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(54) **SERVICE/DEVICE INDICATION WITH GRAPHICAL INTERFACE**

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See application file for complete search history.

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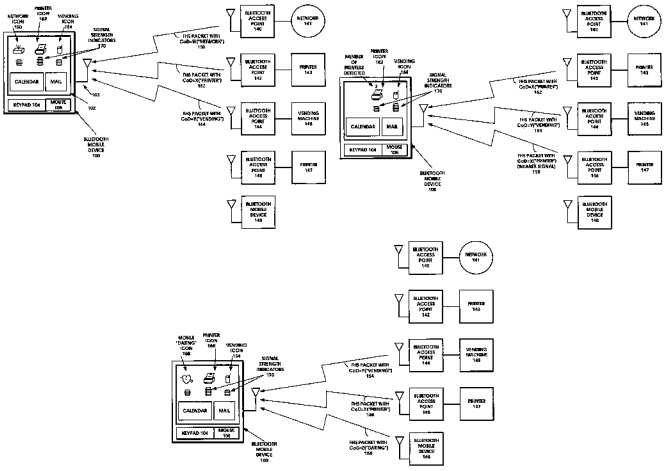
(57) **ABSTRACT**

The method disclosed gives the user rapid notice of those Bluetooth devices within communication range, and yet it selectively blocks any notice about Bluetooth devices that the user wishes to ignore. Bluetooth server devices can indicate to the user's Bluetooth client device the service the server device has available by sewing service/device icon information to Bluetooth client device. This information can be a value in the class-of-device (CoD) field of a frequency hop synchronization (FHS) packet that it sends during the process of exchanging inquiry and paging packets with the Bluetooth client device. If the server device has begun by transmitting an inquiry packet, then the CoD value will be sent in its paging packet. If the server device is responding to an inquiry, then its CoD value will be in its inquiry response packet. Alternately, the service/device icon information can be sent after a connection has been made with the client device, as part of a Service Discovery Protocol (SDP) response packet.

57 Claims, 7 Drawing Sheets



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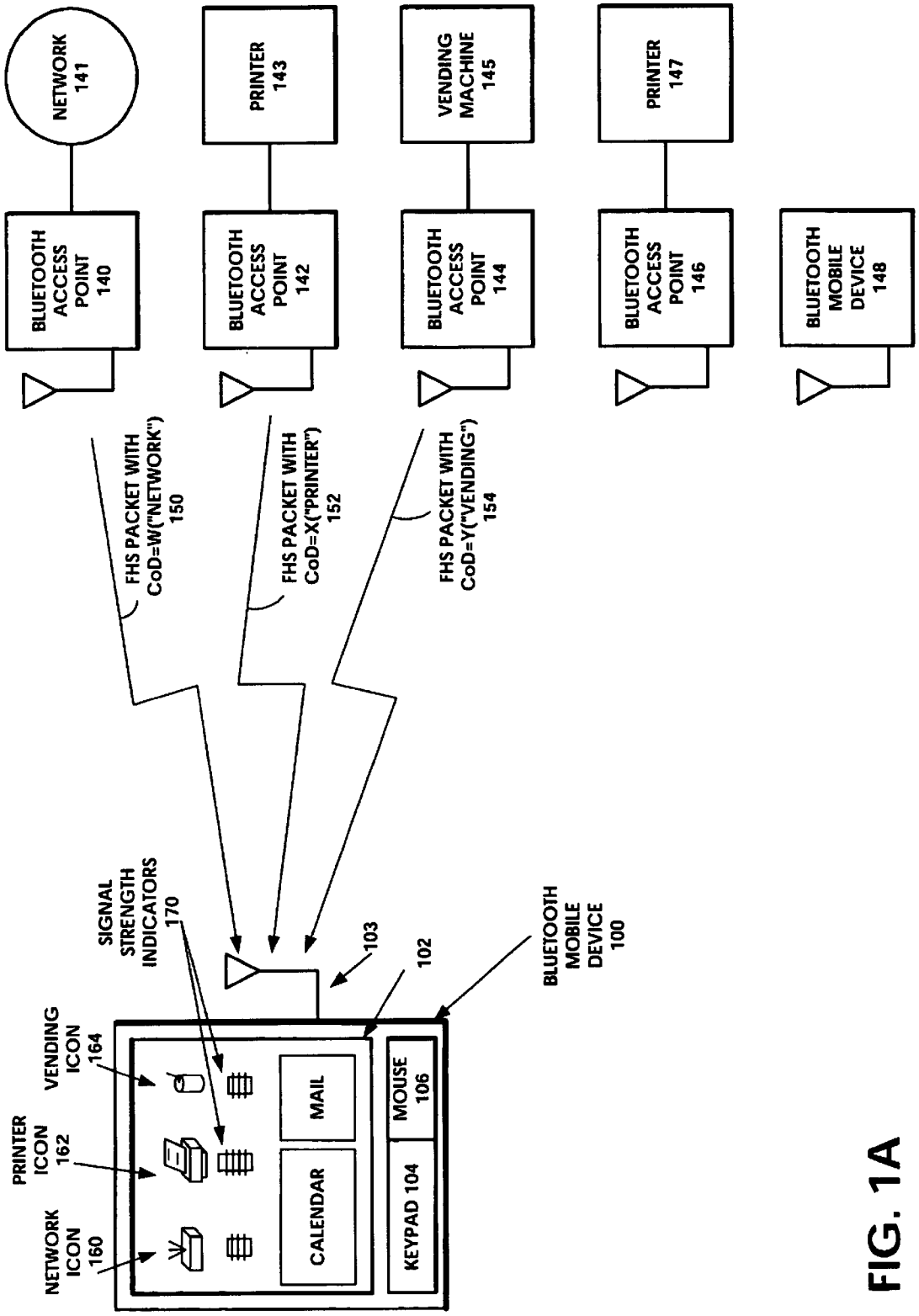
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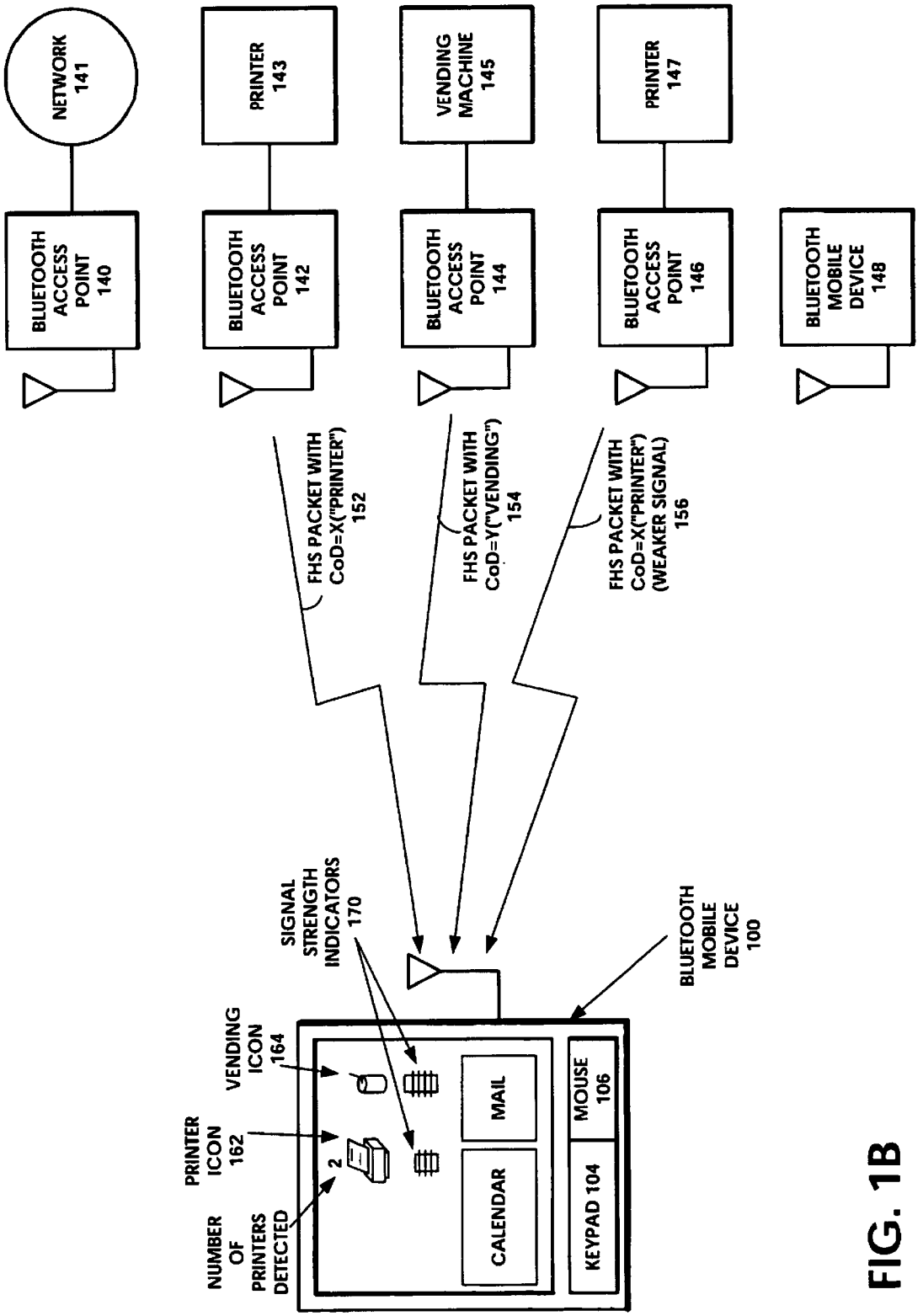
PRINTER 143
VENDING MACHINE 145
PRINTER 147
BLUETOOTH ACCESS POINT 140
BLUETOOTH ACCESS POINT 142
BLUETOOTH ACCESS POINT 144
BLUETOOTH ACCESS POINT 146
BLUETOOTH MOBILE DEVICE 148
FHS PACKET WITH CoD=W("NETWORK") 150
FHS PACKET WITH CoD=X("PRINTER") 152
FHS PACKET WITH CoD=Y("VENDING") 154
SIGNAL STRENGTH INDICATORS 170
103
102
BLUETOOTH MOBILE DEVICE 100
VENDING ICON 164
PRINTER ICON 162
NETWORK ICON 160
MAIL
CALENDAR
MOUSE 106
KEYPAD 104

FIG. 1A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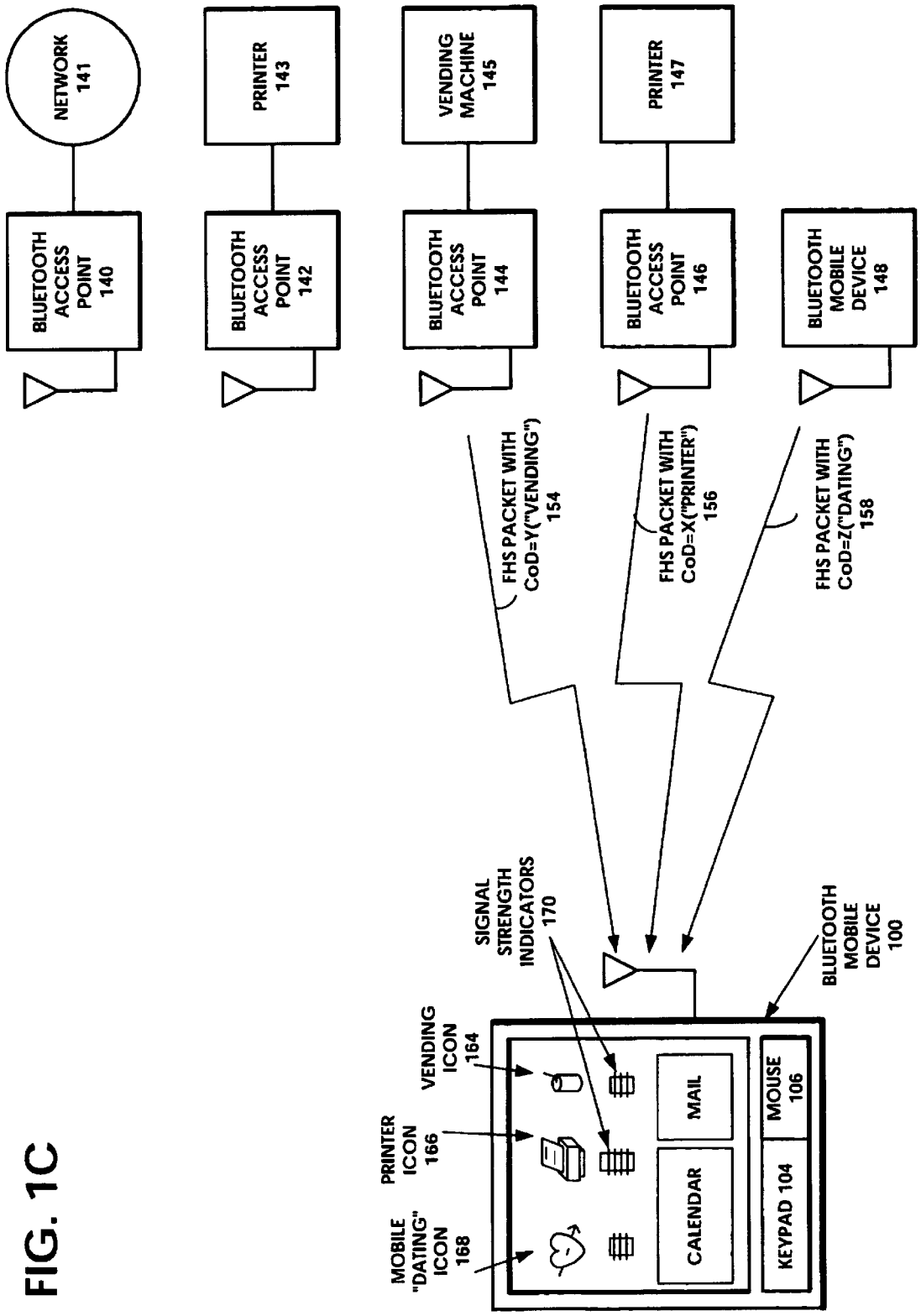
PRINTER 143
VENDING MACHINE 145
PRINTER 147
BLUETOOTH ACCESS POINT 140
BLUETOOTH ACCESS POINT 142
BLUETOOTH ACCESS POINT 144
BLUETOOTH ACCESS POINT 146
BLUETOOTH MOBILE DEVICE 148
FHS PACKET WITH CoD=X("PRINTER") 152
FHS PACKET WITH CoD=Y("VENDING") 154
FHS PACKET WITH CoD=X("PRINTER") (WEAKER SIGNAL) 156
SIGNAL STRENGTH INDICATORS 170
BLUETOOTH MOBILE DEVICE 100
VENDING ICON 164
PRINTER ICON 162
NUMBER OF PRINTERS DETECTED
2
CALENDAR
MAIL
KEYPAD 104
MOUSE 106

FIG. 1B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VENDING ICON 164
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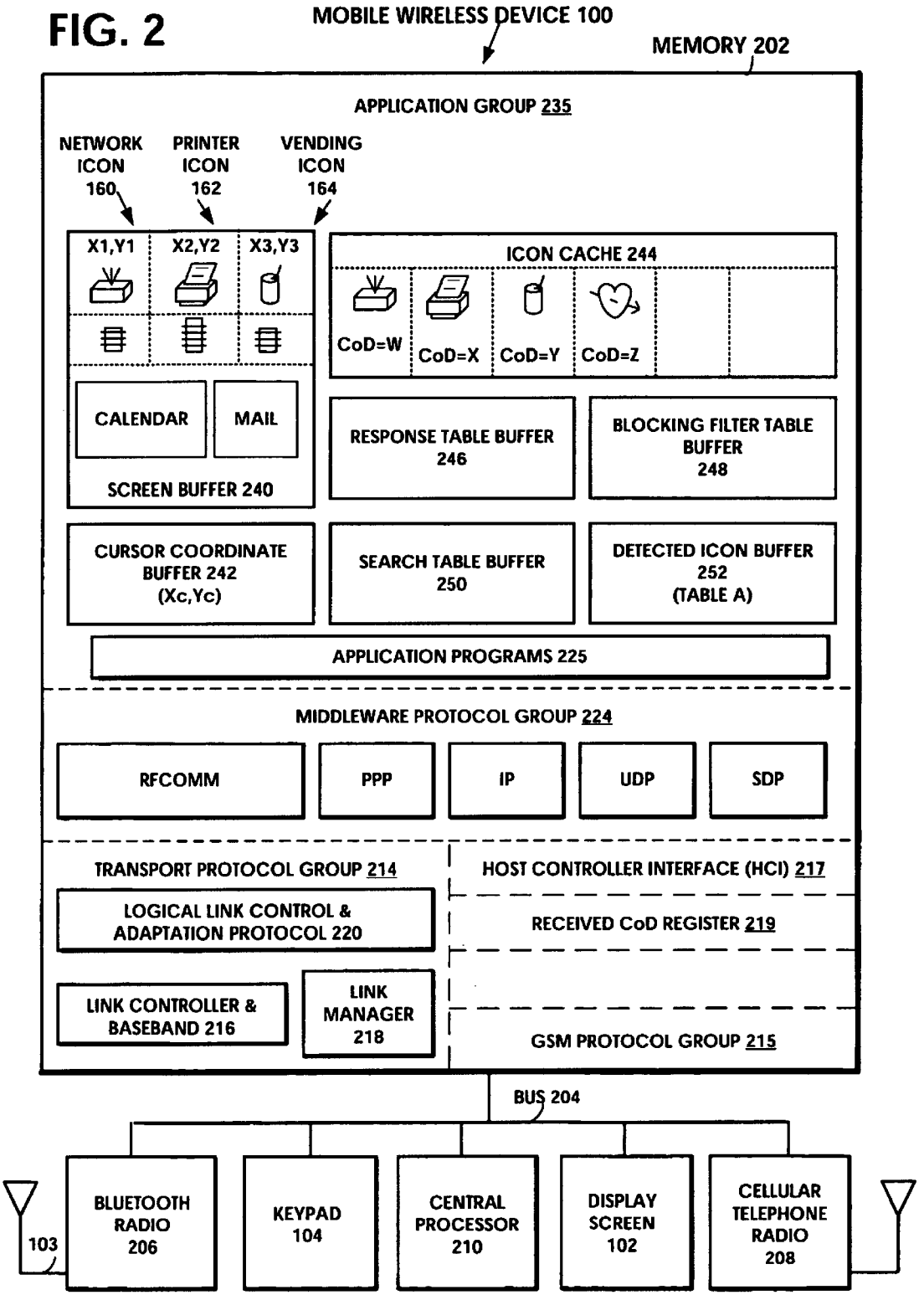
MOBILE "DATING" ICON 168
CALENDAR
MAIL
KEYPAD 104
MOUSE 106

FIG. 1C

FIG. 2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X1,Y1
X2,Y2
X3,Y3
ICON CACHE 244
CoD=W
CoD=X
CoD=Y
CoD=Z
CALENDAR
MAIL
SCREEN BUFFER 240
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CURSOR COORDINATE BUFFER 242 (Xc,Yc)
SEARCH TABLE BUFFER 250
DETECTED ICON BUFFER 252 (TABLE A)
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MIDDLEWARE PROTOCOL GROUP 224
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GSM PROTOCOL GROUP 215
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BLUETOOTH RADIO 206
KEYPAD 104
CENTRAL PROCESSOR 210
DISPLAY SCREEN 102
CELLULAR TELEPHONE RADIO 208

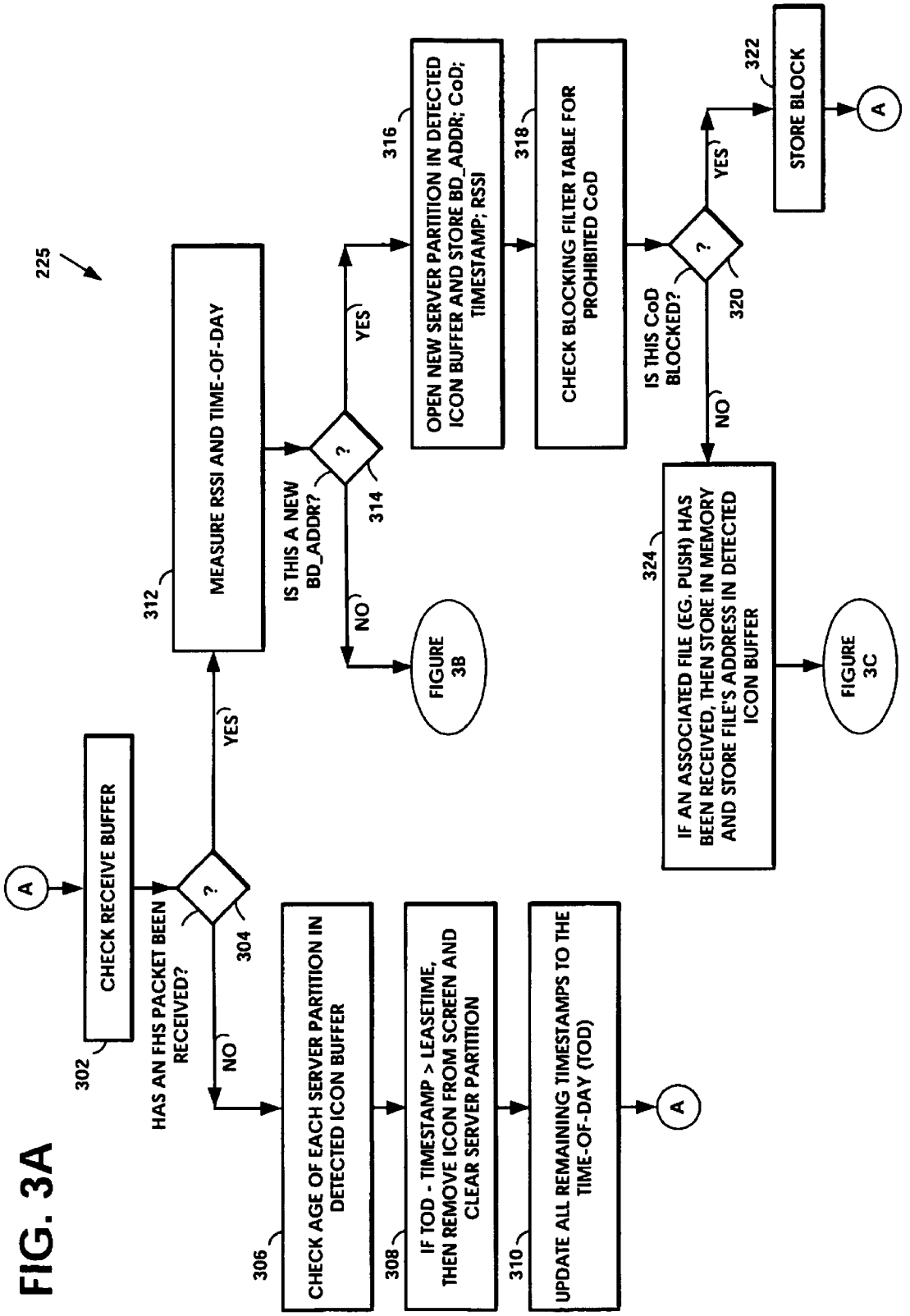

225
A
CHECK RECEIVE BUFFER
302
HAS AN FHS PACKET BEEN RECEIVED?
304
YES
NO
MEASURE RSSI AND TIME-OF-DAY
312
CHECK AGE OF EACH SERVER PARTITION IN DETECTED ICON BUFFER
306
IF TOD - TIMESTAMP > LEASETIME, THEN REMOVE ICON FROM SCREEN AND CLEAR SERVER PARTITION
308
UPDATE ALL REMAINING TIMESTAMPS TO THE TIME-OF-DAY (TOD)
310
A
IS THIS A NEW BD_ADDR?
314
YES
NO
FIGURE 3B
OPEN NEW SERVER PARTITION IN DETECTED ICON BUFFER AND STORE BD_ADDR; CoD; TIMESTAMP; RSSI
316
CHECK BLOCKING FILTER TABLE FOR PROHIBITED CoD
318
IS THIS CoD BLOCKED?
320
YES
NO
STORE BLOCK
322
A
IF AN ASSOCIATED FILE (EG. PUSH) HAS BEEN RECEIVED, THEN STORE IN MEMORY AND STORE FILE'S ADDRESS IN DETECTED ICON BUFFER
324
FIGURE 3C

FIG. 3A

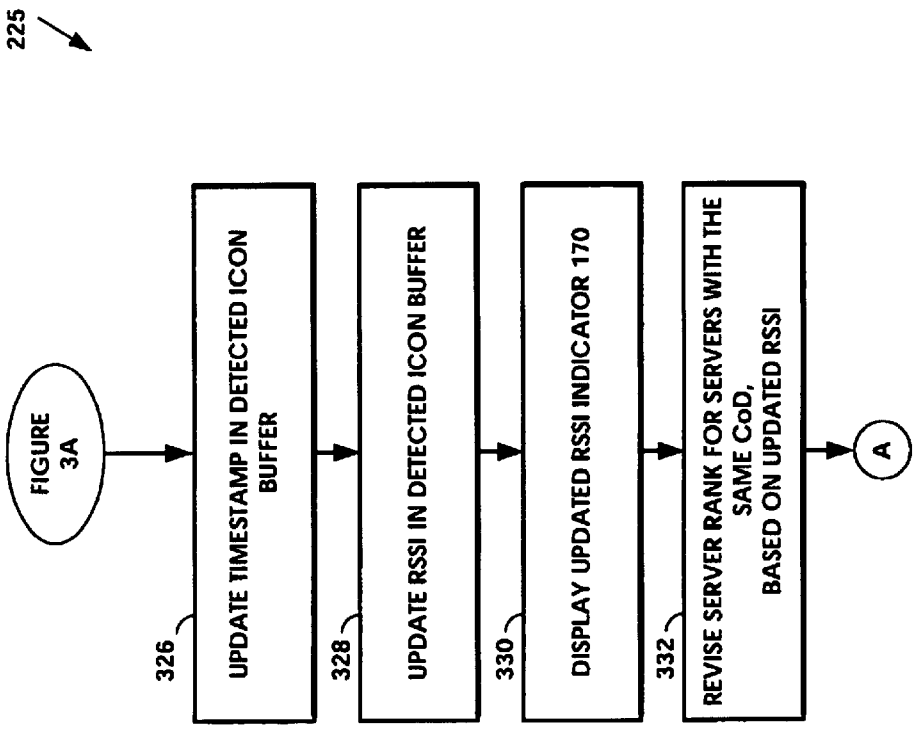

225
FIGURE 3A
326
UPDATE TIMESTAMP IN DETECTED ICON BUFFER
328
UPDATE RSSI IN DETECTED ICON BUFFER
330
DISPLAY UPDATED RSSI INDICATOR 170
332
REVISE SERVER RANK FOR SERVERS WITH THE SAME CoD, BASED ON UPDATED RSSI
A

FIG. 3B

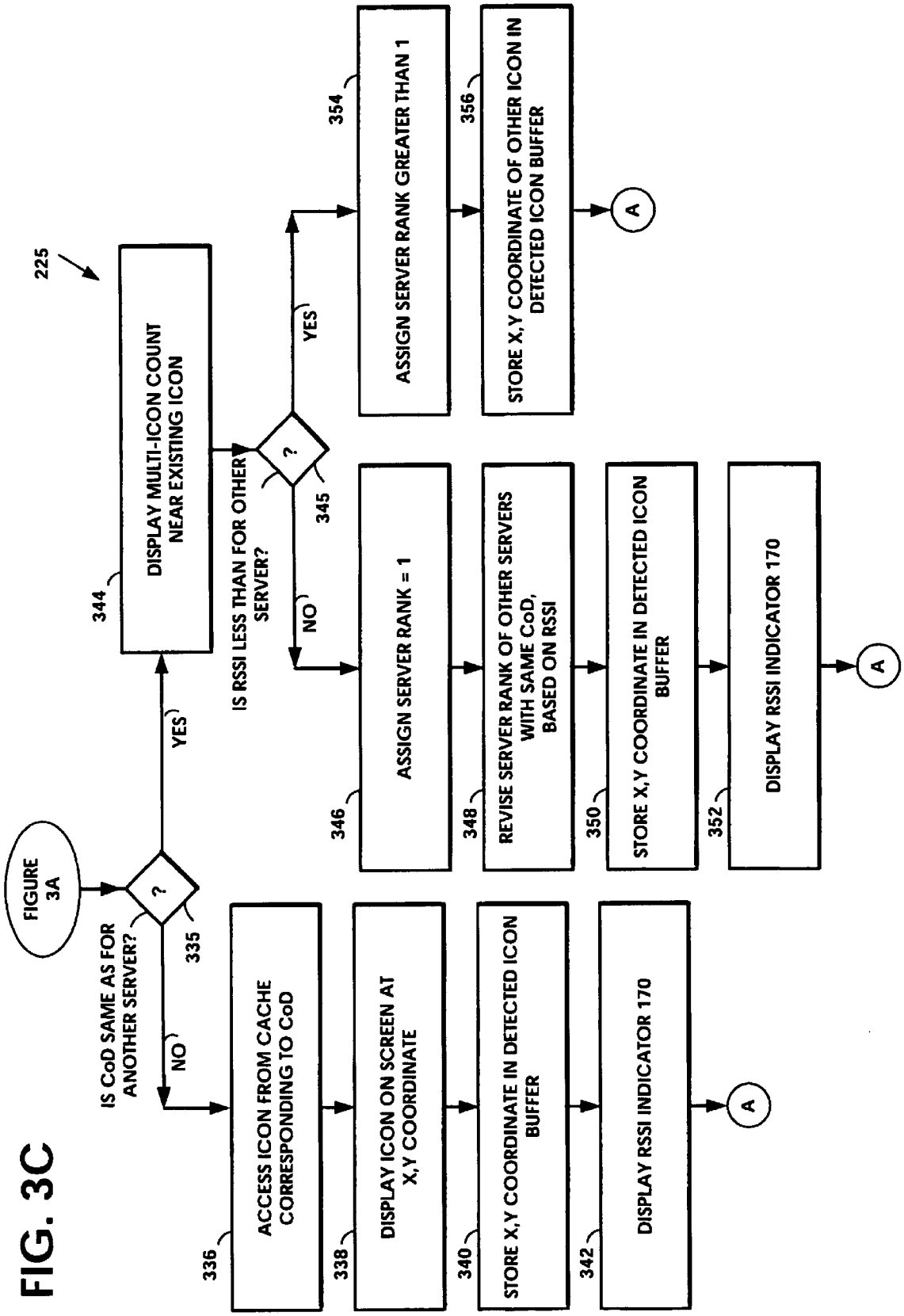

225
FIGURE 3A
IS CoD SAME AS FOR ANOTHER SERVER?
?
335
NO
YES
ACCESS ICON FROM CACHE CORRESPONDING TO CoD
336
DISPLAY ICON ON SCREEN AT X,Y COORDINATE
338
STORE X,Y COORDINATE IN DETECTED ICON BUFFER
340
DISPLAY RSSI INDICATOR 170
342
A
DISPLAY MULTI-ICON COUNT NEAR EXISTING ICON
344
IS RSSI LESS THAN FOR OTHER SERVER?
?
345
NO
YES
ASSIGN SERVER RANK = 1
346
REVISE SERVER RANK OF OTHER SERVERS WITH SAME CoD, BASED ON RSSI
348
STORE X,Y COORDINATE IN DETECTED ICON BUFFER
350
DISPLAY RSSI INDICATOR 170
352
A
ASSIGN SERVER RANK GREATER THAN 1
354
STORE X,Y COORDINATE OF OTHER ICON IN DETECTED ICON BUFFER
356
A

FIG. 3C

SERVICE/DEVICE INDICATION WITH GRAPHICAL INTERFACE

FIELD OF THE INVENTION

The invention disclosed broadly relates to ubiquitous computing and more particularly relates to improvements in short range RF technology.

BACKGROUND OF THE INVENTION

Bluetooth is a short-range radio network, originally intended as a cable replacement. It can be used to create ad hoc networks of up to eight devices operating together. The Bluetooth Special Interest Group, *Specification Of The Bluetooth System*, Volumes 1 and 2, Core and Profiles: Version 1.1, Feb. 22, 2001, describes the principles of Bluetooth device operation and communication protocols. The devices operate in the 2.4 GHz radio band reserved for general use by Industrial, Scientific, and Medical (ISM) applications. Bluetooth devices are designed to find other Bluetooth devices within their ten-meter radio communications range and to discover what services they offer.

A connection between two Bluetooth devices is initiated by an inquiring device sending out an inquiry message searching for other devices in its vicinity. Any other Bluetooth device that is listening by means of conducting an inquiry scan, will recognize the inquiry message and respond. The inquiry response is a frequency hop synchronization (FHS) packet containing all of the information required by the inquiring device to address the responding device. This information includes clock value of the sender (i.e., the responding device), the sender's correct device access code, and the class-of-device (CoD) field. The FHS packet contains more information than is mentioned here. The access code includes the lower address part (LAP) and the upper address part (UAP) of the sender's Bluetooth Device Address (BD_ADDR), a unique, 48-bit IEEE address that is electronically engraved into each Bluetooth device.

The class-of-device (CoD) field of the FHS packet indicates which device class the sender belongs to, such as printer access point, network access point, PDA, cellular telephone, and the like. The class-of-device (CoD) field is a 24 bit field divided into three subfields and a two-bit format field. The high order eleven bit subfield is reserved for indicating general service classes such as information, telephony, audio, object transfer, capturing, rendering, networking, and positioning. The middle five bit subfield comprises the major device class, which can indicate up to 32 different device types. The low order six bit subfield consists is the minor device class, which can indicate up to 64 different variations of each device type. The lowest order two bits are the format field for identifying the format type of the CoD field.

The inquiring device (after it sends a paging packet) will become the master and the responding device will become the slave in the eventual piconet, if a connection is established. To establish a connection, the inquiring device must enter the page state. The paging device uses the information provided in the inquiry response packet, to prepare and send a paging message to the responding device. The paging device uses the estimated clock CLKE and access code of the responding device (i.e., the eventual slave device) to temporarily synchronize with it. Since the paging device intends to be the master, it includes an assignment of an active member address (AM_ADDR) in the paging message. The paging message sent by the paging device is also a frequency hop synchronization (FHS) packet containing all of the information required by the responding device to directly reply to the paging device. This information includes clock value of the sender (i.e., the paging device) and the paging device's correct device access code. The responding device must be in the page scan state to allow the paging device to connect with it. Once in the page scan state, the responding device will receive the paging packet that provides the clock timing and access code of the paging device. The responding device responds with a page acknowledgment packet. This enables the two devices to form a connection and both devices transition into the connection state. The paging device that has initiated the connection assumes the role of a master device and the responding device assumes the role of a slave device in a new ad hoc network piconet, using the CLK clock timing and access code of the master device.

Each piconet has one master device and up to seven active slave devices. All communication is directed between the master device and each respective slave device. The master initiates an exchange of data and the slave responds to the master. When two slave devices are to communicate with each other, they must do so through the master device. The master device maintains the piconet's network clock and controls when each slave device can communicate with the master device. Members of the ad hoc network piconet join and leave as they move into and out of the range of the master device. Piconets support distributed activities, such as multi-user gateways to the Internet or to a content server, wherein one device serves as the access point and is connected to an infrastructure network or content server. A user's device that joins a multi-user gateway piconet, does so to enable its user to access the infrastructure network or content server.

To form ad hoc connections, a Bluetooth device has to have the ability to rapidly discover target Bluetooth devices to which the user wishes to connect. In many cases the target device is known, e.g. a headset, and thus the procedure for connection establishment is straightforward. However, in certain cases it is not possible to have information about the target device. Additional problems are created by a crowded environment where many Bluetooth devices are present, which respond to the user device's inquiries.

What is needed a way to rapidly give the user notice of those Bluetooth devices within communication range, and yet not inundate the user with information about those Bluetooth devices that he/she wishes to ignore.

SUMMARY OF THE INVENTION

The invention disclosed gives the user notice of those Bluetooth devices within communication range, and yet it selectively blocks any notice about Bluetooth devices that the user wishes to ignore. In accordance with the invention, Bluetooth server devices can indicate to the user's Bluetooth client device the service that the server device has available by sending service/device icon information to Bluetooth client device. This information can be a value in the class-of-device (CoD) field of a frequency hop synchronization (FHS) packet that it sends during the process of exchanging inquiry and paging packets with the Bluetooth client device. If the server device has begun by transmitting an inquiry packet, then the CoD value will be sent in its paging packet. If the server device is responding to an inquiry, then its CoD value will be in its inquiry response packet.

The service/device icon is a small, graphic bitmap that is displayed on the screen of the client device, having an

appearance that serves to describe the service that the server device has to offer. Alternately, the icon can also serve to identify characteristics of the user of the server device, such as business-related or personal characteristics. In either case, the icon bitmap must reside in the client device in order to be displayed on its screen. For conventional services, such as an access point for an Internet gateway or an access point for a printer, standard icon bitmaps can be stored in an icon cache in all Bluetooth client devices. Optionally, new icon bitmaps and their corresponding CoD values can be downloaded from an Internet service provider, such as Nokia Club, to be stored in the icon cache of the client device in association with their CoD values. This can be, for example, a new graphical design of an icon for an existing, assigned CoD value, such as that for a printer. The service/device icon is typically a 16 by 16 pel bitmap. A black and white icon can be stored in a 32-byte memory partition of the receiver's icon cache. An eight bit per pel color icon can be stored in a 256-byte memory partition of the receiver's icon cache. Audible tones can be played when the icon is initially displayed. The tone string can be downloaded from the Internet service provider at the same time as is the icon bitmap and stored in the icon cache of the client device in association with the CoD value.

When the icon is initially displayed on the screen of the client device, a partition is opened in a detected icon buffer to store the status of the icon. A time stamp value is recorded at the start of the display, in association with the received CoD value. Periodically, the time stamp value is compared with the time of day clock of the client device. When the time stamp is older than a threshold value called the lease-time (30 seconds, for example), the icon is removed from the screen and its partition is closed in the detected icon buffer. During the period that the icon remains actively displayed on the screen, if additional FHS packets are received from the same server device containing the same CoD value, the time stamp value is updated to the current time of day value. This enables retaining the display of an icon for a server device that remains in the vicinity of the client device. As soon as the client device moves out of communications range of the server device and no more FHS packets are received, then after the expiration of the lease-time, the icon is removed from the screen.

If the client device has initiated a connection with the server device to carry out SDP searching or other operations, the client device assumes a temporary master role in its new piconet. Most server devices are programmed to request a master/slave role switch if the client device has initiated the connection. Once the client changes to a slave role, it can only remain in its piconet, either as an active slave or a parked slave. (It is possible for the slave to switch between several piconets, when timing information is known.) Thus, the client device is programmed to terminate such connections after completing any necessary SDP searching or other operations. In order to continue displaying icons of server devices within communications range, the client device continues to operate in the inquiry and page scanning modes, detecting the FHS paging packets and FHS inquiry response packets from server devices in its vicinity. When the FHS packets from a given server device are no longer received, then the lease-time interval is started in preparation to remove the corresponding icon from the display.

The detected icon buffer also stores the Bluetooth device address BD_ADDR of the server device, in association with the received CoD value. The ith icon in the detected icon buffer has a device address BD_ADDRi and a CoD value CoDi. The detected icon buffer also stores coordinates, such as the (x,y) coordinates, of the displayed position of the icon with respect to the origin of coordinates on the screen, in association with the received CoD value. The ith icon on the screen has a position (xi,yi) associated in the detected icon buffer with the its CoD value CoDi. Other origins for coordinates can be used, such as the center of the screen.

Also, other coordinate systems can be used, such as polar coordinates. A cursor is also displayed on the screen, whose position is represented by coordinates, such as the (X,Y) coordinates with respect to the origin of coordinates on the screen. A pointing device, such as a mouse or a track ball controls the displayed position (X,Y) of the cursor on the screen. When the user presses the mouse button, the (X,Y) coordinates of the cursor are compared with the (x,y) coordinates of each icon in the detected icon buffer. If the cursor coordinates (X,Y) are within range of the ith icon coordinates (xi,yi), then the ith icon is selected. The client device can be programmed to access the device address BD_ADDRi to complete the connection with the corresponding server device and exchange further messages with it. The further messages can include the client device sending an SDP request to the server device to find out information about other files or services, followed by accessing a file from the server device.

Where the server device has initiated the connection by sending inquiry and paging packets to the client device, the server device may use the Bluetooth object push profile (OPP) to push an unsolicited file, such as a business card, to the client device. The client device is programmed to store the unsolicited file in a unsolicited file buffer, associated with the CoD and the BD_ADDR of the sending server device. The detected icon buffer opens a partition for the server device and stores an indication that there is an associated file in the unsolicited file buffer. When the user presses the mouse button, the (X,Y) coordinates of the cursor are compared with the (x,y) coordinates of each icon in the detected icon buffer. If the cursor coordinates (X,Y) are within range of the ith icon coordinates (xi,yi), then the ith icon is selected. The client device can be programmed to check if there is an associated file in the unsolicited file buffer. If there is, that file is accessed and displayed on the screen. This feature enables the server device to send more informative messages to the client device, along with the CoD of the icon bitmap.

The detected icon buffer also stores a server rank value, in association with the received CoD value. The first server device of a given CoD type to be entered into the detected icon buffer will be assigned the a server rank value of "1". Two different server devices having different device addresses BD_ADDR, can offer the same service and will transmit the same CoD value. The client device is programmed to identify this circumstance. The second server device of the same CoD type to be entered into the detected icon buffer will be assigned the a server rank value of "2", and so on. Instead of placing two identical icon bitmaps on the screen, the first displayed icon will have appended to it a numeral indicating how many of that type of server device are in the vicinity. The displayed icon is referred to as a multi-icon.

The detected icon buffer also stores a received signal strength indication (RSSI) for each respective server device listed in the detected icon buffer. Where there are two or more server devices in the detected icon buffer having a given CoD type, the client device is programmed to rank them by their RSSI values. The server rank values of those servers having the same type CoD value are reassigned, in accordance with the RSSI for each server device. The server

device with the strongest RSSI will be reassigned a server rank value of "1", and weaker server devices will be assigned consecutively greater values. When the cursor coordinates (X,Y) are within range of the multi-icon's coordinates (xi,yi), then the multi-icon is selected. The client device can be programmed to access the device address BD_ADDRi of the server device with the strongest RSSI to complete the connection with the corresponding server device and exchange further messages with it. As individual server devices move out of communication range of the client device, the respective partition in the detected icon buffer is cleared, and the server rank values are reassigned, as needed.

The RSSI value can be displayed beneath each icon shown on the screen, thereby allowing the user to select server devices having better link quality. Alternately, "color bars" can be presented to represent RSSI values, such as green=good RSSI, yellow=still acceptable, and red=data transmission is not possible. Any kind of indication of RSSI reading is possible (e.g. actual value, number of bars, color etc).

The user can enter CoD values for types of server devices or services to be ignored, such as advertisement broadcasting server devices and certain types of vending machine server devices. These prohibited CoD values are stored in a blocking filter buffer in the client device. When a CoD value is received in an FHS packet, it is compared with the prohibited CoD values and if there is a match, no entry is made in the detected icon buffer, thereby ignoring the prohibited server devices.

There are up to eleven bits available in the CoD field for assignment as service descriptions, yielding up to 2048 different possible services that can be represented. Some subset, for example the six bits of the CoD minor device class sub-field, can be used to assign up to 64 service description values.

When the icon serves to identify characteristics of the user of the server device, such as business-related or personal characteristics, the device can be optionally programmed to accept manual changes to the CoD field. The user of the sending device has the ability to select the icon to be sent. Optionally, the server device can be manually reset by its user to indicate in its class-of-device (CoD) field of its FHS packet, that particular types of service/device icon information are available, such as dating/match-making information.

The client device can also be programmed to search for specified class-of-device (CoD) values received from a server device. The client device can match the CoD values received in FHS packets, with an entry in a search list in the client device. For example, the client device can be programmed by its user to search for that particular class-of-device (CoD) value among those CoDs received. When a match is found, the client device is programmed to display the icon bitmap and sound an alarm tone.

In the current Bluetooth specification, an inquiry result is reported over the Host Computer Interface (HCI) only after the inquiry period is over, which is 10.24 seconds. During that period, it may be possible that the client device will move out of the range of the server device. In another aspect of the invention, the receipt of FHS packets is a result event that is reported over the HCI as soon as each new FHS packet arrives. The HCI is programmed to write the received CoD value of the FHS packet in a memory register at the time that the packet arrives. The Host can then read the register and process the CoD value to display the corresponding icon, as described above.

The client device can be programmed by its user to recognize selected class-of-device (CoD) values and either ignore them or display the corresponding icon bitmap.

In an alternate embodiment of the invention, the service/device icon information can be sent after a connection has been made with the client device, as part of a Service Discovery Protocol (SDP) response packet. The client device can search for interesting services using the Service Discovery Protocol (SDP). When interesting services are found, their service records are accessed by the client device. Icons are included in the service records as an IconURL parameter. Icons can be loaded using hypertext transfer protocol (http). If there is no icon included in the service record of an interesting service, a default icon for its type may be displayed, as identified by the CoD value of the sending device.

The process of retrieving the icon bitmap in the Service Discovery Protocol (SDP) of the alternate embodiment, starts by examining the public browse root of the SDP service registry in the server device. It then follows the hierarchy out to service classes which are the branches of the tree, and from there to the leaf nodes, where individual services are described in service records. To get specific information about the icon bitmap, the client device and the server device exchange messages carried in SDP packets. There are two types of SDP packets, the SDP Service Search Attribute Request packet and the SDP Service Search Attribute Response packet. The SDP Request packet carries the SDP Service Search Attribute Request, which includes a service search pattern and an attribute ID list. The service search pattern is the description of the desired service records containing the icon bitmap information in the server device. The server device specifically searches its registry of for the attribute containing information about the icon bitmap. The server device responds with the service handle of the icon bitmap or a pointer to the icon bitmap. The service handle identifies the service record containing the icon bitmap. Optionally, the service record contains a pointer to the icon bitmap. When the client device receives the icon bitmap, it is displayed on the screen. Optionally, it can also be stored in the client's icon cache.

DESCRIPTION OF THE FIGURES

FIG. **1**A shows a wireless network diagram of the Bluetooth mobile client device and five server devices, with the mobile device being within Bluetooth communication range of a network access point, a first printer access point, and a vending machine access point, according to an embodiment of the present invention.

FIG. **1**B shows the same wireless network as FIG. **1**A, but with the mobile client device having moved out of the range of the network access point and into range with a second printer access point.

FIG. **1**C shows the same wireless network as FIGS. **1**A and **1**B, but with the mobile client device having further moved out of the range of both the network access point and the first printer access point, and into range with a second mobile device.

FIG. **2** shows the memory layout of the mobile client device, according to an embodiment of the present invention.

FIGS. **3**A, **3**B, and **3**C show the flow diagram of the operation of the mobile client device, according to an embodiment of the present invention.

DISCUSSION OF THE PREFERRED EMBODIMENT

In the following description of the preferred embodiment, reference is made to the accompanying drawings, which

form a part hereof, and in which is shown by way of illustration various embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized and structural and functional modifications may be made without departing from the scope of the present invention.

The invention disclosed gives the user notice of those Bluetooth devices within communication range, and yet it selectively blocks any notice about Bluetooth devices that the user wishes to ignore. FIG. **1**A shows a wireless network diagram of six Bluetooth devices: the user's mobile, client device **100**, four access point devices connected to their respective servers, and another mobile device. Access point **140** is connected to the network **141**. Access point **142** is connected to the printer **143**. Access point **144** is connected to the vending machine **145**. Access point **146** is connected to the second printer **147**. The second mobile device **148** can be a Bluetooth equipped cellular telephone. In the first location of the mobile device **100** shown in FIG. **1**A, the user's mobile device **100** is within the Bluetooth communication range of the network access point **140**, the first printer access point **142**, and the vending machine access point **144**.

The four Bluetooth access point devices **140**, **142**, **144** and **146** and the Bluetooth mobile device **148** of FIG. **1**A are collectively referred to here as "server devices", for convenience. In accordance with the invention, the server devices can indicate to the user's Bluetooth client device the type of service that the server device has available by sending service/device icon information to Bluetooth client device. This information can be a value in the class-of-device (CoD) field of a frequency hop synchronization (FHS) packet that it sends during the process of exchanging inquiry and paging packets with the Bluetooth client device. If the server device has begun by transmitting an inquiry packet, then the CoD value will be sent in its paging packet. If the server device is responding to an inquiry, then its CoD value will be in its inquiry response packet. The network access point **140** sends the FHS packet **150** to the user's mobile device **100**, with a CoD value of "W" indicating by convention that the access point **140** is connected to a network **141**. The first printer access point **142** sends the FHS packet **152** to the user's mobile device **100**, with a CoD value of "X" indicating by convention that the access point **142** is connected to a printer **143**. The vending machine access point **144** sends the FHS packet **154** to the user's mobile device **100**, with a CoD value of "Y" indicating by convention that the access point **144** is connected to a vending machine **145**.

The user's Bluetooth mobile device **100** of FIG. **1**A includes an antenna **103**, keypad **104**, mouse or pointer device **106**, and a display screen **102**. The display screen **102** presents calendar functions, mail functions, and other user applications to the user. In accordance with the invention, when the user's device **100** receives the FHS packet **150** with a CoD value="W", a corresponding network icon **160** is displayed on the screen **102**. When the user's device **100** receives the FHS packet **152** with a CoD value="X", a corresponding printer icon **162** is displayed on the screen **102**. When the user's device **100** receives the FHS packet **154** with a CoD value="Y", a corresponding vending icon **164** is displayed on the screen **102**. Signal strength indicators **170** can also be displayed on the screen **102** next to the icons **160**, **162**, and **164**, indicating the relative signal strength of the respective FHS packets **150**, **152**, and **154**.

The service/device icons **160**, **162**, and **164** in FIG. **1**A are each a small, graphic bitmap that is displayed on the screen **102** of the client device **100**, having an appearance that serves to describe the service that the respective server device **141**, **143**, and **145** has to offer. Alternately, an icon can also serve to identify characteristics of the user of the server device, such as business-related or personal characteristics. In either case, the icon bitmap **160**, **162**, or **164** must reside in the client device **100** in order to be displayed on its screen **102**. For conventional services, such as an access point **140** for an Internet gateway or an access point **142** for a printer **143**, standard icon bitmaps can be stored in an icon cache **244** in all Bluetooth client devices **100**, as shown in FIG. **2**.

FIG. **2** illustrates the memory and components of the user's mobile wireless device **100**, according to an embodiment of the present invention. The user's device can be a Bluetooth equipped cellular telephone, for example. The memory **202** is connected by the bus **204** to the Bluetooth radio **206**, the keypad **104**, the central processor **210**, the display screen **102**, and the cellular telephone radio **208**. The memory **202** stores programs that are sequences of executable instructions which, when executed in the central processor **210**, carry out the methods of the invention. The memory **202** includes the Bluetooth transport group **214** that includes the link controller **216**, the link manager **218**, and the logical link control and adaptation layer **220**.

The memory **202** of FIG. **2** also includes the host controller interface (HCI) **217**. In systems where the higher layers are run on a host device's processor and the lower layers on a Bluetooth device, the host controller interface (HCI) **217** provides a standard interface between the higher and lower layers. The host controller interface (HCI) **217** provides event packets used by the lower Bluetooth layers **216**, **218**, and **220** to inform the higher layers of the host's application group **235** of changes in the lower layers. In accordance with one aspect of the invention, a received CoD register **219** is included in the memory **202**, which is associated with the host controller interface (HCI) **217**. In the current Bluetooth specification, the receipt of an FHS packet is reported as a result over the Host Computer Interface (HCI) only after the inquiry period is over, which is 10.24 seconds. During that period, it may be possible that the client device will move out of the range of the server device. In accordance with the invention, the receipt of an FHS packet is reported as a result event over the host controller interface (HCI) **217** as soon as new FHS packet arrives. The host controller interface (HCI) **217** is programmed to write the received CoD value of the FHS packet in the received CoD register **219** at the time that the FHS packet arrives. The higher layers of the host's application group **235** can then immediately read the register **219** and process the CoD value to display the corresponding icon, as described above.

The memory **202** of FIG. **2** also includes the GSM protocol group **215** to provide telephony functions for the cellular telephone circuits. The memory **202** also includes the Bluetooth middleware protocol group **224** that includes the RFCOMM, PPP, IP, UDP, and SDP program modules.

The memory **202** of FIG. **2** also includes the application group **235**. The application group **235** includes application programs **225** and various memory partitions. The application programs **225** can include GUI applications, wireless application protocol (WAP) programs, and various user applications such as calendar and email programs. The application programs **225** also include programs to carry out the operations of an embodiment of the present invention, as represented by the flow diagrams of FIGS. **3**A, **3**B, and **3**C.

The application group **235** includes a screen buffer **240** showing the relative display positions of the icon bitmaps

160, **162**, and **164** on the display screen **102**. The network icon **160** has the coordinates X1,Y1. The printer icon **160** has the coordinates X2,Y2. The vending icon **164** has the coordinates X3,Y3. The application group **235** includes a cursor coordinate buffer **242** with the current values of the cursor coordinates Xc,Yc on the display screen **102**. The application group **235** includes a response table buffer **246** listing the sending device address BD_ADDR of each FHS packet received.

The application group **235** includes an icon cache **244** storing the icon bitmaps **160**, **162**, and **164**. These bit maps may have been optionally installed by the manufacturer, they may be optionally downloaded from a network service provider such as Nokia Club, or they may be optionally received from server devices such as **140**, **142**, etc. Icon bitmaps can be stored in the icon cache **244** of the client device **100** in association with their CoD values. New icon bit maps can be, for example, a new graphical design of an icon for an existing, assigned CoD value, such as that for a printer. The service/device icon is typically a 16 by 16 pel bitmap. A black and white icon can be stored in a 32-byte memory partition of the receiver's icon cache **244**. An eight bit per pel color icon can be stored in a 256-byte memory partition of the receiver's icon cache **244**. Audible tones can be played when the icon is initially displayed. The tone string can be downloaded from the Internet service provider at the same time as is the icon bitmap and stored in the icon cache **244** of the client device **100** in association with the CoD value.

The application group **235** includes a blocking filter table buffer **248** listing those CoD values that the user has selected to be ignored. The application group **235** includes a search table buffer **250** listing those CoD values that the user has selected to be searched.

The application group **235** includes a detected icon buffer **252**, which is shown in greater detail in Tables A, B, and C. Tables A, B, and C show the contents of the detected icon buffer **252** for the user's device **100** located at the three respective locations in FIGS. **1**A, **1**B, and **1**C. Tables A, B, and C have the following fields:

[1] the name of the icon's server device (network, printer, vending, etc.);

[2] the (X,Y) coordinates of the displayed location of the icon;

[3] the CoD value for the icon's server;

[4] the BD_ADDR of the icon's server;

[5] the time stamp for the icon;

[6] the server rank for the icon (e.g., 1=first printer, 2=second printer);

[7] the binary yes/no if there is a filter block for the icon;

[8] the address of any associated server push (OPP) file stored for the icon; and

[9] the RSSI strength of the FHS packet for the icon's server device.

TABLE A

Detected Icon Buffer 252 (First Location shown in FIG. 1A)

Name	Screen Location	CoD Value	BD_ADDR Address	Time Stamp	Server Rank	Filter Block	Associate File	RSSI Strength
Network AP 140	X1, Y1	W	BD_ADDR1	T1	1	No	Address1	RSSI1
Printer AP 142	X2, Y2	X	BD_ADDR2	T2	1	No	Address2	RSSI2
Vending AP 144	X3, Y3	Y	BD_ADDR3	T3	1	No	Address3	RSSI3

TABLE B

Detected Icon Buffer 252 (Second Location shown in FIG. 1B)

Name	Screen Location	CoD Value	BD_ADDR Address	Time Stamp	Server Rank	Filter Block	Associate File	RSSI Strength
Printer AP 142	X2, Y2	X	BD_ADDR2	T2	1	No	Address2	RSSI2
Vending AP 144	X3, Y3	Y	BD_ADDR3	T3	1	No	Address3	RSSI3
Printer AP 146	X2, Y2	X	BD_ADDR5	T4	2	No	Address4	RSSI4

TABLE C

Detected Icon Buffer 252 (Third Location shown in FIG. 1C)

Name	Screen Location	CoD Value	BD_ADDR Address	Time Stamp	Server Rank	Filter Block	Associate File	RSSI Strength
Vending AP 144	X3, Y3	Y	BD_ADDR3	T3	1	No	Address3	RSSI3
Printer AP 146	X2, Y2	X	BD_ADDR5	T4	1	No	Address4	RSSI4
Mobile Device 148	X1, Y1	Z	BD_ADDR5	T5	1	No	Address5	RSSI5

When the icon **160**, for example, is initially displayed on the screen **102** of the client device **100**, a partition is opened in a detected icon buffer **252** shown in Table A, to store the status of the icon. Table A illustrates the detected icon buffer **252** for the first location of the user's mobile device **100** shown in FIG. **1**A. A time stamp value is recorded at the start of the display, in association with the received CoD value. Periodically, the time stamp value is compared with the time of day clock of the client device. When the time stamp is older than a threshold value called the lease-time (30

seconds, for example), the icon is removed from the screen **102** of the device **100** and its partition is closed in the detected icon buffer **252**. During the period that the icon remains actively displayed on the screen **102** of the device **100**, if additional FHS packets **150** are received from the same server access point device **140** containing the same CoD value, the time stamp value is updated in the buffer **252** to the current time of day value. This enables retaining the display of an icon for a server device **140** that remains in the vicinity of the client device **100**. As soon as the client device **100** moves out of Bluetooth communications range of the server device **140** and no more FHS packets **150** are received, then after the expiration of the lease-time, the icon **160** is removed from the screen **102** of the user's device **100**. Optionally, if the icon is annoying, the user can manually remove the icon from the display at an earlier time, if desired.

If the client device **100** has initiated a connection with the server device **140**, for example, to carry out SDP searching or other operations, the client device **100** assumes a temporary master role in its new piconet. Most server devices **140**, for example, are programmed to request a master/slave role switch if the client device **100** has initiated the connection. Once the client **100** changes to a slave role, it can only remain in its piconet, either as an active slave or a parked slave. (It is possible for the slave to switch between several piconets, when timing information is known.) Thus, the client device **100** is programmed to terminate such connections after completing any necessary SDP searching or other operations. In order to continue displaying icons of server devices **140**, for example, within communications range, the client device **100** continues to operate in the inquiry and page scanning modes, detecting the FHS paging packets **150** and FHS inquiry response packets **150** from server devices **140**, for example, in its vicinity. When the FHS packets **150** from a given server device **140**, for example, are no longer received, then the lease-time interval is started in preparation to remove the corresponding icon **160** from the display screen **102** of the device **100**.

FIG. **1**B shows the same wireless network as FIG. **1**A, but with the mobile client device having moved out of the range of the network access point and into range with a second printer access point. Table B illustrates the detected icon buffer **252** for the second location of the user's mobile device **100** shown in FIG. **1**B. Table B shows that the server partition for the network access point **140** is removed from the detected icon buffer **252** since the user's device **100** has moved out of range of the access point **140** and no longer receives FHS packets **150**. Correspondingly, the screen **102** of the user's device **100** in FIG. **1**B shows that the icon **160** has been removed. Table B also shows that a new server partition for the second printer access point **146** is added to the detected icon buffer **252** since the user's device **100** has moved into range of the access point **146** and is now receiving FHS packets **156**.

The detected icon buffer **252** also stores the Bluetooth device address BD_ADDR of the server device **140**, for example, in association with the received CoD value "W". The ith icon in the detected icon buffer **252** has a device address BD_ADDRi and a CoD value CoDi. The detected icon buffer **252** also stores the (x,y) coordinates of the displayed position of the icon with respect to the origin of coordinates on the screen **102**, in association with the received CoD value. The ith icon on the screen **102** has a position (xi,yi) associated in the detected icon buffer **252** with the its CoD value CoDi. A cursor is also displayed on the screen **102**, whose position is represented by (Xc,Yc) coordinates with respect to the origin of coordinates on the screen **102**. A pointing device, such as a mouse or a track ball **106** controls the displayed position (Xc,Yc) of the cursor on the screen **102**. When the user presses the mouse button, the (Xc,Yc) coordinates of the cursor are compared with the (x,y) coordinates of each icon in the detected icon buffer **252**. If the cursor coordinates (Xc,Yc) are within range of the ith icon coordinates (xi,yi), then the ith icon is selected. The client device **100** can be programmed to access the device address BD_ADDRi to complete the connection with the corresponding server device **140**, for example, and exchange further messages with it. The further messages can include the client device **100** sending an SDP request to the server device **140**, for example, to find out information about other files or services, followed by accessing a file from the server device **140**.

Where the server device **140**, for example, has initiated the connection by sending inquiry and paging packets **150** to the client device **100**, the server device **140** may use the Bluetooth object push profile (OPP) to push an unsolicited file, such as a business card, to the client device **100**. The client device **100** is programmed to store the unsolicited file in a unsolicited file buffer in the memory **202** of FIG. **2**, associated with the CoD and the BD_ADDR of the sending server device **140**, for example. The detected icon buffer **252** opens a partition for the server device **140** and stores an indication that there is an associated file in the unsolicited file buffer. When the user presses the mouse button **106**, the (X,Y) coordinates of the cursor are compared with the (x,y) coordinates of each icon in the detected icon buffer **252**. If the cursor coordinates (X,Y) are within range of the ith icon coordinates (xi,yi), then the ith icon is selected. The client device **100** can be programmed to check if there is an associated file in the unsolicited file buffer. If there is, that file is accessed and displayed on the screen **102** of device **100**. This feature enables the server device **140**, for example, to send more informative messages to the client device **100**, along with the CoD of the icon bitmap **160**.

The detected icon buffer **252** also stores a server rank value, in association with the received CoD value. The first server device such as the printer access point **142** having a given CoD type to be entered into the detected icon buffer **252**, will be assigned the a server rank value of "1". Two different server devices, such as printer access points **142** and **146**, having different device addresses BD_ADDR, can offer the same printer service and will transmit the same CoD value. The client device **100** is programmed to identify this circumstance. The second server device **146** of the same CoD type to be entered into the detected icon buffer **252** will be assigned a server rank value of "2", and so on. Instead of placing two identical icon bitmaps on the screen **102** of the user's device **100**, the first displayed icon **162** will have appended to it a numeral indicating how many of that type of server device are in the vicinity. The displayed icon **162** in FIG. **1**B is referred to as a multi-icon and has the numeral "2" appended to it.

The detected icon buffer **252** also stores a received signal strength indication (RSSI) for each respective server device **140**, **142**, **144**, etc. listed in the detected icon buffer **252**. Where there are two or more server devices **142** and **146** in the detected icon buffer **252**, having a given CoD type, the client device **100** is programmed to rank them by their RSSI values. The server rank values of those servers **142** and **146** having the same type CoD value are reassigned, in accordance with the RSSI for each server device. The server device **142** with the strongest RSSI will be reassigned a server rank value of "1", and weaker server devices **146** will

be assigned consecutively greater values. When the cursor coordinates (X,Y) are within range of the multi-icon's coordinates (xi,yi), then the multi-icon is selected. The client device **100** can be programmed to access the device address BD_ADDRi of the server device **142** with the strongest RSSI to complete the connection with the corresponding server device **142** and exchange further messages with it. As individual server devices move out of communication range of the client device **100**, the respective partition in the detected icon buffer **252** is cleared, and the server rank values are reassigned, as needed.

The RSSI value can be displayed as a signal strength indicator **170** beneath each icon **160**, **162**, and **164** shown on the screen **102** in FIG. **1**A, thereby allowing the user to select server devices having better link quality. Alternately, "color bars" can be presented to represent RSSI values, such as green=good RSSI, yellow=still acceptable, and red=data transmission is not possible.

The user can enter CoD values for types of server devices to be ignored, such as advertisement broadcasting server devices and certain types of vending machine server devices. These prohibited CoD values are stored in a blocking filter buffer **248** in the client device **100** of FIG. **2**. When a CoD value is received in an FHS packet, it is compared with the prohibited CoD values in the blocking filter buffer **248** and if there is a match, no entry is made in the detected icon buffer **252**, thereby ignoring the prohibited server devices.

There are up to eleven bits available in the CoD field for assignment as service descriptions, yielding up to 2048 different possible services that can be represented. Some subset, for example the six bits of the CoD minor device class sub-field, can be used to assign up to 64 service description values.

When the icon serves to identify characteristics of the user of the server device, such as business-related or personal characteristics, the user of the sending device has the ability to select the icon to be sent. The server device can be manually reset by its user to indicate in its class-of-device (CoD) field of its FHS packet, that particular types of service/device icon information are available, such as a CoD value of "Z" representing "dating/match-making" information. FIG. **1**C shows the same wireless network as FIGS. **1**A and **1**B, but with the mobile client device **1100** having further moved out of the range of both the network access point **140** and the first printer access point **142**, and into range with a second mobile device **148**. The second mobile device **148** can be a Bluetooth equipped cellular telephone that has been selectively programmed by its user to transmit a CoD value of "Z" in its FHS packets **158** indicating a "dating/match-making" status for its user. In this example, the icon **168** shown in FIG. **1**C, is a standard icon that is stored in the icon cache **244** of the client device **100** of FIG. **2**. Table C illustrates the detected icon buffer **252** for the third location of the user's mobile device **100** shown in FIG. **1**C. Table C shows that the server partition for the printer access point **142** is removed from the detected icon buffer **252** since the user's device **100** has moved out of range of the access point **142** and no longer receives FHS packets **152**. Correspondingly, the screen **102** of the user's device **100** in FIG. **1**C shows that the icon **162** no longer indicates that there are two printers being detected. Table C also shows that a new server partition for the mobile device **148** is added to the detected icon buffer **252**, since the user's device **100** has moved into range of the mobile device **148** and is now receiving FHS packets **158**.

The client device **100** can also be programmed to search for specified class-of-device (CoD) values received from a sending device **148**, for example. The client device **100** can match the CoD values received in FHS packets **158**, with an entry in a search list in the search table buffer **250** of the client device **100**. For example, the client device **100** can be programmed by its user to search for that particular class-of-device (CoD) value "Z" for "dating/match-making" among those CoDs received in FHS packets. When a match is found, the client device **100** is programmed to display the icon bitmap **168** and sound an alarm tone.

In an alternate embodiment of the invention, the service/device icon information can be sent after a connection has been made with the client device **100**, as part of a Service Discovery Protocol (SDP) response packet. The client device **100** can search for interesting services using the Service Discovery Protocol (SDP). When interesting services are found, their service records are accessed by the client device **100**. Icons can be included in the service records as an IconURL parameter. Icons can be loaded using the hypertext transfer protocol (http). If there is no icon included in the service record of an interesting service, a default icon for its type may be displayed, as identified by the CoD value of the sending device **140**, for example.

The process of retrieving the icon bitmap in the Service Discovery Protocol (SDP) of the alternate embodiment, starts by examining the public browse root of the SDP service registry in the server device **140**, for example. It then follows the hierarchy out to service classes which are the branches of the tree, and from there to the leaf nodes, where individual services are described in service records. To get specific information about the icon bitmap, the client device **100** and the server device **140**, for example, exchange messages carried in SDP packets. There are two types of SDP packets, the SDP Service Search Attribute Request packet and the SDP Service Search Attribute Response packet. The SDP Request packet carries the SDP Service Search Attribute Request, which includes a service search pattern and an attribute ID list. The service search pattern is the description of the desired service records containing the icon bitmap information in the server device. The server device specifically searches its registry of for the attribute containing information about the icon bitmap. The server device responds with the service handle of the icon bitmap or a pointer to the icon bitmap. The service handle identifies the service record containing the icon bitmap. Optionally, the service record contains a pointer to the icon bitmap. When the client device **100** receives the icon bitmap, it is displayed on the screen **102**. Optionally, it can also be stored in the client's icon cache **244**.

The application programs **225** of FIG. **2** include programs in the user's device **100** to carry out the operations of an embodiment of the present invention, as represented by the flow diagrams of FIGS. **3**A, **3**B, and **3**C. The entry point "A" of the program of FIG. **3**A starts with step **302**, to check the receive buffer in the user's device **100** for any FHS packets, such as packet **150** from the network access point **140** of FIG. **1**A. The receipt of an FHS packet is reported as a result event over the host controller interface (HCI) **217** as soon as new FHS packet arrives. The host controller interface (HCI) **217** is programmed to write the received CoD value of the FHS packet in the received CoD register **219** at the time that the FHS packet arrives. The higher layers of the host's application group **235** can then immediately read the register **219** and process the CoD value to display the corresponding icon. Step **304** determines if an FHS packet has been received. If it has not been received, then the program flows to a loop including steps **306**, **308**, and **310** to age the timestamp values in the detected icon buffer **252**. Step **306**

checks the age of each server partition in the detected icon buffer **252**. Step **308** determines if the difference between the time of day (TOD) and the timestamp is greater than the lease-time (e.g., 30 seconds) and if it is, then it removes the icon from the screen and clears the server partition in the detected icon buffer **252**. Step **310** updates all the remaining timestamps to the current time-of-day (TOD).

If step **304** of FIG. **3**A determines that an FHS packet has been received, then the program flows to step **312** to measure the RSSI strength and the time-of-day of the receipt of the FHS packet. The program then flows to step **314** to determine if the FHS packet has a new BD_ADDR sending device address. If it does not have a new device address, then the program flows to step **326** in FIG. **3**B. Step **326** updates the timestamp in detected icon buffer **252**. Step **328** updates the RSSI in the detected icon buffer **252**. Step **330** displays the updated RSSI indicator **170**. Step **332** revises the server rank for servers with the same cod, based on the updated RSSI. The program then flows to the entry point "A" in FIG. **3**A.

If step **314** in FIG. **3**A determines that the FHS packet does not have a new BD_ADDR sending device address, then the program flows to step **316** in FIG. **3**B. Step **316** opens a new server partition in detected icon buffer **252** and stores the BD_ADDR; CoD; timestamp; and RSSI for the received FHS packet. Step **318** checks the blocking filter table **248** to determine if the CoD is has been selected by the user as prohibited and therefore to be blocked. Step **320** determines if the CoD is blocked. If it is, the program flows to step **322** to store the blocked indication in the detected icon buffer **252** and then to return to the entry point "A" in FIG. **3**A. No corresponding icon is displayed on the screen **102** and the sending server device is effectively ignored.

If step **320** determines that the CoD is not blocked, then the program flows to step **324**. Step **324** determines if an associated file (e.g. a push file) has been received from the same sending server device. If it has, then the program stores the associated file in memory **202** and stores the associated file's address in the detected icon buffer **252**. The program then flows to step **335** of FIG. **3**C. Step **335** determines if the CoD is the same as that for another server currently represented in the detected icon buffer **252**. If the CoD is new and not the same as another in the detected icon buffer **252**, then the program flows to step **336**. Step **336** accesses an icon from the icon cache **244** corresponding to the CoD. Step **338** displays the icon on the screen **102** at the X,Y coordinate. Step **340** stores the X,Y coordinate in the detected icon buffer **252**. Step **342** displays the RSSI indicator **170** indicating the strength of the received FHS packet. The program then returns to the entry point "A" in FIG. **3**A.

If step **335** of FIG. **3**C determines that the CoD is not new, but is the same as that for another server currently represented in the detected icon buffer **252**, then the program flows to step **344**. Step **344** displays the multi-icon count near existing icon, such as the value "2" displayed near the printer icon **162** in FIG. **1**B. Then step **345** determines if the RSSI is less than that for another server currently represented in the detected icon buffer **252**. If the RSSI is not less, but is the greatest, then the program flows to step **346**. Step **346** assigns the highest server rank of "1" to the received FHS packet. Then step **348** revises the server ranks of the other servers having the same CoD, based on the RSSI. Step **350** stores the X,Y coordinate of the icon in the detected icon buffer **252**. Step **352** displays the RSSI indicator **170** indicating the strength of the received FHS packet. The program then returns to the entry point "A" in FIG. **3**A.

If step **345** of FIG. **3**C determines that the RSSI is less than that for another server currently represented in the detected icon buffer **252**, then the program flows to step **354**. Step **354** assigns a lower server rank greater than "1" to the received FHS packet. Step **356** stores the X,Y coordinate of other icon in detected icon buffer **252**, corresponding to the other server currently represented having the same CoD. The program then returns to the entry point "A" in FIG. **3**A.

The resulting invention rapidly gives the user notice of those Bluetooth devices within communication range, and yet does not inundate the user with information about those Bluetooth devices that he/she wishes to ignore.

Although a specific embodiment of the invention has been disclosed, those having skill in the art will understand that changes can be made to that specific embodiment without departing from the spirit and the scope of the invention.

What is claimed is:

1. A method to indicate a service available from a Bluetooth server device, comprising:

receiving at a Bluetooth client device, icon information as a value in a class-of-device (CoD) field of a frequency hop synchronization (FHS) packet from a Bluetooth server device characterizing the server device;

measuring a data link quality value between the client and the server based on the received FHS packet;

displaying at the client device an icon corresponding to the icon information and associating the icon with the data link quality value while within communications range of the server device without establishing a Bluetooth connection between the client device and the server device; and

removing the display of the icon after a predetermined time interval following leaving the communications range of the server device.

2. The method of claim **1**, wherein the data link quality value is displayed with the icon.

3. The method of claim **1**, wherein said receiving step further comprises:

receiving from the server device, the CoD value in a paging packet.

4. The method of claim **1**, wherein said receiving step further comprises:

receiving from the server device, the CoD value in an inquiry response packet.

5. The method of claim **1**, wherein said receiving step further comprises:

receiving the icon information as a value in a Service Discovery Protocol (SDP) response packet.

6. The method of claim **1**, wherein said displaying step further comprises:

displaying a graphic bitmap on a screen of the client device, having an appearance that serves to describe a service that the server device has to offer.

7. The method of claim **1**, wherein said displaying step further comprises:

displaying a graphic bitmap on a screen of the client device, having an appearance that serves to identify characteristics of a user of the server device.

8. The method of claim **1**, which further comprises:

storing the icon in the client device.

9. The method of claim **8**, which further comprises:

downloading new icons from a network service provider and storing them in association with their icon information.

10. The method of claim **9**, which further comprises:

downloading from a network service provider, representations of audible tones to be played when an icon is

displayed, and storing the representations of audible tones in association with the icon information.

11. The method of claim **1**, wherein said receiving step further comprises:

receiving the icon information as a value in a class-of-device (CoD) field of a frequency hop synchronization (FHS) packet from the server device;

reporting the CoD value over a host controller interface (HCI) when the FHS packet is received; and

processing the CoD value to display the corresponding icon.

12. The method of claim **1**, wherein said receiving step further comprises:

receiving the icon information using an SDP Service Search Request packet sent to the server device.

13. The method of claim **1**, wherein said displaying step further comprises:

selectively not displaying the icon based on user-defined prohibited values of the icon information.

14. The method of claim **1**, which further comprises:

storing the icon information in a detected icon buffer.

15. The method of claim **14**, wherein said storing the icon information further comprises:

storing a time stamp value at the start of the display of the icon;

periodically comparing the time stamp value with a time of day clock of the client device; and

removing the display of the icon when the time stamp is older than a threshold lease-time value.

16. The method of claim **15**, wherein said storing the icon information further comprises:

updating the time stamp value when additional signals are received from the server device; and

retaining the display of the icon for the server device as long as it remains in communication range of the client device.

17. The method of claim **1**, wherein said storing the icon information further comprises:

enabling the user to selectively block the icon from display.

18. The method of claim **14**, wherein said storing the icon information further comprises:

storing a Bluetooth device address BD_ADDR of the server device;

storing (x,y) coordinates of a displayed position of the icon with respect to an origin of coordinates on the screen;

representing a position of a cursor displayed on the screen by (X,Y) coordinates with respect to the origin of coordinates on the screen;

comparing the (X,Y) coordinates of the cursor with the (x,y) coordinates of an icon;

determining that the cursor coordinates (X,Y) are within range of an icon's coordinates to select the icon; and

accessing the device address BD_ADDR corresponding to the selected icon to communicate with the server device.

19. The method of claim **18**, which further comprises:

sending an SDP request to the server device to determine information about associated files; and

accessing the associated file from the server device.

20. The method of claim **1**, which further comprises:

receiving an unsolicited file from the server device;

storing the unsolicited file;

storing (x,y) coordinates of a displayed position of the icon with respect to an origin of coordinates on the screen;

representing a position of a cursor displayed on the screen by (X,Y) coordinates with respect to the origin of coordinates on the screen;

comparing the (X,Y) coordinates of the cursor with the (x,y) coordinates of an icon;

determining that the cursor coordinates (X,Y) are within range of an icon's coordinates to select the icon; and

accessing the unsolicited file corresponding to the selected icon to display information from the file on the screen.

21. The method of claim **14**, wherein said storing the icon information further comprises:

storing a first server rank value for a first server device of a given type icon information;

identifying a second server device having a different device address and said given type of icon information;

storing a second server rank value for the second server device; and

displaying a single icon on the screen representing the first and second server devices.

22. The method of claim **21**, which further comprises:

displaying in association with the single icon, the number of server devices detected having the given type icon information.

23. The method of claim **21**, which further comprises:

displaying in association with the single icon, a received signal strength indication (RSSI) as the data link quality value of one of the server devices detected having the given type icon information.

24. The method of claim **21**, which further comprises:

displaying in association with the single icon, a received signal strength indication (RSSI) of one of the server devices detected having the given type icon information and having the strongest RSSI.

25. The method of claim **1**, which further comprises:

storing a received signal strength indication (RSSI) as the data link quality value for each server device detected;

ranking the detected server devices by the respective RSSI values; and

displaying a value representing the RSSI value for corresponding icons displayed on the screen.

26. The method of claim **1**, which further comprises:

storing prohibited icon information values;

comparing received icon information values with the prohibited icon information values; and

ignoring server devices having the prohibited icon information values.

27. The method of claim **1**, wherein said receiving step further comprises:

receiving the icon information as a value in a minor device class sub-field of a class-of-device (CoD) field of a frequency hop synchronization (FHS) packet from the server device.

28. The method of claim **1**, which further comprises:

storing specified icon information values to be searched;

comparing received icon information values with the specified icon information values;

displaying an icon bitmap when a match is found between a received icon information value and a specified icon information value.

29. The method of claim 28, which further comprises:

sounding an alarm tone when a match is found.

30. The method of claim 28, which further comprises:

sending a message to the server device when a match is found between a received icon information value and a specified icon information value.

31. An apparatus to indicate a service available from a Bluetooth server device, comprising:

a receiver in a Bluetooth client device, for receiving icon information as a value in a class-of-device (CoD) field of a frequency hop synchronization (FHS) packet from a Bluetooth server device characterizing the server device;

said receiver measuring a data link quality value between the client and the server based on the received FHS packet;

a display in the Bluetooth client device, for displaying an icon corresponding to the icon information and associating the icon with the data link quality value while within communications range of the server device without establishing a Bluetooth connection between the client device and the server device; and

a processor in the Bluetooth client device, for removing the display of the icon after a predetermined time interval following leaving the communications range of the server device.

32. The apparatus of claim 31, wherein the data link quality value is displayed with the icon.

33. The apparatus of claim 31, wherein said icon information is a CoD value in a paging packet.

34. The apparatus of claim 31, wherein said icon information is a CoD value in an inquiry response packet.

35. The apparatus of claim 31, wherein said icon information is a value in a Service Discovery Protocol (SDP) response packet.

36. The apparatus of claim 31, wherein said icon is a graphic bitmap having an appearance that serves to describe a service that the server device has to offer.

37. The apparatus of claim 31, wherein said icon is a graphic bitmap having an appearance that serves to identify characteristics of a user of the server device.

38. The apparatus of claim 31, which further comprises:

a buffer storing the icon in the client device.

39. The apparatus of claim 38, which further comprises:

said buffer storing new icons received by the receiver from a network service provider.

40. The apparatus of claim 38, which further comprises:

said buffer storing representations of audible tones to be played when an icon is displayed.

41. A computer program product to indicate a service available from a Bluetooth server device, comprising:

a computer readable medium;

program code in said computer readable medium for receiving at a Bluetooth client device, icon information as a value in a class-of-device (CoD) field of a frequency hop synchronization (FHS) packet from a Bluetooth server device characterizing the server device;

program code in said computer readable medium for measuring a data link quality value between the client and the server based on the received FHS packet;

program code in said computer readable medium for displaying at the client device an icon corresponding to the icon information and associating the icon with the data link quality value while within communications range of the server device without establishing a Bluetooth connection between the client device and the server device; and

program code in said computer readable medium for removing the display of the icon after a predetermined time interval following leaving the communications range of the server device.

42. The computer program product of claim 41, wherein the data link quality value is displayed with the icon.

43. The computer program product of claim 41, wherein said icon information is a CoD value in a paging packet.

44. The computer program product of claim 41, wherein said icon information is a CoD value in an inquiry response packet.

45. The computer program product of claim 41, wherein said icon information is a value in a Service Discovery Protocol (SDP) response packet.

46. The computer program product of claim 41, wherein said icon is a graphic bitmap having an appearance that serves to describe a service that the server device has to offer.

47. The computer program product of claim 41, wherein said icon is a graphic bitmap having an appearance that serves to identify characteristics of a user of the server device.

48. The computer program product of claim 41, which further comprises:

program code in said computer readable medium for storing the icon in the client device.

49. The computer program product of claim 48, which further comprises:

program code in said computer readable medium for downloading new icons from a network service provider and storing them in association with their icon information.

50. The computer program product of claim 48, which further comprises:

program code in said computer readable medium for downloading from a network service provider, representations of audible tones to be played when an icon is displayed, and storing the representations of audible tones in association with the icon information.

51. A method to indicate a service available from a Bluetooth server device, comprising:

receiving at a Bluetooth client device, a first address and first icon information from a first Bluetooth server device characterizing it as a first type server device;

determining a first received signal strength indication (RSSI) for said first server device;

receiving at said Bluetooth client device, a second address and said first icon information from a second Bluetooth server device characterizing it as said first type server device;

determining a second received signal strength indication (RSSI) for said second server device;

ranking said first and second server devices according to their respective received signal strength indications (RSSI);

displaying a single icon on the screen representing said first and second server devices without establishing a Bluetooth connection between the client device and the server devices; and

initiating communications with either said first or said second servers having a stronger received signal strength indication (RSSI), in response to a user selection of said single icon.

52. The method to indicate a service available from a Bluetooth server device of claim **51**, further comprising:

displaying in association with the single icon, the number of server devices detected having the given type icon information.

53. The method of claim **51**, which further comprises:

displaying in association with the single icon, a received signal strength indication (RSSI) of one of the server devices.

54. The method of claim **51**, which further comprises:

displaying in association with the single icon, a received signal strength indication (RSSI) of one of the server devices detected having the given type icon information and having the strongest RSSI.

55. The method of claim **51**, which further comprises:

reassigning said ranking of said first or second server devices as individual server devices move out of communication range of the client device.

56. A method to indicate a service available from a Bluetooth server device, comprising:

receiving at a Bluetooth client device, icon information as a value in a class-of-device (CoD) field of a frequency hop synchronization (FHS) packet from a Bluetooth server device characterizing the server device;

accessing in the client device, a list of service indicator icons corresponding to various CoD values;

measuring a data link quality value between the client and the server based on the received FHS packet;

displaying at the client device an icon accessed from the list corresponding to the icon information and associating the icon with the data link quality value while within communications range of the server device without establishing a Bluetooth connection between the client device and the server device; and

removing the display of the icon after a predetermined time interval following leaving the communications range of the server device.

57. The method of claim **56**, wherein the data link quality value is displayed with the icon.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

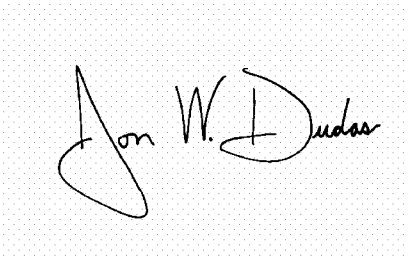
PATENT NO. : 7,102,640 B1
APPLICATION NO. : 10/101688
DATED : September 5, 2006
INVENTOR(S) : Aholainen et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Section (57) "Abstract"
Line 6, "sewing" should be --sending--.

Signed and Sealed this

Twenty-sixth Day of December, 2006



JON W. DUDAS
Director of the United States Patent and Trademark Office