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(54) DEVICE HANDING OVER COMMUNICATION SESSION FROM WIRELESS COMMUNICATION TO POWERLINE COMMUNICATION

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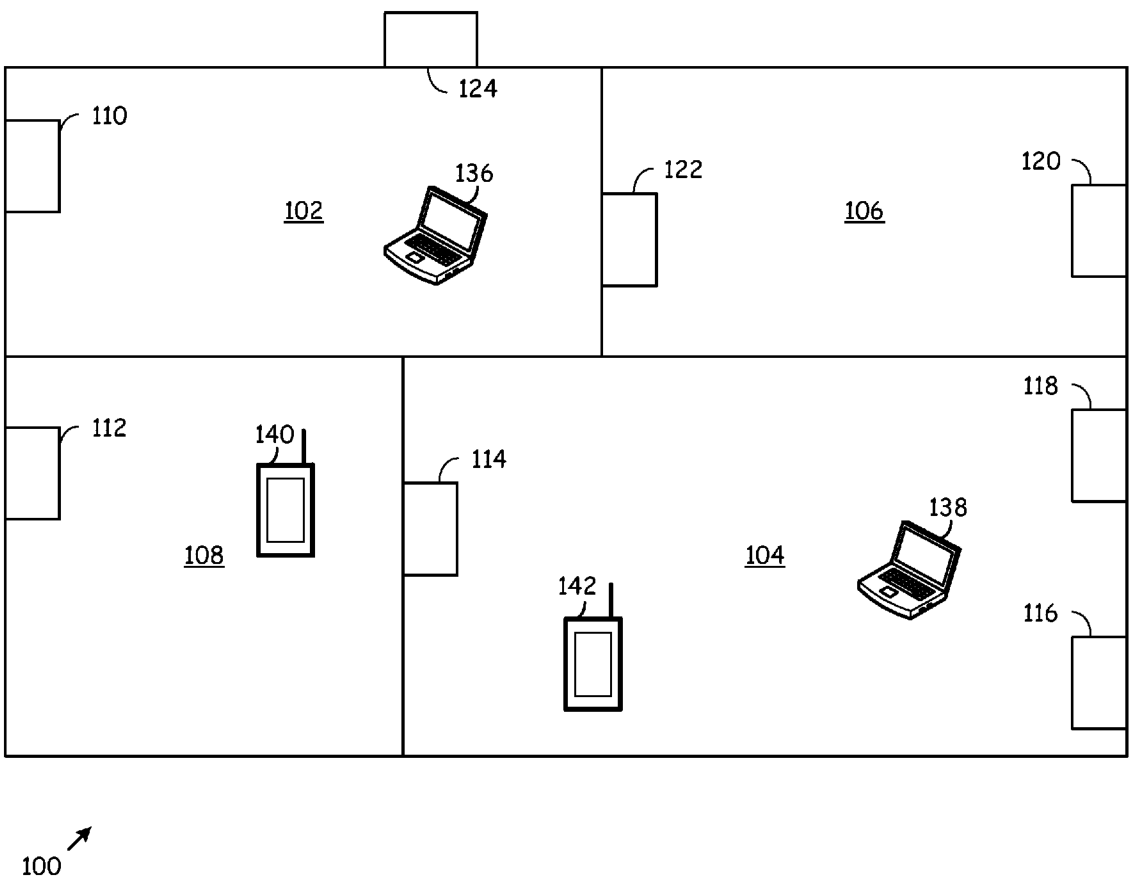
H04W 84/02 (2009.01)

(52) **U.S. Cl.** **370/331**

(57) **ABSTRACT**

A mobile communication device includes a wired interface operable to support Power Line Communications (PLC), a wireless interface, a processing module, and memory. The device establishes a wireless communication link to service a communication session, detects availability of PLC communication path, and at least partially hands over the communication session from the wireless interface to the wired interface. A PLC interface (and power converter) may couple to the wired interface to support the PLC communication path. In at least partially handing over the communication session from the wireless interface to the wired interface, the device terminates the wireless communication and services the communication session via the wired communication interface and the PLC communication path. Alternately the device services a first portion of the communication session via the wireless communication interface and services a second portion of the communication session via the wired communication interface and the PLC communication path.



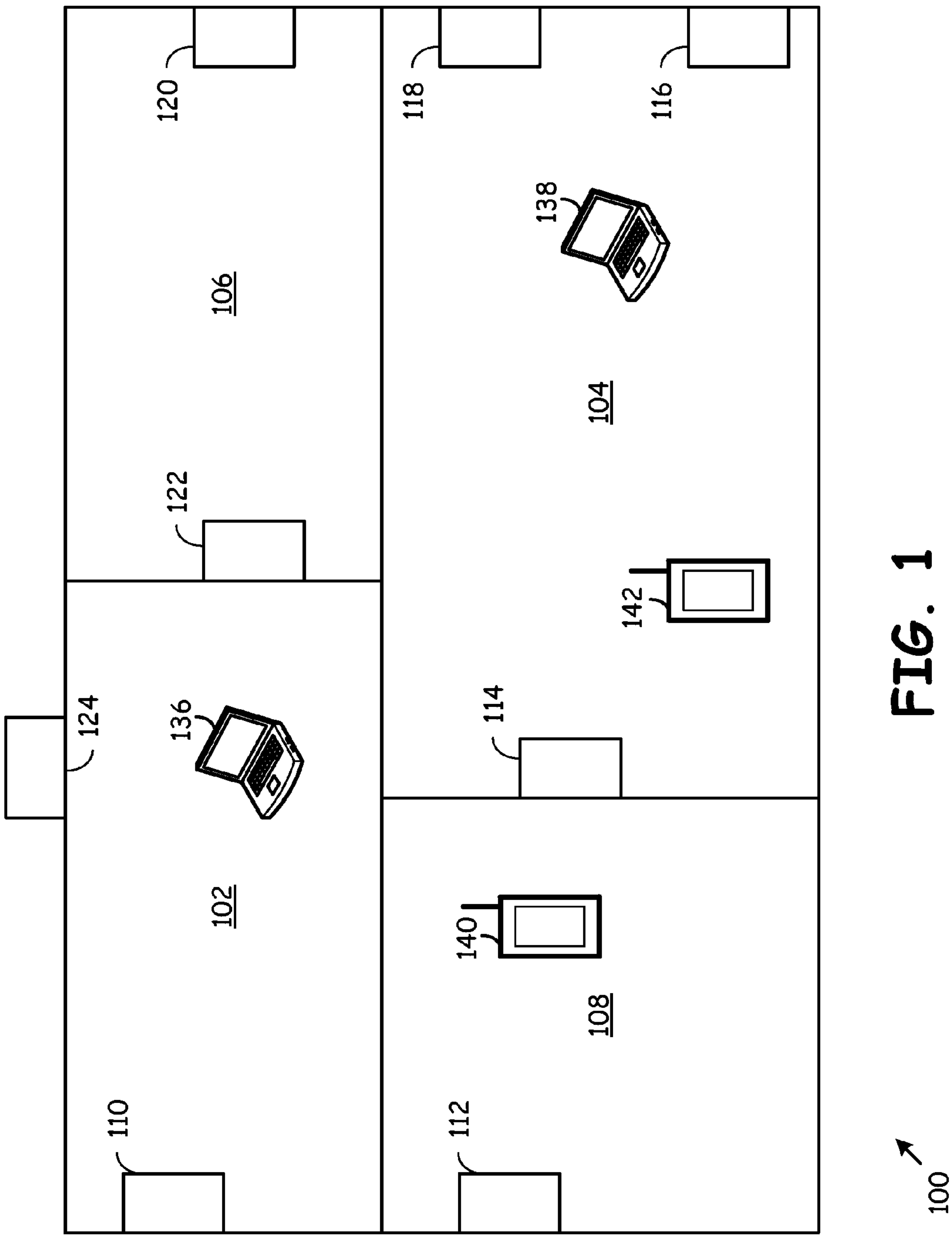

100
102
104
106
108
110
112
114
116
118
120
122
124
136
138
140
142

FIG. 1

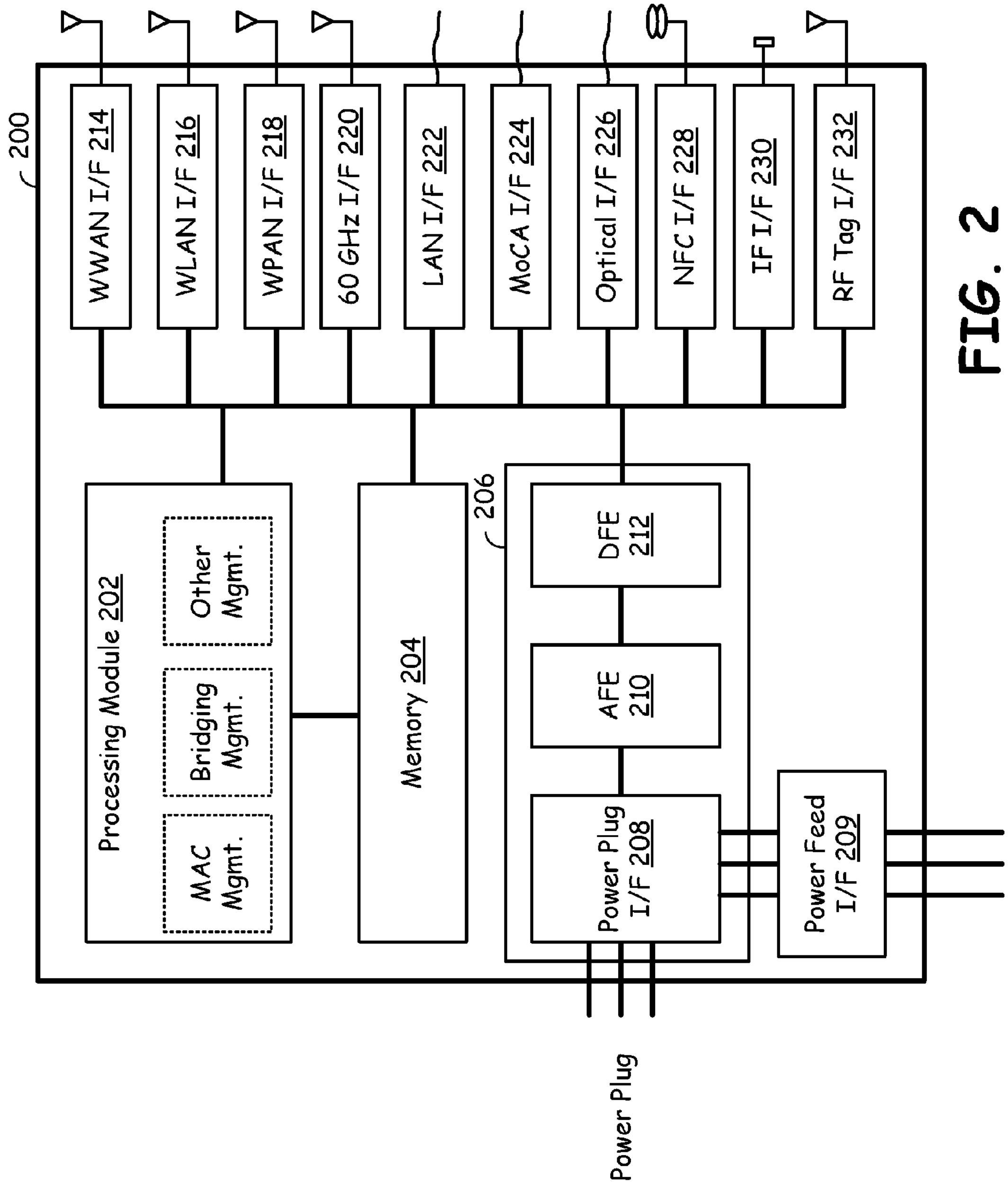

200
WWAN I/F 214
WLAN I/F 216
WPAN I/F 218
60 GHz I/F 220
LAN I/F 222
MoCA I/F 224
Optical I/F 226
NFC I/F 228
IF I/F 230
RF Tag I/F 232
Processing Module 202
MAC Mgmt.
Bridging Mgmt.
Other Mgmt.
Memory 204
206
DFE 212
AFE 210
Power Plug I/F 208
Power Feed I/F 209
Power Plug

FIG. 2

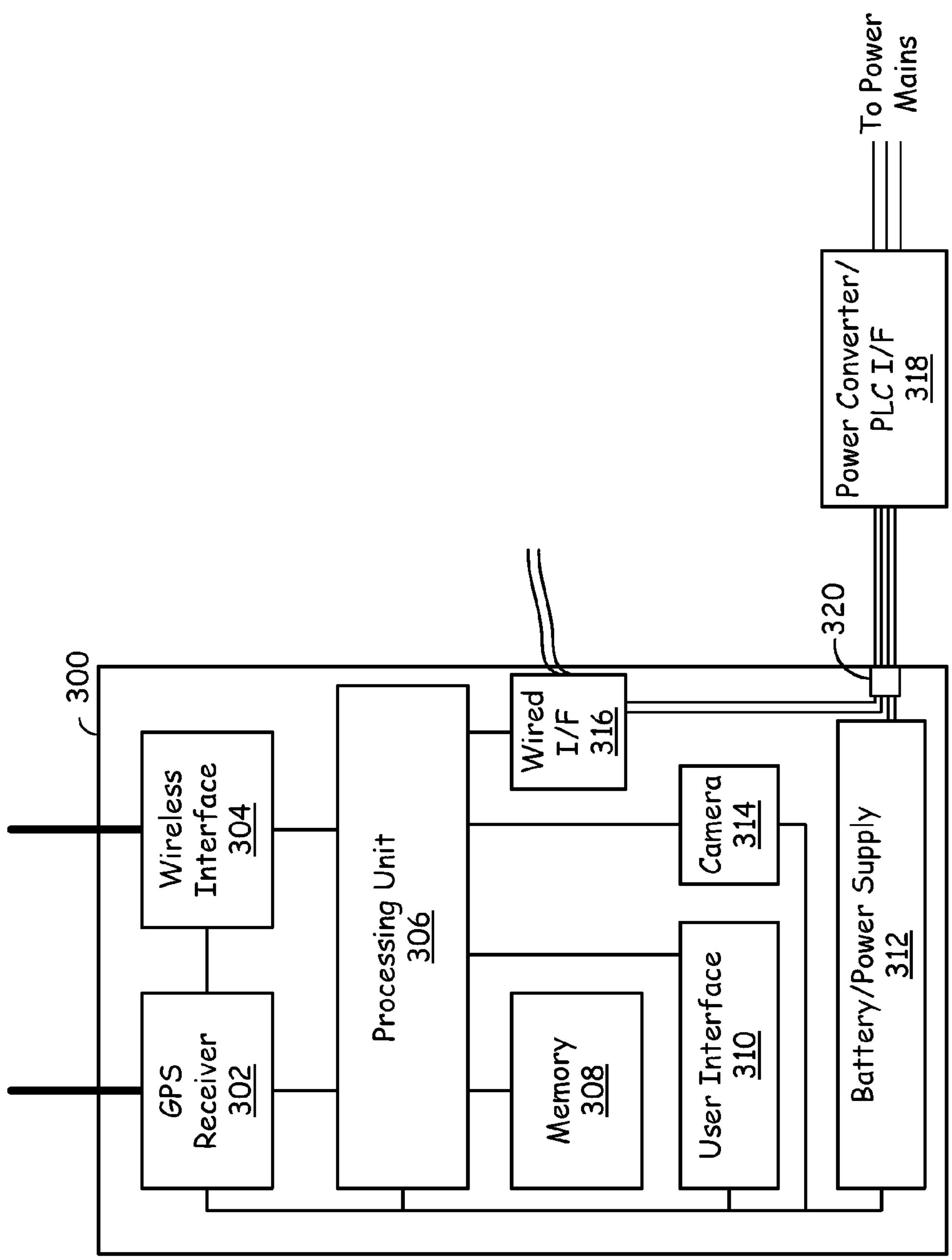

300
GPS Receiver 302
Wireless Interface 304
Processing Unit 306
Memory 308
User Interface 310
Battery/Power Supply 312
Camera 314
Wired I/F 316
Power Converter/ PLC I/F 318
320
To Power Mains

FIG. 3

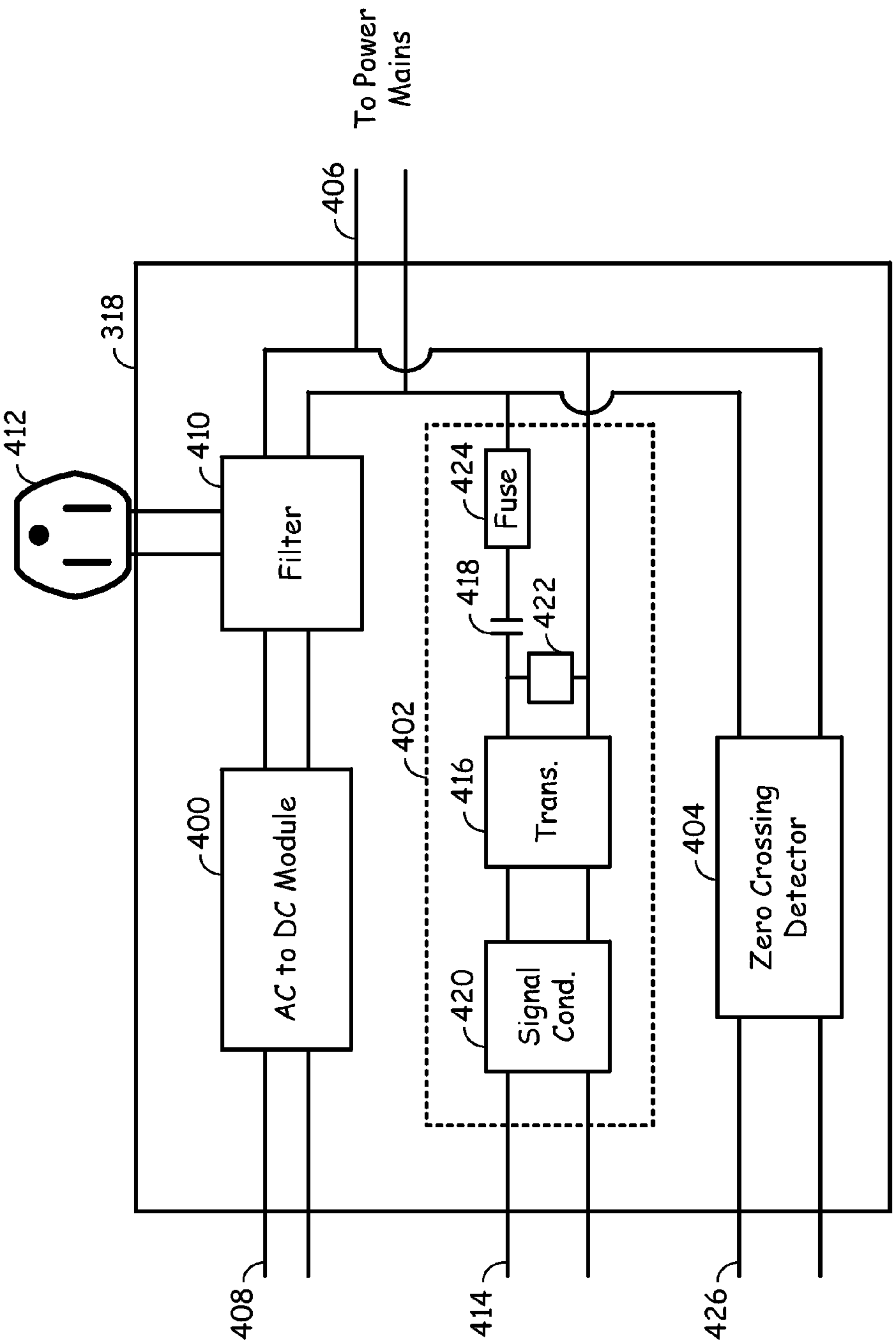

To Power Mains
406
318
412
410
Filter
424
Fuse
418
422
402
416
Trans.
400
AC to DC Module
420
Signal Cond.
404
Zero Crossing Detector
408
414
426

FIG. 4

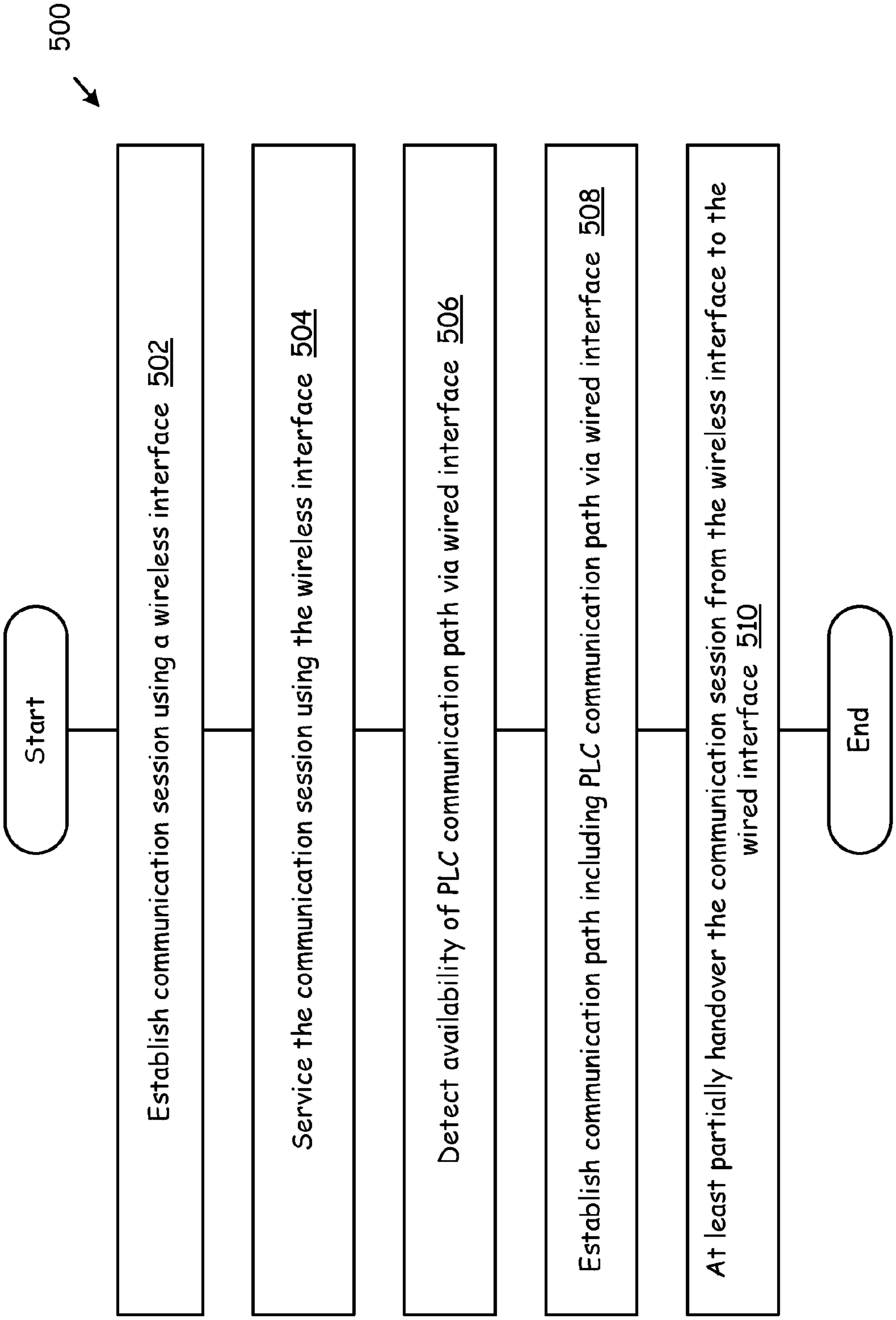

500
Start
Establish communication session using a wireless interface 502
Service the communication session using the wireless interface 504
Detect availability of PLC communication path via wired interface 506
Establish communication path including PLC communication path via wired interface 508
At least partially handover the communication session from the wireless interface to the wired interface 510
End

FIG. 5

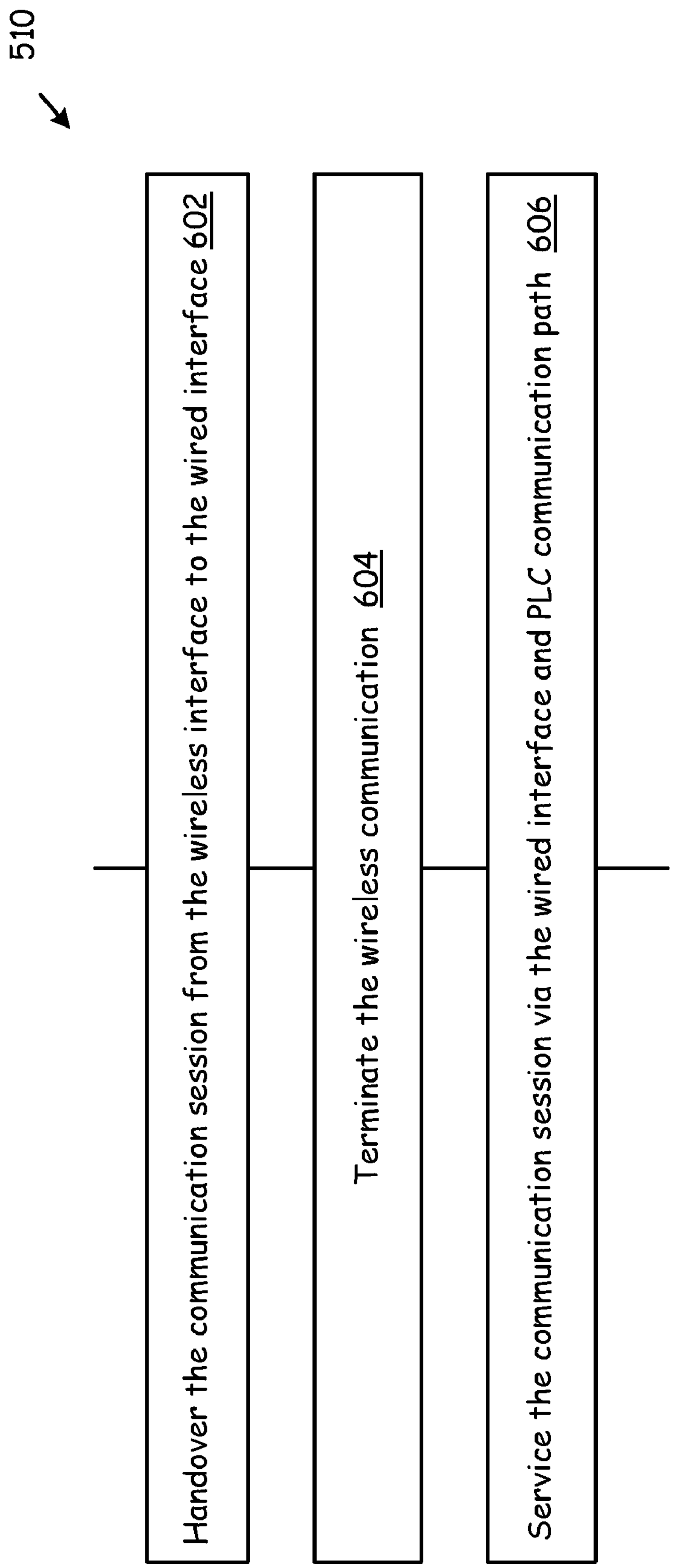

510
Handover the communication session from the wireless interface to the wired interface 602
Terminate the wireless communication 604
Service the communication session via the wired interface and PLC communication path 606

FIG. 6

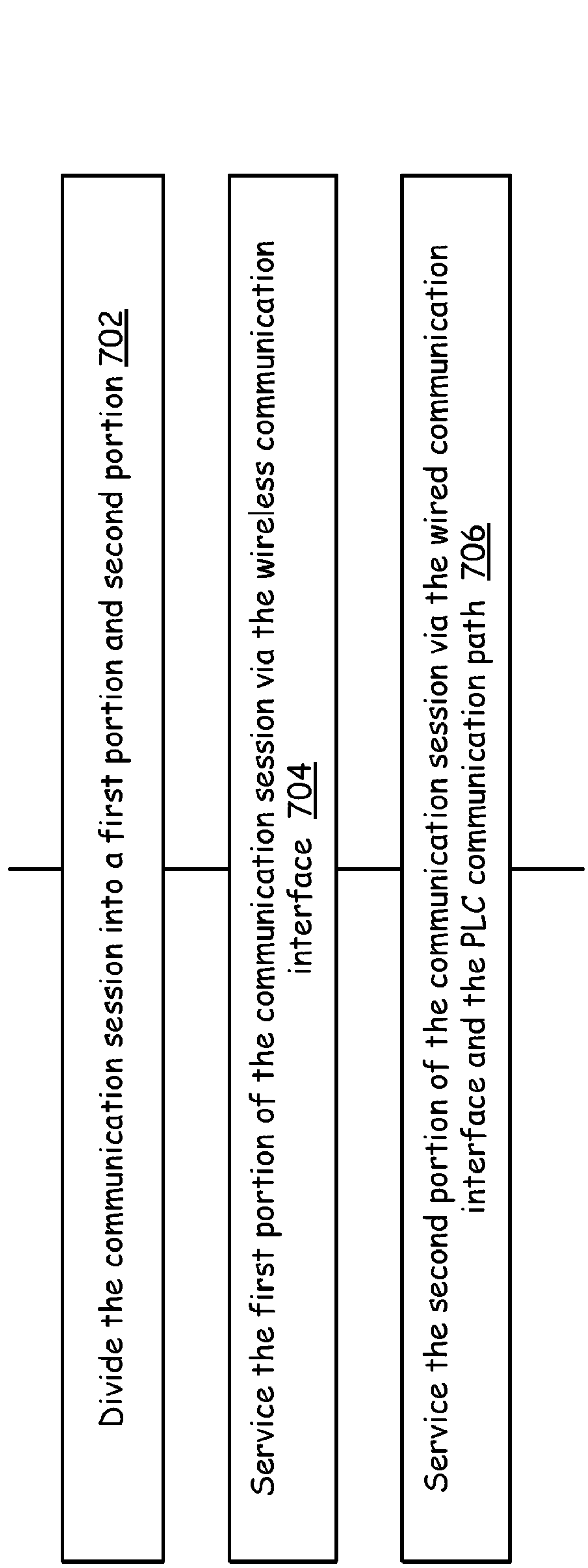

510
Divide the communication session into a first portion and second portion 702
Service the first portion of the communication session via the wireless communication interface 704
Service the second portion of the communication session via the wired communication interface and the PLC communication path 706

FIG. 7

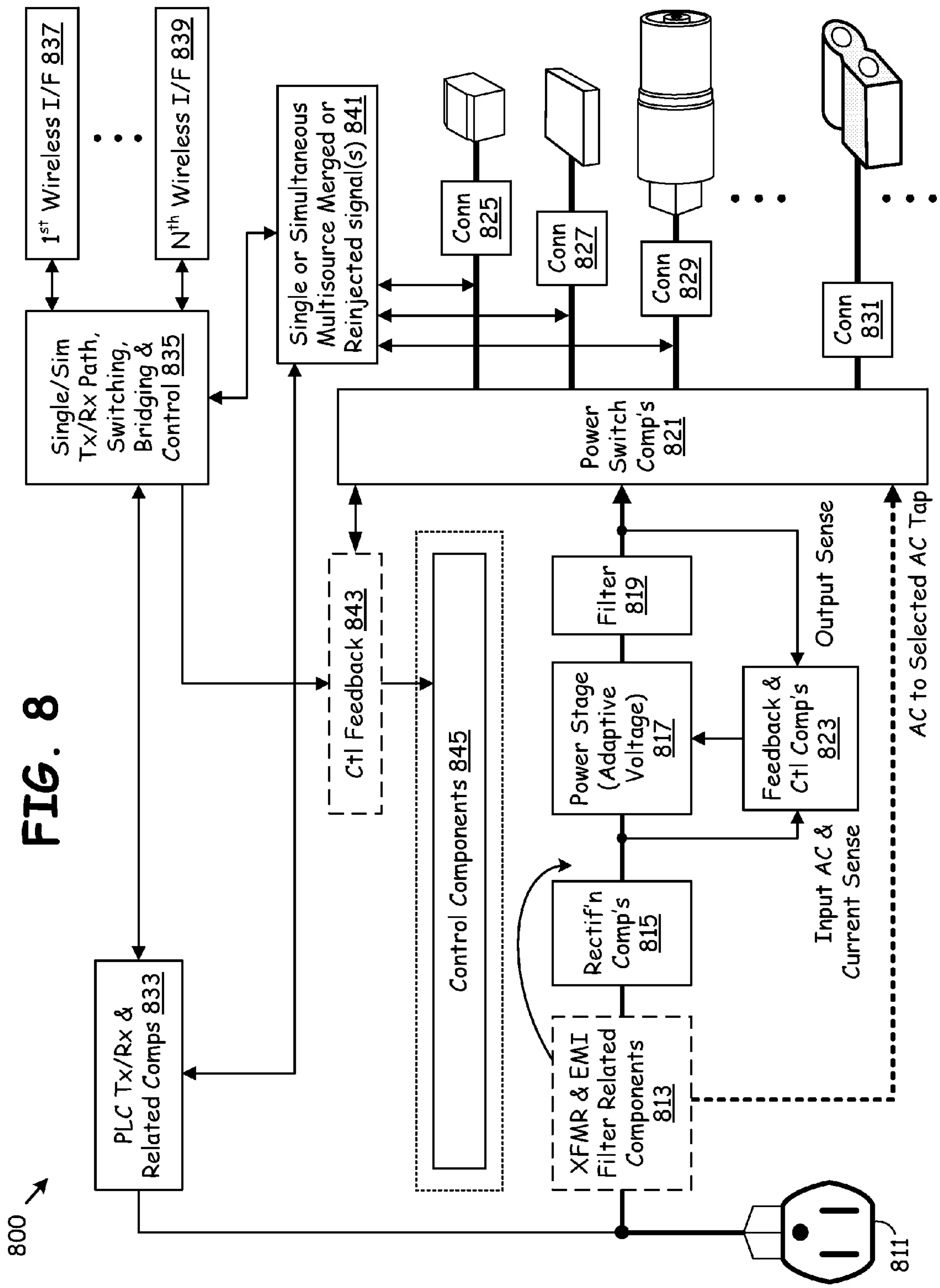

800
1st Wireless I/F 837
Nth Wireless I/F 839
Single/Sim Tx/Rx Path, Switching, Bridging & Control 835
Single or Simultaneous Multisource Merged or Reinjected signal(s) 841
Conn 825
Conn 827
Conn 829
Conn 831
Power Switch Comp's 821
Ctl Feedback 843
Control Components 845
Filter 819
Power Stage (Adaptive Voltage) 817
Feedback & Ctl Comp's 823
Output Sense
AC to Selected AC Tap
Rectif'n Comp's 815
Input AC & Current Sense
XFMR & EMI Filter Related Components 813
PLC Tx/Rx & Related Comps 833
811

FIG. 8

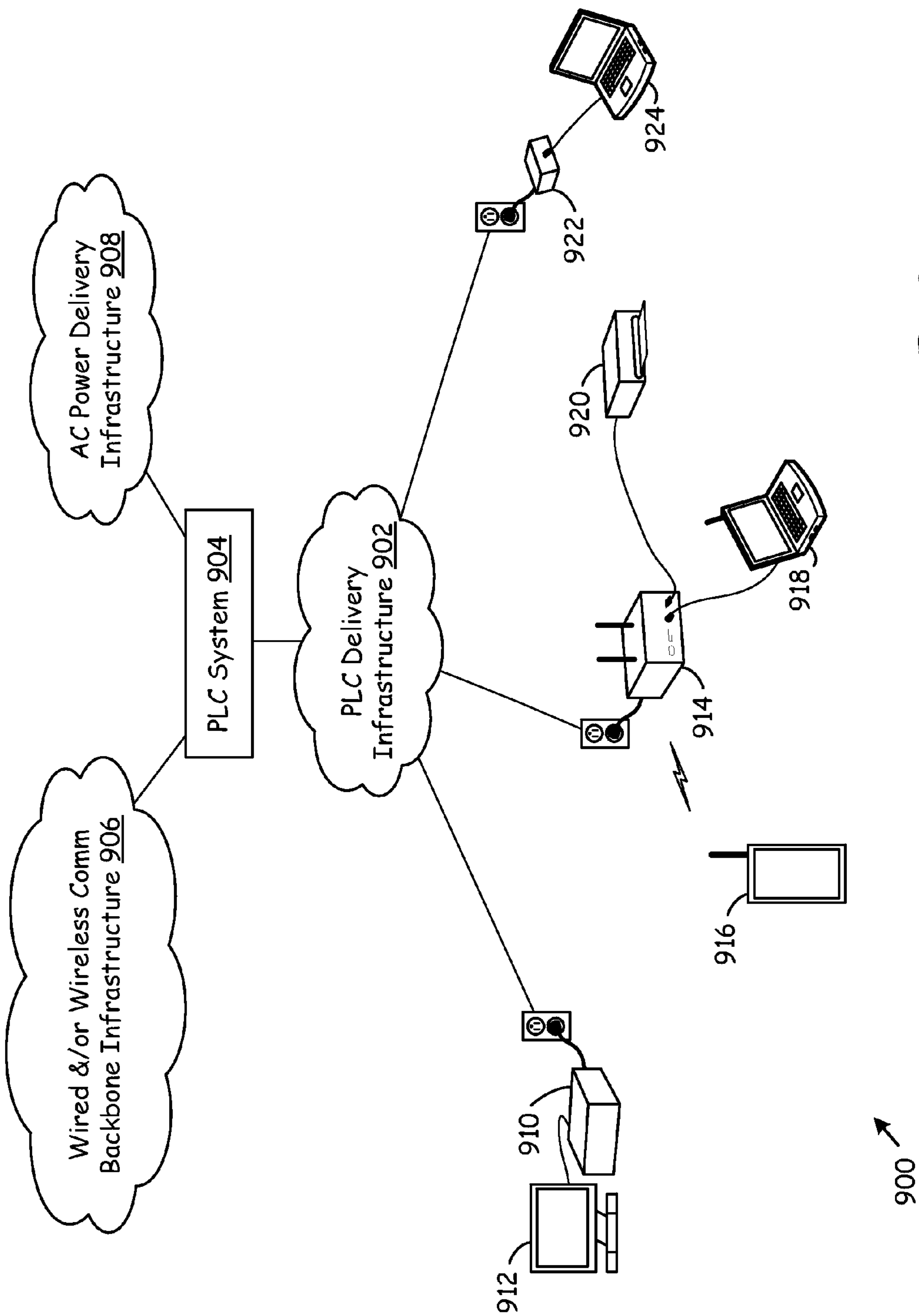

AC Power Delivery Infrastructure 908
Wired &/or Wireless Comm Backbone Infrastructure 906
PLC System 904
PLC Delivery Infrastructure 902
910
912
914
916
918
920
922
924
900

FIG. 9

DEVICE HANDING OVER COMMUNICATION SESSION FROM WIRELESS COMMUNICATION TO POWERLINE COMMUNICATION

CROSS-REFERENCE TO PRIORITY APPLICATION

[0001] This application claims priority under 35 U.S.C. §119(e) to U.S. Provisional Application Ser. No. 61/503,060 filed Jun. 30, 2011, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to powerline communications and in particular, powerline communication devices, and systems of use therefore.

[0004] 2. Description of the Related Art

[0005] With the growing need for the exchange of digital content (e.g. MP3 audio, MPEG4 video and digital photographs) there is a widely recognized need to improve digital communication systems. Powerline communication (PLC) is a technology that encodes data in a signal and transmits the signal on existing electricity powerlines in a band of frequencies that are not used for supplying electricity. Accordingly, PLC leverages the ubiquity of existing electricity networks to provide extensive network coverage. Furthermore, since PLC enables data to be accessed from conventional power-outlets, no new wiring needs to be installed in a building (or different parts of a building). Accordingly, PLC offers the additional advantage of reduced installation costs.

[0006] Communications within a household or within other premises may also be serviced by a Wireless Local Area Network (WLAN), a cellular network, millimeter wave communications, e.g., 60 GHz, Wireless Personal Area Network (WPAN), Cable Modem Network, Local Area Network (LAN), and other communication techniques. Each of these communication types has its respective benefits and shortcomings. None of these communication types is typically able to provide a full coverage solution within the household (or other premises). The shortcoming of all wired technologies is the lack of mobility thereof. Shortcomings of all wireless technologies are coverage holes, which are typical, interference from other wireless devices, including competing wireless devices, Radar, etc., and bandwidth limitations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a system diagram illustrating a premises in which at least one Powerline Communication (PLC) device resides that operates according to one or more embodiments of the present invention;

[0008] FIG. **2** is a block diagram illustrating a PLC device constructed according to one or more embodiments of the present invention;

[0009] FIG. **3** is a block diagram illustrating a portable electronic device constructed according to the present invention;

[0010] FIG. **4** is a block diagram illustrating a power converter/PLC I/F including at least part of a communication interface that operates according to one or more embodiments of the present invention;

[0011] FIG. **5** is a flowchart illustrating operation according to one or more embodiments of the present invention;

[0012] FIG. **6** is a flowchart illustrating operation according to one or more embodiments of the operations of FIG. **5**;

[0013] FIG. **7** is a flowchart illustrating operation according to one or more embodiments of the operations of FIG. **5**;

[0014] FIG. **8** is a block diagram illustrating the construct of another power converter/PLC I/F that operates according to one or more embodiments of the present invention; and

[0015] FIG. **9** is a system diagram illustrating a plurality of PLC devices constructed and operating according to one or more embodiments of the present invention.

DETAILED DESCRIPTION

[0016] FIG. **1** is a system diagram illustrating a premises in which at least one Powerline Communication (PLC) device resides that operates according to one or more embodiments of the present invention. The premises **100** has a distributed mains wiring system (not shown) consisting of one or more ring mains, several stubs and some distribution back to a junction box. In other constructs the distributed mains wiring system has a breaker box with circuits routed there from in a star configuration. For the sake of example, the premises **100** has four areas **102**, **104**, **106**, and **108**, e.g., rooms. Each room **102**, **104**, **106**, and **108** may have a different number of outlets and other power mains connections. Accordingly, there are a variety of distances and paths between different power outlets in the household **100**. In particular, the outlets most closely located to each other are those on multi-plug strips, and the outlets furthest away from each other are those on the ends of stubs of different ring mains (e.g. power outlets in the garden shed and the attic). The majority of outlets associated with a particular application (e.g. Home Cinema) are normally located relatively close together.

[0017] Installed within the premises **100** are a plurality of PLC devices **110**, **112**, **114**, **116**, **118**, **120**, and **122**. Also installed in the premises is a PLC device serving as a Gateway **124** for communications services. Each of the PLC devices **110-122** illustrated has a structure same or similar to the structure described with reference to FIG. **2** and/or FIG. **4** and that operates according to the operations described with reference to FIGS. **5-7**. One or more of these PLC devices **110-122** may be a power adapter PLC I/F that services a coupled mobile communication device, e.g., laptop computer **136** or **138** and/or mobile handset **140** or **142**, which may be telephones, tablet computers, or other portable electronic devices.

[0018] According to a first aspect of the present invention, a mobile communication device, e.g., **136**, **138**, **140**, and/or **142** establishes a wireless communication link with at least one wirelessly coupled device to service a communication session via its wireless interface. This wireless communication link may be one or more of a Wireless Local Area Network (WLAN) communication link, a cellular communication link, a Wireless Wide Area Network (WWAN) communication, or a Millimeter Wave (MMW) communication link. This communication link may be serviced by a WLAN access point located in the premises or external to the premises (not shown) or a MMW access point located within one of the spaces **102**, **104**, **106**, or **108** of the premises **100**.

[0019] In its operation, upon being direct or indirectly coupled to the power mains, the mobile communications device detects availability of a PLC communication path via a wired interface. Then, the mobile communications device at least partially hands over the communication session from the wireless interface to the wired interface.

[0020] In a first embodiment, the mobile communications device couples to a power converter/PLC interface provided by the premises **100** owner/operator. This power converter/PLC interface may be a USB plug, fire wire plug, or another type of plug that supports both charging and communications and may serve as any or more of the PLC devices **110**-**122** of FIG. **1**. Alternately, the mobile communications device has the power converter/PLC interface included so that a user of the mobile communications device simply plugs in the mobile communications device to a plug in the premises **100**. In any case, by itself or via a coupled PLC interface, the mobile communication device may support communications according to a plurality of PLC communication standards. In such case, the mobile communications device may communicate with any of the PLC devices **110**-**122** of the premises **100** or devices outside of the premises that are accessible via the power mains.

[0021] In a first operation, at least partially handing over the communication session from the wireless interface to the wired interface includes terminating the wireless communication and servicing the communication session via the wired communication interface and the PLC communication path. In a second operation, at least partially handing over the communication session from the wireless interface to the wired interface includes servicing a first portion of the communication session via the wireless communication interface and servicing a second portion of the communication session via the wired communication interface and the PLC communication path.

[0022] In determining whether to fully or partially handover the communication session, the mobile communications device may consider data throughput requirements, available data throughput via the wireless link, available data throughput via the wired link (and PLC backbone), cost of each link, and other considerations. For example, a wireless cellular link may charge on the basis of usage with the PLC backbone communications being free. In this case, the communication session would be handed over to reduce cost. In another example, the mobile communications device is servicing a voice call and call quality suffers due to link quality. In this case, the communication session would be handed over to the PLC backbone based upon service quality. In still another operation, some portions of the communication session would be handed over to the PLC backbone while others would continue to be serviced via the wireless link.

[0023] FIG. **2** is a block diagram illustrating a PLC device constructed according to one or more embodiments of the present invention. The PLC device **200** supports PLC operations according to one or more PLC communication standards. The PLC device **200** may be coupled to a power plug, e.g., into a wall plug. The PLC device **200** may further include a power feed I/F **209** to provide switchable power to a coupled load device, e.g., device. In some embodiments, the PLC device **200** may be permanently installed within a home or other premises.

[0024] The PLC device **200** includes a PLC interface **206** that includes a power plug interface **208**, an Analog Front End (AFE) **210**, and a Digital Front End (DFE) **212**. Generally the AFE **210** includes analog signal processing elements while the DFE **212** includes digital signal processing elements. At least one Analog to Digital Converter (ADC) and at least one Digital to Analog Converter (DAC) service analog to digital and digital to analog signal conversion operations, respectively. Various components of the PLC interface **206** as they relate to embodiments of the present invention will be described further herein.

[0025] The PLC device **200** also includes one or more other communication interfaces, including a Wireless Wide Area Network (WWAN) interface **214**, e.g., a WiMAX interface, a Wireless Local Area Network (WLAN) interface **216**, e.g., an 802.11x interface, a Wireless Personal Area Network (WPAN) interface **218**, e.g., a Bluetooth interface, a 60 GHz interface **220** (millimeter wave interface), a Local Area Network (LAN) interface **222**, e.g., an Ethernet interface, a cable interface, e.g. Multimedia over Coax Alliance (MoCA) interface **224**, an optical interface **226**, a Near Field Communication (NFC) I/F **228**, an Infra-Red I/F **230**, and/or an RF Tag I/F **232**. The user should appreciate that the PLC device **200** may bridge communications between a power plug and one or more devices, e.g., between the power plug and a desktop computer, a laptop computer, a touchpad computer, an device, a television, another entertainment system device, etc., via the PLC interface **206** and one or more of the other communication interfaces **214**, **216**, **218**, **220**, **222**, **224**, **226**, **228**, **230**, and/or **232**.

[0026] The processing module **202** may include one or more of a system processor, a digital signal processor, a processing module, dedicated hardware, an application specific integrated circuit (ASIC), or other circuitry that is capable of executing software instructions and for processing data. In particular, the processing module **202** is operable to support Medium Access Control (MAC) management, communications bridging management, and other management of the communications circuitry of the PLC device **200**. The memory **204** may be RAM, ROM, FLASH RAM, FLASH ROM, optical memory, magnetic memory, or other types of memory that is capable of storing data and/or instructions and allowing processing circuitry to access same. The processing module **202** and the memory **204** supports operations of embodiments of the present invention as further described herein. These operations may be embodied in software instructions stored in the memory **204** and executed by the processing module **202**. The PLC device **200** of FIG. **2** supports the operations previously described with reference to FIG. **1** and that will be described further with reference to FIG. **5**-**7**.

[0027] FIG. **3** is a block diagram illustrating a portable electronic device constructed according to the present invention. The portable electronic device **300** includes a GPS receiver **302**, a wireless interface **304**, a processing unit **306**, memory **308**, user interface **310**, a battery/power supply **312**, a camera **314**, and a wired I/F **316**. The components of the portable electronic device **300** are typically contained within a hard case that provides protection from the elements. The wireless interface **304** will have particular structure and functionality based upon the type of the portable electronic device **300**. For example, when the portable electronic device **300** is a cellular telephone, the wireless interface **304** will support a corresponding interface standard e.g., GSM, GPRS, EDGE, UMTS, 1xRTT, 1xEV-DO, 1xEV-DV, LTE, etc. The wireless interface **304** of the cellular telephone **304** may also/alternately support WWAN, WLAN, and/or WPAN functionality. When the portable electronic device is a WLAN terminal for example, the wireless interface **304** will support standardized communication according to the IEEE 802.11x group of standards, for example. When the portable electronic device is a WPAN device, the wireless interface **304** supports the Bluetooth interface standard or another WPAN standard. In any case, the wireless interface **304** may support all or a subset of cellular telephone, WLAN, and WPAN operations.

[0028] The processing unit **306** may include any type of processor such as a microprocessor, a digital signal processor, an Application Specific Integrated Circuit (ASIC), or a combination of processing type devices. The processing unit **306** is operable to execute a plurality of software instructions that are stored in memory **308** and downloaded for execution. The processing unit **306** may also include specialized hardware required to implement particular aspects of the present invention. Memory **308** may include SRAM, DRAM, PROM, flash RAM, or any other type of memory capable of storing data and instructions.

[0029] A user interface **310** may include a microphone, a speaker, a keypad, a screen, a touch screen, a light, a voice recognition system, an optical recognition system that would authenticate a user's iris, for example, and/or any other type of interface that may be employed in the portable electronic device. In some embodiments, the user interface **310** may include therewith ability to service a headset including microphone and earpiece for the user. The wireless device **300** is operable to support the operations described further with reference to FIGS. **5**-**7**.

[0030] The wired I/F **316** may support USB communications, Firewire communications, other serial communications and/or parallel communications. A power converter/PLC I/F **318** is shown to be external to the portable electronic device **300**. However, in other embodiments, the power converter/PLC I/F **318** may be internal to the portable electronic device **300**. The power converter/PLC I/F is described further with reference to FIG. **4**.

[0031] FIG. **4** is a block diagram illustrating a power converter/PLC I/F including at least part of a communication interface that operates according to one or more embodiments of the present invention. The power converter/PLC I/F **318** is made up of three main elements, an AC to DC module **400**, signal coupling circuitry **402** and zero crossing circuitry **404**. While power converter/PLC I/F **318** can be integral with a device, according to the embodiment of FIGS. **2** and/or **3**, power converter/PLC I/F **318** is often external to, and/or detachable from, an device, e.g., personal computer, router, laptop computer, tablet computer, cell phone, etc. The device for which the power converter/PLC I/F **318** is designed may include a wired interface configured to send and receive digitally encoded signals consistent with one or more PLC communication standards, and other wired communication standards. Such wired interface typically includes data transmission (TX) circuits for transmitting digitally encoded signals, and data reception (RX) circuits for receiving digitally encoded signals, as is known in the art. Such a device can also include at least some of the active and/or passive components of a communication interface.

[0032] The AC to DC module **400** is configured to convert the AC line voltage of a power main **406** to one or more DC voltages (e.g., +/−5 v, +/−9 v, +/−12 v, or the like) on one or more conductors **408**. The power converter/PLC I/F **318** may also include an optional filter **410** in electrical communication between AC to DC module **400** and the power line **406**, or between AC to DC module **318** and signal coupling circuitry **408**. The filter **410** is configured to protect other components of power converter/PLC I/F **318** from electrical noise generated by AC to DC module **400**. Filter **410** can be a low-pass filter, for example. The filter **410** can also couple an external AC socket **412** to the power line **406** in some embodiments. The filter **410** can then also serve to remove noise generated by any devices attached to AC socket **412**. A further filter may also be provided on the output side of the AC to DC module **400**.

[0033] As noted, power converter/PLC I/F **318** also includes signal coupling circuitry **402** in electrical communication with power line **406** and configured to send and receive digitally encoded signals over one or more conductors **414**. Signal coupling circuitry **402** includes a transformer **416** and can optionally also include one or more of, all of, any combination of, or part(s) of: coupling capacitor **418**, signal conditioner **420**, an over-voltage protection device **422**, and a fuse **424**. Signal coupling circuitry **402** may include an entire communication interface or merely a part thereof with the remaining part of the communication interface optionally residing in the device attached thereto.

[0034] Zero crossing circuitry **404** may include, for example, a LED (light-emitting diode) and an adjacent photo detector (neither shown). In the zero crossing circuitry **404**, the LED is in electrical communication with power line **406** and is configured to emit light pulses that are synchronized to the waveform of the AC line voltage. Photo detector receives the light pulses and produces a timing signal that can be communicated over one or more conductors **426** to a coupled device.

[0035] Power converter/PLC I/F **318** is connected to the communication device by cabling, which supports communications between the device and the power converter/PLC I/F **318**. Cabling may be integral with power converter/PLC I/F **318**. The cabling may include one or more conductors **408** (typically two) configured to convey the one or more DC voltages between power converter/PLC I/F **318** and the device, one or more conductors **414** (typically two) configured to convey the digitally encoded signals between an device and power converter/PLC I/F **318** and one or more conductors (typically two) for communicating the timing signal from the zero-crossing circuitry **404**. Therefore there are typically six output conductors from the AC/DC converter. Where the power converter/PLC I/F **318** is detachable from an device, the conductors **408**, **414**, and **426** may be wrapped together by a common insulation layer, or else each may be insulated separately from the other conductors. Conductors **414** are optionally rated for the digitally encoded signals but not rated for voltages as high as the AC voltages found on the power line.

[0036] FIG. **5** is a flowchart illustrating operation according to one or more embodiments of the present invention. Operations **500** of FIG. **5** are performed by a mobile communication device, such as one of the mobile communication devices **136**, **138**, **140**, or **142** illustrated in FIG. **1**. Operation commences with the mobile communication device establishing a communication session using its wireless interface (Step **502**). This communication session may be serviced according to one or more of WLAN communications, cellular communication, WWAN communications or MMW communications. Operations **500** continue with the mobile communication device servicing the communication session using its wireless interface (Step **504**).

[0037] Next, operation **500** includes the mobile communication device detecting the availability of PLC communications via the device's wired interface or PLC I/F (Step **504**). In some embodiments, detecting the availability may be based upon a user of the mobile communication device plugging the device into a power plug within a premises having PLC support. In other operations, the mobile communication device may learn of the PLC availability via a WLAN broadcast.

[0038] Operation continues with the mobile communication device establishing a communication path that includes a PLC communication path via its wired interface (Step **508**). Such PLC communication path may be serviced by a built in PLC interface or via an external power adapter/PLC I/F such as **318** illustrated in FIGS. **2** and **3**, via USB connector, for example. Then, operation concludes with the mobile communication device at least partially handing over its established communication session from its wireless interface to its wired interface such that the communication session is at least partially serviced by a PLC communication path (Step **510**).

[0039] FIG. **6** is a flowchart illustrating operation according to one or more embodiments of the operations of FIG. **5**. The operations **510** of FIG. **6** represent a particular embodiment of step **510** of FIG. **5**. With the operations **510** of FIG. **6**, the mobile communication device fully hands over the communication session from the wireless interface to the wired interface (Step **602**). Then, the mobile communication device terminates the wireless communication (Step **604**). From Step **604**, the communication session is fully serviced via the wired communication interface and the PLC communication path (Step **606**).

[0040] FIG. **7** is a flowchart illustrating operation according to one or more embodiments of the operations of FIG. **5**. The operations **510** of FIG. **6** represent another particular embodiment of step **510** of FIG. **5**. The operations **510** of FIG. **7** include first dividing the communication session into at least a first portion and a second portion (Step **702**). This division may be based upon the relative costs of the communications via the wired and wireless interfaces, the available data throughput available via these interfaces, or upon other factors. Then, operation includes servicing a first portion of the communication session via the wireless communication interface (Step **704**) and servicing a second portion of the communication session via the wired communication interface and the PLC communication path (Step **706**).

[0041] FIG. **8** is a block diagram illustrating the construct of another power converter/PLC I/F that operates according to one or more embodiments of the present invention. The PLC I/F **800** of FIG. **8** includes a plurality of components that may be housed in a single device or a combination of devices. The PLC I/F **800** supports both charging and communication operations. The PLC I/F **800** couples to a power main and also includes a power plug **811** to allow another devices to plug into. AC power is drawn from the power mains and is filtered by transformer and electromagnetic interference (EMI) components **813** that down convert the AC voltage to a lower voltage level than that carried by the power mains and provide EMI isolation between the additional components of the PLC I/F **800** and the power plug/power mains.

[0042] The PLC I/F **800** further includes rectification components **815** to rectify the AC voltage at the lower level to a rectified AC voltage at the lower voltage level. The output of the rectification components **815** is processed by a power stage (adaptive voltage) component **817** that produces an output voltage at DC. A filter **819** filters the output of the power stage component **817** to provide a DC voltage output to power switch components **821**. Feedback and control components **823** sense the output of the filter **819** and the rectified AC voltage and provide a control signal to the power stage component **817**, directing the power stage component **817**.

[0043] The power switch components **821** couple to a plurality of connectors **825**, **827**, **829** and **831**, each of which couples to a corresponding power/communication plug. For example, connector **825** couples to an Ethernet plug that provides Power over Ethernet (PoE) communication/power service. Further, connector **827** couples to a USB connector that also supports both communications and power service. Connector **829** is simply a power plug that provides DC power to a coupled personal computer, for example. The power switch components **821** also supports a bypass AC to selected AC tap connection to provide AC power via connector **831**. The selected AC tap can be a full bypass of the AC power incoming via the connector **831**. Alternatively, the AC can be particularly selected via a down-conversion process performed by the components **813** to fit a lower voltage AC needs via the connector **831**. The power switch components **821** provide a switch fabric to provide the various AC and DC voltages to the coupled connectors.

[0044] The PLC I/F **800** further includes a plurality of communications and control components, which support PLC communications and other communications. These components include PLC Tx/Rx and related components **833** that couple and decouple PLC communications to the power mains. Further components include single or simultaneous Tx/Rx path switching, bridging, and control component **835** that interfaces the PLC Tx/Rx and related components **833** to one or more wireless interfaces **837** and **839** and to a single or simultaneous multisource merged or reinjected signal(s) interface **841**. Effectively the single or simultaneous Tx/Rx path switching, bridging, and control component **835** bridges communications via the various communication interfaces of the PLC I/F **800**. In particular, control components **845**, based upon control feedback **843**, in some operations, control the flow of communication signals within the PLC I/F **800**. In their various operations these components may bridge PLC/wireless, PLC/Ethernet, PLC/USB, USB/wireless, Ethernet/Wireless, USB/Ethernet, or bridging between any two types of supported communications.

[0045] For each of the connectors **825**, **827**, **829**, **831**, specifically needed AC or DC power can be provided via the power switch components **821**. In addition, such connectors and associated cabling may act as communication pathways as well. Communication exchanges flowing between each of the connectors and the AC connector **811** is managed via the bridging and control **835**. That is, any signal originating from any one of the connectors **811**, **825**, **827**, **829** and **831** can pass to any other of such connectors via switching circuitry provided by the bridging and control component **835**.

[0046] The control feedback **843** may also serve to provide feedback for voltage level. For example, the powered devices coupled via connectors **825**, **827**, and **829** may provide feedback control signals via respective connectors and the single or simultaneous multisource merged or reinjected signals component **841** to the control components **845**. The control components **845** may then control the power switch components via the control feedback **843** to adjust DC voltage levels provided to the connectors.

[0047] FIG. **9** is a system diagram illustrating a plurality of PLC devices constructed and operating according to one or more embodiments of the present invention. The plurality of PLC devices are PLC I/F devices of the type illustrated in FIG. **8** and include PLC I/F device **910**, PLC I/F device **914**, and PLC I/F device **922**. Each of these PLC I/F devices **910**, **914**, and **922** supports PLC communications for at least one serviced device. These PLC I/F devices **910**, **914**, and **922** support communications via a PLC delivery infrastructure **902**, which comprises at least a power mains. The PLC delivery infrastructure **902** couples to PLC system **904**, which further couples to a wired and/or wireless communication backbone infrastructure and an AC power delivery infrastructure **908**. These components support the power mains system of a home or other premises so that the PLC I/F devices **910**, **914**, and **922** can couple to wall plugs and receive PLC communication services therefrom.

[0048] PLC I/F device **910** supports personal computer **912**, providing at least communication support therefore. PLC I/F device **914** supports wireless device **916**, personal computer **918** and printer **920**. Wireless device **916** receives communication services from the PLC I/F device **914** via a wireless link there between with the PLC I/F **914** providing backhaul communication services. The laptop computer **918** and the printer **920** receive at least communication services from the PLC I/F **914** and may also be powered by the PLC I/F **914** according to techniques previously described with reference to FIG. **8**. Laptop computer **924** receives communication and/or power support from PLC I/F **922**.

[0049] With respect to the system of FIG. **9** and the PLC I/F **800** described with reference to FIG. **8**, each PLC I/F may support multiple communication paths, e.g., PLC and wireless. By servicing these multiple communication paths, the PLC I/Fs may select one communication path over the other or divide communications between these multiple communication paths to support greater data throughput.

[0050] Circuitry described herein that performs particular functions may be a microprocessor, micro-controller, digital signal processor, microcomputer, central processing unit, field programmable gate array, programmable logic device, state machine, logic circuitry, analog circuitry, digital circuitry, and/or any device that manipulates signals (analog and/or digital) based on hard coding of the circuitry and/or operational instructions, which may be considered singularly or in combination a "processing module." The processing module, module, processing circuit, and/or processing unit may be, or further include, memory and/or an integrated memory element, which may be a single memory device, a plurality of memory devices, and/or embedded circuitry of another processing module, module, processing circuit, and/or processing unit. Such a memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, cache memory, and/or any device that stores digital information. Note that if the processing module, module, processing circuit, and/or processing unit includes more than one processing device, the processing devices may be centrally located (e.g., directly coupled together via a wired and/or wireless bus structure) or may be distributed located (e.g., cloud computing via indirect coupling via a local area network and/or a wide area network). Further note that if the processing module, module, processing circuit, and/or processing unit implements one or more of its functions via a state machine, analog circuitry, digital circuitry, and/or logic circuitry, the memory and/or memory element storing the corresponding operational instructions may be embedded within, or external to, the circuitry including the state machine, analog circuitry, digital circuitry, and/or logic circuitry. Still further note that, the memory element may store, and the processing module, module, processing circuit, and/or processing unit executes, hard coded and/or operational instructions corresponding to at least some of the steps and/or functions illustrated in one or more of the FIGs. Such a memory device or memory element can be included in an article of manufacture.

[0051] The present invention has been described above with the aid of method steps illustrating the performance of specified functions and relationships thereof. The boundaries and sequence of these functional building blocks and method steps have been arbitrarily defined herein for convenience of description. Alternate boundaries and sequences can be defined so long as the specified functions and relationships are appropriately performed. Any such alternate boundaries or sequences are thus within the scope and spirit of the claimed invention. Further, the boundaries of these functional building blocks have been arbitrarily defined for convenience of description. Alternate boundaries could be defined as long as the certain significant functions are appropriately performed. Similarly, flow diagram blocks may also have been arbitrarily defined herein to illustrate certain significant functionality. To the extent used, the flow diagram block boundaries and sequence could have been defined otherwise and still perform the certain significant functionality. Such alternate definitions of both functional building blocks and flow diagram blocks and sequences are thus within the scope and spirit of the claimed invention. One of average skill in the art will also recognize that the functional building blocks, and other illustrative blocks, modules and components herein, can be implemented as illustrated or by discrete components, application specific integrated circuits, processors executing appropriate software and the like or any combination thereof.

[0052] The present invention may have also been described, at least in part, in terms of one or more embodiments. An embodiment of the present invention is used herein to illustrate the present invention, an aspect thereof, a feature thereof, a concept thereof, and/or an example thereof. A physical embodiment of an apparatus, an article of manufacture, a machine, and/or of a process that embodies the present invention may include one or more of the aspects, features, concepts, examples, etc. described with reference to one or more of the embodiments discussed herein. Further, from figure to figure, the embodiments may incorporate the same or similarly named functions, steps, modules, etc. that may use the same or different reference numbers and, as such, the functions, steps, modules, etc. may be the same or similar functions, steps, modules, etc. or different ones.

[0053] Unless specifically stated to the contra, signals to, from, and/or between elements in a figure of any of the figures presented herein may be analog or digital, continuous time or discrete time, and single-ended or differential. For instance, if a signal path is shown as a single-ended path, it also represents a differential signal path. Similarly, if a signal path is shown as a differential path, it also represents a single-ended signal path. While one or more particular architectures are described herein, other architectures can likewise be implemented that use one or more data buses not expressly shown, direct connectivity between elements, and/or indirect coupling between other elements as recognized by one of average skill in the art.

[0054] The term "module" is used in the description of the various embodiments of the present invention. A module includes a processing module, a functional block, hardware, and/or software stored on memory for performing one or more functions as may be described herein. Note that, if the module is implemented via hardware, the hardware may operate independently and/or in conjunction software and/or firmware. As used herein, a module may contain one or more sub-modules, each of which may be one or more modules.

[0055] While particular combinations of various functions and features of the present invention have been expressly described herein, other combinations of these features and functions are likewise possible. The present invention is not limited by the particular examples disclosed herein and expressly incorporates these other combinations.

[0056] The present invention has also been described above with the aid of method steps illustrating the performance of specified functions and relationships thereof. The boundaries and sequence of these functional building blocks and method steps have been arbitrarily defined herein for convenience of description. Alternate boundaries and sequences can be defined so long as the specified functions and relationships are appropriately performed. Any such alternate boundaries or sequences are thus within the scope and spirit of the invention.

[0057] Moreover, although described in detail for purposes of clarity and understanding by way of the aforementioned embodiments, the present invention is not limited to such embodiments. It will be obvious to one of average skill in the art that various changes and modifications may be practiced within the spirit and scope of the invention.

1. A mobile communication device comprising:

a wired interface operable to support Power Line Communications (PLC);

a wireless interface;

a processing module;

memory coupled to the processing module, wherein the processing module, the wired interface, and the wireless interface are operable to:

establish a wireless communication link with at least one wirelessly coupled device to service a communication session;

detect availability of PLC communication path via the wired interface; and

at least partially handover the communication session from the wireless interface to the wired interface.

2. The mobile communication device of claim **1**, wherein the wired interface is a PLC interface that supports communications according to at least one PLC communication standard.

3. The mobile communication device of claim **1**, further comprising a PLC interface coupled to the wired interface that is operable to support the PLC communication path.

4. The mobile communication device of claim **1**, wherein the PLC interface further comprises a power converter that is operable to provide power to the mobile communication device.

5. The mobile communication device of claim **1**, wherein the wired interface includes a Universal Serial Bus (USB) port.

6. The mobile communication device of claim **1**, wherein the wireless communication comprises one of:

a Wireless Local Area Network (WLAN) communication;

a cellular communication;

a Wireless Wide Area Network (WWAN) communication; and

a Millimeter Wave (MMW) communication.

7. The mobile communication device of claim **1**, wherein in at least partially handing over the communication session from the wireless interface to the wired interface, processing circuitry is operable to:

terminate the wireless communication; and

service the communication session via the wired communication interface and the PLC communication path.

8. The mobile communication device of claim **1**, wherein in at least partially handing over the communication session from the wireless interface to the wired interface, processing circuitry is operable to:

service a first portion of the communication session via the wireless communication interface; and

service a second portion of the communication session via the wired communication interface and the PLC communication path.

9. A method for operating a mobile communication device comprising:

establishing a wireless communication link with at least one wirelessly coupled device to service a communication session via a wireless interface;

detecting availability of a PLC communication path via a wired interface; and

at least partially handing over the communication session from the wireless interface to the wired interface.

10. The method of claim **9**, further comprising supporting communications according to a plurality of PLC communication standards.

11. The method of claim **9**, further comprising supporting the PLC communication path via a PLC interface coupled to the wired interface.

12. The method of claim **9**, further comprising further comprising receiving power and wired communication service from a coupled power converter.

13. The method of claim **9**, wherein the wired interface communications are serviced according to a Universal Serial Bus (USB) communication standard.

14. The method of claim **9**, wherein the wireless communication comprises one of:

a Wireless Local Area Network (WLAN) communication;

a cellular communication;

a Wireless Wide Area Network (WWAN) communication; and

a Millimeter Wave (MMW) communication.

15. The method of claim **9**, wherein at least partially handing over the communication session from the wireless interface to the wired interface comprises:

terminating the wireless communication; and

servicing the communication session via the wired communication interface and the PLC communication path.

16. The method of claim **9**, wherein at least partially handing over the communication session from the wireless interface to the wired interface comprises:

servicing a first portion of the communication session via the wireless communication interface; and

servicing a second portion of the communication session via the wired communication interface and the PLC communication path.

17. A mobile communication device comprising:

a wired interface;

a power converter/PLC interface operable to support Power Line Communications (PLC) and coupled to the wired interface;

a wireless interface;

a processing module;

memory coupled to the processing module, wherein the processing module, the wired interface, and the wireless interface are operable to:

establish a wireless communication link with at least one wirelessly coupled device to service a communication session;

detect availability of PLC communication path via the wired interface; and

at least partially handover the communication session from the wireless interface to the wired interface.

18. The mobile communication device of claim **17**, wherein the wireless communication comprises one of:

a Wireless Local Area Network (WLAN) communication;

a cellular communication;

a Wireless Wide Area Network (WWAN) communication; and

a Millimeter Wave (MMW) communication.

19. The mobile communication device of claim **17**, wherein in at least partially handing over the communication session from the wireless interface to the wired interface, processing circuitry is operable to:

terminate the wireless communication; and

service the communication session via the wired communication interface and the PLC communication path.

20. The mobile communication device of claim **17**, wherein in at least partially handing over the communication session from the wireless interface to the wired interface, processing circuitry is operable to:

service a first portion of the communication session via the wireless communication interface; and

service a second portion of the communication session via the wired communication interface and the PLC communication path.

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