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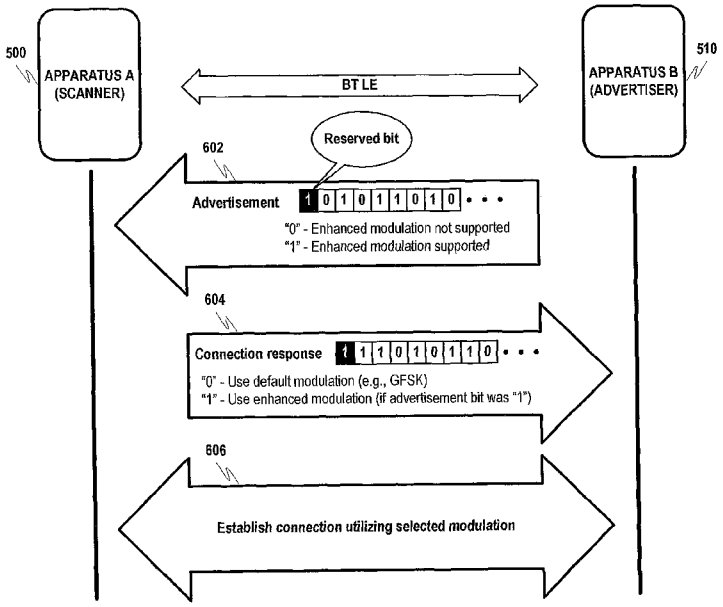
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(54) **Title**: FEATURE SELECTION IN WIRELESS COMMUNICATION

FIG. 6



(57) **Abstract**: A system for negotiating wireless connection configuration. 'Features' for wireless connection configuration may be proposed during connection establishment. At least one other apparatus (e.g., to which connection is being sought) may respond to the proposed configuration by selecting one or more of the proposed features. The features selected in the response may then be implemented in the wireless connection configuration. The same or further features may also be configured after the connection has already been established, for example, in based on current interaction.

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FEATURE SELECTION IN WIRELESS COMMUNICATION

BACKGROUND

1. Field of Invention:

[0001] Various embodiments of the present invention relate to connection management, and in particular, to a system for negotiating the use of features that may be configured for a wireless connection in view of information provided by one or more participating apparatuses.

2. Background:

[0002] Apparatuses enabled for wireless communication are continuing to become more integrated in ordinary daily activity. This growth in utilization may be due, at least in part, to rapid technological development occurring in the area of multifunction wireless communication devices (WCD). Due to improvements in speed, quality of service, etc., these apparatuses may now replace common standalone devices, like computers, laptops, facsimile machines, personal digital assistants, etc., with a single apparatus capable of performing all of these functions. These abilities have been embraced by users who often find that tasks can now be completed during time that was previously wasted (e.g., commuting to and from work, school, home, etc.)

[0003] However, while these apparatuses may be empowered with a variety of beneficial features, the small size and power constraints of these apparatuses may also create challenges for users. Operator interfaces installed in these apparatuses are often small, and therefore, may not be conducive to inputting large amounts of data. As a result, users may rely on peripheral input apparatuses such as keyboards, mice, headsets, etc. in order to perform their work. Further, the small size of many apparatuses today also implies that there is a lack of physical connections to connect wired apparatuses. Therefore, multifunction wireless devices should not only support a wireless connection to one peripheral device, but should also be able to support simultaneous connections with multiple peripheral apparatuses, as well as concurrent links to various resources that may provide voice and data service over long-range and/or short-range wireless transports.

[0004] While a multifunction wireless device may have the ability to communicate via a myriad of different protocols, modulation schemes, etc., lower complexity apparatuses may not include the same abilities. Moreover, apparatuses are not implemented in a uniform manner. The features that are supported by apparatuses may depend on the particular application for which the device is intended, resources available in a device, etc. For example, in situations where resources (e.g., power, processing, etc.) are limited, a manner of operation that "works" (e.g., will allow a desired communication transaction to proceed) may nonetheless not be the most effective configuration for interaction. In particular, a communication configuration that allows for interaction between a plurality of apparatuses may not be efficient based on available apparatus functionality, current apparatus status, current environmental conditions, etc.

SUMMARY

[0005] Example implementations of the present invention, in accordance with various embodiments, may be directed to at least a method, apparatus, computer program and system for negotiating wireless connection configuration. For example, "features" for configuring wireless connections may be proposed during connection establishment. At least one other apparatus (e.g., to which connection is being sought) may respond to the proposed configuration by selecting one or more of the proposed features. The features selected in the response may then be implemented in the wireless connection configuration. The same or further features may also be configured after the connection has already been established, for example, in based on current interaction.

[0006] In accordance with at least one embodiment of the present invention, an initiating apparatus may send a wireless message advertising the desire to establish a connection. The advertising message may include information that indicates connection features supported by the initiating apparatus. A receiving apparatus may interpret the feature information contained in the advertising message. The receiving apparatus may then select from amongst the available features, or alternatively, may not select any features. The selection may be based, for example, on whether features are supported by the receiving apparatus, whether features are appropriate based on the condition of the apparatus, environmental conditions, a particular transaction, etc.

[0007] The selections made by the receiving apparatus may be included in a response message to the initiating apparatus. The response message may then be used by

the initiating apparatus to implement the features identified by the receiving apparatus. While connection establishment has been discussed, configuration changes during established connections (e.g., due to changes in apparatus interaction) are also instances where this functionally can be used.

[0008] The foregoing summary includes example embodiments of the present invention that are not intended to be limiting. The above embodiments are used merely to explain selected aspects or steps that may be utilized in implementations of the present invention. However, it is readily apparent that one or more aspects, or steps, pertaining to an example embodiment can be combined with one or more aspects, or steps, of other embodiments to create new embodiments still within the scope of the present invention. Therefore, persons of ordinary skill in the art would appreciate that various embodiments of the present invention may incorporate aspects from other embodiments, or may be implemented in combination with other embodiments.

DESCRIPTION OF DRAWINGS

[0009] The present invention may be understood from the following detailed description of various implementation examples taken in conjunction with the appended drawings, wherein:

[0010] FIG. 1A discloses an example of a wireless communication device, in terms of a modular layout, that may be usable with at least one embodiment of the present invention.

[0011] FIG. 1B discloses an example of a structural description for the wireless communication device previously described in FIG. 1A.

[0012] FIG. 2 discloses an example of a Bluetooth™ protocol stack and a Bluetooth™ Low Energy (LE) protocol stack usable with at least one embodiment of the present invention.

[0013] FIG. 3A discloses an example of multiple wireless peripheral apparatuses attempting to communicate concurrently with a dual-mode radio modem in accordance with at least one embodiment of the present invention.

[0014] FIG. 3B discloses further detail pertaining to the example of FIG. 3A regarding operational enhancements for managing the operation of a dual-mode modem in accordance with at least one embodiment of the present invention.

[0015] FIG. 4 discloses a more detailed example of a Bluetooth™ Low Energy (LE) protocol stack in accordance with at least one embodiment of the present invention.

[0016] FIG. 5A discloses an example of communications between an advertiser and a receiving apparatus in accordance with at least one embodiment of the present invention.

[0017] FIG. 5B discloses an example of a particular feature, namely modulation scheme, usable in accordance with at least one embodiment of the present invention.

[0018] FIG. 6 discloses an example interaction between an advertising apparatus and receiving apparatus in accordance with at least one embodiment of the present invention.

[0019] FIG. 7 discloses another example interaction between an advertising apparatus and receiving apparatus in accordance with at least one embodiment of the present invention.

[0020] FIG. 8A discloses a flowchart of a process example wherein wireless connection features may be selected in accordance with at least one embodiment of the present invention.

[0021] FIG. 8B discloses a flowchart of a process example wherein wireless connection features may be changed in accordance with at least one embodiment of the present invention.

DESCRIPTION OF EXAMPLE EMBODIMENTS

[0022] While the present invention has been described below embodied in terms of one or more implementation examples, various changes can be made therein without departing from the spirit and scope of the invention, as described in the appended claims.

I. Wireless communication device

[0023] As previously set forth, the present invention, in accordance with at least one embodiment, may be implemented utilizing a variety of apparatuses. Therefore,

establishing an understanding of wirelessly-enabled apparatuses that may be used in implementing these various example embodiments may aid in comprehending the following disclosure. For example, in the case of a cellular handset, palmtop or laptop computer, wireless communicator or other handheld wireless apparatus, the integrated data handling capabilities of the apparatus may play an important role in facilitating transactions between the transmitting and receiving apparatuses.

[0024] FIG. 1A discloses an example of a modular layout for a wireless communication device usable with various example embodiments of the present invention. WCD 100 may be represented as an organization functional modules corresponding to the various operational aspects/elements of the apparatus. These functional modules may be implemented by various combinations of software and/or hardware components as previously discussed below.

[0025] Control module 110 may regulate the operation of the apparatus. Inputs into control module 110 may be received from various other modules included within WCD 100. For example, interference sensing module 120 may use various techniques known in the art to sense sources of environmental interference within transmission range of WCD 100. Control module 110 may interpret these inputs, and in response, may issue control commands to other modules.

[0026] Communications module 130 may generally incorporate all of the wired and/or wireless communication features of WCD 100. As shown in FIG. 1A, communications module 130 may include, for example, long-range communication module 132, short-range communication module 134 and machine-readable data module 136. Communications module 130 may utilizes at least these sub-modules to receive a multitude of different types of communication from both local and long distance sources, and to transmit data to apparatuses within the transmission range of WCD 100. Communications module 130 may be triggered by control module 110, or by control resources local to the module responding to sensed messages, environmental influences and/or other apparatuses in proximity of WCD 100.

[0027] User interface module 140 includes visual, audible and tactile elements which allow a user to receive data from, and enter data into, the apparatus. The data entered by a user may be interpreted by control module 110 to affect the behavior of WCD 100. User-inputted data may also be transmitted by communications module 130

to other apparatuses within transmission range (e.g., for wireless communication). Conversely, other apparatuses may also send information to WCD 100 via communications module 130, and control module 110 may cause this information to be transferred to user interface module 140 for presentment to the user.

[0028] Applications module 180 may incorporate all other hardware and/or software resources on WCD 100. Applications in this module may include sensors, interfaces, utilities, interpreters, data applications, or any other functionality executable on WCD 100. Applications within application module 180 may be invoked by control module 110 to, for example, read information provided by various modules and in turn supply information to requesting modules.

[0029] FIG. 1B discloses a structural layout example for WCD 100, in accordance with at least one embodiment of the present invention, usable for implementing the functionality of the modular system previously described with respect to FIG. 1A. Processor 150 may control overall apparatus operation, for example, by interfacing with other elements in WCD 100, like communication sections 154, 158 and 166. Processor 150 can be implemented with one or more microprocessors that are each capable of executing software instructions stored in memory 152.

[0030] Memory 152 may include fixed and/or removable memory media (e.g., magnetic, optical, etc.) that may comprise, for example, random access memory (RAM), read only memory (ROM), rewritable solid state memory like flash, etc. Memory 152 may store information in the form of data and software components (also referred to herein as modules). The data stored by memory 152 may be associated with particular control, application or database modules such as command databases, contacts databases or business databases for scheduling, email, etc.

[0031] The software components stored by memory 152 may include computer-readable instructions that can be executed by processor 150. Various types of software components may be stored in memory 152. For instance, memory 152 may store software components that control communication sections 154, 158 and 166. Memory 152 may also store software components related to operating system components, user interfaces, applications, utilities, security, entertainment and any communication utilities modules required to support WCD 100.

[0032] Long-range communications 154 may perform activities related to the exchange of information over large geographic areas (such as cellular network communication). These long-range network technologies have traditionally been classified by generations, starting in the late 1970s to early 1980s with first generation (1G) analog cellular telephones that provided baseline voice communication, to modern digital cellular telephones. Global System for Mobile Communications (GSM) is an example of a widely employed 2G digital cellular network communicating in the 900 MHZ/1.8 GHZ bands in Europe and at 850 MHz and 1.9 GHZ in the United States. In addition to voice functionality (e.g., via GSM), long-range communications 154 may operate to establish wireless data communication sessions, such as General Message Radio Service (GPRS) sessions and/or Universal Mobile Telecommunications System (UMTS) sessions. Long-range communications 154 may also operate to transmit and receive text messages, such as via the short messaging service (SMS), and/or multimedia content via multimedia messaging service (MMS) messages.

[0033] As a subset of long-range communications 154, or alternatively operating as an independent module separately coupled to processor 150, broadcast receivers 156 allows WCD 100 to receive unsolicited wireless communication via mediums such as Digital Video Broadcast for Handheld Apparatuses (DVB-H). Transmissions may be encoded so that only certain apparatuses may access transmission content, and may contain text, audio or video information. In at least one example, WCD 100 may receive broadcasts and/or information within the broadcast signal to determine if the apparatus is permitted to view the received content.

[0034] Short-range communications 158 may support the exchange of information across short-range wireless networks. As described above and depicted in FIG. 1B, examples of such short-range communications 158 are not limited to Bluetooth™, Bluetooth™ Low Energy (BT LE) technology, Wireless Local Area Network (WLAN), Ultra-Wide Band (UWB) and Wireless Universal Serial Bus (WUSB) connections. Short-range communications 158 may perform functions related to the establishment of short-range connections, as well as processing related to the transmission and reception of wireless information via, for example, the above connections.

[0035] Short-range input device 166, also depicted in FIG. 1B, may provide functionality related to the short-range scanning of machine-readable data (e.g., Near

Field Communication (NFC)). For example, processor 150 may control short-range input device 166 to generate Radio Frequency (RF) scanning signals for activating a Radio Frequency Identification (RFID) transponder, and may in turn control the reception of signals from an active transponder. Other short-range scanning methods for reading machine-readable data that may be supported by short-range input apparatus 166 are not limited to Infra-Red (IR) communication, linear and 2-D (e.g., Quick Response (QR)) bar code readers (including processes related to interpreting universal product codes (UPC) labels), and optical character recognition devices for reading magnetic, Ultraviolet (UV), conductive or other types of coded data that may be provided in a tag using suitable ink. In order for short-range input apparatus 166 to scan the aforementioned types of machine-readable data, the input device may include optical detectors, magnetic detectors, Charge Coupled Devices (CCDs) or other sensors known in the art for interpreting machine-readable information.

[0036] As further shown in FIG. 1B, user interface 160 may also be coupled to processor 150. User interface 160 may facilitate the exchange of information with a user of an apparatus. User interface 160, as shown, may include user input 162 and user output 164. User input 162 may include one or more components that allow a user to input data into WCD 100. Examples of such components include keypads, touch screens, microphones, etc. User output 164 may allow a user to obtain information from WCD 100. Thus, user output portion 164 may include various components, such as a display, Light Emitting Diodes (LED), tactile emitters, audio speakers, etc. Displays usable in user output 164 may include, for example, Liquid Crystal Displays (LCDs) and other types of video displays.

[0037] WCD 100 may also include one or more transponders 168. A transponder may be an essentially passive apparatus that may be programmed by processor 150 with information to be delivered in response to a scan from an outside source. For example, an RFID scanner mounted in an entryway may continuously emit radio frequency waves. When an apparatus containing transponder 168 passes through the entryway, the transponder may be energized and may respond with information identifying the apparatus, person, security information (e.g., security codes), etc. In addition, a reader may be mounted (e.g., as discussed above with regard to examples of short-range input device 166) in WCD 100 so that it can read information from other transponders in the

vicinity. Further, in an alternative configuration the reader may be equipped with logic that provides means for the reader to also operate as a transponder.

[0038] Hardware corresponding to communications sections 154, 156, 158 and 166 provide for the transmission and reception of signals. Accordingly, these sections may include components (e.g., electronics) that perform functions such as modulation, demodulation, amplification, and filtering. These sections may be locally controlled, or may be controlled by processor 150 in accordance with software communication components stored in memory 152.

[0039] The elements shown in FIG. 1B may be constituted and coupled according to various techniques in order to produce the functionality described in FIG. 1A. One such technique involves coupling separate hardware components corresponding to processor 150, communications sections 154, 156 and 158, memory 152, short-range input device 166, user interface 160, transponder 168, etc. through one or more wired or wireless bus interfaces. Alternatively, any and/or all of the individual components may be replaced by an integrated circuit in the form of a programmable logic apparatus, gate array, ASIC, multi-chip module, etc. programmed to replicate the functions of the stand-alone components. Each of these components may be coupled to a power source, such as a removable and/or rechargeable battery (not shown).

[0040] During apparatus operation, user interface 160 may, for example interact with one or more communication software components (e.g., stored in memory 152) that may provide for the establishment of communication service sessions using long-range communications 154 and/or short-range communications 158. The communication utility software components may include various routines that allow for the transmission and reception of information and services from remote apparatuses according to mediums such as the Wireless Application Medium (WAP), Hypertext Markup Language (HTML) variants like Compact HTML (CHTML), etc.

II. Wireless communication mediums

[0041] In accordance with at least one example embodiment, the present invention may be implemented with a short-range wireless communication medium. Bluetooth™ is an example of a commonly employed short-range wireless technology. A Bluetooth™-enabled WCD may transmit and receive data, for example, at a rate of 720

Kbps within a range of 10 meters, and may transmit up to 100 meters with additional power boosting. Current Bluetooth™-enabled apparatuses may operate at a nominal rate of 1 Mbps. A user does not have to actively instigate a Bluetooth™ network. Instead, a plurality of apparatuses within communication range of each other may automatically form a network group called a "piconet". Any apparatus may promote itself to be the master of the piconet, allowing it to manage data exchanges between up to seven "active" slaves and 255 "parked" slaves. Active slaves may exchange data based on the clock timing of the master. Parked slaves may monitor a beacon signal in order to stay synchronized with the master apparatus, and wait for one of the seven active slots to become available. The networked Bluetooth™ apparatuses may continually switch between active and power saving modes in order to conserve resources when not communicating with other piconet members. In addition to Bluetooth™ other popular short-range wireless networks include WLAN (of which "Wi-Fi" local access points communicating in accordance with the IEEE 802.11 standard, is an example), WUSB, UWB, ZigBee (802.15.4, 802.15.4a), Bluetooth™ Low Energy (BT LE) technology and UHF RFID.

[0042] The present invention, in accordance with various example embodiments, may be implemented with any communication configuration enabled to operate, for example, in a manner similar to the above identified communication mediums. While Bluetooth™ Low Energy (BT LE) technology will be used for the sake of explanation in the following disclosure, as previously set forth, the following example embodiments of the present invention are not specifically limited to this wireless communication medium. BT LE is an open standard industry initiative that was initially called Wibree™ at its introduction, but has since been adopted by the Bluetooth™ Special Interest Group (SIG) for use in extending local connectivity to small apparatuses. BT LE may enable close range communication with Bluetooth™-like performance of 1 Mbps in the 0-10 meter range. BT LE may be optimal for installations requiring extremely low power consumption, small size and low cost. BT LE may be implemented either as stand-alone chip or as Bluetooth™ BT LE dual-mode chip.

[0043] Now referring to FIG. 2, an example of a Bluetooth™ protocol stack and an example of a BT LE protocol stack are shown. Bluetooth™ stack 200 may include elements that convey information from a system level to a physical layer where it may

then be transmitted wirelessly to another apparatus. At the top level, BT Profiles 202 include at least a description of a known peripheral apparatuses that may be wirelessly coupled to WCD 100, or an application that may utilize Bluetooth™ in order to engage in wireless communication with a peripheral apparatus. The use of the phrase "peripheral apparatuses" is not intended to limit the scope of the present invention, and is used only to represent any apparatus external to WCD 100 that is also capable of wirelessly communicating with WCD 100. Bluetooth™ profiles corresponding to other apparatuses may be established, for example, through a pairing process wherein identification and connection information for a peripheral apparatus may be received by WCD 100 by polling the other apparatus. This information may then be saved in order to expedite the connection to the apparatus at a later time.

[0044] After the application and/or target peripheral apparatus (or apparatuses) have been established, information to be sent must be prepared for transmission. Extended Synchronous Connection Oriented (eSCO) logical transport/Logical Link Control and Adaptation Protocol (L2CAP) layer 204 may include at least a transport adapted to support voice transmission error handing (e.g., packet retransmission) while improving audio latency, as well as a logical link controller and adaptation protocol. The L2CAP may support higher level protocol multiplexing message segmentation and reassembly, and the conveying of quality of service information. The information prepared by eSCO/L2CAP level 204 may then be passed to an application-optional host controller interface (HCI) 206. This layer may provide a command interface to the lower link manager protocol (LMP) layers, link manager (LM) 208 and link controller (LC) 210. LM 208 may establish the link setup, authentication, link configuration and other protocols related to establishing a wireless link between two or more apparatuses. Further, LC 210 may manage active links between two or more apparatuses by handling low-level baseband protocols. Wireless communication may then be established and conducted using hardware (modem, antenna, etc.) residing in physical layer (PHY) 212. Of course, the above identified layers of Bluetooth™ stack 200 may also be utilized in an order reversed from that disclosed above in order to receive a wireless transmission into WCD 100 from a peripheral apparatus.

[0045] The layers in the standalone BT LE stack 220 are similar to the elements previously described. However, due to the relative simplicity of BT LE when compared

to Bluetooth™, there may actually be fewer layers utilized to achieve wireless communication. BT LE Profiles 222, similar to the profiles used in Bluetooth™, may specify applications that can use BT LE for communication, as well as peripheral apparatuses with which a BT LE modem may wirelessly communicate. An adaptation layer 224 may be used to prepare the information for transmission via wireless communication. L2CAP 224 may be similar to Bluetooth™, but configured for simplified and/or low-power operation. HCI 226 may provide an interface between the upper layers communicating with applications and schedulers in WCD 100, and the lower layers of the BT LE stack 220 which establish and maintain the links to peripheral apparatuses. Lower layers of the BT LE stack 220 may further include at least link layer (LL) 228. LL 228 may both establish and maintain wireless communications with other wireless enabled apparatuses through the use of Physical Layer (PHY) 230. However, LL 228 as shown in the BT LE stack may differ significantly from LM 208 and LC 210 in Bluetooth™.

III. Dual-mode modem

[0046] FIG. 3A discloses an example of a communication configuration usable in implementing various embodiments of the present invention. Again, in this example the three peripheral apparatuses (300, 302 and 304) are attempting concurrent communication with WCD 100 through dual-mode radio modem 306. Radio modem 306 may include local control resources for managing both "radios" (e.g., Bluetooth™ and BT LE software based radio control stacks) attempting to use PHY layer resources of dual-mode radio modem 306. In this example, radio modem 306 may include at least two radio stacks or radio protocols (labeled "Bluetooth" and "BT LE") that may share PHY layer resources (e.g., hardware resources, antenna, etc.) of radio modem 306. The local control resources may include an admission controller ("Adm Ctrl") and a dual-mode controller ("DuMo Manager"). These local control resources may be embodied as a software program and/or in hardware form (e.g., logic apparatus, gate array, MCM, ASIC, etc.) in a dual-mode radio modem interface, and the radio modem interface may be coupled to, or alternatively, embedded in dual-mode radio modem 306. The interaction of these control resources with the protocols utilizing dual-mode radio modem 306 is explained below.

[0047] In FIG. 3B, an example of the combination of the two individual radio protocol stacks discussed in FIG. 2 into a single dual-mode communication entity is now

disclosed. Adaptive profiles 312 may span, or may be hybrids of, both BT and BT LE profiles. Local control may be implemented by at least an admission control 314 and a DuMo manager 316. The two previously described standalone protocol stacks are shown to establish the individual elements that may be incorporated into integrated dual-mode entity 310. For a more specific discussion of the functioning of admission control 312 and a DuMo manager 316 in terms of managing the operations of dual-mode modem 306, please refer to Application No. 11/538,310, filed October 3, 2006, which is hereby incorporated by reference. Briefly, Admission control 312 may operate as a gateway for dual-mode radio modem 306 by filtering out Bluetooth™ and BT LE communication requests from other entities in WCD 100 that may result in conflicts. Scheduling information may also be provided by Multiradio controller (MRC) 170, wherein certain periods of operation are allocated to dual-mode radio modem 306 in view of the other active radio modems operating in WCD 100. This scheduling information may be passed down to both the HCI + Extension level of the dual-mode stack and also to DuMo manager 316 for further processing. However, if scheduling information from MRC 170 is critical (e.g., delay-sensitive), it may be sent through MCS 190 via a direct connection to DuMo Manager 316. The information received by DuMo manager 316 may be used to create a schedule for dual-mode radio modem 300 allowing both Bluetooth™ and BT LE to operate substantially concurrently.

IV. Protocol stacks and message routing

[0048] FIG. 4 discloses a more detailed example of the upper layers of the BT LE communication protocol. The BT LE system may comprise BT LE Profiles and Protocols 222, BT LE Host 224, BT LE HCI 226 and BT LE Radio 416. Application layer 400 may include, for example, various programs executable by a computing apparatus. Examples of applications may include communication, entertainment or productivity programs running on WCD 100. Applications may utilize Profiles and Protocols 222 in order to send information into the BT LE protocol stack 220 in a transaction that may be supervised by Host 224. Profiles and Protocols 222 may include one or more profiles 402 and/or protocols 404.

[0049] Host 224 may accept information from a profile 402 in Profiles and Protocols 222 via ATT 410. Host 224 may then process the information in preparation for transmission using one or more of security module 406, signaling channel 408, fixed

channels 412 and signaling channel 414. The information may then be routed to BT LE radio 416 via HCI 226, wherein LL 228 may both establish new wireless connections and manage existing connections with peripheral apparatuses through the resources (modem, antenna, etc.) included in PHY layer 230.

V. Communication between an advertiser and at least one receiving apparatus with connection.

[0050] Referring now to FIG. 5A, an example of communication between apparatuses, including the establishment of a formal network connection, is disclosed. Apparatus A 500 (hereafter referred to as scanner 500) may initiate wireless communication with Apparatus B (hereafter referred to as advertiser 510) after receiving a broadcast signal from advertiser 510. The initiation of wireless communication by scanner 500 and subsequent interaction between these apparatuses may be automatic or manual (e.g., including at least some intervention from user). Apparatuses 500 and 510 may also include communication profiles 502 and 512, respectively. Further, these apparatuses may be known to each other before the interaction shown in FIG. 5A (e.g., they may be two apparatuses owned by the same user), or alternatively, they may have previously been unknown to each other, such as, for example, in a scenario where a user in possession of WCD 100 moves into transmission range of advertiser 510 at a public location, such as a shopping mall.

[0051] As mentioned above, advertiser 510 broadcasts a signal that may be repeated in a periodic manner upon the realization of a need for resources not present in advertiser 500, after being manually activated, after being triggered by events in the same or other apparatuses (e.g., a motion sensor), etc. An example event may, for example, alert advertiser 510 to the presence of potential scanning apparatuses 500, etc. The example interaction shown in FIG. 5 may represent a typical Bluetooth™ connection establishment scheme, wherein apparatuses in proximity to advertiser 510 (e.g., scanner 500) must be active scan mode in order to receive the advertisement signal. Advertisement reception may then cause scanner 500 to issue a link request message and a connection to be established at 520. At the other extreme, at least one purpose of BT LE is to conserve resources during apparatus operation, and therefore, ADV_IND messages should be as small as possible (e.g., may only contain the advertiser address) while being designed to invite connection establishment between apparatuses without the

requirement of active scanning for advertisements that is currently seen in the Bluetooth™ specification. The identification of advertiser 510 may be public (e.g., the actual fixed apparatus address) or may be private (e.g., a dynamically generated pseudonym that receiving apparatuses can decode using an algorithm, and then compare to stored information to determine whether advertiser 510 is the same device as previously encountered without disclosing the public address of the advertiser). However, there are some security-related scenarios where apparatuses would need to disclose its public address.

[0052] The ADV_IND message may be broadcast, in accordance with at least one embodiment of the present invention on a predetermined advertising channel. All scanners 500 may be aware that any broadcast messages should be expected on the designated advertising channel (also, in some instance, called the initialization channel). In a more specific scenario, BT LE may include three predetermined advertising channels. Therefore, scanner 500 and advertiser 510, when using BT LE, may be able to utilize one or more of the three advertising channels in a strategy to enhance broadcast coverage in view of advertising channel availability.

[0053] Scanner 500, upon receiving the ADV_IND message from advertiser 510, may either ignore the message and continue listening for another ADV_IND message with different content, or may initiate communications with advertiser 510. At least one scenario where scanner 500 may decide to continue monitoring the initialization channel is to determine whether any other advertisers are present. Further information may be obtained about an advertiser by transmitting a SCAN_REQ packet from scanner 500, to which advertiser 510 may reply with a SCAN_RSP packet that contains, for example, an advertiser's name and supported profile ID.

[0054] Scanner 500 may choose to respond, for example, if advertiser 510 is recognized (e.g., scanner 500 was previously paired) and/or is identified as having information of interest to applications executing on the apparatus, to an apparatus user, etc. Recognition and/or response to advertisements may occur automatically in view of parameters, rules, etc. set in scanner 500, or alternatively, the receipt of a message from advertiser 510 may trigger a request for user interaction with scanner 500 (e.g., via user interface 160 in WCD 100). For example, a request may ask whether communication is desired with advertiser 510. If communication is desired, scanner 500 may transmit a

response message requesting wireless connection establishment. If advertiser 510 is in a condition to honor the request (e.g., advertiser 510 is, for example, not already connected to another apparatus/exceeded maximum connections, has adequate power, etc.) a formal network connection may be established between the two apparatuses 500 and 510.

[0055] A formal network connection, such as shown in FIG. 5A ("APPARATUSES CONNECTED ON DATA CHANNEL"), will not be established on the advertising channel. Instead, a set of different channels specifically for the subsequent exchange of data will be used by the apparatuses. This new connection will allow the apparatuses to exchange information without occupying the advertising channel. Apparatus interaction (e.g., Data_PDU) may continue until, for example, scanner 500 receives all data requested from advertiser 510, either apparatus intentionally breaks the link, the apparatuses move out of transmission range of each other, resource limitations (power, processor, etc.) necessitate ending a link, interference, etc.

V. Connection feature example.

[0056] Modulation scheme is an example of a connection feature that may influence the overall performance of apparatuses engaged in wireless communication. As a result, the choice of a modulation scheme may depend on the performance delivered in view of the resource cost. BT LE is a good example of this tradeoff. The only modulation scheme currently specified for BT LE communication is Gaussian Frequency Shift Keying (GFSK). GFSK transceivers offer low implementation cost and low power consumption with reasonable link performance. This modulation scheme enables use of a simple open-loop direct VCO modulation transmitter architecture. However, the low cost, low power and simplicity of GFSK may be negatively impacted by poor bandwidth efficiency, as well as real-world operational requirements for high signal-to-noise ratio (SNR) and high carrier-to-interference (CIR) ratio in order to perform well.

[0057] The impact of GFSK may be seen with respect to mode-dependent power consumption in apparatuses. For example, power consumption in apparatuses using GFSK is only between 1/10 and 1/100 of the standard Bluetooth™ power consumption when operating in a connectable mode, but not yet in an actual connection. That means that apparatuses having limited resources (e.g., wireless sensors) using BT LE can operate in a standby mode for long periods of time. However, while two BT LE devices are in connection, the power consumption is only 2-3 times smaller than in regular Bluetooth™.

While the time that an apparatus remains in either a connectable mode or in a connection is highly dependent on the usage case, it is evident that adjusting at least this connection feature may result in a potential power savings.

[0058] Other modulation schemes exist that can offer better bandwidth efficiency and better performance in noisy environments (e.g., on interfered-with channels) than what can be provided by GFSK. For example, two different modulation schemes that may be configured for a Bluetooth™ connection, either individually or in combination, are disclosed in FIG. 5B. An example Bluetooth™ link utilizing GFSK is shown at 550. GFSK 550 may be an appropriate modulation scheme for use in many wireless transactions (e.g., in view of the corresponding abilities and weaknesses shown in FIG. 5B). However, certain scenarios may present challenges (e.g., large amounts of data, resource restrictions and/or environmental interference) that can make the use of GFSK 550 unreliable and/or inefficient. These problematic situations may dictate the use of an alternative modulation scheme, for example, Phase Shift Keying (PSK).

[0059] PSK is capable of higher data rates than GFSK 550, which may over time result in lower total power consumption when energy per bit is considered. In view of the potential performance improvement, the Bluetooth™ core specification has evolved to now include better modulation schemes. In particular, where originally GFSK 550 was the only option, an option to use PSK in the packet payload has been added as shown in FIG. 5B at 552. This configuration is often referred to as EDR (enhanced data rate). The combination of Bluetooth™ using original modulation and enhanced modulation is called BR/EDR, where BR stands for basic rate. In BR/EDR, access code and header bits may be modulated using GFSK 550, while only the packet payload is modulated using enhanced modulation (e.g., PSK). This solution may be used with BR/EDR since access code and header bits are protected against errors in Bluetooth™, and thus, better modulation can be used in the payload. However, the same solution cannot be applied to BT LE since these packet error safeguards have been removed for the sake of efficiency.

[0060] The access code and header bits are not protected against link errors in wireless transports like BT LE, and thus, communication performance is limited by the access code header bits sent using a default configuration (e.g., GFSK 550), even if the modulation in the payload portion is able to provide better link performance. This situation will unavoidably cause performance problems as transmission data amounts

increase. Performance increases similar to the evolution of Bluetooth™ will be expected in BT LE, especially if some sort of IP adaptation or 6LoWPAN-like solution is considered to be used over BT LE to enable IP-based wireless sensor solutions, which could result in a substantially large amount of data for transmission.

VI. Example feature selection during connection establishment

[0061] Now referring to FIG. 6, an example of apparatus interaction in accordance with various embodiments of the present invention is disclosed. In similarity to previously discussed examples, scanner 500 and advertiser 510 are configured to interact via wireless communication, and in this instance, via BT LE. However, the various embodiments of the present invention are not limited to this particular application or type of wireless interaction, which have been selected merely for the sake of explanation herein. The various embodiments of the present invention can be implemented in any usage situation where a plurality of apparatuses are interacting wirelessly.

[0062] Advertisement message 602 may be sent from advertiser 510 as an invitation to establish a wireless connection with other apparatuses. Advertisement 602 may be directed to specific apparatuses, or may be a general broadcast to devices within communication range of advertiser 510. The content of advertisement 602 may be at least partially dictated the protocol of the wireless transport being used. For example, some of the information in advertisement 602 may be set forth in a specific manner to address the information requirements of an apparatus connecting to advertiser 510. However, some portions of the message structure may still be unallocated (often referred to as "reserved for future use"). In accordance with at least one embodiment of the present invention, one or more unused portions of advertisement messages may be utilized to convey options that may be configured as a part of connection establishment.

[0063] For example, advertisement 602 may comprise one or more reserved bits. These bits may be defined as part of emerging specifications to convey configuration options to other apparatuses. In the example disclosed in FIG. 6, the highlighted reserved bit may inform other apparatuses as to whether enhanced modulation is supported ("1" in this example means that the feature is supported). Support for a feature in this instance means that advertiser 510 is able to operate using this feature, and may implement the particular feature upon confirmation from the one or more devices to which connection is

sought. A sample connection response 604 is also disclosed in FIG. 6. In this instance a portion of the information contained in response 604 may indicate (as defined, for example, in the specification for the wireless transport) whether or not to activate the particular feature that was offered by advertiser 510 in advertisement 602.

[0064] Scanner 500, as represented in the example of FIG. 6, responds affirmatively by requesting activation of the offered feature (e.g., enhanced modulation) in response message 604. It is important to note that regardless of whether the acceptance bit in the response message 604 is "0" (e.g., decline offered feature) or "1" (e.g., activate offered feature"), advertisement 602 would have had to first offer the feature (e.g., the highlighted bit in advertisement 602 would have had to be "1") before the feature can be implemented. This is because the ability to offer a feature does not imply the feature should be implemented. For example, the feature may not be supported by advertiser 510, may not appropriate for anticipated wireless interaction, if the current condition of advertiser 510 will not allow for the implementation of the feature, etc.

[0065] In the example of FIG. 6, advertiser 510 and scanner 500 may negotiate whether to activate the feature offered in advertisement 602. Since scanner 500 answers affirmatively in connection response 604, a wireless connection that implements the enhanced modulation feature may be established at 606. While this example presents modulation scheme as an offered feature that may be configured during connection establishment, the various embodiments of the present invention are not limited to utilizing only this feature. Any feature that is configurable during establishment of a wireless connection between apparatuses may be negotiated in this manner.

VII. Example feature selection during an established connection

[0066] An alternative configuration of the present invention may include, in accordance with at least one embodiment, altering the communication features of an established connection. For example, changes in wireless connection activity may necessitate reconfiguration. Changes may include, for example, an increase in the amount of data being conveyed via a connection, a change in the type of data being conveyed via the connection, increased/reduced environmental interference, changes apparatus position (e.g., distance between the devices is increasing), etc.

[0067] In the example disclosed in FIG. 7, a wireless connection has already been established between scanner 500 and advertiser 510 at 700. A connection configuration change necessitated, for example by one or more of the example changes discussed above, may result in feature request 702. Feature request 702 may include one or more indicators corresponding to features that can be configured in the wireless connection as originally set forth in advertisement 602. In the depicted scenario, feature request has the ability to request "feature 1," "feature 2" and "feature 3." However, only features 1 and 3 are being requested by scanner 500 in feature request 702. Similar to the prior example, feature 2 may be omitted by scanner 500 for various reasons related to, for example, the particular transactions to occur via the wireless connection.

[0068] Feature response 704 may provide confirmation from advertiser 510 that the one or more features originally offered in advertisement 602 are still available and will be activated in the wireless connection. In at least one embodiment of the present invention, feature response 704 may individually address each feature requested by scanner 500. This may be seen in example feature response message 704 of FIG. 7 wherein the bit corresponding to feature 1 is not set (e.g., "0") while the bit corresponding to feature 3 is set (e.g., "1"). As a result of feature response 704, only feature 3 will be activated in the wireless connection (as shown at 706).

[0069] Now referring to FIG. 8A, flowcharts of example processes in accordance with at least one embodiment is disclosed. Steps 800-810 correspond to an example process for an initiating apparatus (e.g., an advertiser), while steps 830 to 840 correspond to an example process for a receiving device (e.g., a scanner). Communication arrows 820, 822 and 824 demonstrate the interaction between the two example processes.

[0070] In the example process corresponding to an initiating apparatus, an activity in the initiating apparatus may desire and/or require connection establishment in step 800. Activities that may prompt connection establishment may include, for example, applications executing on the initiating apparatus, user interaction with the initiating apparatus, periodic information gathering operations on the initiating apparatus, etc. In response to step 800, an advertisement message may be transmitted in step 802. Advertisement 820 may contain one or more features that can be configured during connection establishment or in order to alter the operation of an existing connection. This message sent to one or more predetermined apparatuses (e.g., where a resource exists on a

particular device), or may be broadcast to all proximate apparatuses in order to locate other apparatuses that can fulfill the needs of the initiating apparatus. Transmission of advertisement 820 may continue in step 802 until a response message is received in step 804.

[0071] Upon receipt of a response (e.g., messages 822 or 824), the initiating apparatus may determine in step 806 whether any of the features offered in advertisement 820 have been selected. If no features are selected in the response message, then in step 808 the connection may be established utilizing a default configuration (e.g., using predetermined connection features known to all participating apparatuses). The process may then return to step 800 to await the next wireless communication requirement. Alternatively, if one or more features are selected in the response message, then in step 810 the selected features may be implemented as part of connection established, or in changing an existing wireless connection. The process may then proceed to step 800 to await the next wireless communication requirement.

[0072] An example process occurring in a receiving device is described with respect to steps 830-840. Advertisement 820 may be received from the initiating apparatus in step 830. In step 832, the receiving device may determine if any features have been offered in the message. If no features have been offered in the advertisement, then response 822 omitting any feature selections may be sent to the initiating apparatus in step 834. The process may then reinitiate in step 830 in order to prepare for reception of the next advertising message.

[0073] On the instance that one or more features are offered in the advertisement, then in step 836 a determination may be made as to whether more than one feature is being proposed by the initiating apparatus. If only one feature is offered, then in step 838 a determination may be made as to whether the feature should be implemented. The determination may be made in view of various criteria, such as whether the feature is supported by a receiving device, whether a receiving device is currently in a condition that will allow the feature to be successfully implemented, the one or more transactions planned for execution via the wireless connection, current environmental conditions, etc. If the feature is not selected, then response 850 may be sent without any selection in step 834. If the receiving apparatus selects the feature, then the selection may be included in

response 824 (step 840). The process may then return to step 830 in preparation for the next advertising message.

[0074] In accordance with at least one embodiment of the present invention, if offers for multiple features are included in advertisement 820, then in step 842 a determination may be made as to whether the receiving apparatus supports each offered feature. Once the offered features that are supported by the receiving device have been identified (e.g., as "selectable" features), the process may execute step 838 to determine whether each selectable feature should be implemented. If none of the offered features should be implemented in a new wireless connection, then response 822 may be sent in step 834. Otherwise, the features that are selected may be sent in response 824 in step 840. The process may then return to step 830 in order to prepare for the next advertising message.

[0075] FIG. 8B discloses a flowchart of an example configuration change process in accordance with at least one embodiment of the present invention. After a connection has been established (e.g., using the example process of FIG. 8A), the connection may proceed in step 850. In step 852 the detection of an event may trigger consideration of a configuration change. Events may include, for example, changes in apparatus condition (e.g., power level, processing load, position, etc.), changes in data type or amount, changes in environmental characteristics, etc. If an event is determined to have occurred in step 852, a further determination may be made in step 854 as to whether any new features should be implemented. These features may include features that were previously available but were not offered in the initial advertisement message, features that were previously offered by an advertiser but were declined by a scanner, features that have just become available or applicable to the connection, etc. If none of these features would be applicable to the aforementioned change, then the process may continue using the existing configuration (step 850). Otherwise, a feature request 872 may be sent in step 856 in order to request one or more of the features discussed in the advertisement message.

[0076] The feature request may be sent in step 856 until feature response 874 is received in step 858. Upon receipt of the feature response, a determination may be made as to whether the requested features have been accepted (e.g., will be implemented in the wireless connection). For instance, this determination may be made on a feature-by-

feature basis. If a feature is accepted, the feature may be activated in the scanner in step 862 in preparation for the feature to be implemented in the wireless connection. Any features that are determined in step 860 to be refused may remain unchanged in step 864. The process may then return to step 860 in order to await further events that may require consideration of wireless connection configuration changes.

[0077] Steps 880 to 886 are directed to an example process with which an advertiser may react to feature request 872. The connection may proceed for the advertiser in step 880 until feature request 872 is received in step 882. After feature request 872 is received in step 882, the advertiser may determine in step 884 whether the requested features can still be implemented in the wireless connection. In particular, features that were originally offered in advertisement 820 may no longer be available due to, for example, changes in apparatus condition, in data being conveyed over the wireless connection, in environment, etc. Feature response 874 may then be formulated and sent in step 886, where feature response 874 may indicate, for example, requested features that can still be implemented and the features that are no longer available. The process may then return to step 880 to await the receipt of the next feature request 872.

[0078] Accordingly, it will be apparent to persons skilled in the relevant art that various changes in forma and detail can be made therein without departing from the spirit and scope of the invention. The breadth and scope of the present invention should not be limited by any of the above-described example embodiments, but should be defined only in accordance with the following claims and their equivalents.

WHAT IS CLAIMED:

1. A method, comprising:

transmitting an advertising message, the advertising message comprising one or more indicators identifying features that can be configured when establishing a wireless connection;

receiving a message responding to the advertising message;

determining whether any of the features corresponding to the one or more indicators have been selected based on information in the response message; and

implementing the selected features when establishing the wireless connection.

2. The method of claim 1, wherein the one or more indicators are bits within a standard advertising message that are currently reserved for future functionality.

3. The method of claim 1, wherein the features comprise at least a modulation scheme.

4. The method of claim 1, wherein determining whether any of the features corresponding to the one or more indicators have been selected comprises determining if the response message includes one or more indicators corresponding to selected features.

5. A method, comprising:

receiving an advertising message, the advertising message comprising one or more indicators identifying features that can be configured when establishing a wireless connection;

determining whether any of the features corresponding to the one or more indicators are selectable based at least on local information;

if any of the features are selectable, determining whether the selectable features should be used when establishing the wireless connection;

sending a response message, the response message comprising one or more indicators corresponding to the selectable features that should be used.

6. The method of claim 5, wherein the local information comprises at least an identification of features that are supported in an apparatus that is receiving the advertisement.

7. The method of claim 6, wherein determining whether any of the features corresponding to the one or more indicators are selectable comprises comparing the features identified in the advertising message to the features identified in the local information.

8. The method of claim 5, wherein determining whether the selectable features should be used comprises determining if any of the selectable features should be used based on at least one transaction to be conducted via the wireless connection.

9. A computer program product comprising a computer executable program code recorded on a computer readable medium, comprising:

computer program code configured to transmit an advertising message, the advertising message comprising one or more indicators identifying features that can be configured when establishing a wireless connection;

computer program code configured to receive a message responding to the advertising message;

computer program code configured to determine whether any of the features corresponding to the one or more indicators have been selected based on information in the response message; and

computer program code configured to implement the selected features when establishing the wireless connection.

10. The computer program product of claim 9, wherein the one or more indicators are bits within a standard advertising message that are currently reserved for future functionality.

11. The computer program product of claim 9, wherein the features comprise at least a modulation scheme.

12. The computer program product of claim 9, wherein determining whether any of the features corresponding to the one or more indicators have been selected comprises determining if the response message includes one or more indicators corresponding to selected features.

13. A computer program product comprising a computer executable program code recorded on a computer readable medium, comprising:

computer program code configured to receive an advertising message, the advertising message comprising one or more indicators identifying features that can be configured when establishing a wireless connection;

computer program code configured to determine whether any of the features corresponding to the one or more indicators are selectable based at least on local information;

computer program code configured to, if any of the features are selectable, determining whether the selectable features should be used when establishing the wireless connection;

computer program code configured to send a response message, the response message comprising one or more indicators corresponding to the selectable features that should be used.

14. The computer program product of claim 13, wherein the local information comprises at least an identification of features that are supported in an apparatus that is receiving the advertisement.

15. The computer program product of claim 14, wherein determining whether any of the features corresponding to the one or more indicators are selectable comprises comparing the features identified in the advertising message to the features identified in the local information.

16. The computer program product of claim 13, wherein determining whether the selectable features should be used comprises determining if any of the selectable

features should be used based on at least one transaction to be conducted via the wireless connection.

17. An apparatus, comprising:

a processor, the processor being configured to:

transmit an advertising message, the advertising message comprising one or more indicators identifying features that can be configured when establishing a wireless connection;

receive a message responding to the advertising message;

determine whether any of the features corresponding to the one or more indicators have been selected based on information in the response message; and

implement the selected features when establishing the wireless connection.

18. The apparatus of claim 17, wherein the one or more indicators are bits within a standard advertising message that are currently reserved for future functionality.

19. The apparatus of claim 17, wherein the features comprise at least a modulation scheme.

20. The apparatus of claim 17, wherein determining whether any of the features corresponding to the one or more indicators have been selected comprises determining if the response message includes one or more indicators corresponding to selected features.

21. An apparatus, comprising:

a processor, the processor being configured to:

receive an advertising message, the advertising message comprising one or more indicators identifying features that can be configured when establishing a wireless connection;

determine whether any of the features corresponding to the one or more indicators are selectable based at least on local information;

if any of the features are selectable, determine whether the selectable features should be used when establishing the wireless connection;

send a response message, the response message comprising one or more indicators corresponding to the selectable features that should be used.

22. The apparatus of claim 21, wherein the local information comprises at least an identification of features that are supported in an apparatus that is receiving the advertisement.

23. The apparatus of claim 22, wherein determining whether any of the features corresponding to the one or more indicators are selectable comprises comparing the features identified in the advertising message to the features identified in the local information.

24. The apparatus of claim 21, wherein determining whether the selectable features should be used comprises determining if any of the selectable features should be used based on at least one transaction to be conducted via the wireless connection.

25. An apparatus, comprising:

means for transmitting an advertising message, the advertising message comprising one or more indicators identifying features that can be configured when establishing a wireless connection;

means for receiving a message responding to the advertising message;

means for determining whether any of the features corresponding to the one or more indicators have been selected based on information in the response message; and

means for implementing the selected features when establishing the wireless connection.

26. An apparatus, comprising:

means for receiving an advertising message, the advertising message comprising one or more indicators identifying features that can be configured when establishing a wireless connection;

means for determining whether any of the features corresponding to the one or more indicators are selectable based at least on local information;

means for, if any of the features are selectable, determining whether the selectable features should be used when establishing the wireless connection;

means for sending a response message, the response message comprising one or more indicators corresponding to the selectable features that should be used.

27. A system, comprising:

an initiating apparatus; and

at least one receiving apparatus;

the initiating apparatus transmitting an advertising message, the advertising message comprising one or more indicators identifying features that can be configured when establishing a wireless connection;

the at least one receiving apparatus receiving an advertising message and determining whether any of the features corresponding to the one or more indicators are selectable based at least on local information;

the at least one receiving apparatus, if any of the features are selectable, determining whether the selectable features should be used when establishing the wireless connection and sending a response message, the response message comprising one or more indicators corresponding to the selectable features that should be used;

the initiating apparatus further receiving a message responding to the advertising message, determining whether any of the features corresponding to the one or more indicators have been selected based on information in the response message, and implementing the selected features when establishing the wireless connection.

FIG. 1A

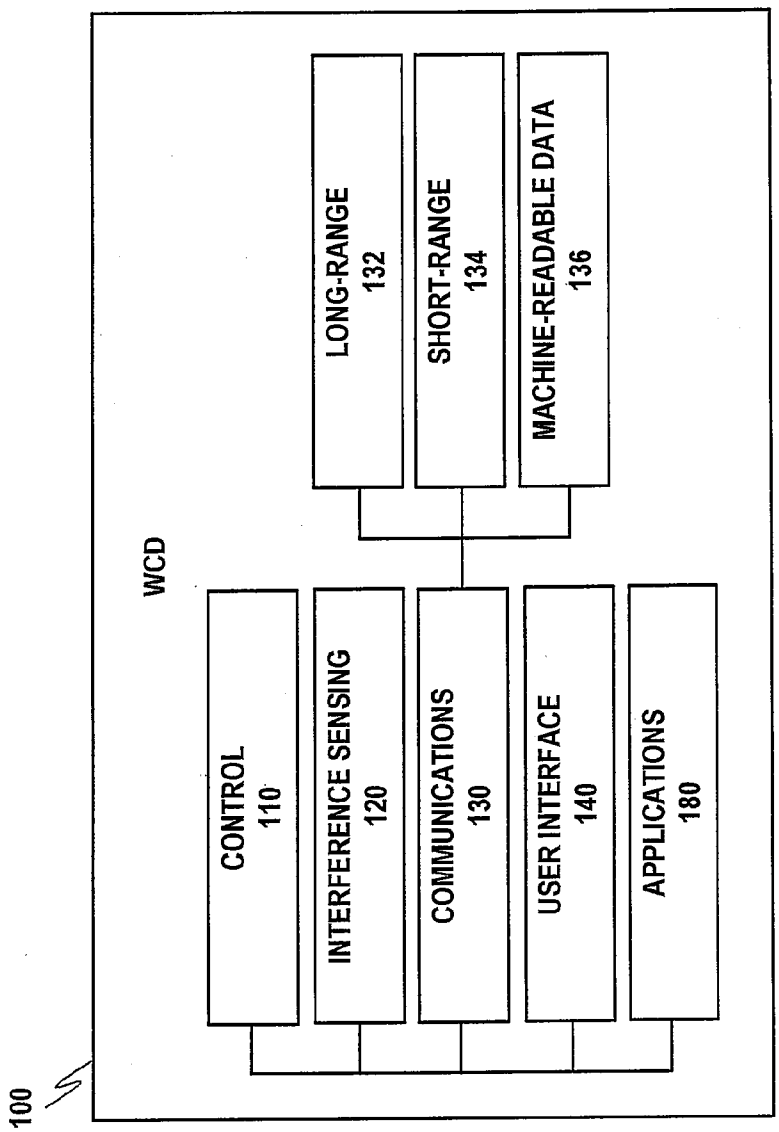

100
WCD
CONTROL 110
INTERFERENCE SENSING 120
COMMUNICATIONS 130
USER INTERFACE 140
APPLICATIONS 180
LONG-RANGE 132
SHORT-RANGE 134
MACHINE-READABLE DATA 136

FIG. 1B

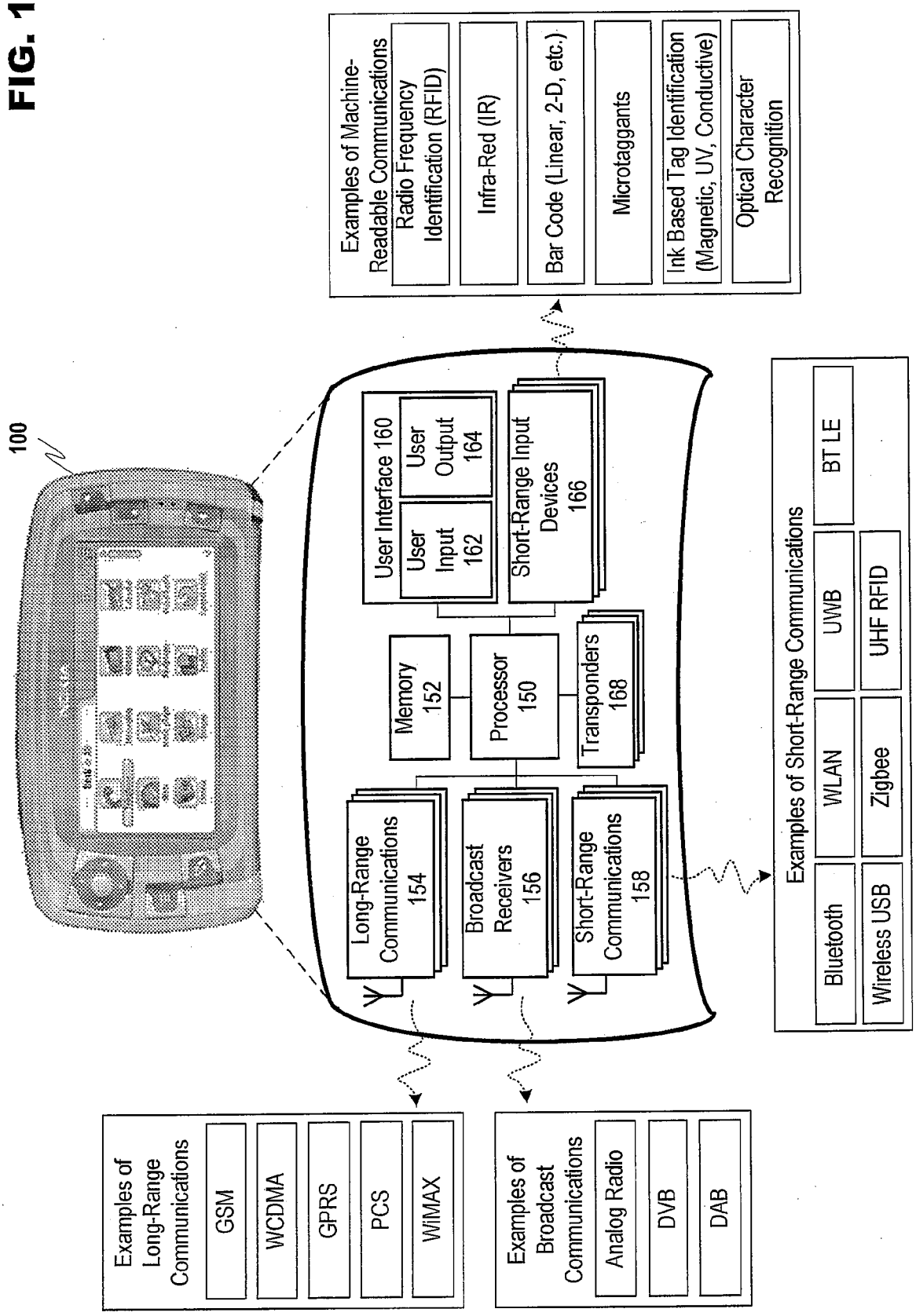
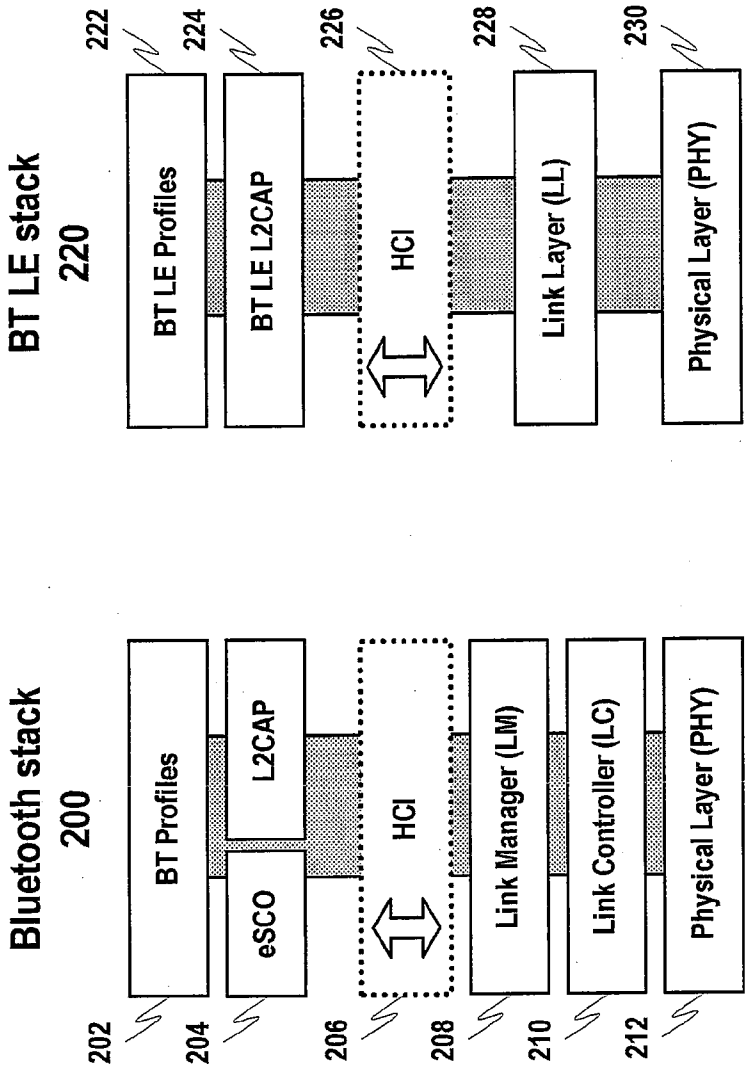

100
Examples of Machine-Readable Communications
Radio Frequency Identification (RFID)
Infra-Red (IR)
Bar Code (Linear, 2-D, etc.)
Microtaggants
Ink Based Tag Identification (Magnetic, UV, Conductive)
Optical Character Recognition
User Interface 160
User Input 162
User Output 164
Short-Range Input Devices 166
Memory 152
Processor 150
Transponders 168
Long-Range Communications 154
Broadcast Receivers 156
Short-Range Communications 158
Examples of Short-Range Communications
Bluetooth
WLAN
UWB
BT LE
Wireless USB
Zigbee
UHF RFID
Examples of Long-Range Communications
GSM
WCDMA
GPRS
PCS
WiMAX
Examples of Broadcast Communications
Analog Radio
DVB
DAB

FIG. 2


BT LE stack
220
222
224
226
228
230
BT LE Profiles
BT LE L2CAP
HCI
Link Layer (LL)
Physical Layer (PHY)
Bluetooth stack
200
202
204
206
208
210
212
BT Profiles
L2CAP
eSCO
HCI
Link Manager (LM)
Link Controller (LC)
Physical Layer (PHY)

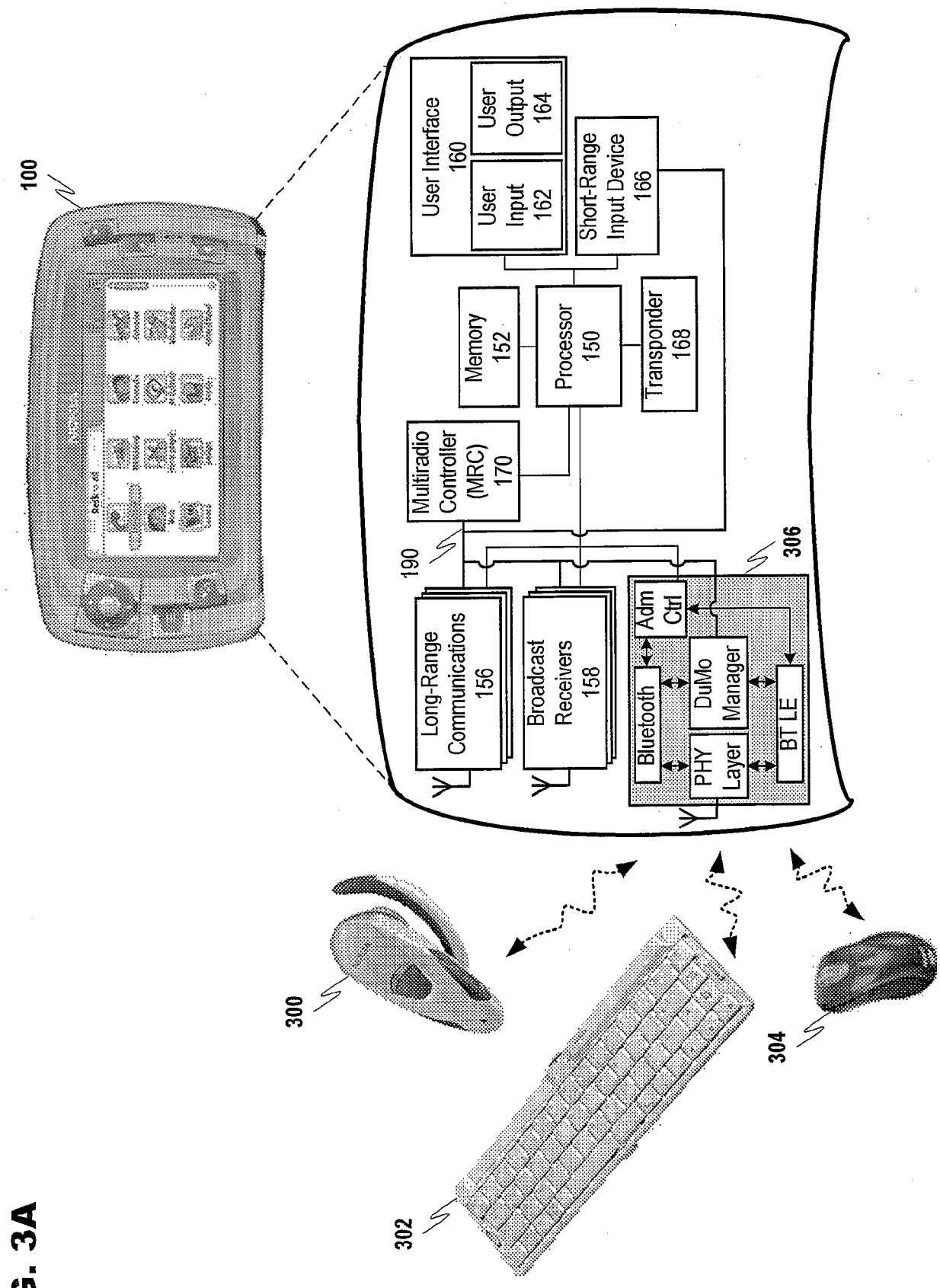

100
User Interface 160
User Input 162
User Output 164
Short-Range Input Device 166
Memory 152
Processor 150
Transponder 168
Multiradio Controller (MRC) 170
190
306
Long-Range Communications 156
Broadcast Receivers 158
Adm Ctrl
Bluetooth
DuMo Manager
PHY Layer
BT LE
300
302
304

FIG. 3A

FIG. 3B

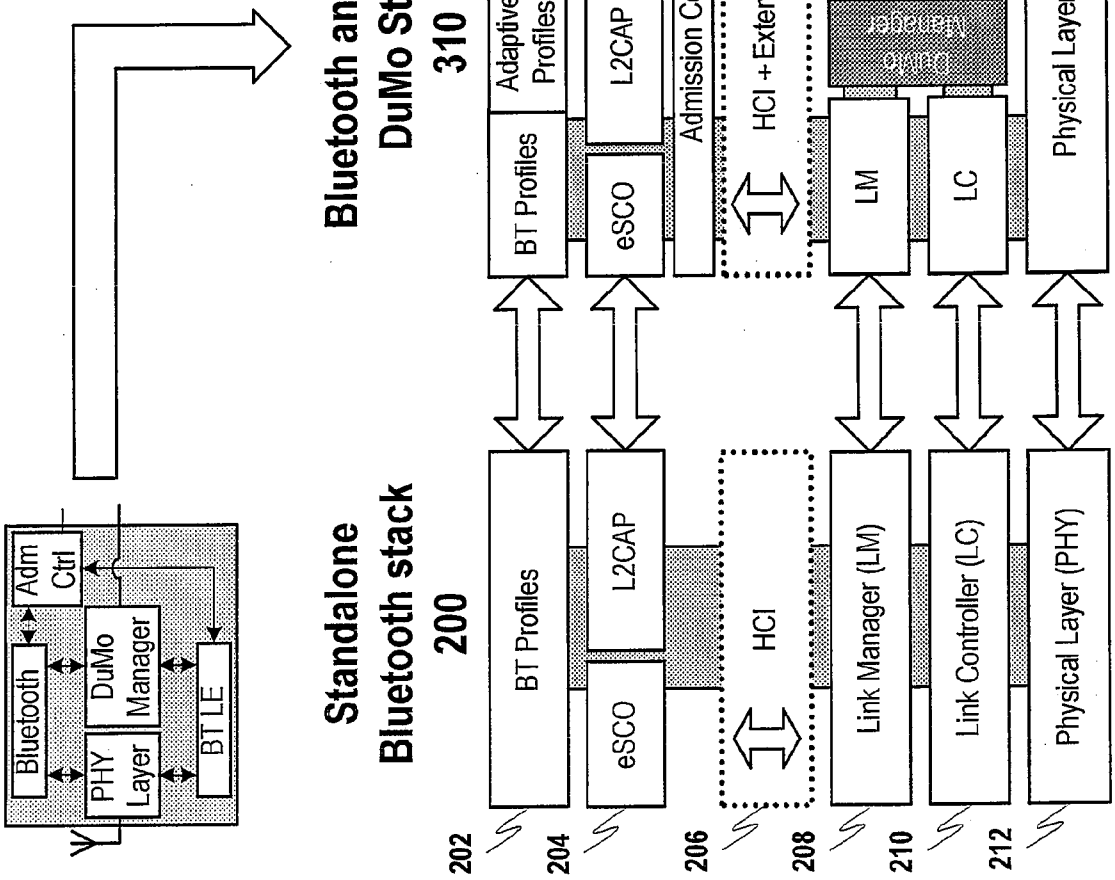

Bluetooth
Adm Ctrl
DuMo Manager
PHY Layer
BT LE
Standalone Bluetooth stack 200
Bluetooth and BT LE DuMo Stack 310
312
Standalone BT LE Stack 220
BT Profiles
eSCO
L2CAP
HCI
Adaptive Profiles
BT LE Profiles
BT LE control
Admission Control
HCI + Extension
314
316
LM
LC
LL
Link Manager (LM)
Link Controller (LC)
Link Layer (LL)
Physical Layer (PHY)
BT LE L2CAP
202
204
206
208
210
212
222
224
226
228
230

FIG. 4

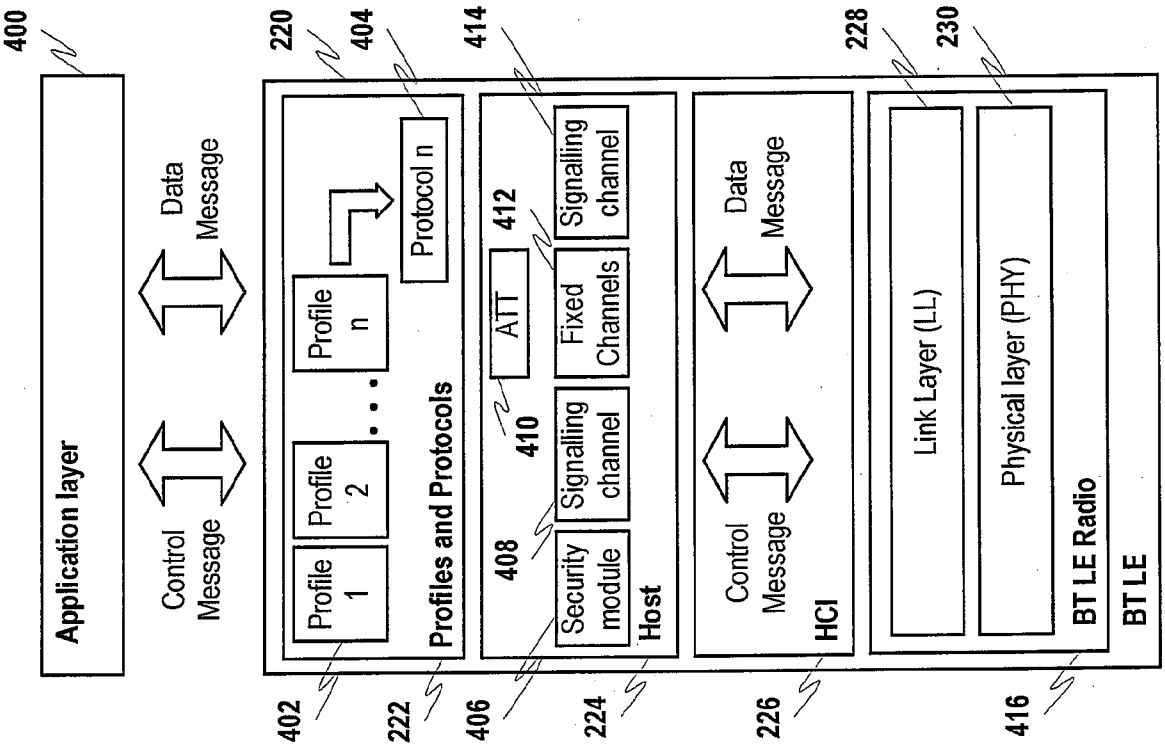

400
Application layer
Control Message
Data Message
220
404
414
228
230
Profile 1
Profile 2
Profile n
Protocol n
Profiles and Protocols
408
410
ATT
412
Signalling channel
Fixed Channels
Signalling channel
Security module
Host
Control Message
Data Message
HCI
Link Layer (LL)
Physical layer (PHY)
BT LE Radio
BT LE
402
222
406
224
226
416

FIG. 5A

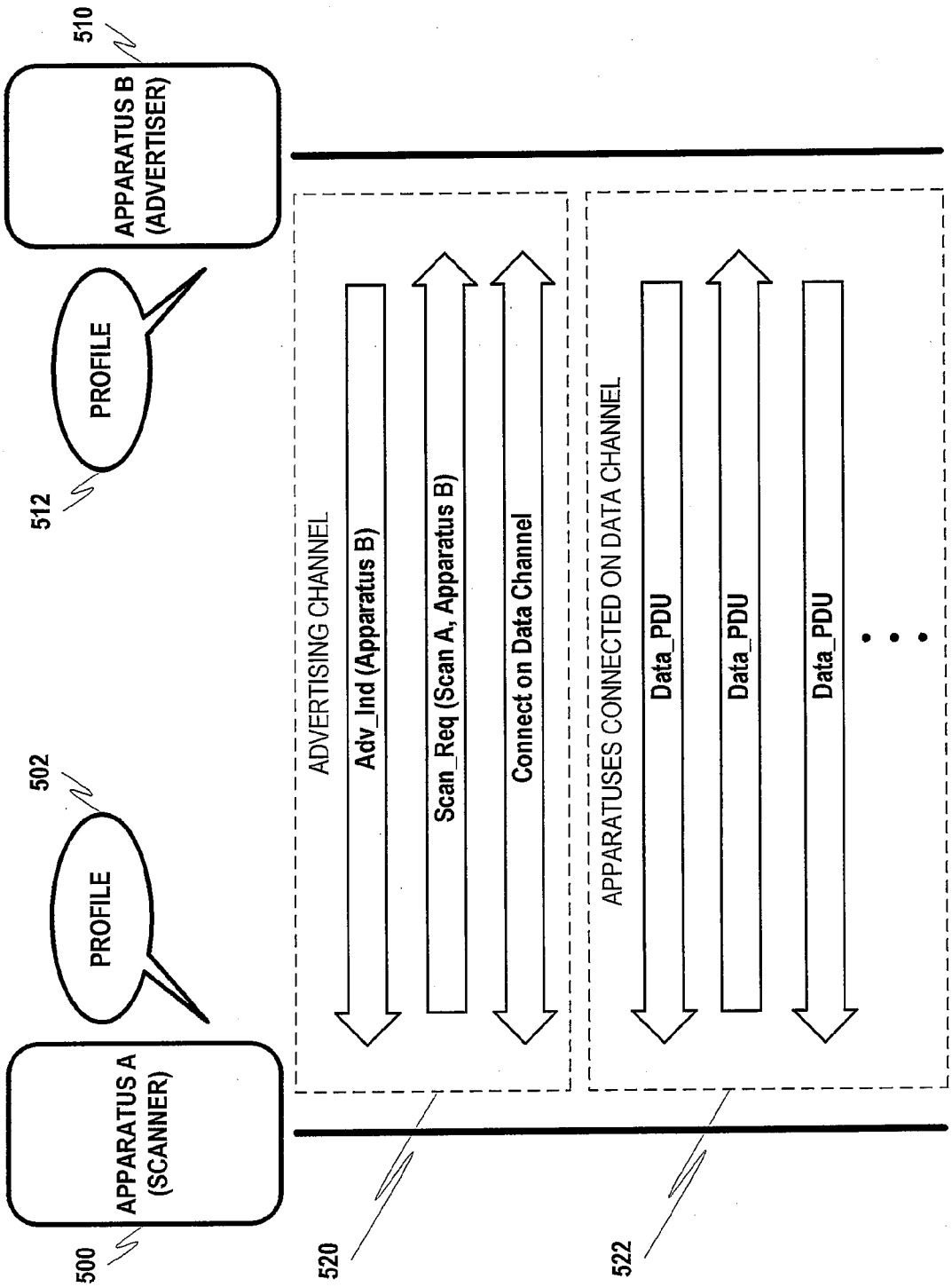

510
APPARATUS B (ADVERTISER)
PROFILE
512
502
PROFILE
APPARATUS A (SCANNER)
500
ADVERTISING CHANNEL
Adv_Ind (Apparatus B)
Scan_Req (Scan A, Apparatus B)
Connect on Data Channel
APPARATUSES CONNECTED ON DATA CHANNEL
Data_PDU
Data_PDU
Data_PDU
520
522

FIG. 5B

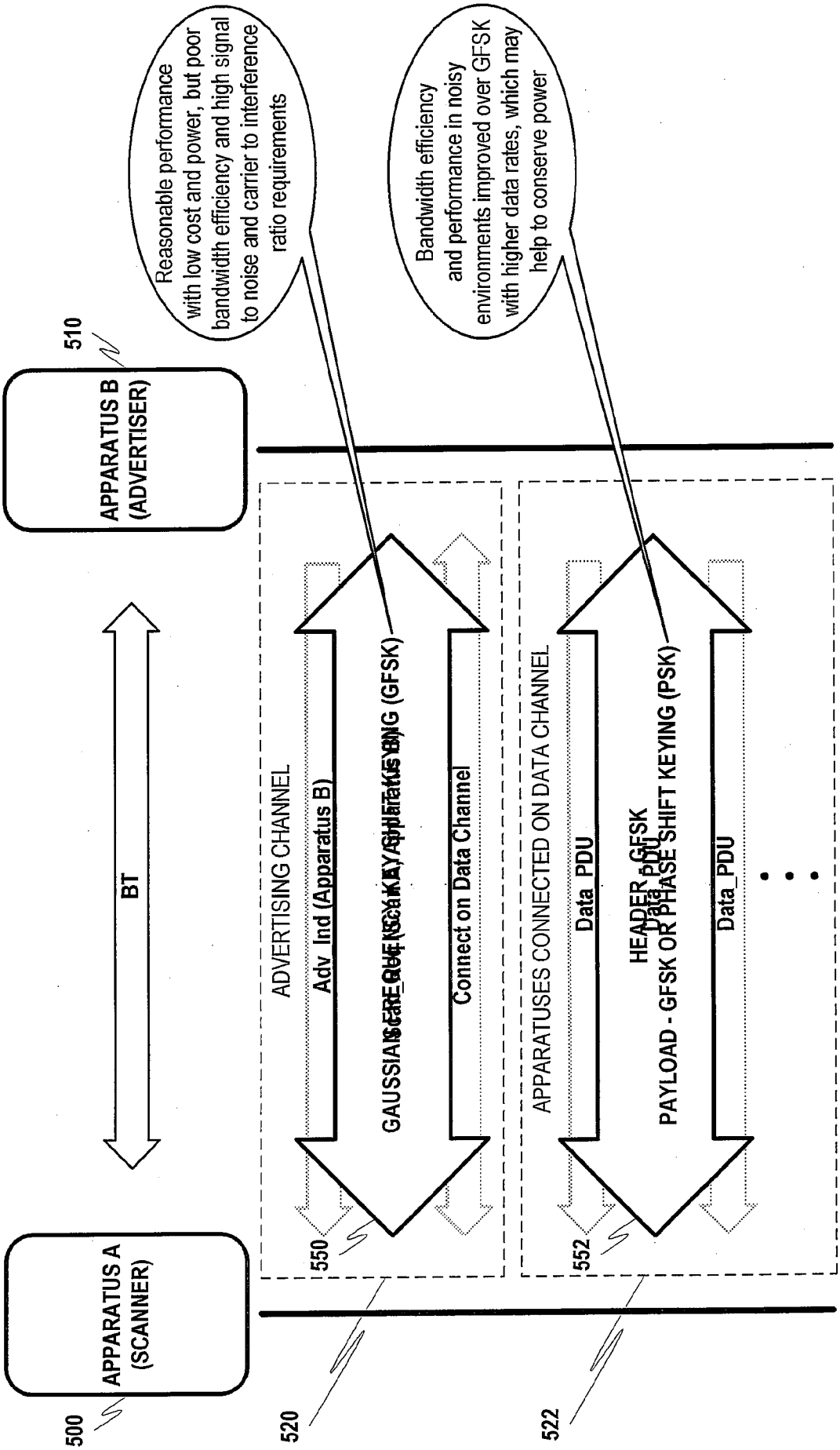

Reasonable performance with low cost and power, but poor bandwidth efficiency and high signal to noise and carrier to interference ratio requirements
Bandwidth efficiency and performance in noisy environments improved over GFSK with higher data rates, which may help to conserve power
510
APPARATUS B (ADVERTISER)
BT
APPARATUS A (SCANNER)
500
520
522
ADVERTISING CHANNEL
APPARATUSES CONNECTED ON DATA CHANNEL
Adv_Ind (Apparatus B)
Connect on Data Channel
Data_PDU
Data_PDU
550
552
HEADER - GFSK
PAYLOAD - GFSK OR PHASE SHIFT KEYING (PSK)

FIG. 6

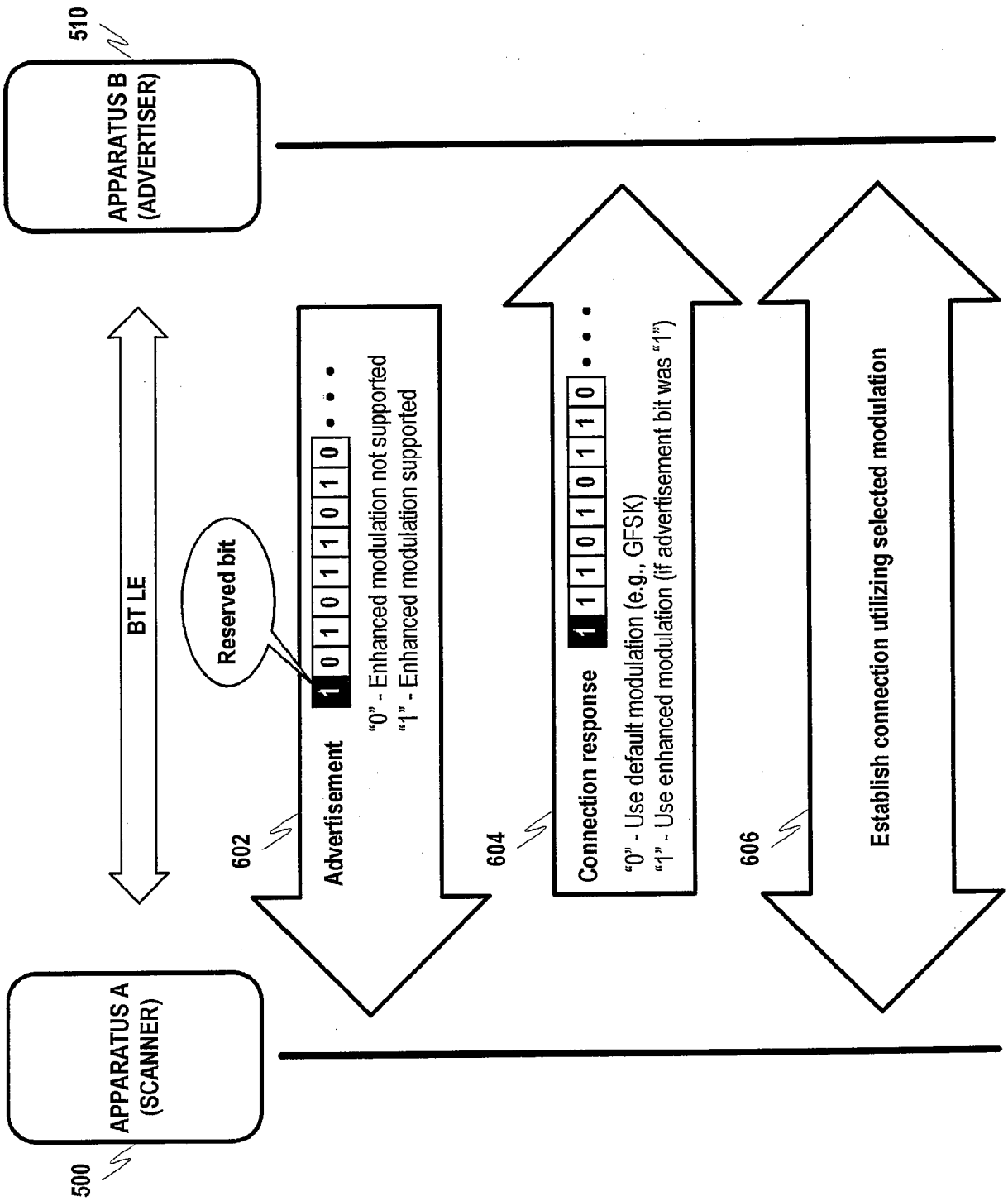

510
APPARATUS B (ADVERTISER)
BT LE
Reserved bit
602
Advertisement
1 0 1 0 1 1 0 1 0 • • •
"0" - Enhanced modulation not supported
"1" - Enhanced modulation supported
604
Connection response
1 1 1 0 1 0 1 1 0 • • •
"0" - Use default modulation (e.g., GFSK)
"1" - Use enhanced modulation (if advertisement bit was "1")
606
Establish connection utilizing selected modulation
500
APPARATUS A (SCANNER)

FIG. 7

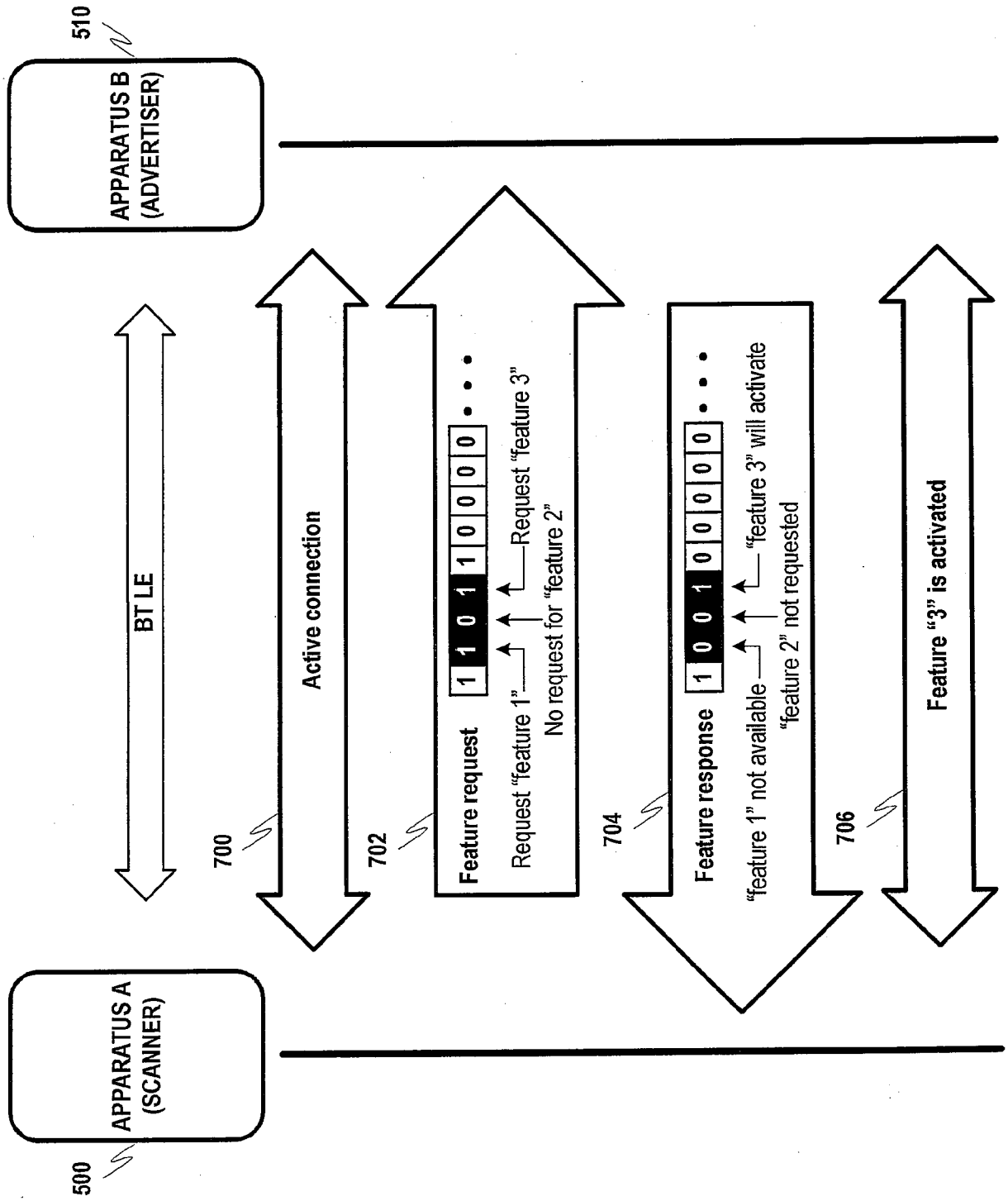

APPARATUS A
(SCANNER)
500
APPARATUS B
(ADVERTISER)
510
BT LE
Active connection
700
702
Feature request
1 1 0 1 1 0 0 0 0 • • •
Request "feature 1"
Request "feature 3"
No request for "feature 2"
704
Feature response
1 0 0 1 0 0 0 0 0 • • •
"feature 1" not available
"feature 3" will activate
"feature 2" not requested
706
Feature "3" is activated

FIG. 8A

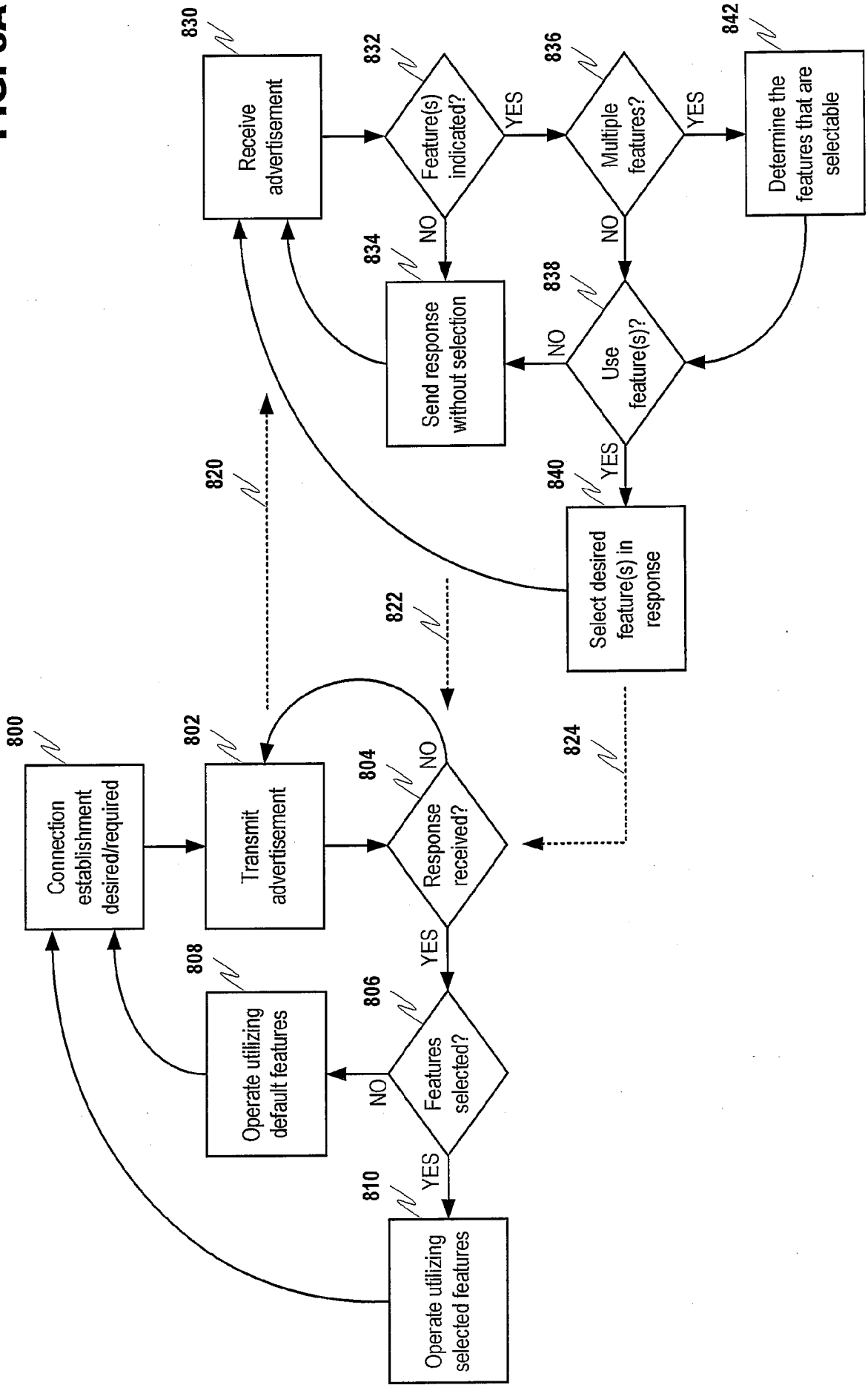
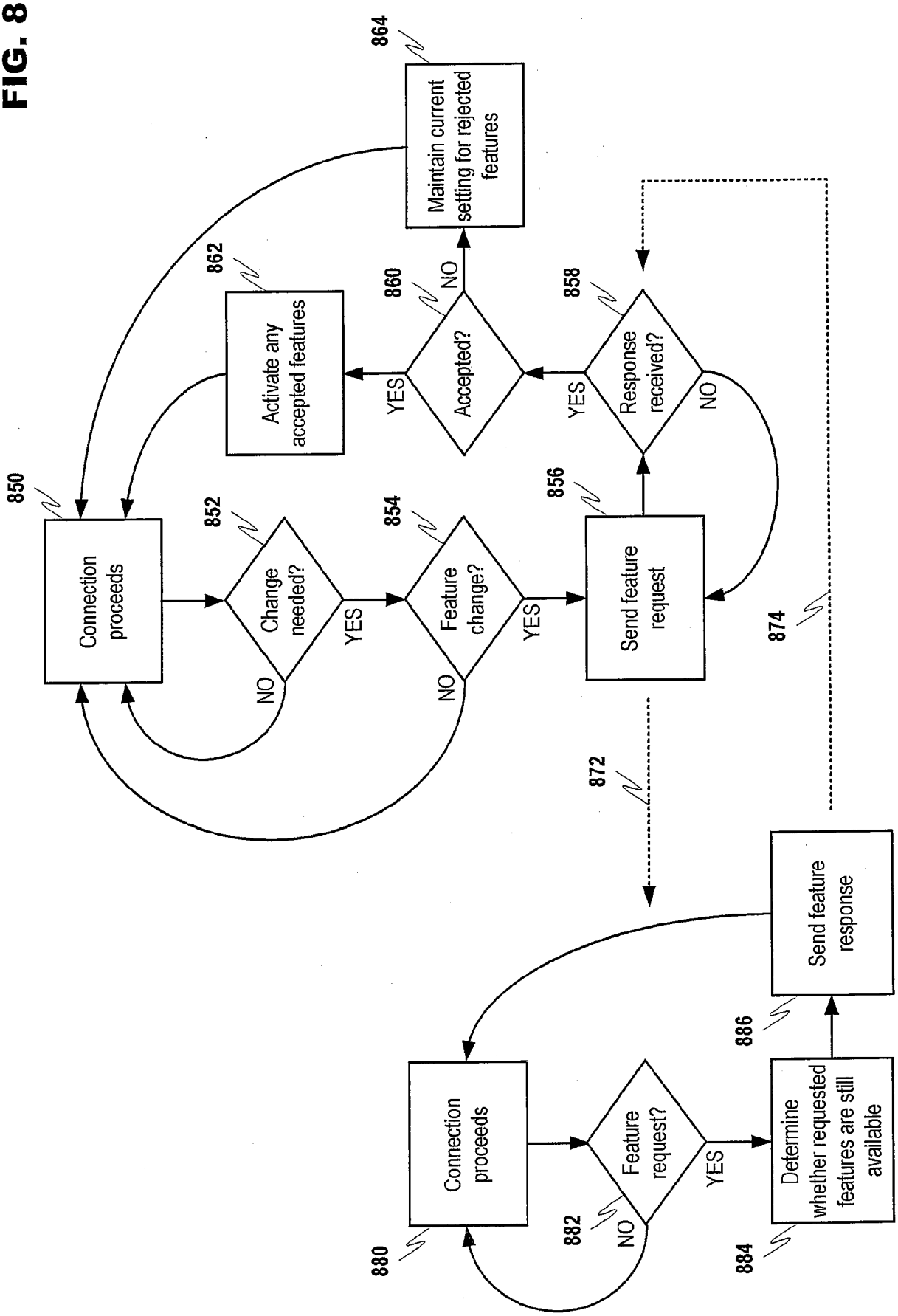

800
Connection establishment desired/required
802
Transmit advertisement
804
Response received?
NO
YES
806
Features selected?
NO
YES
808
Operate utilizing default features
810
Operate utilizing selected features
820
822
824
830
Receive advertisement
832
Feature(s) indicated?
YES
NO
834
Send response without selection
836
Multiple features?
YES
NO
838
Use feature(s)?
NO
YES
840
Select desired feature(s) in response
842
Determine the features that are selectable

FIG. 8B


Connection proceeds
850
Change needed?
852
NO
YES
Feature change?
854
NO
YES
Send feature request
856
Response received?
858
YES
NO
Accepted?
860
YES
NO
Activate any accepted features
862
Maintain current setting for rejected features
864
872
874
Send feature response
886
Connection proceeds
880
Feature request?
882
NO
YES
Determine whether requested features are still available
884

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2008/054410

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W48/08

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00/72611 A (MOTOROLA INC [US]) 30 November 2000 (2000-11-30) abstract page 5, line 24 - page 8, line 33	1-27
X	US 2007/019575 A1 (SHAHEEN KAMEL M [US]) 25 January 2007 (2007-01-25) abstract paragraphs [0007], [0020], [0022]	1-27
A	US 2007/041347 A1 (BEALE MARTIN W [GB] ET AL) 22 February 2007 (2007-02-22) abstract paragraphs [0103], [0120], [0127], [0139] - [0155]	1-27

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 July 2009	10/08/2009

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2008/054410

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