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(54) **APPARATUS AND METHOD FOR DIRECT PAIRING IN A WIRELESS DOCKING SYSTEM**

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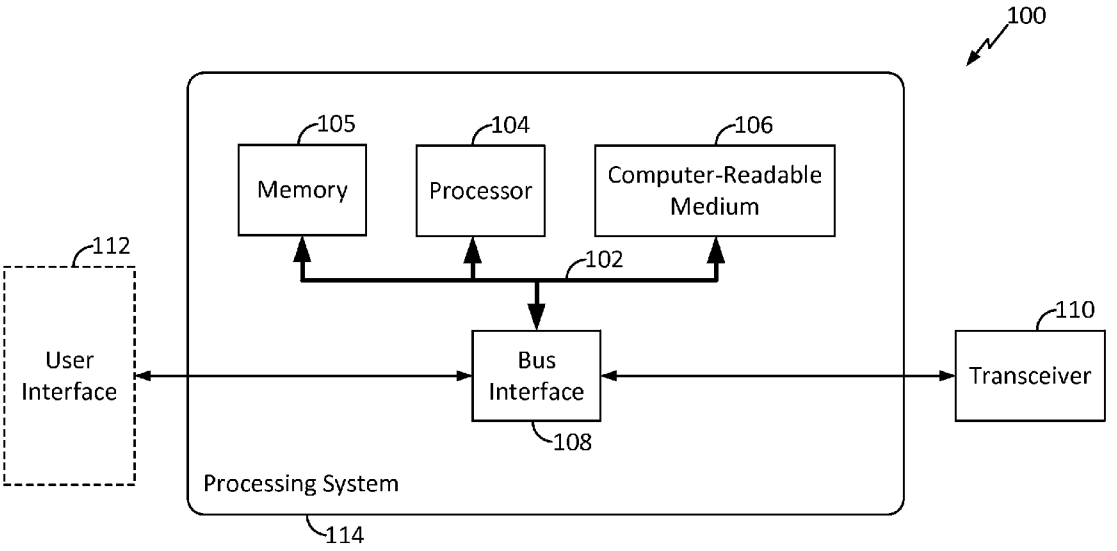
(57) **ABSTRACT**

Various aspects of the present disclosure enable a docking procedure where a dockee, when docking with a docking host that manages a docking environment, can become directly paired with the peripherals in the docking environment in a straightforward fashion. Furthermore, a persistent direct pairing may be established such that after a first docking session, subsequent docking sessions where the dockee is directly paired with the same peripherals can further be expedited. Other aspects, embodiments, and features are also claimed and described.



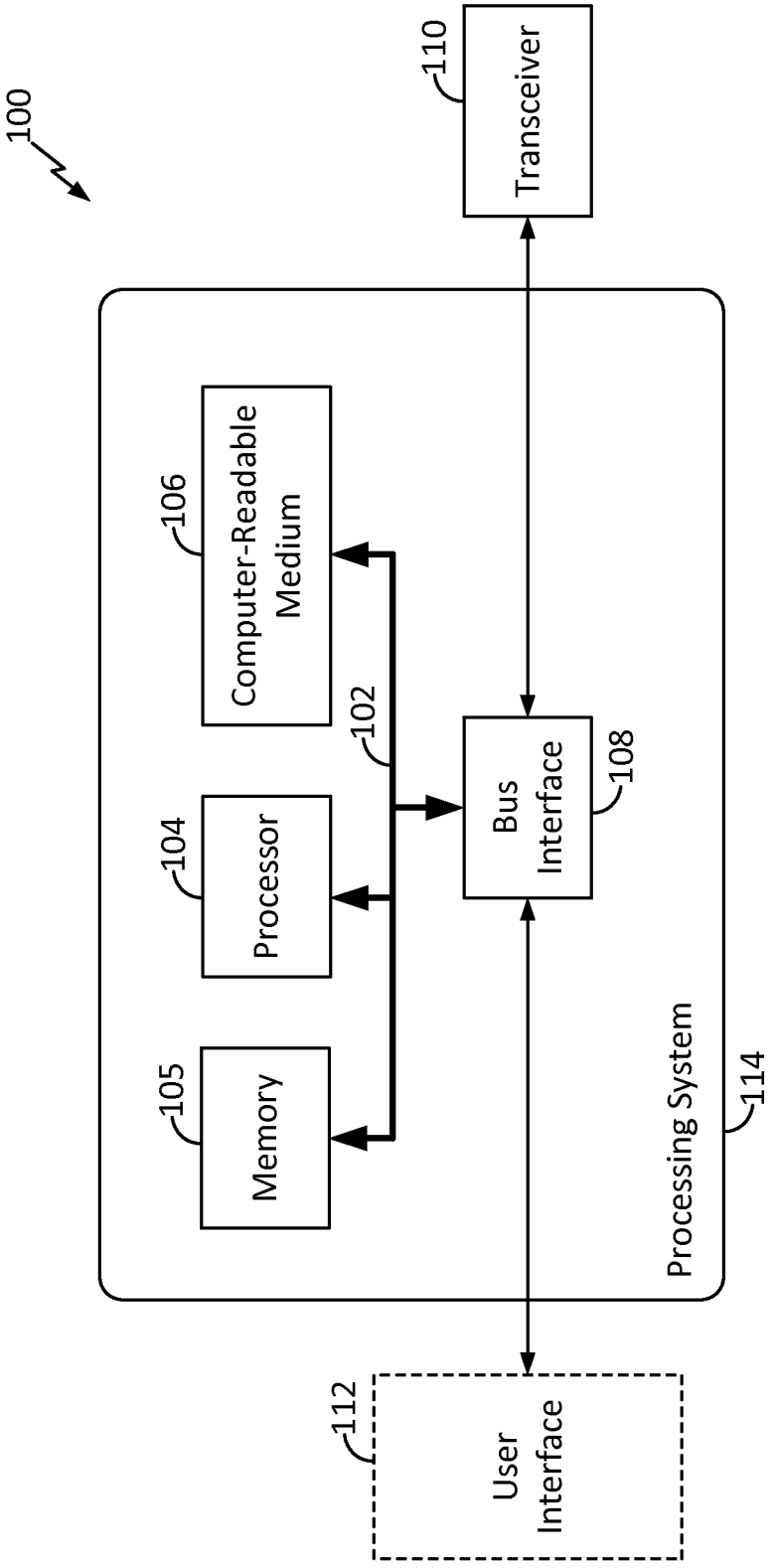

100
110
Transceiver
Computer-Readable Medium
106
102
Bus Interface
108
Processor
104
Memory
105
Processing System
114
User Interface
112

FIG. 1

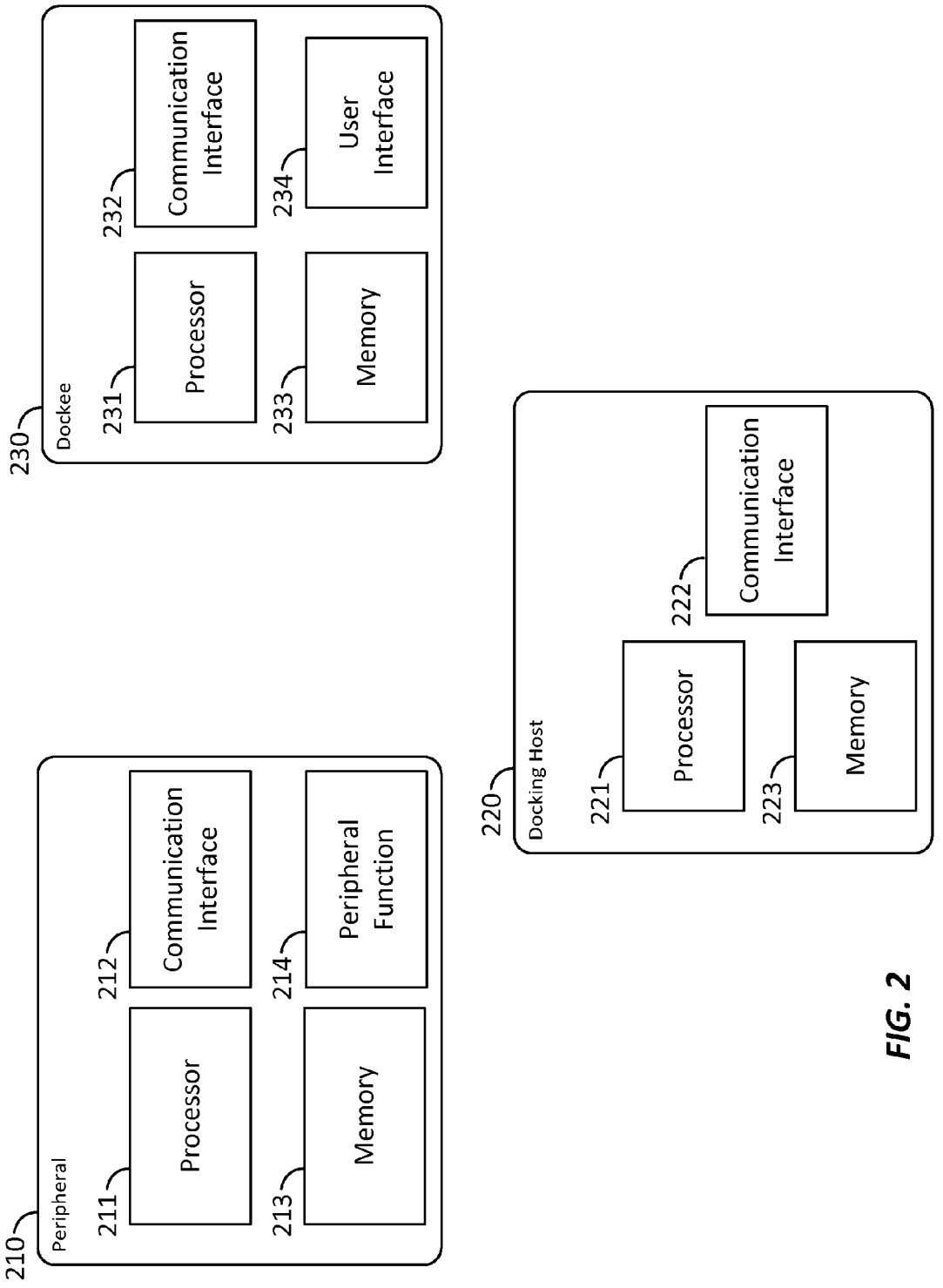

Peripheral
210
Processor
211
Communication Interface
212
Memory
213
Peripheral Function
214
Dockee
230
Processor
231
Communication Interface
232
Memory
233
User Interface
234
Docking Host
220
Processor
221
Communication Interface
222
Memory
223

FIG. 2

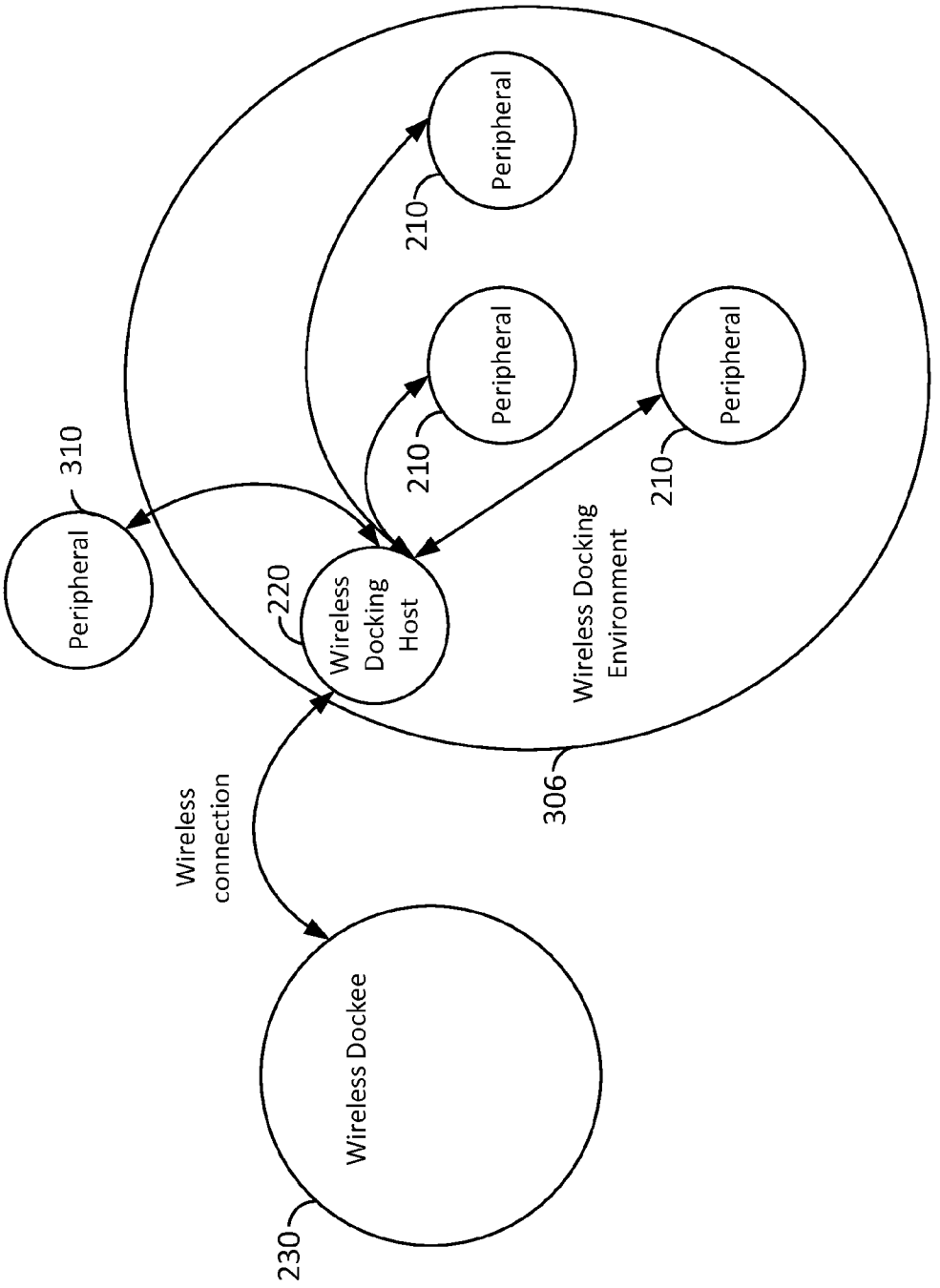

Peripheral
310
Wireless Docking Host
220
Peripheral
210
Peripheral
210
Peripheral
210
Wireless Docking Environment
306
Wireless connection
Wireless Dockee
230

FIG. 3

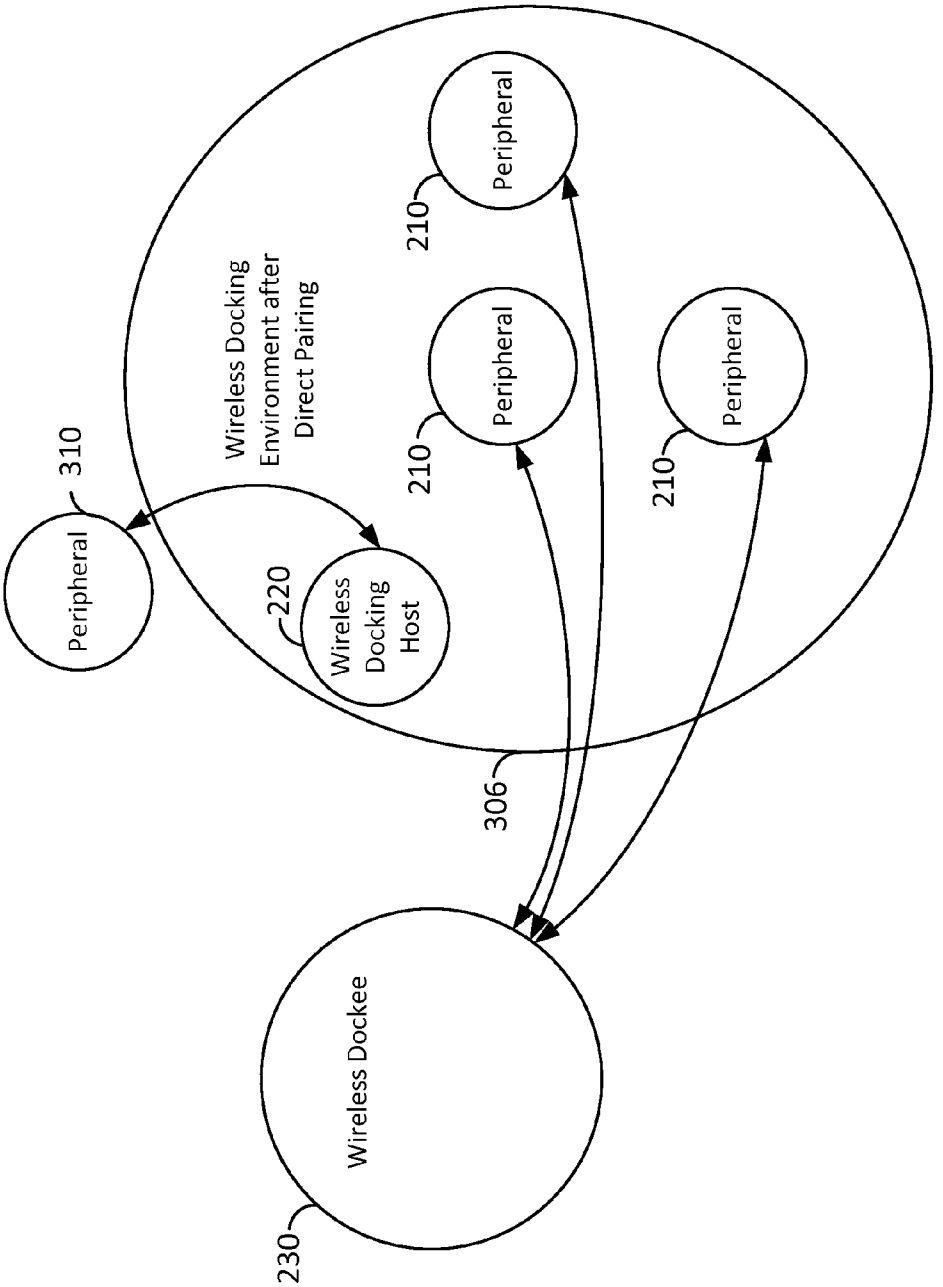

Wireless Docking Environment after Direct Pairing
Peripheral
310
Wireless Docking Host
220
Peripheral
210
Peripheral
210
Peripheral
210
306
Wireless Dockee
230

FIG. 4

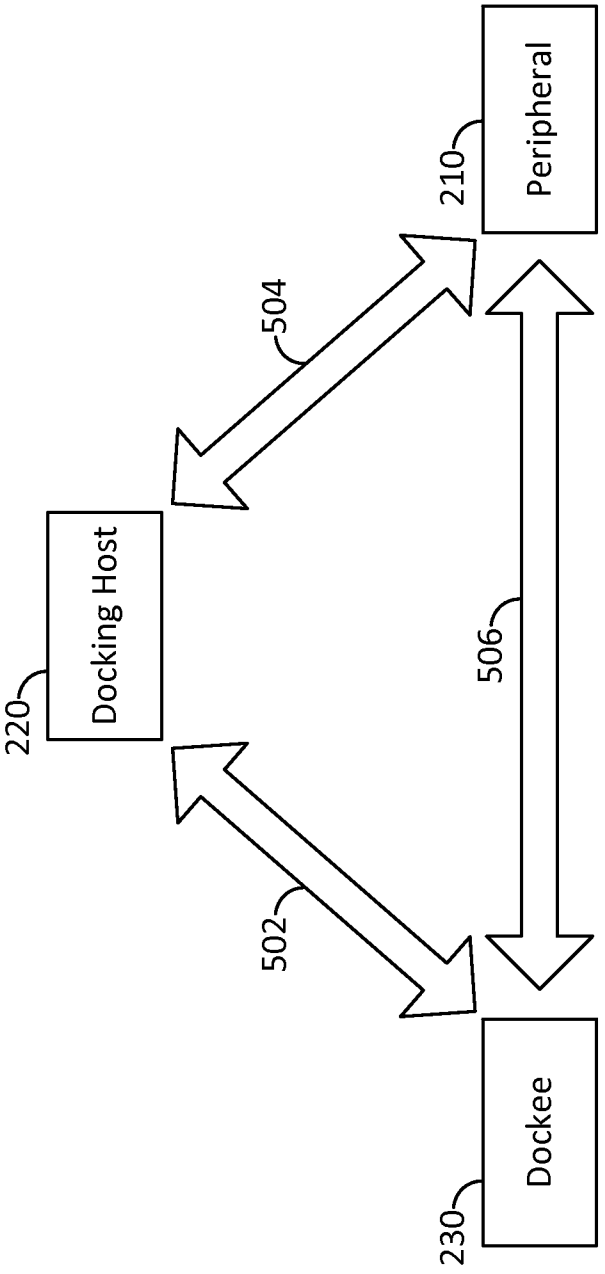


FIG. 5

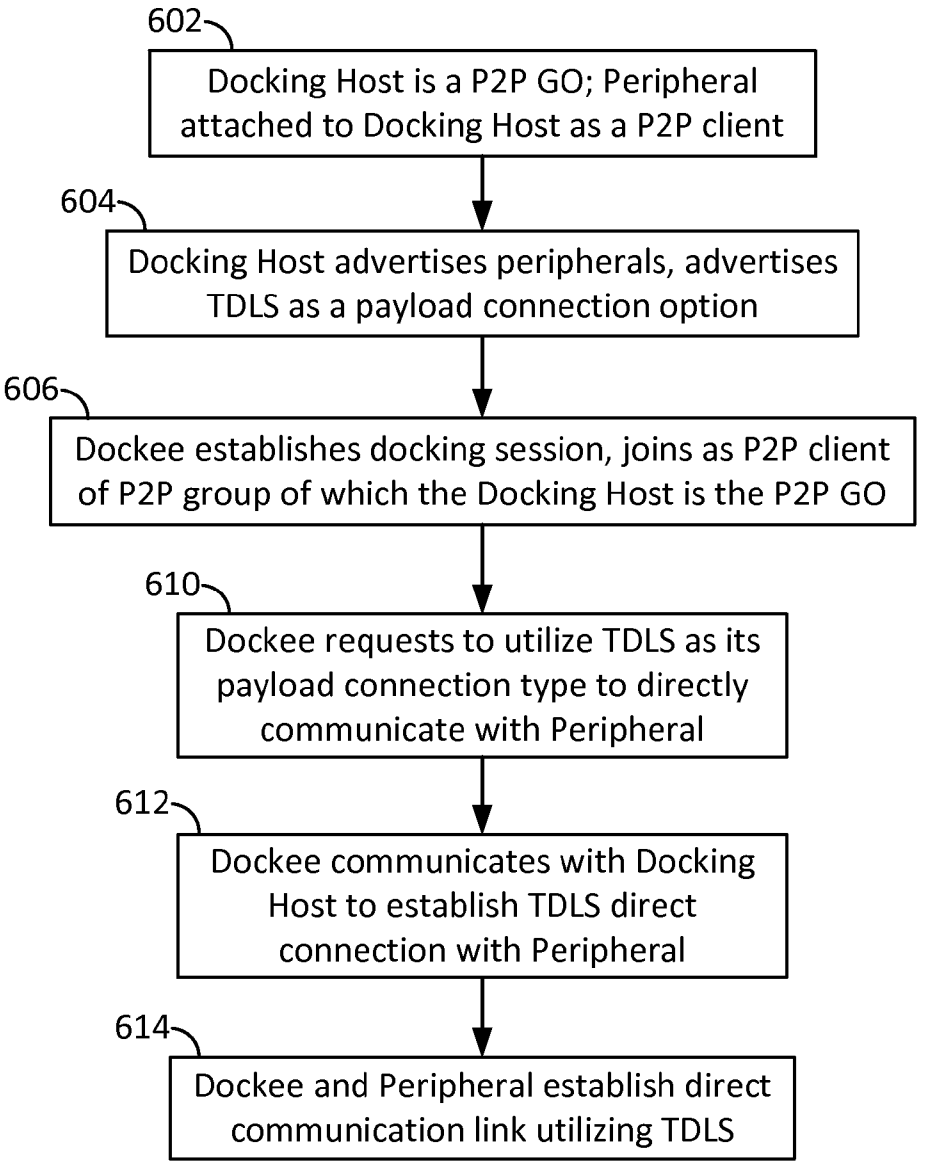

602
Docking Host is a P2P GO; Peripheral attached to Docking Host as a P2P client
604
Docking Host advertises peripherals, advertises TDLS as a payload connection option
606
Dockee establishes docking session, joins as P2P client of P2P group of which the Docking Host is the P2P GO
610
Dockee requests to utilize TDLS as its payload connection type to directly communicate with Peripheral
612
Dockee communicates with Docking Host to establish TDLS direct connection with Peripheral
614
Dockee and Peripheral establish direct communication link utilizing TDLS

FIG. 6

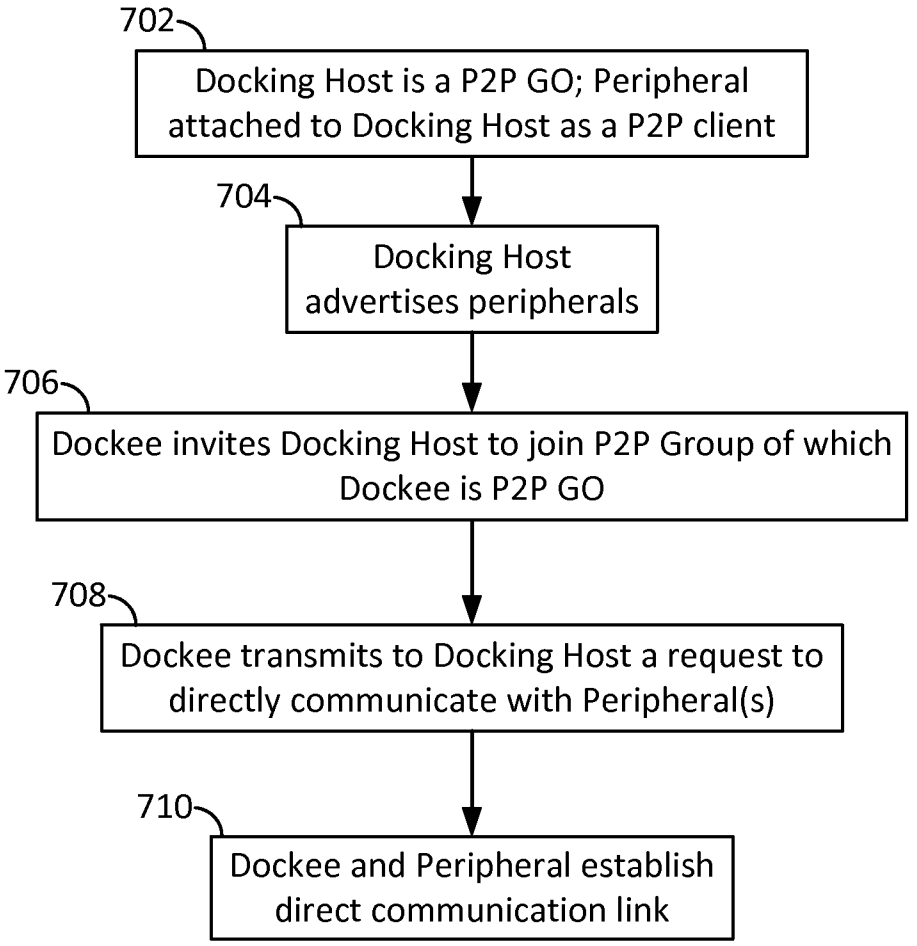

702
Docking Host is a P2P GO; Peripheral attached to Docking Host as a P2P client
704
Docking Host advertises peripherals
706
Dockee invites Docking Host to join P2P Group of which Dockee is P2P GO
708
Dockee transmits to Docking Host a request to directly communicate with Peripheral(s)
710
Dockee and Peripheral establish direct communication link

FIG. 7

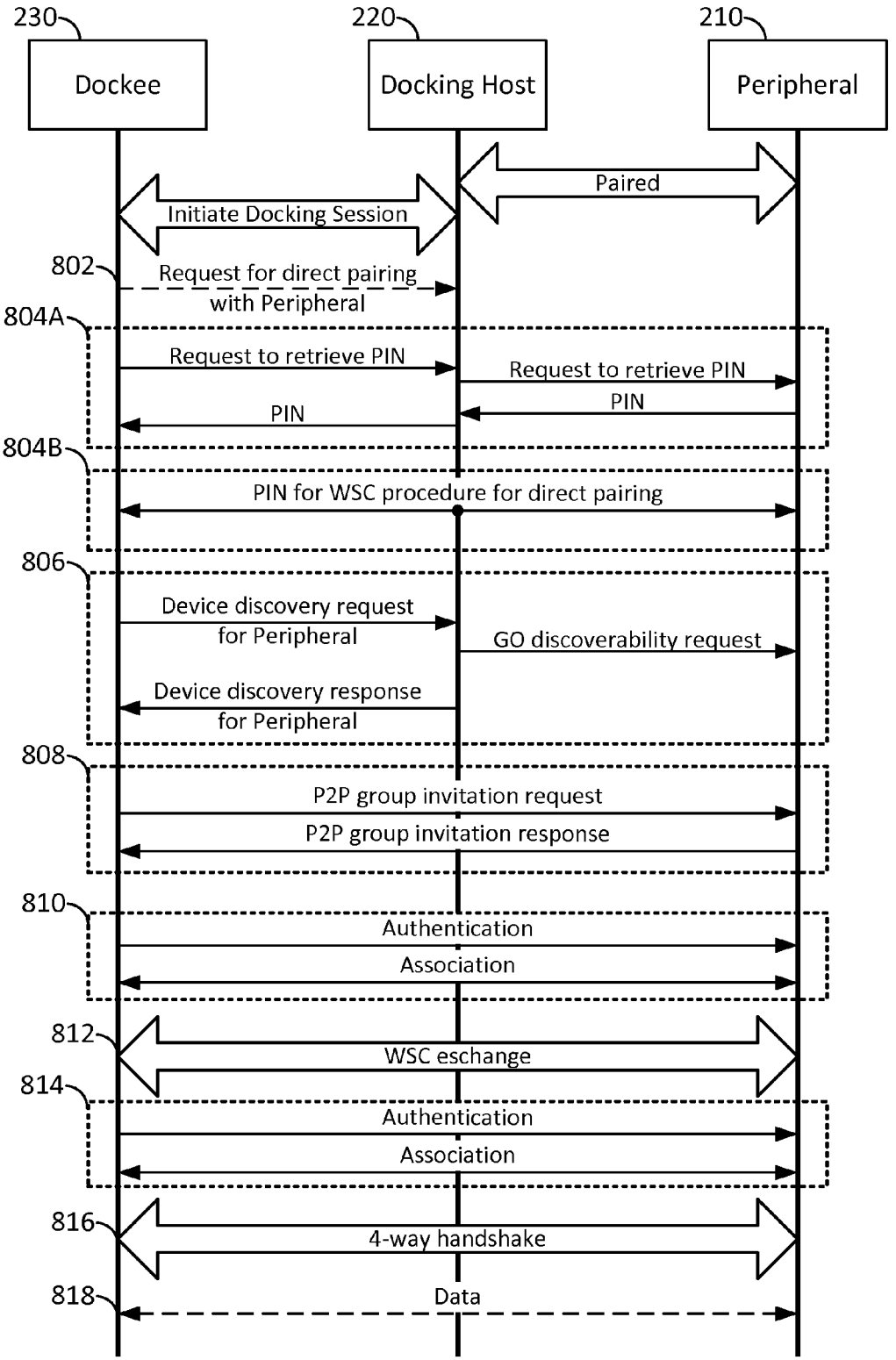

230
220
210
Dockee
Docking Host
Peripheral
Paired
Initiate Docking Session
802
Request for direct pairing with Peripheral
804A
Request to retrieve PIN
Request to retrieve PIN
PIN
PIN
804B
PIN for WSC procedure for direct pairing
806
Device discovery request for Peripheral
GO discoverability request
Device discovery response for Peripheral
808
P2P group invitation request
P2P group invitation response
810
Authentication
Association
812
WSC eschange
814
Authentication
Association
816
4-way handshake
818
Data

FIG. 8

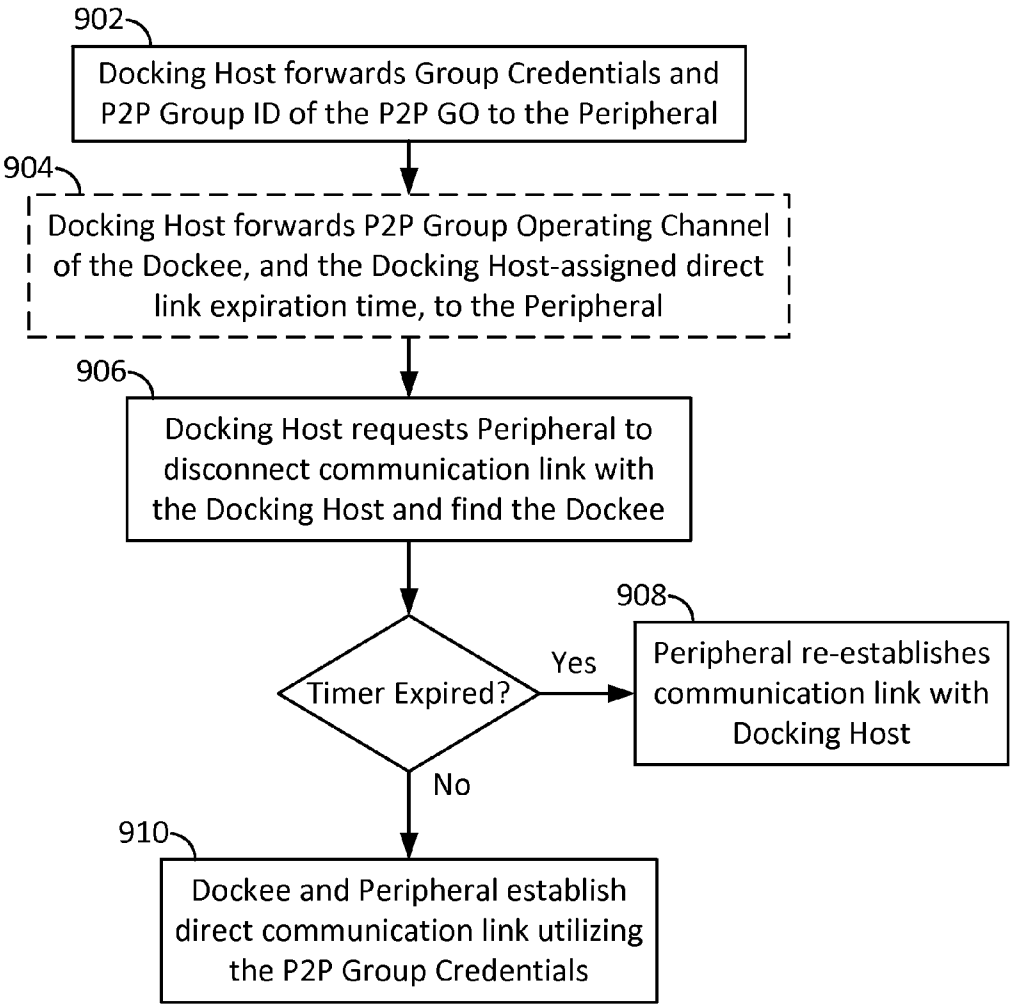

902
Docking Host forwards Group Credentials and P2P Group ID of the P2P GO to the Peripheral
904
Docking Host forwards P2P Group Operating Channel of the Dockee, and the Docking Host-assigned direct link expiration time, to the Peripheral
906
Docking Host requests Peripheral to disconnect communication link with the Docking Host and find the Dockee
908
Timer Expired?
Yes
Peripheral re-establishes communication link with Docking Host
No
910
Dockee and Peripheral establish direct communication link utilizing the P2P Group Credentials

FIG. 9

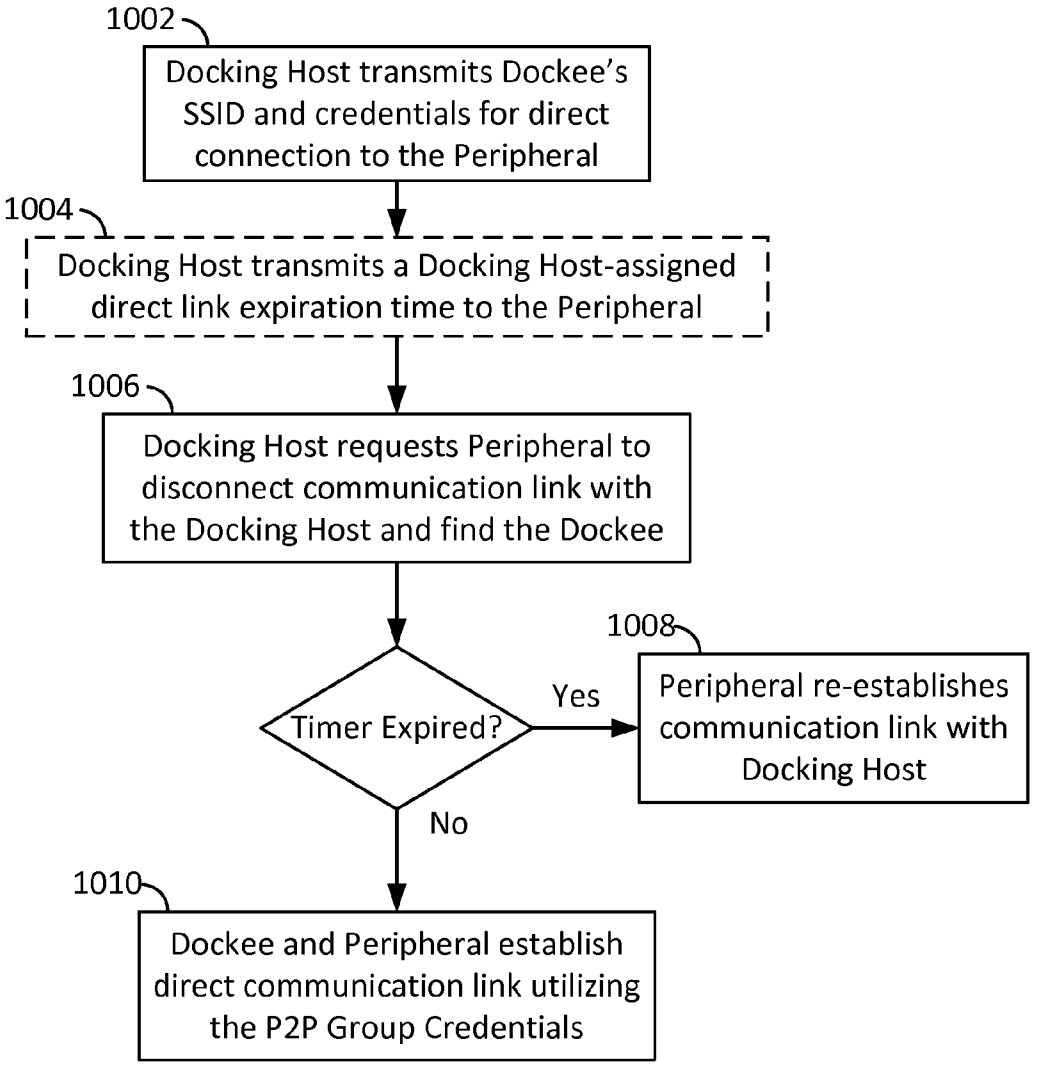

1002
Docking Host transmits Dockee's SSID and credentials for direct connection to the Peripheral
1004
Docking Host transmits a Docking Host-assigned direct link expiration time to the Peripheral
1006
Docking Host requests Peripheral to disconnect communication link with the Docking Host and find the Dockee
Timer Expired?
Yes
1008
Peripheral re-establishes communication link with Docking Host
No
1010
Dockee and Peripheral establish direct communication link utilizing the P2P Group Credentials

FIG. 10

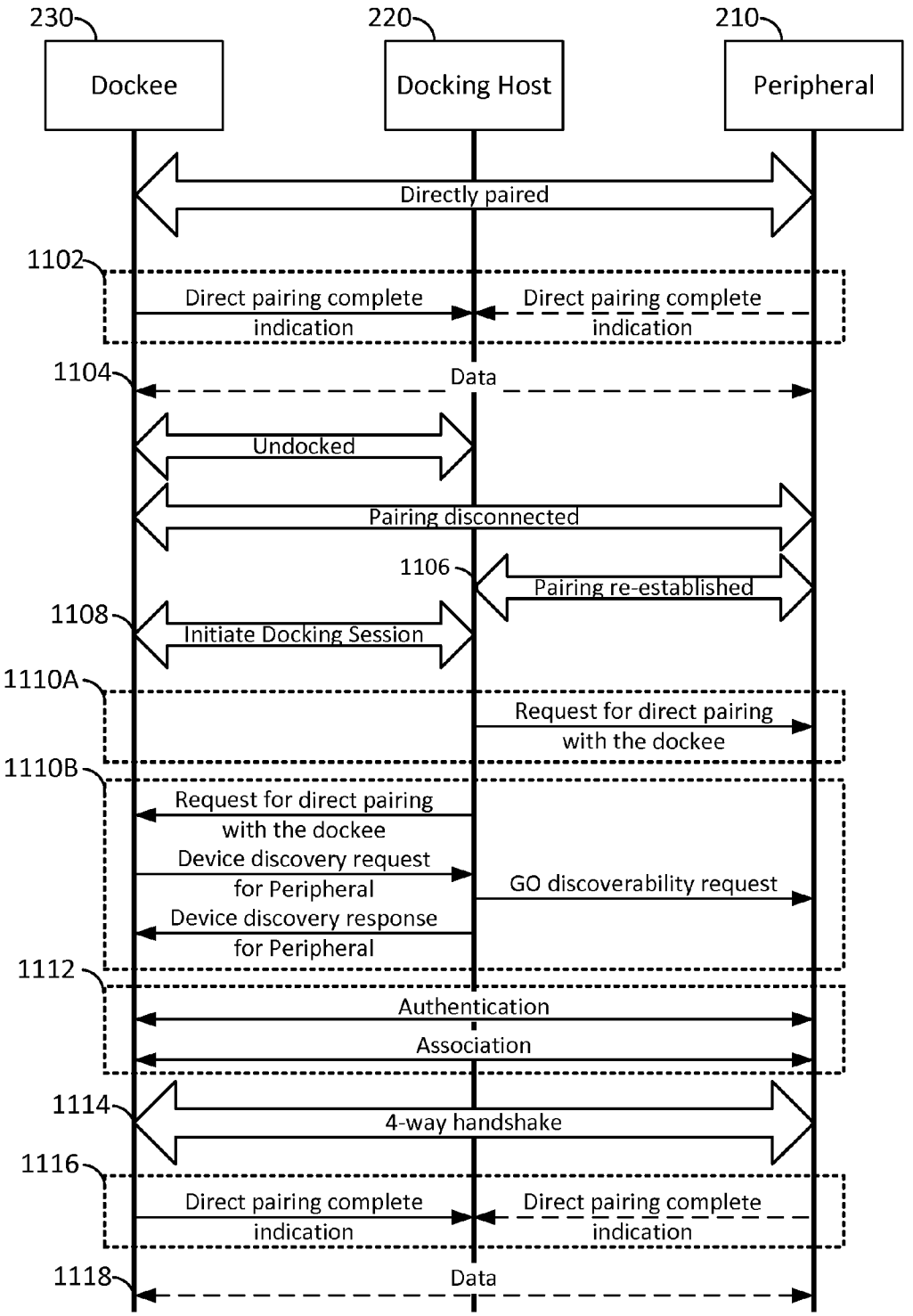

230
Dockee
220
Docking Host
210
Peripheral
Directly paired
1102
Direct pairing complete indication
Direct pairing complete indication
1104
Data
Undocked
Pairing disconnected
1106
Pairing re-established
1108
Initiate Docking Session
1110A
Request for direct pairing with the dockee
1110B
Request for direct pairing with the dockee
Device discovery request for Peripheral
GO discoverability request
Device discovery response for Peripheral
1112
Authentication
Association
1114
4-way handshake
1116
Direct pairing complete indication
Direct pairing complete indication
1118
Data

FIG. 11

APPARATUS AND METHOD FOR DIRECT PAIRING IN A WIRELESS DOCKING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of provisional patent application No. 61/649,863, titled "SYSTEM AND METHOD FOR WIRELESS DOCKING UTILIZING A WIRELESS DOCKING PROFILE" and filed in the United States Patent and Trademark Office on May 21, 2012; provisional patent application No. 61/651,991, titled "APPARATUS AND METHOD FOR PERSISTENT WIRELESS DOCKING" and filed in the United States Patent and Trademark Office on May 25, 2012; provisional patent application No. 61/658,352, titled "APPARATUS AND METHOD FOR DIRECT PAIRING IN A WIRELESS DOCKING SYSTEM" and filed in the United States Patent and Trademark Office on Jun. 11, 2012; and provisional patent application No. 61/658,363, titled "APPARATUS AND METHOD FOR WIRELESS DOCKING UTILIZING A WIRELESS DOCKING PROFILE IN THE PRESENCE OF WIRELESS DOCKING ENVIRONMENTS" and filed in the United States Patent and Trademark Office on Jun. 11, 2012, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] Aspects of the present disclosure relate generally to wireless docking systems, and more particularly, to systems and methods of establishing a direct pairing between a dockee and one or more peripherals in a wireless docking system.

BACKGROUND

[0003] Wireless communication networks are widely deployed to provide various communication services such as telephony, video, data, messaging, broadcasts, and so on. Such networks, which are usually multiple access networks, support communications for multiple users by sharing the available network resources.

[0004] Recent interest has been directed toward WLAN connectivity, where a dockee, e.g., a mobile device such as a cellular telephone, can utilize a WLAN interface (e.g., an IEEE 802.11 "Wi-Fi" interface) to establish wireless communication links with one or more peripheral devices. Here, peripheral devices can be any of numerous types, such as a mouse, keyboard, display, printer, camera, speakers, mass storage devices, media servers, sensors, and many others. Some such WLAN-enabled devices are configured for direct connectivity between devices, e.g., without the need of an intermediate wireless router or docking host. For example, Wi-Fi Direct is a known standard for direct connectivity between a device such as a mobile phone with peripheral devices.

[0005] As the demand for mobile broadband access continues to increase, research and development continue to advance wireless technologies not only to meet the growing demand for mobile broadband access, but to advance and enhance the user experience with mobile communications.

BRIEF SUMMARY OF SOME EXAMPLES

[0006] The following presents a simplified summary of one or more aspects of the present disclosure, in order to provide a basic understanding of such aspects. This summary is not an extensive overview of all contemplated features of the disclosure, and is intended neither to identify key or critical elements of all aspects of the disclosure nor to delineate the scope of any or all aspects of the disclosure. Its sole purpose is to present some concepts of one or more aspects of the disclosure in a simplified form as a prelude to the more detailed description that is presented later.

[0007] Various aspects of the present disclosure enable a docking procedure where a dockee, when docking with a docking host that manages a docking environment, can become directly paired with the peripherals in the docking environment in a straightforward fashion. Furthermore, a persistent direct pairing may be established such that after a first docking session, subsequent docking sessions where the dockee is directly paired with the same peripherals can further be expedited.

[0008] In one aspect, the disclosure provides a method operable at a docking host for direct pairing between a dockee and a peripheral paired with the docking host, the method including the steps of establishing a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host, establishing a second communication link with the dockee such that the dockee is a P2P client of the docking host, and transmitting information to the dockee over the second communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral.

[0009] In another aspect, the disclosure provides a method operable at a dockee for direct pairing with a peripheral in a docking environment managed by a docking host, the method including the steps of establishing a first communication link with the docking host such that the docking host is a P2P group owner (GO) and the dockee is a P2P client of the docking host, receiving information from the docking host over the first communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral, and establishing a second communication link with the peripheral utilizing TDLS in accordance with the received information.

[0010] In another aspect, the disclosure provides a method operable at a docking host for direct pairing between a dockee and a peripheral paired with the docking host, the method including the steps of establishing a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host, establishing a second communication link with the dockee such that the dockee is a P2P GO and the docking host is a P2P client of the dockee, and receiving a request from the dockee over the second communication link for information enabling establishment of a direct pairing between the dockee and the peripheral.

[0011] In another aspect, the disclosure provides a method operable at a dockee for direct pairing with a peripheral in a docking environment managed by a docking host, the method including the steps of establishing a first communication link with the docking host such that the dockee is a P2P group owner (GO) and the docking host is a P2P client of the dockee, transmitting a request to the docking host over the first communication link for information enabling establishment of a direct pairing between the dockee and the peripheral, and establishing a second communication link with the peripheral in accordance with the received information.

[0012] In another aspect, the disclosure provides a method operable at a dockee for direct pairing with a peripheral in a docking environment managed by a docking host, the method including the steps of establishing an initial docking session with the docking host, receiving information from the docking host to enable a direct pairing between the dockee and the peripheral, communicating with the peripheral to obtain a persistent key adapted to enable a persistent direct pairing between the dockee and the peripheral, and communicating with the peripheral to obtain a session key adapted to enable secure communication during a first direct pairing session.

[0013] In another aspect, the disclosure provides a method operable at a docking host for direct pairing between a dockee and a peripheral paired with the docking host, the method including the steps of establishing a docking session with the dockee, transmitting information to the dockee to enable a direct pairing between the dockee and the peripheral, determining that the dockee and the peripheral have engaged in direct pairing in a prior docking session, and transmitting a request for direct pairing to at least one of the peripheral or the dockee.

[0014] In another aspect, the disclosure provides a docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, including at least one processor, a transceiver communicatively coupled to the at least one processor, and a memory communicatively coupled to the at least one processor, wherein the at least one processor is configured to establish a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host, to establish a second communication link with the dockee such that the dockee is a P2P client of the docking host, and to transmit information to the dockee over the second communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral.

[0015] In another aspect, the disclosure provides a dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, including at least one processor, a transceiver communicatively coupled to the at least one processor, and a memory communicatively coupled to the at least one processor, wherein the at least one processor is configured to establish a first communication link with the docking host such that the docking host is a P2P group owner (GO) and the dockee is a P2P client of the docking host, to receive information from the docking host over the first communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral, and to establish a second communication link with the peripheral utilizing TDLS in accordance with the received information.

[0016] In another aspect, the disclosure provides a docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, including at least one processor, a transceiver communicatively coupled to the at least one processor, and a memory communicatively coupled to the at least one processor, wherein the at least one processor is configured to establish a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host, to establish a second communication link with the dockee such that the dockee is a P2P GO and the docking host is a P2P client of the dockee, and to receive a request from the dockee over the second communication link for information enabling establishment of a direct pairing between the dockee and the peripheral.

[0017] In another aspect, the disclosure provides a dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, including at least one processor, a transceiver communicatively coupled to the at least one processor, and a memory communicatively coupled to the at least one processor, wherein the at least one processor is configured to establish a first communication link with the docking host such that the dockee is a P2P group owner (GO) and the docking host is a P2P client of the dockee, to transmit a request to the docking host over the first communication link for information enabling establishment of a direct pairing between the dockee and the peripheral, and to establish a second communication link with the peripheral in accordance with the received information.

[0018] In another aspect, the disclosure provides a dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, including at least one processor, a transceiver communicatively coupled to the at least one processor, and a memory communicatively coupled to the at least one processor, wherein the at least one processor is configured to establish an initial docking session with the docking host, to receive information from the docking host to enable a direct pairing between the dockee and the peripheral, to communicate with the peripheral to obtain a persistent key adapted to enable a persistent direct pairing between the dockee and the peripheral, and to communicate with the peripheral to obtain a session key adapted to enable secure communication during a first direct pairing session.

[0019] In another aspect, the disclosure provides a docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, including at least one processor, a transceiver communicatively coupled to the at least one processor, and a memory communicatively coupled to the at least one processor, wherein the at least one processor is configured to establish a docking session with the dockee, to transmit information to the dockee to enable a direct pairing between the dockee and the peripheral, to determine that the dockee and the peripheral have engaged in direct pairing in a prior docking session, and to transmit a request for direct pairing to at least one of the peripheral or the dockee.

[0020] In another aspect, the disclosure provides a docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, including means for establishing a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host, means for establishing a second communication link with the dockee such that the dockee is a P2P client of the docking host, and means for transmitting information to the dockee over the second communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral.

[0021] In another aspect, the disclosure provides a dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, including means for establishing a first communication link with the docking host such that the docking host is a P2P group owner (GO) and the dockee is a P2P client of the docking host, means for receiving information from the docking host over the first communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral, and

means for establishing a second communication link with the peripheral utilizing TDLS in accordance with the received information.

[0022] In another aspect, the disclosure provides a docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, including means for establishing a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host, means for establishing a second communication link with the dockee such that the dockee is a P2P GO and the docking host is a P2P client of the dockee, and means for receiving a request from the dockee over the second communication link for information enabling establishment of a direct pairing between the dockee and the peripheral.

[0023] In another aspect, the disclosure provides a dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, including means for establishing a first communication link with the docking host such that the dockee is a P2P group owner (GO) and the docking host is a P2P client of the dockee, means for transmitting a request to the docking host over the first communication link for information enabling establishment of a direct pairing between the dockee and the peripheral, and means for establishing a second communication link with the peripheral in accordance with the received information.

[0024] In another aspect, the disclosure provides a dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, including means for establishing an initial docking session with the docking host, means for receiving information from the docking host to enable a direct pairing between the dockee and the peripheral, means for communicating with the peripheral to obtain a persistent key adapted to enable a persistent direct pairing between the dockee and the peripheral, and means for communicating with the peripheral to obtain a session key adapted to enable secure communication during a first direct pairing session.

[0025] In another aspect, the disclosure provides a docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, including means for establishing a docking session with the dockee, means for transmitting information to the dockee to enable a direct pairing between the dockee and the peripheral, means for determining that the dockee and the peripheral have engaged in direct pairing in a prior docking session, and means for transmitting a request for direct pairing to at least one of the peripheral or the dockee.

[0026] In another aspect, the disclosure provides a computer-readable storage medium including instructions for causing a computer at a docking host to establish a first communication link with a peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host, to establish a second communication link with a dockee such that the dockee is a P2P client of the docking host, and to transmit information to the dockee over the second communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral.

[0027] In another aspect, the disclosure provides a computer-readable storage medium including instructions for causing a computer at a dockee to establish a first communication link with a docking host such that the docking host is a P2P group owner (GO) and the dockee is a P2P client of the docking host, to receive information from the docking host over the first communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with a peripheral, and to establish a second communication link with the peripheral utilizing TDLS in accordance with the received information.

[0028] In another aspect, the disclosure provides a computer-readable storage medium including instructions for causing a computer at a docking host to establish a first communication link with a peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host, to establish a second communication link with a dockee such that the dockee is a P2P GO and the docking host is a P2P client of the dockee, and to receive a request from the dockee over the second communication link for information enabling establishment of a direct pairing between the dockee and the peripheral.

[0029] In another aspect, the disclosure provides a computer-readable storage medium including instructions for causing a computer at a dockee to establish a first communication link with a docking host such that the dockee is a P2P group owner (GO) and the docking host is a P2P client of the dockee, to transmit a request to the docking host over the first communication link for information enabling establishment of a direct pairing between the dockee and a peripheral, and to establish a second communication link with the peripheral in accordance with the received information.

[0030] In another aspect, the disclosure provides a computer-readable storage medium including instructions for causing a computer at a dockee to establish an initial docking session with a docking host, to receive information from the docking host to enable a direct pairing between the dockee and a peripheral, to communicate with the peripheral to obtain a persistent key adapted to enable a persistent direct pairing between the dockee and the peripheral, and to communicate with the peripheral to obtain a session key adapted to enable secure communication during a first direct pairing session.

[0031] In another aspect, the disclosure provides a computer-readable storage medium including instructions for causing a computer at a docking host to establish a docking session with a dockee, to transmit information to the dockee to enable a direct pairing between the dockee and a peripheral, to determine that the dockee and the peripheral have engaged in direct pairing in a prior docking session, and to transmit a request for direct pairing to at least one of the peripheral or the dockee.

[0032] These and other aspects of the invention will become more fully understood upon a review of the detailed description, which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] FIG. **1** is a block diagram illustrating an example of a hardware implementation for an apparatus employing a processing system.

[0034] FIG. **2** is a simplified block diagram of a dockee, peripheral, and docking host as may be utilized for direct pairing according to one example.

[0035] FIG. **3** is a simplified schematic diagram of a wireless docking system utilizing a docking environment according to one example.

[0036] FIG. **4** is a simplified schematic diagram of a wireless docking system with direct pairing according to one example.

[0037] FIG. **5** is a block diagram illustrating various communication links as they may appear in a direct pairing system according to one example.

[0038] FIG. **6** is a flow chart illustrating an exemplary process of direct pairing wherein the dockee is a P2P client for a docking host in accordance with one example.

[0039] FIG. **7** is a flow chart illustrating an exemplary process of direct pairing wherein the docking host is a P2P client for a dockee in accordance with one example.

[0040] FIG. **8** is a call flow diagram illustrating a process for persistent direct pairing in accordance with one example.

[0041] FIG. **9** is a flow chart illustrating an exemplary process of direct pairing wherein the peripheral connects to the dockee as a P2P client connects to a P2P group owner according to one example.

[0042] FIG. **10** is flow chart illustrating an exemplary process of direct pairing wherein the peripheral connects to the dockee as a legacy STA connects to an infrastructure AP.

[0043] FIG. **11** is a call flow diagram illustrating a process for persistent direct pairing in accordance with one example.

DETAILED DESCRIPTION

[0044] The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known structures and components are shown in block diagram form in order to avoid obscuring such concepts.

[0045] FIG. **1** is a conceptual diagram illustrating an example of a hardware implementation for an apparatus **100** employing a processing system **114**. In accordance with various aspects of the present disclosure, an element, or any portion of an element, or any combination of elements may be implemented with a processing system **114** that includes one or more processors **104**. For example, in various aspects, the apparatus **100** may represent any one or more of a wireless dockee, a wireless docking host, and/or a peripheral device. Examples of processors **104** that may be utilized in an apparatus **100** include microprocessors, microcontrollers, digital signal processors (DSPs), field programmable gate arrays (FPGAs), programmable logic devices (PLDs), state machines, gated logic, discrete hardware circuits, and other suitable hardware configured to perform the various functionality described throughout this disclosure.

[0046] In this example, the processing system **114** may be implemented with a bus architecture, represented generally by the bus **102**. The bus **102** may include any number of interconnecting buses and bridges depending on the specific application of the processing system **114** and the overall design constraints. The bus **102** links together various circuits including one or more processors (represented generally by the processor **104**), a memory **105**, and computer-readable media (represented generally by the computer-readable medium **106**). The bus **102** may also link various other circuits such as timing sources, peripherals, voltage regulators, and power management circuits, which are well known in the art, and therefore, will not be described any further. A bus interface **108** provides an interface between the bus **102** and a transceiver **110**. The transceiver **110** provides a means for communicating with various other apparatus over a transmission medium. Depending upon the nature of the apparatus, a user interface **112** (e.g., keypad, display, speaker, microphone, joystick) may also be provided.

[0047] The processor **104** is responsible for managing the bus **102** and general processing, including the execution of software stored on the computer-readable medium **106**. The software, when executed by the processor **104**, causes the processing system **114** to perform the various functions described infra for any particular apparatus. The computer-readable medium **106** may also be used for storing data that is manipulated by the processor **104** when executing software.

[0048] One or more processors **104** in the processing system may execute software. Software shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. The software may reside on a computer-readable medium **106**. The computer-readable medium **106** may be a non-transitory computer-readable medium. A non-transitory computer-readable medium includes, by way of example, a magnetic storage device (e.g., hard disk, floppy disk, magnetic strip), an optical disk (e.g., a compact disc (CD) or a digital versatile disc (DVD)), a smart card, a flash memory device (e.g., a card, a stick, or a key drive), a random access memory (RAM), a read only memory (ROM), a programmable ROM (PROM), an erasable PROM (EPROM), an electrically erasable PROM (EEPROM), a register, a removable disk, and any other suitable medium for storing software and/or instructions that may be accessed and read by a computer. The computer-readable medium may also include, by way of example, a carrier wave, a transmission line, and any other suitable medium for transmitting software and/or instructions that may be accessed and read by a computer. The computer-readable medium **106** may reside in the processing system **114**, external to the processing system **114**, or distributed across multiple entities including the processing system **114**. The computer-readable medium **106** may be embodied in a computer program product. By way of example, a computer program product may include a computer-readable medium in packaging materials. Those skilled in the art will recognize how best to implement the described functionality presented throughout this disclosure depending on the particular application and the overall design constraints imposed on the overall system.

[0049] One or more aspects of the disclosure relate to wireless docking systems. A wireless docking system can provide seamless connectivity, enabling a portable device such as a mobile handset, PDA, tablet computer, etc. to connect with a group of peripheral devices without needing wires or a docking connector, a PIN code or elaborate pairing process for between the dockee and each individual peripheral. The peripherals in any docking environment may act as a group, which needs only to be set up once. Many different types of peripherals may be supported in a docking environment, including the bridging of legacy peripherals. Ideally, the best link, protocol, and QoS would be automatically set up for each type of peripheral connection. The best connection may be selected depending on the application (e.g., for a productivity application, for watching videos, or for playing games,

etc.), and the environment (e.g., the home enterprise, internet café, etc.). Here, existing application sessions/connections may be left intact.

[0050] FIG. **2** includes a simplified block diagram illustrating an exemplary peripheral **210**, an exemplary docking host **220**, and an exemplary dockee **230** in accordance with some aspects of the disclosure. In the illustrated example, the peripheral **210** includes at least one processor **211**, a memory **213** communicatively coupled to the at least one processor **211**, a communication interface **212** communicatively coupled to the at least one processor **211**, and optional peripheral function circuitry **214**. In some aspects of the disclosure, the at least one processor **211** may be the processor **104** included in the processing system **114** described above and illustrated in FIG. **1**; similarly, the memory **212** may be the memory **105** described above and illustrated in FIG. **1**.

[0051] In various aspects of the disclosure, the communication interface **212** may be a wireless interface configured for communication with a docking host **220**. For example, the communication interface **212** may include a Wi-Fi interface compatible with any of the family of standards defined under the IEEE 802.11 standards, an IEEE 802.15.1 "Bluetooth" interface, an IEEE 802.15.4 "ZigBee" interface, or any other suitable wireless communication interface. Of course, some examples of a peripheral **210** may include two or more of the above-described or other communication interfaces. In a particular example described in further detail below, the communication interface **212** may be configured to be compatible with Wi-Fi Direct protocols. Further, when included in a peripheral **210**, the peripheral function circuitry **214** may be embodied in any number of ways, including for example a user interface, a display, microphone, speaker, network interface, etc.

[0052] Further, in the illustrated example, the docking host **220** includes at least one processor **221**, a communication interface **222** communicatively coupled to the at least one processor **221**, and a memory **223** communicatively coupled to the at least one processor **221**. In some aspects of the disclosure, the at least one processor **221** may be the processor **104** included in the processing system **114** described above and illustrated in FIG. **1**; similarly, the memory **222** may be the memory **105** described above and illustrated in FIG. **1**.

[0053] In various aspects of the disclosure, the communication interface **222** may include a Wi-Fi interface compatible with any of the family of standards defined under the IEEE 802.11 standards, an IEEE 802.15.1 "Bluetooth" interface, an IEEE 802.15.4 "ZigBee" interface, or any other suitable wireless communication interface. Of course, some examples of a docking host **220** may include two or more of the above-described or other communication interfaces. In a particular example described in further detail below, the communication interface **222** may be configured to be compatible with Wi-Fi Direct protocols.

[0054] Still further, in the illustrated example, the dockee **230** includes at least one processor **231**, a communication interface **232** communicatively coupled to the at least one processor **231**, a memory **233** communicatively coupled to the at least one processor **231**, and a user interface **234** communicatively coupled to the at least one processor **231**. In some aspects of the disclosure, the at least one processor **231** may be the processor **104** included in the processing system **114** described above and illustrated in FIG. **1**; similarly, the memory **232** may be the memory **105** described above and illustrated in FIG. **1**.

[0055] In various aspects of the disclosure, the communication interface **232** may include a Wi-Fi interface compatible with any of the family of standards defined under the IEEE 802.11 standards, an IEEE 802.15.1 "Bluetooth" interface, an IEEE 802.15.4 "ZigBee" interface, or any other suitable wireless communication interface. Of course, some examples of a dockee **230** may include two or more of the above-described or other communication interfaces. In a particular example described in further detail below, the communication interface **232** may be configured to be compatible with Wi-Fi Direct protocols.

[0056] In a further aspect of the disclosure, the dockee **230** may include a user interface **234** for input/output functionality enabling communication between a user and the wireless docking system. As an illustrative but non-limiting example, the dockee **230** may be embodied as a smartphone or tablet device, including a touch-screen interface providing user input and output functionality.

[0057] A wireless docking system may provide a wireless connection between a wireless dockee and a wireless docking environment. FIG. **3** is a simplified schematic diagram that illustrates a wireless docking system **300** including a dockee **230** in wireless communication with a plurality of peripherals **210**, **310** by way of a wireless docking host **220**, as a part of a wireless docking environment **306**.

[0058] The dockee **230** may be any suitable device capable of wirelessly connecting to the wireless docking environment **306** utilizing any suitable communication protocol, which may include but is not limited to IEEE 802.11 "Wi-Fi." By connecting to the wireless docking environment **306**, the dockee **230** may be capable of connecting directly or indirectly to each of the peripherals **210** that are part of the wireless docking environment **306**.

[0059] The wireless docking environment **306** is a group of one or more physical devices, including one or more wireless docking hosts **220** and one or more peripherals **210**. A wireless docking environment **306** can take any suitable configuration or topology, for example, including nothing more than a wireless docking host **220**, or additionally including one or more peripherals **210**.

[0060] The peripherals **210** may represent logical peripheral functions. In general, a peripheral function may be any I/O function implemented in a wireless docking host **220** that can be made available to a wireless dockee **230** through any of various suitable wireless interfaces; any I/O function in an external peripheral device that can be made available to the wireless dockee **230** through the wireless docking host **220**, where the external peripheral device may be directly connected to the wireless docking host **220**; or any I/O function in an external peripheral device that can be connected directly to the wireless dockee **230**, and whose connection to the wireless dockee **230** is set up utilizing information provided by the wireless docking host **220**. Peripherals **210** may in some examples be embodied as physical devices having wired and/or wireless interfaces for communicating with the wireless dockee **230** through the wireless docking host **220**. Some nonlimiting examples of peripherals might include LCD monitors or other display devices, utilizing, e.g., an HDMI or VGA interface; speakers, microphones a keyboard, mouse, printer, scanner, camera, a mass storage device, etc. utilizing any suitable wired or wireless interface, such as USB; general

purpose USB ports or hubs for coupling any suitable USB-compatible device; Ethernet ports for coupling to a network; or any other suitable device.

[0061] In the illustration, some peripherals **210** are shown in the wireless docking environment **306**, and an extra peripheral **310** is shown outside the wireless docking environment **306**. Here, this extra peripheral **310** illustrates that not necessarily all peripherals **210**, **310** that are paired with the wireless docking host **220** are included in a particular wireless docking environment **306**. That is, a wireless docking environment **306** associated with a wireless docking host **220** may include only a subset of the peripherals **210**, **310** that are paired with, or in communication with the docking host **220**. Moreover, the extra peripheral **310** may be one of numerous extra peripherals **310**, and further, the wireless docking host may provide a plurality of wireless docking environments such as the environment **306**. Here, the set of peripherals in a particular wireless docking environment may include any number, from zero or greater, of peripherals, and further, in some examples, a particular peripheral **210**, **310** may be included in zero, one, two, or more established wireless docking environments **306**.

[0062] The wireless docking host **220** may be any suitable device capable of connecting to the wireless dockee **230** and one or more peripherals **210**. For example, a wireless docking host **220** may make available to a wireless dockee **230** peripheral functions on external peripherals **210** that are connected to the docking host **220** directly, as well as peripheral functions the wireless docking host **220** itself may implement (e.g., a display).

[0063] The docking host **220** may provide different docking experiences or docking environments **306** to different dockees **230**. For example, at a given time a dockee **230** may have a particular need for certain peripheral functions, and upon learning of this need, the docking host **220** may therefore provide a corresponding docking environment **306** for that dockee.

[0064] One example of a way for a docking host **220** to provide these capabilities to different dockees **230** is for the docking host **220** to preconfigure multiple docking environments **306**. That is, multiple groups of peripherals **210** can be preconfigured at the docking host **220**, e.g., by randomly selecting groups of available peripherals **210** or by selecting certain peripherals to be grouped together. Here, each group may be a logical group including suitable peripherals **210**, which may be manually or automatically configured with the docking host **220**.

[0065] In this example, the docking host **220** may group its attached and/or wirelessly paired peripherals **210** into multiple hierarchical groups and enable each dockee to use one group. For example, assume that a particular docking host **220** has peripherals A-G available. Here, peripherals A, B, and C may be grouped together into a first group, and peripherals D, E, F, and G may be grouped together into a second group. This way, the groups may be disjoint groups of peripherals. In another example, peripherals A, B, and C may be grouped together into a first group, and peripherals C, D, and E may be grouped together into a second group. This way, the groups may have some intersection or overlap of peripherals.

[0066] With a hierarchical grouping, separate groups of peripherals might be disjoint groups, and separate groups might have a common parent. For the common parent, peripherals A, B, C, D, E, and F might be a parent group in the hierarchy, and at the next level of the hierarchy, groups might include, for example, peripherals A, B, and C as a first group; and peripherals D, E, and F as a second group. By utilizing such groups of peripherals, each such group can be considered a separate wireless docking environment **306** as discussed above. That is, a particular wireless docking host **220** may be capable of providing any from a plurality of wireless docking environments **306** to a particular wireless dockee **230**, each wireless docking environment **306** including a different group of peripherals that may be one of a plurality of preconfigured hierarchical groups.

[0067] In any wireless docking system utilizing docking environments as described above, there are certain disadvantages relating to the use of the docking host **220** in maintaining the docking session. For example, due to the interposition of the docking host **220** between the dockee **230** and the peripherals **210**, there can be a reduced efficiency according to any latency added by processing and communication at the docking host **220**. Furthermore, it may be the case that the docking host **220** is managing docking sessions for large numbers of dockees **230**, which can ultimately overload the processing and/or communication capabilities of the docking host **220**.

[0068] Therefore, in accordance with an aspect of the disclosure, a direct pairing between the dockee **230** and one or more peripherals **210** may be enabled. For example, FIG. **4** is a simplified illustration showing a direct pairing between the dockee **230** and various peripherals **210**. In the illustration, as compared to FIG. **3**, here, the wireless connections between the wireless docking host **220** and the peripherals **210**, as well as the wireless connection between the wireless dockee **230** and the wireless docking host **220**, have been terminated. Further, a direct wireless connection is shown to be established between the wireless dockee **230** and each of the peripherals **210** in the docking environment **306**. However, in this example, a wireless connection between the wireless docking host **220** and a peripheral **310** outside the docking environment **306** is maintained.

[0069] To enable the direct pairing between the wireless dockee **230** and the one or more peripherals **210**, it may be desirable to simplify a transition from the existence of the conventional docking environment (as in FIG. **3**) to a direct pairing between the dockee **230** and one or more peripherals **210** in the docking environment (as in FIG. **4**). To establish this direct pairing, it may further be desired not to require manual operation on the part of the dockee **230** or its user, e.g., typing in a personal identification number (PIN) or password phrase, touching a "pair" button at the dockee **230** and the peripheral **210**, etc. That is, if manual operations were required for the pairing between the dockee **230** and the peripheral **210**, the docking environment does not serve any purpose in assisting the direct pairing and conventional pairing procedures may be utilized. On the other hand, since it is known that the docking host **220** is already configured with information corresponding to the peripheral **210** by virtue of its pairing and utilization in the docking environment **306**, a handing over of the peripheral **210** to the dockee **230** for a direct pairing may be enabled.

[0070] FIG. **5** is a simplified schematic diagram illustrating the various communication links that may be utilized in various aspects of the disclosure. In general, as described below, a peripheral **210** is paired, or has a first communication link **504** established, with the docking host **220**. At this time, the dockee **230** initiates a second communication link **502** with the docking host **220**, to establish a docking session including

the peripheral **210**, e.g., as a part of a docking environment. In an aspect of the disclosure, a direct communication link **506** may be established between the dockee **230** and the peripheral **210**, such that the first communication link **504** between the docking host **220** and the peripheral **210** may be severed.

[0071] One technology that may enable such a direct communication link **506** between the dockee **230** and the peripheral **210** without the use of a LAN access point such as the docking host **220** is frequently referred to as Wi-Fi Direct. Wi-Fi Direct is an existing, published standard that enables such wireless devices to communicate directly with one another, without requiring an intermediate wireless access point. In accordance with various aspects of the present disclosure, wireless LAN communication may utilize the Wi-Fi standard, the Wi-Fi Direct standard, or any other suitable standard for wireless communication over a LAN. For ease of explanation, in the description that follows, the dockee **230** and the peripheral **210** include a communication interface **232**, **212**, respectively, configured for communication utilizing the Wi-Fi Direct standard.

[0072] Various aspects of the present disclosure provide a dockee **230** with a capability to pair directly with one or more peripherals **210** paired with a docking host **220** within a docking environment **306**. Further aspects of the disclosure provide a persistent direct pairing capability, wherein the dockee **230** may return to the docking host **220** at a later time and the direct docking between the dockee **230** and the one or more peripherals **210** may be efficiently re-established.

[0073] Among various possible configurations, below, two potential use cases are discussed. In a first example, the docking host **220** may be configured as a P2P group owner (GO), with the dockee **230** being configured as a P2P client of the docking host **220**; in another example, the dockee **230** may be configured as a P2P (GO), such that the docking host **220** is a P2P client of the dockee **230**.

Docking Host as a P2P GO

[0074] In an example where the dockee **230** is a client (e.g., a P2P client) of the docking host **220**, it is generally the case that one or more peripherals **210** would additionally be P2P clients of the docking host **220**. In this case, tunneled direct link setup (TDLS) may be utilized directly to connect the dockee **230** with the one or more peripherals **210**. Because TDLS is standardized, such a direct pairing can be simplified. That is, the dockee **230** may initiate the TDLS procedure through the docking host **220**, and accordingly, the dockee **230** can directly connect with the one or more peripherals **210**.

[0075] FIG. **6** is a flow chart illustrating a simplified exemplary process **600** of establishing a direct pairing session in accordance with an aspect of the disclosure wherein the dockee **230** is a P2P client for a docking host **220**. In an aspect of the disclosure, the steps of the process **600** may be operable at the peripheral **210**, the docking host **220**, and/or the dockee **230**, as described below. At step **602**, the docking host **220** is established as a P2P GO, having the peripheral **210** attached to the docking host **220** as a P2P client. At **604**, when in a service discovery phase, the docking host **220** may advertise its peripherals for proximate dockees, and in an aspect of the disclosure, may additionally advertise TDLS as a payload connection option for use by a dockee in a direct pairing session.

[0076] At **606**, the dockee **230** may establish a docking session with the docking host **220**, joining as a P2P client of the P2P group of which the docking host **220** is the P2P GO. Here, in some aspects of the disclosure, the attachment of the dockee **230** with the docking host **220** may include some manual operation on the part of the user; however, in a further aspect of the disclosure, the handing over of the peripheral(s) **210** to the dockee **230** for direct pairing need not include any further manual pairing operations.

[0077] Here, if TDLS is enabled, then at step **610**, in a connection negotiation phase, the dockee **230** may transmit to the docking host **220** a request to utilize TDLS as its payload connection type to directly communicate with the peripheral (s) **210**. Once accepted, at **612** the dockee **230** may communicate with the docking host **220** to establish the TDLS direct communication link **506** between the dockee **230** and the peripheral(s) **210** for direct communication, and at **614** the direct communication link **506** utilizing TDLS may be established between the dockee **230** and the peripheral(s) **210**.

Dockee as a P2P GO

[0078] Referring now to the second example introduced above, a direct pairing between a dockee **230** and one or more peripherals **210** may be enabled utilizing wherein the dockee **230** is a P2P group owner (GO), and the docking host **220** is a P2P client for the dockee **230**.

[0079] FIG. **7** is a flow chart illustrating a simplified exemplary process **700** of establishing a direct pairing session in accordance with an aspect of the disclosure wherein the dockee **230** acts as a P2P GO for one or more peripherals **210**. At step **702**, one or more peripheral(s) **210** may be attached to the docking host **220** as a P2P client. That is, the docking host **220** may be a P2P GO for the one or more peripherals **210**. At **704**, when in a service discovery phase, the docking host **220** may advertise its peripherals **210** for proximate dockees.

[0080] At **706**, the dockee **230** may establish a docking session with the docking host **220** by inviting the docking host **220** to join a P2P Group of which the dockee **230** is the P2P GO. Next, at **708**, the dockee **230** may dock with the docking host **220** and transmit to the docking host **220** a request to communicate with the one or more peripheral(s) **210** directly; and at **710**, the dockee **230** and peripheral(s) **210** may establish a direct communication link **506** wherein the dockee **230** is the P2P GO of a group including the peripheral(s) **210**.

[0081] In various aspects of the disclosure, as a part of the process of step **710**, the docking host **220** may assist the peripheral(s) **210** to directly connect to the dockee **230** in various suitable manners. Below, three examples are provided for the docking host **220** to assist the peripheral **210** to establish the direct communication link **504** with the dockee **230**. In a first example, the peripheral **210** connects to the dockee **230** as a P2P client connects to a P2P GO, e.g., by going first through a PIN-based Wi-Fi Simple Configuration (WSC) procedure, wherein the PIN is dynamically generated and given by the docking host **220** to the dockee **230**. In a second example, the peripheral **210** may connect to the dockee **230** as a P2P Client connects to a P2P GO, utilizing the P2P Group Credential. In a third example, the peripheral **210** may connect to the dockee **230** as a legacy STA connects to an infrastructure AP, utilizing a credential created by the docking host **220**. Each of these examples is described in further detail below.

[0082] FIG. **8** is a call flow diagram illustrating an exemplary process in accordance with a first example, wherein the dockee **230** acts as the P2P GO. To begin, as described above in relation to FIG. **7**, the peripheral **210** is paired with the

docking host **220**, and a docking session has been initiated between the dockee **230** and the docking host **220**. Further, as described above at step **708**, the dockee **230** may optionally transmit a request **802** for direct pairing with the peripheral **210**. In some aspects of the disclosure the request **802** may include a request to retrieve identification information such as a PIN corresponding to the peripheral **210** for provisioning the peripheral **210** at the dockee **230**. This information may be utilized to enable direct pairing between the peripheral **210** and the dockee **230**.

[0083] **804**A and **804**B illustrate two examples of different ways that PIN or other suitable credential information may be provided to the dockee **230** and/or the peripheral **210** to enable the direct pairing communication link **504** between the dockee **230** and the peripheral **210**.

[0084] At **804**A, as one alternative, either in response to a request from the dockee **230** to retrieve a PIN, or in some examples upon the initiative of the docking host **220**, the docking host **220** may transmit a request to the peripheral **210** to retrieve the identification information such as the PIN corresponding to the peripheral **210** for the provisioning of the dockee **230**. In response, the peripheral **210** may transmit the corresponding identification information to the docking host **220** for provisioning the dockee **230**. Here, the identification information may be generated for the dockee **230**. For example, the identification information may be different from identification information utilized for pairing the peripheral **210** with the docking host. **220**. For example, if a first PIN were used for pairing the docking host **220** with the peripheral **210**, a second PIN different from the first PIN may be provided from the peripheral **220** to the docking host **220** in response to the request for provisioning information for the dockee **230**. In this fashion, in some examples, different identification information may be provided by the peripheral **210** corresponding to each dockee that wishes to employ a direct pairing. The identification information received at the docking host **220** may then be transmitted from the docking host **220** to the dockee **230** in a forwarding message, so that the dockee **230** may register the peripheral **210** utilizing the received identification information. For example, the dockee **230** may include a WTS registrar for registering the peripheral **210** utilizing a received PIN.

[0085] At **804**B, as another alternative, in an aspect of the disclosure, the docking host **220** may dynamically generate a PIN for a WSC procedure for direct pairing between the dockee **230** and the peripheral **210**, and transmit the generated PIN to the peripheral **210** and the dockee **230**. In some examples, the docking host **220** may additionally transmit the P2P Device Address of the peripheral **210** to the dockee **230**, and may complementarily send the P2P Device Address of the dockee **230** to the peripheral **210**, indicating that the PIN is used for the WSC procedure between the peripheral **210** and the dockee **230**. In some examples, here, the P2P Group Operating Channel of the dockee **230** may be included, as well as a docking host-assigned direct link expiration time.

[0086] Following either alternative **804**A or **804**B, the dockee **230** may begin a process to contact with the peripheral **210**. Thus, at **806** a device phase may begin. Here, the dockee **230** may request the docking host **220** to make the peripheral **210** discoverable, and then invite the peripheral **210** to join the P2P Group of which the dockee **230** is the GO.

[0087] For example, the dockee **230** may transmit a device discovery request for the peripheral **210** to the docking host **220**; and the docking host **220** may forward the discoverability request as a GO discoverability request to the peripheral **210**. This discoverability request may be configured to inform the peripheral **210** about its needed availability on a particular channel used by the dockee **230**, or other communication information for use between the dockee **230** and the peripheral **210**. The docking host **220** may further transmit a device discovery response for the peripheral **210** to the dockee **230**, such that the dockee **230** is configured with information for communicating with the peripheral **210**.

[0088] Thereafter, at **808** the dockee **230** may configure its communication interface **232** to utilize the configuration information received above so that it may communicate with the peripheral **210**, and accordingly transmit a P2P group invitation request directly to the peripheral **210**. The peripheral **210** may accordingly respond with a P2P group invitation response to the dockee **230**. Next, the dockee **230** and the peripheral **210** may enter into an authentication phase **810**.

[0089] As illustrated, two authentication phases **810** and **814** are utilized. Here, the first authentication phase **810** may establish a persistent key for implementing a persistent direct pairing between the dockee **230** and the peripheral **210**; and the second authentication phase **814** may establish a session key for implementing a particular direct pairing session between the dockee **230** and the peripheral **210**. The persistent direct pairing and the session are described in further detail below.

[0090] That is, the first authentication message **810** may include an authentication request that may specify the dockee **230** or the peripheral **210**. The authentication may utilize the identification information (e.g., a PIN) provided to the dockee **230** by the docking host **220** (as described above in alternatives **804**A and **804**B). Following the first authentication phase **810**, provisioning may be implemented utilizing a Wi-Fi Simple Configuration (WSC) exchange **812**. At this point, both entities, i.e., the dockee **230** and the peripheral **210**, will have a persistent key to utilize to communicate with one another. Here, the persistent key may be a different entity than the identification information discussed above, and may be a secret key shared only by the dockee **230** and the peripheral **210**. From that time, the dockee **230** and the peripheral **210** may utilize the second authentication message **814**, an association message, and a 4-way handshake **816** to establish a session key to be utilized for the current pairing session. Once the session key is established during the 4-way handshake **816** for the current pairing session, data **818** may begin to flow between the dockee **230** and the peripheral **210** in a secure fashion.

[0091] Furthermore, with the persistent key established at the first authentication phase **810** described above, a persistent direct pairing session may be established between the dockee **230** and the peripheral **210**. That is, the above-described process shown and described in relation to FIG. **8** may be utilized upon an initial pairing of the dockee **230** with the docking environment **306** including the peripheral **210**. However, upon subsequent docking sessions between the dockee **230** and the docking host **220** to utilize the peripheral **210**, the prior pairing may persist and the subsequent pairing procedure may be simplified, as described below in relation to FIG. **11**.

[0092] Referring once again to FIG. **7**, a second example for establishing the direct communication link **504** between the dockee **230** and the peripheral **210** as in step **710** is described herein below, wherein the peripheral **210** may connect to the dockee **230** as a P2P client connects to a P2P GO,

utilizing a P2P Group Credential forwarded to the peripheral **210** by the docking host **220**. FIG. **9** is a flow chart illustrating an exemplary process **900** of establishing the direct communication link **504** in accordance with this second example.

[0093] In this example, as above, while the peripheral **210** is connected to the docking host **220** as a P2P client, the dockee **230** approaches the docking host **220** and establishes a communication link **502** such that the dockee **230** is a P2P GO.

[0094] At step **902**, the docking host **220** may forward the Group Credentials and P2P Group ID of the P2P GO (i.e., the dockee) to the peripheral **210**. In some examples, at step **904** the docking host **220** may additionally forward the P2P Group Operating Channel of the dockee **230** and the docking host-assigned direct link expiration time to the peripheral **210**.

[0095] At step **906**, the docking host **220** may then request the peripheral **210** to disconnect the first communication link **504** from the docking host **220**, and instead find the dockee **230**. Upon the expiration of a timer, at **908** the peripheral **210** may reconnect to the docking host to check whether the establishment of the direct communication link **506** can continue. Finally, at step **910** the dockee **230** and the peripheral **210** may find each other and establish the direct communication link **506** utilizing the P2P Group, i.e., utilizing the Group Credentials received at step **902**.

[0096] Referring yet again to FIG. **7**, a third example for establishing the direct communication link **504** between the dockee **230** and the peripheral **210** as in step **710** is described herein below, wherein the peripheral **210** may connect to the dockee **230** as a legacy STA connects to an infrastructure AP utilizing a credential created by the docking host **220**. FIG. **10** is a flow chart illustrating an exemplary process **1000** of establishing the direct communication link **504** in accordance with this third example.

[0097] In this example, as above, while the peripheral **210** is connected to the docking host **220** as a P2P client, the dockee **230** approaches the docking host **220** and establishes a communication link **502** such that the dockee **230** is a P2P GO. However, here, the docking host may serve as an external registrar for the dockee's direct connection to the peripheral **210**, and therefore may push the credential for the direct connection to the dockee **210** utilizing an EAP procedure.

[0098] At step **1002**, the docking host **220** may transmit to the peripheral **210** an SSID of the dockee **230** and a P2P group credential for the direct connection. In some examples, at step **1004** the docking host **220** may additionally transmit a docking host-assigned direct link expiration time to the peripheral **210**.

[0099] At step **1006**, the docking host **220** may then request the peripheral **210** to disconnect the first communication link **504** from the docking host **220**, and instead find the dockee **230**. Upon the expiration of a timer, at **1008** the peripheral **210** may reconnect to the docking host **220** to check whether the direct communication link **506** can continue. Finally, at step **1010** the dockee **220** and the peripheral **210** may then find each other and establish the direct communication link **506** utilizing the dockee's SSID and Group Credential received at step **1002** to authenticate each other and to directly connect to one another.

[0100] As described above, once an initial direct pairing session has been established between a dockee **230** and one or more peripherals **210** in a wireless docking environment, the pairing between the dockee **230** and the peripherals **210** may persist and accordingly enable the establishment of subsequent docking sessions to become even more efficient, as described below.

[0101] FIG. **11** is a call flow diagram illustrating the subsequent docking session, to illustrate persistent direct pairing between the dockee **230** and the peripheral **210** in accordance with an aspect of the disclosure. The process illustrated in FIG. **11** may follow any of the above-described examples of the establishment of an initial direct pairing session. That is, at the beginning of FIG. **11**, the dockee **230** and the peripheral **210** are directly paired, as described above in relation to any of FIGS. **6-10**. That is, referring in particular to FIG. **8**, the persistent key established during the first authentication phase **810** and the session key established during the second authentication phase **814** may be established and shared between the dockee **230** and the peripheral **210**. Thus, at **1102** the dockee **230** may transmit a direct pairing complete indication to the docking host **220**; and/or the peripheral **210** may transmit a direct pairing complete indication to the docking host **220**. This way, the docking host **220** is informed about the direct pairing between the dockee **230** and the peripheral **210** and can accordingly sever the first communication link **504** as the data **1104** flows directly between the dockee **230** and the peripheral **210**.

[0102] At this time, dockee **230** may wish to end the docking session with the docking host **220**, thereby accordingly resulting in an ending of the direct pairing between the dockee **230** and the peripheral **210**. Therefore, at step **508** the dockee **230** may communicate with the docking host **220** to sever the docking session. For example, the user of the dockee **230** may explicitly indicate an instruction utilizing the user interface **234**, or in another example, the user may simply pick up the dockee **230** and walk away. In any case, the direct communication link **506** between the dockee **230** and the peripheral **210** may be disconnected. Once the direct pairing is disconnected, at **1106**, the peripheral **210** may pair back with the docking host **220** so that it may be utilized within a docking environment in the future by one or more dockees as needed.

[0103] At **1108**, the dockee **230** may return to the docking host **220**, and may once again dock with the docking host **220**, requesting to utilize a docking environment **306** that includes the peripheral **210**. In this case, in accordance with an aspect of the present disclosure, the persistent pairing described above may be enabled to simplify the re-establishment of a direct pairing between the dockee **230** and the peripheral **210**.

[0104] That is, the docking host **220** may recognize that the dockee **230** and the peripheral **210** have utilized a direct pairing in a previous docking session. For example, the docking host **220** may determine that a direct pairing previously occurred in accordance with the direct pairing complete indication **1102** previously received from either the dockee **230** or the peripheral **210**. In this case, the docking host **230** may suggest to the dockee **230** or the peripheral **210** to utilize direct pairing once again. Two alternatives are described herein for the docking host to suggest direct pairing between the dockee **230** and the peripheral **210**, and illustrated as alternatives **1110**A and **1110**B. In an aspect of the disclosure, a process may choose to implement one or the other of **1110**A or **1110**B.

[0105] In some aspects of the disclosure, as illustrated at **1110**A, in one alternative the docking host **220** may transmit to the peripheral **210** a request for direct pairing between the dockee **230** and the peripheral **210**.

[0106] In another aspect of the disclosure, as another alternative as illustrated at **1110**B, the docking host **220** may transmit a request to the dockee **230** for direct pairing. Here, the dockee **230** may respond with a device discovery request for the peripheral **210**, and the docking host **220** may transmit a corresponding GO discoverability request to the peripheral **210**. Further, the docking host **220** may transmit a device discovery response to the dockee **230**.

[0107] Thereafter, the dockee **230** and the peripheral **210** may be configured to communicate on a suitable channel and may be enabled for direct communication with one another. As described above, the dockee **230** and the peripheral **210** are already provisioned with a persistent key to be utilized for persistent pairing. Thus, at **1112**, the dockee **230** and the peripheral **210** may undergo authentication and association to establish a session key for the current pairing session, and at **1114** they may engage in a 4-way handshake.

[0108] At this time, the dockee **230** and the peripheral **210** are paired, and thus, in an aspect of the disclosure (as described above at **1102**), at **1116** a direct pairing complete indication may be transmitted from the dockee **230** to the docking host **220**, as well as a direct pairing complete indication may be transmitted from the peripheral **210** to the docking host **220** to inform the docking host **220** that the dockee **230** and the peripheral **210** are directly paired, and thus, the docking host **220** need not act as an intermediate host between the dockee **230** and the peripheral **210**. Thereafter, data **1118** may be transferred directly between the dockee **230** and the docking host **210** utilizing the direct communication link **506**.

[0109] Several aspects of a wireless docking system have been presented with reference to a system utilizing IEEE 802.11 "Wi-Fi" communication protocols. As those skilled in the art will readily appreciate, various aspects described throughout this disclosure may be extended to other communication systems, network architectures and communication standards. The actual telecommunication standard, network architecture, and/or communication standard employed will depend on the specific application and the overall design constraints imposed on the system.

[0110] It is to be understood that the specific order or hierarchy of steps in the methods disclosed is an illustration of exemplary processes. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the methods may be rearranged. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented unless specifically recited therein.

[0111] The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but are to be accorded the full scope consistent with the language of the claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more. A phrase referring to "at least one of" a list of items refers to any combination of those items, including single members. As an example, "at least one of: a, b, or c" is intended to cover: a; b; c; a and b; a and c; b and c; and a, b and c. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed under the provisions of 35 U.S.C. §112, sixth paragraph, unless the element is expressly recited using the phrase "means for" or, in the case of a method claim, the element is recited using the phrase "step for."

What is claimed is:

1. A method operable at a docking host for direct pairing between a dockee and a peripheral paired with the docking host, the method comprising:
- establishing a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host;
- establishing a second communication link with the dockee such that the dockee is a P2P client of the docking host; and
- transmitting information to the dockee over the second communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral.

2. The method of claim **1**, further comprising:
- severing the first communication link with the peripheral.

3. The method of claim **1**, further comprising:
- broadcasting an advertisement message indicating TDLS as a payload connection option.

4. The method of claim **3**, further comprising:
- receiving a request from the dockee to utilize TDLS as its payload connection type for direct communication with the peripheral.

5. A method operable at a dockee for direct pairing with a peripheral in a docking environment managed by a docking host, the method comprising:
- establishing a first communication link with the docking host such that the docking host is a P2P group owner (GO) and the dockee is a P2P client of the docking host;
- receiving information from the docking host over the first communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral; and
- establishing a second communication link with the peripheral utilizing TDLS in accordance with the received information.

6. The method of claim **5**, further comprising:
- receiving a broadcasted advertisement message from the docking host indicating TDLS as a payload connection option.

7. The method of claim **5**, further comprising:
- transmitting a request to the docking host to utilize TDLS as a payload connection type for direct communication with the peripheral.

8. A method operable at a docking host for direct pairing between a dockee and a peripheral paired with the docking host, the method comprising:
- establishing a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host;
- establishing a second communication link with the dockee such that the dockee is a P2P GO and the docking host is a P2P client of the dockee; and

receiving a request from the dockee over the second communication link for information enabling establishment of a direct pairing between the dockee and the peripheral.

9. The method of claim **8**, further comprising:

severing the first communication link with the peripheral.

10. The method of claim **9**, further comprising:

transmitting a docking host-assigned direct link expiration time over the first communication link to the peripheral, prior to the severing of the first communication link; and

re-establishing the first communication link with the peripheral when the expiration time passes without the dockee establishing the direct pairing with the peripheral.

11. The method of claim **8**, further comprising:

receiving a request from the dockee over the second communication link for a PIN corresponding to the peripheral;

transmitting a request to the peripheral over the first communication link for the PIN;

receiving the PIN from the peripheral over the first communication link; and

transmitting the PIN to the dockee over the second communication link.

12. The method of claim **8**, further comprising:

generating credential information corresponding to a direct pairing between the dockee and the peripheral; and

transmitting the credential information to the dockee and to the peripheral, such that the dockee and the peripheral are enabled to directly, securely communicate with one another utilizing the generated credential information.

13. The method of claim **12**, wherein the credential information comprises a dynamically generated PIN corresponding to the peripheral, such that the dockee is enabled to invite the peripheral to join its P2P group and utilize a PIN-based Wi-Fi Simple Configuration procedure utilizing the dynamically generated PIN.

14. The method of claim **8**, further comprising:

transmitting one or more of P2P Group Credentials, a P2P Group ID, or a P2P Group Operating Channel corresponding to the dockee, to the peripheral, such that the peripheral is enabled to connect to the dockee as a P2P client connects to a P2P group owner.

15. The method of claim **8**, further comprising:

transmitting an SSID and a P2P group credential corresponding to the dockee, to the peripheral, such that the peripheral is enabled to establish a direct communication link with the peripheral.

16. A method operable at a dockee for direct pairing with a peripheral in a docking environment managed by a docking host, the method comprising:

establishing a first communication link with the docking host such that the dockee is a P2P group owner (GO) and the docking host is a P2P client of the dockee;

transmitting a request to the docking host over the first communication link for information enabling establishment of a direct pairing between the dockee and the peripheral; and

establishing a second communication link with the peripheral in accordance with the received information.

17. The method of claim **16**, further comprising:

transmitting a request to the docking host over the first communication link for a PIN corresponding to the peripheral; and

receiving the PIN from the docking host over the first communication link.

18. The method of claim **16**, further comprising:

receiving credential information generated by the docking host, from the docking host over the first communication link, wherein the credential information corresponds to a direct pairing between the dockee and the peripheral,

wherein the establishing of the second communication link with the peripheral utilizes the received credential information.

19. The method of claim **18**, wherein the credential information comprises a dynamically generated PIN corresponding to the peripheral,

wherein the establishing of the second communication link with the peripheral comprises inviting the peripheral to join its P2P group and utilize a PIN-based Wi-Fi Simple Configuration procedure utilizing the dynamically generated PIN.

20. The method of claim **16**, further comprising:

receiving one or more of P2P Group Credentials, a P2P Group ID, or a P2P Group Operating Channel corresponding to the dockee, from the docking host,

wherein the establishing of the second communication link with the peripheral comprises connecting to the dockee as a P2P client connects to a P2P group owner.

21. The method of claim **16**, wherein the establishing of the second communication link with the peripheral comprises receiving P2P Group Credentials from the peripheral, and utilizing the received P2P Group Credentials to establish the direct communication link with the dockee.

22. A method operable at a dockee for direct pairing with a peripheral in a docking environment managed by a docking host, the method comprising:

establishing an initial docking session with the docking host;

receiving information from the docking host to enable a direct pairing between the dockee and the peripheral;

communicating with the peripheral to obtain a persistent key adapted to enable a persistent direct pairing between the dockee and the peripheral; and

communicating with the peripheral to obtain a session key adapted to enable secure communication during a first direct pairing session.

23. The method of claim **22**, further comprising:

establishing the direct pairing between the dockee and the peripheral utilizing the session key; and

transmitting a direct pairing complete indication to the docking host.

24. The method of claim **23**, further comprising:

ending the initial docking session and ending the direct pairing between the dockee and the peripheral;

initiating a subsequent docking session with the docking host; and

utilizing the persistent key to enable a subsequent direct pairing between the dockee and the peripheral.

25. A method operable at a docking host for direct pairing between a dockee and a peripheral paired with the docking host, the method comprising:

establishing a docking session with the dockee;

transmitting information to the dockee to enable a direct pairing between the dockee and the peripheral;

determining that the dockee and the peripheral have engaged in direct pairing in a prior docking session; and

transmitting a request for direct pairing to at least one of the peripheral or the dockee.

26. The method of claim **25**, further comprising:

receiving a direct pairing complete indication from at least one of the dockee or the peripheral.

27. A docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, comprising:

at least one processor;

a transceiver communicatively coupled to the at least one processor; and

a memory communicatively coupled to the at least one processor,

wherein the at least one processor is configured to:

establish a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host;

establish a second communication link with the dockee such that the dockee is a P2P client of the docking host; and

transmit information to the dockee over the second communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral.

28. The docking host of claim **27**, wherein the at least one processor is further configured to sever the first communication link with the peripheral.

29. The docking host of claim **27**, wherein the at least one processor is further configured to broadcast an advertisement message indicating TDLS as a payload connection option.

30. The docking host of claim **29**, wherein the at least one processor is further configured to receive a request from the dockee to utilize TDLS as its payload connection type for direct communication with the peripheral.

31. A dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, comprising:

at least one processor;

a transceiver communicatively coupled to the at least one processor; and

a memory communicatively coupled to the at least one processor,

wherein the at least one processor is configured to:

establish a first communication link with the docking host such that the docking host is a P2P group owner (GO) and the dockee is a P2P client of the docking host;

receive information from the docking host over the first communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral; and

establish a second communication link with the peripheral utilizing TDLS in accordance with the received information.

32. The dockee of claim **31**, wherein the at least one processor is further configured to receive a broadcasted advertisement message from the docking host indicating TDLS as a payload connection option.

33. The dockee of claim **31**, wherein the at least one processor is further configured to transmit a request to the docking host to utilize TDLS as a payload connection type for direct communication with the peripheral.

34. A docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, comprising:

at least one processor;

a transceiver communicatively coupled to the at least one processor; and

a memory communicatively coupled to the at least one processor,

wherein the at least one processor is configured to:

establish a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host;

establish a second communication link with the dockee such that the dockee is a P2P GO and the docking host is a P2P client of the dockee; and

receive a request from the dockee over the second communication link for information enabling establishment of a direct pairing between the dockee and the peripheral.

35. The docking host of claim **34**, wherein the at least one processor is further configured to sever the first communication link with the peripheral.

36. The docking host of claim **35**, wherein the at least one processor is further configured to:

transmit a docking host-assigned direct link expiration time over the first communication link to the peripheral, prior to the severing of the first communication link; and

re-establish the first communication link with the peripheral when the expiration time passes without the dockee establishing the direct pairing with the peripheral.

37. The docking host of claim **34**, wherein the at least one processor is further configured to:

receive a request from the dockee over the second communication link for a PIN corresponding to the peripheral;

transmit a request to the peripheral over the first communication link for the PIN;

receive the PIN from the peripheral over the first communication link; and

transmit the PIN to the dockee over the second communication link.

38. The docking host of claim **34**, wherein the at least one processor is further configured to:

generate credential information corresponding to a direct pairing between the dockee and the peripheral; and

transmit the credential information to the dockee and to the peripheral, such that the dockee and the peripheral are enabled to directly, securely communicate with one another utilizing the generated credential information.

39. The docking host of claim **38**, wherein the credential information comprises a dynamically generated PIN corresponding to the peripheral, such that the dockee is enabled to invite the peripheral to join its P2P group and utilize a PIN-based Wi-Fi Simple Configuration procedure utilizing the dynamically generated PIN.

40. The docking host of claim **34**, wherein the at least one processor is further configured to transmit one or more of P2P Group Credentials, a P2P Group ID, or a P2P Group Operating Channel corresponding to the dockee, to the peripheral, such that the peripheral is enabled to connect to the dockee as a P2P client connects to a P2P group owner.

41. The docking host of claim **34**, wherein the at least one processor is further configured to transmit an SSID and a P2P group credential corresponding to the dockee, to the periph-

eral, such that the peripheral is enabled to establish a direct communication link with the peripheral.

42. A dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, comprising:

at least one processor;

a transceiver communicatively coupled to the at least one processor; and

a memory communicatively coupled to the at least one processor,

wherein the at least one processor is configured to:

establish a first communication link with the docking host such that the dockee is a P2P group owner (GO) and the docking host is a P2P client of the dockee;

transmit a request to the docking host over the first communication link for information enabling establishment of a direct pairing between the dockee and the peripheral; and

establish a second communication link with the peripheral in accordance with the received information.

43. The dockee of claim **42**, wherein the at least one processor is further configured to:

transmit a request to the docking host over the first communication link for a PIN corresponding to the peripheral; and

receive the PIN from the docking host over the first communication link.

44. The dockee of claim **42**, wherein the at least one processor is further configured to:

receive credential information generated by the docking host, from the docking host over the first communication link, wherein the credential information corresponds to a direct pairing between the dockee and the peripheral,

wherein the establishing of the second communication link with the peripheral utilizes the received credential information.

45. The dockee of claim **44**, wherein the credential information comprises a dynamically generated PIN corresponding to the peripheral,

wherein the establishing of the second communication link with the peripheral comprises inviting the peripheral to join its P2P group and utilize a PIN-based Wi-Fi Simple Configuration procedure utilizing the dynamically generated PIN.

46. The dockee of claim **42**, wherein the at least one processor is further configured to:

receive one or more of P2P Group Credentials, a P2P Group ID, or a P2P Group Operating Channel corresponding to the dockee, from the docking host,

wherein the establishing of the second communication link with the peripheral comprises connecting to the dockee as a P2P client connects to a P2P group owner.

47. The dockee of claim **42**, wherein the wherein the at least one processor, being configured to establish the second communication link with the peripheral, is further configured to receive P2P Group Credentials from the peripheral, and utilizing the received P2P Group Credentials to establish the direct communication link with the dockee.

48. A dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, comprising:

at least one processor;

a transceiver communicatively coupled to the at least one processor; and

a memory communicatively coupled to the at least one processor,

wherein the at least one processor is configured to:

establish an initial docking session with the docking host;

receive information from the docking host to enable a direct pairing between the dockee and the peripheral;

communicate with the peripheral to obtain a persistent key adapted to enable a persistent direct pairing between the dockee and the peripheral; and

communicate with the peripheral to obtain a session key adapted to enable secure communication during a first direct pairing session.

49. The dockee of claim **48**, wherein the at least one processor is further configured to:

establish the direct pairing between the dockee and the peripheral utilizing the session key; and

transmit a direct pairing complete indication to the docking host.

50. The dockee of claim **49**, wherein the at least one processor is further configured to:

end the initial docking session and ending the direct pairing between the dockee and the peripheral;

initiate a subsequent docking session with the docking host; and

utilize the persistent key to enable a subsequent direct pairing between the dockee and the peripheral.

51. A docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, comprising:

at least one processor;

a transceiver communicatively coupled to the at least one processor; and

a memory communicatively coupled to the at least one processor,

wherein the at least one processor is configured to:

establish a docking session with the dockee;

transmit information to the dockee to enable a direct pairing between the dockee and the peripheral;

determine that the dockee and the peripheral have engaged in direct pairing in a prior docking session; and

transmit a request for direct pairing to at least one of the peripheral or the dockee.

52. The docking host of claim **51**, wherein the at least one processor is further configured to receive a direct pairing complete indication from at least one of the dockee or the peripheral.

53. A docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, comprising:

means for establishing a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host;

means for establishing a second communication link with the dockee such that the dockee is a P2P client of the docking host; and

means for transmitting information to the dockee over the second communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral.

54. A dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, comprising:

means for establishing a first communication link with the docking host such that the docking host is a P2P group owner (GO) and the dockee is a P2P client of the docking host;

means for receiving information from the docking host over the first communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral; and

means for establishing a second communication link with the peripheral utilizing TDLS in accordance with the received information.

55. A docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, comprising:

means for establishing a first communication link with the peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host;

means for establishing a second communication link with the dockee such that the dockee is a P2P GO and the docking host is a P2P client of the dockee; and

means for receiving a request from the dockee over the second communication link for information enabling establishment of a direct pairing between the dockee and the peripheral.

56. A dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, comprising:

means for establishing a first communication link with the docking host such that the dockee is a P2P group owner (GO) and the docking host is a P2P client of the dockee;

means for transmitting a request to the docking host over the first communication link for information enabling establishment of a direct pairing between the dockee and the peripheral; and

means for establishing a second communication link with the peripheral in accordance with the received information.

57. A dockee configured for direct pairing with a peripheral in a docking environment managed by a docking host, comprising:

means for establishing an initial docking session with the docking host;

means for receiving information from the docking host to enable a direct pairing between the dockee and the peripheral;

means for communicating with the peripheral to obtain a persistent key adapted to enable a persistent direct pairing between the dockee and the peripheral; and

means for communicating with the peripheral to obtain a session key adapted to enable secure communication during a first direct pairing session.

58. A docking host configured for direct pairing between a dockee and a peripheral paired with the docking host, comprising:

means for establishing a docking session with the dockee;

means for transmitting information to the dockee to enable a direct pairing between the dockee and the peripheral;

means for determining that the dockee and the peripheral have engaged in direct pairing in a prior docking session; and

means for transmitting a request for direct pairing to at least one of the peripheral or the dockee.

59. A computer-readable storage medium comprising instructions for causing a computer at a docking host to:

establish a first communication link with a peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host;

establish a second communication link with a dockee such that the dockee is a P2P client of the docking host; and

transmit information to the dockee over the second communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with the peripheral.

60. A computer-readable storage medium comprising instructions for causing a computer at a dockee to:

establish a first communication link with a docking host such that the docking host is a P2P group owner (GO) and the dockee is a P2P client of the docking host;

receive information from the docking host over the first communication link to enable the dockee to establish a tunneled direct link setup (TDLS) connection with a peripheral; and

establish a second communication link with the peripheral utilizing TDLS in accordance with the received information.

61. A computer-readable storage medium comprising instructions for causing a computer at a docking host to:

establish a first communication link with a peripheral such that the docking host is a P2P group owner (GO) and the peripheral is a P2P client of the docking host;

establish a second communication link with a dockee such that the dockee is a P2P GO and the docking host is a P2P client of the dockee; and

receive a request from the dockee over the second communication link for information enabling establishment of a direct pairing between the dockee and the peripheral.

62. A computer-readable storage medium comprising instructions for causing a computer at a dockee to:

establish a first communication link with a docking host such that the dockee is a P2P group owner (GO) and the docking host is a P2P client of the dockee;

transmit a request to the docking host over the first communication link for information enabling establishment of a direct pairing between the dockee and a peripheral; and

establish a second communication link with the peripheral in accordance with the received information.

63. A computer-readable storage medium comprising instructions for causing a computer at a dockee to:

establish an initial docking session with a docking host;

receive information from the docking host to enable a direct pairing between the dockee and a peripheral;

communicate with the peripheral to obtain a persistent key adapted to enable a persistent direct pairing between the dockee and the peripheral; and

communicate with the peripheral to obtain a session key adapted to enable secure communication during a first direct pairing session.

64. A computer-readable storage medium comprising instructions for causing a computer at a docking host to:

establish a docking session with a dockee;

transmit information to the dockee to enable a direct pairing between the dockee and a peripheral;

determine that the dockee and the peripheral have engaged in direct pairing in a prior docking session; and

transmit a request for direct pairing to at least one of the peripheral or the dockee.

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