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(54) **Title:** TECHNIQUES TO SUPPORT POWER-SAVING BACKGROUND DEVICE DISCOVERY IN A WIRELESS COMMUNICATIONS SYSTEM

FIG. 1

100



(57) **Abstract:** Techniques to support power-saving background device discovery in a wireless communications system are described. In one embodiment, for example, an apparatus may comprise logic, at least a portion of which is in hardware, the logic to send a neighbor awareness networking (NAN) discovery request, receive a NAN discovery response in response to the NAN discovery request, and initiate a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process based on the NAN discovery response. Other embodiments are described and claimed.



**TECHNIQUES TO SUPPORT POWER-SAVING
BACKGROUND DEVICE DISCOVERY IN A WIRELESS COMMUNICATIONS SYSTEM**

RELATED CASE

This application claims priority to United States Provisional Patent Application Number
5 61/823,776, filed May 15, 2013, the entirety of which is hereby incorporated by reference.

TECHNICAL FIELD

Embodiments herein generally relate to wireless communications between devices in wireless networks.

BACKGROUND

10 In a wireless communications system, an application service platform may be defined and utilized to implement common functions required for interoperability of application services provided by devices in the wireless communications system. Such an application service platform may also include protocol elements that enable device discovery and/or service
15 discovery operations, connection management operations, and/or session management operations. Devices utilizing such an application service platform may periodically advertise device and/or service information in order that those devices and services that they provide may be discoverable by peers. Such periodic advertisements may create significant power and traffic loads, however. The integration of techniques for power-saving background device discovery into the application service platform may allow these issues to be addressed.

BRIEF DESCRIPTION OF THE DRAWINGS

20 **FIG. 1** illustrates an embodiment of an operating environment.
FIG. 2 illustrates an embodiment of an application service platform.
FIG. 3 illustrates an embodiment of an extended application service platform.
FIG. 4 illustrates an embodiment of an integrated discovery process.
25 **FIG. 5** illustrates an embodiment of a first communications flow.
FIG. 6 illustrates an embodiment of a second communications flow.
FIG. 7 illustrates an embodiment of a third communications flow.
FIG. 8 illustrates an embodiment of an apparatus and an embodiment of a system.
FIG. 9 illustrates an embodiment of a first logic flow.
30 **FIG. 10** illustrates an embodiment of a second logic flow.
FIG. 11 illustrates an embodiment of a storage medium.
FIG. 12 illustrates an embodiment of a device.
FIG. 13 illustrates an embodiment of wireless network.

DETAILED DESCRIPTION

Various embodiments may be generally directed to techniques to support power-saving background device discovery in a wireless communications system. In one embodiment, for example, an apparatus may comprise logic, at least a portion of which is in hardware, the logic to send a neighbor awareness networking (NAN) discovery request, receive an NAN discovery response in response to the NAN discovery request, and initiate a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process based on the NAN discovery response. Other embodiments are described and claimed.

Various embodiments may comprise one or more elements. An element may comprise any structure arranged to perform certain operations. Each element may be implemented as hardware, software, or any combination thereof, as desired for a given set of design parameters or performance constraints. Although an embodiment may be described with a limited number of elements in a certain topology by way of example, the embodiment may include more or less elements in alternate topologies as desired for a given implementation. It is worthy to note that any reference to “one embodiment” or “an embodiment” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. The appearances of the phrases “in one embodiment,” “in some embodiments,” and “in various embodiments” in various places in the specification are not necessarily all referring to the same embodiment.

FIG. 1 illustrates an example of an operating environment 100 such as may be representative of various embodiments. As shown in FIG. 1, in operating environment 100, a wireless device 102 communicates with a wireless device 104 over a wireless channel 106. In some embodiments, wireless devices 102 and 104 may operate according to one or more Wi-Fi Alliance (WFA) standards. In various embodiments, for example, wireless devices 102 and 104 may communicate according to the WFA Wi-Fi Direct standard, 2010 Release. In some embodiments, wireless devices 102 and 104 may additionally or alternatively operate and/or communicate using interfaces, protocols, and/or standards developed by the WFA Wi-Fi Direct Services (WFDS) Task Group and/or the WFA Neighbor Awareness Networking (NAN) Task Group. The embodiments are not limited in this context.

This disclosure is not limited to Wi-Fi Direct related standards, but may also apply to wireless local area networks (WLANs), such as WLANs implementing one or more Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards (sometimes collectively referred to as “Wi-Fi”). This disclosure may also apply to wireless wide area networks (WWANs), wireless personal area networks (WPANs), and 3G or 4G wireless standards (including progenies and variants) related to wireless devices, user equipment or network equipment included in WWANs.

Examples of 3G or 4G wireless standards may include without limitation any of the IEEE 802.16m and 802.16p standards, 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) and LTE-Advanced (LTE-A) standards, and International Mobile Telecommunications Advanced (IMT-ADV) standards, including their revisions, progeny and variants.

Other suitable examples may include, without limitation, Global System for Mobile Communications (GSM)/Enhanced Data Rates for GSM Evolution (EDGE) technologies, Universal Mobile Telecommunications System (UMTS)/High Speed Packet Access (HSPA) technologies, Worldwide Interoperability for Microwave Access (WiMAX) or the WiMAX II technologies, Code Division Multiple Access (CDMA) 2000 system technologies (e.g., CDMA2000 1xRTT, CDMA2000 EV-DO, CDMA EV-DV, and so forth), High Performance Radio Metropolitan Area Network (HIPERMAN) technologies as defined by the European Telecommunications Standards Institute (ETSI) Broadband Radio Access Networks (BRAN), Wireless Broadband (WiBro) technologies, GSM with General Packet Radio Service (GPRS) system (GSM/GPRS) technologies, High Speed Downlink Packet Access (HSDPA) technologies, High Speed Orthogonal Frequency-Division Multiplexing (OFDM) Packet Access (HSOPA) technologies, High-Speed Uplink Packet Access (HSUPA) system technologies, 3GPP Rel. 8-12 of LTE/System Architecture Evolution (SAE), and so forth. The embodiments are not limited in this context.

In various embodiments, wireless device 102 may comprise a device that seeks to obtain a particular type of service from another nearby device. Such a device that seeks to obtain a remotely-provided service may be referred to as a service seeker. In some embodiments, wireless device 104 may comprise a device that is willing to provide a service 108 to other nearby devices. Such a device that is willing to provide a service to one or more remote devices may be referred to as a service advertiser. In various embodiments, the service 108 that wireless device 104 is willing to provide may be of the same type as that sought by wireless device 102. In some embodiments, wireless device 102 may be operative to initiate a discovery process via which it becomes aware that service 108 may be obtained from wireless device 104. In various such embodiments, the discovery process may involve exchanging communications with wireless device 104 over wireless channel 106. The embodiments are not limited in this context.

In some embodiments, in conjunction with discovery of wireless device 104 and service 108 on the part of wireless device 102, wireless devices 102 and 104 may be operative to operate and/or communicate using WFDS application programming interfaces (APIs), methods, events, and/or other primitives. More particularly, in various embodiments, wireless devices 102 and 104 may be operative to operate and/or communicate using APIs, methods, events, and/or other

primitives of a WFDS application service platform (WFDS-ASP). The WFDS-ASP may generally comprise a logical entity that defines and/or implements protocol elements and/or functions in support of WFDS service advertising, seeking, discovery, sharing, and/or usage. The embodiments are not limited in this context.

5 **FIG. 2** illustrates an application service platform (ASP) 200 such as may be representative of some embodiments. More particularly, ASP 200 may comprise an example of a WFDS-ASP that defines and/or implements protocol elements and/or functions in support of WFDS service advertising, seeking, discovery, sharing, and/or usage on the part of wireless devices 102 and 104 of FIG. 1. As shown in FIG. 2, ASP 200 comprises elements associated with various types
10 of operations and/or communications that may be associated with WFDS service advertising, seeking, discovery, sharing, and/or usage. In the example of FIG. 2, ASP 200 comprises discovery abstract elements 210, topology management elements 220, and session management elements 230. The embodiments are not limited to these examples.

Discovery abstract elements 210 may comprise logic defining protocol elements and/or
15 functions for implementing device discovery in support of WFDS service advertising, seeking, discovery, sharing, and/or usage. In the example of FIG. 2, discovery abstract elements 210 comprise peer-to-peer (P2P) discovery engine 212. P2P discovery engine 212 may comprise logic defining protocol elements and/or functions to support Wi-Fi Direct (previously known as Wi-Fi P2P) device discovery. Topology management elements 220 may comprise logic defining
20 protocol elements and/or functions for managing inter-device data connections in support of WFDS service advertising, seeking, discovery, sharing, and/or usage. In the example of FIG. 2, topology management elements 220 comprise P2P connection management engine 222. P2P connection management engine 222 may comprise logic defining protocol elements and/or functions to support Wi-Fi Direct/P2P connection management. Session management elements
25 230 may comprise logic defining protocol elements and/or functions for managing inter-device communication sessions in support of WFDS service advertising, seeking, discovery, sharing, and/or usage. In the example of FIG. 2, session management elements 230 comprise P2P session management engine 232. P2P session management engine 232 may comprise logic defining protocol elements and/or functions to support Wi-Fi Direct/P2P session management. The
30 embodiments are not limited in this context.

In various embodiments, ASP 200 may define one or more logical interfaces via which one or more services 240 and/or one or more applications 250 may access elements of ASP 200. In some embodiments, such logical interfaces may be described in terms of method and event primitives. In various embodiments, methods may propagate from services 240 and/or
35 applications 250 to elements in ASP 200, and events may propagate from elements in ASP 200

to services 240 and/or applications 250. In some embodiments, one or more applications 250 may access P2P discovery engine 212 via enable 252. Enable 252 may comprise a set of APIs providing interfaces via which to access P2P discovery engine 212. In various embodiments, the elements of ASP 200 may collectively define and/or implement protocol elements and/or functions to support WFDS service advertising, seeking, discovery, sharing, and/or usage via a Wi-Fi Direct network 260. The embodiments are not limited in this context.

In order to make a service available to other devices, a WFDS service advertiser may periodically advertise corresponding service information. As a result of these periodic advertisements, the air interface may become more congested, and the advertiser may incur significant power consumption costs. Additionally, according to existing WFDS protocols, no mechanism is provided via which two sleeping devices may discover each other. In order to enable the use of NAN power-saving discovery techniques to address these issues, it may be desirable to integrate NAN components into a WFDS-ASP.

FIG. 3 illustrates an extended ASP 300 such as may be representative of some embodiments. More particularly, ASP 300 may comprise an example of an extended version of WFDS-ASP 200 of FIG. 2 that incorporates NAN protocol elements, functions, APIs, methods, events, and/or other primitives in order to enable the integration of NAN discovery procedures with WFDS-ASP discovery procedures in various embodiments. In some embodiments, ASP 300 may be representative of a WFDS-ASP version 2 (WFDS-ASP 2). Like ASP 200 of FIG. 2, extended ASP 300 of FIG. 3 may comprise topology management elements 220, P2P connection management engine 222, session management elements 230, and P2P session management engine 232. Also like ASP 200 of FIG. 2, extended ASP 300 of FIG. 3 may define logical interfaces for use by services 240 and/or applications 250 to access elements of extended ASP 300, and these elements may collectively define and/or implement protocol elements and/or functions to support WFDS service advertising, seeking, discovery, sharing, and/or usage via a Wi-Fi Direct network 260. However, unlike ASP 200 of FIG. 2, extended ASP 300 of FIG. 3 may comprise a NAN discovery engine 364. For example, as shown in FIG. 3, extended ASP 300 may comprise discovery abstract elements 310 that include the NAN discovery engine 364 along with the P2P discovery engine 212 of FIG. 2. The embodiments are not limited to this example.

In various embodiments, NAN discovery engine 364 may implement common functions enabling the performance of NAN power-saving discovery techniques. In some embodiments, NAN discovery engine 364 may be accessible to services 240 and/or applications 250 through a logical interface described in terms of method and event primitives. In various embodiments, methods may propagate from services 240 and/or applications 250 to NAN discovery engine

364, and events may propagate from NAN discovery engine 364 to services 240 and/or applications 250. In some embodiments, NAN discovery engine 364 may utilize time synchronization and periodic discovery frames provided by NAN MAC 366 to enable continuous background scanning and advertisement. In various embodiments, NAN discovery engine 364 may define a NAN discovery process via which service seeking devices and service advertising devices may discover each other while operating in low power states. In some embodiments, extended ASP 300 may define a mechanism by which a WFDS-ASP device discovery sub-process may be skipped following the NAN discovery process. The embodiments are not limited in this context.

In various embodiments, NAN enable 368 may comprise a set of APIs providing interfaces to access NAN discovery engine 364. In some embodiments, NAN enable 368 may comprise a NAN subscribe API primitive that enables a seeker application running in a low power background state to find advertised services during NAN discovery. In various such embodiments, the NAN subscribe API primitive may invoke a NAN discovery result method that returns a list of discovered services. In some embodiments, NAN enable 368 may comprise a NAN publish API primitive that enables an advertiser application running in a low power background state to advertise services during NAN discovery. In various embodiments, extended ASP 300 may enable the performance of NAN power-saving discovery techniques while maintaining interoperability for services 240 advertised in Wi-Fi Direct network 260. The embodiments are not limited in this context.

FIG. 4 illustrates an integrated discovery process 400 such as may be representative of some embodiments. More particularly, integrated discovery process 400 may comprise an example of an integrated discovery process that may be performed in various embodiments by wireless devices 102 and 104 of FIG. 1 in conjunction with extended ASP 300 of FIG. 3. As shown in FIG. 4, integrated discovery process 400 comprises a NAN discovery process 402 and a WFDS-ASP discovery process 404. NAN discovery process 402 may enable a service seeking device and a service advertising device to discover each other while operating in respective low power states. In some embodiments, NAN discovery process 402 may be defined by a NAN discovery engine such as NAN discovery engine 364 of FIG. 3. WFDS-ASP discovery process 404 may comprise a WFDS-ASP device discovery sub-process 406 and a WFDS-ASP service discovery sub-process 408. WFDS-ASP device discovery sub-process 406 may generally comprise a sub-process according to which a service seeking device and a service advertising device may exchange P2P probe request and response frames. In various embodiments, WFDS-ASP device discovery sub-process 406 may be defined by P2P discovery engine 212 of FIGs 2 and 3. In some embodiments, performance of NAN discovery process 402 may enable WFDS-

ASP device discovery sub-process 406 to be skipped. As such, WFDS-ASP device discovery sub-process 406 is depicted with a dashed border in FIG. 4. WFDS-ASP service discovery sub-process 408 may generally comprise a sub-process according to which a service seeking device and a service advertising device may exchange P2P service discovery request and response frames. In various embodiments, WFDS-ASP service discovery sub-process 408 may be defined by P2P discovery engine 212 of FIGs 2 and 3. The embodiments are not limited in this context.

It is worthy of note that in some embodiments, an extended ASP such as extended ASP 300 FIG. 3 may define an integrated discovery process comprising a structure that differs from that depicted in the example of FIG. 4. In various embodiments, such a differently-structured integrated discovery process may be defined as an available alternative to an integrated discovery process such as that in FIG. 4, while in other embodiments, such a differently-structured integrated discovery process may be implemented in lieu of an integrated discovery process such as that in FIG. 4. In some embodiments, for example, an extended ASP such as extended ASP 300 of FIG. 3 may define an integrated discovery process according to which both WFDS-ASP device discovery sub-process 406 and WFDS-ASP service discovery sub-process 408 may be skipped. In various such embodiments, a WFDS-ASP discovery process such as WFDS-ASP discovery process 404 may comprise a provision discovery sub-process that is initiated directly following a NAN discovery process such as NAN discovery process 402. Examples of operations and/or communications that may be associated with some such embodiments are discussed below with reference to FIG. 7. The embodiments are not limited in this context.

FIG. 5 illustrates a communications flow 500 such as may be representative of operations and/or communications on the part of a service advertiser (which also may be referred to as a service publisher) and a service seeker (which also may be referred to as a service subscriber) during an integrated discovery process in some embodiments. For example, communications flow 500 may be representative of operations and/or communications on the part of wireless devices 102 and 104 of FIG. 1 during integrated discovery process 400 of FIG. 4. More particularly, communications flow 500 may be representative of various embodiments in which WFDS-ASP device discovery sub-process 406 of FIG. 4 is not skipped during performance of integrated discovery process 400. As shown in FIG. 5, some communications within communications flow 500 may occur during a NAN discovery process, such as NAN discovery process 402 of FIG. 4. Other communications within communications flow 500 may occur during a WFDS-ASP discovery process, such as WFDS-ASP discovery process 404 of FIG. 4. The embodiments are not limited in this context.

During the NAN discovery process, at 502 and 504 respectively, the advertiser and the seeker may perform time synchronization. At 506, a service may be selected at the advertiser for advertisement or publication. At 508, an AdvertiseService() or PublishingService90 method may be utilized to cause the service to be advertised or published using an extended WFDS-ASP
5 featuring a NAN discovery engine. At 510, an application at the seeker may determine that a search for services should be performed. At 512, a Subscribe() method may be utilized to cause NAN discovery to be undertaken via the extended WFDS-ASP. At 514, the seeker may transmit a NAN Discovery Request to the advertiser. At 516, the advertiser may utilize local matching techniques to identify services matching specified criteria. At 518, the advertiser may transmit a
10 NAN Discovery Response to the seeker. At 520, a DiscoveryResult primitive may be generated via the extended WFDS-ASP based on the NAN Discovery Response. At 522, a list of available services may be provided to the application at the seeker based on the DiscoveryResult primitive.

During the WFDS-ASP discovery process, at 524, the application at the seeker may select a service for use. At 526, a SeekService() method may be utilized to cause P2P discovery to be
15 undertaken via the extended WFDS-ASP. At 528, the seeker may transmit a P2P Probe Request to the advertiser, and the P2P Probe Request may comprise one or more service hashes. At 530, the advertiser may perform hash matching to identify one or more service names and/or advertisement IDs matching the service hashes in the P2P Probe Request. At 532, the advertiser may transmit a P2P Probe Response to the seeker, and the P2P Probe Response may comprise
20 the one or more service names and/or advertisement IDs identified during the hash matching. At 534, the seeker may transmit a P2P Service Discovery Request to the advertiser, and the P2P Service Discovery Request may comprise one or more service names and/or service information requests. At 536, the advertiser may perform name matching and service information matching techniques to identify advertisement IDs and service statuses for services identified in the P2P
25 Service Discovery Request. At 538, the advertiser may transmit a P2P Service Discovery Response to the seeker, and the P2P Service Discovery Response may comprise the identified advertisement IDs and service statuses. At 540, a SearchResult primitive may be generated via the extended WFDS-ASP based on the P2P Service Discovery Response. At 542, a list of devices may be provided to the application at the seeker based on the SearchResult primitive.

30 The embodiments are not limited in this context.

FIG. 6 illustrates a communications flow 600 such as may be representative of operations and/or communications on the part of a service advertiser (which also may be referred to as a service publisher) and a service seeker (which also may be referred to as a service subscriber) during an integrated discovery process in some embodiments. For example, communications
35 flow 600 may be representative of operations and/or communications on the part of wireless

devices 102 and 104 of FIG. 1 during integrated discovery process 400 of FIG. 4. More particularly, communications flow 600 may be representative of various embodiments in which WFDS-ASP device discovery sub-process 406 of FIG. 4 is skipped during performance of integrated discovery process 400. The embodiments are not limited in this context.

5 Many of the elements of communications flow 600 match those previously discussed with respect to communications flow 500 of FIG. 5, and in the interest of brevity, their descriptions will not be repeated. However, at 618 in communications flow 600, the advertiser includes a service name in the NAN discovery response that it sends to the seeker. This service name may comprise a service name that matches a service ID included in the NAN discovery request sent at
10 514. At 626, the SeekService() method is invoked with a flag set to indicate that transmission of a P2P Probe Request can be skipped. As such, the P2P Probe Request at 528, the hash matching at 530, and the P2P Probe Response at 532 in communications flow 500 of FIG. 5 are skipped in communications flow 600. Following invocation of the SeekService() method at 626, the seeker proceeds directly to transmission of the P2P Service Discovery Request at 534. One advantage
15 associated with some such embodiments may be that forgoing the P2P probe request and response exchange of FIG. 5 may result in reduced power consumption on the part of the advertiser and seeker devices. Other advantages are both possible and contemplated, and the embodiments are not limited in this context.

FIG. 7 illustrates a communications flow 700 such as may be representative of operations
20 and/or communications on the part of a service advertiser (which also may be referred to as a service publisher) and a service seeker (which also may be referred to as a service subscriber) during an integrated discovery process in some embodiments. More particularly, communications flow 700 may be representative of various embodiments in which an integrated discovery process is performed according to which both WFDS-ASP device discovery sub-
25 process 406 and WFDS-ASP service discovery sub-process 408 of FIG. 4 are skipped and a WFDS-ASP provision discovery sub-process is initiated following a NAN discovery process. The embodiments are not limited in this context.

During the NAN discovery process, at 702, an AdvertiseService() method may be utilized by the advertiser to cause a service to be advertised or published using an extended WFDS-ASP
30 featuring a NAN discovery engine. In various embodiments, the AdvertiseService() method may be invoked with an AutoAccept provision. At 704 and 706 respectively, the advertiser and the seeker may perform time synchronization. At 708, an application at the seeker may identify a desired service. At 710, the seeker may invoke a SeekService() method to cause NAN discovery to be undertaken via the extended WFDS-ASP. At 712, the seeker may transmit a NAN
35 Discovery Request to the advertiser. At 714, the advertiser may perform hash matching to

identify one or more service names and/or advertisement IDs that match the desired service. At 716, the advertiser may transmit a NAN Discovery Response to the seeker. At 718, a SearchResult primitive may be generated via the extended WFDS-ASP based on the NAN Discovery Response. At 720, a list of devices may be provided to the application at the seeker based on the SearchResult primitive.

During the WFDS-ASP discovery process, at 722, the application at the seeker may select the advertiser as a device from which to obtain the desired service. In some embodiments, this selection may be performed based on user input. At 724, the seeker may invoke a ConnectSessions() method in order to establish a P2P connection with the advertiser. At 726, the seeker may initiate a WFDS-ASP provision discovery sub-process by sending a P2P provision discovery request to the advertiser. At 728, the advertiser may send a P2P provision discovery response to the seeker in response to the P2P provision discovery request. In various embodiments, the P2P provision discovery response may comprise a status(0) parameter. At 730, the advertiser and the seeker may begin a process by which they become members of a same P2P group in order to establish their P2P connection. In various embodiments they may create and join a new P2P group, while in some other embodiments they may join an existing P2P group. The embodiments are not limited in this context.

FIG. 8 illustrates a block diagram of an apparatus 800. Apparatus 800 may comprise an example of a device capable of operating as a service seeker, such as wireless device 102 of FIG. 1. Apparatus 800 may additionally or alternatively comprise an example of a device capable of operating as a service advertiser, such as wireless device 104 of FIG. 1. As shown in FIG. 8, apparatus 800 comprises multiple elements including a processor circuit 802, a memory unit 804, and a communications component 806. The embodiments, however, are not limited to the type, number, or arrangement of elements shown in this figure.

In various embodiments, apparatus 800 may comprise processor circuit 802. Processor circuit 802 may be implemented using any processor or logic device, such as a complex instruction set computer (CISC) microprocessor, a reduced instruction set computing (RISC) microprocessor, a very long instruction word (VLIW) microprocessor, an x86 instruction set compatible processor, a processor implementing a combination of instruction sets, a multi-core processor such as a dual-core processor or dual-core mobile processor, or any other microprocessor or central processing unit (CPU). Processor circuit 802 may also be implemented as a dedicated processor, such as a controller, a microcontroller, an embedded processor, a chip multiprocessor (CMP), a co-processor, a digital signal processor (DSP), a network processor, a media processor, an input/output (I/O) processor, a media access control (MAC) processor, a radio baseband processor, an application specific integrated circuit (ASIC),

a field programmable gate array (FPGA), a programmable logic device (PLD), and so forth. In one embodiment, for example, processor circuit 802 may be implemented as a general purpose processor, such as a processor made by Intel® Corporation, Santa Clara, Calif. The embodiments are not limited in this context.

5 In some embodiments, apparatus 800 may comprise or be arranged to communicatively couple with a memory unit 804. Memory unit 804 may be implemented using any machine-readable or computer-readable media capable of storing data, including both volatile and non-volatile memory. For example, memory unit 804 may include read-only memory (ROM), random-access memory (RAM), dynamic RAM (DRAM), Double-Data-Rate DRAM

10 (DDRAM), synchronous DRAM (SDRAM), static RAM (SRAM), programmable ROM (PROM), erasable programmable ROM (EPROM), electrically erasable programmable ROM (EEPROM), flash memory, polymer memory such as ferroelectric polymer memory, ovonic memory, phase change or ferroelectric memory, silicon-oxide-nitride-oxide-silicon (SONOS) memory, magnetic or optical cards, or any other type of media suitable for storing information.

15 It is worthy of note that some portion or all of memory unit 804 may be included on the same integrated circuit as processor circuit 802, or alternatively some portion or all of memory unit 804 may be disposed on an integrated circuit or other medium, for example a hard disk drive, that is external to the integrated circuit of processor circuit 802. Although memory unit 804 is comprised within apparatus 800 in FIG. 8, memory unit 804 may be external to apparatus 800 in
20 various embodiments. The embodiments are not limited in this context.

In some embodiments, apparatus 800 may comprise a communications component 806. Communications component 806 may comprise logic, circuitry, and/or instructions operative to send messages to one or more remote devices and/or to receive messages from one or more remote devices. In various embodiments, communications component 806 may be operative to
25 send and/or receive messages over one or more wired connections, one or more wireless connections, or a combination of both. In some embodiments, communications component 806 may additionally comprise logic, circuitry, and/or instructions operative to perform various operations in support of such communications. Examples of such operations may include selection of transmission and/or reception parameters and/or timing, frame, packet, and/or
30 protocol data unit (PDU) construction and/or deconstruction, encoding and/or decoding, error detection, and/or error correction. The embodiments are not limited to these examples.

In various embodiments, apparatus 800 may comprise a service management component 808. Service management component 808 may comprise logic, circuitry, and/or instructions operative to manage the seeking and/or advertising of services on the part of apparatus 800. In
35 some embodiments, service management component 808 may be operative to manage the

seeking and/or advertising of services in conjunction with an extended WFDS-ASP 810. In various embodiments, extended WFDS-ASP 810 may incorporate NAN protocol elements, functions, APIs, methods, events, and/or other primitives in order to enable the integration of NAN discovery procedures with WFDS-ASP discovery procedures. In some embodiments, extended WFDS-ASP 810 may be the same as or similar to the extended ASP 300 of FIG. 3. In various embodiments, communications component 806 may be operative to manage, support, and/or perform one or more communications in accordance with extended WFDS-ASP 810. The embodiments are not limited in this context.

FIG. 8 also illustrates a block diagram of a system 840. System 840 may comprise any of the aforementioned elements of apparatus 800. System 840 may further comprise a radio frequency (RF) transceiver 842. RF transceiver 842 may comprise one or more radios capable of transmitting and receiving signals using various suitable wireless communications techniques. Such techniques may involve communications across one or more wireless networks. Exemplary wireless networks include (but are not limited to) cellular radio access networks, wireless local area networks (WLANs), wireless personal area networks (WPANs), wireless metropolitan area network (WMANs), and satellite networks. In communicating across such networks, RF transceiver 842 may operate in accordance with one or more applicable standards in any version. The embodiments are not limited in this context.

In some embodiments, system 840 may comprise one or more RF antennas 844. Examples of any particular RF antenna 844 may include, without limitation, an internal antenna, an omnidirectional antenna, a monopole antenna, a dipole antenna, an end-fed antenna, a circularly polarized antenna, a micro-strip antenna, a diversity antenna, a dual antenna, a tri-band antenna, a quad-band antenna, and so forth. In various embodiments, RF transceiver 842 may be operative to send and/or receive messages and/or data using one or more RF antennas 844. The embodiments are not limited in this context.

In some embodiments, system 840 may comprise a display 846. Display 846 may comprise any display device capable of displaying information received from processor circuit 802. Examples for display 846 may include a television, a monitor, a projector, and a computer screen. In one embodiment, for example, display 846 may be implemented by a liquid crystal display (LCD), light emitting diode (LED) or other type of suitable visual interface. Display 846 may comprise, for example, a touch-sensitive display screen ("touchscreen"). In various implementations, display 846 may comprise one or more thin-film transistors (TFT) LCD including embedded transistors. The embodiments, however, are not limited to these examples.

In some embodiments, during general operation of apparatus 800 and/or system 840, service management component 808 may determine that a service of a particular type is to be

sought. In various embodiments, for example, an application running on processor circuit 802 may be operative to invoke a primitive to instruct service management component 808 to seek a particular type of service. In some embodiments, service management component 808 may be operative to perform this determination at a time during which apparatus 800 and/or system 840 is operating in a low power state. In various embodiments, in response to the determination that a service of the particular type is to be sought, service management component 808 may be operative to instruct communications component 806 to perform communications in support of NAN discovery.

In some embodiments, based on such an instruction, communications component 806 may be operative to send a NAN discovery request 812 to a peer device 850. In various embodiments, communications component 806 may be operative to send the NAN discovery request 812 to the peer device 850 at a time during which the peer device 850 is operating in a low power state. In some embodiments, the NAN discovery request 812 may comprise a service ID 814 that identifies the desired service type. In various embodiments, communications component 806 may be operative to receive a NAN discovery response 816 from the peer device 850 in response to the NAN discovery request 812. In some embodiments, the peer device 850 may be operative to include a service name 818 in the NAN discovery response 816. In various embodiments, the service name 818 may identify an advertised service of peer device 850 that is of the same type as that sought by service management component 808 as indicated by service ID 814. In some other embodiments, the peer device 850 may not include service name 818 within NAN discovery response 816. The embodiments are not limited in this context.

In various embodiments, service management component 808 may be operative to initiate a WFDS-ASP discovery process based on NAN discovery response 816. In some embodiments, the WFDS-ASP discovery process may be the same as or similar to WFDS-ASP discovery process 404 of FIG. 4. In various embodiments, service management component 808 may be operative to initiate the WFDS-ASP discovery process by invoking a WFDS-ASP primitive. In some embodiments, the WFDS-ASP primitive may be defined by extended WFDS-ASP 810. In various embodiments, the WFDS-ASP primitive may comprise a flag indicating whether a device discovery sub-process of the WFDS-ASP discovery process is to be skipped. In some other embodiments, the WFDS-ASP primitive may not comprise such a flag. The embodiments are not limited in this context.

In various embodiments, in response to initiation of the WFDS-ASP discovery process, communications component 806 may be operative to initiate either a WFDS-ASP device discovery sub-process or a WFDS-ASP service discovery sub-process. In some embodiments, when service management component 808 invokes the WFDS-ASP primitive with the flag set to

indicate that the WFDS-ASP device discovery sub-process is to be skipped, communications component 806 may be operative to skip the WFDS-ASP device discovery sub-process and initiate the WFDS-ASP service discovery sub-process. In various embodiments, when service management component 808 invokes the WFDS-ASP primitive with the flag set to indicate that the WFDS-ASP device discovery sub-process is not to be skipped or the WFDS-ASP primitive does not comprise the flag, communications component 806 may be operative to initiate the WFDS-ASP device discovery sub-process.

In some embodiments, in order to initiate the WFDS-ASP device discovery sub-process, communications component 806 may be operative to send a P2P probe request 820 to peer device 850 and to receive a P2P probe response 822 from peer device 850 in response. In various embodiments, peer device 850 may include a service name 824 in the P2P probe response 822. In some embodiments, the service name 824 may identify an advertised service of peer device 850 that is of the same type as that sought by service management component 808 as indicated by service ID 814. In various embodiments, peer device 850 may include service name 824 in P2P probe response 822 in lieu of including service name 818 in NAN discovery response 816. In some other embodiments, peer device 850 may include service name 824 in P2P probe response 822 and also include service name 818 in NAN discovery response 816. In various embodiments, in response to receipt of the P2P probe response 822, communications component 806 may be operative to initiate the WFDS-ASP service discovery sub-process. As noted above, in some other embodiments, communications component 806 may be operative to skip the WFDS-ASP device discovery sub-process and proceed directly to initiation of the WFDS-ASP service discovery sub-process in response to initiation of the WFDS-ASP discovery process by service management component 808. The embodiments are not limited in this context.

In various embodiments, in order to initiate the WFDS-ASP service discovery sub-process, communications component 806 may be operative to send a P2P service discovery request 826 to peer device 850. In some embodiments, communications component 806 may be operative to include a service name 828 in the P2P service discovery request 826. In various embodiments, the service name 828 may match a service name 818 received from peer device 850 via NAN discovery response 816 and/or may match a service name 824 received from peer device 850 via P2P probe response 822. In some embodiments, communications component 806 may be operative to receive a P2P service discovery response 830 from peer device 850 in response to P2P service discovery request 826. In various embodiments, when the P2P service discovery response 830 indicates that an advertised service identified by service name 828 is available via peer device 850, service management component 808 may be operative to proceed with

connection and session establishment procedures to enable apparatus 800 and/or system 840 to obtain that service from peer device 850. The embodiments are not limited in this context.

Operations for the above embodiments may be further described with reference to the following figures and accompanying examples. Some of the figures may include a logic flow.

5 Although such figures presented herein may include a particular logic flow, it can be appreciated that the logic flow merely provides an example of how the general functionality as described herein can be implemented. Further, the given logic flow does not necessarily have to be executed in the order presented unless otherwise indicated. In addition, the given logic flow may be implemented by a hardware element, a software element executed by a processor, or any
10 combination thereof. The embodiments are not limited in this context.

FIG. 9 illustrates one embodiment of a logic flow 900, which may be representative of the operations executed by one or more embodiments described herein. For example, logic flow 900 may be representative of operations that may be performed in some embodiments by apparatus 800 and/or system 840 of FIG. 8. As shown in logic flow 900, a NAN discovery request may be
15 sent at 902. For example, communications component 806 of FIG. 8 may be operative to send NAN discovery request 812 to peer device 850. At 904, a NAN discovery response may be received in response to the NAN discovery request. For example, communications component 806 of FIG. 8 may be operative to receive NAN discovery response 816 from peer device 850 in response to NAN discovery request 812. At 906, a WFDS-ASP discovery process may be
20 initiated based on the NAN discovery response. For example, communications component 806 of FIG. 8 may be operative to initiate WFDS-ASP discovery process 404 of FIG. 4 based on NAN discovery response 816. The embodiments are not limited to these examples.

FIG. 10 illustrates one embodiment of a logic flow 1000, which may be representative of the operations executed by one or more embodiments described herein. For example, logic flow
25 1000 may be representative of operations that may be performed in various embodiments by peer device 850 of FIG. 8. As shown in logic flow 1000, a NAN discovery request may be received at 1002 that comprises a service ID. For example, peer device 850 of FIG. 8 may be operative to receive NAN discovery request 812 from apparatus 800 and/or system 840, and NAN discovery request 812 may comprise service ID 814. At 1004, a NAN discovery response may be sent that
30 comprises a service name matching the service ID received in the NAN discovery request received at 1002. For example, peer device 850 of FIG. 8 may be operative to send a NAN discovery response 816 to apparatus 800 and/or system 840 that comprises a service name 818 that corresponds to a service of a same type as that indicated by service ID 814. At 1006, a P2P service discovery request comprising the service name may be received in response to the NAN
35 discovery response. For example, peer device 850 of FIG. 8 may be operative to receive P2P

service discovery request 826 from apparatus 800 and/or system 840, and P2P service discovery request 826 may comprise a service name 828 that is the same as the service name 818 sent in the NAN discovery response 816. The embodiments are not limited to these examples.

FIG. 11 illustrates an embodiment of a storage medium 1100. Storage medium 1100 may comprise any non-transitory computer-readable storage medium or machine-readable storage medium, such as an optical, magnetic or semiconductor storage medium. In various embodiments, storage medium 1100 may comprise an article of manufacture. In some embodiments, storage medium 1100 may store computer-executable instructions, such as computer-executable instructions to implement one or both of logic flow 900 of FIG. 9 and logic flow 1000 of FIG. 10. Examples of a computer-readable storage medium or machine-readable storage medium may include any tangible media capable of storing electronic data, including volatile memory or non-volatile memory, removable or non-removable memory, erasable or non-erasable memory, writeable or re-writable memory, and so forth. Examples of computer-executable instructions may include any suitable type of code, such as source code, compiled code, interpreted code, executable code, static code, dynamic code, object-oriented code, visual code, and the like. The embodiments are not limited in this context.

FIG. 12 illustrates an embodiment of a communications device 1200 that may implement one or more of apparatus 800 and/or system 840 of FIG. 8, logic flow 900 of FIG. 9, logic flow 1000 of FIG. 10, and storage medium 1100 of FIG. 11. In various embodiments, device 1200 may comprise a logic circuit 1228. The logic circuit 1228 may include physical circuits to perform operations described for one or more of apparatus 800 and/or system 840 of FIG. 8, logic flow 900 of FIG. 9, and logic flow 1000 of FIG. 10, for example. As shown in FIG. 12, device 1200 may include a radio interface 1210, baseband circuitry 1220, and computing platform 1230, although the embodiments are not limited to this configuration.

The device 1200 may implement some or all of the structure and/or operations for one or more of apparatus 800 and/or system 840 of FIG. 8, logic flow 900 of FIG. 9, logic flow 1000 of FIG. 10, storage medium 1100 of FIG. 11, and logic circuit 1228 in a single computing entity, such as entirely within a single device. Alternatively, the device 1200 may distribute portions of the structure and/or operations for one or more of apparatus 800 and/or system 840 of FIG. 8, logic flow 900 of FIG. 9, logic flow 1000 of FIG. 10, storage medium 1100 of FIG. 11, and logic circuit 1228 across multiple computing entities using a distributed system architecture, such as a client-server architecture, a 3-tier architecture, an N-tier architecture, a tightly-coupled or clustered architecture, a peer-to-peer architecture, a master-slave architecture, a shared database architecture, and other types of distributed systems. The embodiments are not limited in this context.

In one embodiment, radio interface 1210 may include a component or combination of components adapted for transmitting and/or receiving single-carrier or multi-carrier modulated signals (e.g., including complementary code keying (CCK), orthogonal frequency division multiplexing (OFDM), and/or single-carrier frequency division multiple access (SC-FDMA) symbols) although the embodiments are not limited to any specific over-the-air interface or modulation scheme. Radio interface 1210 may include, for example, a receiver 1212, a frequency synthesizer 1214, and/or a transmitter 1216. Radio interface 1210 may include bias controls, a crystal oscillator and/or one or more antennas 1218-*f*. In another embodiment, radio interface 1210 may use external voltage-controlled oscillators (VCOs), surface acoustic wave filters, intermediate frequency (IF) filters and/or RF filters, as desired. Due to the variety of potential RF interface designs an expansive description thereof is omitted.

Baseband circuitry 1220 may communicate with radio interface 1210 to process receive and/or transmit signals and may include, for example, an analog-to-digital converter 1222 for down converting received signals, a digital-to-analog converter 1224 for up converting signals for transmission. Further, baseband circuitry 1220 may include a baseband or physical layer (PHY) processing circuit 1226 for PHY link layer processing of respective receive/transmit signals. Baseband circuitry 1220 may include, for example, a medium access control (MAC) processing circuit 1227 for MAC/data link layer processing. Baseband circuitry 1220 may include a memory controller 1232 for communicating with MAC processing circuit 1227 and/or a computing platform 1230, for example, via one or more interfaces 1234.

In some embodiments, PHY processing circuit 1226 may include a frame construction and/or detection module, in combination with additional circuitry such as a buffer memory, to construct and/or deconstruct communication frames. Alternatively or in addition, MAC processing circuit 1227 may share processing for certain of these functions or perform these processes independent of PHY processing circuit 1226. In some embodiments, MAC and PHY processing may be integrated into a single circuit.

The computing platform 1230 may provide computing functionality for the device 1200. As shown, the computing platform 1230 may include a processing component 1240. In addition to, or alternatively of, the baseband circuitry 1220, the device 1200 may execute processing operations or logic for one or more of apparatus 800 and/or system 840 of FIG. 8, logic flow 900 of FIG. 9, logic flow 1000 of FIG. 10, storage medium 1100 of FIG. 11, and logic circuit 1228 using the processing component 1240. The processing component 1240 (and/or PHY 1226 and/or MAC 1227) may comprise various hardware elements, software elements, or a combination of both. Examples of hardware elements may include devices, logic devices, components, processors, microprocessors, circuits, processor circuits, circuit elements (e.g.,

transistors, resistors, capacitors, inductors, and so forth), integrated circuits, application specific integrated circuits (ASIC), programmable logic devices (PLD), digital signal processors (DSP), field programmable gate array (FPGA), memory units, logic gates, registers, semiconductor device, chips, microchips, chip sets, and so forth. Examples of software elements may include software components, programs, applications, computer programs, application programs, system programs, software development programs, machine programs, operating system software, middleware, firmware, software modules, routines, subroutines, functions, methods, procedures, software interfaces, application program interfaces (API), instruction sets, computing code, computer code, code segments, computer code segments, words, values, symbols, or any combination thereof. Determining whether an embodiment is implemented using hardware elements and/or software elements may vary in accordance with any number of factors, such as desired computational rate, power levels, heat tolerances, processing cycle budget, input data rates, output data rates, memory resources, data bus speeds and other design or performance constraints, as desired for a given implementation.

The computing platform 1230 may further include other platform components 1250. Other platform components 1250 include common computing elements, such as one or more processors, multi-core processors, co-processors, memory units, chipsets, controllers, peripherals, interfaces, oscillators, timing devices, video cards, audio cards, multimedia input/output (I/O) components (e.g., digital displays), power supplies, and so forth. Examples of memory units may include without limitation various types of computer readable and machine readable storage media in the form of one or more higher speed memory units, such as read-only memory (ROM), random-access memory (RAM), dynamic RAM (DRAM), Double-Data-Rate DRAM (DDRAM), synchronous DRAM (SDRAM), static RAM (SRAM), programmable ROM (PROM), erasable programmable ROM (EPROM), electrically erasable programmable ROM (EEPROM), flash memory, polymer memory such as ferroelectric polymer memory, ovonic memory, phase change or ferroelectric memory, silicon-oxide-nitride-oxide-silicon (SONOS) memory, magnetic or optical cards, an array of devices such as Redundant Array of Independent Disks (RAID) drives, solid state memory devices (e.g., USB memory, solid state drives (SSD) and any other type of storage media suitable for storing information.

Device 1200 may be, for example, an ultra-mobile device, a mobile device, a fixed device, a machine-to-machine (M2M) device, a personal digital assistant (PDA), a mobile computing device, a smart phone, a telephone, a digital telephone, a cellular telephone, user equipment, eBook readers, a handset, a one-way pager, a two-way pager, a messaging device, a computer, a personal computer (PC), a desktop computer, a laptop computer, a notebook computer, a netbook computer, a handheld computer, a tablet computer, a server, a server array or server farm, a web

server, a network server, an Internet server, a work station, a mini-computer, a main frame computer, a supercomputer, a network appliance, a web appliance, a distributed computing system, multiprocessor systems, processor-based systems, consumer electronics, programmable consumer electronics, game devices, display, television, digital television, set top box, wireless
5 access point, base station, node B, subscriber station, mobile subscriber center, radio network controller, router, hub, gateway, bridge, switch, machine, or combination thereof. Accordingly, functions and/or specific configurations of device 1200 described herein, may be included or omitted in various embodiments of device 1200, as suitably desired.

Embodiments of device 1200 may be implemented using single input single output (SISO)
10 architectures. However, certain implementations may include multiple antennas (e.g., antennas 1218-f) for transmission and/or reception using adaptive antenna techniques for beamforming or spatial division multiple access (SDMA) and/or using MIMO communication techniques.

The components and features of device 1200 may be implemented using any combination of discrete circuitry, application specific integrated circuits (ASICs), logic gates and/or single
15 chip architectures. Further, the features of device 1200 may be implemented using microcontrollers, programmable logic arrays and/or microprocessors or any combination of the foregoing where suitably appropriate. It is noted that hardware, firmware and/or software elements may be collectively or individually referred to herein as “logic” or “circuit.”

It should be appreciated that the exemplary device 1200 shown in the block diagram of
20 FIG. 12 may represent one functionally descriptive example of many potential implementations. Accordingly, division, omission or inclusion of block functions depicted in the accompanying figures does not infer that the hardware components, circuits, software and/or elements for implementing these functions would be necessarily be divided, omitted, or included in embodiments.

FIG. 13 illustrates an embodiment of a wireless network 1300. As shown in FIG. 13,
25 wireless network 1300 comprises an access point 1302 and wireless stations 1304, 1306, and 1308. In various embodiments, wireless network 1300 may comprise a wireless local area network (WLAN), such as a WLAN implementing one or more Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards (sometimes collectively referred to as “Wi-Fi”). In some
30 other embodiments, wireless network 1300 may comprise another type of wireless network, and/or may implement other wireless communications standards. In various embodiments, for example, wireless network 1300 may comprise a WWAN or WPAN rather than a WLAN. The embodiments are not limited to this example.

In some embodiments, wireless network 1300 may implement one or more broadband
35 wireless communications standards, such as 3G or 4G standards, including their revisions,

progeny, and variants. Examples of 3G or 4G wireless standards may include without limitation any of the IEEE 802.16m and 802.16p standards, 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE) and LTE-Advanced (LTE-A) standards, and International Mobile Telecommunications Advanced (IMT-ADV) standards, including their revisions, progeny and variants. Other suitable examples may include, without limitation, Global System for Mobile Communications (GSM)/Enhanced Data Rates for GSM Evolution (EDGE) technologies, Universal Mobile Telecommunications System (UMTS)/High Speed Packet Access (HSPA) technologies, Worldwide Interoperability for Microwave Access (WiMAX) or the WiMAX II technologies, Code Division Multiple Access (CDMA) 2000 system technologies (e.g.,
10 CDMA2000 1xRTT, CDMA2000 EV-DO, CDMA EV-DV, and so forth), High Performance Radio Metropolitan Area Network (HIPERMAN) technologies as defined by the European Telecommunications Standards Institute (ETSI) Broadband Radio Access Networks (BRAN), Wireless Broadband (WiBro) technologies, GSM with General Packet Radio Service (GPRS) system (GSM/GPRS) technologies, High Speed Downlink Packet Access (HSDPA)
15 technologies, High Speed Orthogonal Frequency-Division Multiplexing (OFDM) Packet Access (HSOPA) technologies, High-Speed Uplink Packet Access (HSUPA) system technologies, 3GPP Rel. 8-12 of LTE/System Architecture Evolution (SAE), and so forth. The embodiments are not limited in this context.

In various embodiments, wireless stations 1304, 1306, and 1308 may communicate with
20 access point 1302 in order to obtain connectivity to one or more external data networks. In some embodiments, for example, wireless stations 1304, 1306, and 1308 may connect to the Internet 1312 via access point 1302 and access network 1310. In various embodiments, access network 1310 may comprise a private network that provides subscription-based Internet-connectivity, such as an Internet Service Provider (ISP) network. The embodiments are not limited to this
25 example.

In various embodiments, two or more of wireless stations 1304, 1306, and 1308 may communicate with each other directly by exchanging peer-to-peer communications. For example, in the example of FIG. 13, wireless stations 1304 and 1306 communicate with each other directly by exchanging peer-to-peer communications 1314. In some embodiments, such
30 peer-to-peer communications may be performed according to one or more Wi-Fi Alliance (WFA) standards. For example, in various embodiments, such peer-to-peer communications may be performed according to the WFA Wi-Fi Direct standard, 2010 Release. In various embodiments, such peer-to-peer communications may additionally or alternatively be performed using one or more interfaces, protocols, and/or standards developed by the WFA Wi-Fi Direct
35 Services (WFDS) Task Group. The embodiments are not limited to these examples.

Various embodiments may be implemented using hardware elements, software elements, or a combination of both. Examples of hardware elements may include processors, microprocessors, circuits, circuit elements (e.g., transistors, resistors, capacitors, inductors, and so forth), integrated circuits, application specific integrated circuits (ASIC), programmable logic devices (PLD), digital signal processors (DSP), field programmable gate array (FPGA), logic gates, registers, semiconductor device, chips, microchips, chip sets, and so forth. Examples of software may include software components, programs, applications, computer programs, application programs, system programs, machine programs, operating system software, middleware, firmware, software modules, routines, subroutines, functions, methods, procedures, software interfaces, application program interfaces (API), instruction sets, computing code, computer code, code segments, computer code segments, words, values, symbols, or any combination thereof. Determining whether an embodiment is implemented using hardware elements and/or software elements may vary in accordance with any number of factors, such as desired computational rate, power levels, heat tolerances, processing cycle budget, input data rates, output data rates, memory resources, data bus speeds and other design or performance constraints.

One or more aspects of at least one embodiment may be implemented by representative instructions stored on a machine-readable medium which represents various logic within the processor, which when read by a machine causes the machine to fabricate logic to perform the techniques described herein. Such representations, known as “IP cores” may be stored on a tangible, machine readable medium and supplied to various customers or manufacturing facilities to load into the fabrication machines that actually make the logic or processor. Some embodiments may be implemented, for example, using a machine-readable medium or article which may store an instruction or a set of instructions that, if executed by a machine, may cause the machine to perform a method and/or operations in accordance with the embodiments. Such a machine may include, for example, any suitable processing platform, computing platform, computing device, processing device, computing system, processing system, computer, processor, or the like, and may be implemented using any suitable combination of hardware and/or software. The machine-readable medium or article may include, for example, any suitable type of memory unit, memory device, memory article, memory medium, storage device, storage article, storage medium and/or storage unit, for example, memory, removable or non-removable media, erasable or non-erasable media, writeable or re-writeable media, digital or analog media, hard disk, floppy disk, Compact Disk Read Only Memory (CD-ROM), Compact Disk Recordable (CD-R), Compact Disk Rewriteable (CD-RW), optical disk, magnetic media, magneto-optical media, removable memory cards or disks, various types of Digital Versatile

Disk (DVD), a tape, a cassette, or the like. The instructions may include any suitable type of code, such as source code, compiled code, interpreted code, executable code, static code, dynamic code, encrypted code, and the like, implemented using any suitable high-level, low-level, object-oriented, visual, compiled and/or interpreted programming language.

5 The following examples pertain to further embodiments:

Example 1 is a wireless communication apparatus, comprising logic, at least a portion of which is in hardware, the logic to send a neighbor awareness networking (NAN) discovery request, receive an NAN discovery response in response to the NAN discovery request, and initiate a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process
10 based on the NAN discovery response.

In Example 2, the logic of Example 1 may optionally include a service identifier (ID) in the NAN discovery request.

In Example 3, the logic of any of Examples 1 to 2 may optionally initiate the WFDS-ASP discovery process by invoking a WFDS-ASP primitive.

15 In Example 4, the WFDS-ASP primitive of Example 3 may optionally comprise a flag indicating whether a device discovery sub-process of the WFDS-ASP discovery process is to be skipped.

In Example 5, the WFDS-ASP discovery process of any of Examples 1 to 4 may optionally comprise a service discovery sub-process.

20 In Example 6, the NAN discovery response of any of Examples 1 to 5 may optionally comprise a service name for an advertised service of a peer device.

In Example 7, the logic of Example 6 may optionally initiate the service discovery sub-process by sending a peer-to-peer (P2P) service discovery request comprising the service name comprised in the NAN discovery response.

25 In Example 8, the logic of Example 7 may optionally receive a P2P service discovery response in response to the P2P service discovery request.

In Example 9, the WFDS-ASP discovery process of Example 1 may optionally comprise a provision discovery sub-process.

30 In Example 10, the logic of Example 9 may optionally skip a WFDS-ASP device discovery sub-process and a WFDS-ASP service discovery sub-process and initiate the provision discovery sub-process in response to the NAN discovery response.

In Example 11, the logic of Example 10 may optionally initiate the provision discovery sub-process by sending a peer-to-peer (P2P) provision discovery request.

35 In Example 12, the logic of Example 11 may optionally receive a P2P provision discovery response in response to the P2P provision discovery request.

Example 13 is a system, comprising a wireless communication apparatus according to any of Examples 1 to 12, a radio frequency (RF) transceiver, and one or more RF antennas.

Example 14 is at least one non-transitory computer-readable storage medium comprising a set of wireless communication instructions that, in response to being executed on a computing device, cause the computing device to send a neighbor awareness networking (NAN) discovery request, receive an NAN discovery response in response to the NAN discovery request, and initiate a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process based on the NAN discovery response.

In Example 15, the at least one non-transitory computer-readable storage medium of Example 14 may optionally comprise wireless communication instructions that, in response to being executed on the computing device, cause the computing device to include a service identifier (ID) in the NAN discovery request.

In Example 16, the at least one non-transitory computer-readable storage medium of any of Examples 14 to 15 may optionally comprise wireless communication instructions that, in response to being executed on the computing device, cause the computing device to initiate the WFDS-ASP discovery process by invoking a WFDS-ASP primitive.

In Example 17, the WFDS-ASP primitive of Example 16 may optionally comprise a flag indicating whether a device discovery sub-process of the WFDS-ASP discovery process is to be skipped.

In Example 18, the WFDS-ASP discovery process of any of Examples 14 to 17 may optionally comprise a service discovery sub-process.

In Example 19, the NAN discovery response of any of Examples 14 to 18 may optionally comprise a service name for an advertised service of a peer device.

In Example 20, the at least one non-transitory computer-readable storage medium of Example 19 may optionally comprise wireless communication instructions that, in response to being executed on the computing device, cause the computing device to initiate the service discovery sub-process by sending a peer-to-peer (P2P) service discovery request comprising the service name comprised in the NAN discovery response.

In Example 21, the at least one non-transitory computer-readable storage medium of Example 20 may optionally comprise wireless communication instructions that, in response to being executed on the computing device, cause the computing device to receive a P2P service discovery response in response to the P2P service discovery request.

In Example 22, the WFDS-ASP discovery process of Example 14 may optionally comprise a provision discovery sub-process.

In Example 23, the at least one non-transitory computer-readable storage medium of Example 22 may optionally comprise wireless communication instructions that, in response to being executed on the computing device, cause the computing device to skip a WFDS-ASP device discovery sub-process and a WFDS-ASP service discovery sub-process and initiate the provision discovery sub-process in response to the NAN discovery response.

In Example 24, the at least one non-transitory computer-readable storage medium of Example 23 may optionally comprise wireless communication instructions that, in response to being executed on the computing device, cause the computing device to initiate the provision discovery sub-process by sending a peer-to-peer (P2P) provision discovery request.

In Example 25, the at least one non-transitory computer-readable storage medium of Example 24 may optionally comprise wireless communication instructions that, in response to being executed on the computing device, cause the computing device to receive a P2P provision discovery response in response to the P2P provision discovery request.

Example 26 is a wireless communication method, comprising sending a neighbor awareness networking (NAN) discovery request, receiving an NAN discovery response in response to the NAN discovery request, and initiating, by a processor circuit, a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process based on the NAN discovery response.

In Example 27, the wireless communication method of Example 26 may optionally comprise including a service identifier (ID) in the NAN discovery request.

In Example 28, the wireless communication method of any of Examples 26 to 27 may optionally comprise initiating the WFDS-ASP discovery process by invoking a WFDS-ASP primitive.

In Example 29, the WFDS-ASP primitive of Example 28 may optionally comprise a flag indicating whether a device discovery sub-process of the WFDS-ASP discovery process is to be skipped.

In Example 30, the WFDS-ASP discovery process of any of Examples 26 to 29 may optionally comprise a service discovery sub-process.

In Example 31, the NAN discovery response of any of Examples 26 to 30 may optionally comprise a service name for an advertised service of a peer device.

In Example 32, the wireless communication method of Example 31 may optionally comprise initiating the service discovery sub-process by sending a peer-to-peer (P2P) service discovery request comprising the service name comprised in the NAN discovery response.

In Example 33, the wireless communication method of Example 32 may optionally comprise receiving a P2P service discovery response in response to the P2P service discovery request.

5 In Example 34, the WFDS-ASP discovery process of Example 26 may optionally comprise a provision discovery sub-process.

In Example 35, the wireless communication method of Example 34 may optionally comprise skipping a WFDS-ASP device discovery sub-process and a WFDS-ASP service discovery sub-process and initiating the provision discovery sub-process in response to the NAN discovery response.

10 In Example 36, the wireless communication method of Example 35 may optionally comprise initiating the provision discovery sub-process by sending a peer-to-peer (P2P) provision discovery request.

In Example 37, the wireless communication method of Example 36 may optionally comprise receiving a P2P provision discovery response in response to the P2P provision discovery request.

15 Example 38 is at least one non-transitory computer-readable storage medium comprising a set of instructions that, in response to being executed on a computing device, cause the computing device to perform a wireless communication method according to any of Examples 26 to 37.

20 Example 39 is an apparatus, comprising means for performing a wireless communication method according to any of Examples 26 to 37.

Example 40 is a system, comprising an apparatus according to Example 39, a radio frequency (RF) transceiver, and one or more RF antennas.

25 Example 41 is a wireless communication apparatus, comprising means for sending a neighbor awareness networking (NAN) discovery request, means for receiving an NAN discovery response in response to the NAN discovery request, and means for initiating a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process based on the NAN discovery response.

30 In Example 42, the wireless communication apparatus of Example 41 may optionally comprise means for including a service identifier (ID) in the NAN discovery request.

In Example 43, the wireless communication apparatus of any of Examples 41 to 42 may optionally comprise means for initiating the WFDS-ASP discovery process by invoking a WFDS-ASP primitive.

In Example 44, the WFDS-ASP primitive of Example 43 may optionally comprise a flag indicating whether a device discovery sub-process of the WFDS-ASP discovery process is to be skipped.

5 In Example 45, the WFDS-ASP discovery process of any of Examples 41 to 44 may optionally comprise a service discovery sub-process.

In Example 46, the NAN discovery response of any of Examples 41 to 45 may optionally comprise a service name for an advertised service of a peer device.

10 In Example 47, the wireless communication apparatus of Example 46 may optionally comprise means for initiating the service discovery sub-process by sending a peer-to-peer (P2P) service discovery request comprising the service name comprised in the NAN discovery response.

In Example 48, the wireless communication apparatus of Example 47 may optionally comprise means for receiving a P2P service discovery response in response to the P2P service discovery request.

15 In Example 49, the WFDS-ASP discovery process of Example 41 may optionally comprise a provision discovery sub-process.

In Example 50, the wireless communication apparatus of Example 49 may optionally comprise means for skipping a WFDS-ASP device discovery sub-process and a WFDS-ASP service discovery sub-process and initiating the provision discovery sub-process in response to the NAN discovery response.

In Example 51, the wireless communication apparatus of Example 50 may optionally comprise means for initiating the provision discovery sub-process by sending a peer-to-peer (P2P) provision discovery request.

25 In Example 52, the wireless communication apparatus of Example 51 may optionally comprise means for receiving a P2P provision discovery response in response to the P2P provision discovery request.

Example 53 is a system, comprising a wireless communication apparatus according to any of Examples 41 to 52, a radio frequency (RF) transceiver, and one or more RF antennas.

30 Example 54 is a wireless communication apparatus, comprising logic, at least a portion of which is in hardware, the logic to receive a neighbor awareness networking (NAN) request, send a NAN discovery response in response to the NAN discovery request, and engage in a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process that is initiated in response to the NAN discovery response.

35 In Example 55, the NAN request of Example 54 may optionally comprise a service identifier (ID).

In Example 56, the logic of Example 55 may optionally determine a service name matching the service ID and include the service name in the NAN discovery response.

In Example 57, the logic of any of Examples 55 to 56 may optionally receive a peer-to-peer (P2P) service discovery request during the WFDS-ASP discovery process.

5 In Example 58, the P2P service discovery request of Example 57 may optionally comprise the service name.

In Example 59, the logic of any of Examples 57 to 58 may optionally send a P2P service discovery response in response to the P2P service discovery request.

10 In Example 60, the logic of Example 54 may optionally receive a peer-to-peer (P2P) provision discovery request in response to the NAN discovery response.

In Example 61, the logic of Example 60 may optionally send a P2P provision discovery response in response to the P2P provision discovery request.

Example 62 is a system, comprising a wireless communication apparatus according to any of Examples 54 to 61, a radio frequency (RF) transceiver, and one or more RF antennas.

15 Example 63 is at least one non-transitory computer-readable storage medium comprising a set of wireless communication instructions that, in response to being executed on a computing device, cause the computing device to receive a neighbor awareness networking (NAN) request, send a NAN discovery response in response to the NAN discovery request, and engage in a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process that is initiated
20 in response to the NAN discovery response.

In Example 64, the NAN request of Example 63 may optionally comprise a service identifier (ID).

In Example 65, the at least one non-transitory computer-readable storage medium of Example 64 may optionally comprise wireless communication instructions that, in response to
25 being executed on the computing device, cause the computing device to determine a service name matching the service ID, and include the service name in the NAN discovery response.

In Example 66, the at least one non-transitory computer-readable storage medium of any of Examples 64 to 65 may optionally comprise wireless communication instructions that, in response to being executed on the computing device, cause the computing device to receive a
30 peer-to-peer (P2P) service discovery request during the WFDS-ASP discovery process.

In Example 67, the P2P service discovery request of Example 66 may optionally comprise the service name.

In Example 68, the at least one non-transitory computer-readable storage medium of any of Examples 66 to 67 may optionally comprise wireless communication instructions that, in

response to being executed on the computing device, cause the computing device to send a P2P service discovery response in response to the P2P service discovery request.

In Example 69, the at least one non-transitory computer-readable storage medium of Example 63 may optionally comprise wireless communication instructions that, in response to
5 being executed on the computing device, cause the computing device to receive a peer-to-peer (P2P) provision discovery request in response to the NAN discovery response.

In Example 70, the at least one non-transitory computer-readable storage medium of Example 69 may optionally comprise wireless communication instructions that, in response to
10 being executed on the computing device, cause the computing device to send a P2P provision discovery response in response to the P2P provision discovery request.

Example 71 is a wireless communication method, comprising receiving a neighbor awareness networking (NAN) request, sending a NAN discovery response in response to the NAN discovery request, and engaging, using a processor circuit, in a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process that is initiated in response to the
15 NAN discovery response.

In Example 72, the NAN request of Example 71 may optionally comprise a service identifier (ID).

In Example 73, the wireless communication method of Example 72 may optionally comprise determining a service name matching the service ID, and including the service name in
20 the NAN discovery response.

In Example 74, the wireless communication method of any of Examples 72 to 73 may optionally comprise receiving a peer-to-peer (P2P) service discovery request during the WFDS-ASP discovery process.

In Example 75, the P2P service discovery request of Example 74 may optionally comprise
25 the service name.

In Example 76, the wireless communication method of any of Examples 74 to 75 may optionally comprise sending a P2P service discovery response in response to the P2P service discovery request.

In Example 77, the wireless communication method of Example 71 may optionally
30 comprise receiving a peer-to-peer (P2P) provision discovery request in response to the NAN discovery response.

In Example 78, the wireless communication method of Example 77 may optionally comprise sending a P2P provision discovery response in response to the P2P provision discovery request.

Example 79 is at least one non-transitory computer-readable storage medium comprising a set of instructions that, in response to being executed on a computing device, cause the computing device to perform a wireless communication method according to any of Examples 71 to 78.

5 Example 80 is an apparatus, comprising means for performing a wireless communication method according to any of Examples 71 to 78.

Example 81 is a system, comprising an apparatus according to Example 80, a radio frequency (RF) transceiver, and one or more RF antennas.

10 Example 82 is a wireless communication apparatus, comprising means for receiving a neighbor awareness networking (NAN) request, means for sending a NAN discovery response in response to the NAN discovery request, and means for engaging in a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process that is initiated in response to the NAN discovery response.

15 In Example 83, the NAN request of Example 82 may optionally comprise a service identifier (ID).

In Example 84, the wireless communication apparatus of Example 83 may optionally comprise means for determining a service name matching the service ID, and means for including the service name in the NAN discovery response.

20 In Example 85, the wireless communication apparatus of any of Examples 83 to 84 may optionally comprise means for receiving a peer-to-peer (P2P) service discovery request during the WFDS-ASP discovery process.

In Example 86, the P2P service discovery request of Example 85 may optionally comprise the service name.

25 In Example 87, the wireless communication apparatus of any of Examples 85 to 86 may optionally comprise means for sending a P2P service discovery response in response to the P2P service discovery request.

In Example 88, the wireless communication apparatus of Example 82 may optionally comprise means for receiving a peer-to-peer (P2P) provision discovery request in response to the NAN discovery response.

30 In Example 89, the wireless communication apparatus of Example 88 may optionally comprise means for sending a P2P provision discovery response in response to the P2P provision discovery request.

Example 90 is a system, comprising a wireless communication apparatus according to any of Examples 82 to 89, a radio frequency (RF) transceiver, and one or more RF antennas.

Numerous specific details have been set forth herein to provide a thorough understanding of the embodiments. It will be understood by those skilled in the art, however, that the embodiments may be practiced without these specific details. In other instances, well-known operations, components, and circuits have not been described in detail so as not to obscure the
5 embodiments. It can be appreciated that the specific structural and functional details disclosed herein may be representative and do not necessarily limit the scope of the embodiments.

Some embodiments may be described using the expression "coupled" and "connected" along with their derivatives. These terms are not intended as synonyms for each other. For example, some embodiments may be described using the terms "connected" and/or "coupled" to
10 indicate that two or more elements are in direct physical or electrical contact with each other. The term "coupled," however, may also mean that two or more elements are not in direct contact with each other, but yet still co-operate or interact with each other.

Unless specifically stated otherwise, it may be appreciated that terms such as "processing," "computing," "calculating," "determining," or the like, refer to the action and/or processes of a
15 computer or computing system, or similar electronic computing device, that manipulates and/or transforms data represented as physical quantities (e.g., electronic) within the computing system's registers and/or memories into other data similarly represented as physical quantities within the computing system's memories, registers or other such information storage, transmission or display devices. The embodiments are not limited in this context.

20 It should be noted that the methods described herein do not have to be executed in the order described, or in any particular order. Moreover, various activities described with respect to the methods identified herein can be executed in serial or parallel fashion.

Although specific embodiments have been illustrated and described herein, it should be appreciated that any arrangement calculated to achieve the same purpose may be substituted for
25 the specific embodiments shown. This disclosure is intended to cover any and all adaptations or variations of various embodiments. It is to be understood that the above description has been made in an illustrative fashion, and not a restrictive one. Combinations of the above embodiments, and other embodiments not specifically described herein will be apparent to those of skill in the art upon reviewing the above description. Thus, the scope of various embodiments
30 includes any other applications in which the above compositions, structures, and methods are used.

It is emphasized that the Abstract of the Disclosure is provided to comply with 37 C.F.R. § 1.72(b), requiring an abstract that will allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or
35 limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it

can be seen that various features are grouped together in a single embodiment for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all
5 features of a single disclosed embodiment. Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate preferred embodiment. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein," respectively. Moreover, the terms "first," "second," and "third," etc. are used merely as labels, and are not
10 intended to impose numerical requirements on their objects.

Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the
15 claims.

CLAIMS

What is claimed is:

1. An apparatus, comprising:

logic, at least a portion of which is in hardware, the logic to send a neighbor awareness
5 networking (NAN) discovery request, receive an NAN discovery response in response to the
NAN discovery request, and initiate a Wi-Fi Direct Services application service platform
(WFDS-ASP) discovery process based on the NAN discovery response.

2. The apparatus of claim 1, the logic to include a service identifier (ID) in the NAN discovery
10 request.

3. The apparatus of claim 1, the logic to initiate the WFDS-ASP discovery process by invoking
a WFDS-ASP primitive.

4. The apparatus of claim 3, the WFDS-ASP primitive comprising a flag indicating whether a
15 device discovery sub-process of the WFDS-ASP discovery process is to be skipped.

5. The apparatus of claim 1, the WFDS-ASP discovery process comprising a service discovery
sub-process.

6. The apparatus of claim 5, the NAN discovery response comprising a service name for an
20 advertised service of a peer device.

7. The apparatus of claim 6, the logic to initiate the service discovery sub-process by sending a
25 peer-to-peer (P2P) service discovery request comprising the service name comprised in the NAN
discovery response.

8. The apparatus of claim 7, the logic to receive a P2P service discovery response in response to
the P2P service discovery request.

9. The apparatus of claim 1, the WFDS-ASP discovery process comprising a provision
30 discovery sub-process.

10. The apparatus of claim 9, the logic to skip a WFDS-ASP device discovery sub-process and a WFDS-ASP service discovery sub-process and initiate the provision discovery sub-process in response to the NAN discovery response.

5 11. The apparatus of claim 10, the logic to initiate the provision discovery sub-process by sending a peer-to-peer (P2P) provision discovery request.

12. The apparatus of claim 11, the logic to receive a P2P provision discovery response in response to the P2P provision discovery request.

10

13. A system, comprising:
an apparatus according to any of claims 1 to 12;
a radio frequency (RF) transceiver; and
one or more RF antennas.

15

14. At least one non-transitory computer-readable storage medium comprising a set of instructions that, in response to being executed on a computing device, cause the computing device to:

20 send a neighbor awareness networking (NAN) discovery request;
receive an NAN discovery response in response to the NAN discovery request; and
initiate a Wi-Fi Direct Services application service platform (WFDS-ASP) discovery process based on the NAN discovery response.

25 15. The at least one non-transitory computer-readable storage medium of claim 14, comprising instructions that, in response to being executed on the computing device, cause the computing device to include a service identifier (ID) in the NAN discovery request.

30 16. The at least one non-transitory computer-readable storage medium of claim 14, comprising instructions that, in response to being executed on the computing device, cause the computing device to initiate the WFDS-ASP discovery process by invoking a WFDS-ASP primitive.

17. The at least one non-transitory computer-readable storage medium of claim 16, the WFDS-ASP primitive comprising a flag indicating whether a device discovery sub-process of the WFDS-ASP discovery process is to be skipped.

35

18. The at least one non-transitory computer-readable storage medium of claim 14, the WFDS-ASP discovery process comprising a service discovery sub-process.

19. The at least one non-transitory computer-readable storage medium of claim 18, the NAN
5 discovery response comprising a service name for an advertised service of a peer device.

20. The at least one non-transitory computer-readable storage medium of claim 19, comprising
instructions that, in response to being executed on the computing device, cause the computing
device to initiate the service discovery sub-process by sending a peer-to-peer (P2P) service
10 discovery request comprising the service name comprised in the NAN discovery response.

21. The at least one non-transitory computer-readable storage medium of claim 20, comprising
instructions that, in response to being executed on the computing device, cause the computing
device to receive a P2P service discovery response in response to the P2P service discovery
15 request.

22. A method, comprising:
 sending a neighbor awareness networking (NAN) discovery request;
 receiving an NAN discovery response in response to the NAN discovery request; and
20 initiating, by a processor circuit, a Wi-Fi Direct Services application service platform
(WFDS-ASP) discovery process based on the NAN discovery response.

23. The method of claim 22, comprising including a service identifier (ID) in the NAN
discovery request.

24. The method of claim 22, comprising initiating the WFDS-ASP discovery process by
invoking a WFDS-ASP primitive.

25. The method of claim 24, the WFDS-ASP primitive comprising a flag indicating whether a
30 device discovery sub-process of the WFDS-ASP discovery process is to be skipped.

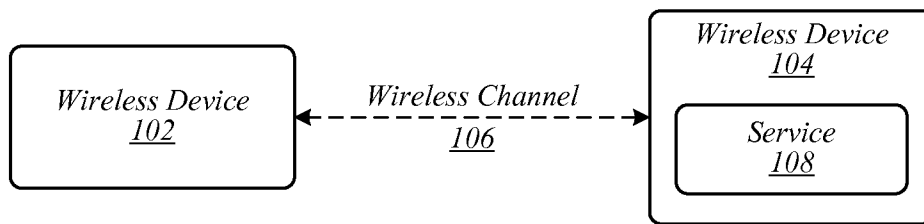
FIG. 1**100**

FIG. 2

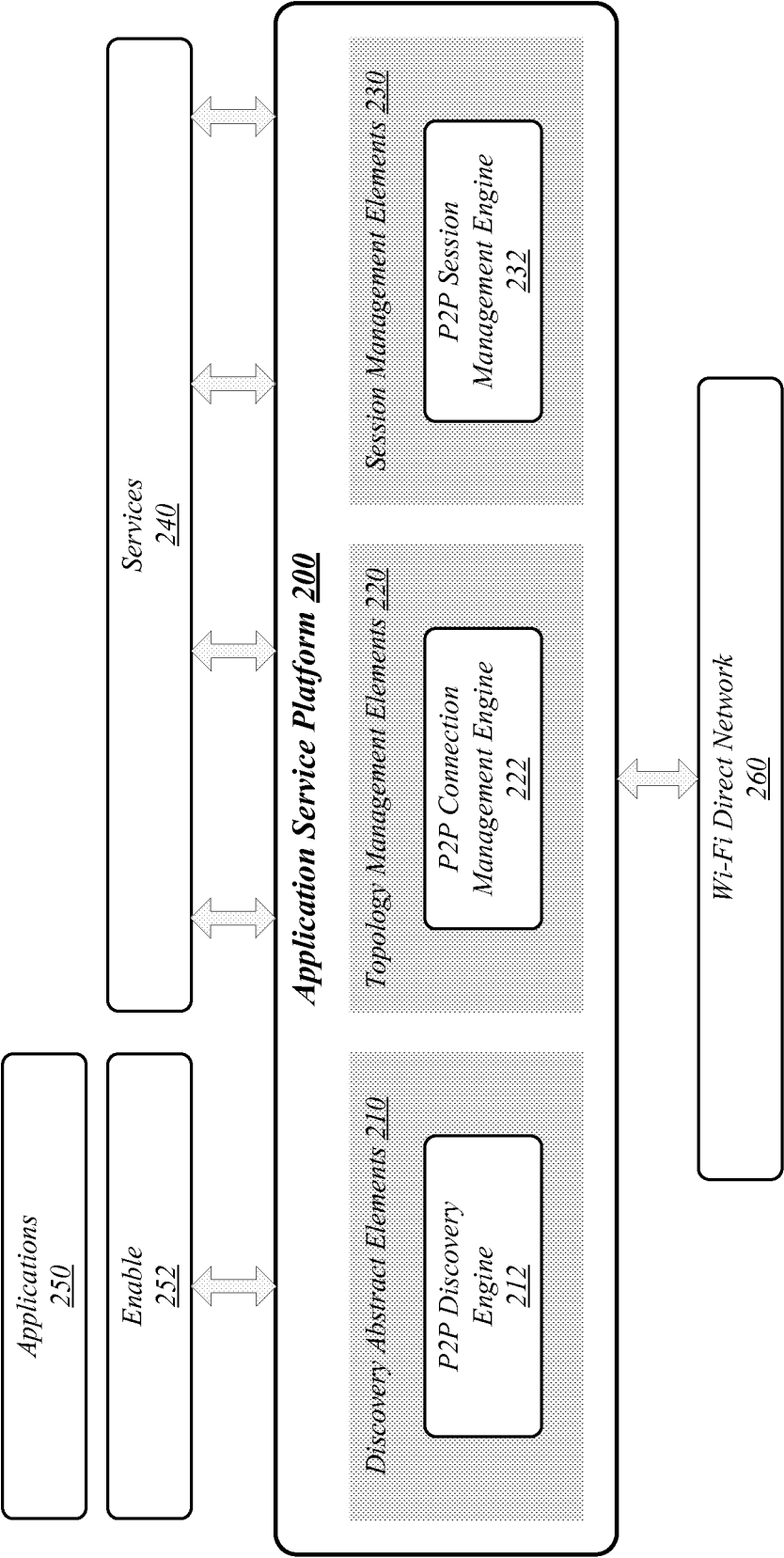


FIG. 3

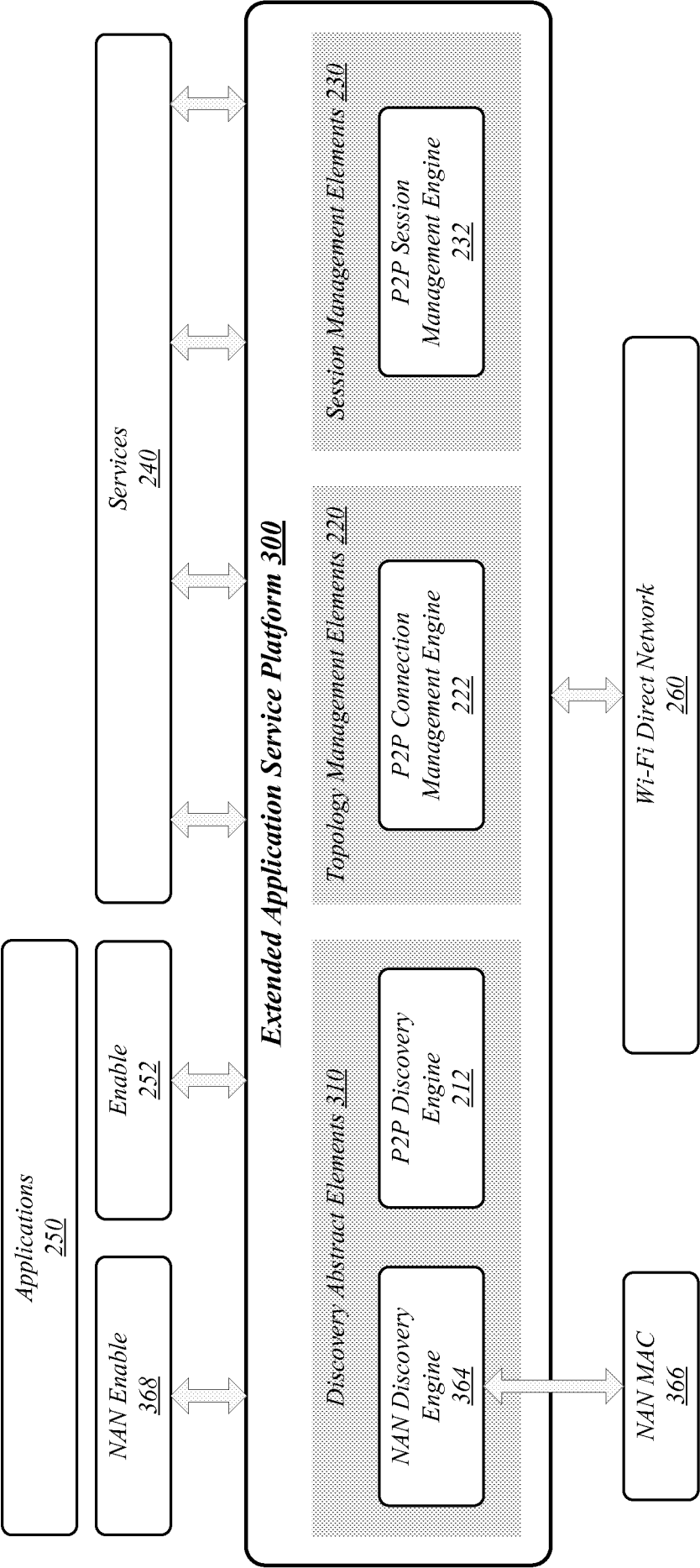


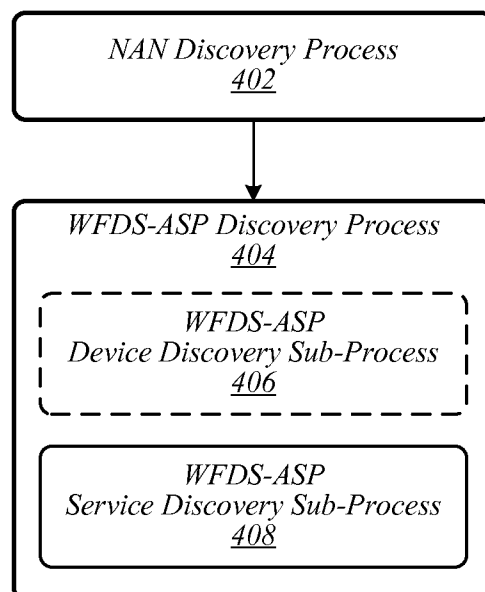
FIG. 4**400**

FIG. 5

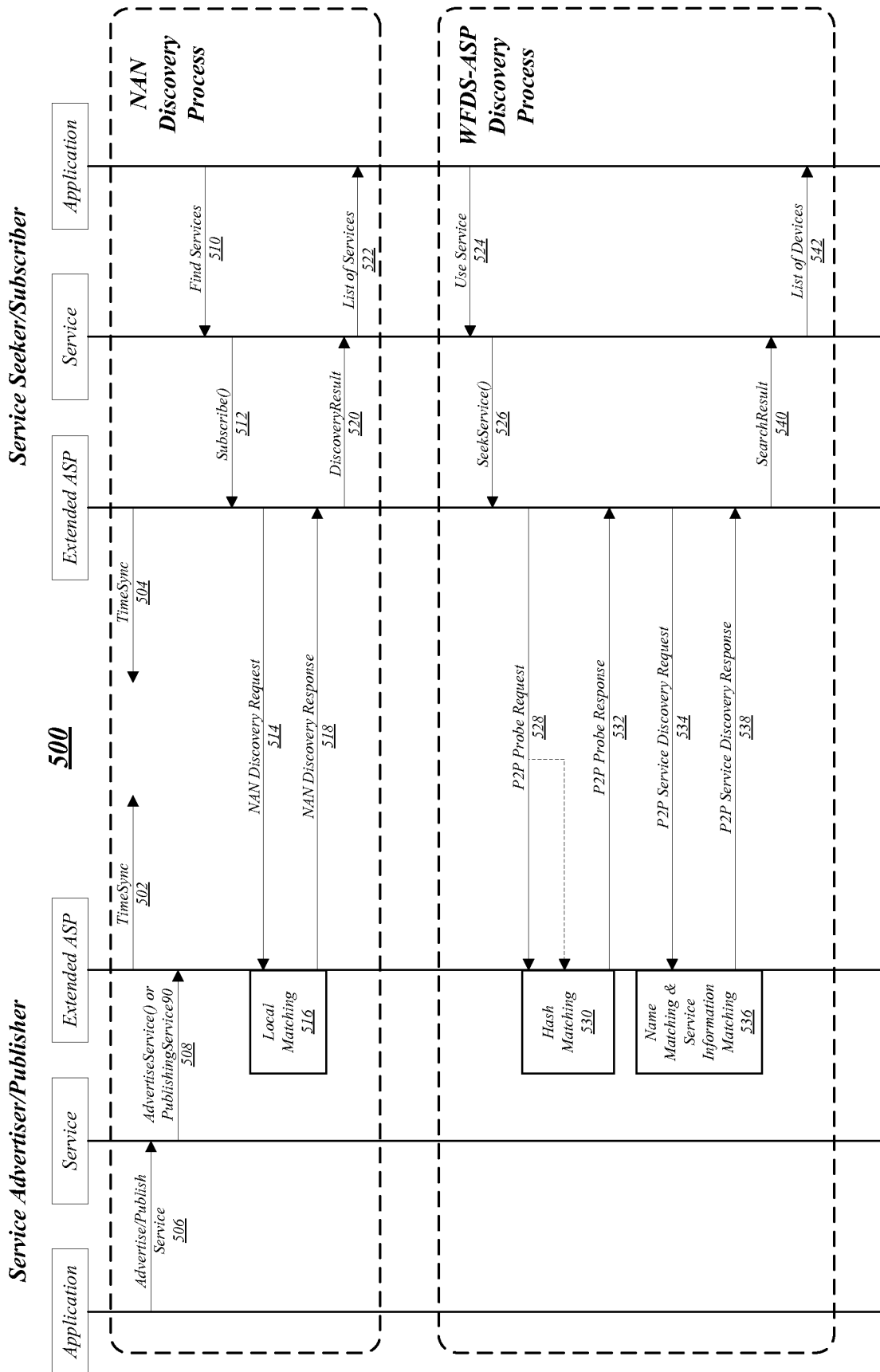


FIG. 6

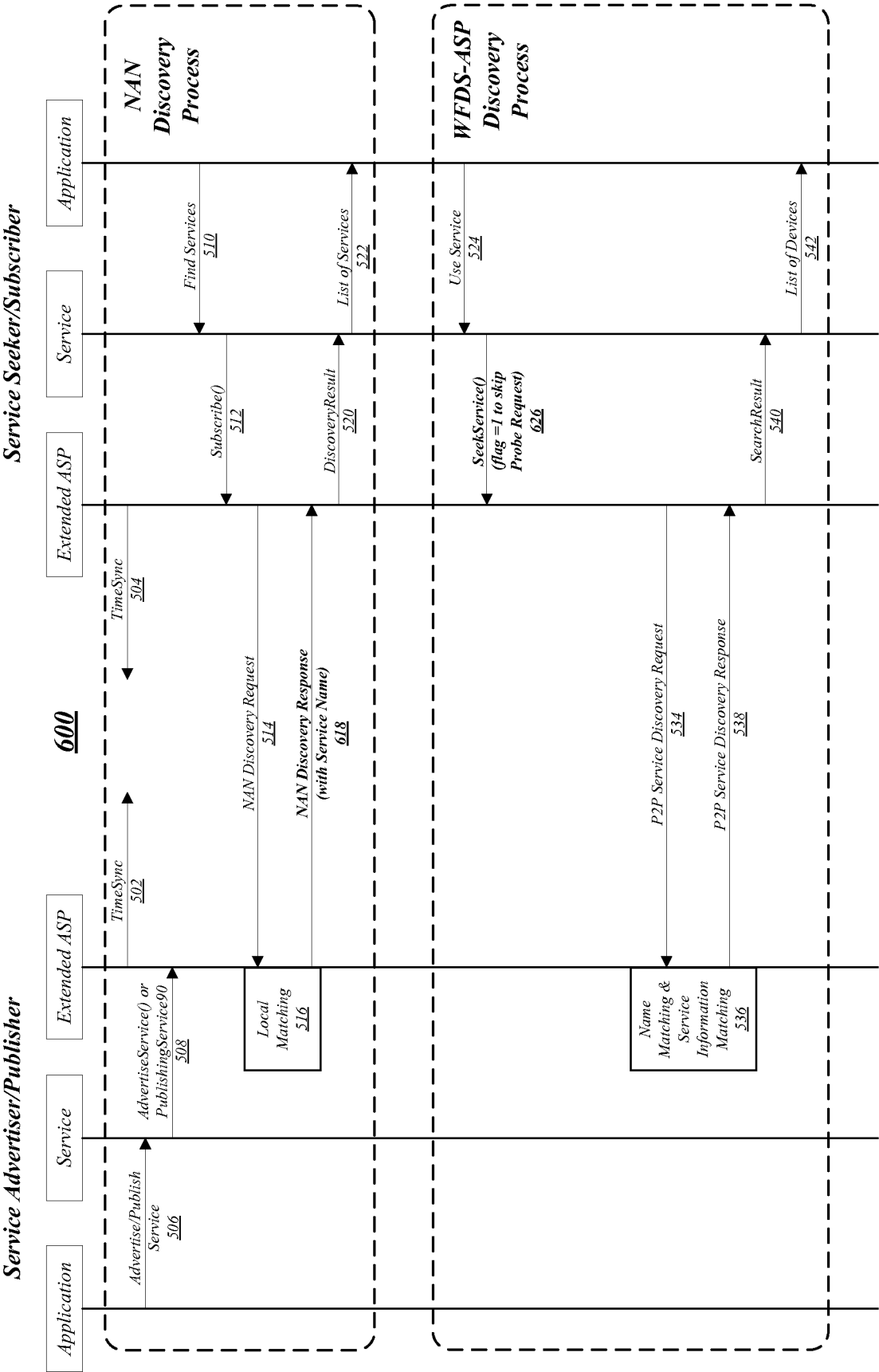


FIG. 7

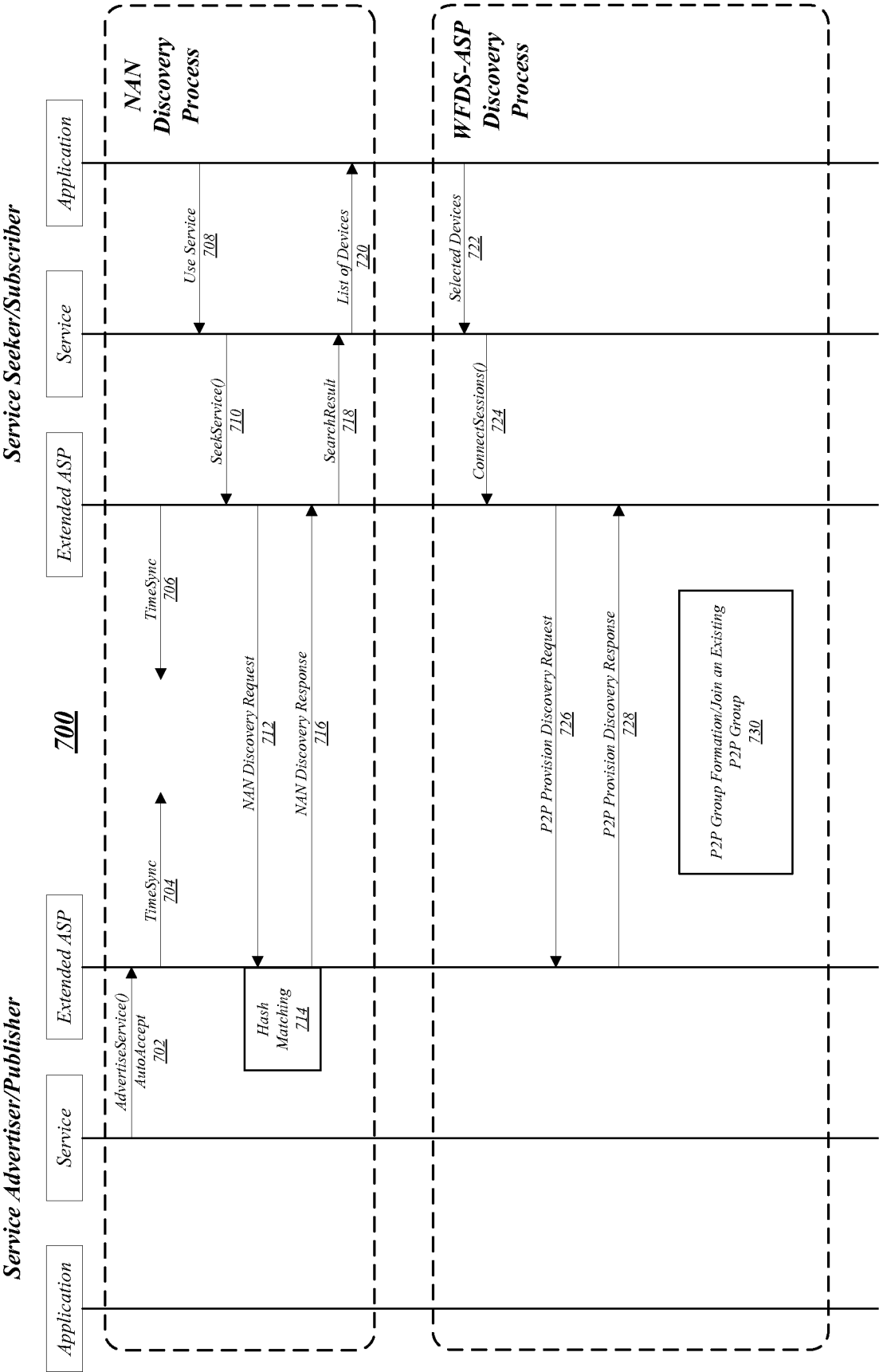


FIG. 8

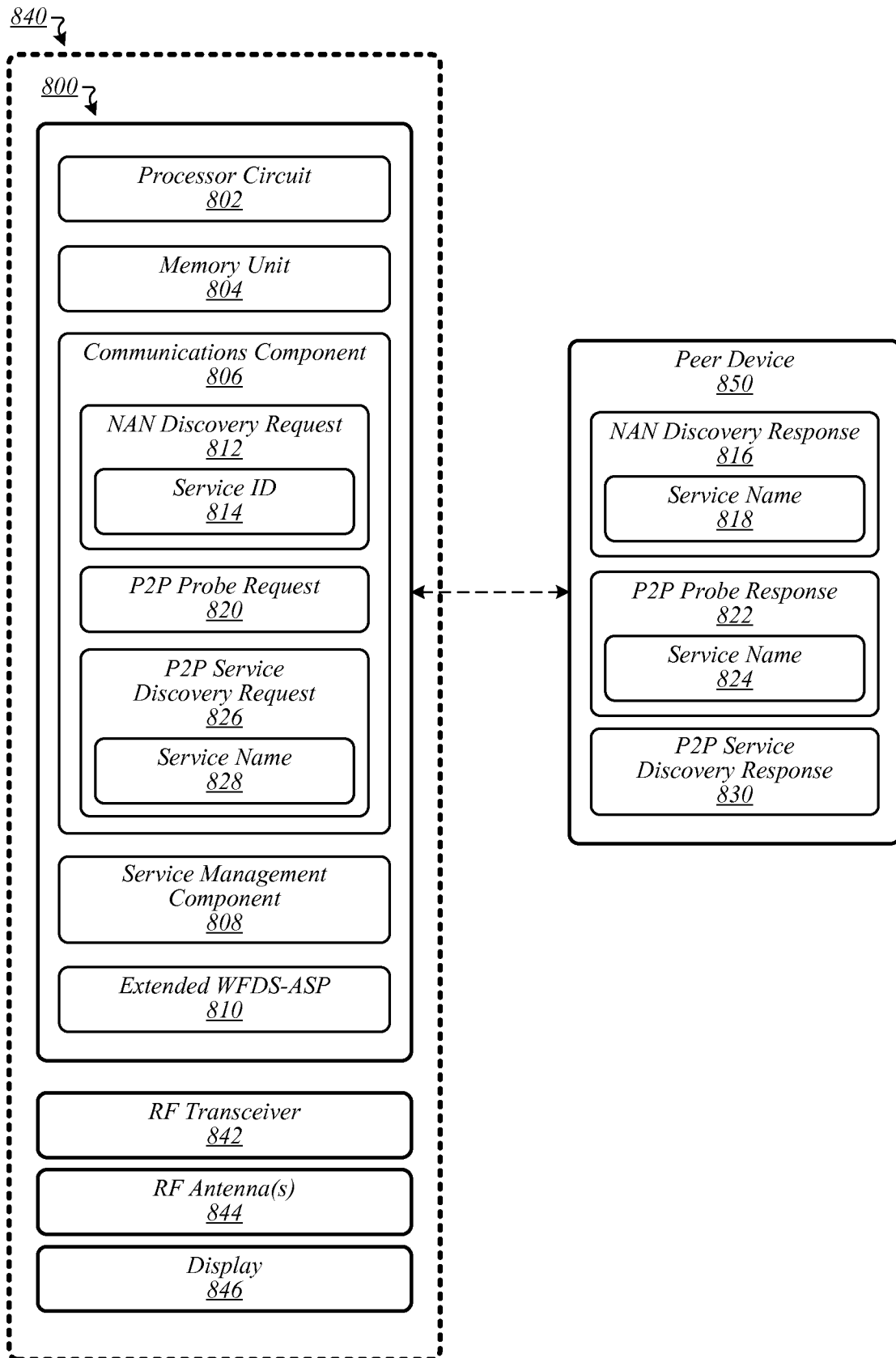


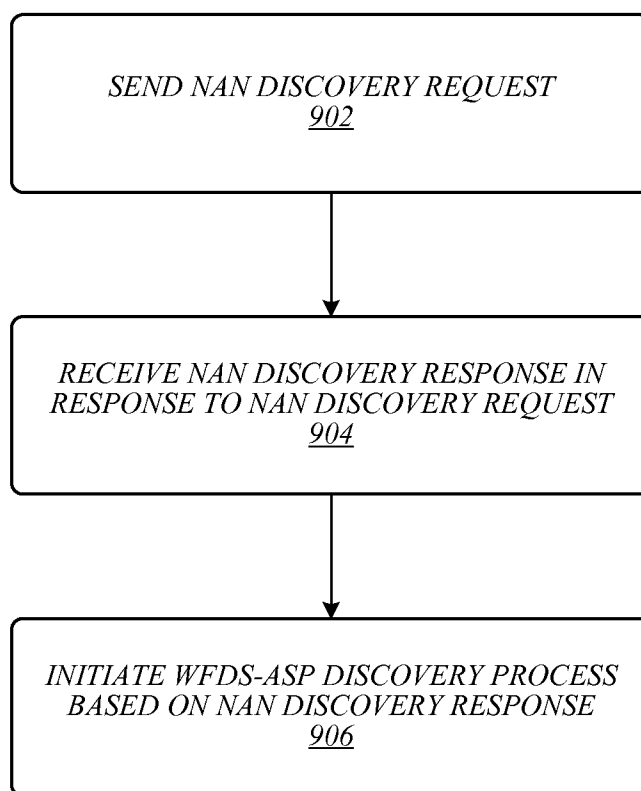
FIG. 9**900**

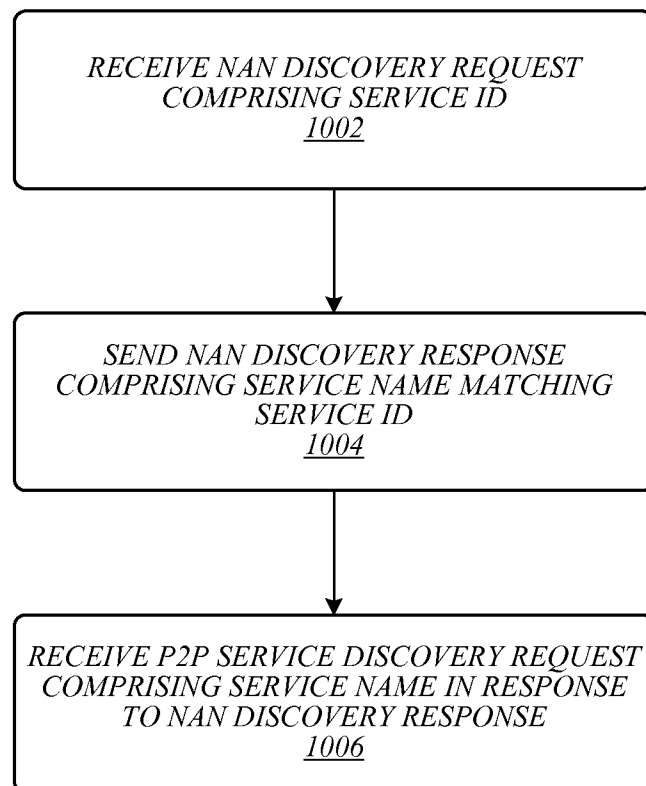
FIG. 10**1000**

FIG. 11

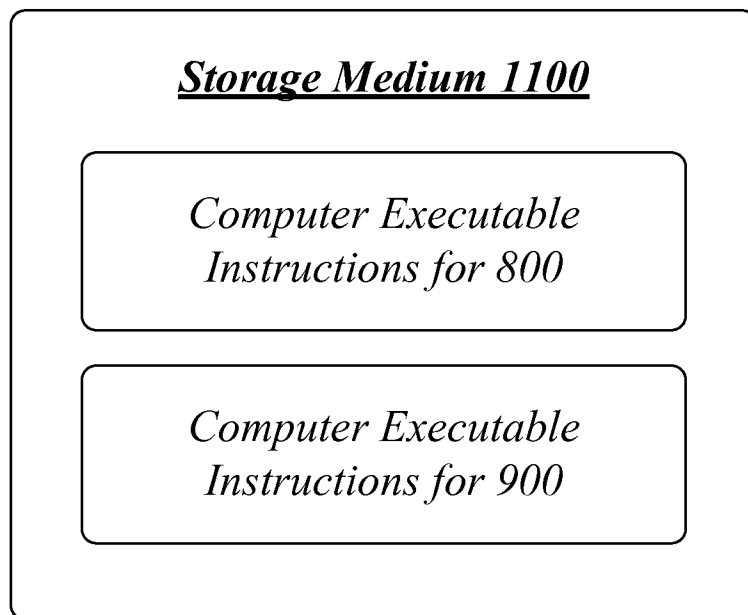


FIG. 12

Device 1200

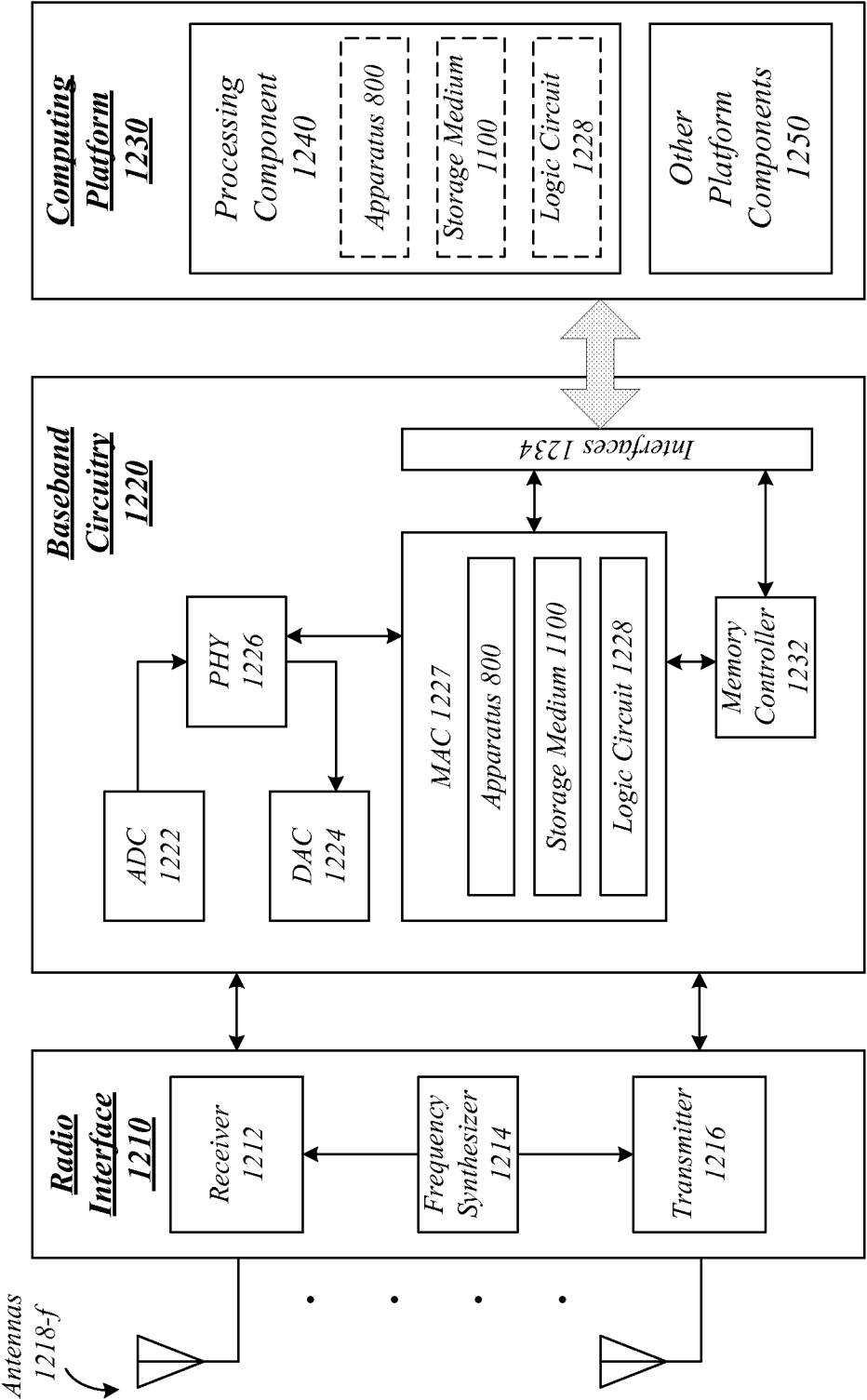
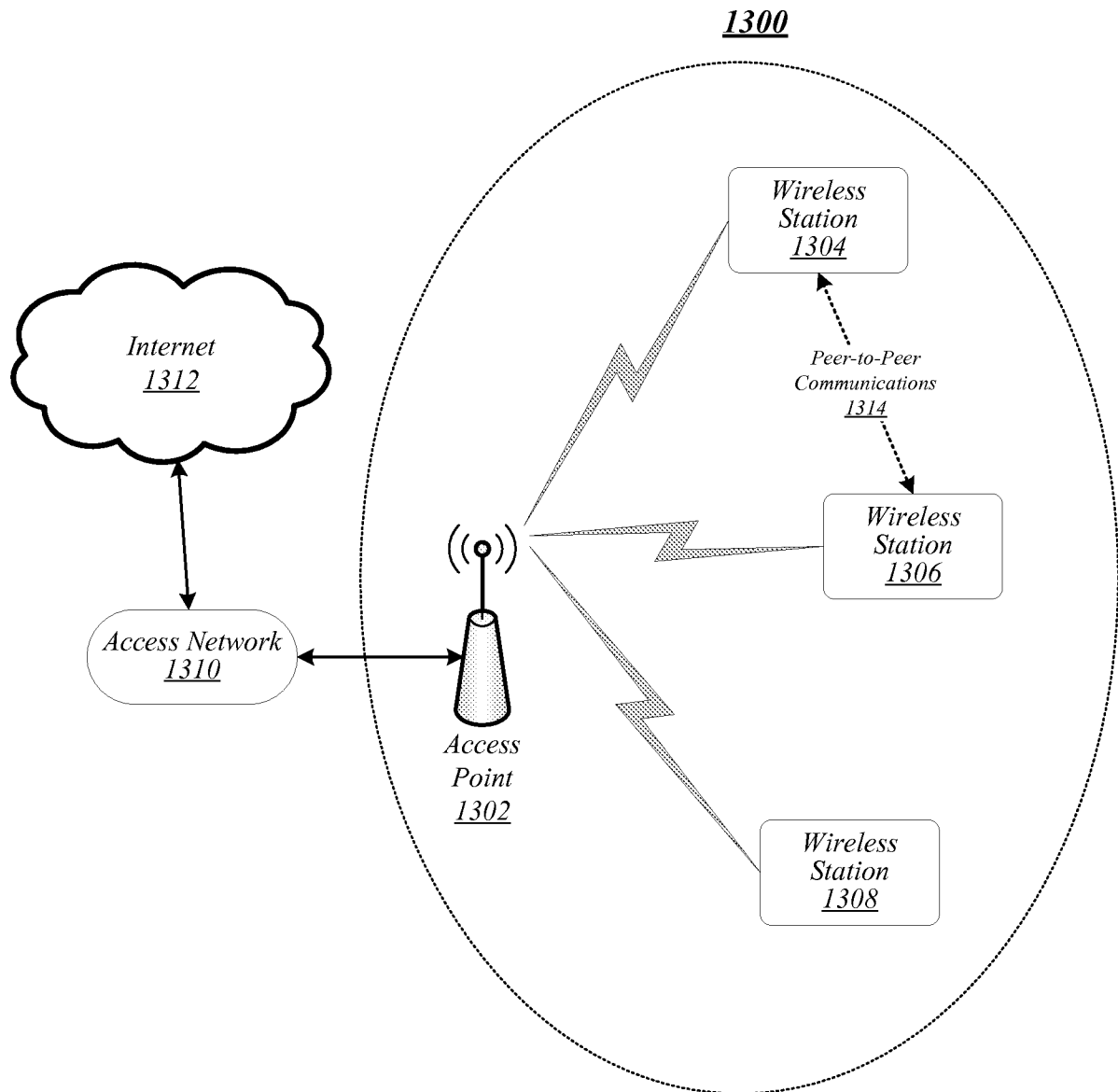


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/038227**A. CLASSIFICATION OF SUBJECT MATTER****H04W 48/14(2009.01)i, H04W 92/18(2009.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W 48/14; H04W 48/16; G06F 17/30; H04Q 7/20; H04L 12/28; H04W 92/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: discovery, WFDS, identifier

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012-0243524 A1 (LOCHAN VERMA et al.) 27 September 2012 See abstract, paragraph [0069], figures 2-3 and claims 1-18.	1-25
A	US 2011-0153634 A1 (THOMAS P. CHU et al.) 23 June 2011 See figures 3-5,8 and corresponding detailed description.	1-25
A	US 2011-0149806 A1 (VERMA LOCHAN et al.) 23 June 2011 See abstract, figures 2-3 and claims 1-23.	1-25
A	US 8433316 B2 (BHUPESH MANOHARLAL UMATT et al.) 30 April 2013 See figures 6-8 and corresponding detailed description.	1-25



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

30 September 2014 (30.09.2014)

Date of mailing of the international search report

01 October 2014 (01.10.2014)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/038227

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 2011-0153634 A1	23/06/2011	CN 102668513 A EP 2514175 A1 JP 05-567683B2 JP 2013-514733A KR 10-1433702 B1 KR 10-2012-0104341 A KR 10-2014-0044948A WO 2011-084272 A1	12/09/2012 24/10/2012 06/08/2014 25/04/2013 27/08/2014 20/09/2012 15/04/2014 14/07/2011
US 2011-0149806 A1	23/06/2011	KR 10-2011-0073239 A US 8559340 B2	29/06/2011 15/10/2013
US 8433316 B2	30/04/2013	BR PI0717888A2 CA 2667157 A1 CN 101529952 A CN 101529952 B EP 2095674 A2 JP 05-069307B2 JP 2010-509854A KR 10-1072714 B1 KR 10-2009-0086574A RU 2009120984 A TW 200830915 A US 2008-0108346 A1 WO 2008-058045 A2 WO 2008-058045 A3	05/11/2013 15/05/2008 09/09/2009 04/09/2013 02/09/2009 07/11/2012 25/03/2010 11/10/2011 13/08/2009 10/12/2010 16/07/2008 08/05/2008 15/05/2008 16/10/2008