embodiment, referring to FIG. **13**, the electronic device **101** may determine a frequency band for the second protocol (e.g., Wi-Fi Direct technology) in the second frequency band (e.g., about 2.4 GHz band) different from the first frequency band (e.g., about 5 GHz band), and determine channel No. 1 of the second frequency band as a discovery channel.

[0262] According to an embodiment, the second external electronic device **820** may perform a Wi-Fi Direct discovery operation by using a discovery channel (e.g., channel No. 1) of the second frequency band (e.g., about 2.4 GHz band). According to an embodiment, the electronic device **101** may perform discovery for the second external electronic device **820** on channel No. 1 of the second frequency band (e.g., about 2.4 GHz band) substantially simultaneously with transmission of the discovery mode start message through the OOB. For example, the electronic device **101** may maintain a listen mode for receiving a discovery message of the second external electronic device **820** on channel No. 1 of the second frequency band. According to an embodiment, the electronic device **101** may receive a probe request message or a probe response message transmitted by the second external electronic device **820** through channel No. 1 of the second frequency band and complete the discovery.

[0263] According to an embodiment, the electronic device **101** may perform NAN discovery and Wi-Fi Direct discovery simultaneously in heterogeneous frequency bands (e.g., about 5 GHz band and about 2.4 GHz band) as described above. For example, the electronic device **101** may perform simultaneous discovery in the same time interval (e.g., an overlapping interval). According to an embodiment, the electronic device **101** can improve discovery speed while preventing conflict caused by the same frequency band by simultaneously performing NAN discovery and Wi-Fi Direct discovery in different frequency bands within the same time interval.

[0264] In operation **1217**, the electronic device **101** may generate a discovery list including the first external electronic device **810** and the second external electronic device **820**, and select one external electronic device based on a specified condition. According to an embodiment, the electronic device **101** may perform a connection procedure based on the determined protocol with the selected external electronic device.

[0265] FIG. **14** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure.

[0266] According to an embodiment, FIG. **14** may illustrate an example of supporting device discovery and connection of an external electronic device for a D2D service based on a second discovery procedure in the electronic device **101** according to an embodiment.

[0267] In the electronic device **101** according to an embodiment of the disclosure, a device discovery method based on multiple frequency bands may be performed, for example, according to the flowchart illustrated in FIG. **14**. The flowchart illustrated in FIG. **14** is merely a flowchart according to an embodiment of the device discovery method of the electronic device **101**, and the order of at least some operations may be changed, performed in parallel, or performed as independent operations, or at least some other operations may be performed complementarily to the at least some operations. According to an embodiment of the disclosure, operations **1401** to **1417** may be performed in at least one processor **120** of the electronic device **101**.

[0268] According to an embodiment, the operations described in FIG. **14** may be performed heuristically, for example, in combination with the operations described in FIGS. **2** to **13**, or may be performed heuristically as detailed operations of at least some of the described operations.

[0269] Referring to FIG. **14**, an operation method (e.g., an operation method according to a second discovery procedure for supporting device discovery based on multiple discovery channels for multiple frequency bands) performed by the electronic device **101** according to an embodiment may include an operation of determining a second discovery procedure in operation **1401**, determining a third frequency band and a third discovery channel to be used for discovery based on a second communication scheme in operation **1403**, determining a fourth frequency band and a

fourth discovery channel to be used for discovery based on the second communication scheme in operation **1405**, transmitting a discovery mode start message including configuration information for simultaneous discovery of external electronic devices in operation **1407**, discovering a first external electronic device based on a second protocol in the third discovery channel of the third frequency band in operation **1409**, discovering a second external electronic device based on the second protocol in the fourth discovery channel of the fourth frequency band in operation **1411**, generating a discovery list including the first external electronic device and the second external electronic device in operation **1413**, selecting a service target device from the discovery list in operation **1415**, and performing a connection procedure based on the protocol used to discover the selected external electronic device in operation **1417**.

[0270] Referring to FIG. **14**, in operation **1401**, the processor **120** of the electronic device **101** may determine a second discovery procedure. According to an embodiment, the processor **120** may determine the second discovery procedure based on the operation described in the description part referring to FIG. **10** described above.

[0271] In operation **1403**, the processor **120** may perform an operation of determining a third frequency band and a third discovery channel to be used for discovery based on a second communication scheme. According to an embodiment, the processor **120** may determine a frequency band and a discovery channel in which Wi-Fi Direct technology, which is a second protocol, is to be used when a D2D service is requested.

[0272] In operation **1405**, the processor **120** may perform an operation of determining a fourth frequency band and a fourth discovery channel to be used for discovery based on the second communication scheme. According to an embodiment, the processor **120** may determine a different frequency band and a different discovery channel in which the Wi-Fi Direct technology, which is the second protocol, is to be used when a D2D service is requested.

[0273] According to an embodiment, operations **1403** and **1405** are not limited to the illustrated order and may be performed in parallel, substantially simultaneously, or heuristically. According to an embodiment, a description is made with reference to the drawings described below in relation to determining (or configuring) multiple frequency bands through dual bands based on Wi-Fi Direct.

[0274] In operation **1407**, the processor **120** may perform an operation of transmitting a discovery mode start message including configuration information for simultaneous discovery of external electronic devices. In an embodiment, the processor **120** may broadcast the discovery mode start message including the configuration information through OOB by using the second communication circuit **740** (e.g., the second communication circuit **740** of FIG. **7**).

[0275] In operation **1409**, the processor **120** may perform an operation of discovering a first external electronic device, based on the second protocol in the third discovery channel of the third frequency band.

[0276] In operation **1411**, the processor **120** may perform an operation of discovering a second external electronic device, based on the second protocol in the fourth discovery channel of the fourth frequency band.

[0277] According to an embodiment, operations **1409** and **1411** are not limited to the illustrated order and may be performed in parallel, substantially simultaneously, or heuristically. According to an embodiment, the following is described in relation to an operation of discovering external electronic devices in multiple discovery channels of multiple frequency bands by using the Wi-Fi Direct technology which is the second protocol.

[0278] In operation **1413**, the processor **120** may perform an operation of generating a discovery list including the first external electronic device and the second external electronic device.

[0279] In operation **1415**, the processor **120** may perform an operation of selecting a service target device from the discovery list. According to an embodiment, the processor **120** may determine (or select) an external electronic device to be connected from among at least one external electronic device according to the discovery list based on various conditions specified as in the above-

described example.

[0280] In operation **1417**, the processor **120** may perform a connection procedure based on the protocol used to discover the selected external electronic device.

[0281] FIG. **15** is a diagram illustrating an example in which electronic devices operate based on a second discovery procedure according to an embodiment of the disclosure.

[0282] FIG. **16** is a diagram illustrating an example in which electronic devices operate based on a first discovery procedure according to an embodiment of the disclosure.

[0283] According to an embodiment, FIGS. **15** and **16** may illustrate an example of a Wi-Fi P2P discovery method performed based on a second discovery procedure between electronic devices according to an embodiment. For example, FIGS. **15** and **16** may illustrate an example of an operation in which the electronic device **101** simultaneously discovers external electronic devices supporting a specified protocol by simultaneously using multiple frequency bands according to an embodiment. According to an embodiment, FIGS. **15** and **16** may illustrate an example of an operation in which the electronic device **101** simultaneously performs multi-discovery based on Wi-Fi Direct by using multiple frequency bands based on a homogeneous protocol.

[0284] Referring to FIG. **15**, in operation **1501**, the electronic device **101** may initiate a service in response to a D2D service request. For example, the electronic device **101** may start various Wi-Fi P2P-based service scenarios. The electronic device **101** and an external electronic device (e.g., the first external electronic device **810** and the second external electronic device **820**) according to an embodiment may perform a Wi-Fi P2P connection and perform data communication through Wi-Fi P2P discovery between each other. For example, a service may be initiated based on a service request in various application fields such as a device-to-device content transmission service, a device-to-device continuity service, or a device-to-device screen sharing service.

[0285] In operation **1503**, the electronic device **101** may activate an interface for a second communication scheme (e.g., short-range wireless communication based on Wi-Fi Direct). According to an embodiment, when a D2D service is requested, the electronic device **101** may determine two frequency bands in which Wi-Fi Direct technology, which is a second protocol, is to be used, and two discovery channels corresponding to the respective frequency bands. According to an embodiment, the electronic device **101** may simultaneously support different frequency bands (e.g., dual bands) such as dual Wi-Fi (e.g., RSDB or DBS). According to an embodiment, the electronic device **101** may be used to discover external electronic devices in different frequency bands based on the Wi-Fi Direct technology. According to an embodiment, the electronic device **101** may simultaneously discover external electronic devices supporting a corresponding protocol by utilizing the Wi-Fi Direct technology.

[0286] According to an embodiment, the electronic device **101** may configure a third frequency band (e.g., about 5 GHz band) and a third discovery channel in the third frequency band, and a fourth frequency band (e.g., about 2.4 GHz band) and a fourth discovery channel in the fourth frequency band for simultaneous discovery based on the second protocol. According to an embodiment, the electronic device **101** may be synchronized to discover the external electronic devices **810** and **820** in different frequency bands according to a situation in one P2P protocol (e.g., the second protocol). For example, the electronic device **101** can prevent conflict between protocols by using different frequency bands in a homogeneous protocol, and can improve discovery speed by independently performing discovery in each frequency band.

[0287] In operations **1505** and **1507**, the electronic device **101** may include discovery configuration information of a P2P protocol (e.g., the second protocol) determined by the electronic device **101** in a discovery mode start message to broadcast the message to the external electronic devices **810** and **820** through OOB such as BLE.

[0288] According to an embodiment, the first external electronic device **810** may receive the discovery mode start message including the configuration information from the electronic device **101** through the OOB. According to an embodiment, the first external electronic device **810** may

determine a communication scheme which is supportable by the first external electronic device **810**, based on the configuration information of the discovery mode start message. In an embodiment, the first external electronic device **810** may be a device capable of supporting dual bands (e.g., the third frequency band and the fourth frequency band).

[0289] According to an embodiment, in operation **1509**, the first external electronic device **810** may activate the interface for the second communication scheme (e.g., short-range wireless communication based on Wi-Fi Direct). For example, the first external electronic device **810** may determine the third frequency band (e.g., about 5 GHz band) in which the Wi-Fi Direct technology, which is the second protocol, is to be used. According to an embodiment, FIG. **15** may illustrate an example in which the first external electronic device **810** determines the third frequency band having priority (e.g., a relatively superior performance). According to an embodiment, the first external electronic device **810** may determine a frequency band to be utilized for device discovery in response to a frequency band of a protocol configured by the electronic device **101** based on the configuration information. According to an embodiment, the first external electronic device **810** may also determine the fourth frequency band (e.g., about 2.4 GHz band) based on a state of the first external electronic device **810**. For example, the first external electronic device **810** may determine discovery and connection based on the fourth frequency band when the fourth frequency band is already being used in Wi-Fi Direct.

[0290] According to an embodiment, in the examples of FIGS. **15** and **16**, the electronic device **101** and the first external electronic device **810** may activate the interface for short-range wireless communication based on Wi-Fi Direct by using the third frequency band (e.g., about 5 GHz band) as configured by the electronic device **101**.

[0291] According to an embodiment, the second external electronic device **820** may receive the discovery mode start message including the configuration information from the electronic device **101** through the OOB. According to an embodiment, the second external electronic device **820** may determine a communication scheme which is supportable by the second external electronic device **820**, based on the configuration information of the discovery mode start message. In an embodiment, the second external electronic device **820** may be a device which does not support dual bands and is capable of supporting the fourth frequency band, or a device which is capable of supporting dual bands but has priority applied to the fourth frequency band.

[0292] According to an embodiment, in operation **1511**, the second external electronic device **820** may activate the interface for the second communication scheme (e.g., short-range wireless communication based on Wi-Fi Direct). For example, the second external electronic device **820** may determine the fourth frequency band (e.g., about 2.4 GHz band) in which the Wi-Fi Direct technology, which is the second protocol, is to be used.

[0293] In operation **1513**, the electronic device **101** may discover the first external electronic device **810** in the third discovery channel of the third frequency band, based on the second communication scheme. According to an embodiment, the electronic device **101** may exchange a probe message with the first external electronic device **810**, based on the third frequency band (e.g., about 5 GHz band).

[0294] In operation **1515**, the electronic device **101** may discover the second external electronic device **820** in the fourth discovery channel of the fourth frequency band, based on the second communication scheme. According to an embodiment, the electronic device **101** may exchange a probe message with the second external electronic device **820**, based on the fourth frequency band (e.g., about 2.4 GHz band).

[0295] According to an embodiment, FIG. **16** may illustrate an example in which the electronic device **101** determines the third frequency band (e.g., about 5 GHz band) and the fourth frequency band (e.g., about 2.4 GHz band) as utilization frequency bands of the second protocol (e.g., Wi-Fi Direct technology). According to an embodiment, the electronic device **101** may configure Wi-Fi Direct, which is the second protocol, to both of the dual bands (or dual frequency bands) and

determine each channel to be utilized for discovery in each frequency band. According to an embodiment, a discovery channel for each frequency band may be a predetermined channel which has been already defined, and may be determined by referring to a connection channel with an access point (AP) to which the electronic device **101** is currently connected.

[0296] According to an embodiment, in the example of FIG. **16**, assuming that the electronic device **101** is connected to the access point (AP) on channel No. 36, channel No. 36 is configured for the third frequency band (e.g., about 5 GHz band), channel No. 1 is configured for the fourth frequency band (e.g., about 2.4 GHz band), and the discovery mode start message is then transmitted to the external electronic devices **810** and **820**. According to an embodiment, although not illustrated, the electronic device **101** may operate to be synchronized by using channel No. 149, which is a social channel of the third frequency band (e.g., about 5 GHz band).

[0297] According to an embodiment, the external electronic devices **810** and **820** having received the discovery mode start message may determine a frequency band to participate in discovery by considering the capability of the external electronic devices. For example, an external electronic device which supports the third frequency band (e.g., about 5 GHz band) may basically determine the third frequency band as a discovery frequency band. For example, an external electronic device which supports only the fourth frequency band (e.g., about 2.4 GHz band) may determine the fourth frequency band as the discovery frequency band. According to an embodiment, even when the external electronic devices **810** and **820** support the third frequency band (e.g., about 5 GHz band), the external electronic devices **810** and **820** may determine to participate in the fourth frequency band when P2P communication is already taking place in the fourth frequency band (e.g., about 2.4 GHz band).

[0298] According to an embodiment, the external electronic devices **810** and **820** having selected each frequency band may perform a specified discovery operation, for example, transmitting a probe message, in a specified discovery channel. According to an embodiment, the electronic device **101** may determine a frequency band for the second protocol (e.g., Wi-Fi Direct technology) in the third frequency band (e.g., about 5 GHz band) and the fourth frequency band (e.g., about 2.4 GHz band) different from the third frequency band, and may determine channel No. 36 of the third frequency band and channel No. 1 of the fourth frequency band as discovery channels, respectively.

[0299] According to an embodiment, the electronic device **101** may perform a Wi-Fi Direct discovery operation by using a discovery channel (e.g., channel No. 36) of the third frequency band (e.g., about 5 GHz band). According to an embodiment, the electronic device **101** may perform discovery for the first external electronic device **810** on channel No. 36 of the third frequency band (e.g., about 5 GHz band) substantially simultaneously with transmission of the discovery mode start message through the OOB. For example, the electronic device **101** may maintain a listen mode for receiving a discovery message of the first external electronic device **810** on channel No. 36 of the third frequency band. According to an embodiment, the electronic device **101** may receive a probe request message or a probe response message transmitted by the first external electronic device **810** through channel No. 36 of the third frequency band and complete the discovery.

[0300] According to an embodiment, the electronic device **101** may perform a Wi-Fi Direct discovery operation by using a discovery channel (e.g., channel No. 1) of the fourth frequency band (e.g., about 2.4 GHz band). According to an embodiment, the electronic device **101** may perform discovery for the second external electronic device **820** on channel No. 1 of the fourth frequency band (e.g., about 2.4 GHz band) substantially simultaneously with transmission of the discovery mode start message through the OOB. For example, the electronic device **101** may maintain a listen mode for receiving a discovery message of the second external electronic device **820** on channel No. 1 of the fourth frequency band. According to an embodiment, the electronic device **101** may receive a probe request message or a probe response message transmitted by the second external electronic device **820** through channel No. 1 of the fourth frequency band and complete the discovery.

[0301] According to an embodiment, the electronic device **101** may receive probe messages transmitted by the external electronic devices **810** and **820** simultaneously on a discovery channel of each frequency band while existing in the same time interval on the discovery channel of each frequency band configured by the electronic device **101**, and complete the discovery.

[0302] According to an embodiment, the electronic device **101** may perform Wi-Fi Direct discovery simultaneously in heterogeneous frequency bands (e.g., about 5 GHz band and about 2.4 GHz band) as described above. For example, the electronic device **101** may perform simultaneous discovery in the same time interval (e.g., an overlapping interval). According to an embodiment, the electronic device **101** can improve discovery speed while preventing conflict caused by the same frequency band by simultaneously performing Wi-Fi Direct discovery in different frequency bands within the same time interval.

[0303] In operation **1517**, the electronic device **101** may generate a discovery list including the first external electronic device **810** and the second external electronic device **820**, and select one external electronic device based on a specified condition. According to an embodiment, the electronic device **101** may perform a connection procedure based on the determined protocol with the selected external electronic device. According to an embodiment, when a connection with at least one external electronic device among external electronic devices discovered in each frequency band is determined, the electronic device **101** may directly establish an autonomous GO in the currently discovered frequency band or on a channel of the frequency band to complete the connection.

[0304] FIG. **17** is a flowchart illustrating an operation method of an electronic device according to an embodiment of the disclosure.

[0305] According to an embodiment, FIG. **17** may illustrate an example of supporting device discovery and connection based on a first communication scheme or a second communication scheme when the electronic device **101** according to an embodiment operates as an electronic device (e.g., an external electronic device) on a reception side.

[0306] In the electronic device **101** according to an embodiment of the disclosure, a device discovery method based on multiple frequency bands may be performed, for example, according to the flowchart illustrated in FIG. **17**. The flowchart illustrated in FIG. **17** is merely a flowchart according to an embodiment of the device discovery method of the electronic device **101**, and the order of at least some operations may be changed, performed in parallel, or performed as independent operations, or at least some other operations may be performed complementarily to the at least some operations. According to an embodiment of the disclosure, operations **1701** to **1713** may be performed in at least one processor **120** of the electronic device **101**.

[0307] According to an embodiment, the operations described in FIG. **17** may be performed heuristically, for example, in combination with the operations described in FIGS. **2** to **16**, or may be performed heuristically as detailed operations of at least some of the described operations.

[0308] Referring to FIG. **17**, an operation method (e.g., an operation method for supporting device discovery based on multiple frequency bands) performed by the electronic device **101** according to an embodiment may include an operation of detecting reception of a discovery mode start message in operation **1701**, identifying configuration information in operation **1703**, determining whether a specified communication scheme is supportable, based on the configuration information in operation **1705**, activating a function (or interface) for the specified communication scheme, based on determining that the specified communication scheme is supported in operation **1707**, transmitting a discovery message including information on a specified frequency band of the specified communication scheme in operation **1709**, activating a function (or interface) for a second communication scheme, based on determining that the specified communication scheme is not supported in operation **1711**, and transmitting a discovery message including information on a specified frequency band of the second communication scheme in operation **1713**.

[0309] Referring to FIG. **17**, in operation **1701**, the processor **120** of the electronic device **101** may

perform an operation of detecting reception of a discovery mode start message. According to an embodiment, the processor **120** may receive a discovery mode start message broadcasted by an external electronic device through OOB. According to an embodiment, the processor **120** may determine a trigger for initiating a discovery mode, based on detecting the reception of the discovery mode start message.

[0310] In operation **1703**, the processor **120** may identify configuration information. According to an embodiment, the processor **120** may identify the configuration information included in the discovery mode start message to identify a communication scheme (or protocol) available for discovery by the electronic device **101**.

[0311] In operation **1705**, the processor **120** may perform an operation of determining whether a specified communication scheme (e.g., a first communication scheme) is supportable, based on the configuration information. According to an embodiment, the processor **120** may determine whether the specified communication scheme (e.g., the first communication scheme) is supported, based on the capability of the electronic device **101**.

[0312] According to an embodiment, when the first communication scheme (or a first protocol) is supported, the processor **120** may further determine whether an operation by the first communication scheme is possible. For example, the processor **120** may determine whether the first communication scheme is available, based on whether a communication scheme currently being used is activated, based on the first communication circuit **710**. For example, the processor **120** may assign priority to a second communication scheme when the second communication scheme is being used by the first communication circuit **710**, and may determine that the first communication scheme is not supportable.

[0313] In operation **1707**, the processor **120** may perform an operation of activating a function (or interface) for the specified communication scheme, based on determining in operation **1705** that the specified communication scheme (e.g., the first communication scheme) is supported (e.g., "Yes" in operation **1705**). According to an embodiment, the processor **120** may activate the interface for the specified communication scheme (or the first communication scheme) through the first communication circuit **710** (e.g., the first communication circuit **710** of FIG. **7**). For example, the processor **120** may control the first communication circuit **710** to activate short-range wireless communication based on NAN.

[0314] In operation **1709**, the processor **120** may perform an operation of transmitting a discovery message including information on a specified frequency band of the first communication scheme. According to an embodiment, the processor **120** may transmit, to a specified external electronic device, a discovery message including information on determination of a first frequency band and the first communication scheme determined to be used for discovery of the external electronic device.

[0315] In operation **1711**, the processor **120** may perform an operation of activating a function (or interface) for the second communication scheme, based on determining in operation **1705** that the specified communication scheme (e.g., the first communication scheme) is not supported (e.g., "No" in operation **1705**) based on the configuration information. According to an embodiment, the processor **120** may activate the interface for the second communication scheme (or a second protocol) through the first communication circuit **710** (e.g., the first communication circuit **710** of FIG. **7**). For example, the processor **120** may control the first communication circuit **710** to activate short-range wireless communication based on Wi-Fi Direct.

[0316] In operation **1713**, the processor **120** may perform an operation of transmitting a discovery message including information on a specified frequency band (e.g., a third frequency band or a fourth frequency band) of the second communication scheme. According to an embodiment, the processor **120** may transmit, to a specified external electronic device, a discovery message including information on determination of the specified frequency band (e.g., the third frequency band or the fourth frequency band) and the second communication scheme determined to be used

for discovery with the external electronic device.

[0317] An operation method performed by an electronic device **101** according to an embodiment of the disclosure may include an operation of detecting initiation of a service. The operation method may include an operation of configuring, based on detecting the initiation of the service, a discovery protocol for each of multiple frequency bands related to discovering, using a first communication circuit (e.g., the wireless communication module **192** of FIG. **1** and/or the first communication circuit **710** of FIG. **7**) configured to support device-to-device (D2D) communication, an external electronic device for which the service is to be performed. The operation method may include an operation of transmitting a discovery mode start message through a second communication circuit (e.g., the wireless communication module **192** of FIG. **1** and/or the second communication circuit **740** of FIG. **7**) configured to support out-of-band (OOB) communication. The operation method may include an operation of discovering at least one external electronic device through the first communication circuit, based on a protocol corresponding to each of the multiple frequency bands. The operation method may include an operation of determining one of the at least one discovered external electronic device as a service target device. The operation method may include an operation of performing a connection procedure with the external electronic device determined as the service target device.

[0318] According to an embodiment, the service may include a D2D service which can be provided based on a direct connection with the external electronic device determined as the service target device.

[0319] According to an embodiment, the discovery mode start message may include configuration information regarding the discovery protocol.

[0320] According to an embodiment, the configuration information may include information on different frequency bands related to a first protocol for simultaneously discovering the at least one external electronic device and/or a second protocol different from the first protocol.

[0321] According to an embodiment, the operation of transmitting the discovery mode start message may include an operation of transmitting the configuration information regarding the configured discovery protocol by using OOB communication through the second communication circuit.

[0322] According to an embodiment, the operation of configuring the discovery protocol may include an operation of configuring multiple discovery channels, based on each of a first frequency band and a second frequency band different from the first frequency band, based on heterogeneous protocols or a homogeneous protocol.

[0323] According to an embodiment, the operation of discovering the external electronic device may include an operation of performing discovery with at least one first external electronic device, based on a first protocol, and an operation of performing discovery with at least one second external electronic device, based on a second protocol.

[0324] According to an embodiment, the operation of discovering the external electronic device may include an operation of discovering at least one first external electronic device having determined a discovery mode in the first frequency band, and an operation of discovering at least one second external electronic device having determined a discovery mode in the second frequency band different from the first frequency band.

[0325] According to an embodiment, the operation of discovering the external electronic device may include an operation of discovering, based on a first frequency band according to a first protocol, at least one first external electronic device having determined a discovery mode in the first frequency band, and an operation of discovering, based on a second frequency band according to a second protocol different from the first protocol, at least one second external electronic device having determined a discovery mode in the second frequency band.

[0326] According to an embodiment, the operation of discovering the external electronic device may include an operation of discovering, based on a first frequency band according to a specified

protocol, at least one first external electronic device having determined a discovery mode in the first frequency band, and an operation of discovering, based on a second frequency band according to the specified protocol, at least one second external electronic device having determined a discovery mode in the second frequency band.

[0327] According to an embodiment, the operation of determining the service target device may include an operation of generating a discovery list related to at least one external electronic device discovered based on the multiple frequency bands, and an operation of determining at least one external electronic device to be connected for the service as the service target device, based on the discovery list.

[0328] According to an embodiment, the operation of performing the connection procedure may include an operation of performing a direct connection with the external electronic device determined as the service target device, based on a protocol used to discover the external electronic device determined as the service target device.

[0329] According to an embodiment, the operation of performing the connection procedure may include an operation of, when the external electronic device determined as the service target device is a first external electronic device supporting a first protocol, performing a connection procedure with the first external electronic device through the first protocol used for discovery of the first external electronic device. According to an embodiment, the operation of performing the connection procedure may include an operation of, when the external electronic device determined as the service target device is a second external electronic device supporting a second protocol, performing a connection procedure with the second external electronic device through the second protocol used for discovery of the second external electronic device.

[0330] It will be appreciated that various embodiments of the disclosure according to the claims and description in the specification can be realized in the form of hardware, software or a combination of hardware and software.

[0331] Any such software may be stored in non-transitory computer readable storage media. The non-transitory computer readable storage media store one or more computer programs (software modules), the one or more computer programs include computer-executable instructions that, when executed by one or more processors of an electronic device individually or collectively, cause the electronic device to perform a method of the disclosure.

[0332] Any such software may be stored in the form of volatile or non-volatile storage such as, for example, a storage device like read only memory (ROM), whether erasable or rewritable or not, or in the form of memory such as, for example, random access memory (RAM), memory chips, device or integrated circuits or on an optically or magnetically readable medium such as, for example, a compact disk (CD), digital versatile disc (DVD), magnetic disk or magnetic tape or the like. It will be appreciated that the storage devices and storage media are various embodiments of non-transitory machine-readable storage that are suitable for storing a computer program or computer programs comprising instructions that, when executed, implement various embodiments of the disclosure. Accordingly, various embodiments provide a program comprising code for implementing apparatus or a method as claimed in any one of the claims of this specification and a non-transitory machine-readable storage storing such a program.

[0333] While the disclosure has been shown and described with reference to various embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the disclosure as defined by the appended claims and their equivalents.

Claims

1. An electronic device comprising: a first communication circuit configured to support device-to-device (D2D) communication; a second communication circuit configured to support out-of-band

(OOB) communication; memory storing one or more computer programs; and one or more processors communicatively coupled to the first communication circuit, the second communication circuit, and the memory, wherein the one or more computer programs include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to: based on detecting initiation of a service, configure a discovery protocol for each of multiple frequency bands related to discovering, using the first communication circuit, an external electronic device for which the service is to be performed, transmit a discovery mode start message through the second communication circuit, discover at least one external electronic device through the first communication circuit, based on a protocol corresponding to each of the multiple frequency bands, determine one of the discovered at least one external electronic device as a service target device, and perform a connection procedure with the external electronic device determined as the service target device.

2. The electronic device of claim 1, wherein the service comprises a D2D service which can be provided based on a direct connection with the external electronic device determined as the service target device.

3. The electronic device of claim 1, wherein the discovery mode start message comprises configuration information regarding the discovery protocol, and wherein the configuration information comprises information on different frequency bands related to a first protocol for simultaneously discovering the at least one external electronic device, and/or a second protocol different from the first protocol.

4. The electronic device of claim 1, wherein the one or more computer programs further include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to configure multiple discovery channels, based on each of a first frequency band and a second frequency band different from the first frequency band, based on heterogeneous protocols or a homogeneous protocol.

5. The electronic device of claim 1, wherein the one or more computer programs further include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to: perform discovery with at least one first external electronic device, based on a first protocol; and perform discovery with at least one second external electronic device, based on a second protocol.

6. The electronic device of claim 1, wherein the one or more computer programs further include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to: based on a first frequency band according to a first protocol, discover at least one first external electronic device having determined a discovery mode in the first frequency band; and based on a second frequency band according to a second protocol different from the first protocol, discover at least one second external electronic device having determined a discovery mode in the second frequency band.

7. The electronic device of claim 1, wherein the one or more computer programs further include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to: based on a first frequency band according to a specified protocol, discover at least one first external electronic device having determined a discovery mode in the first frequency band; and based on a second frequency band according to the specified protocol, discover at least one second external electronic device having determined a discovery mode in the second frequency band.

8. The electronic device of claim 1, wherein the one or more computer programs further include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to: generate a discovery list related to at least one external electronic device discovered based on the multiple frequency bands; and based on the discovery list, determine at least one external electronic device to be connected for the service as the service target device.

9. The electronic device of claim 1, wherein the one or more computer programs further include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to perform a direct connection with the external electronic device determined as the service target device, based on a protocol used to discover the external electronic device determined as the service target device.

10. The electronic device of claim 9, wherein the one or more computer programs further include computer-executable instructions that, when executed by the one or more processors individually or collectively, cause the electronic device to: in case that the external electronic device determined as the service target device is a first external electronic device supporting a first protocol, perform a connection procedure with the first external electronic device through the first protocol used for discovery of the first external electronic device; and in case that the external electronic device determined as the service target device is a second external electronic device supporting a second protocol, perform a connection procedure with the second external electronic device through the second protocol used for discovery of the second external electronic device.

11. An operation method performed by an electronic device, the method comprising: based on detecting initiation of a service, configuring a discovery protocol for each of multiple frequency bands related to discovering, using a first communication circuit configured to support device-to-device (D2D) communication, an external electronic device for which the service is to be performed; transmitting a discovery mode start message through a second communication circuit configured to support out-of-band (OOB) communication; discovering at least one external electronic device through the first communication circuit, based on a protocol corresponding to each of the multiple frequency bands; determining one of the at least one discovered external electronic device as a service target device; and performing a connection procedure with the external electronic device determined as the service target device.

12. The method of claim 11, wherein the configuring of the discovery protocol comprises configuring multiple discovery channels, based on each of a first frequency band and a second frequency band different from the first frequency band, based on heterogeneous protocols or a homogeneous protocol.

13. The method of claim 11, wherein the discovering of the external electronic device comprises: performing discovery with at least one first external electronic device, based on a first protocol; and performing discovery with at least one second external electronic device, based on a second protocol.

14. The method of claim 11, wherein the discovering of the external electronic device comprises: discovering at least one first external electronic device having determined a discovery mode in a first frequency band; and discovering at least one second external electronic device having determined a discovery mode in a second frequency band different from the first frequency band.

15. The method of claim 11, wherein the performing of the connection procedure comprises performing a direct connection with the external electronic device determined as the service target device, based on a protocol used to discover the external electronic device determined as the service target device.

16. The method of claim 11, wherein the discovery mode start message comprises configuration information regarding the discovery protocol, and wherein the configuration information comprises information on different frequency bands related to a first protocol for simultaneously discovering the at least one external electronic device, and/or a second protocol different from the first protocol.

17. The method of claim 11, further comprising performing a direct connection with the external electronic device determined as the service target device, based on a protocol used to discover the external electronic device determined as the service target device.

18. The method of claim 17, further comprising: in case that the external electronic device determined as the service target device is a first external electronic device supporting a first protocol, performing a connection procedure with the first external electronic device through the

first protocol used for discovery of the first external electronic device; and in case that the external electronic device determined as the service target device is a second external electronic device supporting a second protocol, performing a connection procedure with the second external electronic device through the second protocol used for discovery of the second external electronic device.

19. One or more non-transitory computer-readable storage media storing one or more computer programs including computer-executable instructions that, when executed by one or more processors of an electronic device individually or collectively, cause the electronic device to perform operations, the operations comprising: based on detecting initiation of a service, configuring a discovery protocol for each of multiple frequency bands related to discovering, using a first communication circuit configured to support device-to-device (D2D) communication, an external electronic device for which the service is to be performed; transmitting a discovery mode start message through a second communication circuit configured to support out-of-band (OOB) communication; discovering at least one external electronic device through the first communication circuit, based on a protocol corresponding to each of the multiple frequency bands; determining one of the at least one discovered external electronic device as a service target device; and performing a connection procedure with the external electronic device determined as the service target device.

20. The one or more non-transitory computer-readable storage media of claim 19, the operations further comprising: performing discovery with at least one first external electronic device, based on a first protocol; and performing discovery with at least one second external electronic device, based on a second protocol.