ted respectively thereto. However, it is also possible that the bits inputted to the circuits **841** to **843** are collectively treated as one word to add error control information to the word. This advantageously leads to a simplified configuration of the error control circuits.

Although detailed description has not been given of the encryption in the embodiment shown in FIG. **5**, it is possible to execute the processing as shown in FIG. **6** by combining the encryption circuit **171** with the interface circuit **172**. FIG. **6** shows an example of the configuration to carry out the encryption in the system of FIG. **5**. The system shown in FIG. **6** includes encryption/decryption circuits **821** to **826**, interface circuits **830** and **831** including encryption, and error control circuits **841** to **847**.

In the example of FIG. **6**, the bit selection circuit **811** selects predetermined bits as in the example shown in FIG. **5**. For the respective bits, the error control circuits **841** and **842** conduct error control. For the resultant signals, the encryption/decryption circuits **821** and **822** respectively carry out encryption. The obtained signals are inputted respectively to the QPSK modem circuit **801** and the 64QAM modem circuit **802** to be demodulated. The signals demodulated respectively by the circuits **801** and **802** are delivered to the encryption/decryption circuits **824** and **825** to be decrypted. The decrypted signals are fed to the bit selection circuit **812** and are therein bit-combined with each other. As a result, the signal processing can be executed according to importance of signals to possibly suppress errors in the processing of more important information. Hence, the signals of information can be efficiently transmitted without deteriorating the picture quality.

It is also possible to further increase transmission efficiency by combining lossless coding with the encryption/decryption circuits **821** to **826**. For example, in the example of FIG. **6**, before executing the encryption processing in the encryption/decryption circuits **821** to **823**, the number of bits to be transmitted is reduced, for example, by use of reversible arithmetic codes based on a statistic property. In the video display apparatus **200**, the received signals are decrypted by the encryption/decryption circuits **824** to **826**. Thereafter, the reversible codes corresponding to the circuits **821** to **823** are decoded to be fed to the error control circuits **845** to **846** for the error detection and correction thereof. The obtained signals are fed to the bit selection circuit **812** to be bit-combined with each other. Since the transmission rate of the information to be transmitted can be lowered by combining the reversible codes as above, the signal can be more efficiently transmitted.

Description will be supplementally given of the encryption. By using AES128 bit encryption in all encryption circuits for the encryption, it is possible to conduct the encryption with high safety for the protection of contents. Moreover, if the AES128 bit encryption is employed for the content encryption circuit **821** and the Data Encryption Standard (DES) encryption is used for the other encryption circuits, there can be easily constructed a system in which the protection of important contents and the processing efficiency are appropriately achieved.

It is also possible to construct a system in which a changeover operation is conducted between the baseband signal transmission and the compressed signal transmission in response to an inter-apparatus control signal. With the configuration, to transmit a compressed signal according to, for example, a content protection request, the error resistivity is enhanced on the transmission path by transmitting the signal using the QPSK modulation. To transmit the baseband signal, the transmission efficiency is increased by using the 64QAM modulation.

The operations of the video processing apparatus **100** and the video display apparatus **200** in FIG. **6** are basically similar to those of the apparatuses **100** and **200** shown in FIG. **5**. To transmit a signal, the video processing apparatus **100** determines the state of an associated transmission path, specifically, detects by a carrier detection circuit, not shown, whether or not the channel to be used is occupied by another apparatus. In the carrier detection, a check is made to determined whether or not a carrier is detected in a predetermined frequency band for a predetermined period of time. If it is detected by the detector that the channel is occupied by another apparatus, the check is again carried out after a lapse of a predetermined period of time to determine whether or not an available channel is present. If such available channel is present, the condition is notified to the microprocessor **115** of the video processing apparatus **100**. The microprocessor **115** outputs from the QPSK modem circuit **803** a channel use request signal as an inter-apparatus control signal to secure the channel use right. Thereafter, the microprocessor **115** sends a transmission request signal to a bit selection circuit **811**.

The error control circuit **843** adds error control bits for error detection and correction to the transmission request signal which is in turn encrypted by an encryption/decryption circuit **823** and then transferred to the QPSK modem **803**. The modem **803** conducts a QPSK modulation for the signal to resultantly transmit a radio signal via the antenna **83** to the display apparatus **200**. The apparatus **200** then receives the radio signal by the antenna **86**, carries out a QPSK demodulation for the signal by the modem **806**, and decrypts the signal by the encryption/decryption circuit **826**. For the demodulated signal, the error control circuit **847** conducts error detection and correction control to produce an inter-apparatus control signal and delivers the signal to the bit selection circuit **812**. The microprocessor in the video display apparatus **200** decodes the inter-apparatus control signal and receives the transmission request signal from the video processing apparatus **100** together with apparatus category information regarding the apparatus **100** (information to identify a category indicating whether the associated apparatus is a display apparatus or a recording apparatus) and an apparatus identification number of the apparatus **100**. An image to urge the user to determine whether or not a connection is established to the video processing apparatus **100** is presented on a display screen of the display apparatus **200**. In response thereto, the user indicates allowance for the connection by use of an input device such as a remote control of the display apparatus **200**. Thereafter, between the apparatuses **100** and **200**, the apparatus category information and the identification number to identify each of the apparatuses are communicated to exchange information to observe the copyright protection and the replication restriction condition of the content. If there does not exist any problem, it is allowed that the apparatuses **100** and **200** are connected to each other. In a situation wherein the connection is meaningless, for example, each of the apparatuses **100** and **200** is an input or output dedicated unit or the copyright protection or the replication restriction condition of the content is not observed, the connecting operation is interrupted and the status is displayed on the apparatuses **100** and **200**. As above, in a situation wherein the copyright protection and the replication restriction condition of the content are observed, the connection is established to transmit video and audio signals from the video processing apparatus **100** to the video display apparatus **200**.

Second Embodiment

FIG. **3** shows a second embodiment of the present invention and is another configuration of the video display appa-

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ratus **200** shown in FIG. **1**. The configuration of FIG. **3** is partially equal to that of FIG. **2**. The same constituent components are assigned with the same reference numerals, and detailed description thereof will be avoided. The apparatus **200** of FIG. **3** includes a decryption circuit **212**, encryption/decryption circuits **245** and **290**, compression/transcoding circuits **291** and **292**, and copy control circuit **293** which is a multiplexing circuit.

In the embodiment of FIG. **3**, when a baseband signal is inputted via the terminal **201** or **202**, the system operates in almost the same way as for the embodiment shown in FIG. **2**. Each of the compression/transcoding circuits **291** and **292** operates as a compression circuit for the baseband signal. When a compressed signal is inputted from the terminal **201** or **202**, the signal is fed via the input/output interface **210** to the encryption/decryption circuit **212** to be decrypted. The signal is then delivered to the demultiplexer circuit **250** to be separated into a compressed video signal and a compressed audio signal. These signals are inputted to the replication control circuit **290**, which determines allowance or rejection of replication of the signals based on information indicating a replication restriction condition. If the replication is allowed, the bit rates of the compressed video and audio signals are lowered by the compression/transcoding circuits **291** and **292** by using, for example, a compression method having high compression efficiency according to necessity. Output signals from the circuits **291** and **292** are multiplexed by the multiplexer circuit **293** to be inputted to the encryption/decryption circuit **245**. In this situation, if the replication is allowed by the replication control circuit **290**, the circuit **245** encrypts the input signal for the storage thereof to store the encrypted signals in the storage **230** and/or the memory **221**. To reproduce the stored signal, the circuit **245** decrypts the signal read from the storage **230** or the memory **221**, and the decrypted signal is separated by the demultiplexer circuit **241** into a video signal and an audio signal. Thereafter, these signals are processed in almost the same way as described above and the user resultantly enjoys the image and the sound. In a situation wherein the user enjoys the image and the sound while storing the signal in the storage **230** or the memory **221**, the signal from the multiplexer **293** is delivered via the encryption/decryption circuit **245** to the demultiplexer **241** to be processed almost in the same way as above. In this case, it is possible to confirm the picture quality of the transcoded signal. To enjoy the image and the sound without storing the signal, the signal is fed from the decryption circuit **212** via the circuit **245** to the demultiplexer **241** to be separated into a video signal and an audio signal. Thereafter, the signals are processed in substantially the same way as described above.

According to the embodiment of FIG. **3**, also in a situation wherein a compressed signal is inputted thereto, by conducting the transcoding for the signal, the signal can be efficiently stored with a high compression ratio. Although the signal processing is carried out by use of circuits such as the compression circuits **111** and **113** in the embodiment, the circuits may be implemented by software means. In this situation, there can also be obtained similar advantages. According to the present invention, the signal processing may be accomplished in any appropriate fashion, that is, the present invention does not particularly limit how to implement the signal processing.

It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the invention, the invention is not limited thereto and various changes and modifications may be made without departing from the spirit of the invention and the scope of the appended claims.

The invention claimed is:

1. A display apparatus, comprising:

a first radio communication unit capable of receiving digital video information by radio from an external video processing apparatus;

a second radio communication unit capable of connecting by radio to the external video processing apparatus, accessing to an internet or a home network through the external video processing apparatus by radio, and receiving digital information; and

a control unit for controlling assignment of connection by radio transmission for each of the first and second radio communication units, so that the first radio communication unit receives digital video information from the external video processing apparatus and the second radio communication unit connects to the internet or the home network simultaneously,

wherein said first radio communication unit and said second radio communication unit are different from each other in frequency bandwidth and modulation/demodulation method,

wherein the control unit controls assignment of a transmission rate between the first radio communication unit and the external video processing apparatus, and assignment of a transmission rate between the second radio communication unit and the internet or the home network, and

wherein the control unit controls the assignment of the transmission rate such that the transmission rate between the first radio communication unit and the external video processing apparatus, is more than the transmission rate between the second radio communication unit and the internet or the home network, when a user issues an indication to receive video information by using the first radio communication unit from the video processing apparatus while acquiring information from the Internet by use of the second radio communication unit.

2. A display apparatus according to claim **1**, wherein the control unit assigns connection of the first radio communication unit with higher priority.

3. A display apparatus according to claim **1**, further comprising a detection unit for detecting a state of a transmission path, wherein

a demodulation method in the first or second radio communication unit is controlled according to a result of detection conducted by the detection unit.

4. A video processing apparatus, comprising:

a first radio communication unit capable of transmitting digital video information by radio to an external display apparatus;

a second radio communication unit capable of connecting by radio to the external display apparatus, accessing to an internet or a home network, and receiving digital information; and

a control unit for controlling assignment of connection by radio transmission for each of the first and second radio communication units, so that the first radio communication unit transmits digital video information from the external video processing apparatus and the second radio communication unit connects to the internet or the home network simultaneously,

wherein said first radio communication unit and said second radio communication unit are different from each other in frequency bandwidth and modulation/demodulation method,

wherein the control unit controls assignment of a transmission rate between the first radio communication unit and

the external video display apparatus, and assignment of a transmission rate between the second radio communication unit and the internet or the home network, and

wherein the control unit controls the assignment of the transmission rate such that the transmission rate between the first radio communication unit and the external video display apparatus, is more than the transmission rate between the second radio communication unit and the internet or the home network, when a user issues an indication to receive video information by using the first radio communication unit from the video processing apparatus while acquiring information from the Internet by use of the second radio communication unit.

5. A video processing apparatus according to claim **4**, wherein the control unit assigns connection of the first radio communication unit with higher priority.

6. A video processing apparatus according to claim **4**, further comprising a detection unit for detecting a state of a transmission path, wherein

a demodulation method in the first or second radio communication unit is controlled according to a result of detection conducted by the detection unit.

* * * * *

EXHIBIT 1012

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Trachewsky (43) **Pub. Date: May 17, 2007**

(54) **CO-LOCATION INTERFERENCE AVOIDANCE IN MULTIPLE PROTOCOL COMMUNICATION NETWORKS**

(75) Inventor: **Jason A. Trachewsky**, Menlo Park, CA (US)

Correspondence Address:
GARLICK HARRISON & MARKISON
P.O. BOX 160727
AUSTIN, TX 78716-0727 (US)

(73) Assignee: **Broadcom Corporation, a California Corporation**, Irvine, CA

(21) Appl. No.: **11/651,784**

(22) Filed: **Jan. 10, 2007**

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(60) Provisional application No. 60/694,948, filed on Jun. 29, 2005. Provisional application No. 60/855,856, filed on Nov. 1, 2006.

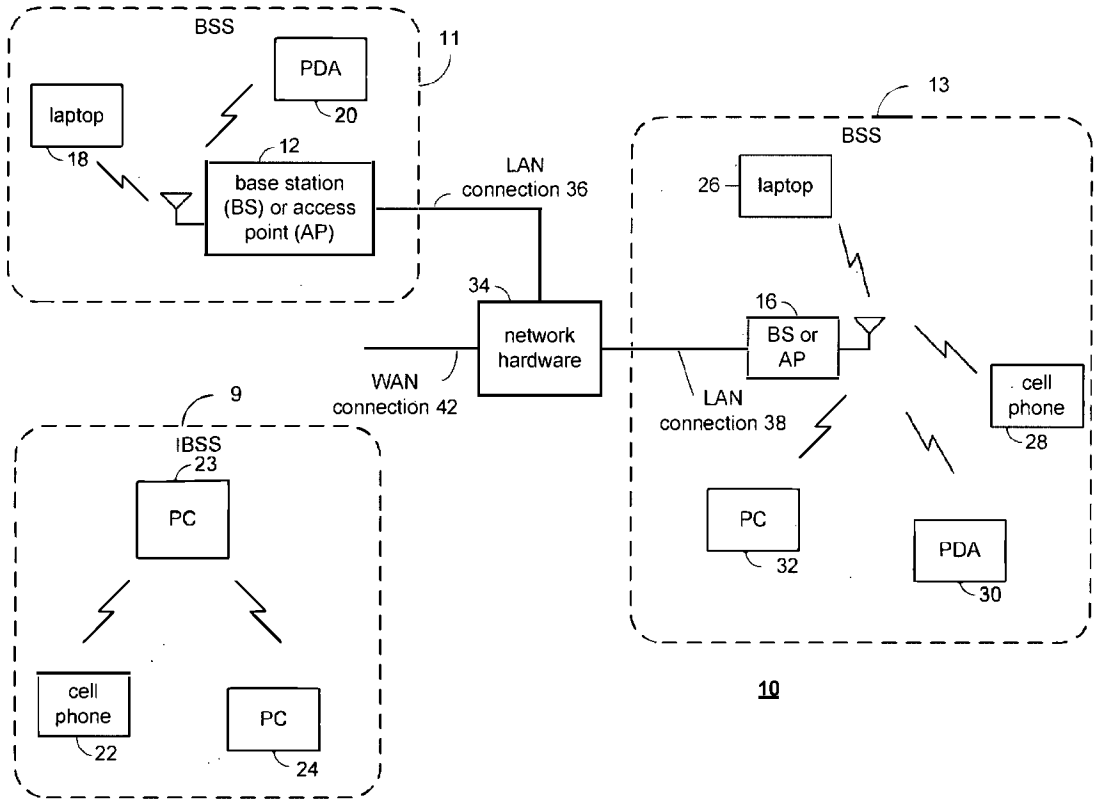
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H04Q 7/00 (2006.01)
H04Q 7/24 (2006.01)

(52) **U.S. Cl.** **370/252**; 370/329; 370/338

(57) **ABSTRACT**

A method includes an access point providing a request for co-location interference information to at least one multiple protocol device. The method continues with the at least one multiple protocol device obtaining co-location interference information in response to the request. The method continues with the at least one multiple protocol device providing the co-location interference information to the access point.



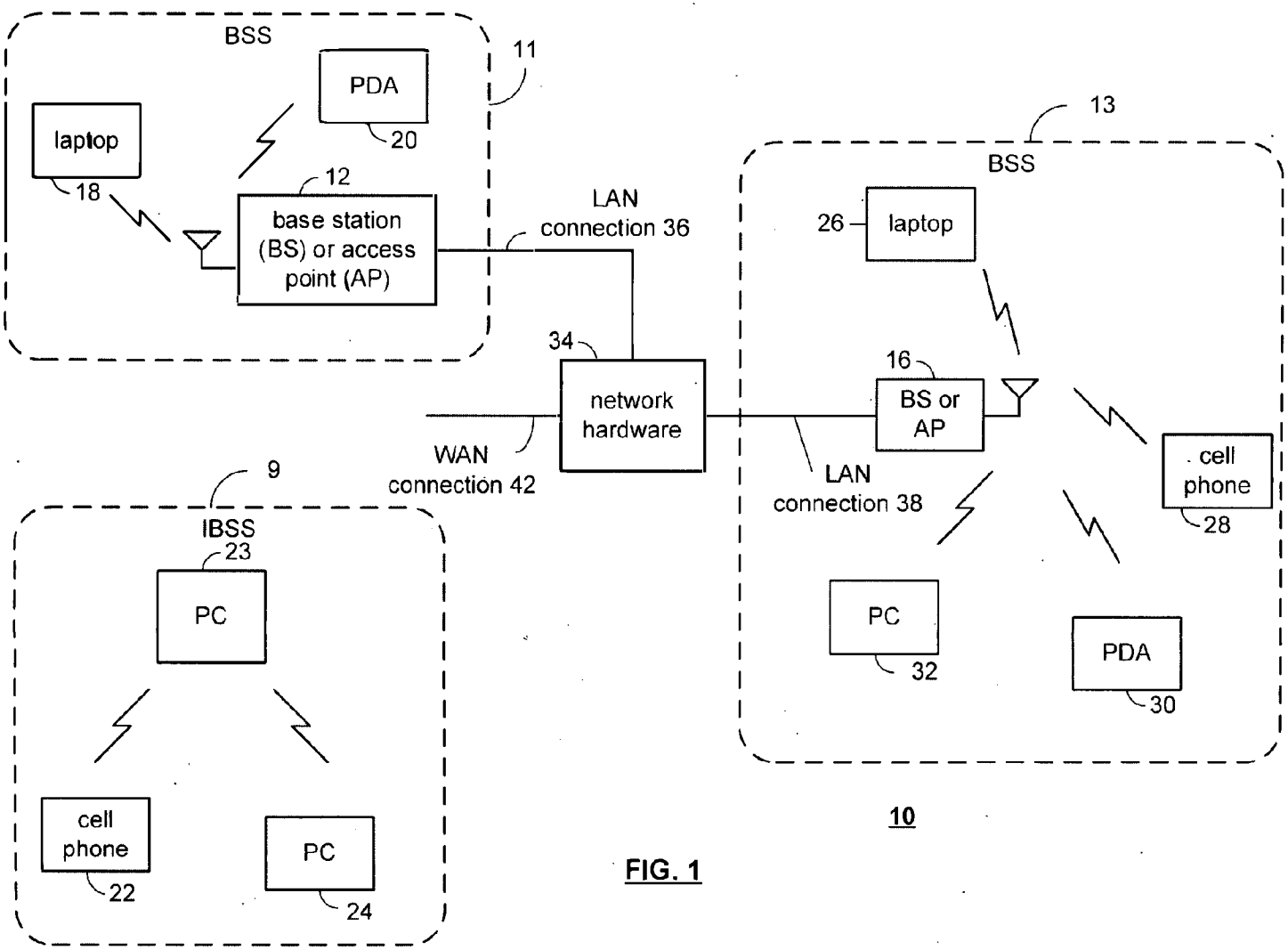

BSS
11
PDA
20
laptop
18
12
base station (BS) or access point (AP)
LAN connection 36
13
BSS
26
laptop
34
network hardware
16
BS or AP
WAN connection 42
LAN connection 38
cell phone
28
9
IBSS
23
PC
PC
32
PDA
30
cell phone
22
PC
24
10

FIG. 1

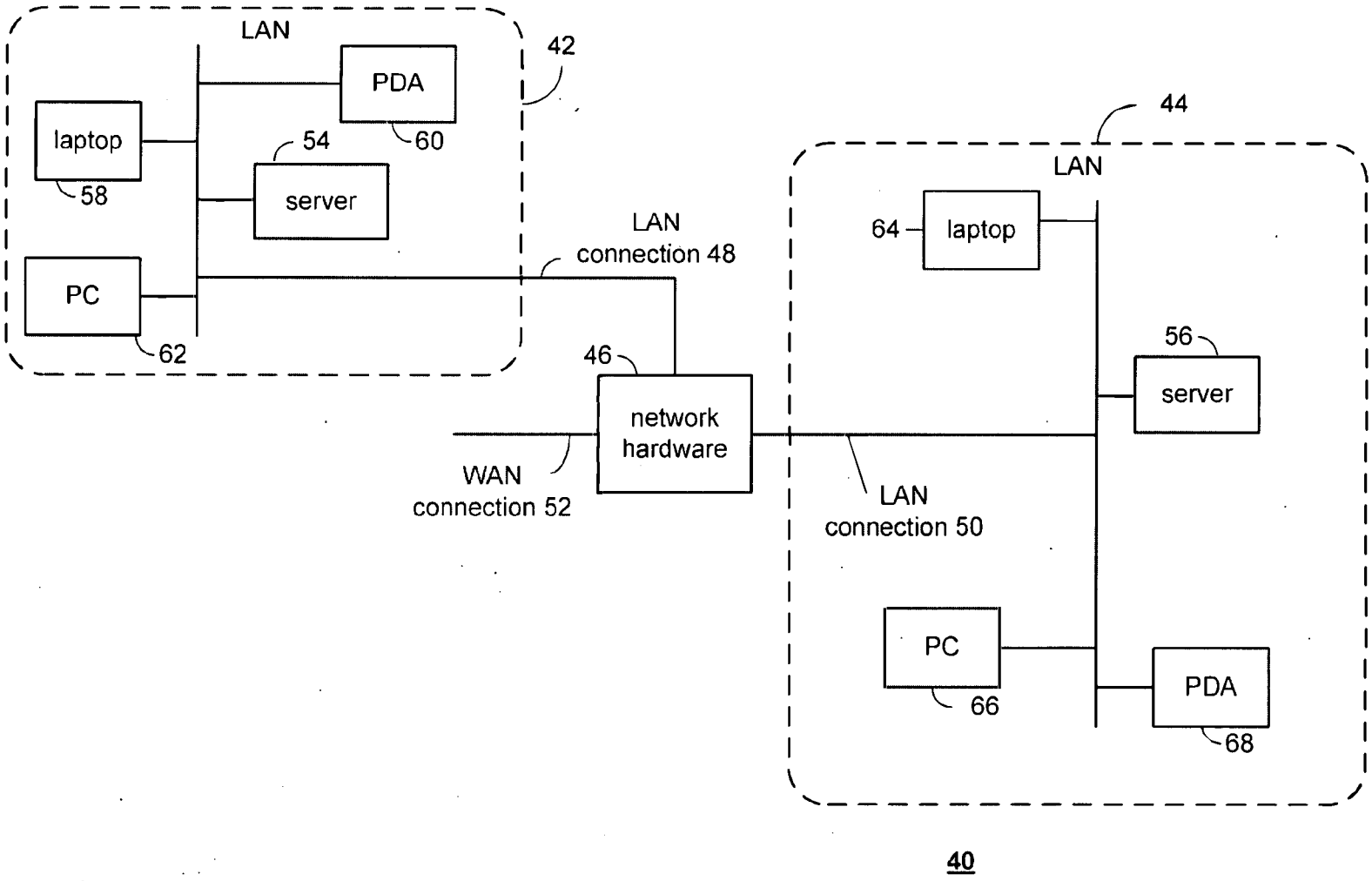

LAN
42
PDA
60
laptop
58
54
server
PC
62
LAN
connection 48
46
network
hardware
WAN
connection 52
44
LAN
64
laptop
56
server
LAN
connection 50
PC
66
PDA
68
40

FIG. 2

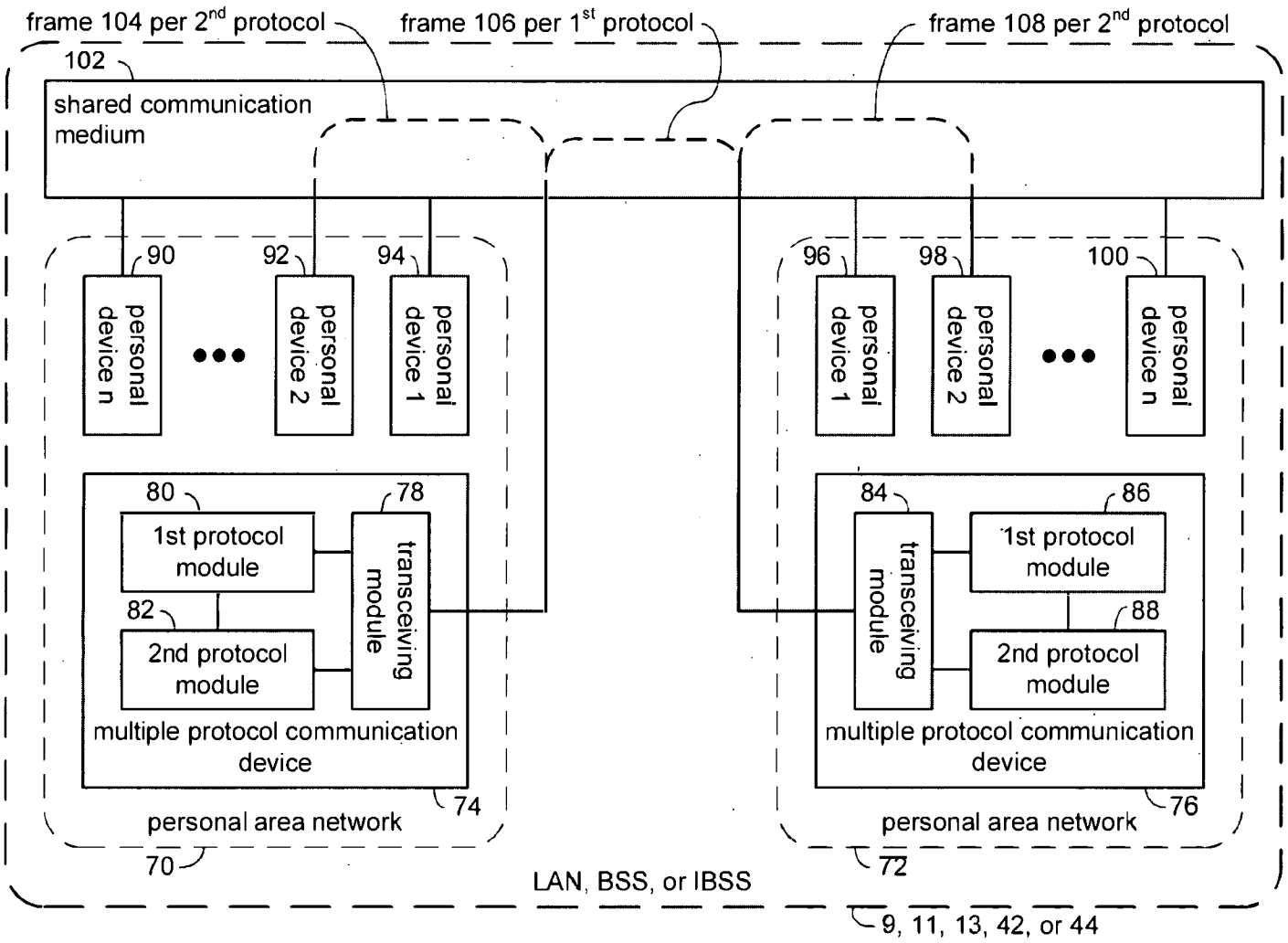

frame 104 per 2nd protocol
frame 106 per 1st protocol
frame 108 per 2nd protocol
102
shared communication medium
90
92
94
personal device n
personal device 2
personal device 1
96
98
100
personal device 1
personal device 2
personal device n
80
78
1st protocol module
82
2nd protocol module
transceiving module
multiple protocol communication device
74
personal area network
70
84
86
88
transceiving module
1st protocol module
2nd protocol module
multiple protocol communication device
76
personal area network
72
LAN, BSS, or IBSS
9, 11, 13, 42, or 44

FIG. 3

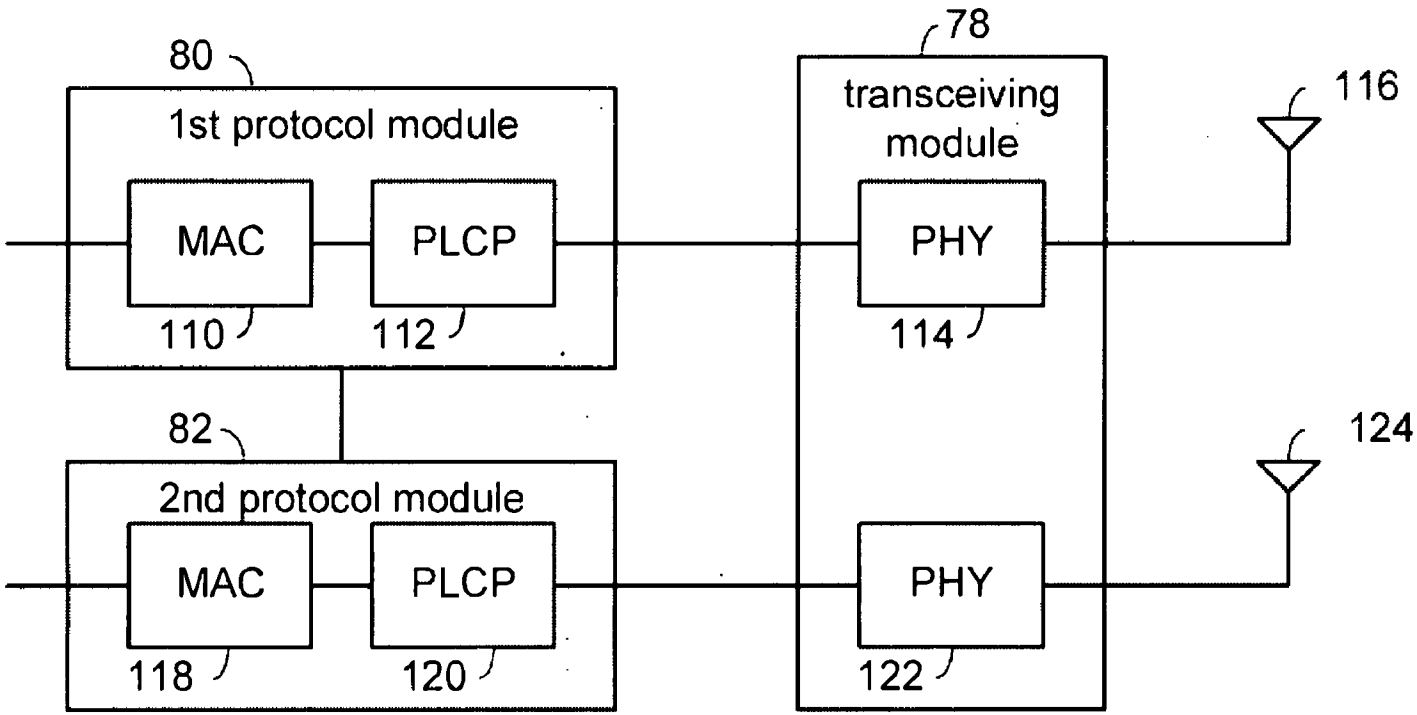

80
1st protocol module
MAC
PLCP
110
112
82
2nd protocol module
MAC
PLCP
118
120
78
transceiving module
PHY
114
PHY
122
116
124

FIG. 4

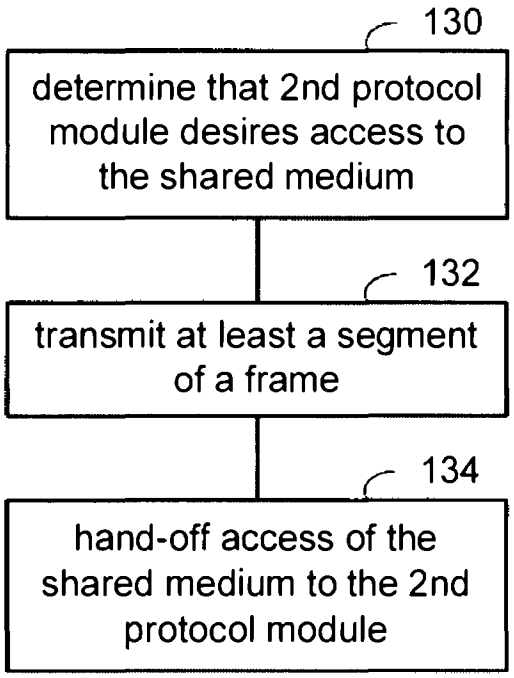

130
determine that 2nd protocol module desires access to the shared medium
132
transmit at least a segment of a frame
134
hand-off access of the shared medium to the 2nd protocol module

FIG. 5

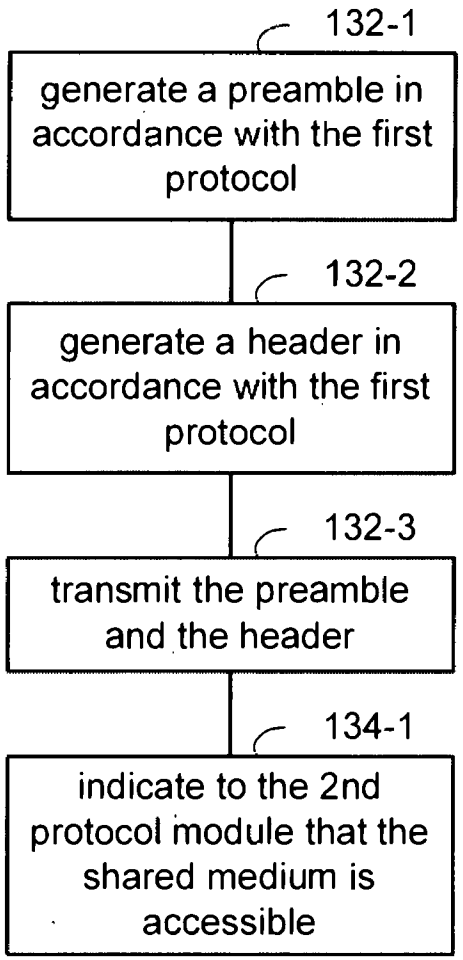

132-1
generate a preamble in accordance with the first protocol
132-2
generate a header in accordance with the first protocol
132-3
transmit the preamble and the header
134-1
indicate to the 2nd protocol module that the shared medium is accessible

FIG. 6

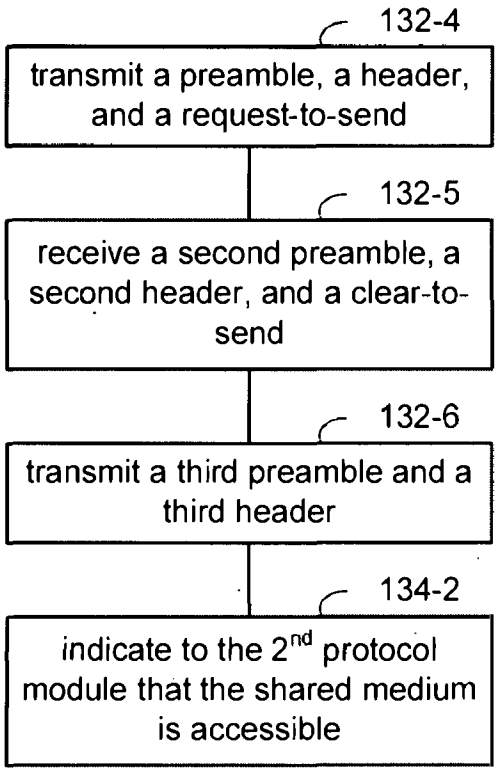

132-4
transmit a preamble, a header, and a request-to-send
132-5
receive a second preamble, a second header, and a clear-to-send
132-6
transmit a third preamble and a third header
134-2
indicate to the 2nd protocol module that the shared medium is accessible

FIG. 7

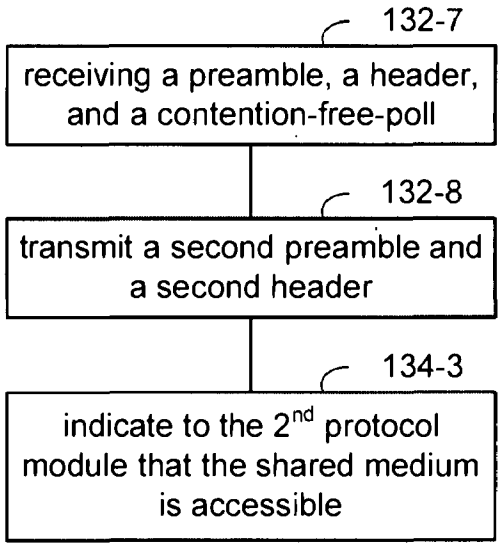

132-7
receiving a preamble, a header, and a contention-free-poll
132-8
transmit a second preamble and a second header
134-3
indicate to the 2nd protocol module that the shared medium is accessible

FIG. 8

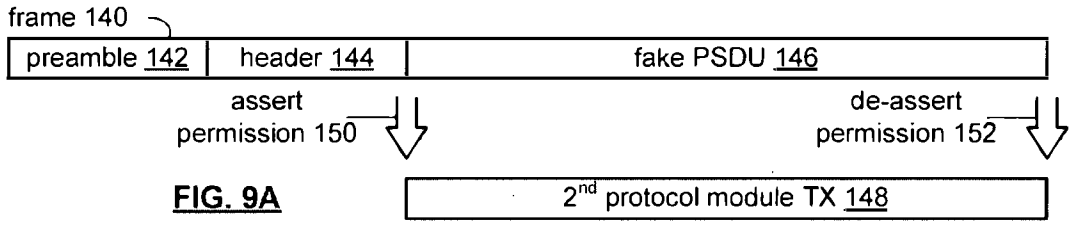


FIG. 9A

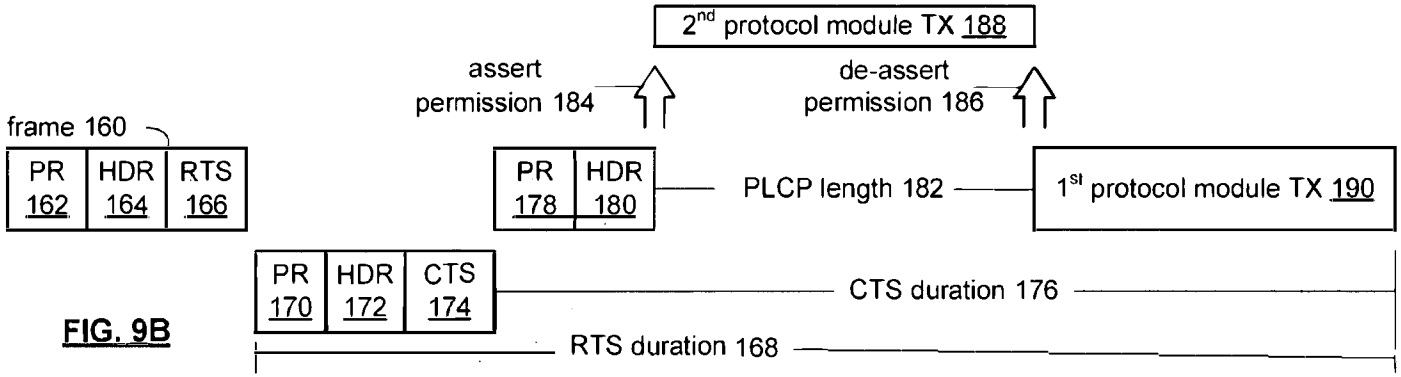


FIG. 9B

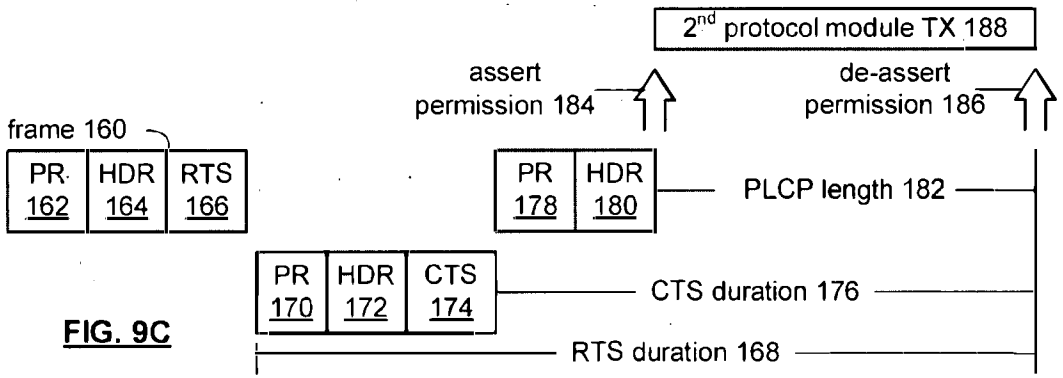


FIG. 9C

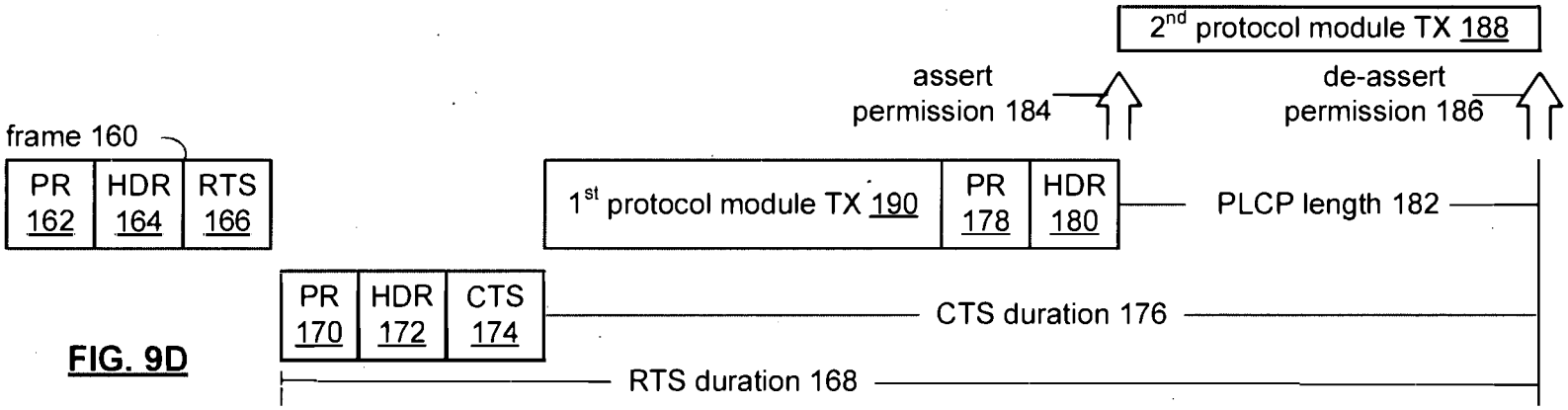

2nd protocol module TX 188
assert permission 184
de-assert permission 186
frame 160
PR 162
HDR 164
RTS 166
1st protocol module TX 190
PR 178
HDR 180
PLCP length 182
PR 170
HDR 172
CTS 174
CTS duration 176
RTS duration 168

FIG. 9D

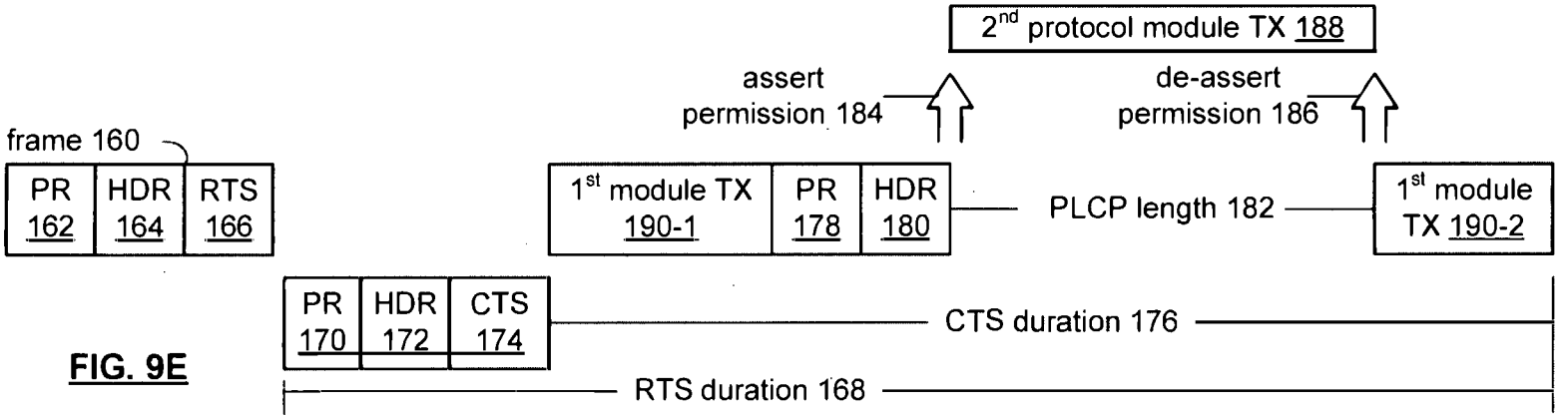

2nd protocol module TX 188
assert permission 184
de-assert permission 186
frame 160
PR 162
HDR 164
RTS 166
1st module TX 190-1
PR 178
HDR 180
PLCP length 182
1st module TX 190-2
PR 170
HDR 172
CTS 174
CTS duration 176
RTS duration 168

FIG. 9E

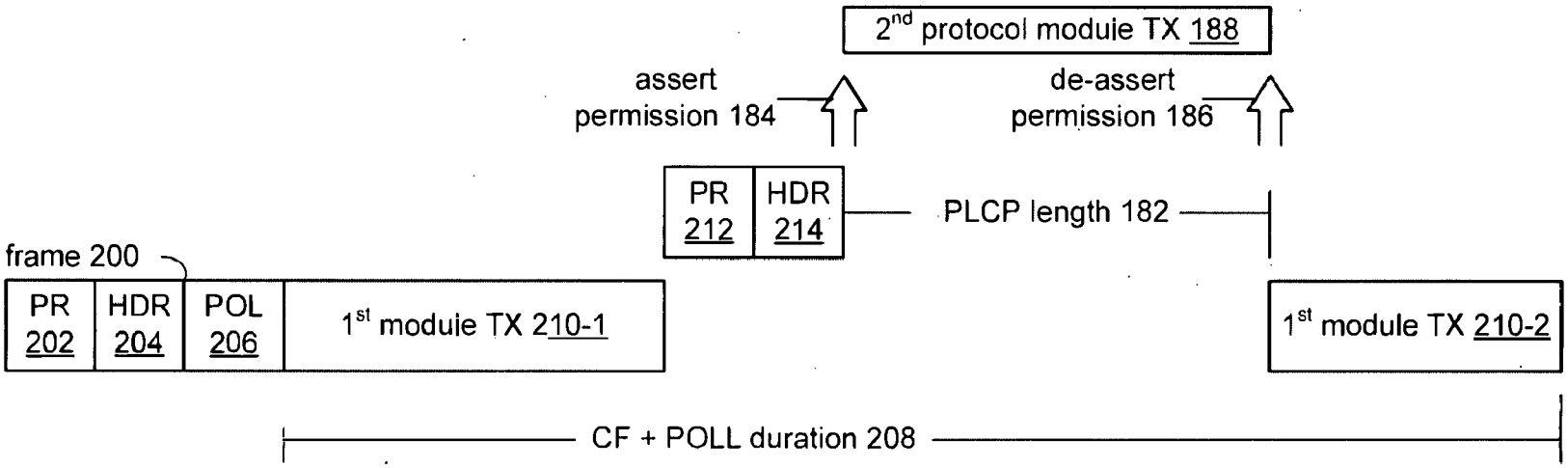

2nd protocol module TX 188
assert permission 184
de-assert permission 186
PR 212
HDR 214
PLCP length 182
frame 200
PR 202
HDR 204
POL 206
1st module TX 210-1
1st module TX 210-2
CF + POLL duration 208

FIG. 9F

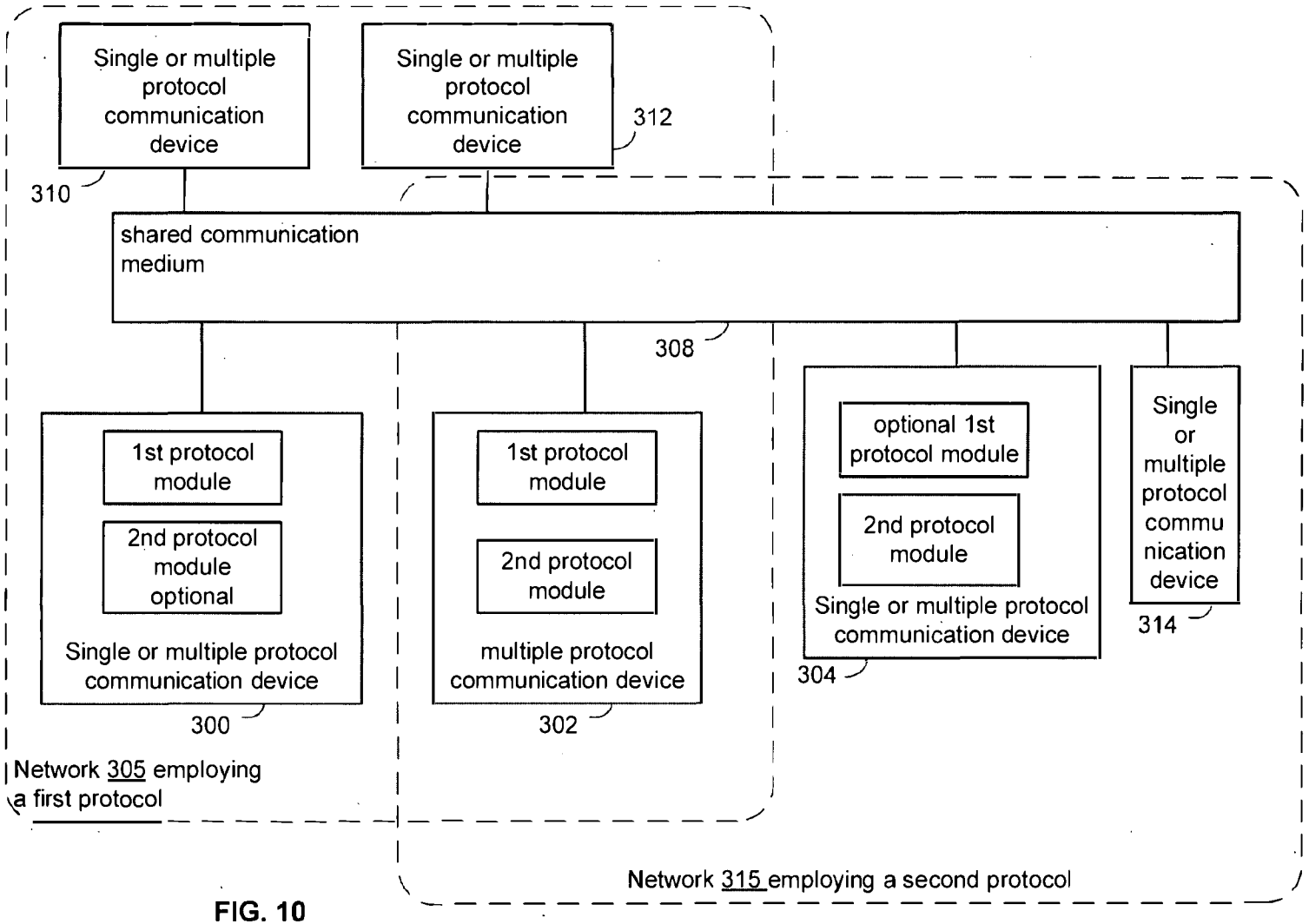

Single or multiple protocol communication device
Single or multiple protocol communication device
312
310
shared communication medium
308
1st protocol module
2nd protocol module optional
Single or multiple protocol communication device
300
1st protocol module
2nd protocol module
multiple protocol communication device
302
optional 1st protocol module
2nd protocol module
Single or multiple protocol communication device
304
Single or multiple protocol communication device
314
Network 305 employing a first protocol
Network 315 employing a second protocol

FIG. 10

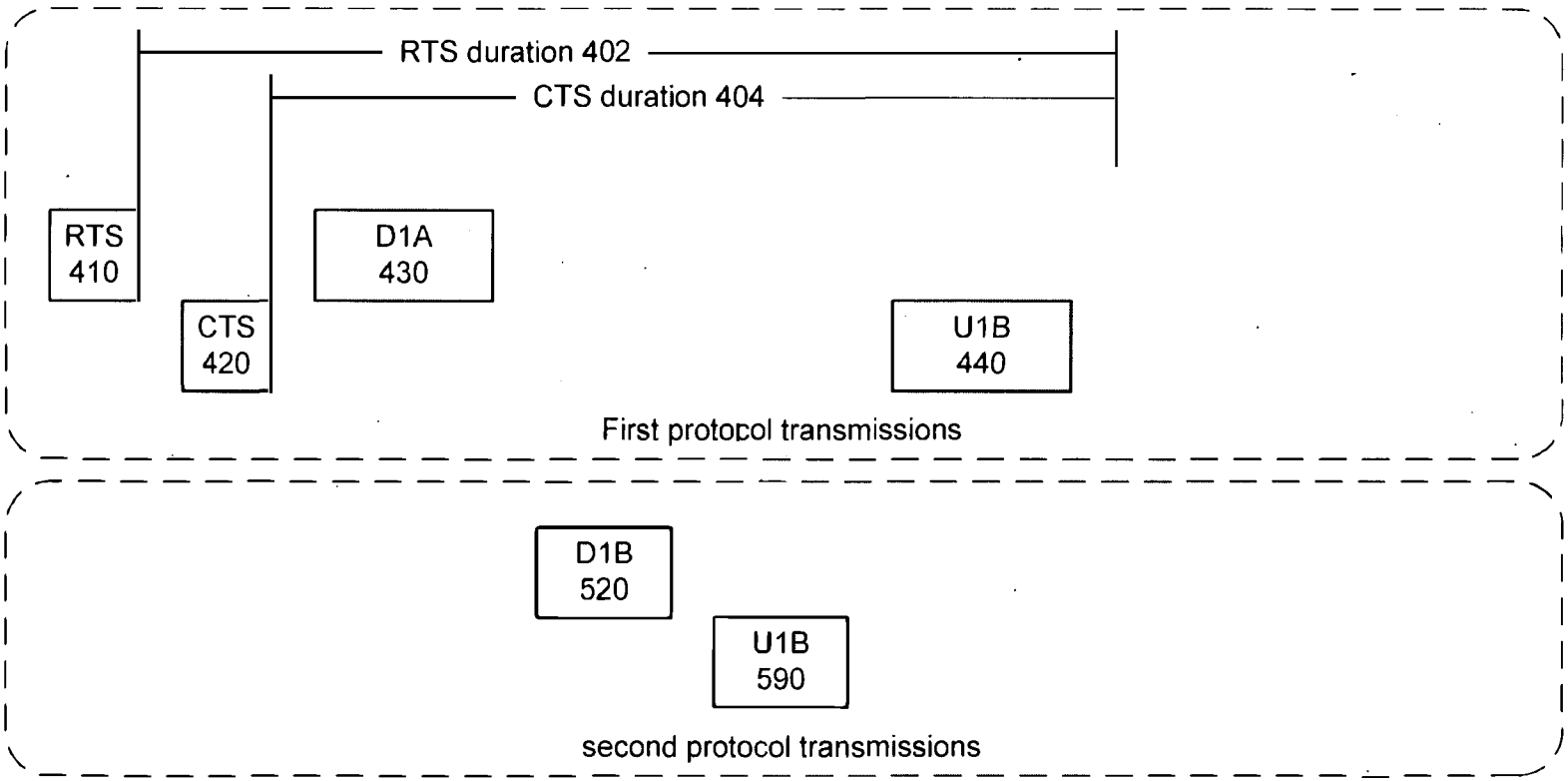

RTS duration 402
CTS duration 404
RTS
410
CTS
420
D1A
430
U1B
440
First protocol transmissions
D1B
520
U1B
590
second protocol transmissions

FIG. 11

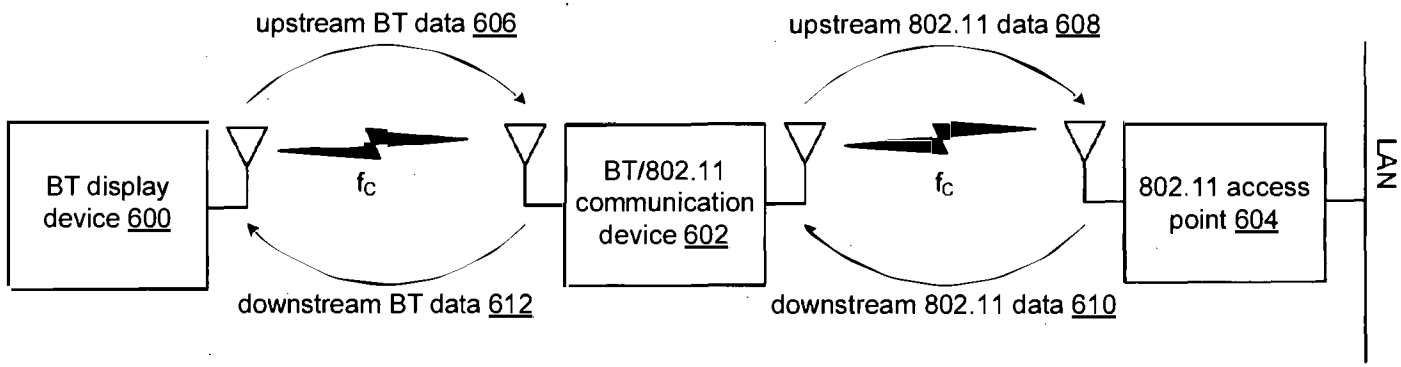

upstream BT data 606
upstream 802.11 data 608
BT display device 600
f_C
BT/802.11 communication device 602
f_C
802.11 access point 604
LAN
downstream BT data 612
downstream 802.11 data 610

FIG. 12

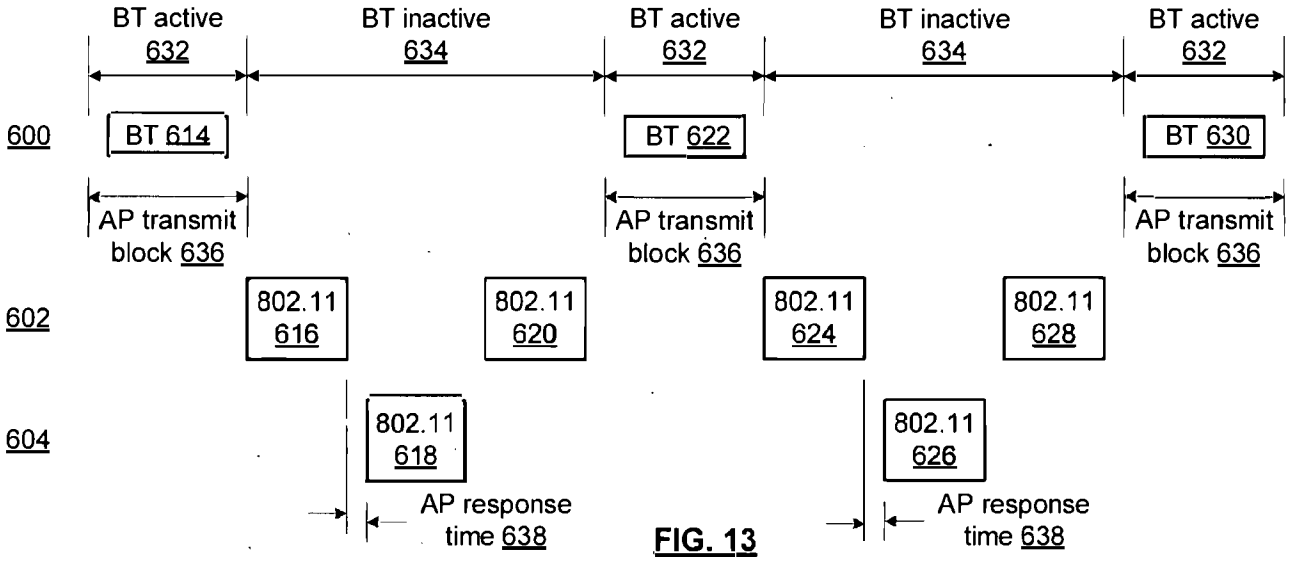

BT active 632
BT inactive 634
BT active 632
BT inactive 634
BT active 632
600
BT 614
BT 622
BT 630
AP transmit block 636
AP transmit block 636
AP transmit block 636
602
802.11 616
802.11 620
802.11 624
802.11 628
604
802.11 618
802.11 626
AP response time 638
AP response time 638

FIG. 13

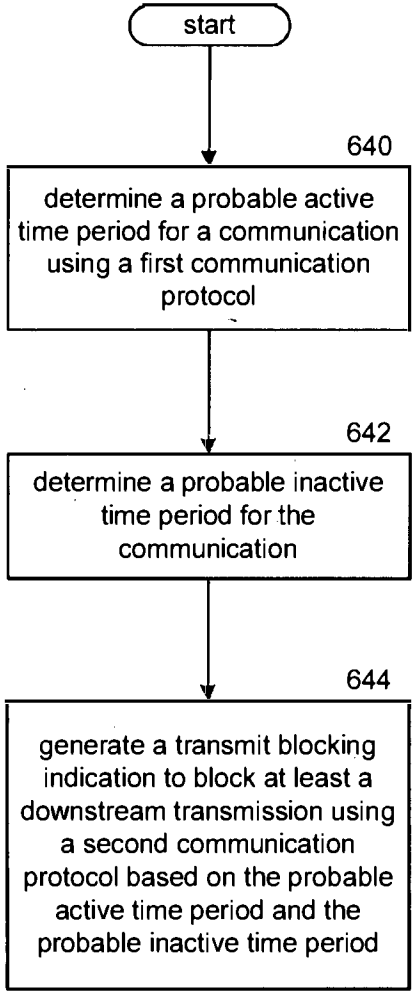


FIG. 14

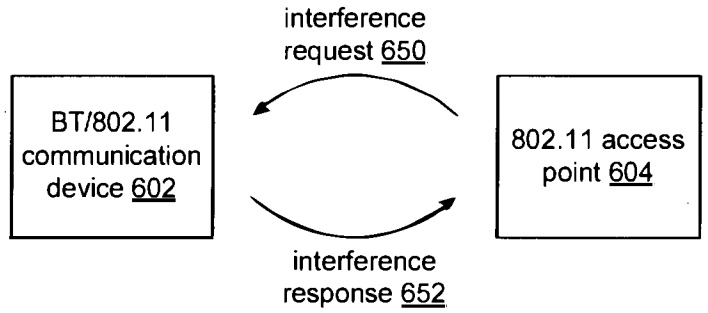


FIG. 15

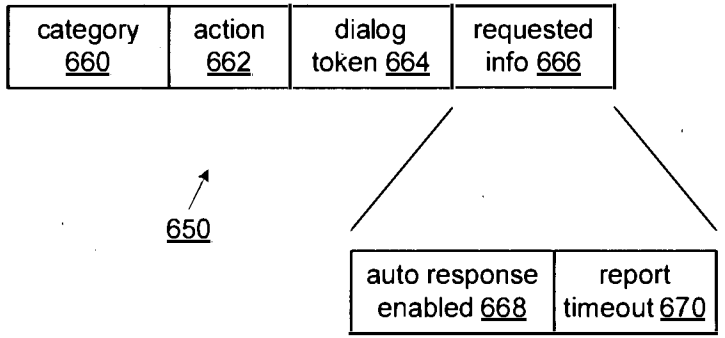


FIG. 16

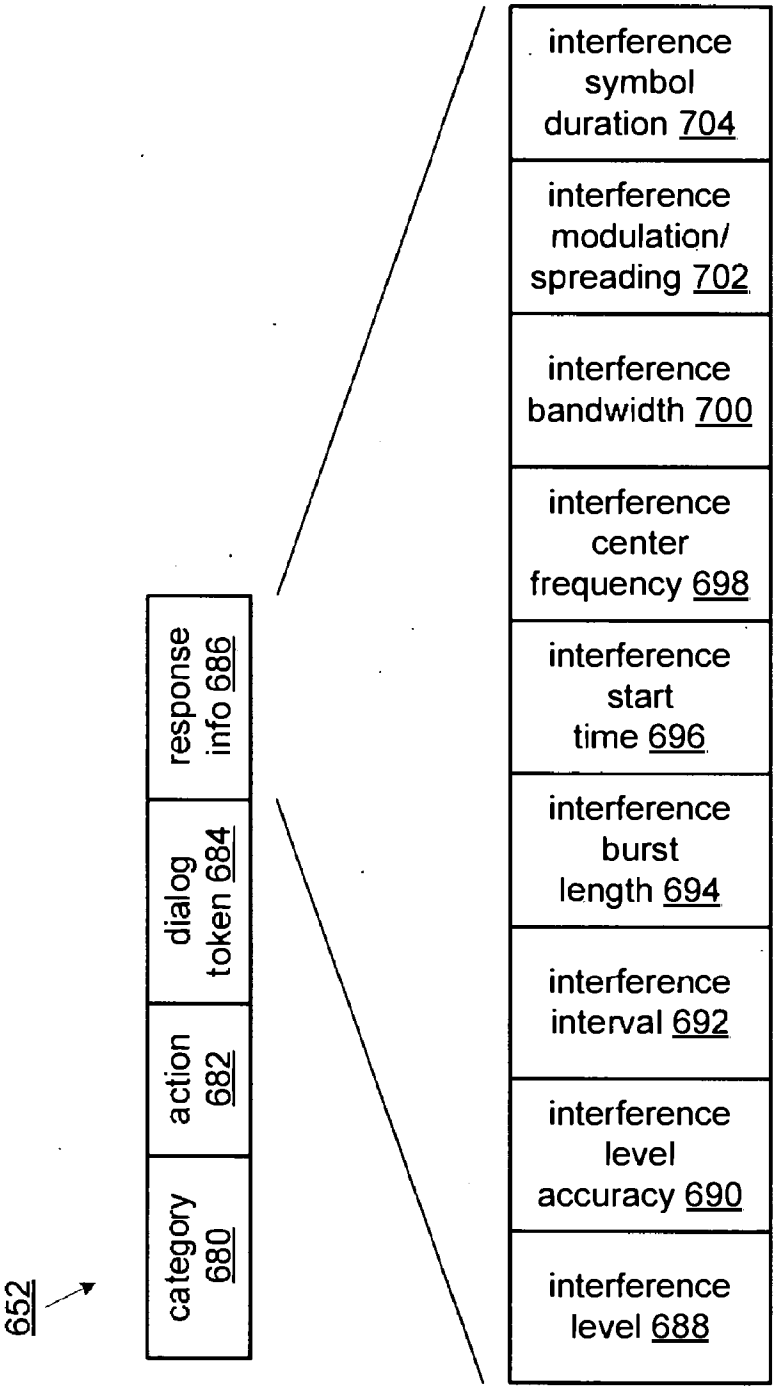

652
category 680
action 682
dialog token 684
response info 686
interference level 688
interference level accuracy 690
interference interval 692
interference burst length 694
interference start time 696
interference center frequency 698
interference bandwidth 700
interference modulation/ spreading 702
interference symbol duration 704

FIG. 17

CO-LOCATION INTERFERENCE AVOIDANCE IN MULTIPLE PROTOCOL COMMUNICATION NETWORKS

[0001] This patent application is claiming priority under 35 USC § 119 to a provisionally filed patent application entitled CO-LOCATION INTERFERENCE AVOIDANCE IN MULTIPLE PROTOCOL COMMUNICATION NETWORKS, having a provisional filing date of Nov. 01, 2006, and a provisional Ser. No. of 60/855,856, and is claiming priority under 35 USC § 120 as a continuation in part of co-pending patent application entitled COLLISION AVOIDANCE IN MULTIPLE PROTOCOL COMMUNICATION NETWORKS USING A SHARED COMMUNICATION MEDIUM, having a filing date of Oct. 10, 2006, and a Ser. No. of 11/545,743; of COORDINATION OF MULTIPLE PROTOCOLS USING A SHARED COMMUNICATION MEDIUM having a filing date of Mar. 9, 2005 and a Ser. No. of 11/075,981; and of co-pending patent application entitled MULTIPLE NETWORK MULTIPLE PROTOCOL COMMUNICATION USING A SHARED COMMUNICATION MEDIUM, having a filing date of Jun. 26, 2006, and a Ser. No. of 11/475,634, which claims priority to a provisionally filed patent application having the same title, a provisional filing date of Jun. 29, 2005, and a provisional Ser. No. of 60/694,948.

CROSS REFERENCE TO RELATED PATENTS

[0002] NOT APPLICABLE

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0003] NOT APPLICABLE

INCORPORATION-BY-REFERENCE OF MATERIAL SUBMITTED ON A COMPACT DISC

[0004] NOT APPLICABLE

BACKGROUND OF THE INVENTION

[0005] 1. Technical Field of the Invention

[0006] This invention relates generally to communication systems and more particularly to obtaining co-location interference information to improve access to a shared medium by multiple protocols of one or more communication systems.

[0007] 2. Description of Related Art

[0008] Communication systems are known to support wireless and wire lined communications between wireless and/or wire lined communication devices. Such communication systems range from national and/or international cellular telephone systems to the Internet to point-to-point in-home wireless networks. Each type of communication system is constructed, and hence operates, in accordance with one or more communication standards. For instance, wireless communication systems may operate in accordance with one or more standards including, but not limited to, IEEE 802.11, Bluetooth, advanced mobile phone services (AMPS), digital AMPS, global system for mobile communications (GSM), code division multiple access (CDMA), local multi-point distribution systems (LMDS), multi-channel-multi-point distribution systems (MMDS), and/or variations thereof.

[0009] Depending on the type of wireless communication system, a wireless communication device, such as a cellular telephone, two-way radio, personal digital assistant (PDA), personal computer (PC), laptop computer, home entertainment equipment, et cetera communicates directly or indirectly with other wireless communication devices. For direct communications (also known as point-to-point communications), the participating wireless communication devices tune their receivers and transmitters to the same channel or channels (e.g., one of the plurality of radio frequency (RF) carriers of the wireless communication system) and communicate over that channel(s). For indirect wireless communications, each wireless communication device communicates directly with an associated base station (e.g., for cellular services) and/or an associated access point (e.g., for an in-home or in-building wireless network) via an assigned channel. To complete a communication connection between the wireless communication devices, the associated base stations and/or associated access points communicate with each other directly, via a system controller, via the public switch telephone network, via the Internet, and/or via some other wide area network.

[0010] For each wireless communication device to participate in wireless communications, it includes a built-in radio transceiver (i.e., receiver and transmitter) or is coupled to an associated radio transceiver (e.g., a station for in-home and/or in-building wireless communication networks, RF modem, etc.). As is known, the receiver is coupled to the antenna and includes a low noise amplifier, one or more intermediate frequency stages, a filtering stage, and a data recovery stage. The low noise amplifier receives inbound RF signals via the antenna and amplifies then. The one or more intermediate frequency stages mix the amplified RF signals with one or more local oscillations to convert the amplified RF signal into baseband signals or intermediate frequency (IF) signals. The filtering stage filters the baseband signals or the IF signals to attenuate unwanted out of band signals to produce filtered signals. The data recovery stage recovers raw data from the filtered signals in accordance with the particular wireless communication standard.

[0011] As is also known, the transmitter includes a data modulation stage, one or more intermediate frequency stages, and a power amplifier. The data modulation stage converts raw data into baseband signals in accordance with a particular wireless communication standard. The one or more intermediate frequency stages mix the baseband signals with one or more local oscillations to produce RF signals. The power amplifier amplifies the RF signals prior to transmission via an antenna.

[0012] For both wireless and wireline communication systems, there are many standards that provide protocols as to how audio, text, video, data, and/or any other type information is to be conveyed within the system. Communication devices that are designed to be compliant with a particular standard (e.g., Ethernet 10Base-T, IEEE 802.11b, Bluetooth) are able to communication with any other communication device within the communication system that is compliant with the same standard. For example, wireless communication devices that are compliant with IEEE

802.11b can communicate with each other, provided they are properly registered to the same communication system.

[0013] As is known, differing standards sometimes use the same communication medium (e.g., allocated radio frequency spectrum, wired connections, etc.) due to a finite amount of communication medium. For example, both Bluetooth and IEEE 802.11b use the 2.4 GHz spectrum. As long as communication systems that are compliant with differing standards that share a communication medium do not physically overlap, the systems operate without interference from each other. However, if the communication systems do physically overlap, they will interfere with each other, degrading the performance of both systems. For example, if a Bluetooth pico net physically overlaps with an IEEE 802.11b local area network, simultaneous use of the 2.4 GHz spectrum will cause interference that will most likely cause both transmissions to fail.

[0014] To help reduce this problem, communication devices have been developed to be compliant with multiple standards that have different protocols for a shared communication medium. For example, wireless communication devices have been developed that are compliant with both Bluetooth and IEEE 802.11(a), (b), and/or (g). In such devices, the Medium Access Control (MAC) layer of one protocol communicates with the MAC layer of another protocol to avoid simultaneous use of the shared communication medium.

[0015] While this substantially reduces simultaneous use of a shared communication medium on a device-by-device basis, it does little to reduce simultaneous use on a communication system level. For example, if a first communication device desires to use the shared communication medium in accordance with a first protocol, it will block its use of a second protocol for the duration of the use per the first protocol, however, a second communication device may concurrently desire to use the shared communication medium in accordance with the second protocol. Since the protocols are different, the first device will obtain access of the shared communication medium in accordance with the first protocol and the second device will obtain access of the shared communication medium in accordance with the second protocol. With both devices concurrently accessing the shared communication medium, their transmissions will interfere with each other, causing at least one of the transmissions to fail.

[0016] Therefore, a need exists for a method and apparatus for coordinating multiple protocols using a shared communication medium based on co-location interference information.

BRIEF SUMMARY OF THE INVENTION

[0017] The present invention is directed to apparatus and methods of operation that are further described in the following Brief Description of the Drawings, the Detailed Description of the Invention, and the claims. Other features and advantages of the present invention will become apparent from the following detailed description of the invention made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

[0018] FIG. **1** is a schematic block diagram of a wireless communication system in accordance with the present invention;

[0019] FIG. **2** is a schematic block diagram of a wireline communication system in accordance with the present invention;

[0020] FIG. **3** is a schematic block diagram of a LAN, BSS, and/or IBSS in accordance with the present invention;

[0021] FIG. **4** is a schematic block diagram of a wireless communication device in accordance with the present invention;

[0022] FIG. **5** is a logic diagram of a method for coordinating multiple protocols using a shared communication medium in accordance with the present invention;

[0023] FIGS. **6-8** are logic diagrams of various embodiments of transmitting a frame, or portion thereof, and handing-off access of the shared communication medium of the method of FIG. **5**;

[0024] FIGS. **9A-9F** are diagrams of various examples of coordinating multiple wireless protocols using a shared communication medium in accordance with the present invention;

[0025] FIG. **10** is a schematic block diagram of another LAN, BSS, and/or IBSS in accordance with the present invention;

[0026] FIG. **11** is a diagram of an example of coordinating a multiple protocol multiple network communication in accordance with the present invention;

[0027] FIG. **12** is a schematic block diagram of a multiple protocol communication in accordance with the present invention;

[0028] FIG. **13** is a packet diagram of the communication illustrated in FIG. **12**;

[0029] FIG. **14** is a logic diagram of a method for collision avoidance in multiple protocol networks using a shared communication medium in accordance with the present invention;

[0030] FIG. **15** is a schematic block diagram of an access point obtaining co-location interference information from a multiple protocol device in accordance with the present invention;

[0031] FIG. **16** is a diagram of an interference request in accordance with the present invention; and

[0032] FIG. **17** is a diagram of an interference response in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0033] FIG. **1** is a schematic block diagram of an example of a wireless communication system **10** that includes a plurality of base stations and/or access points **12**, **16**, a plurality of wireless communication devices **18-32** and a network hardware component **34**. Note that the network hardware **34**, which may be a router, switch, bridge, modem, system controller, et cetera provides a wide area network connection **42** for the communication system **10**. Further note that the wireless communication devices **18-32** may be laptop host computers **18** and **26**, personal digital assistant hosts **20** and **30**, personal computer hosts **24** and **32** and/or cellular telephone hosts **22** and **28**. The details of the

wireless communication devices will be described in greater detail with reference to FIGS. **3** and **4**.

[**0034**] Wireless communication devices **22**, **23**, and **24** are located within an independent basic service set (IBSS) area and communicate directly (i.e., point to point). In this configuration, these devices **22**, **23**, and **24** may only communicate with each other. To communicate with other wireless communication devices within the system **10** or to communicate outside of the system **10**, the devices **22**, **23**, and/or **24** need to affiliate with one of the base stations or access points **12** or **16**.

[**0035**] The base stations or access points **12**, **16** are located within basic service set (BSS) areas **11** and **13**, respectively, and are operably coupled to the network hardware **34** via local area network connections **36**, **38**. Such a connection provides the base station or access point **1216** with connectivity to other devices within the system **10** and provides connectivity to other networks via the WAN connection **42**. To communicate with the wireless communication devices within its BSS **11** or **13**, each of the base stations or access points **12**-**16** has an associated antenna or antenna array. For instance, base station or access point **12** wirelessly communicates with wireless communication devices **18** and **20** while base station or access point **16** wirelessly communicates with wireless communication devices **26**-**32**. Typically, the wireless communication devices register with a particular base station or access point **12**, **16** to receive services from the communication system **10**.

[**0036**] Typically, base stations are used for cellular telephone systems and like-type systems, while access points are used for in-home or in-building wireless networks (e.g., IEEE 802.11 and versions thereof, Bluetooth, and/or any other type of radio frequency based network protocol). Regardless of the particular type of communication system, each wireless communication device includes a built-in radio and/or is coupled to a radio.

[**0037**] FIG. **2** is a schematic block diagram of an example of a wireline communication system **40** that includes two local area networks (LAN) **42** and **44** and network hardware **46**. Each of the LANs **42** and **44** includes a server **54**, **56** and a plurality of communication devices **58**-**62** and **64**-**68**, which are connected to the network hardware **46** via LAN connections **48** and **50**. Note that the network hardware **46**, which may be a router, switch, bridge, modem, system controller, et cetera provides a wide area network connection **52** for the communication system **40**. Further note that the communication devices **58**-**62** and **64**-**68** each include a network card to communicate with the network hardware **46** and may be a laptop computer **58**, **64**, a personal digital assistant **60**, **68**, or a personal computer **62**, **66**. The details of the communication devices will be described in greater detail with reference to FIG. **3**.

[**0038**] FIG. **3** is a schematic block diagram of an example of a LAN, BSS, and/or IBSS **9**, **11**, **13**, **42**, or **44** that includes personal area networks **70** and **72** and a shared communication medium **102**. Each of the personal area networks **70** and **72** includes a multiple protocol communication device **74**, **76** (which may be any one of the wireless communication devices **18**-**32** of FIG. **1** or the wireline communication devices **58**-**68** of FIG. **2**) and a plurality of personal devices **90**-**94** and **96**-**100**. The personal devices **90**-**100** may be any peripheral device affiliated with the communication device **72**, **74** including, but not limited to, a headset, a keyboard, a mouse, a printer, a monitor, a fax machine, a scanner, a digital camera, a digital camcorder, a digital audio playback device, or a video playback device. The shared communication medium **102** may be a shared twisted pair connection, a shared optical connection, a shared coaxial connection, or a shared frequency spectrum.

[**0039**] Each of the multiple protocol communication devices **74** and **76** includes a first protocol module **80**, **86**, a second protocol module **82**, **88**, and a transceiving module **78**, **84**. In one embodiment, the first protocol module **80**, **86** is configured to support a first protocol that enables the communication device **74**, **76** to communicate at a local area network level and/or wide area network level using the shared communication medium **102**, while the second protocol module is configured to support a second protocol that enables the communication device **72**, **74** to communicate with the personal devices **90**-**94**, **96**-**100** within its personal area network **70**, **72** using the shared communication medium **102**. For instance, the first and second protocols may be one or more of a past, current, or future version of Ethernet, SONET, asynchronous transfer mode (ATM), frame relay, TCP/IP, advanced mobile phone services (AMPS), digital AMPS, global system for mobile communications (GSM), code division multiple access (CDMA), local multi-point distribution systems (LMDS), multi-channel-multi-point distribution systems (MMDS), Bluetooth, IEEE 802.11 (a), (b), (g), (n), any other wireline standard or any other wireless standard.

[**0040**] The first and second protocol modules **80**, **82**, **84**, **86** may be implemented using a processing module and associated memory. The processing module may be a single processing device or a plurality of processing devices. Such a processing device may be a microprocessor, micro-controller, digital signal processor, microcomputer, central processing unit, field programmable gate array, programmable logic device, state machine, logic circuitry, analog circuitry, digital circuitry, and/or any device that manipulates signals (analog and/or digital) based on operational instructions. The associated memory may be a single memory device or a plurality of memory devices. Such a memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, cache memory, and/or any device that stores digital information. Note that when the processing module implements one or more of its functions via a state machine, analog circuitry, digital circuitry, and/or logic circuitry, the memory storing the corresponding operational instructions may be embedded within, or external to, the circuitry comprising the state machine, analog circuitry, digital circuitry, and/or logic circuitry. In general, the memory stores, and the processing module executes, operational instructions corresponding to at least some of the steps and/or functions illustrated in FIGS. **3**-**9**E. In addition, the memory may store data produced by the processing module.

[**0041**] The transceiving modules **78**, **84** may be a wireless transceiver and/or a wireline transceiver. In one embodiment, a wireline transceiver is a network card or multiple network cards that enable the communication device **74**, **76** to communicate within the LAN and outside of the LAN and also to communicate with the personal devices **90**-**94**, **96**-**100**. In another embodiment, a wireless transceiver enables the communication device **74**, **76** to wirelessly

communicate within the LAN and outside of the LAN and also to communicate with the personal devices **90-94**, **96-100**.

[**0042**] In operation, when a multiple protocol communication device **74**, **76** desires to communicate with one of the personal devices **90-94** or **96-100**, the first protocol module **80**, **86** generates a frame, or segment thereof, **106** in accordance with the first protocol and includes an indication of the duration for which the device **74**, **76** desires to use the shared communication medium **102**. The device **74**, **76** transmits the frame **106** to other devices in the system, to an access point, to a base station, to a server, etc. The other devices will process the frame **106** in accordance with the first protocol and, upon proper interpretation, will not use the shared communication medium **102** for the time period indicated in the frame **106**.

[**0043**] After transmitting the frame **106**, the first protocol module **80**, **86** hands-off access of the shared communication medium **102** to the second protocol module **82**, **88**. For the duration of access to the shared communication medium **102**, or a portion thereof, the second protocol module **82**, **88** conveys data, audio, video, and/or text information with one or more personal devices **90-94**, **96-100** in frames **104**, **108** via the shared communication medium **102** and in accordance with the second protocol. Since the other communication devices in the system know that the shared communication medium **102** is being accessed, they will not attempt to access the shared communication medium **102** until it becomes available, again, according to the time period indicated in the frame **106**, thus avoiding collisions from other devices while a different protocol is accessing the shared communication medium **102**.

[**0044**] FIG. **4** is a schematic block diagram of a wireless communication device **74** that includes the first protocol module **80**, the second protocol module **82**, the transceiving module **78**, and antenna structures **116** and **124**. Each of the antenna structures **116** and **124** may be a single antenna or an array of antennas. The first protocol module **80** includes a Medium Access Control (MAC) module **110** in accordance with a first protocol (e.g., a version of IEEE 802.11) and a Physical Layer Convergence Procedure (PLCP) module **112** in accordance with the first protocol. The second protocol module **82** includes a MAC module **118** in accordance with the second protocol (e.g., a version of Bluetooth) and a PLCP module **120**.

[**0045**] The transceiving module **78** includes a first physical layer (PHY) module **114** coupled to the first protocol module **80** and a second PHY module **122** coupled to the second protocol module **82**. Each of the PHY modules **114** and **122** includes a transmit section and a receive section coupled to the corresponding antenna structure **116**, **124** such that each PHY module **114**, **122** converts outbound baseband data into outbound RF signals and converts inbound RF signals into inbound baseband signals. As one of ordinary skill in the art will appreciate, the PHY modules **114** and **122** may share at least a portion of the antenna structures **116** or **124** and may share common components such as the low noise amplifier, power amplifier, RF bandpass filters, direct conversion mixers, etc.

[**0046**] In operation, when a multiple protocol communication device **74** desires to communicate with one of its personal devices **90-94**, the MAC module **110** generates a frame, or segment thereof, **106** in accordance with the first protocol (e.g., a version of the IEEE 802.11 standard) and includes an indication of the duration for which the device **74** desires to use the shared communication medium **102**. The MAC module **110** provides the frame **106** to the PLCP module **112**, which in turn provides the frame **106** to the PHY module **114** for RF transmission to other devices in the system, to an access point, to a base station, to a server, etc. The other devices will process the frame **106** in accordance with the first protocol and, upon proper interpretation, will not use the shared communication medium **102** for the time period indicated in the frame **106**. Note that the MAC and PLCP are higher layer protocols than the PHY layer protocols.

[**0047**] In addition, the MAC module **110** communicates with the MAC module **118** to indicate the duration for which the MAC module **118** will have access to the shared network. The MAC module **110** also hands-off control of the shared communication medium to the MAC module **118** for transmitting and/or receiving communications in accordance with the second protocol.

[**0048**] The communication device **74** may further function to block downstream transmissions (i.e., transmissions to the communication device) from devices utilizing the second protocol (e.g., IEEE 802.11 compliant communications) when the communication device **74** is receiving or transmitting a communication utilizing the first protocol (e.g., Bluetooth communications). In this embodiment, the first protocol module **80** and/or the second protocol module **82** detects a potential collision between the first and second communications (e.g., a Bluetooth device is communicating or will likely be communicating on the shared communication resource and a communication from an access point is expected by the communication device). When a potential collision is detected, the first and/or second protocol module generates a blocking indication to block transmission of at least a portion of one of the first and second communications to substantially avoid a collision between the first and second communications. The first and/or second protocol module provides the blocking indication to the transceiving module **78** for transmission within the first RF signals or within the second RF signals.

[**0049**] FIG. **5** is a logic diagram of a method for coordinating multiple protocols using a shared communication medium that begins at step **130** where the first protocol module determines that the second protocol module desires access to the shared communication medium, wherein the second protocol module operates in accordance with a second protocol. The determination may be made in a plurality of ways including, but not limited to, receiving a communication from the second protocol module indicating the desire to access the shared communication medium; determining, on a periodic basis, that the second protocol module desires access based on an application supported by the second protocol module (e.g. the second protocol module is supporting a headset function polling); receiving from another protocol module that the second protocol module desires access to the shared communication medium (e.g., from a higher layer which knows that a particular program (e.g., a voice program) is active and access is needed); and determining, on a random basis, that the second protocol module desires access to the shared communication medium (e.g., polling).

[0050] The process then proceeds to step **132** where the first protocol module transmits at least a segment of a frame to other devices in the system. The frame, or portion thereof, which is in accordance with a first protocol, includes an indication of a duration that the shared communication medium will be accessed. This will be described in greater detail with reference to FIGS. **6**-**9**E.

[0051] The process then proceeds to step **134** where the first protocol module hands-off access of the shared communication medium to the second protocol module for at least a portion of the duration that the shared communication medium will be accessed such that the second protocol module has access to the shared communication medium with negligible interference from devices of the first protocol. This will be described in greater detail with reference to FIGS. **6**-**9**E.

[0052] FIGS. **6**-**8** are logic diagrams of various embodiments of transmitting a frame, or portion thereof, and handing-off access of the shared communication medium of the method of FIG. **5**. In FIG. **6**, the processing begins at step **132**-**1** where the first protocol module generates generating a preamble in accordance with the first protocol. For example, if the first protocol corresponds to IEEE 802.11(b), the first protocol module generates the preamble to include a short training sequence and a long training sequence. The process then proceeds to step **132**-**2** where the first protocol module generates a header in accordance with the first protocol to include a frame length indication, wherein the frame length indication includes length of a data section of the frame. Continuing with the IEEE 802.11(b) example, the header includes a signal field and a service field, either of which may contain a frame length indication.

[0053] The process then proceeds to step **132**-**3** where the first protocol module transmits the preamble and the header as the at least the segment of the frame to the transceiving module, which, in turn, converts the frame into an RF signal that is sent to other communication devices in the system. With the other devices in the system knowing that the shared communication medium will be accessed for the duration corresponding to the frame length they will not attempt to access it. Thereby avoiding inter-protocol interference (i.e., the devices operable in accordance with first protocol will not access the shared communication medium while a device operable in accordance with the second protocol is accessing the share communication medium.)

[0054] The process then proceeds to step **134**-**1** where the first protocol module indicates to the second protocol module that the shared communication medium is accessible for the duration corresponding to the length of the data section of the frame. This may be accomplished by providing a message, or a signal, from the first protocol module to the second protocol module directly or through a baseband processing module.

[0055] FIG. **7** includes processing that begins at step **132**-**4** where the first protocol module transmits a preamble, a header, and a request-to-send as the at least the segment of the frame to an access point in accordance with the first protocol, which is done via the transceiving module. The processing then proceeds to step **132**-**5** where the first protocol module receives a second preamble, a second header, and a clear-to-send from the access point in accordance with the first protocol. The request-to-send and/or the clear-to-send include a network allocation vector that identifies the duration that the shared communication medium will be accessed following the successful exchange of the request-to-send and/or clear-to-send frames and hence, an indication of the duration of the opportunity for medium sharing between the first protocol module and the second protocol module.

[0056] The process then proceeds to step **132**-**6** where the first protocol module transmits a third preamble and a third header, wherein the third header includes length of a data section of the frame that corresponds to the available opportunity for medium sharing of the duration allocated to the second protocol module, which is conveyed to the system via the transceiving module. The process then proceeds to step **134**-**2** where the first protocol module indicates to the second protocol module that the shared communication medium is accessible for the duration corresponding to the length of the data section of the third frame, or a portion thereof.

[0057] FIG. **8** includes processing that begins at step **132**-**7** where the first protocol module receives a preamble, a header, and a contention-free-poll from an access point in accordance with the first protocol. The contention-free-poll includes a network allocation vector that identifies the maximum duration that the shared communication medium is allowed to be accessed by the receiving node which is addressed in the contention-free-poll frame and hence, an indication of the duration of the opportunity for medium sharing between the first protocol module and the second protocol module. The processing then continues at step **132**-**8** where the first protocol module transmits a second preamble and a second header, wherein the second header includes length of a data section of the frame that corresponds to the available opportunity for medium sharing of the duration allocated to the second protocol module, which is relayed to the access point via the transceiving module. The processing then proceeds to step **134**-**3** where the first protocol module indicates to the second protocol module that the shared communication medium is accessible for the duration corresponding to the length of the data section of the frame, or a portion thereof.

[0058] FIGS. **9**A-**9**F are diagrams of various examples of coordinating multiple wireless protocols using a shared communication medium via a fake PSDU and/or NAV-based indication. In general, the fake PSDU approach operates in a communication device that contains both an 802.11 LAN function and a Bluetooth master node function, or an 802.11 LAN function and the timing master of some other communication protocol function which is dissimilar to the 802.11 LAN function. The mechanism may also be applied to a case wherein the other protocol is also an 802.11 LAN function, such as when a more distant 802.11 LAN device desires access to the shared medium, but is generally unable to communicate with the other devices in the LAN because of, for example, distance limitations, but is able to communicate with the device containing the first 802.11 LAN function. To facilitate this approach, a communication channel exists between the 802.11 LAN function and the Bluetooth Master function within the common device. Such a communication channel may consist of a single signal which acts as a transmit/receive permission signal to the Bluetooth Master function. In one embodiment, the assertion of the signal indicates that the Bluetooth Master function is free to

engage in transmit and receive activity according to the Bluetooth protocol. This is the Bluetooth permission channel.

[0059] In such an embodiment, the Bluetooth master node obeys the communication channel signaling strictly in order to create the desired coordination. In another embodiment, the 802.11 LAN function instructs the Bluetooth Master function to remain idle (i.e. refrain from transmit and receive activity) while the 802.11 LAN function is active. Accordingly, the 802.11 LAN function acts as the master of the Bluetooth function and will dictate the times when the Bluetooth function may become active.

[0060] When the 802.11 LAN function determines that a Bluetooth activity period should begin, the 802.11 LAN function gains control of the 802.11 LAN network (and therefore, the shared medium) and then secures uncontested access to the medium by sending an 802.11 preamble plus physical layer PLCP header which indicates that it is about to transmit a physical layer service data unit (PSDU). However, the PLCP indication is an intentional misdirection to the other 802.11 devices operating in the vicinity. Instead of sending a PSDU, the 802.11 LAN function immediately after sending the PLCP header information, passes control of the shared medium to the Bluetooth Master function through the Bluetooth permission channel. The Bluetooth Master function, through a prior frequency and duration requirements agreement, uses the medium for transmissions and receptions, directing other Bluetooth devices to transmit and receive according to the previously described frequency and duration agreements. (The PLCP header information contains encoded length information which signals to the other 802.11 LAN devices that a PSDU is to be received, and those devices then remain in a receive mode for the duration of time indicated by that length information, regardless of whether an actual PSDU is sent or not.) The length information transmitted in the "fake PSDU" corresponds to the desired Bluetooth activity duration.

[0061] At the end of the agreed upon duration of time which was granted to the Bluetooth Master function for the purpose of transmission and reception activity, the 802.11 LAN function de-asserts the Bluetooth permission signal, thereby disallowing any further Bluetooth function activity. As per the outstanding agreement, the Bluetooth Master function should have completed its current activity on the shared medium. Shortly after the removal of the Bluetooth permission signal, the end of the length of time as was indicated in the PLCP header should occur, allowing the normal 802.11 LAN medium access process to resume.

[0062] Because of the possible existence of hidden nodes, and as a measure to deal with the generally uncontrolled nature of the RF medium (especially when operating in unlicensed bands) and the resulting possible loss of the "fake PSDU"'s PLCP header information, the proxy TXOP mechanism supports additional optional transmissions which serve to offer redundant protection against 802.11 LAN use of the medium. Specifically, protective NAV values can be established around the "fake PSDU" transmission through additional, normal 802.11 LAN protocol mechanisms such as RTS/CTS.

[0063] The transmission of the "fake PSDU" does not require a preceding transmission or reception or succeeding transmission or reception, although such is not precluded. In general, the use of the "fake PSDU" allows a secondary LAN function to operate in a coordinated fashion with the primary, controlling LAN function.

[0064] In the NAV-based indication approach, function, or an 802.11 LAN function, the timing master of some other communication protocol function is dissimilar to the 802.11 LAN function. In this embodiment, a communication channel exists between the 802.11 LAN function and the Bluetooth Master function within the common device.

[0065] When the 802.11 LAN function determines that a Bluetooth activity period should begin, the 802.11 LAN function gains control of the 802.11 LAN network (and therefore, the shared medium) and then secures uncontested access to the medium by sending frames that are intended to cause a Network Allocation Vector (NAV) to become set in the other participating LAN devices. However, the NAV indication is an intentional misdirection to the other 802.11 devices operating in the vicinity. Instead of using the allocated time for additional 802.11 LAN frame exchanges, as would naturally be assumed by the other 802.11 LAN devices which received the NAV-setting frames, the 802.11 LAN function instead passes control of the shared medium to the Bluetooth Master function through the Bluetooth permission channel.

[0066] The Bluetooth Master function, through a prior frequency and duration requirements agreement, uses the medium for transmissions and receptions, directing other Bluetooth devices to transmit and receive according to the previously described frequency and duration agreements. The NAV duration information transmitted in the earlier 802.11 LAN messages corresponds to the desired Bluetooth activity duration. At the end of the agreed upon duration of time which was granted to the Bluetooth Master function for the purpose of transmission and reception activity, the 802.11 LAN function de-asserts the Bluetooth permission signal, thereby disallowing any further Bluetooth function activity. As per the outstanding agreement, the Bluetooth function should have completed its current activity on the shared medium.

[0067] Shortly after the removal of the Bluetooth permission signal, the end of the length of time as was indicated in the NAV duration information should occur, allowing the normal 802.11 LAN medium access process to resume. It is possible that the NAV duration information exceeds the allotment of time required by the Bluetooth Master function—this may be intentionally done in order to allow the device's 802.11 LAN function to perform 802.11 activity within the same shared medium access period. It is also possible that the original NAV setting operation was preceded by other of this device's 802.11 activity, and that following the original NAV setting operation, but preceding any Bluetooth activity, this device's 802.11 LAN function engaged in 802.11 activity.

[0068] The transmission of the NAV information does not require a preceding transmission or reception or succeeding transmission or reception, although it may include such transmission or reception. In general, the use of some of the time which has been secured by the 802.11 LAN function through the NAV mechanism is to be used by the secondary LAN function to operate in a coordinated fashion with the primary, controlling LAN function. Best practices suggest the use of preceding transmissions and/or receptions in order

to provide further/redundant guarantees that the other devices of the same type as the controlling LAN function have temporarily ceased their attempts to use the shared medium.

[0069] FIG. **9**A is a diagram of a frame **140** generated by the first protocol module, which in this example, is compliant with a version of IEEE 802.11. The frame **140** includes a preamble **142**, a header **144**, and a fake PDSU **146**. The preamble **142** and header **144** are implemented in accordance with a version of IEEE 802.11 and the header **144** includes a frame length indication. The fake PDSU **148** corresponds to the data field of a normal IEEE 802.11 compliant frame. However, in this instance, the data field is empty, meaning that the transmitter sends no energy during this period of time, and access permission to the shared communication resource is asserted **150** such that the second protocol module may transmit and/or receive communications **148** via the shared resource. When the frame **140** ends, the first protocol module de-asserts **152** the second protocol module's permission to access the shared medium.

[0070] FIG. **9**B is a diagram of a frame **160** generated by the first protocol module, which in this example, is compliant with a version of IEEE 802.11. The frame **160** includes a preamble **162**, a header **164**, and a request to send (RTS) field **166**. In the RTS field portion of frame **160**, a RTS duration **168** is provided to other devices within the communication system. In response to frame **160**, the first protocol module **160** receives a preamble **170**, a header **172**, and a clear to send (CTS) field **174**. The header **172** and/or within the CTS field **174** include a CTS duration **178**.

[0071] In response to the CTS field **174**, the first protocol module generates another preamble **178** and another header field **180**. In this embodiment, the header field **180** includes a PLP length **182**, which is allocated to the second protocol module for second protocol transmissions **188** via assertion of permission **184** and a subsequent de-assertion of permission **186**. In this example, the shared communication medium is still allocated to the first protocol module after de-assertion of access to the second protocol module such that the first protocol module may transmit **190** because the time allocated to the second protocol module and indicated in the PLCP length **182** was less than the time indicated in the CTS field **174**.

[0072] FIG. **9**C is similar to FIG. **9**B, with the exception that the entire duration of access to the shared communication medium as indicated in the CTS field **174** is granted to the second protocol module.

[0073] FIGS. **9**D and **9**E illustrate variations to the allocation of access to the shared communication medium. In FIG. **9**D, the first protocol module has access to the shared communication medium prior to access being passed to the second protocol module. In FIG. **9**E, the 1st protocol transmission **190** of FIG. **9**D is split into two parts **190-1** and **190-2**.

[0074] FIG. **9**F illustrates another frame **200** that includes a preamble **202**, a header **204**, and a poll field **206**. This field may be constructed in accordance with a version of IEEE 802.11 and include an indication of a CF (contention free)+ Poll duration **208**, which provides an indication of a maximum allowed opportunity for shared medium use on the part of the recipient. In this embodiment, the first protocol module of another transmitter which may or may not contain a second protocol function may transmit **210-1** followed by the transmission of another preamble **212** and a header **214** by the device which contains the first and second protocol functions. The header **214** indicates a PLCP length **182**, during which access to the shared communication medium is provided to the second protocol module for transmissions **188**. After the PLCP length **182** has ended, the first protocol module of the first transmitter may transmit **210-2** which may occur before the completion of the CF+POLL duration **208** time, provided that the recipient of the **210-1** has not employed all of the possible time allotted for transmissions by either the first or second protocol.

[0075] FIG. **10** is a schematic block diagram of an example of a LAN, BSS, and/or IBSS **9**, **11**, **13**, **42**, or **44** that includes a first network **305** that utilizes a first protocol (e.g., Bluetooth, IEEE 802.11a, b, g, n, etc.) and a second network **315** that utilizes a second protocol (e.g., Bluetooth, IEEE 802.11a, b, g, n, etc.). The first network **305** includes and includes devices **300**, **302**, **310** and **312** and the second network includes devices **302**, **304** and **314**. In this example, device **302** is a multiple protocol device (i.e., includes a first protocol module and a second protocol module). Devices **300**, **310**, and **312** include the first protocol module and may optionally include the second protocol module. Similarly, devices **304** and **314** include the second protocol module and may optionally include the first protocol module. Note that devices **310**, **212**, **304**, and **314** need not be present, but are merely depicted to demonstrate versatility of multiple protocol multiple network communications. In this example, the two networks **305** and **315** share a communication medium **308**. The shared communication medium **308** may be a shared twisted pair connection, a shared optical connection, a shared coaxial connection, or a shared frequency spectrum.

[0076] In this example, device **300** determines through examination of the upper layer headers of a packet which has been given to it for transmission to device **302** on network **305**, that the second protocol module of device **302** desires access to network **315**. At the time when the identified packet is to be transmitted by device **300** using the first protocol, device **300** employs for example, any of the mechanisms from FIGS. **11** or **9**A-**9**F to create an opportunity on the shared medium for device **302** to send and receive packets using the second protocol.

[0077] Device **300**, in examining the packet for transmission, must have knowledge from a previous agreement with device **302** that 1) packets containing certain upper layer header information and which are intended for delivery using the first protocol to device **302** will subsequently be forwarded by device **302** using the second protocol 2) that whenever device **300** actually transmits one of the packets so identified using the first protocol, that device **302** will, upon reception, perform the delivery of that packet using the second protocol, and as such, device **302** will require a reservation of time on the shared medium through the use of any of several mechanisms available to the first protocol such as described in FIG. **11** or **9**A-**9**F such that whenever device **300** transmits one of the packets identified using the first protocol, that a specific amount of time, or specific lower bound on the amount of time is required by device **302** for the transmission of packets using the second protocol,

and as such, device **300** will be able to determine how much time to reserve on the shared medium for those transmissions.

[0078] To facilitate the above, an agreement between device **300** and **302** is created to confirm their relationship. Such agreement can be made, for example through any of the following means: 1) through exchange of information within an association and or authentication process whereby device **302** registers to use the network employing the first protocol with device **300**—an example of such would be the presence of information with an element structure contained within an association request frame sent by device **302** to device **300** and the response to the reception of that information which is sent by device **300** to device **302** in an element structure contained within an association response frame, where said information constitutes the consummation of said agreement 2) an exchange as described in the previous means, but with the roles of association requestor and granter reversed 3) through exchange of information within any other set of frames, such as management frames which are not part of the association or authentication process 4) through some other means which does not employ frame exchange, such as through manually entering information at each device, for example, through a user or administrator manually entering device **302** registration information at device **300**, and through a user or administrator manually enabling the agreement at device **302**, through, for example, a selection made through a menu which enables device **302** to connect with and utilize the shared medium through communication employing the first protocol.

[0079] In this example, the registration provides enough information to allow device **300** to determine which upper layer information it needs to identify (for example, internet protocol (IP) header source and destination address information, port numbers and protocol identifier information) in order to determine that a packet for transmission to device **302** and employing the first protocol will require the inclusion of the proper signaling within the first protocol (for example, setting a NAV) to allow the receiving device **302** to be able to use, immediately subsequent to the reception of the packet using the first protocol, the shared medium employing the second protocol for the forwarding and exchange of packets using the second protocol. Packets not containing the appropriate upper layer information will not cause device **300** to create the signaling within the first protocol to accommodate the forwarding and exchange of packets by device **302** using the second protocol, and device **302** will, upon reception of such packets, determine that no such accommodation has been made. The registration also provides information to allow device **300** to determine how much time to reserve on the shared medium for the possible transmissions by device **302**.

[0080] When such agreement exists, has been enabled, and committed to, devices **300** and **302** both then interpret that the transmission by device **300** of a frame matching the criteria for subsequent forwarding on the part of device **302**, implies the presence of a period of time which has been created with the mechanisms contained within the first protocol, to allow the subsequent forwarding of the frame.

[0081] An alternative embodiment includes additional signaling, either within the frame sent from device **300** to device **302** and employing the first protocol as for example, a bit field which indicates that device **302** has been granted use of the shared medium, or within an explicit signaling frame employing the first protocol and subsequent to the transmission of the frame which was used to determine that a sharing of the medium was required, which is an explicit indication that the medium sharing shall be performed. In the case of an explicit mechanism such as is described here, then no registration of an agreement is necessary, although one may be used to confirm that the device being granted the time for transmission employing the second protocol is capable of interpreting the explicit medium sharing permission information and that the device being granted the time for transmission employing the second protocol desires the use of the shared medium for further packet forwarding purposes. (In some instances, the packet may not require further forwarding.)

[0082] FIG. **11** illustrates a transmission of an RTS **410** by device **300** (from FIG. **10**) employing the first protocol which is followed by a transmission of a CTS **420** by device **302** employing the first protocol. The transmission of the RTS **410** is initiated by device **300** when it determines that device **302** will require use of the shared medium, for example, through having examined the packet **430** contents and established that the contents of packet **430** will subsequently require retransmission by device **302** on the shared medium using the second protocol as packet **520**. The RTS **410** includes an air time reservation intended to reserve the medium for a long enough period of time to allow for: a) the transmission of the CTS packet **420** by device **302** using the first protocol b) the transmission of packet **430** by device **300** using the first protocol, c) the subsequent retransmission of packet **430** as packet **520** by device **302** on the shared medium using the second protocol, d) transmission of a packet **590** by device **304** using the second protocol, e) and a retransmission of the second protocol transmission of packet **590** as packet **440** by device **302** using the first protocol. The packets **430**, **520**, **590** and **440** would typically represent, for example, a voice packet from the voice network being sent toward a handset using the first protocol, the retransmission of voice packet **430** from the handset to the headset using the second protocol, the transmission of a voice packet from the headset to the handset using the second protocol, and the retransmission of voice packet **520** from the handset toward the voice network, respectively.

[0083] In other example scenarios, it is possible that the forwarding of the packet **430** elicits no further exchange, such that packets **590** and **440** do not appear. In general, the agreement of the relationship between device **300** and device **302** which establishes the desire of device **302** to employ some portion of the shared medium time for the exchange of packets using the second protocol may include an explicit indication of how much time should be shared per packet **430** which is delivered from device **300**. The exact utilization of that shared medium time is left to device **302**, and may include an exchange of packets different from the one shown in FIG. **11**, so long as the total time employed is as per the time in the agreement. In another embodiment, the agreement between device **300** and **302** specifies a lower value for the time allocation to be granted to the exchange of packets employing the second protocol, and the device **300**, through the explicit reservation made by, for example, the duration value from the RTS frame, shall indicate to

device **302** the exact amount of time being allocated for use by the second protocol packet exchange on a dynamic basis.

[0084] Following the examples of FIGS. **9A-9F**, modifications to the reservation of the shared medium through first protocol means may be substituted for the RTS/CTS exchange as shown in FIG. **11**. These alternative schemes include but are not limited to, employing a CTS-to-self transmission in place of the RTS/CTS exchange, relying on the duration information. (airtime reservation information) from within packet **430**, and employing PHY header length information to reserve the medium time.

[0085] FIG. **12** is a schematic block diagram of a multiple protocol communication between a Bluetooth (BT) display device **600** (e.g., a headset, a digital video player, a digital audio player, digital camera, digital video recorder, etc.) a Bluetooth/IEEE802.11 wireless communication device **602** (e.g., at least one of devices **18-30** of FIG. **1**), and, an IEEE 802.11 access point **604** (e.g., device **12** and/or **16** of FIG. **1**). In this example, the data communicated between devices **600-604** is real-time data such as a digital voice, digital audio playback and/or record, digital video playback and/or record, etc. Thus, to the user of the BT display device **600**, upstream and downstream data should be continuous. While this example is being presented using real-time data, the example applies equally well to non real-time data.

[0086] Continuing with the example, the BT display device **600** transmits upstream BT data **606**, which includes one or more packets formatted in accordance with at least one version of the Bluetooth standard. The BT/802.11 communication device **602** converts the upstream BT data **606** into upstream 802.11 data **608**, which includes one or more packets formatted in accordance with at least one version of the IEEE 802.11 standard (e.g., IEEE 802.11g). The 802.11 access point **604** provides the upstream 802.11 data **608** to a local area network (LAN), which may be coupled to a server, a wide area network (WAN) router, a public telephone network, and/or other real-time based device.

[0087] The 802.11 access point **604** provides downstream 802.11 data **610** from the LAN to the BT/802.11 communication device **602**. The downstream 802.11 data **610** may be voice data from one or more parties participating in a telephone call with the user of the BT display device **600**, may be digital audio data, and/or may be digital video data. The BT/802.11 communication device **602** converts the downstream 802.11 data **610** into downstream BT data **612**, which is subsequently transmitted to the BT display device **600**.

[0088] As is further shown, the shared communication medium has the same carrier frequency band (f_C) for the Bluetooth communications and the 802.11 communications. As such, avoiding overlapping Bluetooth communications with 802.11 communications (i.e., collisions) is an important aspect in providing reliable and efficient wireless LAN services.

[0089] FIG. **13** is packet diagram that demonstrates collision avoidance for the communication illustrated in FIG. **12**. In this example, the shared wireless communication medium may be reserved for the BT communications using any of the mechanisms previously discussed. For each BT packet communicated, the BT/802.11 communication device **602** determines the time that the BT packet communication is active (i.e., active time period **632**) and the time between BT packet communications (i.e., inactive time period **634**). The BT/802.11 communication device **602** utilizes the active time period for a plurality of BT packet communications to determine a probable BT active time period. Such a determination may be done by using a probability density function. In addition, BT/802.11 communication device **602** utilizes the inactive time period between a plurality of BT packet communications to determine a probable BT inactive time period. Such a determination may also be done by using a probability density function.

[0090] The BT/802.11 communication device **602** utilizes the probable BT active and/or inactive time periods to determine when to block **636** transmissions from the 802.11 access point **604** to itself. To further facilitate the determination when to block **636** transmissions form the 802.11 access point, the BT/802.11 communication device may monitor the access point's response time **638** to requests to transmit, to receive a clear to send, polling response, etc. In this manner, the communication device **602** coordinates the transmission to and from the access point **604** and to and from the BT display device **600** such that minimal collisions occur between the BT device transmitting the upstream BT data **606** and the access point **604** transmitting the downstream 802.11 data **610**. Note that once the shared wireless communication resource is in use, the communication device **602** utilizes standardized techniques to avoid collisions, however, when the shared wireless communication resource appears to be available, the communication device **602** can utilize the probable BT active time period **632**, the probable BT inactive time period **634**, and/or the AP response time **638** to coordinate the upstream BT data **606** and the downstream 802.11 data **610**.

[0091] FIG. **14** is a logic diagram of a method for collision avoidance in multiple protocol networks using a shared communication medium. The method begins at step **640** where the communication device determines a first protocol probable active time period for a communication using a first communication protocol (e.g., Bluetooth). The method then proceeds to step **642** where the communication device determines a first protocol probable inactive time period for the communication using the first communication protocol. The method then proceeds to step **644** where the communication device generates a transmit blocking indication to block at least a downstream transmission using a second communication protocol (e.g., IEEE 802.11) based on the first protocol probable active time period and the first protocol probable inactive time period. Note that the first and second communication protocols use the shared communication medium.

[0092] In an embodiment, the communication device may determine the first protocol probable active time period by detecting commencement of transmitting a packet of the communication using the first communication protocol. The commencement of transmitting the packet may be detected by a MAC or higher layer signaling that indicates an up-coming transmission and/or by an over-the-air detection. Once the commencement of transmitting the packet is detected, the communication device then enables a timer. The communication device then detects end of the packet of the communication using the first communication protocol.

The communication device then stores the value of the timer upon the detecting the end to produce a measured active time period. The communication device may do this for a plurality of packets of the communication using the first communication protocol to produce a plurality of measured active time periods. The communication device then may perform a probability function upon the plurality of measured active time periods to obtain the first protocol probable active time period.

[0093] In an embodiment, the communication device may determine the first protocol probable inactive time period by detecting end of the packet of the communication using the first communication protocol. The communication device then resets the timer to an initial value (e.g., 0). The communication device then enables the timer. The communication device then detects commencement of transmitting the packet of the communication using the first communication protocol. The communication device then stores the value of the timer upon the detecting the activation to produce a measured inactive time period. The communication device may do this for a plurality of packets of the communication using the first communication protocol to produce a plurality of measured inactive time periods. The communication device then performs a probability function upon the plurality of measured inactive time periods to obtain the first protocol probable inactive time period.

[0094] In an embodiment, the communication device may generate the transmit blocking indication by setting a power management subfield to a power savings mode (e.g., 1) for a time frame corresponding to the first protocol probable active time period. The communication device then sets the power management subfield to a normal power mode for a time frame corresponding to the first protocol probable inactive time period. The communication device may further determine a downstream transmission response time of the access point. The communication device may then adjust the time at which the setting of the power management subfield occurs based on the downstream transmission response time.

[0095] In an embodiment, the communication device may generate the transmit blocking indication by setting a power management subfield to a power savings mode. The communication device then may send a request for the downstream transmission during the first protocol probable inactive time period. The communication device may further determine a downstream transmission response time of the access point. The communication device may then adjust the time of the sending of the request for the downstream transmission based on the downstream transmission response time.

[0096] In an embodiment, the communication device may generate the transmit blocking indication by generating a clear-to-send-to-self message based on at least one of the first protocol probable active time period and the first protocol probable inactive time period or by a Power Savings+Poll message based on at least one of the first protocol probable active time period and the first protocol probable inactive time period.

[0097] As a particular example, a standardized WLAN MAC engine may be modified to include a free running incrementing timer Timer**1** and logic. The timer is used as follows:

[0098] when a BT RF_ACTIVE signal (e.g., a BT packet is to be transmitted) is asserted the value of Timer**1** is copied to register T**1** and the timer is reset to 0;

[0099] when the BT RF_ACTIVE signal is deasserted the value of Timer**1** is copied to register T**2**. The logic asserts an interrupt signal to the WLAN main processor when the BT RF_ACTIVE signal state changes.

[0100] In addition, a WLAN driver software may be modified as follows:

[0101] include two lists L**1** and L**2** such that each element of list L**1** corresponds to a particular value of register T**1** and each element of list L**2** corresponds to a particular value of register T**2**.

[0102] A software function responsive to BT RF_ACTIVE state change interrupt:

[0103] Read the value of BT RF_ACTIVE signal;

[0104] If RF_ACTIVE signal is asserted increment the value of the element of list L**1** corresponding to the value of register T**1**;

[0105] If RF_ACTIVE signal is deasserted increment the value of the element of list L**2** corresponding to the value of register T**2**;

[0106] A software function executed periodically:

[0107] Analyze the contents of list L**1** to determine probability density function of T**1**;

[0108] Based on T**1** PDF estimation determine the value E**1** corresponding to certain probability of T**1** being larger than E**1**;

[0109] Analyze the contents of list L**2** to determine probability density function of T**2**;

[0110] Based on T**2** PDF estimation determine the value E**2** corresponding to certain probability of T**2** being smaller than E**2**;

[0111] The WLAN MAC engine may be further modified for BT coexistence logic enhancement as follows:

[0112] a register E**1** specifying the time from the previous assertion of BT RF_ACTIVE signal to the next one; The value of E**1** is updated whenever BT RF_ACTIVE signal is asserted.

[0113] a register E**2** specifying the time BT RF_ACTIVE signal will stay asserted. The value of E**1** is updated whenever BT RF_ACTIVE signal is deasserted.

[0114] a decrementing timer Timer**2**, such that:

[0115] When BT RF_ACTIVE signal is asserted the value of register E**1** is copied to Timer**2**;

[0116] Timer**2** stops when it reaches 0;

[0117] change to 802.11 frame transmission logic such that the transmission of the frame is blocked if the Duration field of the 802.11 frame is greater than the value of Timer**2**;

[0118] logic to stop AP from transmitting to STA:

[0119] If WLAN is in BSS mode

[0120] if the value of Timer2 is less than some register F1

[0121] if there is an 802.11 frame pending to be transmitted

[0122] set the power management subfield of this frame to 1;

[0123] else

[0124] send 802.11 management frame with power management subfield of this frame to 1;

[0125] When BT RF_ACTIVE signal is deasserted send power savings (PS)-Poll frame (e.g., change power savings state and request downstream transmission via polling);

[0126] if WLAN is in IBSSS mode

[0127] if the value of Timer2 is less than some register F2

[0128] send CTS-to-Self 802.11 frame with Duration field set to the value in register E2.

[0129] In example embodiment, the communication device always indicates PM=1, which means that the device is always operating as a power-managed device. Further, transmission of a frame with PM=1 occurs at least once in the association, or at some time subsequent to association and transmission of additional frames with a PM=1 indication prior to each BT activity time is not necessary. However, whenever a frame is transmitted, it will indicate PM=1, and sometimes, such transmissions may occur prior to a BT activity time, but such transmissions are not necessary to the invention in this embodiment. As such, frames only get transmitted toward the device when the device explicitly requests the frames, which may be done by the transmission of either a PS-Poll frame or a "trigger frame" if using IEEE 802.11 U-APSD or Wireless Fidelity Alliance (WFA) U-APSD which is a derivative of the IEEE 802.11 U-APSD mechanism.

[0130] In either case, the returned frame(s) might occur at any time (i.e. it typically does not immediately follow the PS-Poll transmission or trigger frame transmission, even though it is permitted to do so), including the time when the next BT transmission occurs. The AP receives the "request" frame and then may need time to retrieve the buffered packet, then queue it and then get access to the network to send it. In an example embodiment, the communication device switches in and out of power management mode, by sending PM=1 before the BT activity and PM=0 after the BT activity.

[0131] FIG. **15** is a schematic block diagram of an access point **604** obtaining co-location interference information from a multiple protocol device **602**. In this embodiment, the access point **604** transmits an interference request **650** to the multiple protocol device **604**, which may be a Bluetooth-IEEE 802.11 communication device. In response to the interference request **650**, which be described in greater detail below, the multiple protocol device **604** generates an interference response **652** and provides it to the access point **604**. In this manner, the access point **604** can control when the requests are transmitted and, to some extent, when the responses are transmitted. In addition to, or in the alternative of, the access point **604** may provide an interference information enable signal to the multiple protocol device **602** such that the multiple protocol device **602** provides the co-location interference information when it changes. Further, the access point **604** may indicate within the interference information enable signal that, even if the multiple protocol device **602** has an update to report, it does not provide the updated information any more often than a predetermined time period (e.g., 1 second).

[0132] Having acquired the interference information from one or more multiple protocol devices, the access point **604** may use the information to avoid collisions of its transmissions with communications compliant to another standard (e.g., Bluetooth, GSM, EDGE, GPRS, CDMA, etc.). For example, if the interfering signal using a frequency hopping scheme, the access point and/or the multiple protocol device(s) may use the known frequency hopping pattern to know when to avoid certain frequencies and for how long. Note that since the multiple protocol device **602** knows what its multiple protocols are, determining pertinent interference information is a relatively simple process.

[0133] As another example, by knowing the periodicity of an interferer, the access point **604** and/or the multiple protocol device **602** may increase its transmission rate such that its frame length may be reduced to avoid a collision with the interferer. This allows the access point **604** and/or the multiple protocol device to response to interference in non-typical fashions. For instance, a typical response to interference is to slow the data transmission rate down, but, in the presence of a periodic interferer, would make the collision worse due to the longer time of transmission.

[0134] As one of ordinary skill in the art will appreciate, by knowing the characteristics of an interferer, the access point **602** and/or the multiple protocol device **602** may work around the interferer to reduce the number of collisions, thereby improving the efficiency of both protocol communications.

[0135] FIG. **16** is a diagram of an interference request **650** that includes a category field **660**, an action field **662**, a dialog token field **664**, and a request information field **666**. The request information field **666** may include an auto response enable field **668** and a report timeout field **670**. Each of fields **660-666** may be 1 octet in length.

[0136] The access point **602** may enable auto response by setting the auto response enable field **668** to 1. In this mode, the station (e.g., the multiple protocol device) will automatically provide an interference report to the access point in accordance with information contained in the other fields **660-664**. The information contained in the report may be specifically requested via the request time out field and/or one of the other fields. For example, the requested information may include one or more of interference level, interference level accuracy, interference interval, interference burst length, interference start time, interferer center frequency, interferer bandwidth, interferer modulation/spreading, and interferer symbol duration. Alternatively, a default interference report may be generated (e.g., have an interferer and its type). Note that the access point **604** may include a report limiting function to limit the rate of reports it receives such that the congesting on the network is controlled and saturating the network is avoided.

[0137] In one embodiment, the multiple protocol device may receive a co-location enable signal from the access point. The multiple protocol device may then determine whether co-location information feature is activated. This may be done by checking a register. The multiple protocol device then provides a null response to the access point when the co-location feature is not activated.

[0138] FIG. **17** is a diagram of an interference response **662** that includes a category field **680**, an action field, a dialog token field **684**, and a response information field **686**. The response information field **686** may include an interference level **688**, an interference level accuracy **690**, an interference interval **692**, an interference burst length **694**, an interference start time **696**, an interference center frequency **698**, an interference bandwidth **700**, an interference modulation/spreading information **702**, and an interference symbol duration **704**.

[0139] In one embodiment, the interference level **688** is a signed integer that indicates a maximum level of the expected interference, which may be in units of dBm averaged over a predetermined period of time (e.g., 4 microseconds) during an interference burst. The interference level accuracy **690** may be an unsigned integer that indicates the expected accuracy of the estimated interference in dB. For example, $+/-3\sigma$ events are within δ dB. The interference interval **692** indicates the interval between two successive periods of interference, which may be measured in microseconds. One or more default values may be used to indicate continuous interference and/or unknown burst intervals. For example, a value of 65535 may be used to indicate continuous interference.

[0140] The interval burst length **694** indicates the duration of a period of the interference, which may be measured in microseconds. As with the interference interval **692**, one or more default values may be used to indicate continuous interference and/or unknown burst intervals. For example, a value of 65535 may be used to indicate continuous interference. The interference start time **696** indicates a counter value as to when the next interference burst will begin. For example, the least significant 4 bytes of the TSF timer may be used to indicate the start of the next interference burst. Note that a default value (e.g., 65535) in this field indicates that no start time information is available.

[0141] The interferer center frequency **698** indicates an approximate center frequency in MHz of the interferer. If the center frequency of the interferer is not known or the interference covers a channel of the interferer, then the center frequency of the channel is used. The interferer bandwidth **700** indicates the approximate 3-dB bandwidth of the signal in KHz. If the bandwidth is unknown, a default value may be used (e.g., 65535).

[0142] The interferer modulation/spreading information **702** indicates the type of digital modulation and/or spreading used by the interferer. The interferer symbol duration **704** indicates the symbol duration in KHz. Recall that since the source of the interference is the other protocol module, the information regarding its channel usage, bandwidth, modulation and/or spreading scheme is known.

[0143] As may be used herein, the terms "substantially" and "approximately" provides an industry-accepted tolerance for its corresponding term and/or relativity between items. Such an industry-accepted tolerance ranges from less than one percent to fifty percent and corresponds to, but is not limited to, component values, integrated circuit process variations, temperature variations, rise and fall times, and/or thermal noise. Such relativity between items ranges from a difference of a few percent to magnitude differences. As may also be used herein, the term(s) "coupled to" and/or "coupling" and/or includes direct coupling between items and/or indirect coupling between items via an intervening item (e.g., an item includes, but is not limited to, a component, an element, a circuit, and/or a module) where, for indirect coupling, the intervening item does not modify the information of a signal but may adjust its current level, voltage level, and/or power level. As may further be used herein, inferred coupling (i.e., where one element is coupled to another element by inference) includes direct and indirect coupling between two items in the same manner as "coupled to". As may even further be used herein, the term "operable to" indicates that an item includes one or more of power connections, input(s), output(s), etc., to perform one or more its corresponding functions and may further include inferred coupling to one or more other items. As may still further be used herein, the term "associated with", includes direct and/or indirect coupling of separate items and/or one item being embedded within another item. As may be used herein, the term "compares favorably", indicates that a comparison between two or more items, signals, etc., provides a desired relationship. For example, when the desired relationship is that signal **1** has a greater magnitude than signal **2**, a favorable comparison may be achieved when the magnitude of signal **1** is greater than that of signal **2** or when the magnitude of signal **2** is less than that of signal **1**.

[0144] While the transistors in the above described figure(s) is/are shown as field effect transistors (FETs), as one of ordinary skill in the art will appreciate, the transistors may be implemented using any type of transistor structure including, but not limited to, bipolar, metal oxide semiconductor field effect transistors (MOSFET), N-well transistors, P-well transistors, enhancement mode, depletion mode, and zero voltage threshold (VT) transistors.

[0145] The present invention has also been described above with the aid of method steps illustrating the performance of specified functions and relationships thereof. The boundaries and sequence of these functional building blocks and method steps have been arbitrarily defined herein for convenience of description. Alternate boundaries and sequences can be defined so long as the specified functions and relationships are appropriately performed. Any such alternate boundaries or sequences are thus within the scope and spirit of the claimed invention.

[0146] The present invention has been described above with the aid of functional building blocks illustrating the performance of certain significant functions. The boundaries of these functional building blocks have been arbitrarily defined for convenience of description. Alternate boundaries could be defined as long as the certain significant functions are appropriately performed. Similarly, flow diagram blocks may also have been arbitrarily defined herein to illustrate certain significant functionality. To the extent used, the flow diagram block boundaries and sequence could have been defined otherwise and still perform the certain significant functionality. Such alternate definitions of both functional building blocks and flow diagram blocks and sequences are

thus within the scope and spirit of the claimed invention. One of average skill in the art will also recognize that the functional building blocks, and other illustrative blocks, modules and components herein, can be implemented as illustrated or by discrete components, application specific integrated circuits, processors executing appropriate software and the like or any combination thereof.

What is claimed is:

1. A method comprises:

providing, by an access point, a request for co-location interference information to at least one multiple protocol device;

obtaining, by the at least one multiple protocol device, co-location interference information in response to the request; and

providing, by the at least one multiple protocol device, the co-location interference information to the access point.

2. The method of claim 1, wherein the co-location interference information comprises at least one of:

interference level;

interference level accuracy;

interference interval;

interference burst length;

interference start time;

interferer center frequency;

interferer bandwidth;

interferer modulation/spreading; and

interferer symbol duration.

3. The method of claim 2 further comprises:

when information regarding the at least one of the co-location interference information is not obtainable, providing a default value.

4. The method of claim 1 further comprises:

determining, by the at least one multiple protocol device, whether the co-location information has changed;

when the co-location information has changed, updating, by the at least one multiple protocol device, the co-location information to produce updated co-location information; and

providing, by the at least one multiple protocol device, the updated co-location information to the access point.

5. The method of claim 4, wherein the providing the updated co-location information to the access point comprises:

determining, by the at least one multiple protocol device, whether an update time period has expired; and

when the update time period has not expired, waiting to provide the updated co-location information to the access point unit the update time period has expired.

6. The method of claim 1, wherein the at least one multiple protocol device is operable in accordance with a wireless local area network communication standard and is operable in accordance with at least one of a cellular telephone communication standard, a data communication standard, and a Bluetooth wireless communication standard.

7. A method comprises:

obtaining, when enabled, co-location interference information in response to the request; and

providing in accordance with the enabled, the co-location interference information to an access point.

8. The method of claim 7, wherein the co-location interference information comprises at least one of:

interference level;

interference level accuracy;

interference interval;

interference burst length;

interference start time;

interferer center frequency;

interferer bandwidth;

interferer modulation/spreading; and

interferer symbol duration.

9. The method of claim 8 further comprises:

when information regarding the at least one of the co-location interference information is not obtainable, providing a default value.

10. The method of claim 7 further comprises:

determining whether the co-location information has changed;

when the co-location information has changed, updating the co-location information to produce updated co-location information; and

providing the updated co-location information to the access point.

11. The method of claim 10, wherein the providing the updated co-location information to the access point comprises:

determining whether an update time period has expired;

when the update time period has not expired, waiting to provide the updated co-location information to the access point unit the update time period has expired.

12. The method of claim 7 further comprises:

receiving a co-location enable signal from the access point;

determining whether co-location information feature is activated; and

when the co-location feature is not activated, providing a null response to the access point.

13. A multiple protocol device comprises:

a transceiver for converting inbound radio frequency (RF) signals into inbound symbols and for converting outbound symbols into outbound RF signals; and

a protocol module coupled to:

obtain, when enabled, co-location interference information in response to the request; and

provide, in accordance with the enabled, the co-location interference information to an access point via the transceiver.

14. The multiple protocol device of claim 13, wherein the co-location interference information comprises at least one of:

interference level;

interference level accuracy;

interference interval;

interference burst length;

interference start time;

interferer center frequency;

interferer bandwidth;

interferer modulation/spreading; and

interferer symbol duration.

15. The multiple protocol device of claim 13, wherein the protocol module further functions to:

when information regarding the at least one of the co-location interference information is not obtainable, provide a default value.

16. The multiple protocol device of claim 13, wherein the protocol module further functions to:

determine whether the co-location information has changed;

when the co-location information has changed, update the co-location information to produce updated co-location information; and

provide, via the transceiver, the updated co-location information to the access point.

17. The multiple protocol device of claim 16, wherein the protocol module further functions to provide the updated co-location information to the access point by:

determining whether an update time period has expired;

when the update time period has not expired, waiting to provide the updated co-location information to the access point unit the update time period has expired.

18. The multiple protocol device of claim 13, wherein the protocol module further functions to:

receive a co-location enable signal from the access point;

determine whether co-location information feature is activated; and

when the co-location feature is not activated, provide a null response to the access point.

* * * * *

EXHIBIT 1013

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Dua (43) Pub. Date: Nov. 16, 2006

(54) WIRELESS MEDIA SYSTEM AND PLAYER AND METHOD OF OPERATION

(76) Inventor: **Robin Dua**, Vienna, VA (US)

Correspondence Address:
Charles B. Lobsenz
Roberts, Mlotkowski & Hobbes, PC
Suite 850
8270 Greensboro Drive
McLean, VA 22102 (US)

(21) Appl. No.: **11/127,979**

(22) Filed: **May 12, 2005**

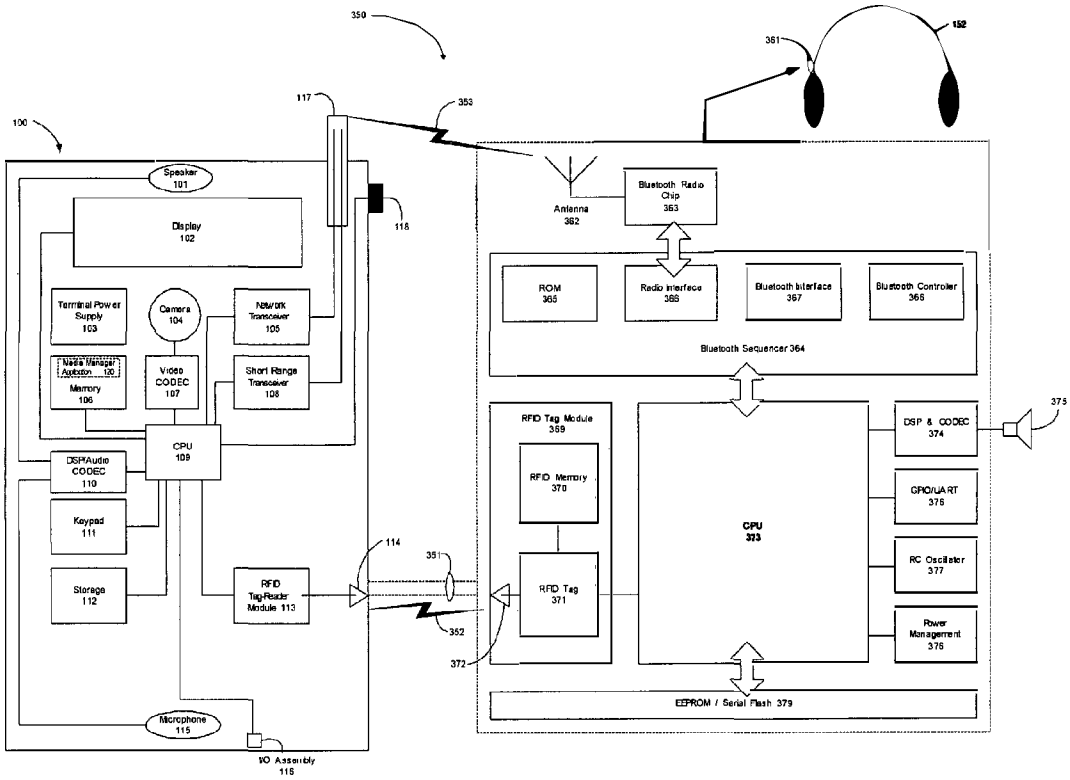
Publication Classification

(51) **Int. Cl.**
H04B 7/00 (2006.01)

(52) **U.S. Cl.** **455/41.3**; 455/41.2

(57) **ABSTRACT**

A wireless media player and a related system and methodology are disclosed. One aspect of the wireless media player system pertains to a virtual connector system, apparatus, and method for the automatic establishment of wireless connectivity with other electronic devices. In one embodiment, the media player device employs the use of integrated Radio Frequency Identification (RFID) technology to exchange communication settings, media capability, and other parameters with an external device that also has integrated RFID technology. The automatic exchange of settings and other information via a proximity-based RFID data exchange allows a media player to quickly establish a secure communication link with another device via a commonly supported wireless protocol such as Ultra Wideband (UWB) or Bluetooth. Another aspect of the media player system pertains to a method of using the captured media capability of the connecting device to customize certain menu options and software parameters in the media player.



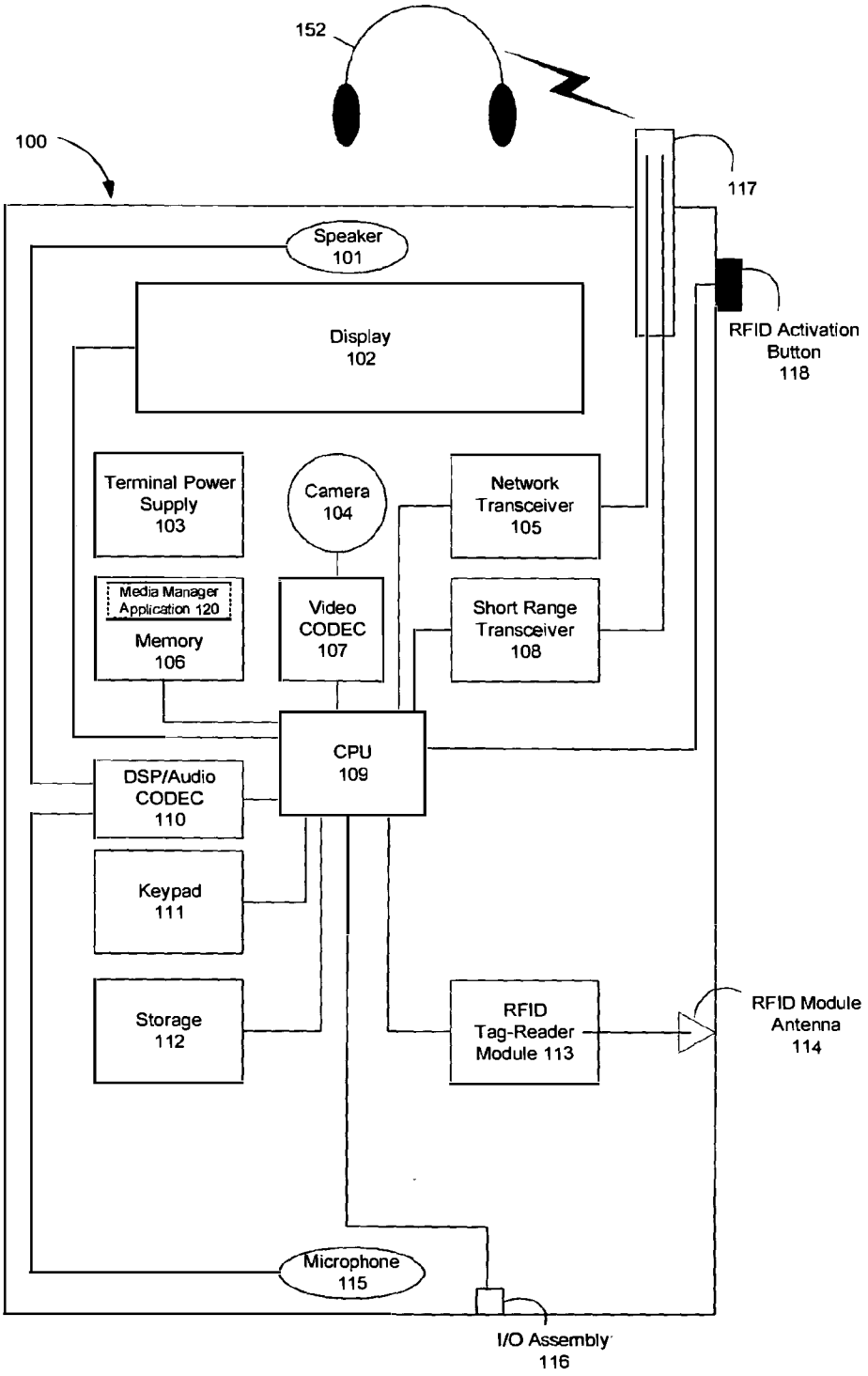

152
100
117
Speaker
101
Display
102
RFID Activation
Button
118
Terminal Power
Supply
103
Camera
104
Network
Transceiver
105
Media Manager
Application 120
Memory
106
Video
CODEC
107
Short Range
Transceiver
108
CPU
109
DSP/Audio
CODEC
110
Keypad
111
Storage
112
RFID
Tag-Reader
Module 113
RFID Module
Antenna
114
Microphone
115
I/O Assembly
116

FIG. 1

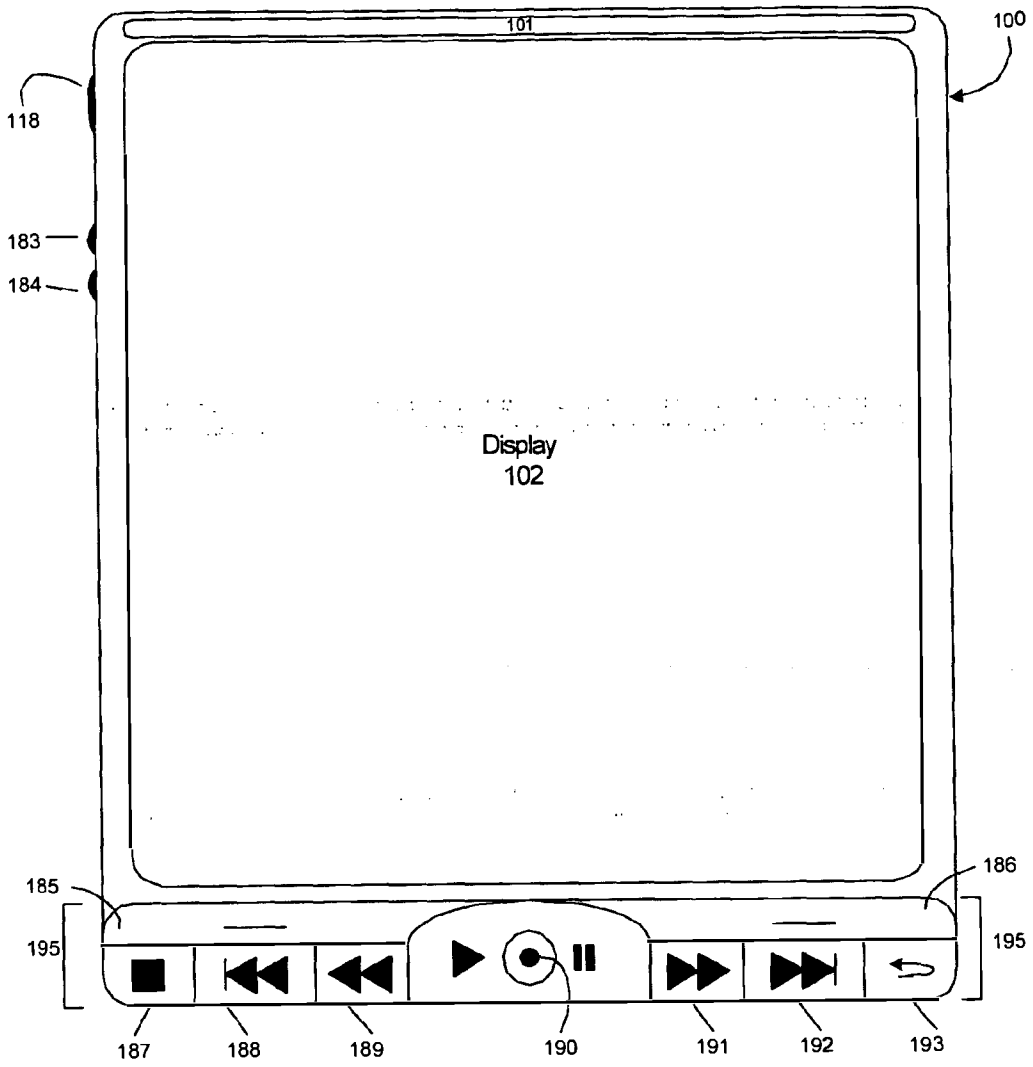

101
100
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183
184
Display
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186
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193

FIG. 2A

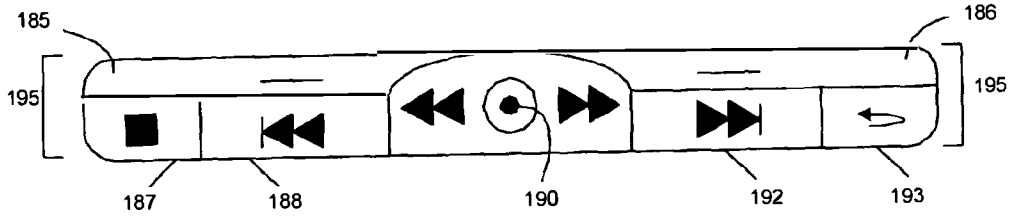

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186
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192
193

FIG. 2B

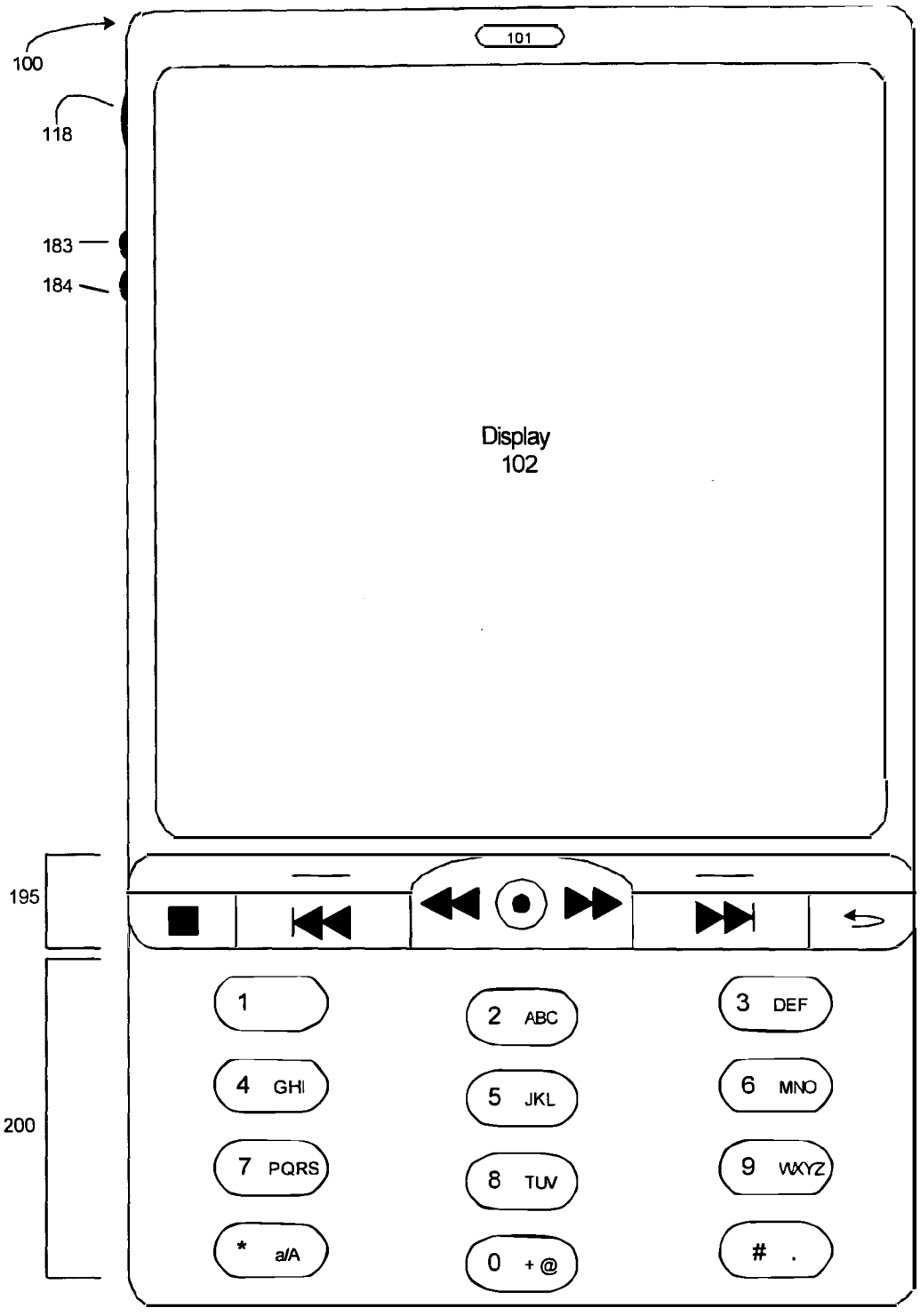

100
101
118
183
184
Display
102
195
200
1
2 ABC
3 DEF
4 GHI
5 JKL
6 MNO
7 PQRS
8 TUV
9 WXYZ
* a/A
0 + @
.

FIG. 2C

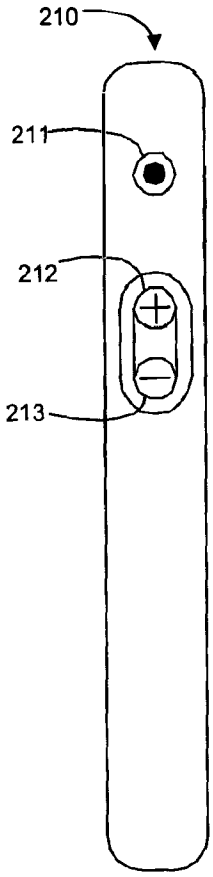


FIG. 3A

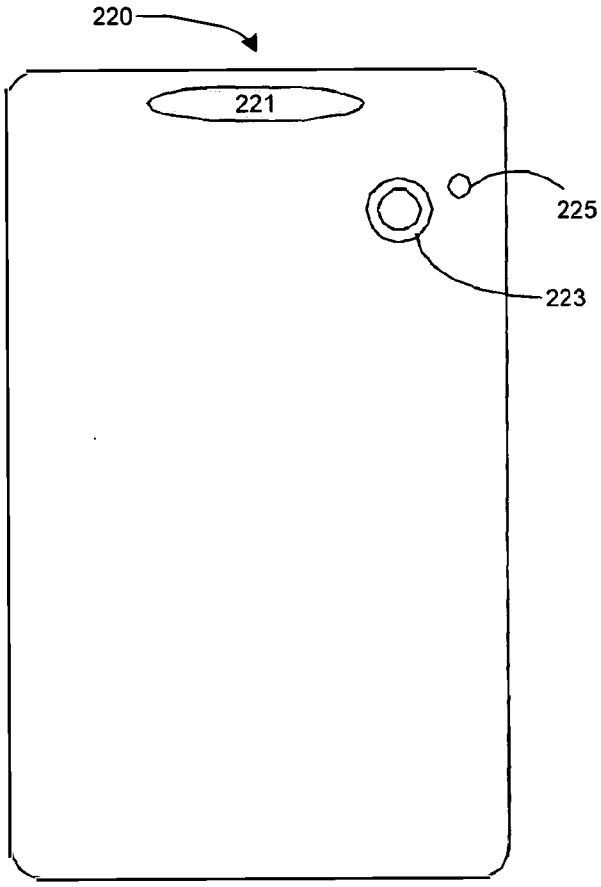


FIG. 3B

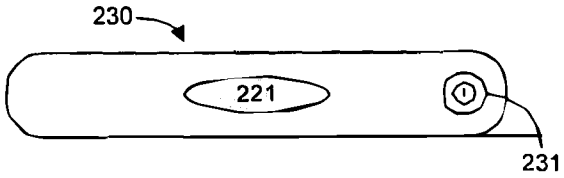


FIG. 3C

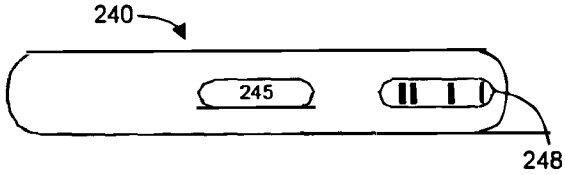


FIG. 3D

FIG. 4A

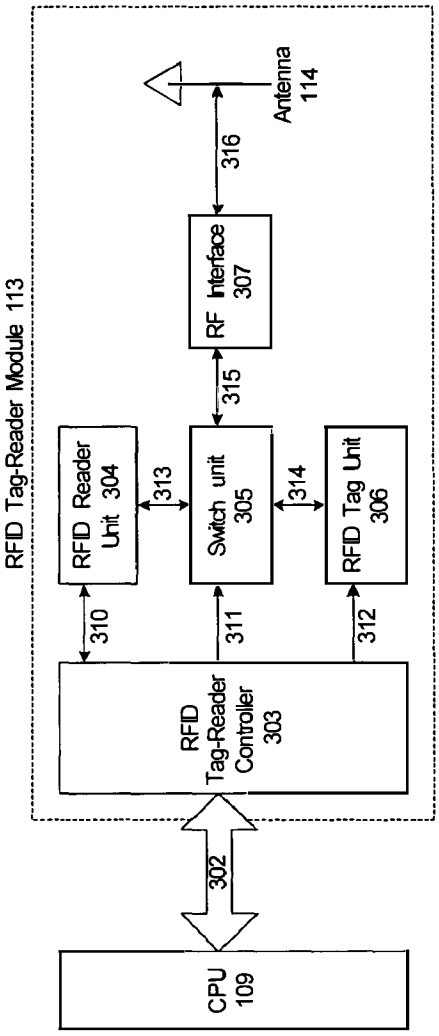
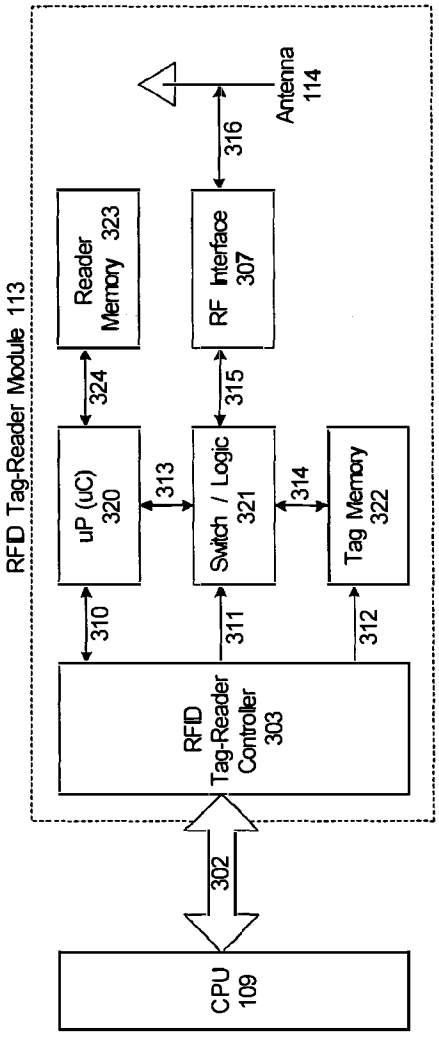


FIG. 4B



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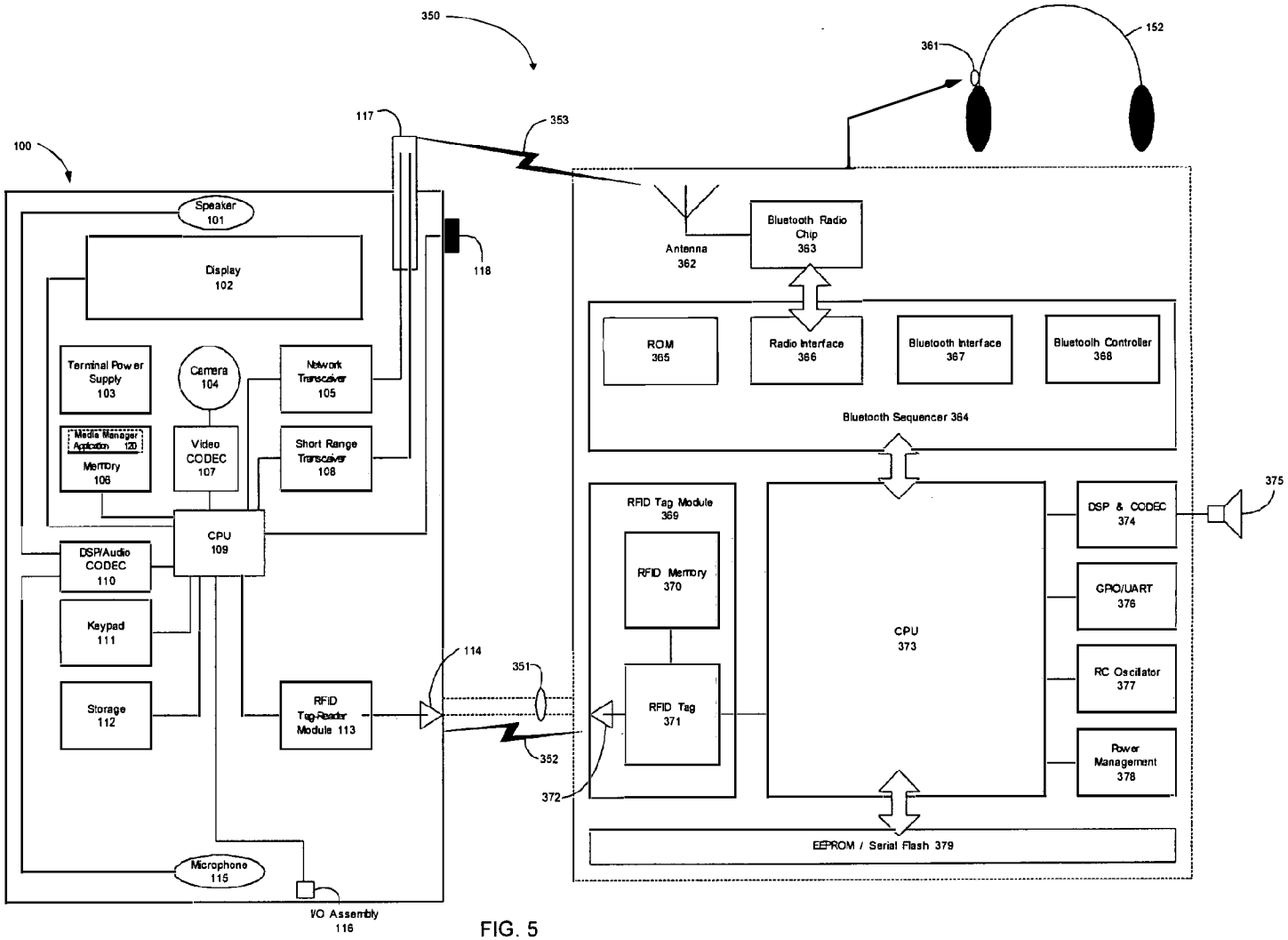

350
361
152
117
353
100
Speaker
101
Display
102
118
Terminal Power Supply
103
Camera
104
Network Transceiver
105
Media Manager Application 120
Memory
106
Video CODEC
107
Short Range Transceiver
108
CPU
109
DSP/Audio CODEC
110
Keypad
111
Storage
112
RFID Tag-Reader Module 113
114
351
352
372
Microphone
115
I/O Assembly
116
Antenna
362
Bluetooth Radio Chip
363
ROM
365
Radio Interface
366
Bluetooth Interface
367
Bluetooth Controller
368
Bluetooth Sequencer 364
RFID Tag Module
369
RFID Memory
370
RFID Tag
371
CPU
373
DSP & CODEC
374
375
GPIO/UART
376
RC Oscillator
377
Power Management
378
EEPROM / Serial Flash 379

FIG. 5

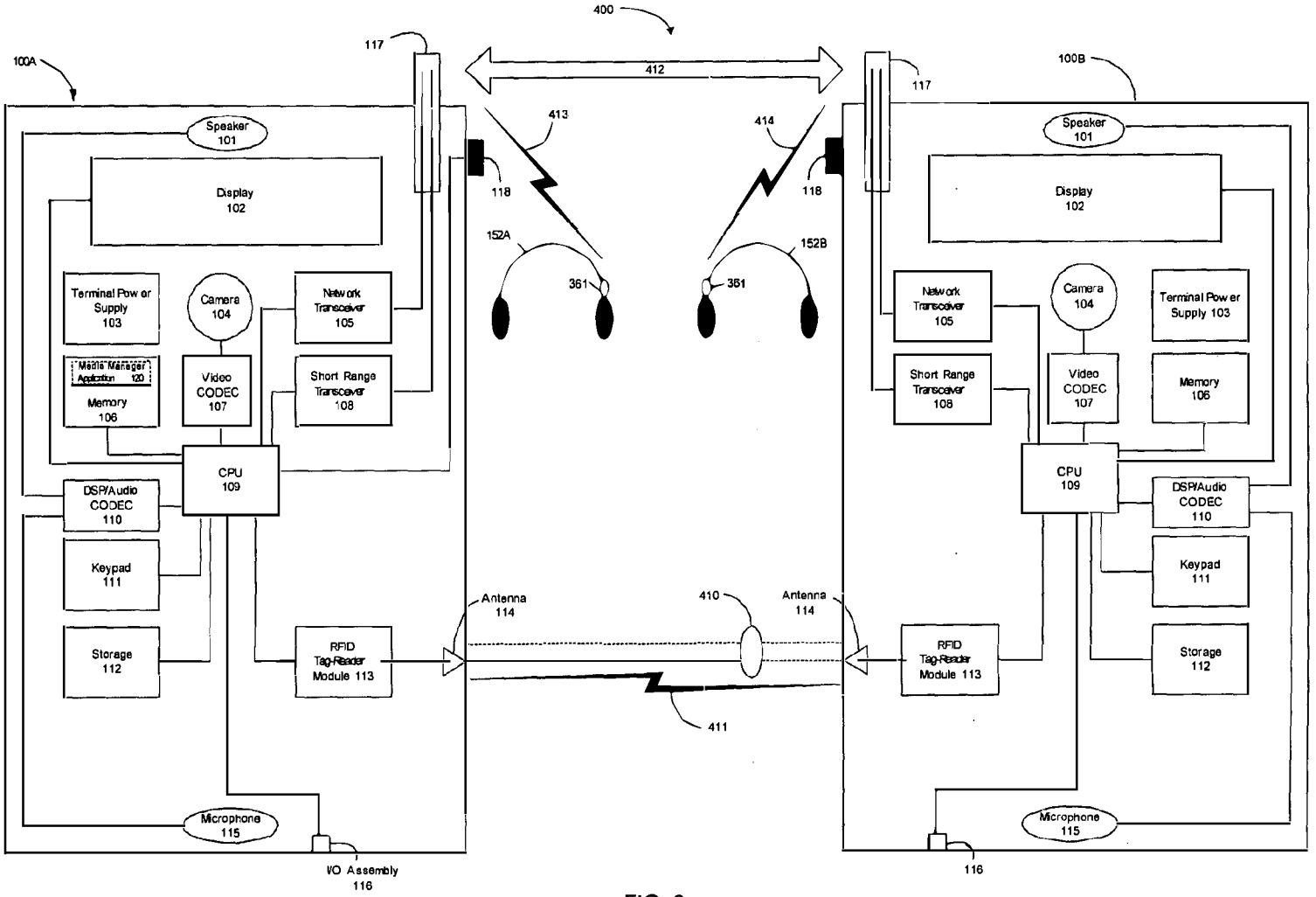

400
100A
117
412
100B
117
Speaker 101
Display 102
413
414
118
118
152A
152B
361
361
Terminal Power Supply 103
Camera 104
Network Transceiver 105
Media Manager Application 120
Memory 106
Video CODEC 107
Short Range Transceiver 108
CPU 109
DSP/Audio CODEC 110
Keypad 111
Storage 112
RFID Tag-Reader Module 113
Antenna 114
410
Antenna 114
411
Microphone 115
I/O Assembly 116
116

FIG. 6

450

Message Component 451	Example Content 452
Device Type 453	• TV • Digital Video Recorder (DVR) • VCR/DVD Player • Cellular Phone • Stereo • MP3 Player • Headset/Earphones • Digital Camera • Telephone • Automobile - Integrated Computer
Device Manufacturer 454	• XYZ Electronics
Device Model 455	• WaveRadio TH-190
Device/User Identifier 456	• Location of Device: "Kitchen" • Device owner's name: "Anthony" • Device owner's calling card (e.g., name, address, tel. #, e-mail)
Profile Settings 457	• Allow Create Profile: "On" or "Off" • Allow Auto-Detect & Connect: "On" or "Off"
RF Capability 458	• Bluetooth • 802.11 a/b/g/n • Ultra Wideband (UWB) • AM/FM • UHF/VHF • ZigBee/802.15.4 • Wireless USB • 802.15.3/ WiMedia • Wireless 1394 • Wireless FireWire
Communication Settings 459	• RF configuration settings • Standardized communication profiles (e.g., Bluetooth - handsfree, headset, etc.) • Supported network protocols (IANA) • Security settings - Challenge/response information, Encryption keys, PINs/ passwords - Device Addresses: e.g., BD_ADDR, MAC
Hardware/Software Parameters 460	• Hardware capabilities (e.g., display, audio, input) • Operating System version & capabilities • Software capabilities
Media Capability 461	• Audio: MP3, WMA, WAV, AAC, HE-AAC, FLAC, Ogg Vorbis • Video: MPEG 1, MPEG 2, MPEG 4, MPEG 7, AVI, XviD • Image: JPEG, JPEG2000, TIFF, GIF, BMP, PNG • Presentation: PPS, PPT • Internet Content: HTML, XHTML, DHTML, JavaScript

FIG. 7

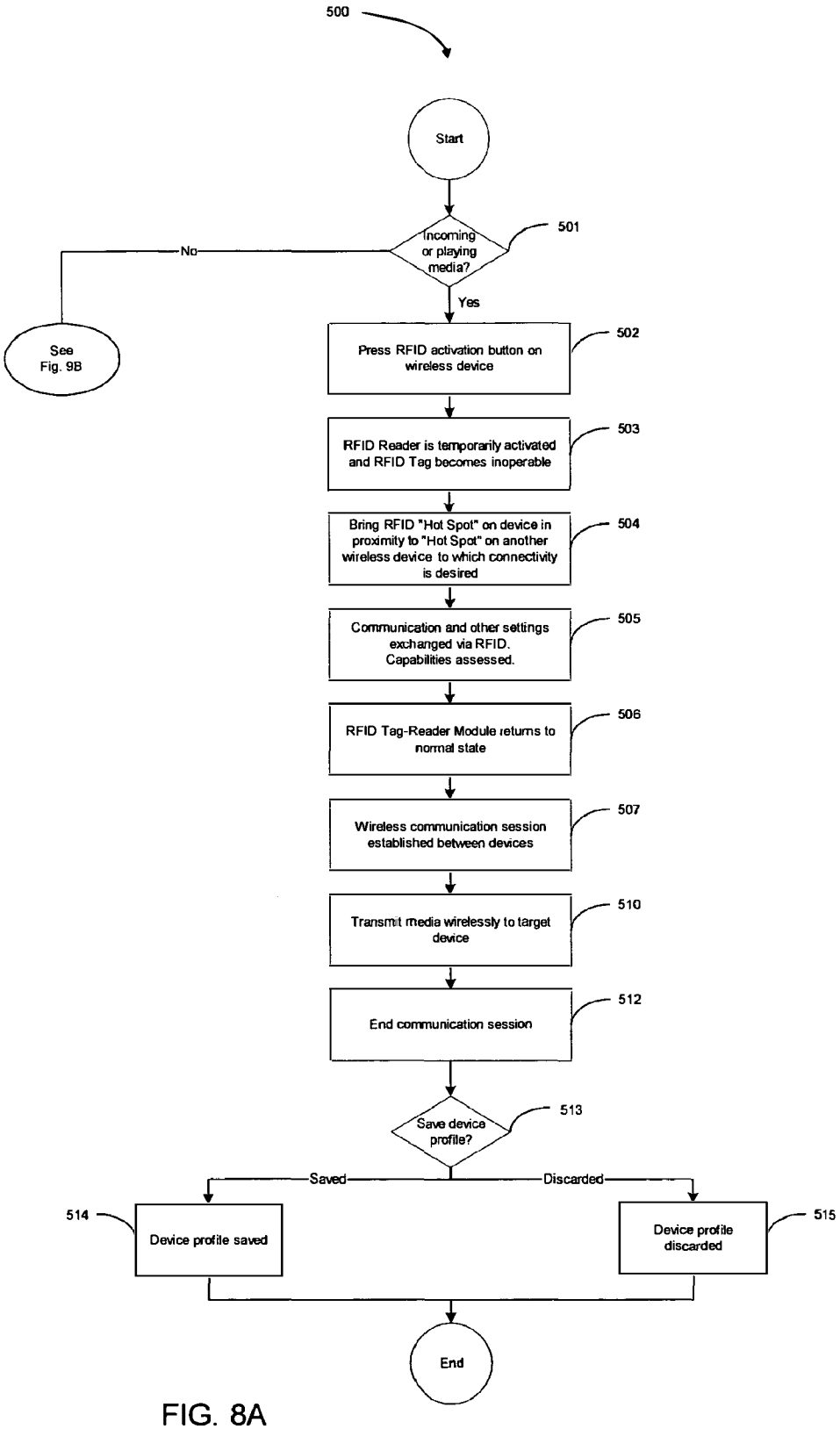

500
Start
Incoming or playing media?
501
No
Yes
See Fig. 9B
Press RFID activation button on wireless device
502
RFID Reader is temporarily activated and RFID Tag becomes inoperable
503
Bring RFID "Hot Spot" on device in proximity to "Hot Spot" on another wireless device to which connectivity is desired
504
Communication and other settings exchanged via RFID. Capabilities assessed.
505
RFID Tag-Reader Module returns to normal state
506
Wireless communication session established between devices
507
Transmit media wirelessly to target device
510
End communication session
512
Save device profile?
513
Saved
Discarded
514
Device profile saved
Device profile discarded
515
End

FIG. 8A

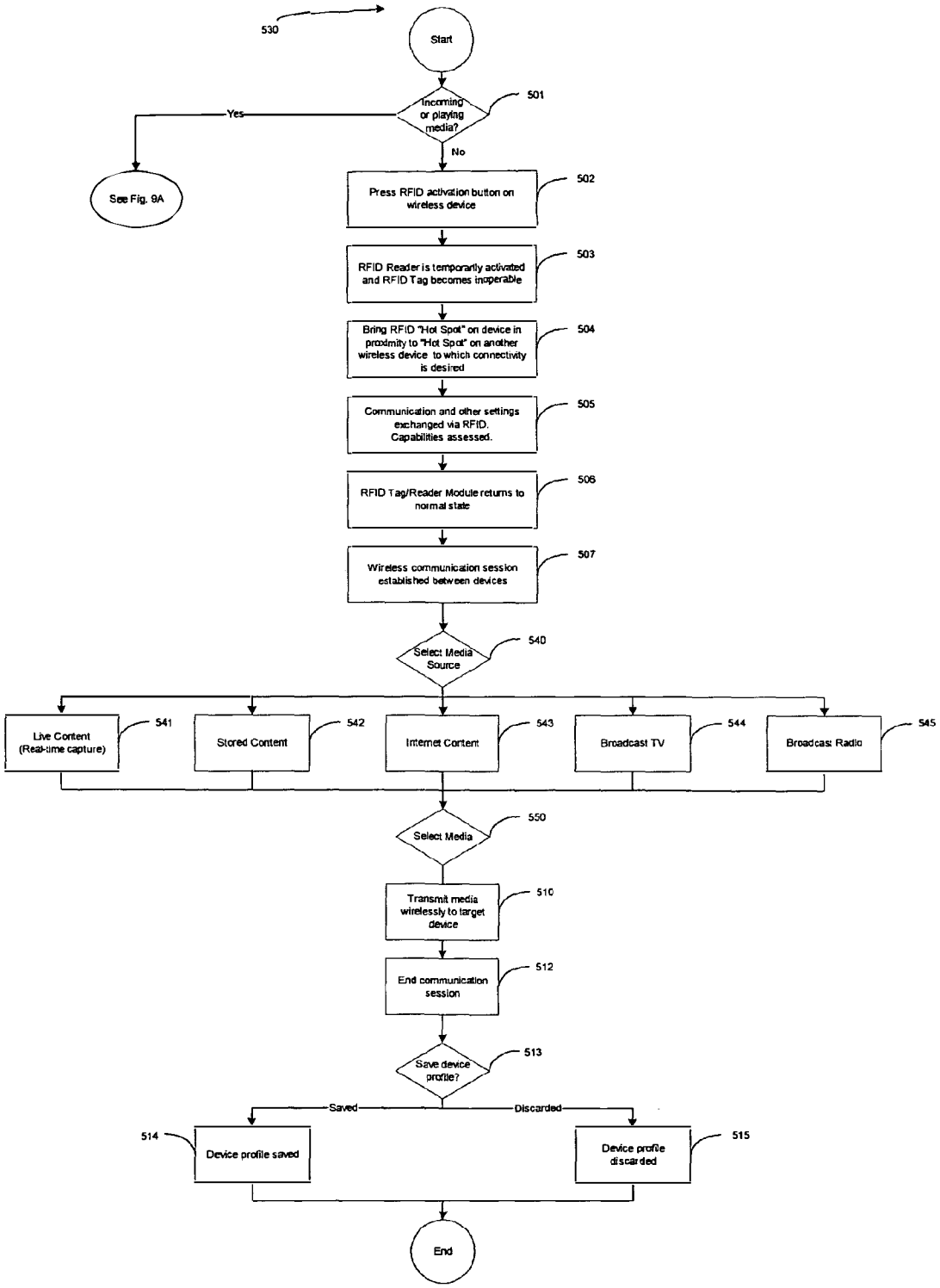

530
Start
Incoming or playing media?
501
Yes
No
See Fig. 9A
Press RFID activation button on wireless device
502
RFID Reader is temporarily activated and RFID Tag becomes inoperable
503
Bring RFID "Hot Spot" on device in proximity to "Hot Spot" on another wireless device to which connectivity is desired
504
Communication and other settings exchanged via RFID. Capabilities assessed.
505
RFID Tag/Reader Module returns to normal state
506
Wireless communication session established between devices
507
Select Media Source
540
Live Content (Real-time capture)
541
Stored Content
542
Internet Content
543
Broadcast TV
544
Broadcast Radio
545
Select Media
550
Transmit media wirelessly to target device
510
End communication session
512
Save device profile?
513
Saved
Discarded
514
Device profile saved
Device profile discarded
515
End

FIG. 8B

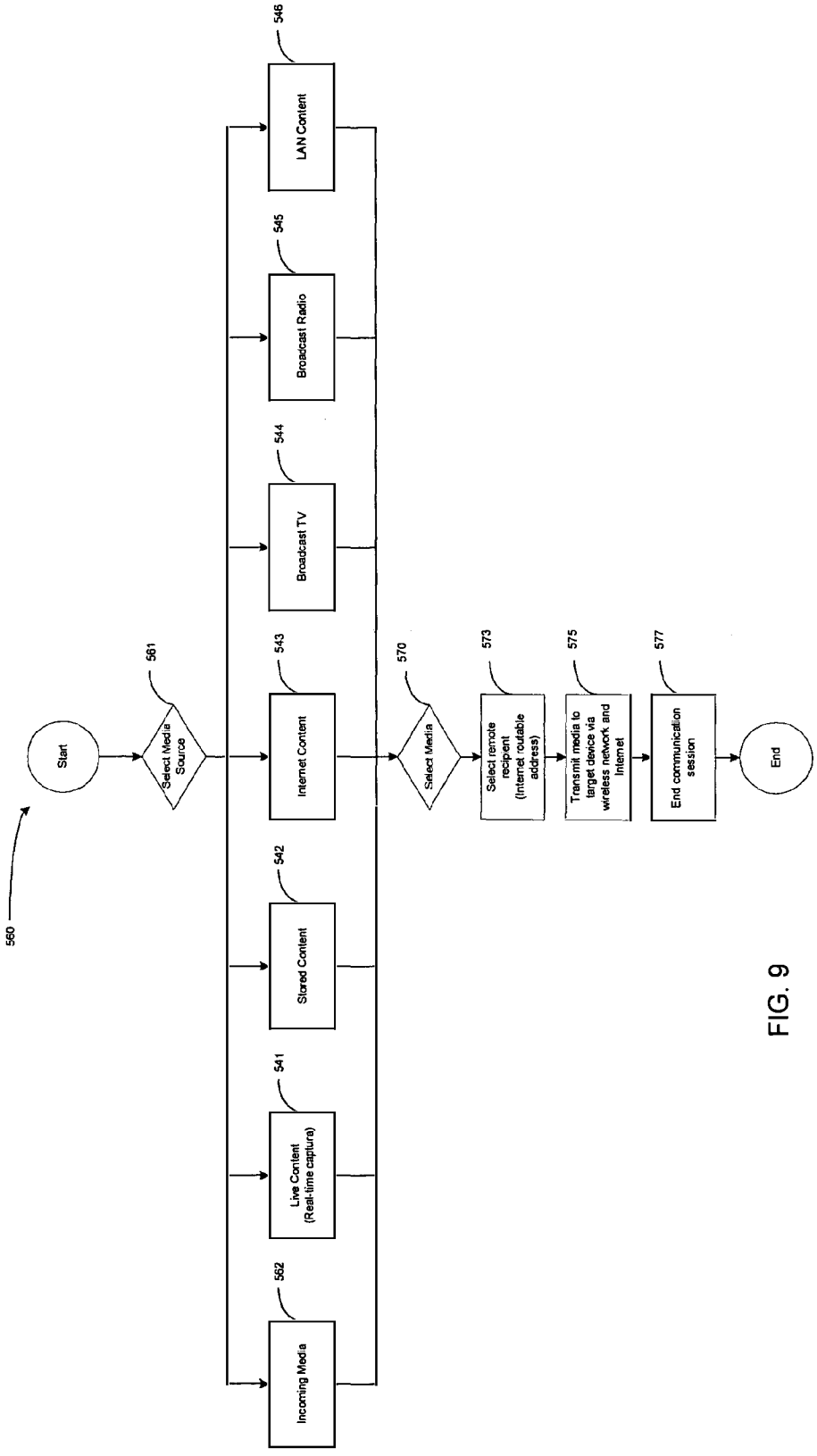


FIG. 9

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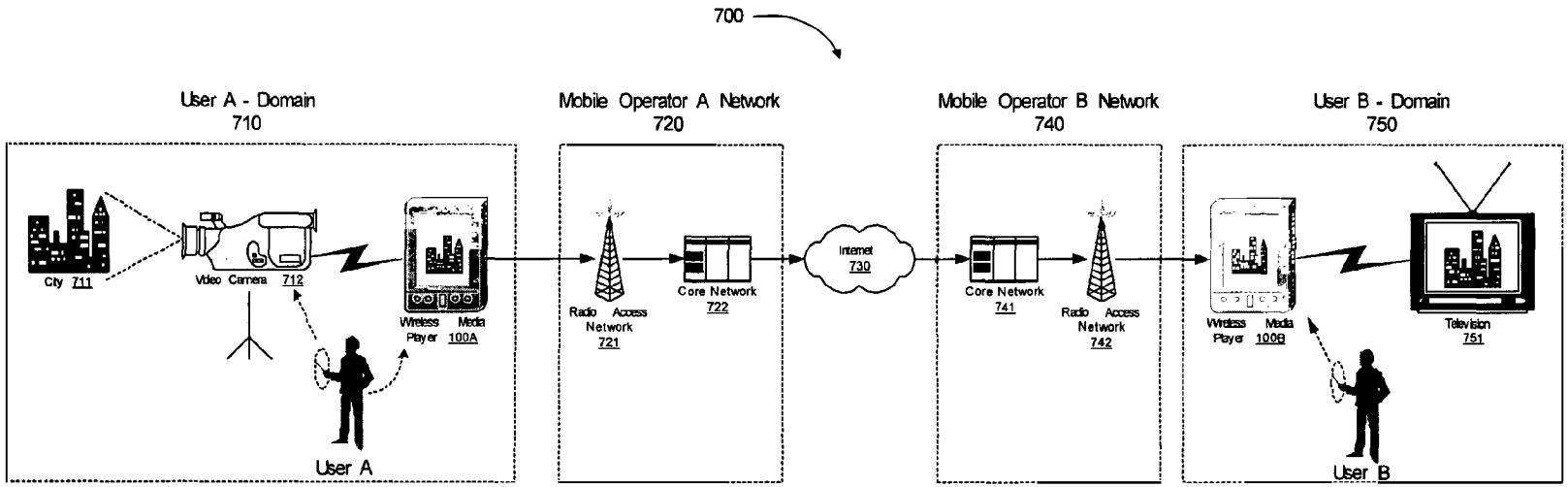

700
User A - Domain
710
Mobile Operator A Network
720
Mobile Operator B Network
740
User B - Domain
750
City 711
Video Camera 712
Wireless Media Player 100A
User A
Radio Access Network 721
Core Network 722
Internet 730
Core Network 741
Radio Access Network 742
Wireless Media Player 100B
Television 751
User B

FIG. 10

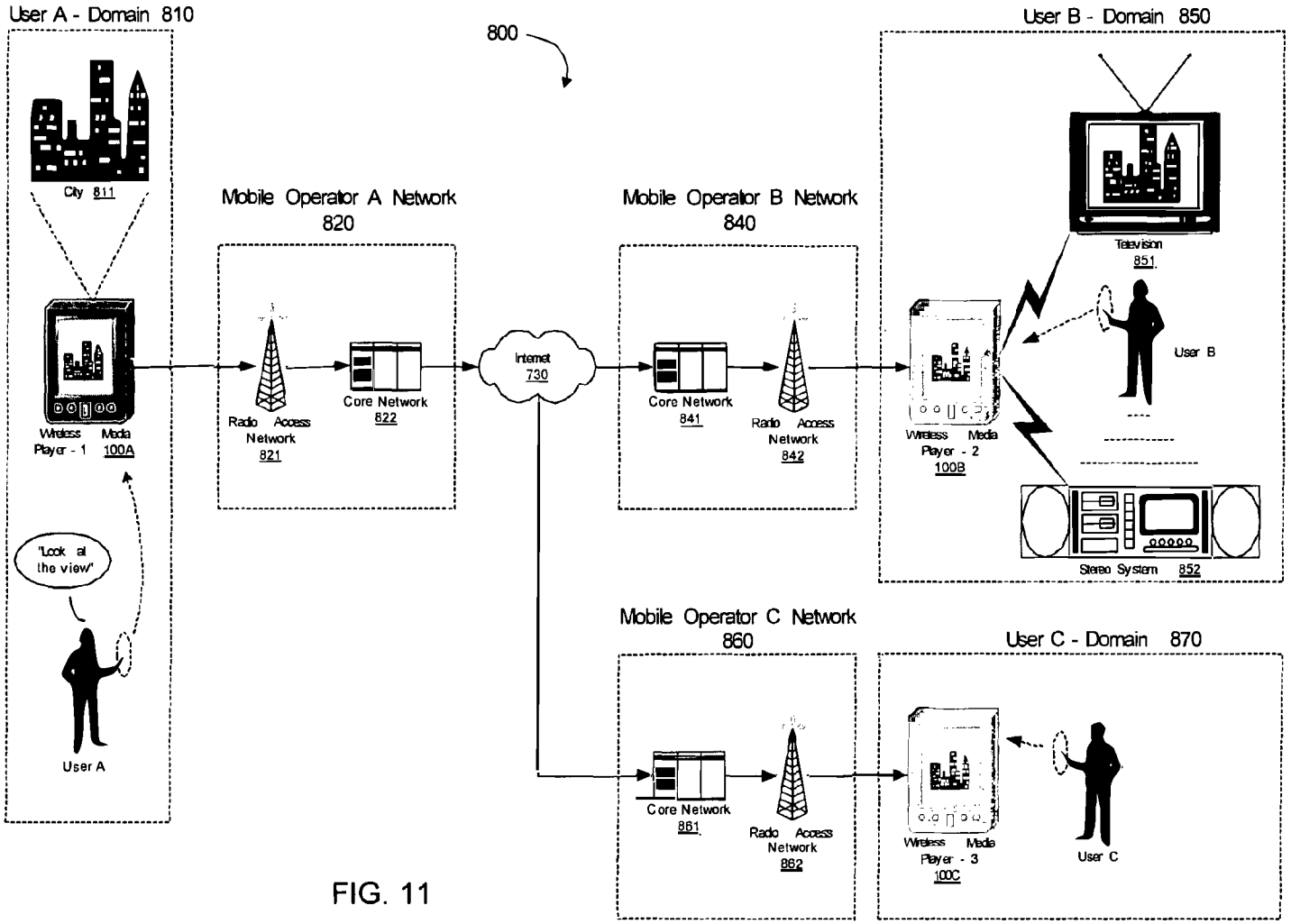

User A - Domain 810
800
User B - Domain 850
City 811
Mobile Operator A Network
820
Mobile Operator B Network
840
Television
851
Wireless Media
Player - 1 100A
Radio Access
Network
821
Core Network
822
Internet
730
Core Network
841
Radio Access
Network
842
User B
Wireless Media
Player - 2
100B
"Look at
the view"
Stereo System 852
Mobile Operator C Network
860
User C - Domain 870
User A
Core Network
861
Radio Access
Network
862
Wireless Media
Player - 3
100C
User C

FIG. 11

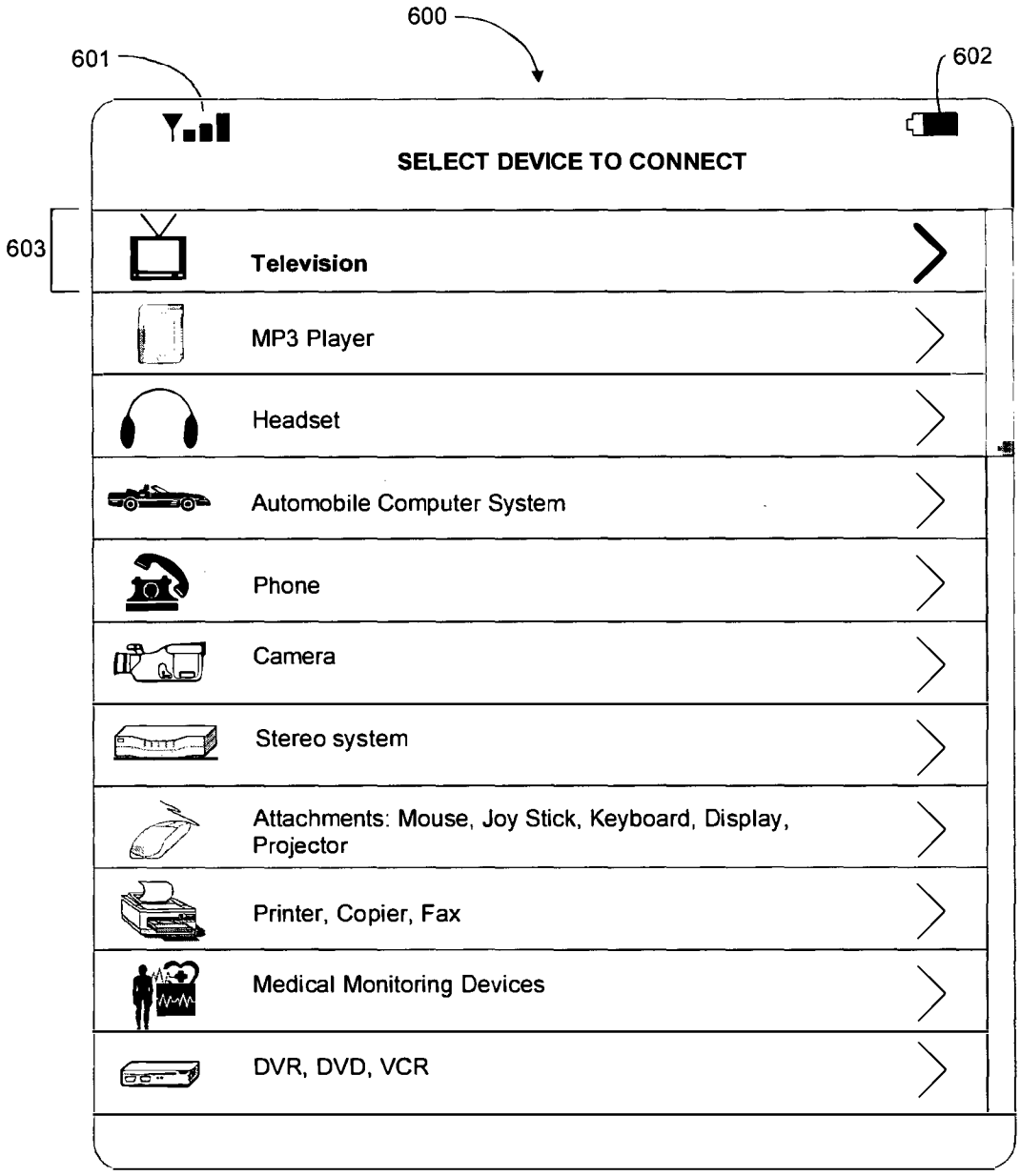

600
601
602
SELECT DEVICE TO CONNECT
603
Television
MP3 Player
Headset
Automobile Computer System
Phone
Camera
Stereo system
Attachments: Mouse, Joy Stick, Keyboard, Display, Projector
Printer, Copier, Fax
Medical Monitoring Devices
DVR, DVD, VCR

FIG. 12

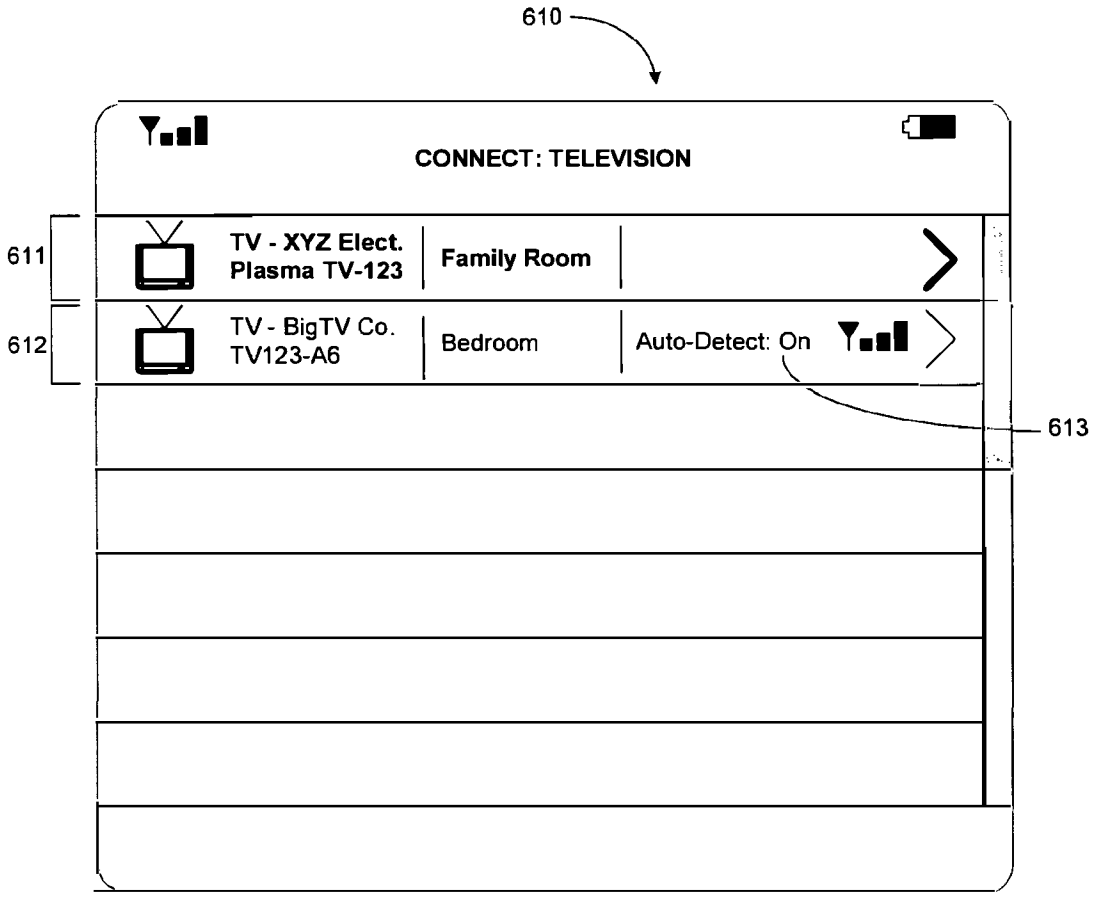

610
CONNECT: TELEVISION
611
TV - XYZ Elect.
Plasma TV-123
Family Room
612
TV - BigTV Co.
TV123-A6
Bedroom
Auto-Detect: On
613

FIG. 13

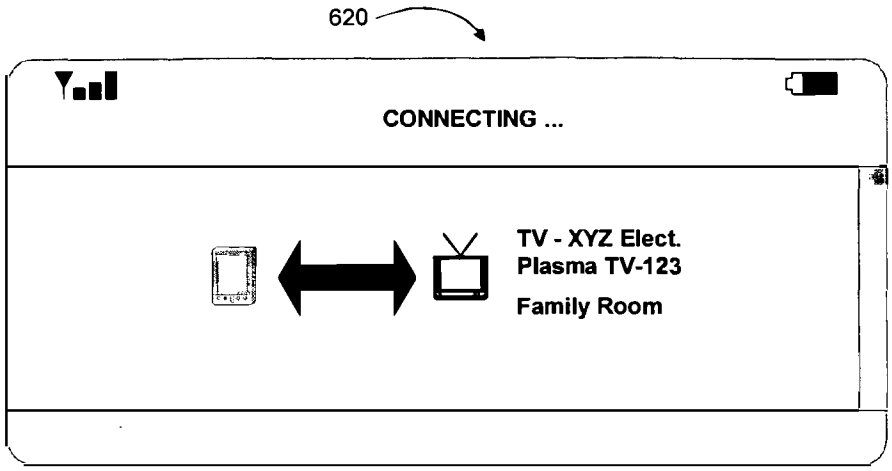

620
CONNECTING ...
TV - XYZ Elect.
Plasma TV-123
Family Room

FIG. 14

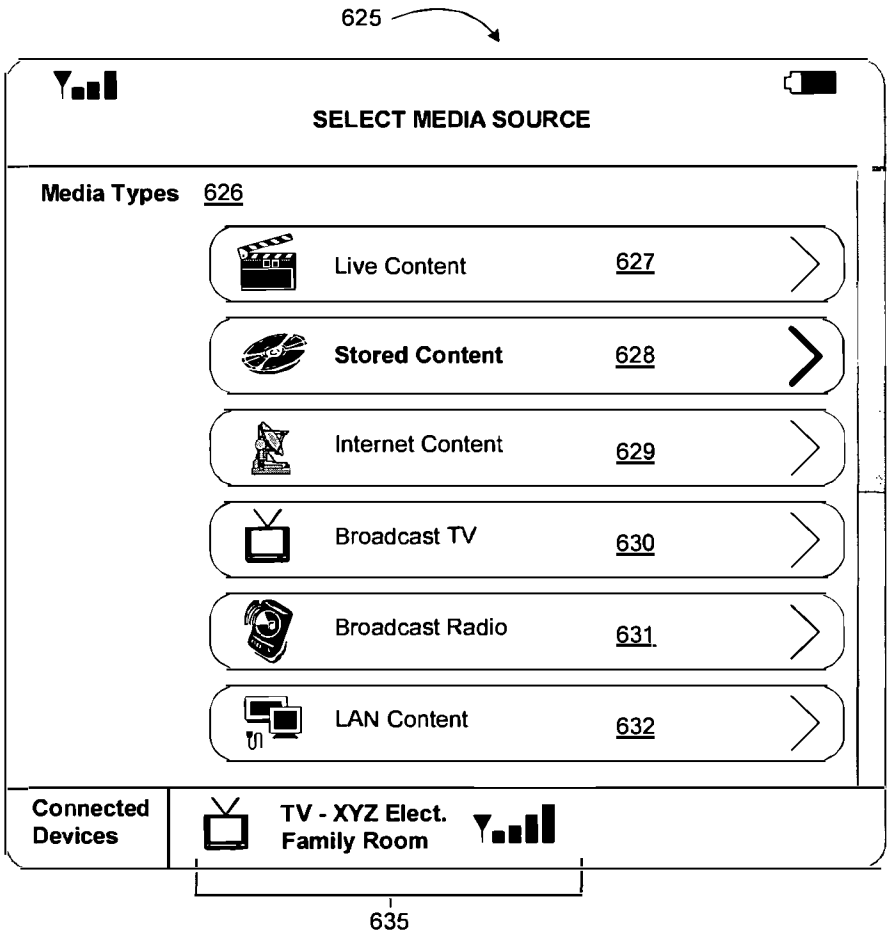

625
SELECT MEDIA SOURCE
Media Types 626
Live Content 627
Stored Content 628
Internet Content 629
Broadcast TV 630
Broadcast Radio 631
LAN Content 632
Connected Devices
TV - XYZ Elect.
Family Room
635

FIG. 15

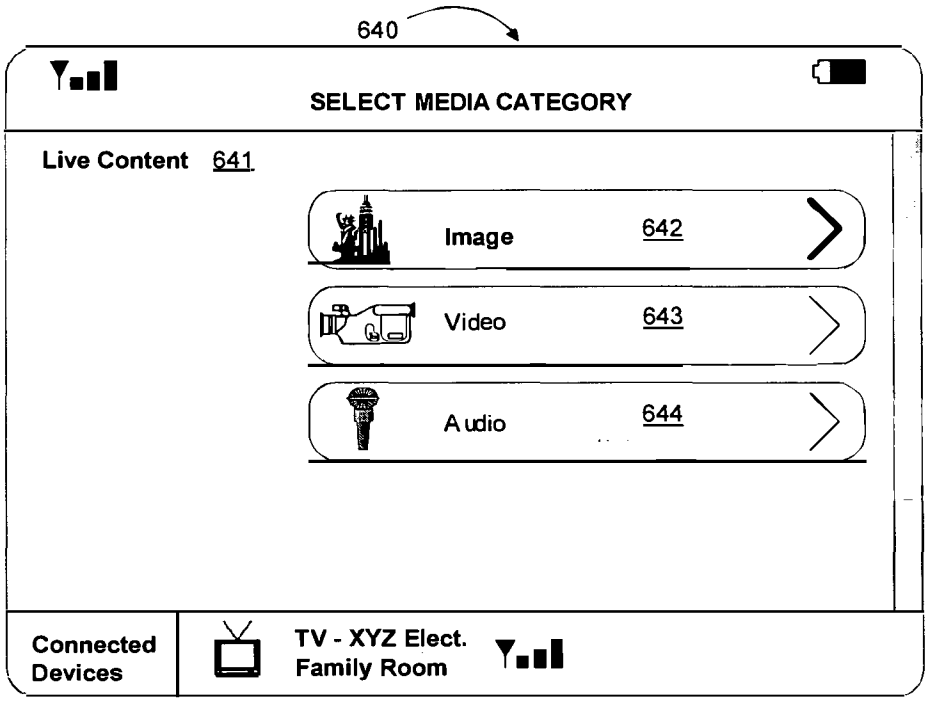

640
SELECT MEDIA CATEGORY
Live Content 641
Image 642
Video 643
Audio 644
Connected Devices
TV - XYZ Elect. Family Room

FIG. 16

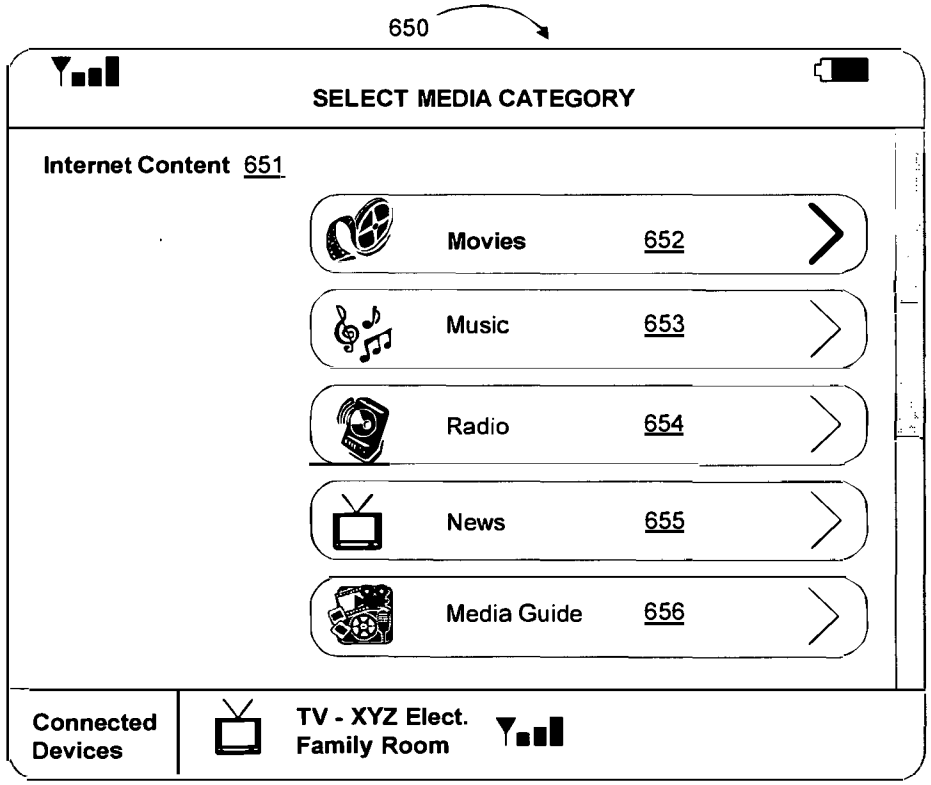

650
SELECT MEDIA CATEGORY
Internet Content 651
Movies 652
Music 653
Radio 654
News 655
Media Guide 656
Connected Devices
TV - XYZ Elect. Family Room

FIG. 17

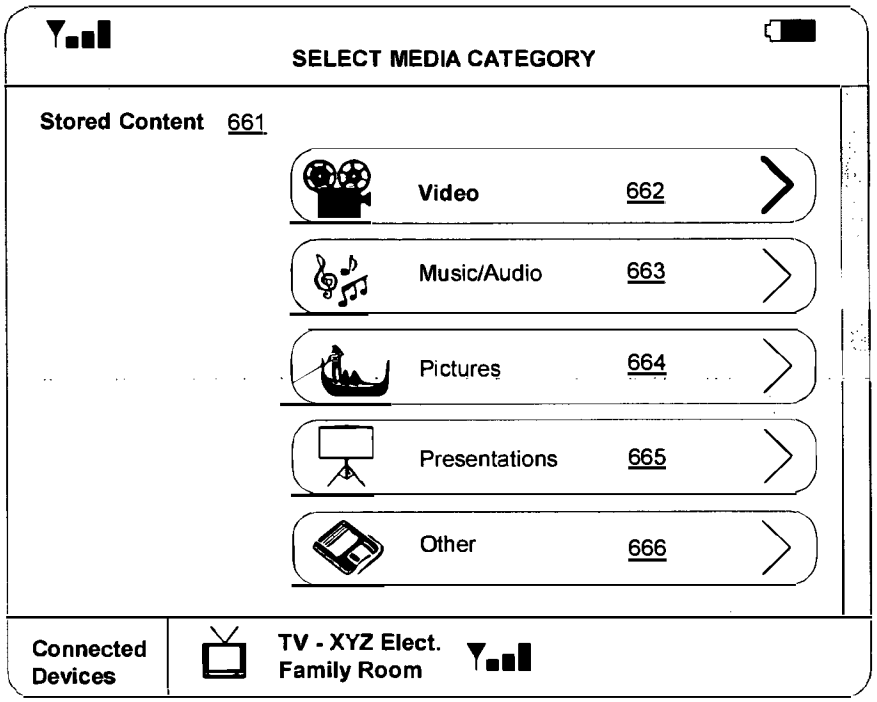

SELECT MEDIA CATEGORY
Stored Content 661
Video 662
Music/Audio 663
Pictures 664
Presentations 665
Other 666
Connected Devices
TV - XYZ Elect. Family Room
660

FIG. 18

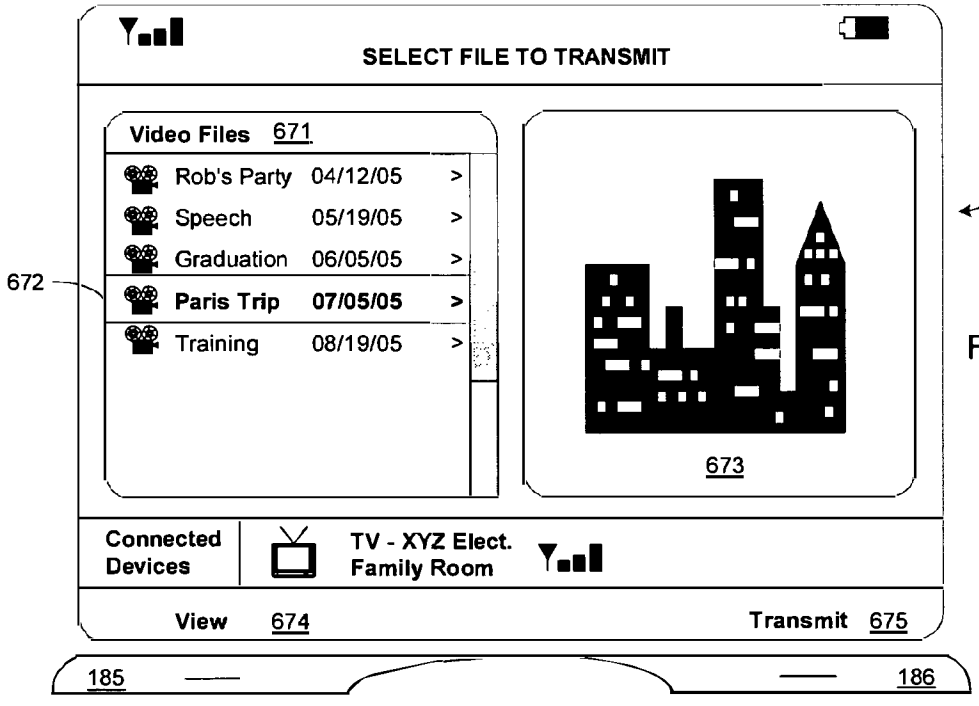

SELECT FILE TO TRANSMIT
Video Files 671
Rob's Party 04/12/05
Speech 05/19/05
Graduation 06/05/05
Paris Trip 07/05/05
Training 08/19/05
672
673
670
Connected Devices
TV - XYZ Elect. Family Room
View 674
Transmit 675
185
186

FIG. 19

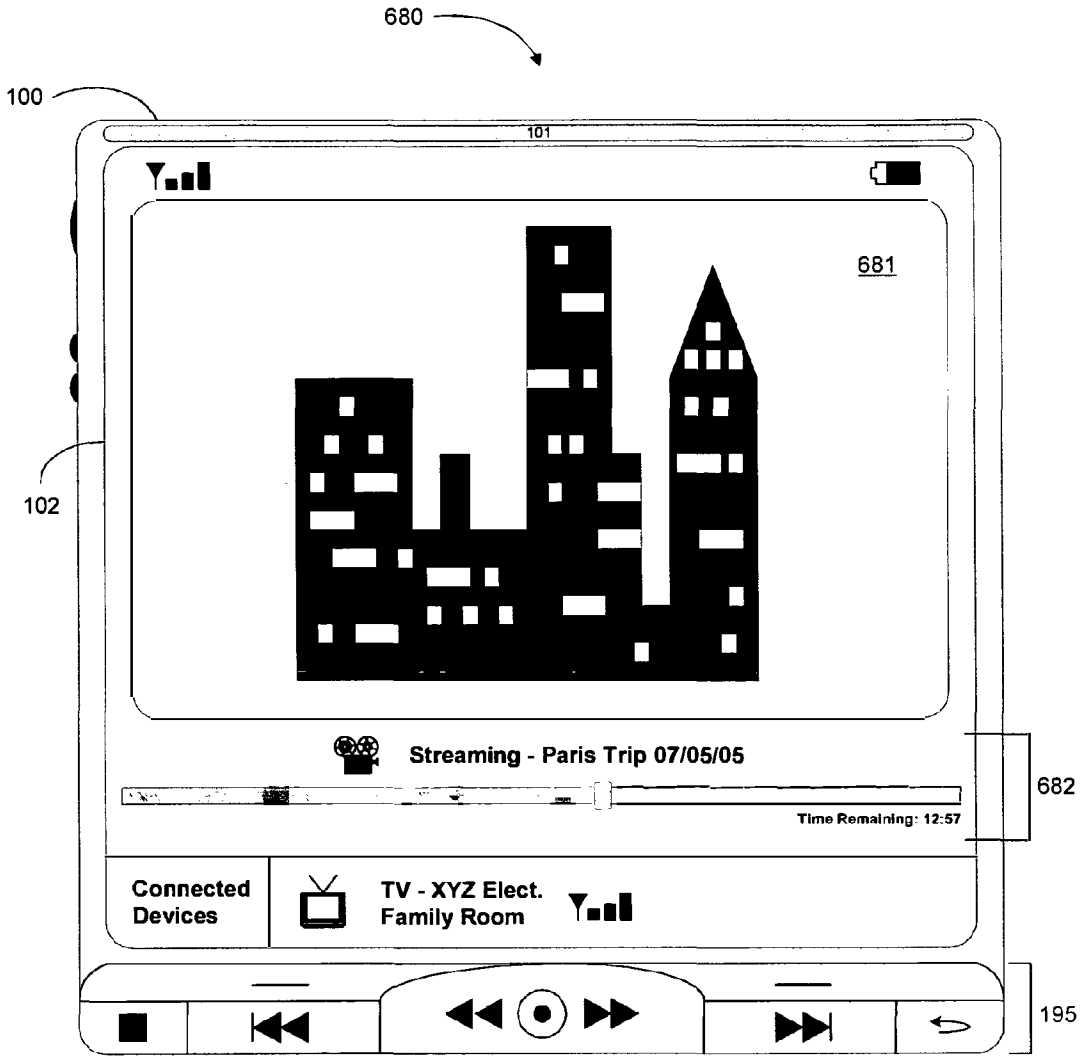

680
100
101
681
102
Streaming - Paris Trip 07/05/05
682
Time Remaining: 12:57
Connected Devices
TV - XYZ Elect. Family Room
195

FIG. 20

WIRELESS MEDIA SYSTEM AND PLAYER AND METHOD OF OPERATION

BACKGROUND

[0001] 1. Field of the Invention

[0002] The present invention relates generally to wireless media players and related systems. More particularly, the present invention relates to a wireless media system and player having improved features for establishing wireless connectivity with various electronic devices.

[0003] 2. Background of the Invention

[0004] The ever increasing speed and the reduced size of electronic components has contributed to the proliferation of consumer electronic devices capable of processing digital media such as audio, video, images, animation, presentations, and other content. Handheld media players include for example, cellular phones, personal digital assistants (PDAs), MP3 players, video players, game players, cameras, radios, televisions, CD/DVD players, Personal Video Recorders (PVRs), etc. Many existing media players are able to store large amounts of digital content, wirelessly connect to the Internet and exchange data over short ranges with other electronic devices.

[0005] It is often desirable to interact on a frequent basis with multiple electronic devices that contain different types of digital media. For example, users might have digital music stored in a pocket-size MP3 player, photos or video stored in a cellular phone, presentations stored in a personal digital assistant (PDA), or a variety of other digital media and applications stored on other portable electronic devices. The standardization of file formats for a variety of media types and the resulting availability of processing support for these media types has allowed users to transfer and share digital information between devices more readily.

[0006] A problem remains in that getting personal electronic devices to communicate with one another in order to transfer or access information is typically a cumbersome and time-consuming process. In some cases, a direct physical connection must be established between two devices prior to and during data transfer or access using, for example, a docking station interface, FireWire connector, Universal Serial Bus (USB) connector, or some type of cable. All of the above connectivity methods impose difficulties in that the devices must be directly attached or tethered to one another while communicating.

[0007] In other instances, connectivity between devices can be established using infra-red capability integrated into the devices. A major short-range infra-red (IR) communications network protocol, defined by the Infra-red Device Association (IrDA), is known as the IrDA standard. Infra-red technology restricts mobility by requiring the devices to be in direct line-of-sight to each other's infra-red port.

[0008] Wireless connectivity offers the most flexible means by which to connect devices and exchange information. Short-range wireless capability using standards such as Bluetooth, 802.11a, 802.11b, 802.11g, Ultra-Wideband (UWB), and others are presently being integrated into media player devices. Wireless technology obviates the need for peripherals such as docking stations, cables, and adapters and provides for mobility within a certain range.

[0009] However, one issue with wireless device-to-device connectivity is that some form of user configuration is typically required. For example, communication settings, software settings, security settings, and other information is typically required to be exchanged between and among the devices which are to communicate. In most cases, user configuration in this manner makes data exchange between the media devices insecure and time consuming. Known over-the-air techniques for configuration between two devices have also proven to be generally insecure.

[0010] As devices such as cellular phones, PDAs, MP3 players, and cameras and other handheld devices capable of storing and playing media become more prevalent and offer more and more features, it is increasingly desirable to provide interconnection between these devices for convenience and to take advantage of the rich feature sets available. Accordingly, there is a need in the art for an improved method, apparatus, and system for wirelessly connecting these devices and discovering each others' communication, media processing, and other capabilities. There is a further need for a solution that allows for the automatic establishment of a secure wireless connection between a source device and a target device and the automatic transmission of certain media assets to the target device. There is also a need for a solution that allows wireless media player devices to connect with and transmit media assets to other devices via the Internet.

SUMMARY OF THE INVENTION

[0011] It is therefore a primary object of the present invention to provide a system and methodology which improves upon prior art systems and methodologies and their related drawbacks as described above.

[0012] It is another object of the present invention to provide an efficient, user-friendly and automated methodology by which two or more devices can establish wireless communication and make each other aware of device capabilities, available media types, communication protocols and other information specific to the devices and the content stored thereon.

[0013] It is another object of the present invention to use Radio Frequency Identification (RFID) to automatically setup and establish a wireless connection between at least one source device and one target device.

[0014] These and other objects of the present invention are obtained through the use of a novel wireless media player system and related methodology. The wireless media system of the present invention includes a handheld media player (source device) capable of transmitting and receiving information over a wireless connection with other electronic devices (target devices). In one embodiment, the media player is able to simultaneously communicate with multiple target devices in close proximity using one or more supported short-range wireless protocols. In another embodiment, the media player may connect with one or more target devices through the Internet or another network, by connecting to a cellular network or a local wireless access point.

[0015] The media player of the present invention preferably includes integrated Radio Frequency Identification (RFID) technology. More specifically, the media player includes an RFID Tag-Reader Module that is capable of

functioning as both an RFID tag and an RFID reader. According to a preferred embodiment, the RFID Tag-Reader Module allows interoperability with all RF 13.56 MHz readers and tags compatible with existing international standards, including ISO 14443 A/B, ISO 15693, FeliCa™, and NFC.

[0016] The RFID Tag-Reader Module also preferably includes an RFID Tag-Reader Controller that manages all communication between the media player's CPU and the RFID Tag-Reader Module's functional components. In addition to the hardware interface between the media player's CPU and the RFID Tag-Reader Controller, an application program interface (API) layer supports communication between applications operating on the terminal and the RFID module. An RFID activation button may be integrated in the media player. This activation button is capable of activating the reader functionality of the RFID Tag-Reader Module when pressed.

[0017] The invention relates, in another embodiment, to a method of using RFID to capture the media processing capability and other parameters of a target device in order to customize certain menu options and software settings in the media player. The method includes for example, recognizing the media processing capability of the target device, and customizing the user interface on the media player so that it only displays media categories and files that could be processed by the target device if transmitted.

[0018] The invention relates, in another embodiment, to a method of using the RFID connector system to quickly establish a wireless communication link with a target device and automatically transmitting certain media assets to it once connectivity has been established. The method includes, in one embodiment, automatically transmitting media which is being viewed/played on the media player at the time of an RFID exchange with the target device.

[0019] The invention relates, in another embodiment, to a method of transmitting media to a target device for viewing or listening, and using controls on the media player, or software operating therein, to alter the viewing/listening experience on the target device. The method includes, for example, transmitting audio or video from the media player to the target device, and using, the "play", "pause", "fast forward", "rewind", "stop", "skip back", and "skip forward" keys on the media player to adjust the viewing/listening experience of the media being transmitted and presented on the target device.

[0020] The invention relates, in another embodiment, to a method of creating, storing, and accessing profiles for target devices that have previously exchanged communication settings, media processing capabilities, and other information with the media player. Profiles can be used to establish automatic connectivity between the media player and one or more target devices that are in proximity via a common short-range wireless communication protocol. The method includes, receiving device information, communication settings, media processing capabilities, and other parameters associated with the target device and using the information to establish a profile for the target device on the media player. The device profile can be enabled at the user's option to automatically detect the target device when within a certain proximity to the media player. At that point wireless connectivity between devices can be automatically established. Alternatively, the profile could also be used to manually establish wireless connectivity with a target device at the user's discretion.

[0021] The invention relates, in another embodiment, to a method of selecting one or more Internet-connected target devices for the delivery of certain media assets. The method includes, selecting a media source, selecting specific media assets, selecting an address for the target device, resolving the address to an Internet routable address, and establishing a peer-to-peer communication session with the target device over the Internet.

[0022] These and other advantages and features of the present invention are described herein with specificity so as to make the present invention understandable to one of ordinary skill in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The present invention is illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which like reference numerals refer to similar elements and in which:

[0024] **FIG. 1** is a functional representation of media player terminal interfacing with a wireless headphone unit, in accordance with one embodiment of the present invention.

[0025] **FIG. 2A** is a front-side perspective view of a media player terminal, in accordance with one embodiment of the present invention.

[0026] **FIG. 2B** is a representation of the keypad interface of a media player terminal, in accordance with another embodiment of the present invention.

[0027] **FIG. 2C** is a front-side perspective view of a media player terminal with an alpha-numeric keypad, in accordance with one embodiment of the present invention.

[0028] **FIG. 3A** is a left-side perspective view of a media player terminal, in accordance with one embodiment of the present invention.

[0029] **FIG. 3B** is a back-side perspective view of a media player terminal, in accordance with one embodiment of the present invention.

[0030] **FIG. 3C** is a top-side perspective view of a media player terminal, in accordance with one embodiment of the present invention.

[0031] **FIG. 3D** is a bottom-side perspective view of a media player terminal, in accordance with one embodiment of the present invention.

[0032] **FIG. 4A** depicts a functional diagram illustrating one embodiment of a RFID tag-reader module according to the invention.

[0033] **FIG. 4B** depicts a functional diagram illustrating an alternative embodiment of a RFID tag-reader module according to the invention.

[0034] **FIG. 5** is a functional diagram of a media player terminal interfacing with a wireless headphone unit, in accordance with one embodiment of the present invention.

[0035] **FIG. 6** is a functional diagram of two media player terminals wirelessly interfacing with one another and their

respective headphone units, in accordance with one embodiment of the present invention.

[0036] **FIG. 7** is a table depicting the message components and example content of a RFID message exchange between two electronic devices, in accordance with one embodiment of the present invention.

[0037] **FIG. 8A** is a flow diagram of a wireless transmission method using RFID setup, in accordance with one embodiment of the present invention.

[0038] **FIG. 8B** is a flow diagram of an alternative wireless transmission method using RFID setup, according to the invention.

[0039] **FIG. 9** is a flow diagram of a wireless transmission method via a wireless network and the Internet, in accordance with one embodiment of the present invention.

[0040] **FIG. 10** is a functional diagram of a media player terminal capturing a video feed from an external video recording device, and transmitting the same video content via a cellular network and the Internet to another media player terminal, which further transmits the content to a television, in accordance with one embodiment of the present invention.

[0041] **FIG. 11** is a functional diagram of a media player terminal with an embedded video recorder, filming a city scene, and transmitting the video content via a cellular network and the Internet to two separate media player terminals connected to different mobile operator networks, in accordance with one embodiment of the present invention.

[0042] **FIG. 12** is an illustration of an exemplary user interface screen depicting device categories, in accordance with one embodiment of the present invention.

[0043] **FIG. 13** is an illustration of an exemplary user interface screen depicting one specific device profile category in accordance with one embodiment of the present invention.

[0044] **FIG. 14** is an illustration of an exemplary user interface screen depicting messaging that indicates that the media player terminal is wirelessly connecting to a target device, in accordance with one embodiment of the present invention.

[0045] **FIG. 15** is an illustration of an exemplary user interface screen depicting options for Media Sources that can be selected in order to select specific media assets for transmission to a target device, in accordance with one embodiment of the present invention.

[0046] **FIG. 16** is an illustration of an exemplary user interface screen depicting Live Content options that can be selected for transmission to a target device, in accordance with one embodiment of the present invention.

[0047] **FIG. 17** is an illustration of an exemplary user interface screen depicting Internet Content options from which media assets can be selected for transmission to a target device, in accordance with one embodiment of the present invention.

[0048] **FIG. 18** is an illustration of an exemplary user interface screen depicting Stored Content options from which media assets can be selected for transmission to a target device, in accordance with one embodiment of the present invention.

[0049] **FIG. 19** is an illustration of an exemplary user interface screen depicting Video Files that can be selected for transmission to a target device, in accordance with one embodiment of the present invention.

[0050] **FIG. 20 a** front-side perspective view of a media player terminal with an exemplary user interface screen depicting a video file being transmitted to a target device, in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0051] The present invention for a media player system, apparatus, and method is now described in specific terms sufficient to teach one of skill in the practice the invention herein. In the description that follows, numerous specific details are set forth by way of example for the purposes of explanation and in furtherance of teaching one of skill in the art to practice the invention. It will, however, be understood that the invention is not limited to the specific embodiments disclosed and discussed herein and that the invention can be practiced without such specific details and/or substitutes therefor. The present invention is limited only by the appended claims and may include various other embodiments which are not particularly described herein but which remain within the scope and spirit of the present invention.

[0052] One important feature of the present invention is the use of RFID technology to establish wireless communication between a diverse set of devices. The methods by which RFID tags and RFID readers interact and communicate are well established and documented. The rising use of RFID technology, especially 13.56 MHz technology, for electronic payments and other applications has promoted standardization efforts to establish a broadly applicable communications framework between RFID tags and RFID readers.

[0053] One such standard was established by European Computer Manufacturers Association (ECMA) International based in Geneva, Switzerland, and is known as the Near Field Communication standard (ECMA-340). The Standard defines communication modes for Near Field Communication Interface and Protocol (NFCIP-1) for use with RFID tags and readers. It also defines both the Active and the Passive communication modes of Near Field Communication Interface and Protocol (NFCIP-1) to realize a communication network using Near Field Communication devices for networked products and also for consumer equipment.

[0054] This Standard specifies, in particular, modulation schemes, codings, transfer speeds, and frame format of the RF interface, as well as initialization schemes and conditions required for data collision control during initialization. Furthermore, this Standard defines a transport protocol including protocol activation and data exchange methods. NFC is also compatible with the broadly established contactless smart card infrastructure based on ISO 14443 A, as well as the Sony FeliCa™ protocol. This allows electronic devices with integrated NFC technology to perform multiple functions such as acting as an electronic key or wallet.

[0055] NFC can be used as a setup tool for quickly establishing wireless communication between two devices,

acting as a virtual connector. Bringing two electronic devices with NFC technology into close vicinity allows the devices to automatically exchange communication settings and other information in complete security via RF signaling. This exchange of information via short-range RF allows the devices to quickly configure and establish a connection via Bluetooth or other wireless protocols supported by both devices. As discussed below, in one embodiment of the present invention, NFC may be used in connection with the teachings presented herein for establishing and maintaining communication between and among a wide variety of electronic devices.

[0056] A general discussion of the present invention is now provided and is thereafter followed by a detailed description of each of the components and functions of the invention according to specific preferred embodiments.

[0057] **FIG. 1** is a functional representation of the components in a media player **100** with cellular phone capability, in accordance with one embodiment of the present invention. The term "media player" generally refers to electronic devices that are capable of processing media such as audio, video, images, presentations, animation, and Internet content, as for example, cellular phones, personal digital assistants (PDAs), music players, game players, video players, cameras, and the like. In some cases, these media players are single-functionality devices (e.g. a media player dedicated to playing digital video) and in other cases these media players are multi-functional devices (e.g. a media player that is capable of playing music, displaying video, presenting images, and the like). In either case, these devices are generally portable so as to allow a user to, for example, listen to music, play video, take pictures, and engage in multi-player gaming without the need for a wired connection to some other electronic device. It should not be presumed for purposes of the following description that the term "media player" necessarily refers to a device which is capable of playing a particular media.

[0058] In the illustrated representation of **FIG. 1**, media player **100** is a pocket sized device that allows a user to process and store a large collection of digital audio/music, video, images, presentations, animation, Internet content, and other types of media. Media player **100** is capable of processing these media types using functionality integrated in its resident operating system. In an alternate embodiment, media processing is handled by a separate application which operates on the device **100**, such as media manager application **120**. The media manager application **120** allows incoming or resident media to be "played", "viewed" or otherwise manipulated on the media player **100** and also allows for the transmission of media assets to other devices in proximity via short-range RF or via the Internet. The media manager application **120** also performs other media processing functions, as described below, such as dynamically converting media file formats, providing control functionality for adjusting the viewing/listening attributes on the media player **100** or a target device, organizing media assets into categories so they can be easily located, and providing a search engine for locating specific media assets using a variety of attributes. As mentioned above, the media manager functionality can be integrated with the operating system operating on the device **100** while still remaining within the scope and spirit of the invention. Media player **100** may also include additional functionality for placing phone calls, video teleconferencing, recording audio/video, taking pictures, storing a calendar, establishing a phone list/directory, storing and executing multi-player network games, text/media messaging, accessing/browsing the Internet, facilitating computations using a calculator, transacting at a point-of-sale location using a digital wallet application and the RFID capability of the player **100**, completing e-commerce transactions over-the-air, and the like. Media player **100** also provides the user with optional password security in order to protect confidential information stored in the device. In another embodiment, an integrated biometric fingerprint reader provides enhanced security for protecting the media player **100** against unauthorized use.

[0059] Media player **100** includes a casing that encloses various internal electrical components (including integrated circuit chips and other circuitry) that provide computing operations for the media player **100**. In addition, the casing may also define the exterior shape, form, and color of the media player. The integrated circuit chips and other circuitry contained within the housing may include a microprocessor (e.g., CPU **109**), memory (e.g., ROM, RAM, flash) **106**, a rechargeable power supply **103** (e.g., rechargeable lithium polymer battery), a circuit board, a hard drive **112**, and various input/output (I/O) support circuitry **116**. The input/output (I/O) assembly **116** allows Media Player **100** to connect to a docking station, or connect to other devices/peripherals via a FireWire port, USB port, PS/2 port, serial port, parallel port, network interface port, infrared (IR), audio jack, video jack, and the like. The I/O assembly **116** is generically shown in **FIG. 1** since the media player **100** could employ a wide variety of connector/port options for interfacing with external hardware. Multiple connector/port types could be integrated into media player **100**.

[0060] As shown in **FIG. 1**, media player **100** includes a microprocessor **109** configured to execute instructions and to carry out various operations. In most instances, microprocessor **109** executes instructions under the control of an operating system or other software (e.g., media manager). The processing function in media player **100** can also be performed by dual-processor chips or multi-processor chips for higher performance.

[0061] The electrical components contained within media player **100** may also include components for inputting or outputting audio such as a speaker **101**, microphone **115**, and an amplifier and a digital signal processor (DSP) **110**. Media player **100** may further comprise additional components for capturing images such as camera **104** (e.g., charge coupled device (CCD) or complimentary oxide semiconductor (CMOS)) or optics (e.g. lenses, splitters, filters). Similarly, media player **100** may also include components for sending and receiving media (e.g. antenna **117**, and transceivers **105** and **108**, etc.). (**00601** As shown in **FIG. 1**, media player **100** includes a display screen and related circuitry **102** for displaying a graphical user interface that allows the user to interact with the device. The display screen **102** also allows a user to visually see data input into terminal via keypad **111** and other information (e.g., video, images, text, objects). By way of example, the display screen **102** may be a liquid crystal display (LCD). In one particular embodiment, the display screen is a high-resolution color display that provides visibility in daylight as well as low-light conditions. The display screen **102** supports "touch-screen" data input using a stylus or other object.

[0062] A short-range transceiver **108** and antenna **117** provide wireless connectivity with external devices or access points using supported communications protocols (e.g., Bluetooth, 802.11 a/b/g/n, Ultra Wideband, Wireless USB, 802.15.3/WiMedia, Wireless 1394, Wireless Fire Wire, WiMax, and 802.1 5.4/ZigBee). The short-range transceiver **108** and antenna **117** system also support broadcast standards such as AM, FM, UHF, VHF, and HDTV. Support for these broadcast standards allows the media player **100** to receive and broadcast radio and television signals over a short-range.

[0063] The short-range transceiver **108** and antenna system **117** are specifically designed to support the widest array of communication protocols and broadcast standards in order to allow the media player **100** to establish communication with a multiplicity of devices now available or which later become available. The short-range transceiver **108**, antenna system **117**, and other components within media player **100**, are also designed to allow for the simultaneous communication with multiple devices, and using multiple communication standards and broadcast standards.

[0064] The antenna used in short-range communication is not the same antenna used in communication with a wide area cellular network, and as such are represented in **FIG. 1** separately, but are enclosed in the same antenna assembly **117**. As such, generic references to antenna **117** may refer herein to the short-range transceiver antenna or the network transceiver antenna. The antenna assembly **117** is represented in **FIG. 1** and may extend out from the main body of the media player **100**. However, in a preferred embodiment the actual antenna system **117** in media player **100** is enclosed within the casing of the media player **100**.

[0065] A receiver for satellite-based Digital Audio Radio Services (DARS) could also be integrated in the media player **100**. The receiver allows the device **100** to receive programming in the "S" band (2.3 GHz) spectrum, broadcast by companies such as XM and Sirius.

[0066] Short-range transceiver **108** interacts with a CPU **109** for implementing short-range communications protocols and processing messages exchanged between other electronic devices and the media player **100**. CPU **109** is linked to a volatile or dynamic random access memory (DRAM) **106**. CPU **109** executes programs stored in a non-volatile or read only memory **106** and provides instructions for managing and controlling the operating of media player **100**. CPU **109** is also connected to network transceiver **105** for interacting with a cellular network, such as a Global System Mobile (GSM) network and the like via antenna **117**. Media player **100** is able to access the Internet through the cellular network, or through a wireless access point using short range transceiver **108** and a supported communications protocol (e.g., WiFi).

[0067] In one embodiment, media player **100** functions as a wireless terminal that has one or more E.164 phone numbers, Uniform Resource Identifiers (URIs), or other types of unique addresses that can be resolved over the Internet associated with it. Media player **100** may also have a built in TCP/IP stack that supports communication over Internet Protocol (IP)-based networks. Preferably, media player **100** supports both the IPv4 and IPv6 network addressing schemes.

[0068] In accordance with the invention, media player **100** includes a Session Initiation Protocol (SIP) application stack for multimedia communication over the Internet. Media player **100** preferably also supports other application layer protocols such as H.323, Real-time Transport Protocol (RTP), HTTP, SMTP, FTP, DNS, and DHCP.

[0069] In accordance with a preferred embodiment of the invention, media player **100** is fully compliant with 3GPP and 3GPP2 standards. 3GPP and 3GPP2 are worldwide standards for the creation, delivery and playback of multimedia over 3rd generation, high-speed wireless networks. Defined by the 3rd Generation Partnership Project and 3rd Generation Partnership Project 2 respectively, these standards seek to provide uniform delivery of rich multimedia over newly evolved, broadband mobile networks (3rd generation networks) to the latest multimedia-enabled devices, such as media player **100**.

[0070] In accordance with the invention, an RFID Tag-Reader Module **113** is integrated into media player **100**. RFID Tag-Reader Module **113** is provided so that, among other things, media player **100** can rapidly exchange information with an electronic device that is in close proximity and which also has integrated RFID technology. Information exchanged between media player **100** and a target device via RFID can allow for the fast and automatic set-up of wireless connectivity between media player **100** and various target devices. As previously stated, RFID Tag-Reader Module **113** can also be used in connection with other applications available through media player **100** such as electronic payments at the point-of-sale and secure key access to buildings, cars, etc.

[0071] RFID Tag-Reader Module **113** is connected to CPU **109**. RFID Tag-Reader Module **113** comprises a radio frequency ID transponder which conforms to the principals of RFID technology and known standards. The RFID Tag-Reader Module **113** also includes a reader component used for transmitting interrogation signals via its antenna to an external electronic device's RFID tag when in close proximity, and receiving a response signal from the external device's RFID tag. RFID Tag-Reader Module **113** uses media player's **100** internal power supply **103** as a power source for transmitting interrogation signals to a target device.

[0072] In accordance with one embodiment of the invention, media player **100** has an integrated RFID activation button **118** which is visible on the exterior of the device. RFID activation button **118** is shown separately from the generic keypad components **111** shown in **FIG. 1** in order to highlight its specific function versus other buttons/controls which are incorporated in media player **100**. RFID activation button **118**, like all other keypad **111** components, interfaces with CPU **109**. When RFID activation button **118** is pressed, CPU **109** signals RFID Tag-Reader Module **113** to disable its RFID tag component and activate its reader component in order to transmit interrogation signals to one or more target devices. In one embodiment, this condition is maintained for as long as RFID activation button **118** remains depressed. In an alternative embodiment, RFID activation button **118** can be pressed and immediately released, and the condition of the disabled RFID tag and activated reader is maintained until such time the reader sends interrogation signals and receives a response from a target device. Upon receiving a response, RFID Tag-Reader Module **113** returns to its normal state whereby the RFID tag

component is active (and awaiting an interrogation signal), and the RFID reader component is disabled. Yet another possible embodiment for the function of RFID activation button **118** is wherein the reader function is activated and the tag function is disabled for some predetermined length of time following the pressing of button **118** after which time, RFID Tag-Reader Module **113** reverts to its normal operation mode.

[0073] According to one important aspect of the present invention, RFID Tag-Reader Module **113** and RFID activation button **118** can be used together, with the media manager application **120** operating on media player **100** as a virtual connector system for automatic setup and establishment of a wireless connection with one or more target devices, and transmission of certain media assets.

[0074] While media player **100** can also connect headphones and speakers via I/O assembly **116**, media player is particularly well suited to interface with wireless sound output devices such as wireless headphone unit **152** in **FIG. 1**. Media player **100** can wirelessly transmit audio signals via short range transceiver **108** to one or more devices that support a common communications protocol.

[0075] **FIG. 2A** is a front-side perspective view of media player **100** in accordance with one embodiment of the present invention. Media player **100** has a large high-resolution color display screen **102** which takes up substantially most of the surface space on the front-side of media player **100**.

[0076] According to one embodiment, on the left-side of media player **100**, are placed a set of integrated buttons. For example, RFID activation button **118** (discussed above) is shown at the top left. Below it are two volume control buttons **183** and **184** for adjusting audio output from the player's integrated speaker system **101** or an external audio output device connected to media player **100**. The top volume control button **183** is for increasing sound volume, and the bottom button **184** is for lowering the sound volume.

[0077] Multiple speakers **101** integrated in player **100** offer a rich surround sound capability. In one embodiment, speakers **101** are situated at the top of the media player terminal, and provide audio output through an opening that extends from the top left of the unit to the top right. Digital audio processor **110** in media player **100** supports Dolby™ and THX™ audio technologies.

[0078] Also present at the bottom of media player **100** is the keypad interface **195** used to interact with the operating system and software loaded in media player **100**. Keypad interface **195** buttons are configured to provide control for making selections or issuing commands associated with operating the media player **100**. Contained in the keypad interface **195** at the bottom are two buttons **185** & **186** used for selecting options that appear directly above the respective buttons in display screen **102** and graphical user interface (known sometimes as "soft keys"). At the center of keypad interface **195** is a miniature joy stick **190**. Joy stick **190** can be pressed down as a button and used as a way to make menu selections in connection with the graphical user interface.

[0079] Joy stick **190** may also function as a play/pause button when used in the same manner with the media manager application **120**. Joy stick **190** can also be used to navigate menus by leaning the stick upwards, downwards, to the right, or left in order to make certain selections. Also contained in the key pad interface **195** is a "stop" button **187**, which stops the playback of the current media asset. The "skip back" button **188** returns to the beginning of the current media asset, or if at the beginning, returns to the beginning of the previous media asset. The "rewind" button **189** rewinds the current media asset; when the rewind button is released, the media manager application **120** begins playing the current media asset. The "fast forward" button **191** advances forward through the current media asset. When the "fast forward" button is released, the media manager application **120** begins playing the current media asset. The "skip forward" button **192** begins playing the beginning of the next media asset in the list. The "back" or "previous screen" button **193** takes the user to the screen that was previously displayed. The "rewind" button **189** can also be used to delete characters that may have been input to the device when in text mode. Pressing the "fast forward" button **191** or leaning the joy stick **190** to the right can also be used to create a "space" when in text mode. The keypad interface **195** can be used to control the viewing of audio, video, images, presentations, or other media assets on the media player terminal **100**.

[0080] The above description with respect to particular layouts of the device and the location and presence of various buttons and control elements is merely exemplary. It will be readily understood that a virtually limitless number of alternatives may be used while still remaining within the scope and spirit of the present invention. For example, the position of display screen **102** and the key pad interface **195** may be widely varied. The shape of display screen **102** may also be varied. The shape of the buttons represented may also be varied. In addition to the above, there could be other buttons or features which provide additional control functions. For example, media player **100** may include additional switches, keys, trackballs, touch pads, touch screens, and the like.

[0081] **FIG. 2B** is a representation of an alternate keypad interface **195** design for media player **100** in accordance with one embodiment of the present invention. In this embodiment, the play/pause functionality still resides with joy stick **190** at the center of key pad interface **195**. Joy stick **190** can be pressed as a button and used as a way to make menu selections, and also function as a play/pause key when used in this manner. Leaning joy stick **190** to the right can provide a "fast forward" capability when manipulating media assets like audio or video files. Similarly, leaning joy stick **190** to the left can provide a "rewind" capability when manipulating audio or video assets. Other buttons represented in **FIG. 2B** have similar functionality to buttons contained in **FIG. 2A**.

[0082] **FIG. 2C** is a front-side perspective view of a media player **100** with an alpha-numeric telephone keypad **200** in accordance with one embodiment of the present invention. Media player **100** has an integrated key pad interface **195** as previously represented in **FIG. 2B** for controlling media assets while using the media manager application, and providing other software navigation functionality. Key pad interface **195** represented in **FIG. 2C** could, in an alternate embodiment, be the key pad interface **195** that is represented in **FIG. 2A**. Below key pad interface **195** in **FIG. 2C** is an alpha-numeric telephone keypad **200** similar to ones found

on most cellular and fixed line telephones. Incorporating alpha-numeric key pad **200** into another embodiment of the device would require the use of a smaller display screen **102** in order make media player **100** illustrated in **FIG. 2C** a pocket-size device. In another embodiment, alpha-numeric key pad **200** could be replaced with a QWERTY keyboard interface similar to those found on Blackberry™ type devices made by Research In Motion (RIM). Regardless of whether media player **100** has a physical alpha-numeric keypad or QWERTY keyboard, the device preferably includes a software-based QWERTY keyboard which is displayed in the graphical user interface and allows data input using joy stick **190** or the touch-screen display **102**.

[0083] **FIG. 3A** is a left-side perspective view of media player **100**, in accordance with another embodiment of the present invention. At the top is RFID activation button **211**. Below it are two volume control buttons **212** and **213**. The button with the "plus sign"**212** is for increasing sound volume, and the button with the "minus sign"**213** is for lowering the volume of sound output.

[0084] **FIG. 3B** is a back-side perspective view of media player **100**, in accordance with another embodiment of the present invention. At the top of the back-side is an RFID "hot spot"**221**. RFID "hot spot"**221** is a marked area representing the location of RFID Tag-Reader Module antenna **114**. RFID "hot spot"**221** is marked to allow a user to know which area of the media player **100** to position over an RFID "hot spot" on a target device to which wireless connectivity is desired.

[0085] In one embodiment, RFID "hot spot" area **221** appears in a different color than the rest of the terminal casing, and is labeled with a symbol that users recognize as being the location of the RFID Tag-Reader Module antenna **114**. Also situated on the back-side of media player **100** may be camera lens **223** and flash **225** for video capture and digital photography. Preferably, the camera lens and related apparatus in the media player **100** is capable of supporting very high-resolution imaging.

[0086] **FIG. 3C** is a top-side perspective view of media player **100**, in accordance with another embodiment of the present invention. RFID "hot spot"**221** previously described could be positioned on any side and in any area of media player **100**. **FIG. 3C** shows RFID "Hot Spot"**221** being on the top-side of media player **100**. Next to RFID "Hot Spot"**221** is a power button **231** for switching the power to the media player **100**"on" or "off".

[0087] **FIG. 3D** is a bottom-side perspective view of the media player **100**, in accordance with another embodiment of the present invention. Located on the bottom of the device is a microphone **245** for audio input. Also situated on the bottom of the terminal is a data and power port **248**. The data port may use any connector/port interface previously mentioned for interfacing with other electronic devices. Also included is a power port that receives a power plug or car charger plug for delivering power and charging the media player's internal battery **103**.

[0088] **FIG. 4A** is a functional diagram illustrating one embodiment of a RFID Tag-Reader Module **113** according to the invention. It is assumed that the RFID Tag-Reader Module **113** as embodied in **FIG. 4A** is attached to or embedded within media player **100**.

[0089] RFID Tag-Reader Module **113** is capable of functioning as both an RFID tag and an RFID reader. In accordance with the invention, RFID Tag-Reader Module **113** allows interoperability with RF 13.56 MHz readers and tags compatible with existing international standards, including ISO 14443 A/B, ISO 15693, FeliCa™, and NFC. Compatibility with these standards gives media player **100** the ability to not only establish a wireless connection with other electronic devices using RFID for setup as earlier described, but also allows media player **100** to function as an electronic key and wallet (for point-of-sale transactions). Alternative protocols and frequencies may be used in connection with RFID Tag-Reader Module **113** while still remaining within the scope and spirit of the present invention.

[0090] With reference to **FIG. 4A**, RFID Tag-Reader Module **113** includes an integrated RFID Tag-Reader Controller **303** that manages all communication between CPU **109** and the functional components of RFID Tag-Reader Module **113**. The hardware and software interface **302** between CPU **109** and RFID Tag-Reader Controller **303** allows an application operating on media player **100** to control functions of RFID Tag-Reader Module **113** and to exchange data with it. In addition to the appropriate hardware interface, an application program interface (API) layer supports communication between applications operating on media player **100** and RFID Tag-Reader Module **113**. RFID Tag-Reader Controller **303** may also provide notification to CPU **109** of unsuccessful read attempts by RFID Tag-Reader Module **113**, successful read attempts, reader time-outs (as discussed below), and other possible results or actions associated with RFID Tag-Reader Module **113**. These notifications are delivered to CPU **109** via the hardware and software interface **302** in order to allow media player **100** to emit distinctive sounds/tones via its integrated speaker **101** or display specific messages when these and other actions occur.

[0091] In one embodiment (**FIG. 4A**), RFID Tag-Reader Controller **303** interfaces with RFID reader unit **304**, a switch unit **305**, and RFID tag unit **306**.

[0092] The **FIG. 4A** version of RFID Tag-Reader Module **113** includes RFID reader unit **304** which represents the RFID tag reader functionality and RFID tag unit **306**, which represents the RFID tag functionality. The embodiment illustrated in **FIG. 4A** includes a common RF interface **307** and a common antenna **114** used by both RFID reader unit **304** and the RFID tag unit **306**. It will be understood that radio frequency interface **307** as well as the antenna **114**, which are presented in the present description, are adaptable to employ any suitable radio frequency used in the field of RFID readers and tags while still remaining within the scope and spirit of the invention. RFID-Tag Reader Module **113** may be adapted, for example, to allow communication in passive and active communication modes with reading/writing functionality in accordance with the near field communication standard (ECMA-340). Antenna **114** can be adapted to communicate with an RFID tag and with another RFID tag reader device.

[0093] RFID Tag-Reader Module **113** comprises a switch **305**, which operates to switch between RFID reader functionality and RFID tag functionality. Switch **305** receives a switching signal from RFID Tag-Reader Controller **303** to

which it connected via interface **311**. RFID Tag-Reader Controller **303** receives the switching signal from CPU **109** when an application operating on media player **100** requires RFID Tag-Reader Module **113** to switch functionality. The RFID Activation button **118** described above may also be used to switch RFID Tag-Reader Module **113** functionality.

[0094] Depending on the switching state or position of switch **305**, either RFID reader unit **304** is coupled to RF interface **307** or RFID tag unit **306** is coupled to RF interface **307**. In the former case, RFID reader functionality is available, whereas in the latter case RFID tag functionality is available. As the RFID reader functionality utilizes the media player's **100** battery power in order to transmit interrogation signals, switching the RFID reader functionality "on" only when desired has the benefit of conserving the media player's **100** battery. In contrast, when the tag functionality is switched "on", the media player **100** does not consume battery power as it is waiting for an interrogation signal from another device.

[0095] When RFID activation button **118** on the media player **100** is pressed, CPU **109** sends a switching signal to RFID Tag-Reader Controller **303** to change the position of switch **305**. RFID Tag-Reader Controller **303**, in turn, signals switch unit **305** to change positions via interface **311**. While RFID activation button **118** is held pressed, the RFID reader functionality is switched on while the RFID tag functionality is disabled. Holding RFID activation button **118** down provides the necessary power for RFID reader unit **304** to transmit one or more interrogation signals and to receive one or more response signals from an RFID tag (associated with an external electronic device) that is within range of antenna **114**.

[0096] When RFID activation button **118** is released, CPU **109** sends a switching signal to RFID Tag-Reader Controller **303** to change the position of switch **305** back to its original state. RFID Tag-Reader Controller **303**, in turn, sends a message to switch unit **305** via interface **311** to change positions. This time the RFID tag functionality is switched on while the RFID reader functionality is disabled. The use of RFID activation button **118** in this manner serves to conserve power for media player **100**, while making RFID reader **304** functionality readily accessible.

[0097] According to another embodiment of the invention, RFID activation button **118** can be pressed and immediately released in order to activate the reader functionality as previously described. In this case, the reader may continue sending interrogation signals via antenna **114** until a response is received (from a target device), or until such time as the reader functionality times-out (without having received a response). In this embodiment, RFID Tag-Reader Controller **303** tracks, via an internal clock, the time that has elapsed before a pre-set time-out limit is achieved. If an interrogation response is received within the time limit or if the reader times-out without receiving a response signal, RFID Tag-Reader Controller **303** will signal switch unit via interface **311** to switch functionality. This results in RFID Tag-Reader Module **113** reverting to its normal state whereby the RFID tag functionality is switched on while the RFID reader functionality is disabled.

[0098] Analogously, RFID Tag-Reader Module **113** may be operable with RFID reader functionality when RFID activation button **118** is pressed (as described above), or media player **100** and/or one or more applications operating thereon instruct RFID Tag-Reader Controller **303** to select/switch to RFID reader functionality.

[0099] According to another embodiment of the invention, RFID activation button **118** can be integrated into an electronic device that only includes an integrated RFID tag (and no reader). Holding RFID activation button **118** down in this case would have the effect of activating the RFID tag to respond to an interrogation signal received by its antenna from another electronic device's RFID reader. The RFID tag would only respond to an interrogation signal received by its antenna while RFID activation button **118** is held pressed. In another embodiment, pressing and immediately releasing the RFID activation button **118** may activate the RFID tag and allow it to respond to interrogation signals received by its antenna **114** within a set time limit after which time the tag returns to its normal state where it is inoperable and unable to respond to interrogation signals.

[0100] In the case of RFID reader **304** functionality, the antenna **114** is adapted to transmit one or more interrogation signals and to receive one or more response signals for retrieving information from an RFID tag in an external electronic device. In case of RFID tag functionality, antenna **114** is adequate to receive one or more interrogation signals and to transmit one or more response signals carrying information retrieved from RFID tag unit **304**. Antenna **114** is connected to RF interface **307** via one or more signal connections which supplies RF/HF signals generated by RF interface **307** to antenna **114** and which accepts RF/HF signals received by antenna **114**.

[0101] RF interface **307** is responsible for both modulating and demodulating the signals to be transmitted and received by antenna **114**, respectively. Therefore, RF interface **307** couples to RFID reader unit **304** and RFID tag unit **306**, respectively. In particular, RF interface **307** receives from RFID reader unit **304** signals to be modulated and transmitted and transmits demodulated signals to RFID reader unit **304**. RF interface **307** also transmits demodulated signals to RFID tag unit **306** and receives signals from RFID tag unit **306** to be modulated and transmitted. More particularly, RF interface provides further signals necessary for the operation of RFID tag unit **306** which are comprised of a power supply signal (voltage signal) and a clock signal. The power supply signal is gained from the coupling of the interrogating electromagnetic field whereas the clock signal is obtained from the demodulator included in the RF interface. The power supply signal and the clock signal are necessary for operating RFID tag unit **306** as a passive RFID tag energized by interrogating signal of a RFID reader device.

[0102] Signal **313** is generated by RFID reader unit **304** to be modulated by RF interface **307** and to be transmitted by antenna **114**. Signal **313** is also received by antenna **114** and demodulated by RF interface **307** to be supplied to RFID reader unit **304**. Signal **313** is provided to switch unit **305** which interfaces with RF interface **307** via signal **315**.

[0103] Signals received by antenna **114** and supplied to RFID reader unit **304**, are passed to RFID Tag-Reader Controller **303** via interface **310**. RFID Tag-Reader Controller **303** in turn, passes the received data to CPU **109** via interface **302** for use by applications operating on media player **100**. Applications operating on media player **100** can also customize interrogation signals by sending a message to RFID reader unit **304** via RFID Tag-Reader Controller **303**.

[0104] Analogously, connection **314** carries signals received by the antenna **114** and demodulated by RF interface **307** to be supplied to RFID tag unit **306**. Connection **314** also carries signals generated by RFID tag unit **306** to be modulated by RF interface **307** and to be transmitted by antenna **114**. Connection **314** is switched by switch unit **305** to RF interface **307** connected to switch **305** via connection **315**. The aforementioned power supply signal and clock signal are supplied from RF interface **307** to RFID tag unit **306** via switch **305** and may be part of the signals transmitted via connection **316** and connection **314**.

[0105] The information stored in RFID tag unit **306** that can be retrieved by an RFID reader device is stored in memory. The memory may be a read-only storage component or a configurable storage component. In case of a configurable storage component, a number of storage technologies including, non-volatile configurable memory can be used. Applications operating on media player **100** can update information stored in RFID tag unit **306** by sending the data to RFID Tag-Reader Controller via interface **302**. RFID Tag-Reader Controller **303** in turn sends the new data to RFID tag unit **306** via interface **312**. Access to the configurable tag memory may be limited to one or more specific applications executed on media player **100** to ensure data integrity, which may be required and necessary depending on the kind of information stored.

[0106] **FIG. 4B** is a block diagram illustrating an alternative embodiment of an RFID Tag-Reader Module **113** according to still another embodiment of the invention. The RFID Tag-Reader Module embodiment illustrated in **FIG. 4B** is comparable to the RFID Tag-Reader Module illustrated in **FIG. 4A** in several ways. RFID Tag-Reader Module **113** according to the embodiment in **FIG. 4B**, includes an integrated RFID Tag-Reader Controller **303** that manages all communication between CPU **109** and the functional components of RFID Tag-Reader Module **113**. The hardware and software interface **302** between CPU and RFID Tag-Reader Controller **303** allows an application operating on media player **100** to control functions of RFID Tag-Reader Module **113** and to exchange data with it. A common RF interface **307** and a common antenna **114** are used by the RFID reader functionality and RFID tag functionality. The reader logic **320** is preferably implemented as a microcontroller (μC) and a microprocessor (μP), respectively, which provide for data communication interface to media player **100** and the application executed thereon, respectively. The reader logic operates the interface and protocol framework for communicating with RFID tags (passive communication mode) and in particular, when supporting active communication mode, for communicating with RFID tag reader devices.

[0107] An optional reader memory **323** is associated with the microcontroller (μC) and a microprocessor (μP), respectively. Conventionally, a distinct reader memory **323** is not necessary for RFID reader functionality, but reader memory **323** may be used as a buffer storage for communication with media player **100** as well as with an RFID tag or another RFID tag reader device.

[0108] A switch/logic component **321** is interposed between RF interface **307** and reader logic **320** to switch between RFID reader functionality and RFID tag functionality as described in detail above. The switch/logic component implement tag logic necessary for providing RFID tag functionality. Correspondingly, the tag memory **322** is connected to the switch/logic component **321**. The tag memory **322** is also connected to the RFID Tag-Reader Controller **303** in order to receive configuration data from applications operating on media player **100**.

[0109] According to the invention, memory components in RFID Tag-Reader Module **113** may be tamper resistant as to prevent hackers from retrieving confidential information and encryption keys.

[0110] Common RF interface **307** provides signals to the switch/logic component **321**, which are required for operation of RFID reader functionality and RFID tag functionality. The switch/logic component **321** passes through signals to the microprocessor (μP) **320**, which are required by the microprocessor (μP) **320**. Signal control is accomplished via switch/logic component **321**.

[0111] As described above, the switching state of switch/logic component **321** and the switch defines the functionality of RFID Tag-Reader Module **113**, respectively. The switching state and therefore the switching operation is important to ensure proper operation of RFID Tag-Reader Module **113**. The switching state of switch/logic component **321** and the switch is controlled by a switching signal supplied via the interface **311** to RFID Tag-Reader Controller **303**.

[0112] RFID Tag-Reader Module **113** may be operable with RFID reader functionality when the RFID activation button **118** is pressed on media player **100** as described earlier, or if one or more applications operating thereon signal RFID Tag-Reader Controller **303** to switch to RFID reader functionality. If no explicit indication to select RFID reader functionality is present, RFID Tag-Reader Module **113** is operated in RFID tag functionality by default to conserve power.

[0113] Alternatively, switch/logic component **321** and the microprocessor (μP) **320** may be implemented in a common logic component (not shown), which is adapted to operate functions of switch/logic component **321** as well as functions of microprocessor (μP) **320**. Other functional components may also be combined, while remaining within the spirit and scope of the invention.

[0114] Further details concerning an RFID Tag-Reader Module with transponder functionality which may be used in connection with the teachings of the present invention are described in U.S. Patent Application Publication US 2004/0176032A1, filed Mar. 19, 2004, which is assigned to Nokia Corporation and which is fully incorporated herein by reference. RFID Tag-Reader Controller **303** and RFID activation button **118** as described herein may be used with other RFID Tag-Reader Module designs while remaining within the scope and spirit of the invention.

[0115] **FIG. 5** is a functional diagram of a media player **100** interfacing with wireless headphone unit **152**, in accordance with one embodiment of the present invention. Media player **100** can securely establish wireless connectivity with headphone unit **152** by first initiating an RFID data exchange between the RFID components integrated in both devices. The exchange of communication settings, device information, media capabilities, and other parameters via RFID is accomplished by bringing the RFID antenna of both devices in proximity to one another. The RF exchange of

communication and other settings facilitates the automatic setup and establishment of a secure wireless connection between the devices in order to allow audio signals to be transmitted over-the-air from media player **100** to headphone unit **152**. The subsequent creation of a "device profile" containing the captured communication settings and other parameters associated with wireless headphone unit **152**, allows media player **100** to establish connectivity with headphone unit **152** in future communication sessions.

[0116] Wireless headphone **152** in this embodiment may be a Bluetooth-enabled device with an integrated RFID tag module **369**. RFID tag module **369** is a component of the System-on-Chip **361** assembly integrated in wireless headphone unit **152**. System-on-Chip assembly **361** is designed for ultra low power consumption. Wireless headphone unit **152** has a rechargeable battery that can be charged using a car charger or charger unit that plugs in to a power outlet.

[0117] System-on-Chip **361** assembly includes a Bluetooth sequencer **364**, a low power 2.4 GHz Bluetooth radio **363**, Bluetooth antenna **363**, CPU **373**, DSP and CODEC unit **374**, high-speed UART/GPIO **376**, RC oscillator **377**, power management unit **378**, EEPROM/Serial Flash Memory **379**, and an RFID Tag Module **369**. The RFID Tag Module **369** in one embodiment includes an RFID tag **371**, an RFID antenna **372**, and an optional RFID tag memory component **370**. The embedded Bluetooth sequencer **364** executes the lower layers of the Bluetooth stack, while the host processor **373** runs the application and the higher levels of the Bluetooth protocol stack software. This architecture guarantees that the real-time operations of the lower levels can't be influenced by the application. The Host Controller Interface (HCI) has been specified into the Bluetooth protocol as a standardized interface between the lower and upper layers. The upper layers are components of software implemented on the host processor **373** and communicating with the Bluetooth sequencer **364** through the HCI. The HCI commands are carried by an internal UART link between the host processor (CPU) **373** and the Bluetooth sequencer **364**.

[0118] The on-chip DSP (Digital Signal Processing) and CODEC unit **374** is connected with the headphone speakers to facilitate high quality audio output. A Serial Peripheral Interface (SPI) directly interfaces to the serial EEPROM or Flash Memory **379**. This memory stores the application and the upper layers of the Bluetooth protocol stack are loaded at boot-up, and executed by the on-chip application processor. The Bluetooth sequencer **364** is ROM-based. The General Purpose Input/Output ports (GPIO) **376** interface to push buttons, LEDs, and other peripherals part of the headphone. The high speed UART supports hardware flow control and data rates up to 460 kbit/s.

[0119] The embedded Bluetooth sequencer **364** executes the lower layers of the Bluetooth stack, while the host processor (CPU) **373** runs the application and the higher levels of the Bluetooth protocol stack software.

[0120] In one embodiment, RFID tag **371** may be a passive tag, which operates without the internal battery source of the headphone **152**, deriving the power to operate from the radio field **351** generated by RFID tag-reader module **113** in media player **100** when in very close proximity (10-20 centimeters). In this case, the Bluetooth device serial number is transmitted by RFID tag **371** to RFID tag-reader module **113** in media player **100**. If System-On-Chip **361** only has a passive tag there is no option to update the tag information, so the information may include only the Bluetooth serial number of the headphone unit **152**, which may be hard-coded within RFID tag **371** during the manufacturing process.

[0121] In another embodiment, RFID tag module **369** can be a semi-passive or active tag powered by an internal battery allowing a greater RF communication range and higher data transmission rates. A semi-passive or active tag module **369** may include a read/write storage device **370**. In the case of a semi-passive tag it is possible to process information before message transmission. This enables the transmission of additional information such as the Bluetooth Clock Offset, Bluetooth device serial number, and other parameters that would allow media player **100** to capture the media capability of the headphone **152** and facilitate the creation of a device profile on media player **100**. Bluetooth communication settings, device information, and other data can be updated in the tag memory **370** by the application processor **373**. The application processor **373** receives the Bluetooth communication settings from the Bluetooth sequencer **364**.

[0122] In one embodiment, RFID activation button **118** on media player **100** may be pressed in order to activate the RFID reader functionality in RFID tag-reader module **113**. Activation of the RFID reader functionality results in the RFID antenna **114** transmitting interrogation signals. When the headphone's RFID tag antenna **372** enters the radio field **351** generated by the media player's RFID antenna **114** and receives interrogation signals, the headphone's RFID tag transmits **352** the Bluetooth serial number and other parameters to the media player's RFID tag-reader module **113**.

[0123] After the media player's RFID tag-reader module **113** receives the Bluetooth serial number and other parameters, the data is transferred to CPU **109**. Media player **100** instantly sends a Bluetooth paging message using the received information via its short range transceiver **108**. In response to the page, the headphone **152** performs a connection setup with media player **100** using normal Bluetooth session set-up procedure. Upon completion, media player **100** can stream all audio output via wireless signal **353** to the headphone unit **152**.

[0124] The RFID discovery/paging process shortens the session setup time as compared to normal Bluetooth terminal discovery process for establishing a session. The RFID discovery methodology and system described herein can also be used in communication between two or more media player devices **100**, if the devices are respectively equipped with RFID tags and RFID readers.

[0125] Along those lines, **FIG. 6** is a functional diagram of two media players **100**A & **100**B wirelessly communicating with one another and their respective headphones **152**A & **152**B, in accordance with one embodiment of the present invention.

[0126] In one embodiment, the first media player **100**A is playing digital music stored in storage unit **112** using the media manager application **120** on media player **100**A. The digital music is being transmitted wirelessly to a headphone unit **152**A to which connectivity was established using the RFID discovery/paging process previously described. The user of media player **100**A who is listening to the audio

output via his wireless headset **152A** decides to allow his friend to listen to the same music he is currently listening to. His friend also possesses a media player **100**B and a wireless headphone **152**B that have already established wireless connectivity via Bluetooth.

[0127] In accordance with the invention, RFID activation button **118** on the first media player **100A** is pressed in order to activate the RFID reader functionality in RFID tag-reader module **113**. Activation of the RFID reader functionality results in the RFID antenna **114** transmitting interrogation signals. At this time, the target media player's RFID tag-reader module **113** is in its normal state with tag functionally operable, and reader functionality disabled. When the target media player's **100**B RFID tag antenna **114** enters the radio field **410** generated by the media player's **100A** RFID antenna **114** and receives interrogation signals, the target media player's **100**B RFID tag transmits the Bluetooth serial number, Bluetooth Clock Offset, media capabilities, and other parameters to the media player's **100A** RFID tag-reader module **113**.

[0128] After the media player's **100A** RFID tag-reader module **113** receives the communication settings, media processing capabilities, and other parameters, the data is transferred to CPU **109**. Media player **100A** instantly sends a Bluetooth paging message using the received information via its short range transceiver **108**. In response to the page, the target media player **100**B performs a connection setup with the media player **100A** using normal Bluetooth session set-up procedure. Upon completion, media player **100A** automatically transmits the music content that is playing at the time the connection is established. The media content is transmitted via wireless signal **412** to the target media player **100**B. Audio content that is transmitted from media player **100A** to the target media player **100**B, can be listened to on the headphone unit **152**B which is wirelessly connected to media player **100**B via wireless signal **414**.

[0129] In accordance with another aspect of the invention, electronic devices with integrated RFID tags or tag-reader modules that use the RFID discovery process for automatically establishing a wireless connection will be capable of transmitting more than just communication settings via RFID. In accordance with one embodiment of the present invention, a sample RFID transmission **450** between two electronic devices may include, for example, the message components **451** outlined in **FIG. 7**. Also represented in the table is example content **452** for the different message components **451**. The example content **452** listed in **FIG. 7** is not meant to be exhaustive; examples are shown for exemplary purposes to help explain the invention.

[0130] The following is a discussion of the message components **451** contained in the RFID transmission data **450**. The first message component is "device type"**453** which describes the unit's primary function (e.g., MP3 player, cellular phone, stereo, etc.). The "device type"**453** may be coded by the manufacturer, and typically corresponds to the same label used to market the device. In one embodiment, device manufacturers use standardized codes to represent the "device type" parameter in the RFID transmission data **450**.

[0131] The second message component is "device manufacturer"**454** (e.g., XYZ Electronics). The name of the "device manufacturer"**454** could be represented in the user interface of another connecting device, as a way to provide validation that it is wirelessly connecting to the correct device. If the user saves the profile for the connecting device, the name of the "device manufacturer" can be helpful in differentiating between similar types of devices within a profile list.

[0132] The next message component is "device model"**455** (e.g., WaveRadio TH-190). The "device model" is the manufacturer's model number/code. In some cases, the "device model" may correspond to a model name that appears directly on the device. The "device model"**455** also helps in identifying a specific device.

[0133] The next message component, "device or user identifier"**456** may have been programmed in the device by the user to denote its location (e.g., "kitchen"), owner (e.g., "Anthony"), or other attributes (e.g., a complete calling card containing the contact information for the device owner such as f all name, title, company, mailing address, E.164 number, e-mail address, etc.). Unlike other message components that are established by the manufacturer or generated by the device itself, the "device/user identifier"**456** is input into the device by the operator. The "device/user identifier"**456** is also helpful in identifying specific devices from a list of device profiles. To properly represent its application, assume that a user has three stereos in his house that are wireless enabled, capable of processing digital music, and have RFID "hot spots" integrated. Further assume that all the stereos are manufactured by the same company, and are the same model.

[0134] In such instances, a differentiating piece of information like location or owner name could help identify the right device from a list of device profiles. Assuming that the stereos allow a user to input a device/user identifier, the user could in this example, input room locations as the identifier (e.g., kitchen, family room, basement). Alternatively, the user could use family member names if each stereo is in a different person's room (e.g., Anthony, Robert, John). Whatever information is input into each stereo as a "device/user identifier"**456**, is what is used in its respective RFID transmission data **450**. This information may also be particularly useful in a business setting wherein a number of users access various shared devices through user provided media players.

[0135] Separately, certain devices such as the wireless media player **100**, may allow a user to specify an electronic calling card for the "device/user identifier"**456**. As such, the user's calling card may be included in the RFID transmission data **450** and provided to the connecting device. This "calling card" may provide specific information about a user such as is included in a "vcard" as is known in the art. In the event that a particular device does not allow data input by the user, the manufacturer may provide a default setting for the "device/user identifier"**456**.

[0136] The next message component is "profile settings"**457** and specifies, for example, whether to allow a profile for the device to be created on a connecting device. If profiles are allowed, the "profile settings"**457** further specify whether to allow the connecting device to be able to auto-detect and connect via wireless when in proximity. The profile settings **457** may be pre-set by the manufacturer, or may be adjusted according to user-driven preferences on the device.

[0137] The next message component is "RF capability"**458**. This parameter specifies the supported wireless

communications protocols (e.g., 802.11a/b/g/n, UWB, 802.15.4/ZigBee, Wireless USB, 802.15.3/WiMedia, Wireless 1394, Wireless FireWire, Bluetooth) and RF frequency bands for broadcast transmission/reception (e.g., UHF/VHF, AM/FM) available through the device. In the event that the device supports multiple communications protocols and frequency bands, they can be listed in the RFID transmission data **450** in order of preference. This information also enables connecting devices to try an alternate communications protocol, in the event that connectivity cannot be first established with a preferred one.

[**0138**] The next message component is "communication settings"**459**. This includes the necessary parameters for configuring the supported wireless communications protocols. For example, if the Bluetooth protocol is supported, a Bluetooth terminal serial number and the Bluetooth Clock Offset of the device would be included. In the case of Bluetooth, "communication settings"**459** may further include details on supported Bluetooth profiles (e.g., handsfree, handset). The configuration settings overall will vary for each of the different communications protocols that are supported by the device. Additional "communication settings"**459** could be included for enabling security.

[**0139**] Security settings such as encryption keys may be included as part of the communication parameters **459**. Various types of encryption keys can be populated by the media player **100** and other devices in their respective RFID transmission messages **450**. For example, encryption data for three layers of the Open Systems Interconnection (OSI) model can be populated in the RFID transmission data **450**: the application, the data link, or the network layers. Data encryption in these layers provides for secure communication over IP networks. Encryption keys for use in descrambling secure video and audio signals over broadcast frequencies like the ones mentioned can also be populated in the RFID transmission data **450** as discussed later.

[**0140**] Also included as part of the communication parameters **459** is a list of supported protocols and parameters for communication via the Internet (IP, SIP, etc.). A complete catalogue of protocols and parameters for operation of the Internet and its future development can be found on the Internet Assigned Numbers Authority (IANA) web site; any possible combination of protocols and parameters from the IANA site can be incorporated in the RFID transmission message **450** if supported by the device.

[**0141**] The next message component is hardware/software parameters **460**. Hardware capabilities related to the device's display, audio equipment, data input hardware, and other components can be populated. Further, the device's operating system (OS) and other software capabilities can be provided in this category. Information such as OS version, list of supported software, and other software parameters may be included as a way to ensure compatibility and interoperability between devices. Certain connecting devices may use this information to only facilitate connections with devices that have identical hardware and software.

[**0142**] Finally, the device's media processing capabilities **461** are listed in the RFID transmission data **450**. This information indicates the device's ability to process media assets that are in specific formats. For example, the media player **100** may support the following audio formats which would be listed in its RFID transmission data: MP3, WMA, WAV, AAC, HE-AAC, FLAC, Ogg Vorbis. Others are also possible. Video formats supported by the media player **100** might include, for example: MPEG 1, MPEG 2, MPEG 4, MPEG 7, AVI, and XviD. Image formats supported by the media player **100** might include, for example: JPEG, JPEG2000, TIFF, GIF, BMP, and PNG. Presentation formats supported by the media player **100** may include: PPS, and PPT. Internet content supported by the media player **100** might include: HTML, XHTML, DHTML, and JavaScript.

[**0143**] This type of information allows media player **100** to only transmit media assets which are supported by the target device(s). This information also allows either or both of the target device and media player **100** to convert media assets into supported formats before transmission to the other when required. The supported media formats for media player **100** listed above are not meant to comprise a complete and exhaustive list. It should also be noted that devices such as media player **100** may periodically update their media processing capabilities to be able to handle additional formats.

[**0144**] A standard message structure containing the RFID transmission information **450** in **FIG. 7** allows a multitude of electronic devices to be able to quickly setup and establish wireless connectivity with each other using the RFID connector system previously discussed. In accordance with one embodiment of the present invention, a standard message structure for RFID transmission information **450** outlined in **FIG. 7** allows different devices to rapidly discover each other's communication and media capabilities and other parameters. According to the invention, transmitting the media player's **100** RFID transmission information **450** and processing a target device's RFID transmission information **450** could facilitate the automatic activation of a radio transceiver with an appropriate communications protocol, allowing the media player **100** and target device to conserve power by not always having their wireless interface turned on.

[**0145**] The RFID transmission information **450** could also facilitate the automatic launching of specific software applications operating on either device. The RFID transmission information **450** could also facilitate the automatic customization of software properties on both devices (e.g., GUI menu options, layout, graphics, messages, etc.); for example, when selecting media assets to transmit to a target device, the media player **100** may only show files that the target device is capable of processing. The RFID transmission information **450** could also facilitate the automatic transmission of certain media assets upon connection (as discussed below). Receiving and processing another device's RFID transmission information **450** on the media player **100** could also facilitate the automatic presentation of media received from that device, without any user action being required on the media player **100**. For example, if another device that has exchanged RFID transmission information **450** with the media player **100** wirelessly transmits a video to the media player **100**, the media player can automatically launch the media manager application **120** and begin displaying the incoming video. Other automated operations by the media player **100** in response to receiving and processing a target device's RFID transmission information **450** are possible and within the scope and spirit of the invention.

[0146] A standard message structure could use special codes to represent message components **451** and content **452**, that applications operating on various electronic devices, such as the media player **100**, could universally interpret and process. The message components **451** listed in **FIG. 7** are only general categories of the types of information that could be encoded in an RFID transmission message **450**. Sub-categories and additional categories of information are possible while remaining within the scope and spirit of the invention.

[0147] RFID transmission information **450** received from other electronic devices can be used to establish and store device profiles on the media player **100**. These device profiles can later be used by the media player **100** to automatically connect to these devices when in the vicinity, or to manually connect to them based on the user selecting a profile and initiating the connection. Data encoded in the RFID transmission **450** allows the media player **100** to appropriately organize the device profiles based on device type **453**, making them easier to find.

[0148] According to the invention, the RFID transmission information **450** could be encoded by the media player **100** and other electronic devices using SOAP/XML. XML is the acronym for extensible Markup Language, the universal format for structured documents and data on the Web. XML is an industry-standard protocol administered by the World Wide Web Consortium (W3C). The use of standard XML tags amongst electronics manufacturers to represent data in the RFID transmission information **450** allows for greater interoperability between devices using the methods described herein. According to the invention, the XML-encoded device information for the media player **100** may be generated by an application operating on the media player and sent to the RFID Tag-Reader Module **113** where it is stored for later transmission.

[0149] According to the invention, an XML message parser may operate on the media player **100** to interpret received RFID transmission information **450** encoded using the XML schema. The XML parser may in turn make the processed data available to other applications operating on the media player **100**. The use of other encoding schemes, other than XML, could be applied to standardizing the RFID transmission information **450**, and would not be outside the scope or spirit of the invention.

[0150] In one embodiment, the RFID transmission information **450** format complies with the Universal Plug and Play (UPnP) specification as promulgated by the Universal Plug and Play Forum. The UPnP Device Architecture document details the protocols and conventions required of UPnP devices, and explains the basic patterns all UPnP devices follow in their operation. The UPnP specification includes similar information related to addressing, description, discovery, control, eventing, and presentation. UPnP is the foundation of other home networking standards such as the Digital Living Network Alliance and Intel's Networked Media Products Requirements (NMPR) specifications; the RFID transmission information **450** could also be formatted according to these other specifications. In yet another embodiment, the RFID transmission information **450** could be formatted according to Apple's Rendezvous specification. Rendezvous, is an open source protocol that enables the automatic discovery of computers, devices, and services on IP networks.

[0151] In one embodiment of the invention, the RFID transmission information **450** for the media player **100** is stored in the RFID tag memory unit **322** of the RFID Tag-Reader Module **113**. Software and other changes which may be executed on the media player **100** may cause the RFID transmission information **450** to be dynamically updated in the RFID Tag-Reader Module **113**. For example, if software operating on the media player **100** is updated to handle new audio and video formats, the software can automatically update the RFID transmission information **450** stored in the RFID tag memory unit **322** with the latest information on the device's media capabilities. This in turn allows a communicating device to ascertain the media player's most current capabilities and only deliver content to it which the media player **100** is capable of processing.

[0152] As mentioned earlier, in one embodiment of the invention, the RFID transmission information **450** is transmitted from the target device which has an operable RFID tag to a master device which has enabled its RFID reader functionality. In accordance with the invention, it should be noted that RFID transmission information **450** as embodied in **FIG. 7** can also be transmitted from a device which has an operable RFID reader to a device with an operable RFID tag. An RFID tag that can be written with data by the master RFID reader device can be realized with varying memory capacities. In this embodiment, both electronic devices transmit each other's device information, communication settings, and other data to facilitate cross-discovery and customization of software properties as described herein. Where there are two devices that will be sharing sensitive media between each other and enhanced security is desired, this embodiment is preferred as both devices can discover each other's capabilities rapidly upon exchanging RFID transmission information **450**. In this embodiment, enhanced security is provided as both devices can share each other's encryption keys via the RFID exchange methods described.

[0153] There are instances where media only flows in one direction, as is the case with the media player **100** transmitting audio signals to a wireless headphone **152**. In such an instance, the media player **100** only needs to discover the capabilities of the headphone **152**, and not vice versa. As such, devices like the headphone unit **152** which may only receive data, only require a passive or active RFID tag.

[0154] In accordance with the invention, data stored in a device profile can periodically be updated over-the-air when the media player **100** establishes a communication session with the target device. According to the invention, the media player **100** may periodically poll the target device for new profile information. A new profile is sent over-the-air to the media player **100**, and the old device profile record is updated. This is an especially important feature for devices that may be continually updating their media processing capabilities. Device profile information stored on the player **100** could be encoded using an XML schema. As such, over-the-air updates of device profiles could be encoded the same way. As previously mentioned, other encoding schemes are also possible.

[0155] **FIG. 8A** is a flow diagram of a wireless transmission method using RFID setup, in accordance with one embodiment of the present invention. The flow diagram is outlined from the perspective of a media player **100** estab-

lishing connectivity with a target electronic device. The method generally begins at decision point **501**, where it is determined if media is being received from an external source and viewed on the player **100**, whether media stored on the device is being played/viewed at that instance, or whether a resident game is operating on the player **100**.

[0156] In the first case mentioned, the user of media player **100** may decide that he wants to wirelessly transmit the incoming media to another electronic device to facilitate enhanced viewing, for example, on a large television with surround sound. Alternatively, he may decide to share the incoming media with a friend in the vicinity that also has a wireless media player device. Similarly, in the second case, the owner of the media player **100** may be listening to digital music stored on the device and may decide to wirelessly transmit the media to a stereo system that provides for enhanced listening with its powerful speakers and sound output capability. Finally, in the last case, the owner of the media player **100** may be in the midst of playing a game operating on the device and may wish to allow one or more of his friends with a similar device to wirelessly connect to his media player **100** and compete in multi-player mode.

[0157] All of these examples assume that the target devices are wireless enabled, have compatible media processing capabilities, and have integrated RFID modules.

[0158] A user that is engaged in viewing incoming media or listening to music stored locally on the media player **100** should be able to automatically establish a wireless connection with a target device and transmit the same media for listening/viewing pleasure on the target device with minimal effort. Similarly, a user should also be able to establish wireless connectivity with minimal effort with other devices in order to play multi-player games. The RFID discovery method previously described allows two electronic devices that have integrated RFID components and a common wireless interface to do just that.

[0159] For the purpose of reviewing the method outlined in **FIG. 8A**, assume that the media player **100** is playing digital music stored on the device. The operator of the media player **100** wants to transmit the media content that is playing on the device to a stereo that has an RFID "hot spot" and an integrated RFID tag-reader module **113** for wireless setup. The stereo is Bluetooth-enabled and allows connectivity to compatible Bluetooth devices such as the media player **100** for exchanging media content. For illustrative purposes, both the media player **100** and stereo are Bluetooth-enabled. For purposes of this invention, the devices could communicate via any other known wireless protocol.

[0160] Following block **502** in **FIG. 8A**, the operator of media player **100** presses the RFID activation button **118** on the media player **100**. As previously outlined, this activates the RFID reader functionality and makes the RFID tag functionality inoperable in the RFID Tag-Reader Module **113** (block **503**). The media player's RFID antenna **114** begins transmitting interrogation signals. Per block **504**, the operator brings the media player's "hot spot"**221** in range of the stereo's RFID "hot spot". In block **505**, the stereo's RFID tag transmits its RFID transmission information **450** to the media player's RFID antenna **114** in response to a received interrogation signal. In an alternate embodiment, the media player **100** first transmits its RFID transmission information **450** to the stereo's RFID tag as part of the interrogation signal, and receives back the stereo's RFID transmission information **450**. In both embodiments, the receiving device uses the received RFID transmission information **450** to process the opposite device's communication, media processing, and other capabilities.

[0161] In block **506**, RFID Tag-Reader Module **113** in the media player **100** returns to its normal state, with the tag functionality switched and the reader functionality inoperable. In block **507**, wireless connectivity between media player **100** and the stereo is established. At block **510**, media player **100** begins wirelessly transmitting the media that is currently playing on media player **100**, from its current position, to the stereo along with information about the media (e.g. song name, artist, album, etc). The stereo can display the received media information on its LCD if one is available. Media player **100** transmits the media to the stereo in a supported format as ascertained during step **505**. In accordance with the invention, if the format of the media that was playing on media player **100** is not supported by the stereo, as ascertained in step **505**, the media player **100** can automatically convert the media into a format that is supported by the stereo. The conversion process of media from one format to another, and the transmission of the converted media can occur dynamically as the media continues to play on media player **100**.

[0162] While connected, media player **100** can transmit the user's playlists or song selections exactly as they play on the media player **100** to the stereo. This allows the user to listen to them via the stereo just as he would have directly from the media player **100**. In accordance with the invention, while connected—the user can use the controls of the media player **100** to control the media playing experience on the target device. For example, the "stop", "pause", "play", "rewind", "fast forward", and other buttons on the media player **100** can be used to control the audio attributes on the stereo in the current example. For other target devices, various other controls may be operated via media player **100**.

[0163] Per block **512**, the user may terminate the wireless session between the stereo and the media player **100** by using the software/hardware controls available on either device to perform the operation. Upon termination of the wireless session, per block **513**, the user will be prompted on the media player **100** to state whether he wants to save the device profile for the stereo. The user would only see this prompt if the stereo specified a permission in its profile settings **457** allowing the user to create a profile for the device. Per block **514**, the user can decide affirmatively to save the profile of the stereo to which he was previously connected. If the user doesn't want to save the device profile, it is discarded as shown in block **515** per the user's action. Device profiles allow users to connect to the same device in the future either automatically (when in range of the device's RF signal), or manually by selecting the profile from a list (and when within range of the device's RF signal).

[0164] **FIG. 8B** is a flow diagram of a wireless transmission method using RFID setup, in accordance with another embodiment of the present invention. Like **FIG. 8A**, the method outlined in **FIG. 8B** also begins at decision point **501**, where it is determined if media is being received from an external source (target device), whether media stored on

the device is being played/viewed, or whether a resident game or other application is operating on the device therein. In contrast to **FIG. 8A**, this example assumes there is no incoming media, no locally stored media being played/viewed, and no game or other application operating therein.

[0165] In the method outlined in **FIG. 8B**, the user desires the ability to wirelessly connect the media player **100** with a target device in its vicinity, in order to transmit certain media assets to the target device. The process of connecting the media player **100** to the target device in steps **502-507** were discussed earlier, and are the same in this example. Upon establishing wireless connectivity with the target device, the media player **100** prompts the user to select the content source from which he wants to select a media asset to transmit to the target device. For example, the user may be presented with three options from which to select from in step **540**. The first option is "live content" (real-time capture) **541**. The options within the "live content" option **541** are dependent on the capabilities of the respective media player **100**. For example, some media players **100** may come equipped with a built-in camera for capturing digital pictures. Other media players **100** may have functionality to capture video and audio.

[0166] As such, selecting the "live content"**541** option will further prompt the user to select the specific type of "live content" he wants to capture and transmit to a target device. Selecting "images", for example, would allow the user to take pictures and have them instantaneously stored locally while also being transmitted to a target device in its vicinity for viewing. Similarly, selecting "video" would activate the video camera functionality in the media player **100** and allow the user to capture a live video feed that is stored locally and transmitted to the target device. Similarly, selecting "audio" would activate the audio capture functionality in the media player **100** allowing the user to record and transmit audio to a target device.

[0167] Another content source is "stored content"**542**. This content source encompasses all media resident in the media player's storage unit **112**. "Stored content"**542** may include video, music/audio, pictures, presentations, animation, Internet-content, and other media types. As above, these media files may be transmitted to one or more target devices as discussed herein.

[0168] The next content source is "Internet content"**543**. This content source encompasses a number of Internet media sources for movies, music, radio, news and other content. Selecting any one of these Internet categories/channels may provide additional sub-categories which help users find the genre or type of content that they may be searching for. A media guide may be available to help users find the content they are looking for on the Internet. The "Internet content" option could, for example, allow a user to browse movie trailers on his wireless media player **100**, select a movie for download, pay for the movie, and use the media player **100** to re-transmit the selected movie to a television in the vicinity using the methods described herein. The user can in turn use the media player's controls to adjust the viewing experience on the television. For example, while watching the movie on his television, the user can pause, rewind, or fast-forward the movie using controls in the media player **100**.

[0169] The next content source is "broadcast TV"**544**. This content source encompasses content received via broadcast frequency bands such as UHF and VHF and other over-the-air sources. A transceiver and tuner in the media player **100** allows the unit to receive local television channels and other content from local devices in the vicinity via these frequency bands. Content from these sources can be further transmitted by the media player **100** to other devices in accordance with the invention. One possible example includes receipt by media player **100** of a satellite based content stream such as "XM" or "Sirius" satellite radio or other providers. The media manager application operating on media player **100** allows the user to browse different channels.

[0170] The next content source is "broadcast radio"**545**. This content source encompasses content received via broadcast frequency bands such as AM and FM. A transceiver and tuner in the media player **100** allows the unit to receive radio channels and content from local devices in the vicinity via these frequency bands. Content from these sources can be further transmitted by the media player **100** to other devices in accordance with the invention. The media manager application operating on media player **100** allows the user to scan and seek different radio channels.

[0171] In one embodiment of the invention, only content sources capable of being processed by a selected target device are displayed to the user by the media player **100** in the graphical user interface. Thus, when the user selects the desired target device, media player **100** can use the profile associated with that target device to determine allowable media types. Further, within a particular content source category, only media assets that can be processed by the target device are displayed on the media player **100** to the user.

[0172] Upon selecting content from any of the content source options, media player **100** begins wirelessly transmitting the media asset that was selected to the target device along with information about the media asset if available (e.g., file name, song name, artist, album, source, copyright, etc). The target device can display the media information on its display screen if one is available. The media player **100** transmits the media asset to the target device in a supported format as ascertained in step **505**. As previously mentioned, the media player **100** can convert the media asset into a format that is supported by the target device if necessary and if the applicable conversion utilities are present. Steps **512-515** that deal with terminating a wireless connection and establishing a profile for the target device on the media player **100** are the same as described earlier during discussion of methods illustrated in **FIG. 8A**.

[0173] **FIG. 9** is a flow diagram of a wireless transmission method **560** via the Internet, in accordance with one embodiment of the present invention. The examples illustrated in **FIG. 8A** and **FIG. 8B** described how two devices that are in within local RF proximity to one another can exchange communication, media processing capabilities, and other parameters via RFID, establish a wireless connection, and exchange media content between one another, either automatically (as outlined in **FIG. 8A**) or manually (as outlined in **FIG. 8B**).

[0174] The example illustrated in **FIG. 9** may be implemented by a media player **100** that has an integrated network receiver **105** that can connect to a cellular network, such as a Global System Mobile (GSM) network, and further gain

access to the Internet. The example **560** depicts how media assets can be selected and targeted for transmission to another Internet-connected media processing device via a wide area network, comprising, for example, a cellular network and the Internet. Alternatively, the media player **100** can use its short range transceiver **108** to connect to a local wireless access point to gain access to the Internet for the same purposes.

[0175] Example **560** requires the use of the media manager application on the media player **100**. The example **560** begins at decision point **561** where the user is prompted on the media player **100** to select a media source from which specific content will be selected for transmission to another Internet-connected device. The user is presented with options which include, "incoming media"**562**, "live-content" (real-time capture) **541**, "stored content"**542**, "Internet content"**543**, "broadcast TV"**544**, and "broadcast radio"**545**.

[0176] "Incoming media"**562** refers to media which is being received by the media player **100** in real-time from an external source (e.g., from an electronic device in close proximity via short range RF, another device via the Internet, etc). "Incoming media"**562** may include, as example, audio, video, and image communication. "Live content"**541** refers to data captured in real-time using the media player's internal media capture capability (e.g., integrated camera, audio recording apparatus, etc). Upon selecting a specific "live content" option, the appropriate internal media capture functionality in the media player **100** is activated. This allows media to be captured, stored on the device, and simultaneously transmitted to one or more target devices. Having the "live content" media stored on the media player **100** may be a user-defined option in the media manager application.

[0177] "Stored content"**542** includes media assets that reside in the media player's hard drive **112**. "Internet content"**543** includes media content (e.g., video/movies, audio/music, images, etc.) that can be selected for download from an Internet connected server or storage device to the media player **100** and re-transmitted to a target device. "Broadcast TV"**544** encompasses content received via broadcast frequency bands such as UHF and VHF. Similarly, "Broadcast Radio"**545** encompasses content received via broadcast frequency bands such as AM and FM. "Local Area Network (LAN) Content"**546** includes media content stored in recognized devices that are within short-range RF proximity of the media player **100**; the media player **100** may "auto-detect" devices in its proximity as described herein, and have access to all/some media content stored in these devices. The media player **100** is able to access the storage apparatus of a target device, obtain a complete list of files available for access, and also obtain information about each respective file such as media type (e.g., video, audio, image, etc.), media title, artist/producer, date, etc. In accordance with the invention, the media player **100** can in turn organize the target device's media library into categories (similar to those found in **FIG. 18**) that can be visually presented to the user to help locate specific files on the target device. In accordance with the invention, the media player **100** also allows an operator to specify if he wants to provide open access to some/all media assets stored in the media player **100** for specific connecting devices or any connecting device. The operator can also specify the access method of specific media assets stored in the media player **100**; for example, media assets can be enabled for download, "view only access", or "listen only access."'View only" and "listen only" access prevent connecting devices from copying the media asset, but allows them to still view or listen to the media asset.

[0178] Upon selecting specific media assets from the media source categories in step **570** the user is prompted (in step **573**) to select the addresses of one or more remote recipients to which the media assets should be transmitted. The user may be presented on screen with a contact list or "buddy list" from which to select one or more recipients of the media assets. In a preferred embodiment, the contact list or "buddy list" profiles contain unique addresses for target devices which can be resolved via the Internet, for routing over the global network. Possible Internet address schemes include E.164 phone numbers and Uniform Resource Identifiers (URIs). As previously mentioned, the media player **100** itself may have one or more of these address types mapped to it for resolution via the Internet.

[0179] E.164 is the name of the international telephone numbering plan administered by the International Telecommunications Union (ITU), which specifies the format, structure, and administrative hierarchy of telephone numbers. "E.164" refers to the ITU document that describes the structure of telephone numbers. A fully qualified E.164 number is designated by a country code, an area or city code, and a phone number. For example, a fully qualified, E.164 number for the phone number 555-1234 in Washington, D.C. (area code 202) in the United States (country code 1) would be +1-202-555-1234.

[0180] In one embodiment, media player **100** transmits a fully qualified E.164 number and connection request to a media gateway within its respective mobile operator's core network. The media gateway uses the Electronic Numbering (ENUM) protocol to resolve the fully qualified E.164 telephone number for the target media processing device to a fully qualified domain name address corresponding to the target device using a DNS-based architecture. ENUM (E.164 Number Mapping, RFC 3761) is a system that uses DNS (Domain Name Service, RFC 1034) in order to translate certain telephone numbers, like '+12025551234', into URIs (Uniform Resource Identifiers, RFC 2396) like 'sip:user@sipcarrier.com'. These URIs are contained within NAPTR (Naming Authority Pointer) Resource Records sent to the media gateway in response to the DNS query. ENUM exists primarily to facilitate the interconnection of systems that rely on telephone numbers with those that use URIs to route transactions.

[0181] The service record may specify that the target user prefers to receive calls addressed to a specific user (bob) at a server address (sip.sampleserver.com). The service field specifies, for example, that the Session Initiation Protocol (SIP) is to be used, in conjunction with the E.164 to URI (E2U) resolution service.

[0182] The media gateway then picks the sip+E2U service and performs the associated regular expression transform using the original E.164 number and the regular expression. This produces the sip: URI. The media gateway then uses the DNS a second time to translate the domain part of the URI (e.g, sip.sampleserver.com), into an IP address using a DNS A record.

[0183] The media gateway then opens up a session with UDP port 5060 on the target SIP server to complete the call

setup, requesting a media session with the user (bob) on this server. If the E.164 number was associated with a wireless device, the request may in turn be forwarded to the target device via a radio access network. Upon connecting with the target device, a secure, peer-to-peer communication session is established between the media player **100** and the target device.

[**0184**] In a preferred embodiment, media player **100** has a Session Initiation Protocol (SIP) framework operating on the device to facilitate communication using the protocol. The use of SIP for transmitting media to one or more target media players connected to the Internet is preferred as mobile operators are moving towards a SIP-based architecture for multimedia services. It is envisioned that the use of SIP for communication between two media player devices could leverage the same SIP registrar, proxy, presence servers, and other related infrastructure used to deliver real-time converged services within a mobile operator's network. The media player's SIP application framework allows media player **100**, in conjunction with SIP infrastructure at the mobile operator, to simultaneously transmit content from media player **100** to multiple devices over the Internet.

[**0185**] Capabilities discovery is an important feature of SIP systems. Similar to the capabilities exchange via RFID described above, SIP offers the ability for devices to exchange media processing and other capabilities information using the protocol.

[**0186**] While the use of SIP for such purposes is preferred, alternative application protocols may be used in lieu of SIP while still remaining within the scope of the present invention.

[**0187**] In step **575**, after peer-to-peer connectivity is established between media player **100** and the target device, the selected media assets are transmitted to the target device from the media player **100**. Media player **100** may simultaneously transmit media content to multiple target devices. In accordance with the invention, the user operating media player **100** may use the media player's control functionality, including buttons (e.g., pause, rewind, fast forward, etc.) for managing the user experience of the media asset on the target device. In accordance with the invention, the operator of the target device(s) may be permitted to use similar controls contained in the target device in order to manipulate media transmission from the media player **100**. In accordance with the invention, information about the control functionality permitted for use on the target device is transmitted by the media player **100** to the target device before the actual transmission of the media asset. This information could specify among other things, what controls to enable on the target device and what specific buttons could be used to activate certain control functions. In another embodiment, the media player **100** may transmit a GUI-based control panel for display on the target device, which can in turn be used by the operator of the target device to control the viewing/listening experience of the media asset being received from the media player **100**.

[**0188**] Upon successfully transmitting media assets to the target device, the operator of the media player **100** or the target device may terminate the peer-to-peer connection (step **577**).

[**0189**] Similar to the methods described above, the media player **100** is capable of receiving media assets from other Internet connected devices.

[**0190**] **FIG. 10** is a functional diagram of a media player **100**A wirelessly capturing a video feed from an external video recording device **712**, and transmitting the same video content via a cellular network **720** and the Internet **730** to another media player **100**B, which further transmits the content to a television **751**, in accordance with one embodiment of the present invention.

[**0191**] In **FIG. 10**, connectivity between the video camera **712** and the wireless media player **100**A is initially established using the RFID setup process as previously discussed. The video camera in **FIG. 10** has an integrated RFID tag-reader module and a wireless interface for communication with other devices.

[**0192**] The video camera **712** is recording a city landscape **711** and simultaneously transmitting the video feed to the wireless media player **100**A in User A's domain **710**. Using the media manager application operating on the media player **100**A, User A specifies that he would like the video feed to be transmitted to User B's wireless device **100**B. User A selects User B's name from a contact list or "buddy list" stored on the media player **100**A. Mapped to User B's name could be an E.164 number, URI, SIP address, or other Internet-routable address which corresponds to User B's wireless media player **100**B. All of these address types can be resolved via the Internet to target the delivery of the live video feed to User B's media player **100**B.

[**0193**] User A's media player **100**A is connected to Mobile Operator A's network **720** via RF signal to the radio access network **721**. Resolution of the address schemes mentioned above and connectivity with the target device may employ the use of Mobile Operator A's core network **722** which may include among other components, DNS servers and SIP registrar, proxy, and presence servers, and other related communications infrastructure connected to the Internet **730**. Mobile Operator A's DNS systems may be configured to resolve the E.164 number, URI, or SIP address to an Internet Protocol (IP) address for communication via the Internet **730** or a private network. The IP address is further used to establish a SIP peer-to-peer session over the Internet between media player **100**A and **100**B as earlier described.

[**0194**] In this case, User B's media player **100**B resolves to Mobile Operator B's network **740**. A SIP invite is sent over the Internet from mobile operator A's core network **722** to mobile operator B's core network **741**. The request is further transmitted through operator B's radio access network **742** to the wireless media player **100**B. Wireless media player **100**B is notified of the connection attempt (and possibly details of the media set for transmission) from media player **100**A. Assuming the connection attempt is accepted by user B, a SIP peer-to-peer connection is established between the two devices. Media player **100**A begins transmitting the video content to media player **100**B. Both devices use buffering and flow control technology to regulate the transmission and reception of media.

[**0195**] As User B watches the video feed from User A's media player **100**A on his media player **100**B, he may decide that he wants to watch the video feed on his television for an

enhanced viewing experience and surround sound. The scenario **700** represented in **FIG. 10** assumes that the television **751** in User B's domain **750** has an integrated RFID module and a RF interface for communication with other devices.

[0196] User B, can simply press the RFID activation button **118** on the media player **100**B and bring the media player "hot spot" in proximity to the RFID "hot spot" on the television. Wireless connectivity between the devices using any number of supported wireless protocols is automatically established, and the media content is automatically transmitted per the steps described in **FIG. 8A**.

[0197] In one embodiment, the television **751** is not able to process packetized streaming video content, but is able to handle a video broadcast signal using its antenna receiver. As such, User B's media terminal **100**B automatically recognizes the television's media processing capabilities using the information captured during the RFID information exchange. In accordance with the invention, the media manager application operating on media player **100**B is able to dynamically convert the incoming packetized streaming content to a broadcast signal (e.g., UHF, VHF) that the television can process using its own receiver and in turn display.

[0198] In accordance with the invention, the media player **100**B in **FIG. 10** has an integrated short-range broadcast antenna and transceiver that supports UHF, VHF, FM, and AM broadcast and reception. The media player **100** also supports the High Definition Television (HDTV), National Television Standards Committee (NTSC), Système Électronique pour Couleur avec Mémoire (SECAM), and Phase Alternating Line (PAL) standards used in different parts of the world. In accordance with the invention, the media player **100** may also have the ability to dynamically convert broadcast signals (e.g., UHF, VHF, FM, or AM) that it receives into a digital format that can be streamed or otherwise transferred to one or more devices over a packet network, such as an Internet Protocol (IP) network using the steps described above. In accordance with the invention, the media manager application **120** operating on the media player **100** also has the ability to receive a broadcast signal (e.g., UHF, VHF, FM, or AM) and convert the content to a digital format that can be recorded and stored in the media player's hard drive **112**.

[0199] Returning to **FIG. 10**, the television **751** in one embodiment automatically displays the broadcast content from the media player **100**B, as the RFID exchange may have triggered the television to automatically change channels to one used specifically for receiving broadcast signals from devices in the proximity.

[0200] To prevent the broadcast from being picked up by other devices in the vicinity, the media player **100**B, can scramble the content before broadcasting it. In one embodiment, the media player **100**B transmits a decryption key for descrambling the broadcast signal in the RFID transmission message **450** during the initial RFID exchange between the devices. The cryptographic techniques and methods for securing video and audio signals is widely known and documented. Commonly used algorithms supported by the media player **100** and used for encrypting digital content include Digital Video Broadcasting---Common Scrambling Algorithm (DVB-CSA), Advanced Encryption Standard (AES), and Triple DES (Data Encryption Standard). The television **751** may have the capability to store a "device profile" for the media player **100**B to facilitate future communication sessions; the "device profile" may contain the decryption key that was initially received from the media player **100**B during the RFID exchange.

[0201] **FIG. 11** is a functional diagram of a media player with an integrated video camera **100**A, filming a city scene **811**, and transmitting video/audio content via a cellular network **820** and the Internet **730** to two separate media player devices **100**B & **100**C connected to different mobile operator networks **840** & **860**, in accordance with one embodiment of the present invention.

[0202] In contrast to **FIG. 10**, user A as represented in **FIG. 11** selects two recipients to which he wants the content streamed. This illustration demonstrates that the media player **100**A is capable of streaming media content over a wide area network, comprising for example a cellular network and the Internet, to multiple devices that are also Internet-enabled. Content distribution to multiple devices via the Internet may be accomplished using the Session Initiation Protocol (SIP) and related infrastructure within mobile operator A's core network **822**.

[0203] In **FIG. 11**, user B is shown to have established wireless connectivity with two devices via an RFID exchange per the steps illustrated in **FIG. 8A** above. The user B domain **850** is shown as such in order to exemplify that an incoming video feed can be separated so as to present the image portion of the feed on a television **851**, and the audio portion via a stereo **852** with surround sound. The ability to separate the audio and image components of incoming or stored video is provided by the media player **100**B. The process of separation is completely automated if connectivity is established with more than one target electronic device using the RFID connector system and methods illustrated in **FIG. 8A** above.

[0204] User C in **FIG. 11** is shown simply to be watching the incoming video feed on his wireless media player's **100**C integrated display screen **102**.

[0205] As described up until now, the media player **100** has the ability to receive media content from a wide array of devices either in local proximity or over a wide area network. The media player **100** also has a built-in transceiver for transmitting/receiving content via broadcast frequency bands such as UHF, VHF, AM, and FM. In accordance with the invention, the media player **100** may have the ability to receive, for example, television and radio content over these broadcast frequency bands and convert the content to a digital format that can be stored in the media player's hard drive **112** and later accessed by the user via the media manager application operating on media player **100**. According to one embodiment of the invention, the media manager application enables the media player **100** to function as a digital video recorder (DVR). The digital video recording functionality can be enabled at the user's option. When enabled, the media player **100** digitally encodes all incoming broadcast signals being viewed by the user, and a saves them to the media player's hard drive, allowing the user to pause, play, rewind, watch video in slow motion, and perform other operations with live programming similar to digital video recording devices such as TiVo or ReplayTV.

[0206] The media manager application **120** operating on the media player **100** also allows the user to record specific

television and radio segments at specific times. The digital video recording functionality part of the media manager is also designed to work with Internet TV implementations. The digital video recording functionality allows the media player **100** to record multiple pieces of incoming media simultaneously. The digital video recording functionality automatically records incoming media transmissions of video, audio, images, presentations, animation, Internet content, and other media types received from other external devices. The automatic recording of incoming content from other devices allows a user to immediately begin viewing or listening to the received content without being prompted up front on whether he would like to store the content on the media player's hard drive. This alleviates the possibility of missing, for example, part of a live event being transmitted to the media player **100**.

[0207] The user may decide after the transmission is complete or at some point in the future on whether to retain the content that is presently stored in the media player's hard drive **112**. If the user decides to retain the content, he will need to mark it as a file he wants moved to the permanent storage area of the media player's hard drive **112** before an expiration date. Otherwise, content that is stored on the hard drive via the digital video recording functionality will automatically be purged from the hard drive's temporary storage area after a set time interval (e.g., 1 month). DVR content that remains in the temporary storage area of the hard drive **112** is automatically purged on a "first in, first out" basis based on a set expiration interval or some other basis as desired by a user or pre-configured in media player **100**.

[0208] The media manager application operating on the media player **100**, supports standards based and proprietary Digital Rights Management (DRM) technologies. As such, the media manager may control certain copyrighted media assets and restrict its usage in certain ways. For example, the media manager, may prevent certain content that is received on the media player **100** from being stored on the device (even temporarily with the use of the DVR functionality). Similarly, the media manager may prevent certain content that was received, but permitted to be stored, from being re-transmitted to other users. Other types of restrictions on the usage of media assets could be enforced by the media manager application operating on media player **100**. Further, the media manager may permit the operator of the media player **100** to impose his own DRM restrictions and rules on content he generates and transmits to other devices via the media player.

[0209] **FIGS. 12-20** are illustrations of exemplary user interface screens depicting various aspects of media player **100** functionality.

[0210] **FIG. 12** is an illustration of an exemplary user interface screen **600** depicting "device profile" categories, in accordance with one embodiment of the present invention. The screen **600** depicts several device categories in which profiles of wireless devices which previously exchanged communication settings, media processing capabilities, and other parameters via RFID exist.

[0211] Device profiles may exist for devices that can generally be classified as either media processing units or peripherals. Media processing units include, for example, MP3 players, digital video players, PDAs, televisions, digital cameras, medical monitoring devices, printers, and copiers that are capable of receiving and processing media assets (e.g., video, audio, images, animation, presentations, text, etc.) transmitted from the media player **100**. In some cases, these media processing units are able to themselves wirelessly transmit media assets to electronic devices such as the media player **100**. Peripheral devices on the other hand, are devices that allow the media player **100** to extend certain of its capabilities as a way to improve, for example, data input, visual display, audio output, and other such functions.

[0212] Examples of wireless peripherals include, keyboard, mouse, joy stick, display, automobile computer system, and telephone (that gives the media player speaker phone capability when interfaced). When peripherals are attached to the media player **100** via the RFID discovery method described herein, the peripheral takes over one or more functions of the media player (e.g., audio output, data input, etc.). One example of a peripheral capable of taking over multiple functions from the media player **100** is an automobile computer system. An automobile computer system, may as example, extend the media player's user interface to the car's display, the media player's audio output to the car's built-in speakers, and the media player's control functionality to built-in controls in the car.

[0213] **603** is one example of a device category. The television category listing in **603** includes an icon that visually represents the category and a category name (e.g., Television). At the top left of the screen is a cellular network signal indicator **601**, and at the top right is a battery-life indicator **602** for the media player **100**. The list of "device profile" categories in **FIG. 12** is not meant to be exhaustive. There could be additional categories added to the list.

[0214] Category labels could also be standardized amongst device manufacturers as part of a strategy to create a universally accepted RFID transmission format **450** as previously discussed.

[0215] **FIG. 13** is an illustration of an exemplary user interface screen **610** depicting a specific device profile category in accordance with one embodiment of the present invention. This screen **610** shows the "television" category with two example device profile entries **611** and **612**. Both device profile entries show an icon to represent the device, the device type (e.g., TV), manufacturer name (e.g., XYZ Elect.), device model (e.g., Plasma TV-123), and a description of the device which may have been set by the user in the device (e.g., Family Room). Device profile **612** differs from **611** in that an auto-detection setting **613** is represented; this setting is currently turned "on" as illustrated. The setting indicates that the user has specified that he wants the media player **100** to automatically detect and establish a connection with the TV in **612** whenever it is within signal range. This particular example assumes that the television in **612** has, for example, a transceiver (e.g., Ultra Wideband) for high-bandwidth communication with other devices (such as the media player **100**).

[0216] When the auto-detect setting is turned "on", the RF signal indicator is represented in **613**. It may be recalled from before, that the auto-detect and connect functionality may not be available for all electronic devices, and is specified in the RFID transmission information **450** in accordance with the invention. The auto-detect and connect functionality is especially useful for mobile users, as their media player **100** can be set to automatically discover and connect with specific devices when in proximity.

[0217] One practical example of how the functionality can be used is described now in accordance with the invention. A user may have a wireless media player **100** in his pocket on which he has his favorite music playlists stored. Rather than listening to the music via a wireless headphone unit **152**, the user prefers listening to his music via a stereo system in his home that has surround sound capability. As such, when the user turns on his media player **100** upon waking up in the morning and selects the music he wants to hear, and the media player **100** automatically detects and connects with the stereo system for which a "device profile" exists on the player **100**. The player **100** automatically begins transmitting the playing music to the stereo system so the user can enjoy his music via the surround sound capability of the stereo system. Continuing with the example, the same user may be ready to leave his home for work. Upon turning off the power to the stereo, the wireless connection between the stereo and media player **100** is terminated.

[0218] The wireless connection may also be dropped by simply exiting the house and leaving the RF coverage area of the stereo (if the stereo's power was left turned on). Either way, the music playing on the media player **100** is automatically paused when the devices lose RF connectivity. Upon getting in his automobile and starting the ignition, the automobile computer turns on its wireless interface. Similarly, the media player **100**, auto-detects and connects to the automobile's onboard computer system; begins playing the music that was paused; and transmits the music to the automobile's onboard computer system which includes a media processing unit. This example assumes that a device profile for the automobile computer is first stored in the media player **100** in accordance with the invention.

[0219] Continuing with the example further, the user may arrive at his workplace with his media player **100**. Upon turning off the car in the parking lot, the wireless connection between the automobile's onboard computer and the media player **100** automatically terminates. This causes the music playing on the media player **100** to be automatically paused. The user then walks into the building and to his office. As the user arrives in his personal office, the media player **100** auto-detects and connects to a small desktop stereo, for which a profile was previously saved in the terminal **100** in accordance with the invention. The media player **100** automatically begins playing and transmitting the media to the desktop stereo in the user's office. This example illustrates just one application for how the auto-detect and connect functionality can be applied and used with RFID device profile information stored in the media player **100**.

[0220] **FIG. 14** is an illustration of an exemplary user interface screen **620** depicting messaging that indicates that the media player **100** is wirelessly connecting to a target device, in accordance with one embodiment of the present invention. The screen **620** may appear on the media player **100** when an RFID exchange is initiated and the devices attempt to wirelessly connect, or when a device profile is selected in order to establish a manual connection.

[0221] **FIG. 15** is an illustration of an exemplary user interface screen **625** depicting the various options for Media Sources **626** that can be selected in order to locate specific media assets for transmission to a target device, in accordance with one embodiment of the present invention. The media source options represented in the illustration and discussed previously include, "Live Content"**627**, "Stored Content"**628**, "Internet Content"**629**, "Broadcast TV"**630**, "Broadcast Radio"**631**, and LAN Content **632**. Each of these media source options is represented with an icon that represents the content type, and an appropriate label as illustrated in **627**, **628**, **629**, **630**, **631**, and **632**. Elements of **628** appear in bold and are highlighted in order to illustrate the user interface treatment for a menu option that the navigation cursor has landed on.

[0222] The screen **625** also shows at the bottom **635**, all devices that are currently connected to the media player **100**. In this illustration, the Connected Devices section indicates that there is a TV connected to the media player **100**. **635** shows an icon of the connected device, the device type (e.g., TV), the manufacturer of the device (e.g., XYZ Elec.), a description (e.g., Family Room), and a signal indicator showing the strength of the RF signal between the devices.

[0223] **FIG. 16** is an illustration of an exemplary user interface screen **640** depicting "Live Content" options **641** for delivery to a target device, in accordance with one embodiment of the present invention. The "Live Content" options represented on the screen include "Image"**642**, "Video"**643**, and "Audio"**644**. Each of these media options is represented with an icon that represents the content type, and an appropriate label as shown in **642**, **643**, and **644**. As previously mentioned, the existence of these options is dependent on the respective media player's media capture capabilities. Selecting any one of these options has the effect of activating the appropriate media capture functionality in the media player **100**.

[0224] **FIG. 17** is an illustration of an exemplary user interface screen **650** depicting "Internet Content" options **651** from which media assets can be selected for delivery to a target device, in accordance with one embodiment of the present invention. The "Internet Content" options represented on the screen include "Movies"**652**, "Music"**653**, "Radio"**654**, "News"**655**, and a "Media Guide"**656**. These options provide further access to lists of web sites or content repositories on the Internet. Selecting the "Music"**653** option may, for example, provide the user with a list of sites from which he can download digital music (e.g., Apple iTunes™). The user may have his login settings for certain music download sites stored in the Media manager application **120** operating on the media player **100** so as to allow the media player **100** to automatically login to a selected site. The user may also have a credit card profile or other payment information stored on the media player **100** or with the respective music web site operator, in order to allow automatic payment of music that is selected for download. Each of the "Internet Content" options **651** is represented with an icon that indicates the type of content that can be accessed, and an appropriate label as shown in **652**, **653**, **654**, **655**, and **656**.

[0225] **FIG. 18** is an illustration of an exemplary user interface screen **660** depicting "Stored Content" options **661** from which media assets can be selected for delivery to a target device, in accordance with one embodiment of the present invention. The "Stored Content" options **661** represent categories of media files that reside in the media player's hard drive **112**. The "Stored Content" options **661** include "Video"**662**, "Music/Audio"**663**, "Pictures"**664**, "Presentations"**665**, and "Other"**666**. There may be addi-

tional sub-categories under any of these options that allow the user to easily locate specific media content. Content for example may be organized according to genre, theme, artist, and other identifying characteristics. A search engine incorporated in the media manager application **120** allows the user to search for specific content based on various search terms such as type of content, file names, dates, genre, artist, etc.

[0226] **FIG. 19** is an illustration of an exemplary user interface screen **670** depicting "Video Files"**671** that can be selected for transmission to a target device, in accordance with one embodiment of the present invention. **671** shows a list of video files resident in the media player's storage unit **112**. The files may be organized according to any number of organization schemes to allow the user to locate specific media files more easily. **672** is an example of a media file that is selected for viewing. **672** shows the user an icon representing that this entry is a video file, the name of the video (Paris Trip), and the date the video was made (07/05/05). Other information could also be presented as screen space permits.

[0227] The user can select this file **672** from the list and use the left menu selection button **185** on the media player **100** to preview the video before transmitting it to a target device in accordance with the invention. The preview of the video is displayed in a window **673** on the right side of the display screen **102**. If the user decides to transmit the same file **672** to a target device in accordance with the invention, he may simply press the right menu selection button **186** on the media player **100**. If the media player **100** is connected to the target device, pressing the right menu selection button **186**, will initiate transmission to the target device. In another embodiment, if the user desires to transmit the selected media asset **672** to a target device via the Internet as described earlier, pressing the transmit button, will then prompt the user to specify the target recipient's address. As such, a directory or "buddy list" of users stored in the media player **100** may be presented for the user to select from.

[0228] **FIG. 21 a** front-side perspective view **680** of a media player **100** with an exemplary user interface screen depicting a video playing **681** while being transmitted to a target device, in accordance with one embodiment of the present invention. The video that is being transmitted to the target device is shown in **681**. **682** provides information on the media asset being transmitted. Included in **682** is an icon to represent the type of media being transmitted (e.g., video, audio/music, etc), the name of the file, the date it was made, and the time remaining in the transmission. Also included in **682** is a sliding bar which visually indicates the amount of time which has elapsed in the media transmission and the relative time remaining. At the bottom of the screen is a list of all devices wirelessly connected to the media player (as previously discussed). In this illustration, it is shown that the "Paris Trip" video is being transmitted to the TV in the family room. The signal strength of RF connectivity with the TV is also represented at the bottom of the screen. Finally, the front-size perspective view of the media player **100** shows the keypad interface **195** used to control media assets and also interact with the operating system and software operating on the media player **100**.

[0229] It will be readily understood by one of skill in the art that various physical and functional alternatives are possible for the implementation of media player **100** of the present invention. As one example, media player **100** may comprise a device similar to an Apple iPod™ specifically customized to perform some or all of the functions of media player **100** as discussed above. For example, an iPod could be customized to include RFID functionality for receiving from and/or exchanging information with one or more target devices as discussed herein. In this regard, the existing media storage and playback capabilities of the iPod can be combined with the RFID functionality and other teachings of the present invention to obtain the benefits and features outlined and discussed herein.

[0230] While this invention has been described in terms of several preferred embodiments, there are alterations, permutations, and equivalents, which fall within the scope of this invention. For example, although the invention has been described in terms of a wireless media player **100**, it should be appreciated that certain features of the invention may also be applied to other types of electronic devices (e.g., cameras, music players, video players, PDAs, cellular phones, game players, portable storage devices, headphones, televisions, DVR/PVRs, VCRs, satellite receivers, DVD players, stereos, radios, automobile computer systems, printers, copiers, fax machines, mouse, joy sticks, keyboards, displays, projectors, medical monitoring devices, home appliances, phones, personal computers, notebook computers, routers, switches, remote controls, and the like). It is therefore intended that the following appended claims be interpreted as including all such alterations, permutations, and equivalents as fall within the true spirit and scope of the present invention.

[0231] The foregoing disclosure of the preferred embodiments of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many variations and modifications of the embodiments described herein will be apparent to one of ordinary skill in the art in light of the above disclosure. The scope of the invention is to be defined only by the claims, and by their equivalents

What is claimed is:

1. A wireless media player comprising:

a first storage component capable of storing at least one electronic media asset;

an RFID tag-reader module for establishing a communication link between said wireless media player and at least one target device;

wherein said RFID tag-reader module communicates with said at least one target device in order to obtain data reflecting the capabilities of said at least one target device.

2. The wireless media player of claim 1 wherein said target device comprises an RFID tag module which communicates with said RFID tag-reader module.

3. The wireless media player of claim 1 further comprising an RFID activation button for initiating communication between said RFID tag-reader and said at least one target device.

4. The wireless media player of claim 1 further comprising a second storage component capable of storing device profile information specific to said at least one target device.

5. The wireless media player of claim 4 wherein said device profile information is obtained as a result of said communication between said RFID tag-reader module and said at least one target device.

6. The wireless media player of claim 1 further comprising a transmitter for transmitting said at least one electronic media asset to said at least one target device.

7. The wireless media player of claim 6 wherein said at least one electronic media asset is transmitted to a plurality of said target devices simultaneously.

8. The wireless media player of claim 1 wherein, following the establishment of a communication link between said wireless media player and said at least one target device, said at least one electronic media asset is transmitted to said at least one target device without any user intervention.

9. The wireless media player of claim 8 wherein said electronic media asset is displayed on said target device without any user intervention.

10. The wireless media player of claim 1 wherein, following the establishment of a communication link between said wireless media player and said at least one target device, said at least one electronic media asset is transmitted to one or more of said at least one target devices based upon a selection by a user.

11. The wireless media player of claim 1 further comprising a display screen for displaying information to a user and a keypad for accepting information from said user.

12. The wireless media player of claim 11 wherein said display screen is capable of displaying soft-keys to allow for custom menu selections reflecting the capabilities of said at least one target device.

13. The wireless media player of claim 1 further comprising a commerce component permitting said wireless media player to conduct commercial transactions as a result of information transmission and reception by said RFID tag-reader module.

14. The wireless media player of claim 1 wherein said at least one electronic media asset comprises at least one audio file.

15. The wireless media player of claim 1 wherein said at least one electronic media asset comprises at least one video file.

16. The wireless media player of claim 1 further comprising an network routing module whereby said wireless media player may communicate with said at least one target device through a network by resolving an address for said at least one target device as a network address.

17. The wireless media player of claim 15 wherein said network is the Internet.

18. The wireless media player of claim 1 wherein at least one user input located on said wireless media player is configured to operate as a function of the capabilities of a selected target device.

19. The wireless media player of claim 1 further comprising a terminal casing having at least one RFID hot spot.

20. The wireless media player of claim 1 further comprising a transceiver permitting said wireless media player to initiate and support voice calls through a cellular network.

21. The wireless media player of claim 1 further comprising a transceiver permitting said wireless media player to access the Internet via an Internet wireless access point.

22. A method for establishing a wireless communication connection between a handheld source device and at least one target device comprising the steps of:

(a) locating said handheld source device proximate to said at least one target device;

(b) said handheld source device detecting the presence of said at least one target device;

(c) said at least one target device providing configuration information to said handheld source device through at least one RFID communication;

(d) said handheld source device establishing said wireless communication connection based upon said configuration information.

23. The method of claim 22 wherein said handheld source device holds at least one media asset and said method further comprising the step of said handheld source device transmitting said at least one media asset to said at least one target device through said wireless communication connection.

24. The method of claim 22 wherein said at least one media asset comprises at least one audio file.

25. The method of claim 22 wherein said handheld source device includes an RFID activation button for initiating said step of said at least one target device providing configuration information to said handheld source device.

26. The method of claim 22 further comprising the step of said handheld source device providing configuration information to said target device.

27. The method of claim 22 further comprising the step of said handheld source device automatically streaming data to said at least one target device upon establishment of said wireless communication connection.

28. The method of claim 27 wherein said data comprises an audio file.

29. The method of claim 27 wherein said data comprises a video file.

30. The method of claim 22 further comprising the step of storing said configuration information on said handheld source device.

31. The method of claim 22 wherein said handheld source device further comprises a transceiver for initiating and maintaining a cellular telephone voice call.

32. A wireless communication system comprising:

(a) at least one source device having RFID tag-reader functionality;

(b) at least one target device having RFID tag functionality;

(c) wherein a wireless communication link may be established between said at least one source device and said at least one target device through an RFID transmission from said at least one target device to said at least one source device.

33. The wireless communication system of claim 32 wherein said wireless communication link is further established as a result of an RFID transmission from said at least one source device to said at least one target device.

34. The wireless communication system of claim 32 wherein said RFID transmission comprises data associated with the configuration of said at least one target device.

35. The wireless communication system of claim 32 wherein said RFID transmission is initiated as a result of the pressing of an RFID activation button.

36. The wireless communication system of claim 34 wherein said data is stored on said at least one source device as a device profile for said at least one target device.

37. The wireless communication system of claim 36 wherein said device profile may be used to establish a later communication link between said at least one source device and said at least one target device.

38. The wireless communication system of claim 36 wherein said device profile is used to configure said at least one source device to reflect at least one characteristic of said at least one target device.

39. The wireless communication system of claim 36 wherein said source device streams at least one media asset to said at least one target device through said wireless communications link.

40. The wireless communication system of claim 39 wherein said media asset comprises an audio file.

41. The wireless communication system of claim 39 wherein said media asset comprises a video file.

42. The wireless communication system of claim 32 wherein said wireless communications link further comprises a link via the Internet.

43. The wireless communication system of claim 42 wherein said link via the Internet is established through the generation of an Internet routable address.

44. The wireless communication system of claim 32 wherein said target device comprises a wireless headset.

45. The wireless communication system of claim 32 wherein said RFID transmission comprises XML encoded information.

46. The wireless communication system of claim 32 wherein said RFID transmission comprises Apple Rendezvous encoded information.

47. The wireless communication system of claim 32 wherein said RFID transmission comprises information encoded according to the Universal Plug and Play standard.

48. The wireless communication system of claim 39 wherein said media asset is converted from a first format to a second format prior to streaming.

49. The wireless communication system of claim 39 wherein said source device is operative to control at least one characteristic of the playback of said media asset on said target device.

50. The wireless communication system of claim 32 wherein said source device receives at least one over-the-air broadcast signal and packetizes said signal prior to transmission to said target device.

51. The wireless communication system of claim 32 wherein said source device and said target device each send and receive RFID data to and from one another, respectively.

52. The wireless communication system of claim 32 wherein the receipt by said source device of said target device's RFID transmission information facilitates the automatic activation of a radio transceiver.

* * * * *

EXHIBIT 1014

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(54) PORTABLE COMMUNICATIONS DEVICE AND METHOD OF USE

(76) Inventor: Melvin L. Barnes JR., Bethesda, MD (US)

Correspondence Address:
MELVIN L. BARNES, JR.
5323 POOKS HILL RD.
BETHESDA, MD 20814 (US)

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(22) Filed: Jan. 10, 2005

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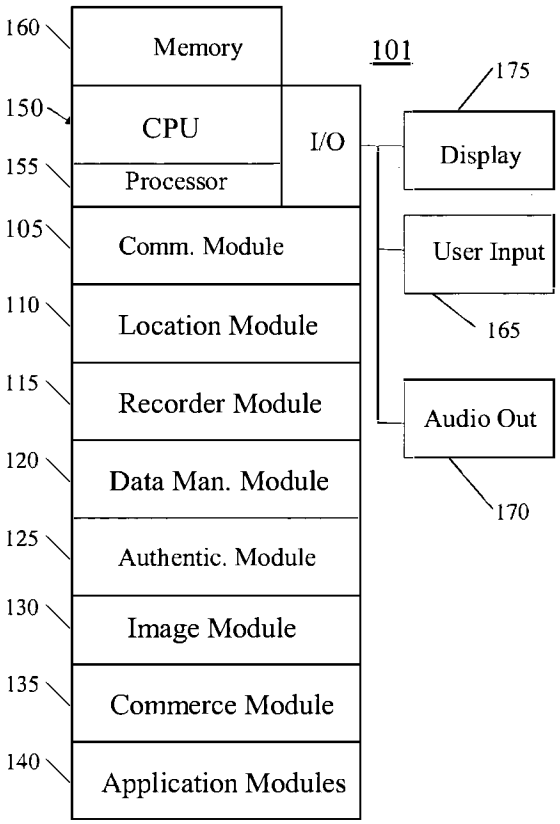
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(51) Int. Cl.[7] H04Q 7/20

(52) U.S. Cl. 455/461; 455/456.6

(57) ABSTRACT

A system, method, apparatus and computer program product for providing location based functions and mobile e-commerce comprising a central processing unit including a processor, a storage device, and programming stored in the storage device, a display device, an audio input device, an audio output device, a communications module, a commerce module, an image module, and a location module. The programming controls the operation of the present invention to provide functions based on location data, to facilitate commercial exchanges by wirelessly exchanging payment and product information with venders, to identify services such as venders meeting selection criteria, to wirelessly exchange select information with other users and systems, to restrict and/or monitor the use of the device based on authorized user parameters, to select one of a plurality networks through which to communicate, to detect a trigger for performing an action based on a change in location and sensed data, to store a voice annotation with a computer data file, to determine service providers and associated communication parameters, to contemporaneously maintain a wireless voice and data link, to provide a system for selecting mobile advertisements, and many other functions and services that are described herein.



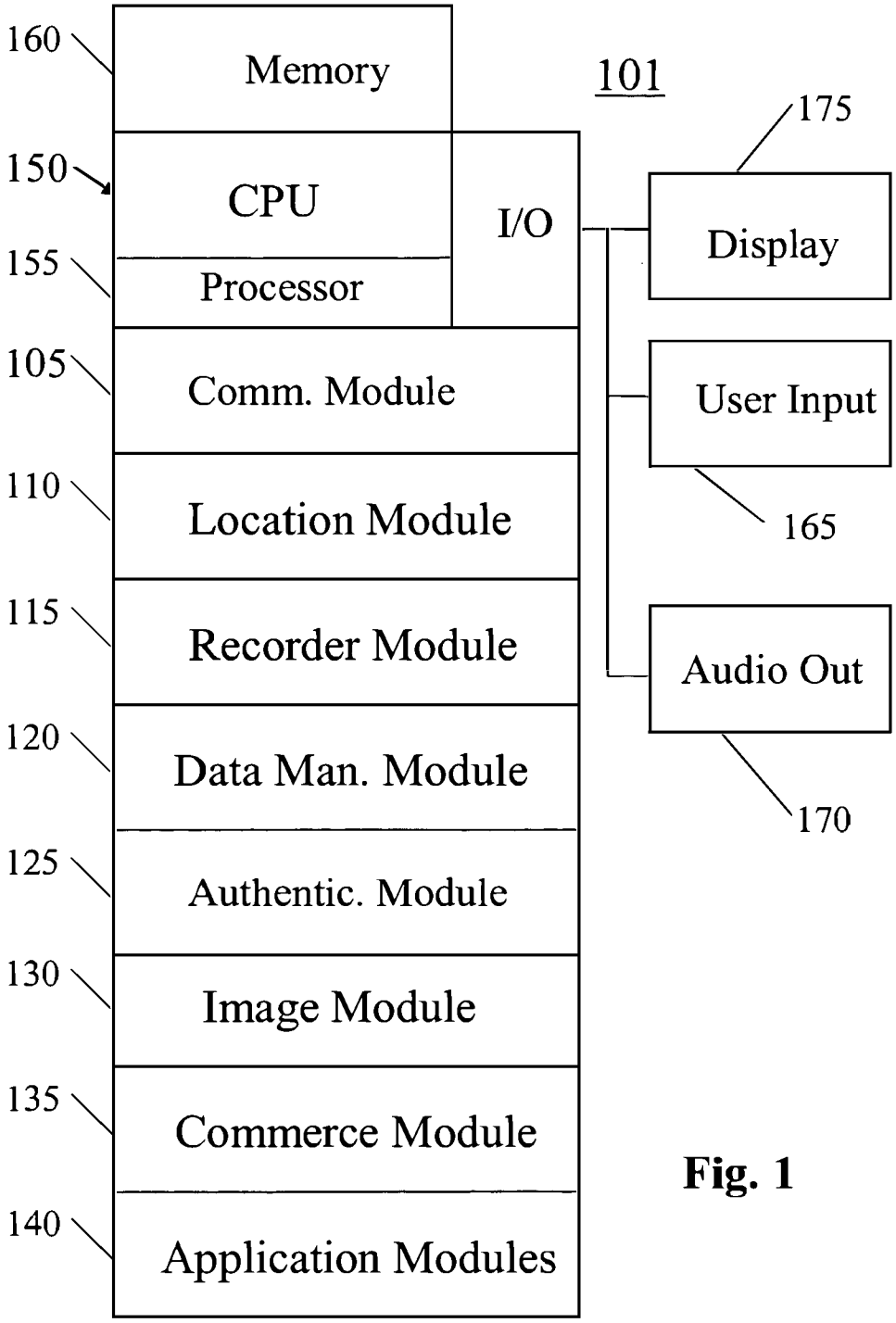
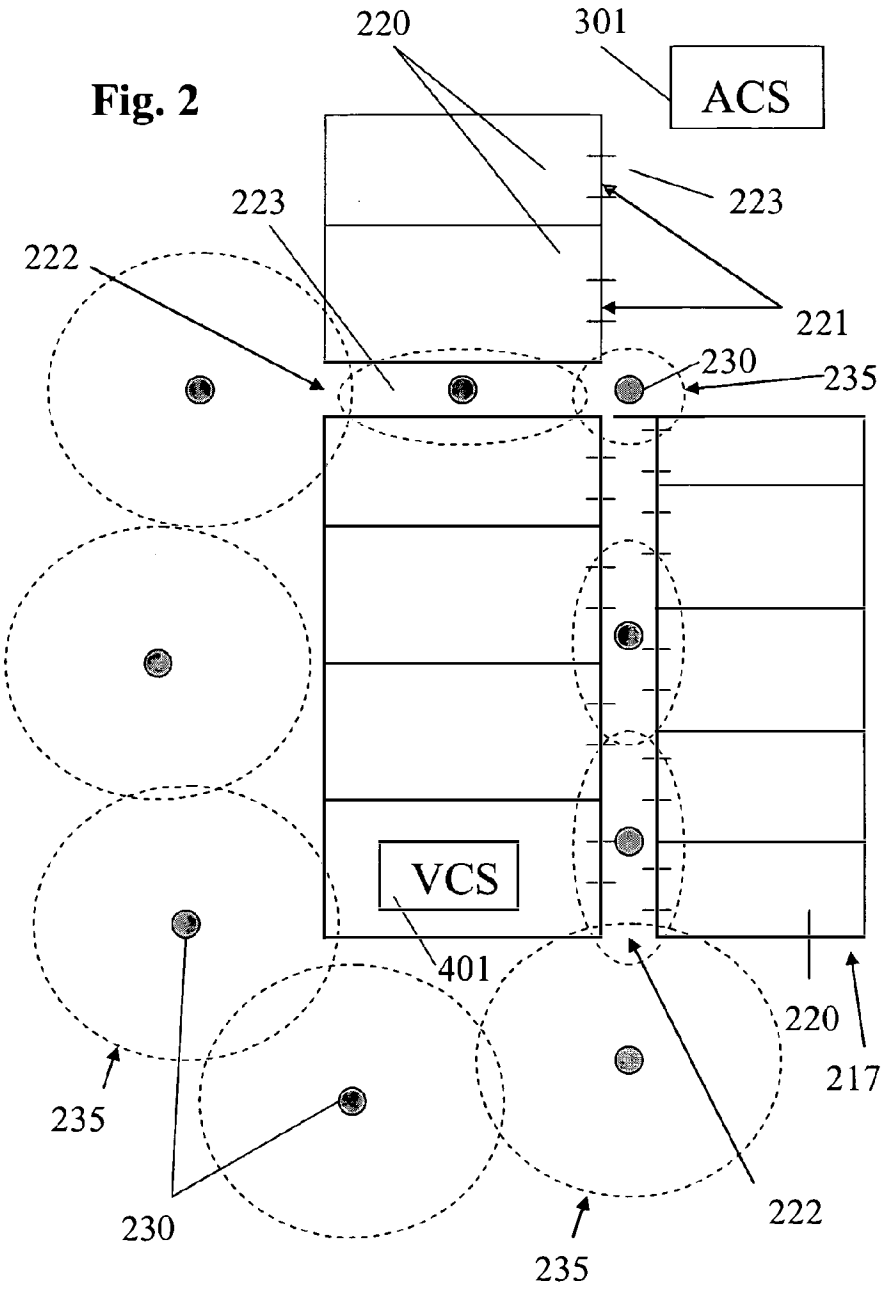

160
Memory
101
175
150
CPU
I/O
Display
155
Processor
105
Comm. Module
User Input
110
Location Module
165
115
Recorder Module
Audio Out
120
Data Man. Module
170
125
Authentic. Module
130
Image Module
135
Commerce Module
140
Application Modules

Fig. 1

Fig. 2


220
301
ACS
223
223
222
221
230
235
VCS
401
220
217
235
230
222
235

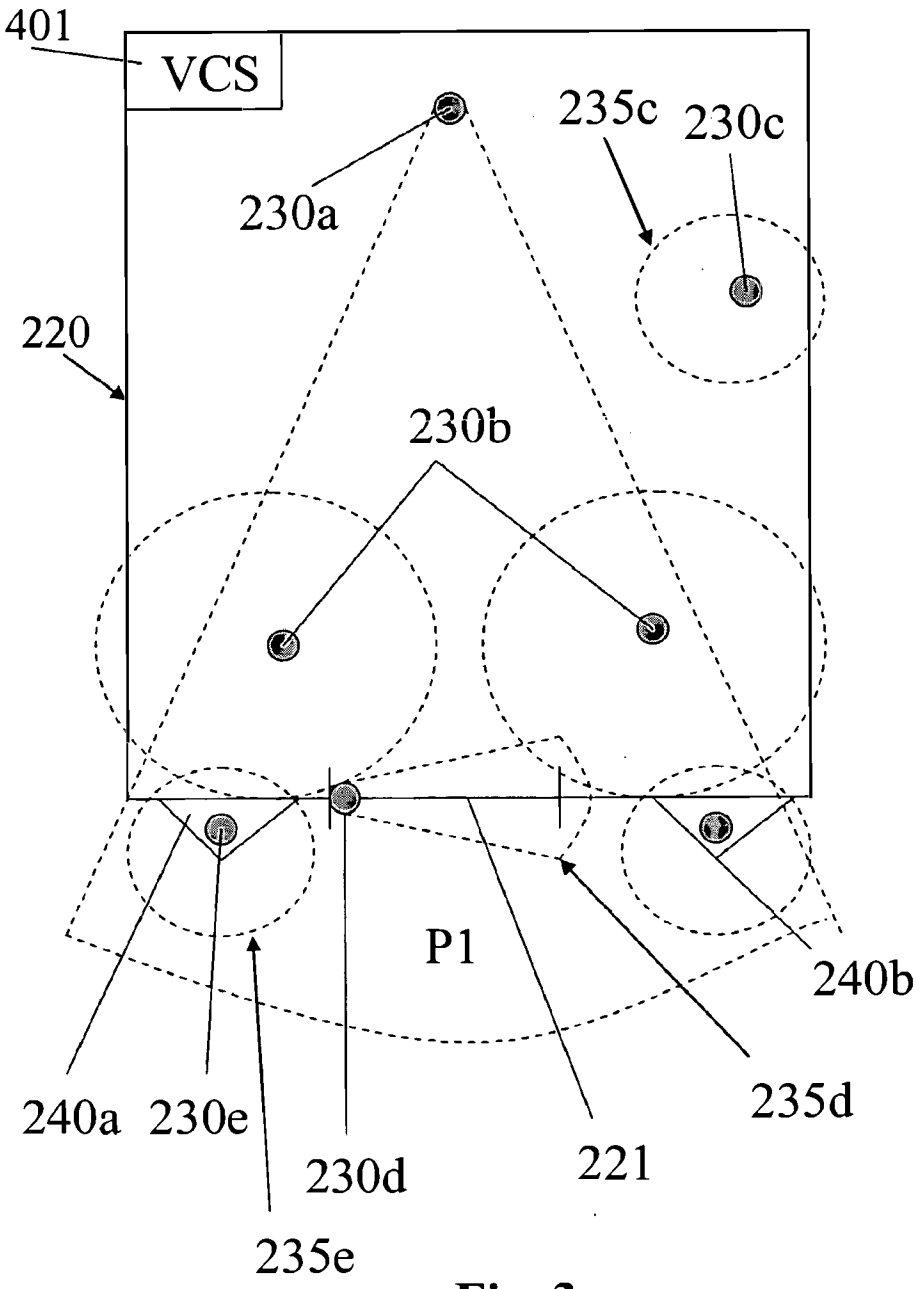

401
VCS
235c
230c
230a
220
230b
P1
240b
240a
230e
235d
230d
221
235e

Fig. 3

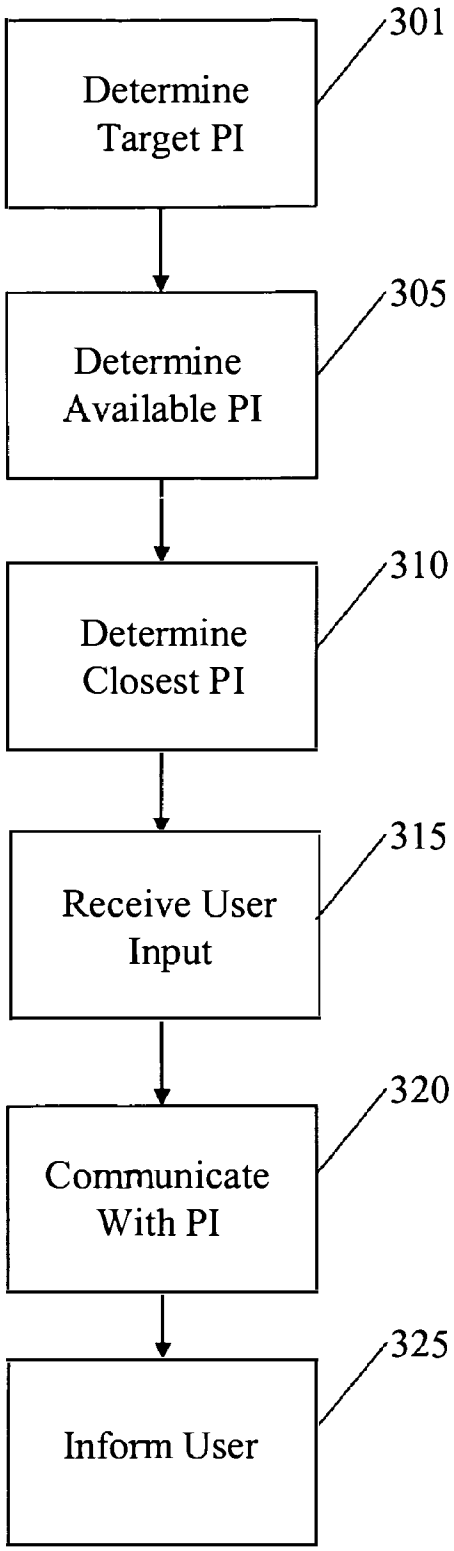

301
Determine Target PI
305
Determine Available PI
310
Determine Closest PI
315
Receive User Input
320
Communicate With PI
325
Inform User

Fig. 4

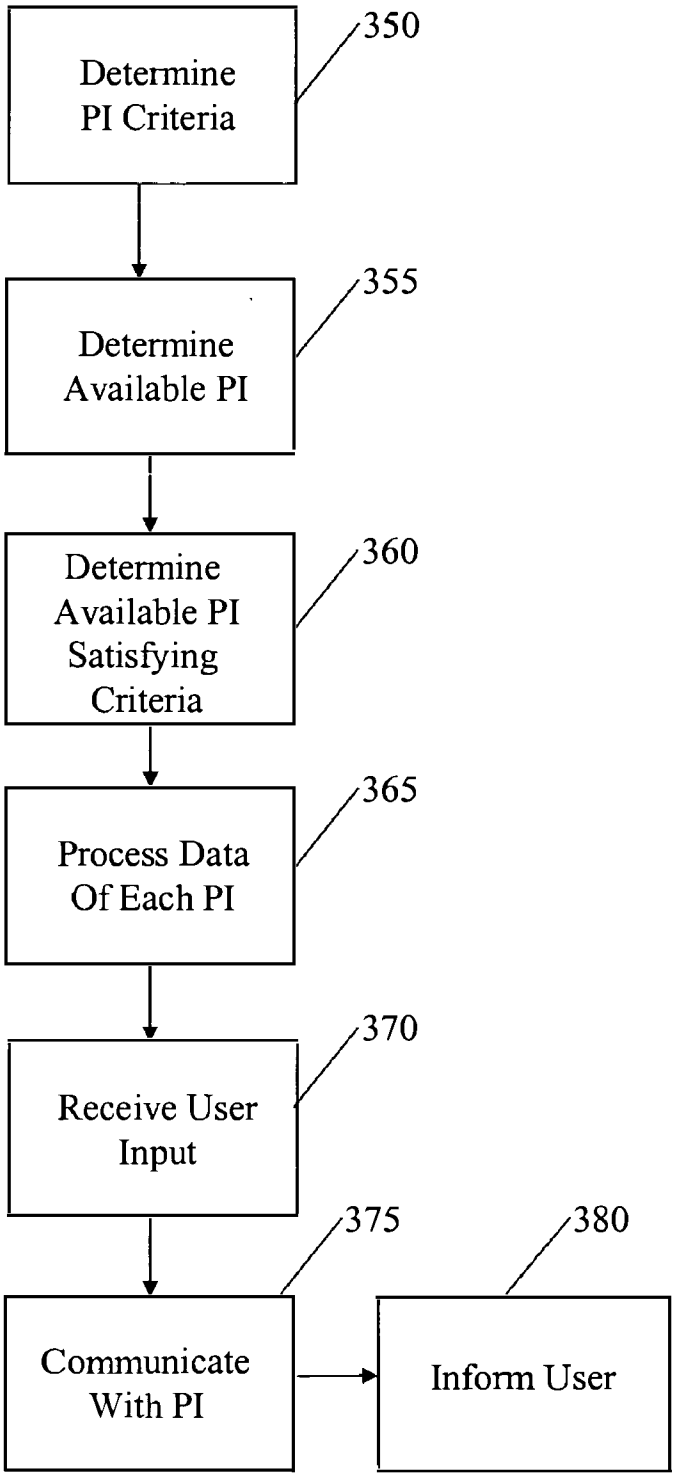

Determine PI Criteria
350
Determine Available PI
355
Determine Available PI Satisfying Criteria
360
Process Data Of Each PI
365
Receive User Input
370
Communicate With PI
375
Inform User
380

Fig. 5

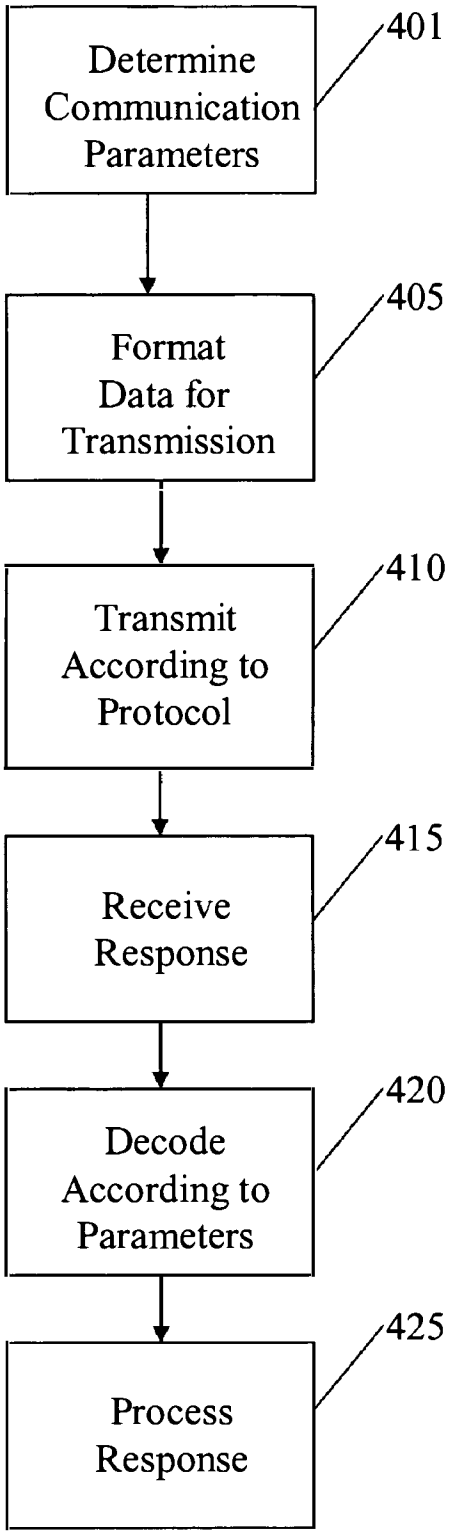

Determine Communication Parameters
401
Format Data for Transmission
405
Transmit According to Protocol
410
Receive Response
415
Decode According to Parameters
420
Process Response
425

Fig. 6

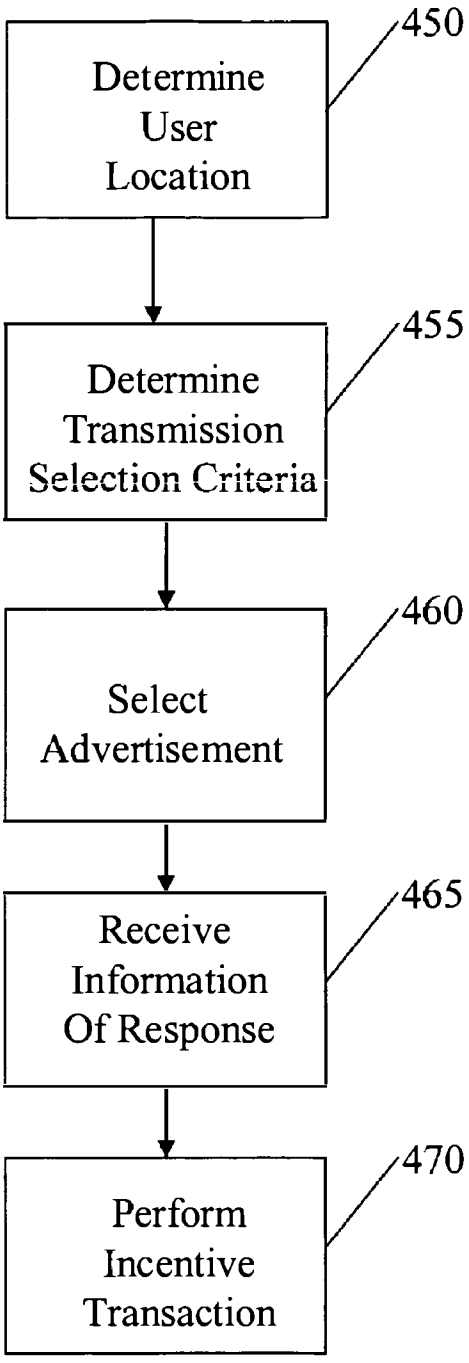

Determine User Location
450
Determine Transmission Selection Criteria
455
Select Advertisement
460
Receive Information Of Response
465
Perform Incentive Transaction
470

Fig. 7

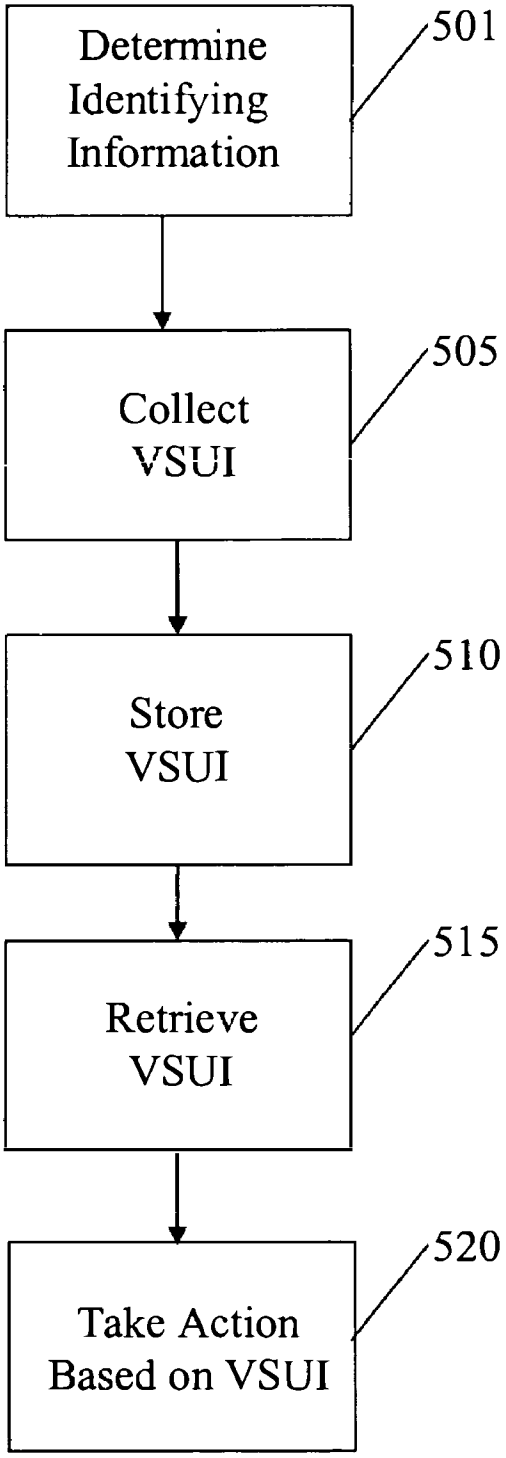

Determine Identifying Information
501
Collect VSUI
505
Store VSUI
510
Retrieve VSUI
515
Take Action Based on VSUI
520

Fig. 8

PORTABLE COMMUNICATIONS DEVICE AND METHOD OF USE

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of U.S. patent application Ser. No. 10/154,008, filed May 23, 2002 (Barnes-3), which is hereby incorporated by reference herein, in its entirety, for all purposes.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates, generally, to the field of mobile communications and computer processing and more particularly, to a system, method, apparatus, and computer program product for providing location based services, mobile e-commerce, and other functions.

[0004] 2. Discussion of the Background

[0005] Mobile phones and personal digital assistants (PDA) include functionality that is typically limited to providing a telephone communication link, which can be also sometimes used as a data communication link, and a set of software programs such as a calendar, email client, mini-browser, word processor, and other similar user applications. Such devices therefore typically have limited functionality. Generally, very few of such devices include image input capabilities, voice recording capabilities, significant voice control capabilities, location determining or location based capabilities, or other capabilities described herein.

[0006] In addition, portable devices are often carried with users who travel through cities, shopping complexes, and other facilities and geographical areas. However, currently portable devices do not provide users with many services and functions that are related to, or based on, the user's location or changes in location. Similarly, while such devices often have capabilities for providing a telephone communication link, very few provide capabilities for providing wireless Local Area Network (LAN), wireless Personal Area Network (PAN), or any other wireless network communications. Furthermore, such devices typically do not include Web services capabilities or access thereto. As a result of these deficiencies and others, such devices fail to provide substantial mobile e-commerce services, location based functions, and functions or services available through the use of a wireless LAN.

[0007] Furthermore, to date, venders have not been able to take advantage of location information associated with customers and potential customers or obtain information about prospective customers. Typically, a vender only identifies the customer, if at all, when the person makes a purchase. Consequently, venders are typically not aware of the nearby or approaching presence of a past customer, potential customer, or person seeking a product that the vender offers. In addition, even if a vender had such information, venders have no mechanism in place for presenting advertisements to the person or otherwise enticing the user to visit the vender store location or make a purchase. Furthermore, even if such a mechanism was in place, the vender typically has no information about the person that can be used as a basis for selecting of an advertisement to be presented to the person or customizing the advertisement and the person has little incentive for viewing such an advertisement.

[0008] These and other deficiencies are overcome by the present invention which provides a system, method, apparatus, and computer program product for providing location based services, location based mobile e-commerce, automated processing, wireless network communications, mobile telephone communications, and many other functions and services described herein.

SUMMARY OF THE INVENTION

[0009] One embodiment of the present invention may include a processor, a memory, a program code stored in memory and executable by the processor, an audio input device, an audio output device, an input device, a location module configured to determine information of the location of the device, a mobile telephone network transceiver configured to wirelessly communicate via a mobile telephone network, and a wireless area network transceiver configured to wirelessly communicate via a wireless area network.

[0010] Execution of the program code by the processor may control the operation of the device to provide functions based on location data, to facilitate commercial exchanges by wirelessly exchanging payment and product information with venders, to identify services such as venders meeting selection criteria, to wirelessly exchange select information with other users and systems, to restrict and/or monitor the use of the device based on user provided parameters, to select one of a plurality networks through which to communicate, to trigger an action based on a change in location and sensed data, to store a voice annotation with computer data file, to determine service providers and associated communication parameters, to contemporaneously maintain a wireless voice and data link, and many other functions and services that are described herein.

[0011] Further features and advantages of the present invention, as well as the structure and operation of various embodiments and applications of the present invention, are described in detail below with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The accompanying drawings, which are incorporated herein and form part of the specification, illustrate various embodiments of the present invention and, together with the description, further serve to explain the principles of the invention and to enable a person skilled in the pertinent art to make and use the invention. In the drawings, like reference numbers indicate identical or functionally similar elements.

[0013] A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

[0014] **FIG. 1** is a functional block diagram of an example system, apparatus, and computer program product in accordance with the present invention.

[0015] **FIG. 2** is a schematic representation illustrating an example of an area, including a facility, for use with a method, system, apparatus, and computer program product of the present invention.

[0016] **FIG. 3** is a schematic representation of an example vender facility for use with a method, system, apparatus, and computer program product of the present invention.

[0017] **FIG. 4** is a data flow diagram of the method steps for implementing an example embodiment of a system, method, apparatus, and computer program product of the present invention for determining the closest point of interest.

[0018] **FIG. 5** is a data flow diagram of the method steps for implementing an example embodiment of a system, method, apparatus, and computer program product of the present invention for determining a point of interest satisfying criteria.

[0019] **FIG. 6** is a data flow diagram of the method steps for implementing an example embodiment of a system, method, apparatus, and computer program product of the present invention for communication with a remote computer system.

[0020] **FIG. 7** is a data flow diagram of the method steps for implementing an example embodiment of a system, method, apparatus, and computer program product of the present invention for providing location based mobile advertising.

[0021] **FIG. 8** is a data flow diagram of the method steps for implementing an example embodiment of a system, method, apparatus, and computer program product of the present invention for providing mobile advertising.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] In the following description, for purposes of explanation and not limitation, specific details are set forth, such as particular networks, communication systems, computers, terminals, devices, components, techniques, data and network protocols, formats, software products and systems, enterprise applications, operating systems, enterprise technologies, middleware, interfaces, hardware, etc. in order to provide a thorough understanding of the present invention.

[0023] However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. Detailed descriptions of well-known networks, communication systems, computers, terminals, devices, components, techniques, data and network protocols, formats, software products and systems, enterprise applications, operating systems, enterprise technologies, middleware, interfaces, and hardware are omitted so as not to obscure the description of the present invention.

[0024] I. General Design Concepts

[0025] References to a product is meant to mean any product, goods, service, or any other article of commerce including, but not limited to, such items as rentals, tickets (e.g., entertainment, travel, etc.), reservations (e.g., travel, hotel, restaurant, entertainment, etc.), real estate, information, food, and financial products among others.

[0026] In many of the applications of the embodiments, payment information is exchanged between the device and a computer system. The payment information may be related to any type of payment account and therefore may include, for example, credit card information, debit card information, bank account information, information for billing the product to the telephone or to an Internet Service Provider (IS) account used by the device, an email address (e.g., a Paypal® payment), brokerage account information, electronic fund transfer data, and/or any other data that may facilitate payment. The payment information will typically be different for each type of payment account. For example, the payment information for a credit card payment account may include a credit card number, expiration date, name of the card holder, billing address information, and possibly other information. However, the payment information for a bank account might include the bank name, bank account number, bank account owner's name, and a routing number.

[0027] Many of the embodiments described below include establishing a communication link or performing some other action upon occurrence of an event such as when the user with the device of the present invention is within a predetermined distance of a point of sale, a vender, a residence, a place for delivery of goods, a place for pick up of goods, or some other location. The communication link may be established by the device or the remote computer system depending on the design of the system and on which system senses the occurrence of the event as will be evident to those skilled in the art. The "predetermined distance" may be any suitable distance for implementation of the embodiment of the invention, is a design choice for the given application, may be different for different venders, different vender types (e.g., hotels versus restaurants), different embodiments and applications of the present invention, points of interest and/or different locations, and may be dependent or based on the strength of the communication signal. In addition, the predetermined distance may be the distance at which a communication link can be established or is established. Thus, the predetermined distance may be different for different user devices, external systems, times, locations, and need not be a fixed distance.

DETAILED DESCRIPTION OF THE INVENTION

[0028] The present invention is a multi-function communications device **101** that includes conventional mobile phone and personal digital assistant (PDA) capabilities and preferably one or more of the functional modules shown in **FIG. 1** such as a communications module **105**, a location module **110**, a recorder module **115**, a data management module **120**, an authentication module **125**, an image module **130**, a commerce module **135**, and application modules **140** (e.g., computer programs), such as those described herein, all of which may make use of other modules. As will be discussed in more detail below, each module is comprised of a combination of hardware and software and may share (i.e., may be formed by) hardware and software of other modules as is well known in the art.

[0029] The preferred embodiment of the present invention is a portable device **101**. The device **101** is preferably handheld, but may also be worn around the neck, on the hip, attached to the arm of the user, or carried in any convenient manner. The preferred embodiment of the present invention includes a central processing unit (CPU) **150**, including a processor **155**, a memory **160** (including volatile and non-volatile), and communicates with various input and output devices described below. The software in the preferred

embodiment of the present invention includes an operating system, and software for implementing the modules described above and in **FIG. 1** and other functions described throughout. The software for implementing the invention is stored in memory such as Read Only Memory (ROM), EPROM (Erasable ROM), EEPROM (Electrically EPROM). In addition, the memory **160**, some of which is preferably upgradeable, may be removably detachable memory to allow replacement if and when necessary (e.g., when becoming full). Thus, the memory **160** may also include one or more other types of storage devices such as a SmartMedia® card, a CompactFlash® card, a Memory Stick®, a MultiMediaCard®, a DataPlay disc®, and/or a SecureDigital® card.

[0030] The device **101** includes a plurality of user input devices **165** such as a microphone, and actuators (e.g., a QWERTY keyboard). The preferred means of supplying user input to the present invention is through a voice command received by a microphone in a wireless single ear headset. However, other means of supplying the user input, such as manual input means via a touch pad, keyboard, buttons, touch screen, etc. may also be used.

[0031] The device **101** also includes a plurality of output devices such as an audio output device **170** (e.g., a speaker phone, stereo headset jack (and headset), earphone jack (and earphone), among others), one or more displays **175**, LED(s), a vibrator mechanism, and a programmable ringer (e.g., which rings differently based on the source of a call, on the type of alarm (a page versus a phone call versus an alarm clock ring). The display **175** is preferably a high resolution color display and dynamic touch screen that allows the user to provide manual input for certain functions. The display is also capable of displaying a bar code that is capable of being read by a barcode reader.

[0032] The audio output devices, such as the earpiece and headset are preferably wirelessly connected to the device. The earpiece and ear portion of the headset are also preferably molded to the shape of the user's ear from rubber or other pliable material by means well-known in the art.

[0033] As discussed above, the device **101** includes the capability of providing conventional mobile telephone functions such as providing a wireless voice communication link, providing a wireless data communication link (for example, for connecting to the Internet, an email server, or other computer system), and includes applications sometimes found in a PDA such as one or more of an email client, a web browser (preferably Internet Explorer®), text messaging software, short message service (SMS) client or Unstructured Supplementary Services Data (USSD) client, an image viewer, an alarm clock, game software, paging software, a calendar, a word processor, a spreadsheet, a database, and a clock (with alarm capabilities). The device **101** also includes one or more of the functional modules (software and possibly hardware) of a voice recorder (preferably forming part of the recorder module **115**), an audio media player, an audio/video player (which may also acts as the audio media player), facsimile software (for sending and receiving), an image editor, a terminal service client, a voice recognition module, and a virtual private network client. As will be discussed in more detail below, the specific functional modules and software applications are a design choice based on the external systems, desired functionability, costs, co-existing applications, and other factors. Likewise, depending on the modules and software applications included, embodiments of the present invention may take the form of a laptop or notebook computer, a radio frequency tag, a Smart Card, a PDA, a mobile phone, a computer integrated into another item such as a vehicle, or another suitable configuration.

[0034] Preferably the audio/video player is compatible with the open MPEG-4 (Moving Picture Experts Group) standard format and/or the other digital video compression standards (such as MPEG-2 and MPEG-1). More preferably, the player is RealPlayer Media Player® and can be used to play .wav, .avi, .mov, .mpeg, .mp3, .au, and .aiff files. While MPEG is preferred over competing formats, such as Video for Windows®, Indeo® and QuickTime®, one or more of these standards could be used instead of, or in addition to, software for processing video received in the one or more MPEG standards. Preferably, the audio player is an MP3 player.

[0035] The operating system of the present invention is preferably Windows XP® or, alternately, PocketPC® (formally known as Windows CE®) or Palm OS®. The power supply for the device **101** is preferably a rechargeable battery unit such as lithium, nickel-cadmium or nickel-metal hydride battery.

[0036] Communications Module

[0037] As discussed above, the present invention includes a communications module **105**, which includes hardware and software to allow the CPU **150** to communicate with external devices and systems. The hardware and software used to implement the communications module **105** will be driven, at least in part, by the input/output devices with which the CPU interfaces as well as the external systems with which the device **101** must communicate (receive data from and/or transmit data to). Preferably, all or part of the communications module **105** is implemented with one or more application specific integrated circuits (ASICs) and software stored in memory.

[0038] As discussed, the software used to implement the communications module **105** is determined, at least in part, by the systems with which the device **101** must communicate. In the preferred embodiment, the device **101** is configured to receive and transmit (and store) conventional digital communications, which include mobile telephone communications, and other data communications including Internet data, mobile videophone communications, and to receive digital television signals, and digital radio signals (e.g., XM® radio signals). Preferably the device **101** is configured to operate with a conventional mobile telephone network or wireless wide area network (WWAN), and one or more other wireless local area networks (wireless LAN or WLAN), wireless Metropolitan Area Networks (MAN), and a wireless personal area networks (PAN) (e.g., a Bluetooth® network). The preferred embodiment of the present invention includes hardware and software for communicating with (or through) a mobile telephone network, a WLAN, and a wireless PAN. In addition, the device **101** includes hardware and software for communicating with another device **101** through a two way radio communication link.

[0039] In addition, the device **101** may also includes software and hardware for receiving AM, FM and televi-

sions signals. Such analog signals are preferably converted to digital signals at the source, or at an intermediate system, and transmitted to the device **101** as a digital signal through a wireless communication link. At reception, the signals are processed and presented to the user (e.g., via RealPlayer Media Player®) as is well known to those skilled in the art. Thus, the device **101** includes software for formatting, processing, and providing a representation of the signal to the display for presentation to the user. The device **101** may also optionally include an analog signal receiver (e.g., tuner, amplifier, etc.) for receiving and presenting analog radio signals directly.

[0040] The device **101** receives the digital signals from a remote receiver (e.g., through a wireless PAN from an automobile or in XM transmission), which provides the signal in digital form to the device **101**, for immediate presentation or storage (e.g., as an MP3 file or an MPEG-4 formatted television broadcast). Furthermore, the remote receiver (e.g., in an automobile) may receive and store the data (e.g., in MP3 format) and transmit the stored data to the device **101** upon request by the user.

[0041] The following descriptions of various networks, standards, formats and protocols are well-known in the art, are provided as a matter convenience, and are not meant to be interpreted as a limitation on the communications capabilities of a device of the present invention. As discussed, technology for using any mobile phone network, WLAN, or PAN that is suitable for desired application(s) may be used. Communication with the wireless networks is accomplished through access points that receive and transmit wireless signals as is known in the art. Each access point is preferably individually addressable by a computer system (e.g., a client-server computer system)—which may be a vender computer system or facility computer system—with which it communicates data.

[0042] Preferably the device **101** includes a short range wireless LAN module (a PAN module) for communicating via a Bluetooth® network. The Bluetooth® wireless specification includes layer and application layer definitions and supports data, voice and content-centric applications. As is known in the art, devices that comply with the Bluetooth® wireless specification operate in the unlicensed, 2.4 GHz radio spectrum ensuring communication compatibility worldwide. The devices use a spread spectrum, frequency hopping, full-duplex signal at up to 1600 hops/sec. The signal hops among 79 frequencies at 1 MHz intervals to give a high degree of interference immunity and up to seven simultaneous connections can established and maintained.

[0043] The short range wireless LAN module (e.g., the Bluetooth® module) or PAN module allows the device **101** to wireless communicate with printers, wirelessly exchange payment information, communicate with automobile computer systems, building computers systems, facility computer systems, point of sale (POS) devices, vender computer systems, and with other devices employing the present invention. In addition, the PAN module can be used to communicate across a WLAN or WWAN.

[0044] Preferably, the device **101** complies with the Bluetooth® Hands-Free profile and imaging profile specifications. The Hands-Free profile enables hands-free use of mobile phones in automobiles and the imaging profile facilitates transmitting digital images over mobile devices. More specifically, the Hands-Free profile allows automatic establishment of a connection between the automobile's hands-free system and a mobile device the user brings into the automobile. The Imaging profile allows digital images to be shared among mobile devices. For example, a digital camera can share content with a mobile phone, personal computer or other handheld or be sent directly to a printer equipped with Bluetooth® wireless technology.

[0045] As is known in the art, Bluetooth® enabled devices include a link controller that identifies other Bluetooth® devices, coordinates a connection with such devices, and facilitates sending and receiving data from such devices. In establishing a connection with another Bluetooth® enabled device (e.g., a printer, computer, another device, etc.) the two devices first exchange a unique global identification code (global ID), which indicates the devices' profiles and capabilities. If the device profiles match, a connection is made. If the device profiles do not match, the devices ignore each other. The profiles include sets of protocols and procedures that define device functionality and identity such as headset, printer, PDA, cell phone, pager, etc.

[0046] After two devices establish a connection, one is set as the master and the other becomes a slave. The connection of two or more Bluetooth enabled devices is creates a PAN called a piconet in which all the devices in the same piconet are synchronized to the same hopping scheme determined by the master. As is known in the art, a Bluetooth® piconet can include up to 255 parked slaves (devices that are not actively receiving or sending data), which can be unparked by the master as needed. Devices in range of the piconet, but not connect to the piconet, are referred to as being in a stand by mode.

[0047] Bluetooth® compatible devices can be designed to have varying distances of communication capability. Consequently, Bluetooth® access points, which form part of a larger WLAN, a WAN, or other network can be strategically positioned so that communication is limited to devices within a predetermined and/or selected distance and/or direction. The Bluetooth® Specification v.1.1, including the Core Specification (Volume I) and Profile Definitions (Volume II), is hereby incorporated by reference.

[0048] As an alternate or in addition to Bluetooth technology, the device **101** may include hardware and software for communicating via the Echnonet standard.

[0049] The device **101** preferably also includes a WLAN module for communicating via a wireless local area network (WLAN), which are commonly used for corporate or Internet communications on campuses or enterprises. More preferably, the WLAN module is Wi-Fi (short for wireless fidelity) compatible, which means that is compliant with the IEEE 802.11b specification, which is DSSS-(direct sequence spread spectrum) compatible and has a communication range of approximately 1,000 feet in open areas and 250 to 400 feet in closed areas. Specifications for WLAN in Europe include HiperLAN2 (High Performance Radio LAN), which may alternately be used.

[0050] As discussed, the device **101** may also include a WWAN module. WWANs are commonly is used to link cities, states or large enterprises. One common protocol for this type of network is 802.11a. The IEEE (Institute for Electrical and Electronics Engineers) 802.11 standard (802.11, 802.11a, 802.11b, and 802.11b) is hereby incorporated by reference.

[0051] Preferably, the device **101** includes hardware and software for communicating with, or through, a third generation (3G) network, which is embodies some, or all, of the in IMT-2000 standard established by the International Telecommunications Union (ITU) or Universal Mobile Telecommunication System (UMTS). The preferred 3G network standard requires support for data packet networking (i.e., packet switched networking) and includes "always on" connection capabilities connection (or in other words an instant connection) and which allows the device **101** to receive incoming transmissions as they are sent. Networks employing at least some of the 3G standard include CDMA-2000 based services (e.g., CDMA 1XRTT, CDMA 2000 1XEV) (CDMA refers to Code-Division Multiple Access), FOMA (Freedom of Mobile Multimedia Access), and Wideband CDMA.

[0052] Alternately, or in addition, the device **101** of the present invention is designed to communicate via a two and a half generation (2.5G) network, which is also a packet-switched network and an always on. Common 2.5G networks include General Packet Radio Service (GPRS) and Enhanced Data for GSM (Global System for Mobile Communications) Evolution (Edge), also referred to as Enhanced Data Rates for Global Evolution and Enhanced Data GSM Environment.

[0053] Alternately, or in addition, the device **101** of the present invention is designed to communicate via a second generation (2G) network. Common 2G networks include CDMA, Time-Division Multiple Access (TDMA), and Global System for Mobile Communications (GSM). 2G networks are circuit switched networks and require logging on to the network (i.e., do not have always on capabilities).

[0054] Alternately, or in addition to the networks identified above, the device **101** of the present invention is designed to communicate via an analog network often referred to first generation network or 1G network.

[0055] The device **101** also preferably includes Wireless Application Protocol (WAP) capability. Depending on the network or systems with which the device **101** is designed to operate, the following steps are performed to connect to the Internet, which are well-known in the art. First, the user opens a browser (e.g., a minibrowser). The device **101** transmits a query signal searching for service, and in response, a connection is made with the service provider. Next, the user requests a particular web page. The request is sent to a Gateway Server using WAP. The Gateway Server retrieves the information (e.g., the web page) via HTTP from the web server hosting the web page. The Gateway Server encodes the HTTP data as WML (Wireless Markup Language) and transmits the WML-encoded data to the device. The device **101** displays the wireless Internet version of the Web page requested.

[0056] As is known to those skilled in the art, WAP is designed to work on any of the existing wireless services, using standards such as Short Message Service (SMS), Circuit Switched Data (CSD), General Packet Radio Service (GPRS), and Unstructured Supplementary Services Data (USSD). Thus, the WAP protocols are designed to operate over a variety of different bearer services, including short message, circuit-switched data, and packet data although the bearers offer differing levels of quality of service with respect to throughput, error rate, and delays. However, the WAP protocols compensate for, or tolerate, these varying levels of service. Since the Wireless Datagram Protocol (WDP) layer provides the convergence between the bearer service and the rest of the WAP stack, the WDP specification lists the bearers that are supported and the techniques used to allow WAP protocols to run over each bearer and is hereby incorporated by reference. It is anticipated that the list of supported bearers will change over time with new bearers being added over time.

[0057] The device **101** may include multiple antennas, some of which may be removably attached. In addition and as discussed above, the device **101** may communicate with systems having their own antennas (e.g., via a LAN or PAN) in order to facilitate communications with the desired systems such as those that may be integrated into a vehicle. The communications module **105** of the device **101** also includes a port for wired connection to external devices, which is preferably a USB port. The protocols and other information necessary for communicating with the external systems (i.e., networks) are stored in memory. As discussed above, the device **101** also includes the capability of receiving processed and compressed video (e.g., MPEG-4) and therefore includes the software and hardware for receiving, decompressing, and processing the incoming compressed video for display.

[0058] In the preferred embodiment of the present invention, the communication module **105** allows the user to establish and maintain multiple communication links contemporaneously (wired and wireless) such as a wireless voice communication link (e.g., via a 3G network), multiple wireless data communication links (e.g., a wireless LAN and PAN link), and one or more wired links simultaneously. In addition, contemporaneous communication links (such as a voice and data link) with multiple external devices may be accomplished through a single network, such as through the 3G network, 2.5G network or WLAN.

[0059] Contemporaneous wireless communication links through the same network may be accomplished by multiplexing of packet data, which is well-known in the art. In addition, information about the incoming data packets sufficient to allow the communication module (or other software) of the device **101** to determine how the incoming data should be processed (e.g., to which module the data should be supplied or to determine how otherwise to process the incoming data) is also supplied to the device. This technique is well-known in the art and the details thereof are, therefore, not provided here. However, this information—the information that allows the communication module to determine how to utilize the data (collectively "utilization information")—may be included in some or all of the packets (e.g., a sub-address), may be determined by the transmission format, data type, communication link, or transmission source, or determined in any suitable manner well-known in the art. In other words, the received data packets are routed by the communications module to the appropriate software and/or hardware such as memory, the headset, the display, an MP3 player, the location module, and/or another application or module based, at least in part, on the utilization information, which may supplied in the packet (e.g., which may simply indicate the source of the data or identify the destination module for the data) or otherwise determined (e.g., from the communication link or format of the received data).

Outgoing data is multiplexed and addressed to the respective addresses of the remote devices with which the device **101** is communicating.

[0060] Thus, the contemporaneous wireless communication links of the present invention permits the user to participate in a conversation via a voice communication link (e.g., via a 3G, 2.5G, or 2G network) while simultaneously using a data communication link (e.g., via a WLAN, PAN, 3G, 2.5G, or 2G network) to receive or send emails, transmit and receive data via the Internet, download audio or video files, upload and download data, or otherwise transmit and/or receive data. Thus, the user can also receive and transmit live audio/visual data—such as live video transmissions (e.g., a video telephone call, receive a television transmission, transmit video camera data), and live audio transmissions (e.g., a telephone call, receive radio transmission, transmit voice data)—while also transmitting and receiving computer data such as emails, word processing files, spreadsheet files, application files, and data to remote computer systems (e.g., such as a web page from a web server) and non-live audio/visual data (previously stored audio data and video data). While the actual reception and transmission of the bits comprising the multiple transmissions may not occur "simultaneously" from a technical perspective, the data from the multiple transmissions is presented to the user and received from the user in the same time periods (or overlapping time periods), which is herein referred to as contemporaneous transmission and/or reception.

[0061] The transmission of "live" audio/visual is meant to mean the process of transmitting an audio or video signal immediately, or immediately after processing (which may include storing), after the signal is received at the device **101** (e.g., from a camera, microphone, or from other remote device). The presentation of "live" audio/visual is meant to mean the process of receiving an audio or video broadcast and immediately, or immediately after processing (e.g., after storing), presenting the audio and visual to the user on the audio output device and/or display device. The data that is received live may be transmitted as captured from live events from the source or may be transmitted from a previously stored audio/visual production and transmitted upon request by the user (e.g., a movie transmitted on demand).

[0062] The communication module and CPU also cooperate to allow multiple modules to work together. For example, if the user is listening to an audio program via the headset (such as a digital radio program or a MP3 production), the device **101** produces an audible alarm (such a beep) to inform the user that a telephone call is being received, or that another application is requesting the user's attention. Alternately or in addition thereto, and at the selection of the user, a vibratory alarm can be used to inform the user of an incoming telephone call, email, page, or other event.

[0063] The communication module may also route certain data to remote devices during live or non-live presentation to the user. For example, a video transmission or computer data (e.g., web pages) received by the device **101** may be routed (e.g., as requested by the user) to a remote display device (e.g., via a wireless PAN to a display in an automobile) that may be large or of better quality than the display of the device. Similarly, audio signals may be transmitted to a remote stereo system (e.g., in an automobile). The data may be processed, such as being compressed and stored for later retrieval, prior to being routed to a remote device.

[0064] As discussed, the device **101** of the present invention preferably includes means for communicating via two or more communication networks (e.g., wireless WAN, LAN, and PAN). Thus, when communications with the desired external system may be accomplished by more than one network, the device **101** must determine the available network with which to establish the communication(s). The programmed rules for determining which available network with which to establish a communication (or communications) are stored in memory and based on information of the available networks with which the device **101** is designed to communicate and may also be based on user activity or anticipated user activity. The programmed rules may be designed to provide any desirable result such as increasing efficiency, reducing costs, and/or increasing throughput.

[0065] In this example, the determination of the available network with which to establish one more communications is based on one or more of the available bandwidth of each available network (i.e., the amount of data that can be communicated over a given time period), the anticipated bandwidth necessary, the available capacity or relative available capacity (e.g., how full to capacity a network is), the historical (or anticipated) availability of bandwidth (which may include, for example, use, volume, capacity, and/or speed data for days of the week or times of the day), the communication capabilities of the device, the amount of data to be transmitted, and the cost of using each network (e.g., connection time, per amount of data transmitted).

[0066] For example, if the available WLAN network has a maximum speed of 50 K/sec, an available 3G network will likely have greater available bandwidth. If the user desires to download and watch a movie (which may determined by a user input in response to a prompt or by the user opening an audio/video player for external retrieval of the video file), relatively high bandwidth can be anticipated as being needed. Since the WLAN does not provide enough bandwidth to receive the communication (e.g., movie data file) in a desired manner without buffering, the higher speed network is selected. If both networks have enough available bandwidth, the network is preferably selected based on the costs of use. For example, many Wi-Fi networks are free, while 2G networks have a cost per minute of use. If these two example available networks have enough available bandwidth for the communication, the programming rules determine selection of the Wi-Fi network since it is less expensive to the user. Thus, in this example embodiment the programmed rules will be based on bandwidth availability (anticipated, current), which may be estimated or known (which may be stored as a result of a transmission), and cost.

[0067] Prior to communicating with the external system, the device **101** preferably transmits a request for communication via the various networks with which the device **101** is designed to communicate. In addition, communications with some networks (e.g., always on networks) may already be established. Thus, the determination of the available networks with which to establish the desired communication, and information relating to it (e.g., bandwidth data), can be established during the requested communication.

[0068] Moreover, the device **101** includes programming for switching communication networks. Thus, when network switching conditions arise, the device **101** establishes a communication with the external device via a second network and preferably terminates the communication established through the first network. Network switching conditions may include one or more of 1) changes in network conditions such as failure of a first network or the first network slowing down (due to high use such as multiple users and/or high levels of data being communicated), such as below a predetermined level (e.g., threshold speed), or increases in noise, 2) the user making a request, or attempting to make the request, to communicate data that is more suitable for communication through a second network (e.g., the user requesting a video file or movie), 3) the anticipated request of the user (e.g., based on the user starting a particular application such as a video player), 4) changes in network availability (e.g., a new network becoming available), 5) changes in conditions of the second network (e.g., more bandwidth or less noise), 6) the available capacity or relative available capacity (e.g., how full to capacity a network is), 7) the communication capabilities of the device, and 8) the historical (or anticipated) availability of bandwidth of network(s) (which may include, for example, use, volume, capacity, and/or speed data for days of the week or times of the day). The device **101** may determine any of the above information itself or receive the information in a transmission from remote computers, which monitor the networks.

[0069] In some situations, more than one network may be operated by the same computer system (e.g., of the same service provider). Thus, a multi-network computer system (MNCS) having information relating to more than one network may determine, or assist the device **101** in determining, which network should be used by the device **101** for communications. The MNCS determines the available network with which to the device **101** establishes the communication based on any of data described above, which may be determined itself (e.g., historical data) or received from the device **101** (e.g., based on a user request for a video file). Upon determining the available network with which the device **101** should establish the communication, the MNCS transmits information identifying the network, which is received and used by the device **101** as a basis for determining the network with which the device establishes the communication. Likewise, the MNCS determines whether network switching conditions (described above) arise and initiates the switch by transmitting data requesting a switch (or used by the device **101** determine whether a switch should be completed), which includes data identifying the second network.

[0070] As discussed, the programming that controls the operation of the communication module **105** and other modules of the preferred embodiment of the present invention is stored in the memory **160** of the device **101**.

[0071] As discussed the communication module facilitates communications, as shown in **FIG. 6**, by performing the steps of receiving data for communications (not shown), determining communications parameters (e.g., format, protocol, communication network, destination) at step **402**, formatting the data for the desired destination at step **405**, transmitting the data at step **410**. The data is transmitted according to the determined protocol and to the determined destination. The communication module **105** also receives transmissions, which may be responses to device **101** transmissions at step **415**. The received data is decoded at step **420**, which may include, but is not limited to, unformatting, deformating, transcoding, and/or interpreting (e.g., name value pairs) the received data. At step **425**, the decoded data is processed by the communication module or other computer program (e.g., the commerce module, authentication module, or other application module).

[0072] In performing these steps and others, the present invention preferably makes use of Web services. As is well-known in the art, a Web services provides a standardized interface that permits software programs in the service provider to communicate with remote programs (e.g., in the device **101**). More specifically, a Web service is a software module hosted by a service provider that can be run remotely. In order for it to be available to remote systems, a descriptor of the Web service is published to a service registry. Information about the Web service and how to use it is found in the descriptor. When a service requestor (which in the present invention is a software executing on the device **101** or on behalf of the device) desires to run a Web service, it contacts the service registry. Based on data found in the descriptor, the requester binds to the service provider and runs the Web service. The directory may also be used to search and identify providers of particular services.

[0073] As is well-known, XML is a mark-up language used to define standardized elements of web pages and business documents such as product name, product number, price, and other characteristics (e.g., color, size, etc.) thereby defining what kinds of information each element contains. In the preferred embodiment, the Web service core technologies include UDDI (Universal Description Discovery and Integration), SOAP (Simple Object Access Protocol), and WSDL (Web Services Description Language) and are in XML format. While these technologies and their functionality are known in the art, the following description is provided for convenience. However, the present invention may employ other features available to these technologies not listed here.

[0074] As discussed, the service registry of the preferred embodiment is a UDDI implementation and is essentially a catalog of businesses and the web-accessible services they provide. The Web Service Registry provides a mechanism to advertise and find Web Services. The Registry contains categorized information about businesses and the services that they offer and associates those services with technical specifications of the Web service. As discussed, these technical specifications are defined using a descriptor, which in the preferred embodiment is a WSDL document.

[0075] WSDL documents describe Web Service function(s), how it communicates, and where it can be found (e.g., an address or destination for communication). In operation, a Web Service requestor (e.g., a device **101**) queries the Registry to find the descriptor to determine how to use the Web Service. The UDDI is itself a Web service and the Registry specification defines an Application Program Interface (API) based on SOAP messages with a description of the registry service. Most registries also provide a browser-based human interface. The UDDI Project operates a global public registry called the UDDI Business Registry, which is available to at http://www.uddi.org. Organizations

can also set up a private registry to support the requirements of an enterprise or a private community such as for a shopping complex. A private registry can impose additional security controls to protect the integrity of the registry data and to prevent access by unauthorized users. A private registry might contain only private information, it might contain a subset of the public registry information, or it might contain a combination of public and private information.

[0076] A UDDI implementation is made up of three different elements. Not all listings in UDDI registries, however, contain all of the elements. The first of the three elements is a "white pages," which contains the basic contact information for each Web service listing. White pages generally includes basic information about the company, as well as how to make contact. Another element is a "yellow pages," which has more details about the company, and includes descriptions of the kind of electronic capabilities the company can offer to users who desire to do business with the company. The yellow pages uses commonly accepted industrial categorization schemes, industry codes, product codes, business identification codes and the like to make it easier for requesters to search through the listings and find exactly what is desired. Third, a UDDI includes a "green pages," which allows the requestor to bind to a Web service after it has been found. The green pages include the various interfaces, URL locations, discovery information and similar data required to find and run the Web service.

[0077] An "identifier" is a type of property or keyword used to uniquely identify a business or specification in the service registry. Identifiers can be applied to <businessEntity> and <tModel> structures. Identifiers, like categorizations, can be used as part of a search when doing a <find_business> or <find_tModel> request message. Identifiers and categorizations are implemented similarly. Identifiers are attached to <businessEntity> and <tModel> documents through an <identifierBag> structure. The <identifierBag> structure can have one or more <keyedReference> structures that provide the name, value, and <tModel> UUID reference for locating more information.

[0078] Preferably, two general-purpose identifier schemes have been incorporated into all operator nodes, but other schemes can be used as well. The identifier types that are a core part of an operator node include D-U-N-S (tModel name of dnb-com:D-U-N-S) and Thomas (tModel name of thomasregister-com:supplierID). The Dun & Bradstreet® (D-U-N-S) number is a unique nine-digit identification sequence. This sequence provides unique identifiers for single business entities, while linking corporate family structures. This information is available at http://www.d-u-n-s.com. The Thomas Registry® scheme (Thomas) provides identifiers for many thousands of manufacturing and e-commerce companies worldwide. Additional information is available at http://www.thomasregister.com.

[0079] tModel documents provide metadata information about a web service specification, categorization specification, or identifier specification. tModel documents are a core data structure in the UDDI specification and represent the most detailed information that a UDDI registry can provide about any specification.

[0080] SOAP (Simple Object Access Protocol) includes a communications protocol that facilitates use of the Web services of the preferred embodiment and used to send commands across a communication link (e.g., HTTP internet connection) and includes destination information, content information, and use information. SOAP is used to publish the descriptor into a service registry; to send a service request from a requestor to the registry; to send information from the registry to the requestor; and then to allow the requestor to bind to the service provider and run the Web service.

[0081] A message sent via SOAP is in XML format, and is made up of three parts—an envelope, a header and a body. The envelope encapsulates the message header and body, and contains a variety of information required for processing the message, including a description of the kind of data to be found inside the envelope, and information about how that data should be processed. It also contains information about the sender and recipient of the message.

[0082] SOAP does not require that a message contain a header, although as a practical matter, messages will include them when SOAP is used in Web services. Information found in headers can perform a variety of functions, such as providing authentication. The data found in headers is organized into header blocks and there can be one or more blocks in a header. The body of the message contains the message data. The data might be a request for information—for example, when a service requestor is searching a service registry for a Web service—or it might be a response to a request for information, such as when the registry sends back a descriptor. The data found in the body is organized into sub-elements and there can be one or more sub-elements in the body.

[0083] As discussed, a descriptor document (e.g., WSDL document) is a set of computerized instructions that provide information relating to the functionality of a Web services application and the protocols and formats it uses. WSDL is an XML-based language used to create documents that provide vital information about how the Web services can be located and executed (or run).

[0084] In order to run a Web service, a requestor first needs to locate the WSDL document that details how to run the services. Once the document is found, it is transmitted to the requestor. The descriptor (e.g. WSDL document) is then processed, and based on the information in the received descriptor, a SOAP request (or requests) is transmitted to the Web service provider. That service provider then sends the information requested using the SOAP protocol.

[0085] A requester can get a WSDL document in a number of different ways. The document may be located in a searchable, public or private UDDI directory as described above. The WSDL document may also be retrieved from memory and can be transmitted from, requested from, and located in a variety of ways, including via HTTP requests, FTP, and email.

[0086] As discussed, a WSDL document describes Web service functionality, details where the service can be located, and then provides specific instructions on how that service can be bound to and run. To accomplish these objectives, a WSDL document includes a number of different important elements. Among the most important ones are "type" and "message" elements, which describe the information to be passed in the Web service. The "type" element

is a container for data type definitions using some type system. The "message" element is an abstract, typed definition of the data being communicated and is in essence the information that is going to be exchanged or requested. The "binding" element details how information is going to be passed between the requestor and the Web service, and includes information such as the protocol and data format. Bindings may be HTTP, SMTP, MIME or other suitable binding. The "portType" describes the operations that will be supported by the Web service. The "service" details the location of the Web service. Finally, the "operation" element is a description of an action supported by the service. Web services and their use are described, in part, in WSDL 1.1, WC3 Note 15 dated March 2001 and I the Web Service Description Requirements W3C Working Draft dated Apr. 29, 2002, which are hereby incorporated by reference.

[0087] Finally, once information regarding a service provider is obtained, the device **101** preferably stores the information for repeat use (either locally or on a remote storage device for retrieval as needed by the device). Specifically, the device **101** stores the list of service providers and their associated data, including the information retrieved from the registry such as the descriptor document (WSDL document), which includes the format and protocol used by the service provider.

[0088] As is known in the art, communication devices include numerous layers that cooperate to facilitate the communication with each layer performing a different function. For example, the physical layer, which is layer 1 of the Open Systems Interconnection (OSI) networking model relates to the mechanical, electrical and functional aspects of connections in a communications medium. Other layers include the data link layer, the network layer, the transport layer, the session layer, the presentation layer, and the application layer. Control and data is passed from one layer to the next. As is known in the art, a communication may begin with the application layer on one end (for example, a user opening an application and typing a request). However, in the present invention, the programming of the present invention may initiate the communications as will be evident by the description of the application program below. Thus, the programming of the present invention, which, for example, receives user inputs and transmits data to remote devices, takes actions based on location and/or triggering events, and performs other functions is preferably designed to execute largely in the application layer as will be evident to those skilled in the art.

[0089] Preferably, the communication module **105** allows for dynamic adjustment of bit rate, protocol, and format to accommodate communications with different types devices and changing network conditions. In the preferred embodiment, an encryption module is included to encrypt and decrypt data before transmission and after reception for systems employing encrypted transmissions and/or when the application being serviced does not provide encryption. The device **101** supports data protection and user authentication using the Extensible Authentication Protocol—Tunneled Transport Layer Security (EAP-TTLS) protocol, which only requires a password from the end user for authentication, for communicating with external systems supporting the protocol.

[0090] Location Module

[0091] The location module includes hardware and software to determine the location of the device. Depending on the implementation of the present invention, the location module may determine the absolute and/or relative location of the device. The absolute location may be determined by using a global position satellite (GPS) receiver that is integrated into the device, which can be used to determine the approximate longitude and latitude of the device. Another method of determining the absolute location is through the use of a network-based position-location system, which may use, for example, triangulation from cell towers to locate the device. Network-based location systems are manufactured by TruePosition Inc. in King of Prussia, Pa., or Forest, Va.-based Grayson Wireless, a division of Allen Telecom Inc. in Beechwood, Ohio. Thus, the location data may be transmitted to the device **101** from an external system (e.g., a network-based position location system) capable of determining its location.

[0092] Absolute location data may also be transmitted from a nearby device (e.g., an airplane, a bus, an automobile, a ship, etc.), which itself has a means for determining its absolute location or transmitted from a nearby device that is fixed in location and that has absolute location data prestored therein (e.g., via WLAN from an access point in a billboard, a road side sign, a vender, etc.). In addition, data in periodic transmissions or in a single transmission from a fixed device could be used with velocity data supplied by a vehicle to determine an accurate and substantially continuous (up to date) absolute location of a device carried in the moving vehicle.

[0093] The location data may be used with map data stored in memory of the device **101**, or stored in a computer system with which the device **101** communicates (such as in a vehicle computer system or remote computer) to provide a real world location (e.g., a street, intersection, address, complex, or business) as is well-known in the art.

[0094] The relative location refers to the location of the device **101** relative to another point of interest such as the distance (or in some applications the time) from a particular point of interest. For example, in some embodiments, in may be necessary to find the closest vender of a given product. In doing so, the relative location of the device **101** from each vender is compared to find the closest vender. The relative location to a point of interest may be determined from the absolute locations of the device **101** and the point of interest. In addition, in some applications the cumulative distance of the thoroughfares (streets, roads, highways, etc.) between the device **101** and the point of interest may be determined and used to determine the relative location of the device **101** with respect to the point of interest. In other embodiments, a communication link with a particular access point (or a plurality of access points) may provide relative location data (e.g., that the device **101** is in a room, facility, parking lot, vender store location, or other area) to the device **101** or an external computer system.

[0095] The relative location may also be determined from data transmitted from nearby devices (e.g., via WLAN from an access point in a billboard, a road side sign, a vender, etc.) that includes information of the relative location of the nearby device. For example, the nearby device (e.g., a billboard with a wireless transceiver therein) may transmit

information to the device to indicate that the device is at, or within, a predetermined distance of a particular point of interest (e.g., a vender). Alternately, the nearby device may transmit the distances from the nearby device to a plurality of points of interests when the communication link with the device **101** is established. In addition, data in periodic or a single transmission from a fixed device could be used with velocity data supplied by a vehicle to determine an accurate and up to date relative location.

[0096] Preferably, the location module includes a GPS receiver with mapping software. In addition, relative location data is determined from the device's **101** communications with access points that form part of a WLAN. However, any suitable means of determining an absolute or relative location that is suitable for the embodiment or an application may be used.

[0097] Authentication Module

[0098] The authentication module **125** authenticates the user (or in some instances the user's device) through the use of authenticating data. Authentication may be used to confirm the identity of the person carrying the device, to prevent the unauthorized use of the device, and to authenticate the creation, use, transmission, or storage of data at the device **101** of the present invention or at a remote device. The authenticating data may include, but is not limited to, a password, pin number, voice data, face data, iris data, and/or finger print data that may be stored in the device **101** and/or at a remote computer system used to authenticate the user.

[0099] The determination as to whether authenticating data is necessary to perform a given action is determined by the remote system with which the action is to be performed (e.g., a purchase made, data stored, information provided) and/or by the programming in the device **101** when predetermined actions are requested (e.g., to make a purchase). For example, authentication may only be necessary when purchases are sufficiently large or other security measures warrant it.

[0100] Authentication may be performed in numerous manners, is largely a design choice and its implementation will vary depending on the application, available data, available hardware, the external systems, and costs. For example, in one embodiment, no authentication is necessary when making a small purchase. When making a purchase above a predetermined price threshold (e.g., $500), a first level of authentication may be required such as entering a pin number or password into the device **101** (much like a debit card), which may be transmitted to a third party computer network for validation thereby providing authenticating data to the external system. In addition, the device **101** may request authenticating information from the user in certain circumstance and include programming that does not permit certain activities (e.g., commercial transactions) unless the user enters a valid password (either at power up or upon requesting a commercial transaction). In addition, confirmation that the user has entered a password to facilitate the commercial transaction (i.e., provided authenticating data to the device) may optionally be transmitted to a vender computer system or other remote computer system during the transaction to give the vender additional confidence of the user's authority to use the device **101** and its payment means.

[0101] Other means of authentication may include recognizing the user's voice (which is compared to a stored voice), receiving a finger print input at the image module which is compared to stored finger print data, and receiving data of an image of the face or iris of the user at a video input, which is compared to stored data of the same.

[0102] Alternately, the user may have an rf tag in the form of an integrated circuit implanted under the skin (or otherwise attached to the person), which contains user identifying information, such as, or similar to, the Verichip® manufactured by Applied Digital Solutions of Palm Beach, Fla. This rf tag can be pinged (transmit an rf signal to) to determine the identity of the user by the device **101** or by a remote system within range of the user. The identification information is transmitted from the rf tag, received by pinging device (or other device), compared with the information associated with the user (which may be supplied to a remote computer system by the device **101** or already present in memory of the remote computer system) to confirm the user's identity or to determine his or her identity.

[0103] Input of authentication data may be required at power up or at the request by the user to enter into a commercial transaction or to otherwise use the device **101** in a fashion that has been determined to require an authentication input.

[0104] In addition, the authentication data may be stored in memory and retrieved for transmission to a remote computer that determines whether the user's voice, face, iris, finger print, or other input matches the data stored in memory. In addition, transmission of the authentication data of the user's voice, face, iris, fingerprint retrieved from memory may require input of a password or pin number. Upon receipt of the authentication data, validation data is transmitted to the vender, the financial institution issuing payment at the request of the user, or other computer system from the remote computer system performing the validation. Thus, a thief or unauthorized user would have to store new authenticating data (their own data) in memory in order to operate the device. Preferably the new data can only be stored, however, if the necessary authentication input (i.e., voice, iris, face, finger print, or other input) is inputted to permit overwriting the old data or the addition of new data for a new user. In addition, some applications may require that the user transmit a live authenticating image or video data (as opposed to being transmitted from stored data). Live data is transmitted along with data sufficient to confirm that the data is not a transmission of a recording, such as information of the time of day and/or date, data supplied by an external system, location data, and/or other data.

[0105] In applications where greater security is needed, a third party computer system (or the computer system of the vender) can store the authentication data (voice, iris, face, finger print, or other data) and compare the data from the user received from a vender input device (e.g., a scanner) with the stored data to authenticate the user. When a valid comparison is made, the third party computer system transmits validation data indicating the authority of the user to perform the requested action (e.g., confirming the user's identity) or information indicating that the person is not authorized to perform the desired action.

[0106] In addition or alternately, an image of the user can be stored in the device **101** and displayed on the display of the device **101** to the vender or entry control personnel who can then compare the stored picture with the face of the user.

The picture (or other data such as voice, iris, or finger print data) stored in the device **101** can also be compared to a picture (or other data such as voice, iris, or finger print data) stored by the vender (or by the entry control computer system) and/or compared to an identification document (e.g., a passport or driver's license) carried by the user.

[0107] In addition, the authentication module includes programming for authenticating a data file at its creation, receipt, modification, transmission, and/or some other operation on the data file. Prior to use, the user supplies authenticating data to the device **101** (e.g., logging in with a password). After (or during) the operation on the data file, the programming embeds, or otherwise attaches or associates, information based on the authenticated data in the data file. For example, prior to creating a text file, modifying a file, upon receiving a file, taking a digital picture, transmitting a file or performing some other action on a file, the user inputs a username and/or password (or supplies other authenticating information as described above) to the device **101** that confirms, or is used to determine, the identity of the user. When the user creates a text file, modifies a file, receives the file, takes a digital picture, (all of which require storing the new version of the file), transmits a file or performs some other operation on a file, the program embeds (or otherwise associates or attaches) information sufficient to identify the user performing the operation when storing the file.

[0108] An authorized user may select which data files to include authenticating data and can program the device **101** to include it for all, or select, operations performed by users who are not the authorized user (e.g., a child or employee). In addition, the device **101** can embed (or otherwise associate or attach) information sufficient to identify the device. In addition, other information such as the time and/or location data (e.g., received from the location module or otherwise supplied) may be embedded in (or otherwise associated with or attached to) the data file at creation, modification, receipt, transmission or some other operation on the file when the file is saved.

[0109] Thus, this feature can allow a person such as a police officer to take a digital photograph of a crime or accident scene, embed (or otherwise associate or attach) information of the location, time, and/or identity of the person taking the photograph in the digital file, wirelessly transmit the file to a remote computer system for storage and use as evidence. The methods of embedding, associating, and attaching a subset of data in, with, and to a data file are well known in the art. Those skilled in the art will recognize that the method, protocol or format for embedding, associating, and attaching the information sufficient to identify the user, device, location, and/or time may be any method which permits the data to used, extracted, read, or otherwise interpreted at a subsequent point in time and that limits the ability of users to alter the embedded or otherwise attached data.

[0110] Recorder Module

[0111] The recorder module **115** of the device **101** also includes the features normally associated with a conventional voice recorder such as voice recording and voice playback. The recorder module **115** may also be used to record data being received or transmitted through the communications module **105**, produced by an output device such as the display **175** or audio output device **170**, and received from any input device **165**. Thus, the recorder module **115** can also record data being received for and/or produced at the audio output device and can be used to record both sides a telephone call conversation and to record music that is being received and/or played live (for example, digital radio). In addition, the recorder module **115** may also be used to store video data received and/or transmitted such as a video telephone communications and digital television transmissions. For video telephone communications, the device **101** can record either or both sides of the conversation (both the incoming and outgoing transmissions).

[0112] In the preferred embodiment, all data supplied to the audio output device, input device, and display, is stored in volatile memory (e.g., RAM). If the user has elected to record the data, the software implementing the recorder module simply does not overwrite the stored data in volatile memory until the data is moved to nonvolatile memory (e.g., EEPROM). The data can then later be retrieved for audible and/or visual reproduction, converted to text using well-known voice recognition software (in the case of stored voice data), or transmitted to a remote computer for processing (such as being converted to text, indexing) and storage.

[0113] The recorder module **115** may be used to store voice annotations for computer data such as a computer file. For example, the user may wish to store a voice annotation for a scanned document such as the spoken words, "Vehicle Registration," which are received at the device's **101** microphone. The voice annotation and document are stored in manner that allows the user to retrieve the annotation alone, with the document, or the document without the annotation. For example, a header of the computer data file may include information identifying all of the voice annotations for the computer data. Thus, when the user retrieves the computer data file, the voice annotations are automatically identified to the user who may select the annotations for audible production. Alternately, they may be automatically produced to the user at retrieval of the computer file or upon some other action. Any suitable scheme for storing the computer data and associated voice annotations may be used. As another example, a file directory may include a list of each computer data file, each voice annotation, and information for identifying the association of each computer data file with its voice annotation(s).

[0114] One or more voice annotations may be stored for each page of data in a computer data file. The voice annotation may be attached to any portion or portions of a computer data file such as an image file, an audio file, a video file, a word processing file, a spreadsheet file, address book entry or file, an image within a composite file, or other application data file.

[0115] Finally, the recorded voice data can be processed for use as file storage data. For example, the voice data may be converted to text and used as the file name of the computer data file for storage of the computer data. Thus, after the user creates a file, for example by taking a digital a photograph, a digital video, or recording an audio file, the user can input voice data that is used as the filename for storing the created file and also used to determine the destination for storing the data file.

[0116] Image Module

[0117] The image module **130** includes the hardware and software used to receive and process image data, which may include digital photographs, bar codes, text, and other image data. The image module **130** preferably includes a digital camera that functions to capture still photographs and video data (i.e., motion video). The image module **130** also includes software for converting received image data (e.g., received as an image when the digital camera acts as a copier by photographing text) to text, which is preferably conventional optical character recognition (OCR) software. The image module **130** may optionally also include a conventional scanner and/or bar code reader, which are well known in the art. Other image input devices may be included instead of, or in addition to, the above image input devices such as an infrared transmitter and/or receiver as is deemed appropriate for the embodiment. Finally, the image module **130** may also optionally include hardware and software for receiving and processing fingerprint, iris, or face data used for authenticating the user (e.g., a fingerprint scanner).

[0118] The hardware portion of the image module **130** may be detachable or, in some embodiments, may be disposed remotely such as in an automobile and in communication with the handheld portion of the device.

[0119] As discussed, the image module **130** allows the user to scan text, bar codes, or other markings or indicia for storage in the device. The data can then be processed according to instructions or other information found in the scanned image or according to a user input. For example, the user could scan a web address and say "connect" to provide a voice command that instructs the device **101** to provide a data communication link to the scanned web site. Alternately, the user can scan a product name or number and input a command (by saying "purchase") to purchase the product. In response, the device **101** retrieves payment information, user information and an address (e.g., web address) of a vender for such products from memory, service registry or other source and transmits the product information, user information, and payment information to the vender to purchase the product.

[0120] When the image input device of the present invention is used to capture the image of text (e.g., a document), the data may be wireless transmitted to a printing device thereby effectively acting as a wireless copying system. Thus, the user need not carry each document to a copier for copying but can simply retrieve the copied pages. Multiple devices may transmit the data to the printing device, which, after processing (e.g., normalizing), queues the data for printing like a conventional printer or fax printer. Instead of a handheld device, another embodiment implementing this application of the present invention may be a desktop device that captures the image and transmits it wirelessly (or via wire) to a remote printing device.

[0121] The captured images may also be transmitted to a remote computer system for processing such as converting the images to text via OCR software, and subsequently printing the data. As discussed above, the user may also annotate the image data with a voice annotation.

[0122] Commerce Module

[0123] The commerce module **135** facilitates commercial transactions and in particular, performs the steps of exchanging payment information, receiving acknowledgement of satisfactory completion of the transaction, providing an indication of the satisfactory or unsatisfactory completion of the transaction to the user, and processing and storing information resulting from the transaction (e.g., a hotel room number, a ticket number, etc.).

[0124] In performing the above steps, the commerce module **135** manages the means for making payment. The commerce module **135** stores data payment information supplied by the user or received from an external source in memory **160** in different categories. In particular, the commerce module **135** stores various categories of information for making a purchase such as credit card data, bank account data, debit card data, telephone account data, email account data, ISP account data, brokerage account data, and/or other data. Each category includes numerous payment account records. For example, data stored in memory **160** for one category includes the credit card number, expiration date, billing address, and credit card holder's name for four different credit cards (a gas card, a MasterCard®, and a Visa® card, and an American Express® card). Likewise, the memory may additionally hold data for two bank accounts (a second category) and two ISP accounts (a third category).

[0125] In many of the applications of the present invention, a request to purchase a product is transmitted to a remote computer system. The product request data transmitted is electronically formatted in a manner suitable for the system receiving the request. The format of the request data may be may be received from the vender near the beginning of the transaction, may be retrieved from memory (which was received and stored during a previous transaction with the vender), may be retrieved from memory after being selected by the user, may be selected as a format that is likely to be acceptable for that type of vender, may be supplied by the user, and/or may be retrieved from a database (which may or may not be in the device) such as a service registry or directory that includes formats for the particular vender, the particular type of vender (e.g., a restaurant), the particular product (e.g., an airline ticket from a particular airline), the particular type of product (e.g., food), and/or the location of the vender (e.g., the country).

[0126] As discussed, the commerce module **135** exchanges payment data to facilitate payment of the product. In doing so, the commerce module selects a payment account that is acceptable to the vender. Data indicating the types of payment accounts that are acceptable to the vender may be received from the vender near the beginning of the transaction, may be retrieved from memory (which was received and stored during a previous transaction with the vender), may be retrieved from memory after being selected by the user, may be selected as a payment account that is likely to be acceptable for that type of vender, may be supplied by the user, and/or may be retrieved from a database, a service registry, or other source that includes data of acceptable payment accounts for the particular vender, the particular type of vender (e.g., a restaurant), the particular product (e.g., an airline ticket from a particular airline), the particular type of product (e.g., food), and/or the location of the vender (e.g., the country).

[0127] In addition, the commerce module **135** preferably selects the payment account i

such as, for example, selecting the credit card with the lowest interest rate. In addition, the commerce module **135** preferably selects the payment account based on 1) whether the purchase is for business or personal purposes (which may be determined by user input or based on the identity of the vender); 2) whether the assets or credit is available to make the purchase; and/or 3) according to predetermined user preferences supplied by the user.

[0128] The commerce module **135** also formats the payment information data in a manner that is appropriate for the receiving computer system. For example, when communicating with an Internet site, credit card data may be included as the values in the variable value pairs for the credit card number, expiration date, name, etc. Other systems may require the data be received in a different format. The format of the payment data is preferably retrieved from memory, (which was received and stored during a previous transaction with the vender), may be provided to the device **101** during the transaction, and/or may be retrieved from a database (e.g., which may or may not be in the device) that includes format data for the particular vender, the particular type of vender (e.g., an internet web site), the particular product (e.g., an airline ticket from a particular airline), the particular type of product (e.g., food), and/or the location of the vender (e.g., the country), and/or may be supplied through the use of Web services. As discussed above, the descriptor found in a service registry may be requested and received to provide the format and protocol data and services data for a particular service provider.

[0129] Next, the payment information is transmitted to the desired destination. If requested or necessary for the system, an acknowledgement, confirmation, or other data may be transmitted by the remote system and received by the device **101** according to the protocol of the external system. The device **101** receives the acknowledgement or confirmation of satisfactory completion of the transaction and provides the user with a visual and/or audible indication of the success of the transaction. For example, upon completion of the satisfactory exchange of payment information with a hotel vender, the device **101** audibly produces and displays the words "Check in to hotel complete. Entry code for room 1524 is 123456." Alternately or in addition, the device **101** transmits the indication to the automobile in which the user is riding for display on the vehicle's heads up display. Information indicating the success or failure of the transaction, as well as information resulting from the transaction (e.g., an entry code, an e-book, information for boarding transportation) is also stored in the memory of the device **101** for later retrieval and use.

[0130] In one example embodiment, when the commerce module **135** executes a commercial transaction, payment information is transmitted to a remote computer system (e.g., the vender's computer system). The remote computer system transmits this information as part of a transaction request to the user's account institution card (e.g., the user's bank) or an acquirer (e.g., in the case of a credit card). As is known in the art, an acquirer is an organization that collects credit-authentication requests from merchants and provides the merchants with a payment guarantee. If the request is to a bank account (or similar account), the remote computer system receives an approval code, which authorizes the transaction, and an electronic fund transfer is performed to a designated account (e.g., a vender's account or the user's account in the case of a cash withdrawal). Alternately, if approved for a purchase (e.g., in the case of a credit card transaction), the remote computer system receives an approval code and an ACH (automated clearing house) transfer of funds is performed to the vender's bank account, typically on the next business day.

[0131] Data Management Module

[0132] The data management module **120** performs various administrative tasks including memory management, perform memory back-ups, and defragment memory. Because the device **101** is portable, and preferably carried on the user's body, it is preferable to keep the size of the device **101** relatively small. As a result, there is limited space for components including memory. The data management module manages the data to make optimal use of the available memory and to reduce the likelihood that other modules and applications do not run out of memory. For example, the storage of video is a relatively memory intensive task and will, therefore, use up large amounts memory and use memory more quickly that other tasks (such as, for example, storing a typical text file).

[0133] To ensure that memory is available to modules and applications, the data management module transmits data stored in the device **101**—or being stored in the device **101**—to a remote storage device. The remote storage device might be a third party remote computer, the user's home computer, a storage device in the user's automobile, the automobile of another person the user is riding, a mass transmit vehicle (airplane, bus, etc.), and/or a separate storage device carried by the user.

[0134] The data management module is preferably implemented to begin storing data remotely when the remaining available (unused) memory reaches a minimum threshold, such as when, for example, only twenty percent of the memory or one gigabyte remains available. When the minimum threshold is available, the device **101** selects the data to be stored remotely. The selection may be based on a number of factors including the size of the data file. Transmitting larger data files reduces the number of files that need be transmitted. In addition, the activity of the data is another factor. For example, it may be undesirable to remotely store a file that the user accesses often or has recently accessed (e.g., a text file) or that an application or module accesses often or has recently accessed (e.g., an address book data file). Thus, the length of time since the data has been used is another factor for determining whether it should be stored remotely. In addition, the data management will also transmit data for remote storage according to predetermined data storage criteria. For example, the user and/or manufacturer of the device **101** may store data storage rules that are based on the type of the data. One example of a data storage rule is always remotely store video data not accessed within the past seven days before any other type of data. When no such video data is present in memory, these example rules then dictate that the data management module remotely store audio data not accessed with the past seven days before any other type of remaining data. In addition, the user or manufacture can designate select data for storage locally. In summary, what data is stored is dependent on data storage rules that may be user or manufactured stored rules and based on data type, the source of the data, the location of the user, the time of day, the day of the week, the purpose of the

data, the activity of the data, and/or other factors. The rules may also be received and stored from a third party or remote source.

[0135] The data management module **120** also manages where the data is to be remotely stored. For example, some data (e.g., word processing files) might be stored at the user's work computer system, while MP3 files are stored on the user's home entertainment system, or the user's automobile computer system. Thus, where the data management module **120** stores the data is also dependent on data storage rules that may include user or manufactured stored rules based on data type, the location of the user, the direction the user is going, anticipation that the user will be at location at a later time (e.g., that the user will be out of transmission range a few minutes hence), recent activities of the user, an external event (e.g., turning off the automobile engine), the intended destination of the user, the source of the data, the time of day, the day of the week, the purpose of the data, and/or other factors.

[0136] Preferably, the data management module **120** works transparently to ensure memory is available. However, if data storage rules are not present or are ambiguous to the data type or situation, or in other circumstances, the data management module **120** may prompt the user to provide an input indicating whether (or what) data should be remotely stored and/or where the data should be stored. The data is stored and retrieved in a conventional manner, such as a manner used by a server or other storage device for use by multiple users, and the mechanics of the data storage and retrieval are therefore not repeated here.

[0137] If the user elects to retrieve the remotely stored data, the device **101** will automatically establish a communication link by means determined by the data management module **120** (if necessary), and transmit a request to the remote storage device that identifies the file as is well known in the art.

[0138] The data management module **120** may establish a first type of communication link to store data and a second type of communication link to retrieve data. For example, when the user is in the automobile and the data management module **120** determines that remote storage is necessary, the data management module **120** can establish a wireless PAN link to store data in the automobile (e.g., of the bus the user is riding, or in the user's automobile) and stores information for communicating with the automobile (e.g., a network address or telephone number) locally. Later, when the user wishes to retrieve the data, the data management module **120** retrieves information for communicating with the automobile from memory, establishes a wireless data link (e.g., by calling the telephone number of the computer system of the automobile or bus), and retrieves the data.

[0139] It also intended that the remote computer system receiving the data have a data management module of its own to manage memory, perform back ups, defragment memory, and perform other management tasks.

[0140] There may also be circumstances in which the device **101** cannot establish a communication link with a primary remote storage system because the device **101** is physically located out of transmission range, due to interference, a component failure, transmission restrictions, or other reason. Such circumstances may occur, for example, when the user is on an airplane, a subway, or at sea. If the device **101** cannot establish a communication link with a primary remote storage device, the device **101** identifies a secondary storage device. Identification may be accomplished by retrieving the necessary information from a database, by transmitting a request for an acknowledgement from any available storage devices, by entering an area serviced by the storage device (e.g., which transmits its storage device information upon entering the area or intercepting transmission from the device), by transmitting a request to a network server or master, or any other suitable means.

[0141] Once the secondary storage device is identified and a communication link established, the device **101** remotely stores data in the secondary remote storage device according to the techniques previously described. In addition, the device **101** may transmit data (which might include a telephone number, an internet address, a network address and ID, and/or other data) that is sufficient to allow the secondary storage device to transmit the stored data to another remote storage device, which is preferably the primary storage device. The data transmitted to the secondary storage device may also include data of instructions to transmit the stored data to the primary storage device immediately, after a time delay, or after occurrence of an event (e.g., when the secondary remote storage device is able to establish a communication with the primary remote storage device). Alternately, the secondary storage device includes preprogrammed instructions relating to when and how the data should be transmitted to the primary storage device. In addition, the device **101** transmits user (or device) information (e.g., a telephone number) that is stored by the secondary storage device and associated with the stored data. The user or (device information) is used by the secondary storage device to identify and retrieve the data if, and when, the user transmits a request to retrieve the data and/or to store the data on the primary remote storage device.

[0142] The data management module also participates in the synchronization of multiple remote storage devices and the device. For example, periodically, or upon request by the user, the memory of the user's home computer system, home entertainment system (e.g., storing video and audio files), work computer system, automobile(s) computer system, and/or device may be synchronized so that they all the devices, or some subset of the devices, include all the same data-files or include all of a subset of the data files (e.g., word processing file, video files, calendar data, address book data, audio files, etc.). The subset may be selected by the user in response to a prompt or retrieved from memory (e.g., according to the user's selections stored in the user profile).

[0143] In addition to the above tasks, the data management module also manages the memory **160** locally determining where data should be stored. In addition to the conventional memory management processes, the data management module also stores data locally according stored storage criteria that, for example, is based on data types and the types of memory available locally. For example, certain types of memory such as a SmartMedia® card, a CompactFlash® card, a Memory Stick®, a MultiMediaCard®, a DataPlay disc®, or a SecureDigital® card, is designated by the storage criteria for storage of video data. Preferably, any type of removable memory is designated for storage of video

data or another particular data type (or vice versa) and the data management module prompts the user to replace the removable memory when the existing removable memory is full or nearing full capacity. In response to the prompt, the user replaces the removable memory. In addition, prior to a prompt, or in response thereto, the user may indicate that the device **101** should download the data in the removable memory device to a particular remote storage device (e.g., when full or nearing full capacity).

[0144] Application Modules

[0145] As discussed, the preferred embodiment of the present invention includes numerous applications. However, the decision to include or not include a particular application module is a design choice. Likewise, the following example embodiments, and their functionality, is not intended to limit the scope of the present invention, which will operate with numerous other application modules. Furthermore, the applications, the functions that are intended to be provided, and the systems with which the device **101** is intended to operate/communicate are some of the factors that will determine the composition of the hardware and software for a given embodiment of the present invention. Thus, various embodiments of the present invention may include different hardware and software configurations depending on costs, the functions provided, and the systems with which the device **101** is intended to operate/communicate as will be evident to one skilled in the art. Finally, steps disclosed in a given example may be used with other applications illustrated by other example applications in which the steps are not specifically disclosed as will be evident to those skilled in the art.

[0146] The modules and other applications described herein often require communicating with external computer systems. One method of communicating with the external system is shown in **FIG. 6** and includes the steps of determining the format, protocol, medium for communicating and/or other communication parameters for communicating with external computer system at step **401**. Next, the data, which may be a request, a command, an informational transmission, or other transmission, is then formatted for the external system according to the communication parameters at step **405**. At step **410**, the formatted transmission is transmitted over the transmission medium, and according to the protocol and other communication parameters for the external system. In many instances, the device **101** may receive the initial communication transmission or receive a response from the external system as shown at step **415**. At step **420**, the incoming transmission is stored and decoded. The decoding includes any processing that is used to convert or change the received data to a form that is usable by, or to provide data for, another application. For example, the decoding may include parsing and storing name value pairs, decompressing the incoming data, decrypting the incoming data, transcoding the incoming data, removing headers and trailers, decimating the incoming data, extrapolating the incoming data, parsing the incoming data, storing data in data structure(s), and/or any other processing that prepares the incoming data for use by another application. Finally, at step **425** the decoded data is provided to another application for processing such as audibly and/or visual production, sorting, removing duplicate data, performing location related processing (e.g., determining the closest), identifying a vender with which to engage in a commercial transaction or transmit a request to, and/or other processing by commercially available software applications or applications described herein.

[0147] The device **101** of the present invention allows the user to find a point of interest based on its location and, if desired, other characteristics. One example application employing this capability is for determining the point of interest within an area that is closest and which, if desired, also meets other selection criteria.

[0148] Steps for performing this example application are shown in **FIG. 4** and include determining a target point of interest (PI) at step **301**, determining the available PIs at step **305**, determining the closest PI at step **310**. In this example, the application also optionally includes the steps of receiving a user input at step **315**, communicating with the PI (e.g., based on the user input) at step **320**, and informing the user of the results of the communication at step **325**.

[0149] In addition, after determining the point of interest (in any of the applications), the device **101** can optionally enter into a commercial exchange on behalf of the user, for example, to purchase a product (e.g., step **320**).

[0150] The device **101** determines the closest point of interest in response to a user request, at a particular time, day, and/or date, in response to a user action (e.g., purchasing a product), in response to the occurrence of an event (e.g., a flat tire, entering a particular area such as a city or hotel lobby, or fuel levels reaching a predetermined depletion threshold) that may or may not be sensed by the device, data stored in memory, at predetermined time intervals, and/or according or based on other parameters or events.

[0151] The criteria for the point of interest can include any desirable, and/or exclude any undesirable, characteristic. For example, the point of interest could be a vender for a particular product (e.g., a vender for tires); type of vender (e.g., a gas station or restaurant), subcategory of a vender (e.g., a fast food restaurant); vender with a particular product in stock or available (e.g., automobile part vender with a particular part available,), a restaurant with no wait for a table, or a particular vender (e.g., McDonalds®). In addition, the determination of the point of interest in some instances may include minimal selection criteria. For example, the point of interest could simply be determining the closest a public place (e.g., a restroom or park), identifying all the shopping complexes in the given area, or any other place of interest. The "area" may be any area such as a city, county, state, or facility.

[0152] In addition, the device **101** can also determine the closest point of interest to another location (e.g., the user's destination) or set of locations (which, for example, includes the user's intended travel route. Thus, for example, the device **101** can determine the closest shopping complex and the closest McDonalds® restaurant to the shopping complex.

[0153] Data presented to the user (e.g., via the display) as a result of the determination may include simply the determined point of interest, a list of determined points of interest, a list with distances to each, a list with travel times to each or other data, and/or any other desirable data.

[0154] At step **301**, the data of the target point of interest is determined and may be supplied by the user or retrieved

from memory based on the circumstances (e.g., location or triggering activity), a product, data present in the user profile, and/or other input. For example, upon sensing that fuel levels have reached a predetermined depletion level, the device **101** determines the closest gas station, which is a type of vender retrieved from memory. Alternately, if the user has entered his or her desire to purchase fuel only from select fuel venders such as Mobil® and Shell® (information of which is stored in the user profile), the device **101** determines the closest of these venders. Likewise, upon receiving a user input of a request (or at a particular time of the day), the device **101** determines the nearest restaurant (type of vender), fast food restaurant (sub-category of vender), or McDonalds® (particular vender) according to the user's preferences (i.e., a user input or user profile).

[**0155**] Determining the closest point of interest in the preferred embodiment is accomplished by retrieving data of the available points of interest in the given area from a database at step **305**. The database may be stored locally (in the device) or remotely (e.g., in an automobile, a web server, at the user's home, etc.) and may, for example be a service registry, a business listing (e.g., an electronic Yellow Pages), a Web site, or other database. The initial determination is preferably limited to a predetermined area or smaller space and may be a search for points of interest having an address that includes a country, state, country, city, zip code, and/or street.

[**0156**] In another embodiment, determining the closest point of interest includes broadcasting a request for a response to points of interest that meet the selection criteria and receiving responses that include points of interest satisfying the selection criteria at step **305**. The responses preferably also include location data (which may be the address, a longitude and latitude, or the address), which is used to determine the closest point of interest as is well known in the art at step **310**.

[**0157**] After the available points of interests meeting the criteria are determined, the closest point of interest meeting the selection criteria is determined at step **310**. This step preferably includes determining the distance (e.g., by traveling the streets and thoroughfares) to the available points of interests meeting the criteria and selecting the available point of interest meeting the criteria with the smallest distance. Alternately, step **310** may include computing the time to travel to the various available points of interests meeting the criteria—which may factor in traffic delays—and selecting the available point of interests meeting the selection criteria to which the user has the shortest travel time.

[**0158**] In addition, the device **101** can find the closest point of interest that meets the first the criteria and then determine whether that point of interest meets second criteria. For example, the software might determine the closest auto parts vender and then query the vender computer system or a third party computer system to determine whether that particular vender offers a particular product and/or has a particular part in stock. Thus, this process includes the steps of determining a first target point of interest satisfying a first criteria, determining whether the first target point of interest satisfies a second criteria, if said first target point of interest does not satisfy said second criteria determining a second target point of interest satisfying the first criteria, determining whether the second target point of interest satisfies the second criteria, and subsequently performing the other steps described herein such as steps **320** and **325**.

[**0159**] After determining the closest point of interest meeting the criteria at step **310**, the device **101** may optionally (at the selection of the user) provide directions thereto and may request purchase of a product (e.g., placing an order for food) and pay for the product at step **320** (skipping step **315** in this example embodiment). The request may be transmitted as a fax, as an electronic transmission (e.g., to the point of sale) such as an email, an instant message, an HTML transmission (e.g., a Post command with associated variable/value pairs), a voice transmission (e.g., synthesized voice), or any format and protocol suitable to the vender. Preferably, the format, protocol, and services are determined through the use of Web services by retrieving the descriptor document from a service registry and transmitted via a SOAP transmission.

[**0160**] As an example, the user, riding in an automobile, enters a voice command which is received by the device **101** at step **301**, and in response, the device **101** determines the closest fast food restaurant performing steps **305** and **310** as described above. The device **101** produces an output (either visually or audibly) identifying the closest fast food restaurant, its location, and estimated driving. The user may then elect to travel to the identified restaurant and provides a voice command indicating that he or she wishes to do so and/or whether he or she needs directions.

[**0161**] In response, the device **101** provides driving instructions to the user, which are displayed on the device **101** or optionally on a heads up display that is projected onto the inside of the windshield of the automobile. As the user approaches an intersection, an arrow is projected onto the windshield by the heads up display to indicate to the driver that the driver should turn left or right. The arrow blinks faster as the driver approaches the intersection and/or changes colors to indicate the closeness of the location at which the driver should turn. In addition or alternately, the device **101** may provide audible directions as are well-known in the art.

[**0162**] In this application of the present invention, when the device **101** is within a predetermined distance of the place of commerce exchange such as a point of sale, a vender location, a place for delivery of goods, or a place for pick up of goods, the device **101** communicates with a computer system (such as that of the vender computer system) through a wireless link to facilitate the transaction, which includes exchanging the payment information. In addition or instead, the device **101** may enter into the commercial exchange based on input from the user at step **315** such as when the user makes a request to purchase (and which may be irrespective of the distance from the place of commerce exchange).

[**0163**] The type of wireless link may be any link that is suitable for the particular vender and may be retrieved from memory and/or determined or based on information in a service registry. Thus, if the vender accepts fax orders, a telephone communication link for faxing the order may be established. If the vender accepts email, an email transmission is sent. If the vender computer system offers Web services a SOAP transmission is employed to place the order for the product (e.g., the food).

[0164] As a result of the communication at step **320** of this example, the user receives the product, the device **101** receives information as the product, and/or the device **101** receives information sufficient to use the product (e.g., an entry code or order number). In addition, as a result of the communication the vender preferably prepares the product for delivery to the user as instructed in the request from the device **101**.

[0165] For example, in the above scenario, when the user selects a point of interest from those presented, the user then supplies an input to the device **101** as a request to place food order. The food order may be a list of items previously stored in memory that are routinely ordered, which may form part of the user's profile, and that is selected from a number of lists associated with that user and that restaurant. In addition, the entire restaurant menu, or a subset thereof, may be stored in memory and retrieved (for example, at the time the user selects the restaurant and prior to being within the predetermined distance) to allow the user to place his or her food order. The lists or menu may be displayed to the user on an automobile display (e.g., on the heads or a in dash flat panel display) and selected by voice commands from the user at step **315**.

[0166] Items stored in memory may be entered manually (such as predetermined food order lists or the entire menu), may be received and stored each time the user purchases a different combination of items (in the case of a list food items), may be periodically transmitted (in the case of the entire menu) such as when the menu changes, may be downloaded, or any received through other suitable means.

[0167] When the device **101** is within a predetermined distance of the restaurant (or when the user supplies information of the request), a communication link between the device **101** and the vender is established (preferably by the device **101**) to request purchase of the desired food (the food order) at step **320**. As discussed, in addition to placing the food order, the device **101** (employing the commerce module as discussed above) and the vender exchange payment information, which is also retrieved from memory of the device **101**. The results of the transaction, which preferably indicate the success of the transaction, are then presented to the user visually or audibly at step **325**.

[0168] Therefore, instead of entering the restaurant to place the food order or entering a drive through to place a food order—both of which typically result in waiting to pay and waiting for preparation of the food —the food is already prepared and paid for when the user arrives.

[0169] In addition, the device **101** may optionally transmit location information to the point of interest during the communication with the point of interest at step **320**. This information, or other data, can be used to estimate the arrival time of the user by the vender or device **101** (in which case the data is transmitted to the vender). As a result, the vender can prepare the food (or other product(s)) for the customers so that the product is fresh and in the order in which the customers are likely to arrive instead of the order in which the customers place the food orders, or some combination thereof.

[0170] Another example application of a preferred embodiment of the present invention retrieves and processes data from a plurality of service providers (e.g., venders). Software on the device **101** processes the data received from the plurality of venders, which may include, for example determining whether a product is available, comparing the price of the product offered by the plurality of venders, and other processing of data. The results of the processing may be supplied to the user and/or used as a basis for taking additional action such as purchasing the product from the vender with the lowest price or making a request (e.g., for additional information).

[0171] As shown in **FIG. 5**, this example application of the present invention includes a computer program and hardware for determining the PI criteria at step **350**, determining the available PIs at step **355**, determining the available PI that satisfy the criteria at step **360**, processing data from the PI at step **365**, receiving user input of the processed data at step **370**, communicating with a PI at step **375**, informing the user of the results of the communication at step **380**.

[0172] For example, a user may wish to purchase a product for the lowest price. To find the lowest price, the device **101** determines the venders offering the product (or who might offer the product), obtains price information, determine the vender with the lowest price (and has the product available), and transmit a request to purchase the product. In this example the identification of the venders is limited to those venders in a given area (e.g., a city, zip code, street, county, state, or country).

[0173] At step **350**, the device **101** is provided with product identifying information and processing instructions. For example, the user provides the product identifying information and instructions through a voice input. This includes, for example, the user stating the processing instruction such as "find lowest price" followed by product identifying information such as manufacturer Calloway®, Big Bertha® driver. Other product identifying information may also be supplied such as product numbers, model numbers and other characteristics such as, for example, size(s), color(s), quantity, etc. In addition, other vender criteria may be supplied such as limiting the search to venders in a particular geographical area such as a county, city, shopping complex, state, and/or other area.

[0174] In addition or alternately, the product identifying information or other inputs to the device **101** may be received from another source such as image data from a scanner that has scanned a barcode, text, or other image or data from a radio frequency tag. While the data preferably includes product identifying data, it may also include vender identifying data (e.g., internet address, phone number, network address, etc.) as well as data for communicating with the vender (e.g., data that might be found in a descriptor document such as data relating to the format, protocol, and other like data). The image data might instead include the Dunn & Bradstreet or Thomas Registry vender identifying information and a service registry for retrieving data for communicating with the vender.

[0175] After the product identifying data and processing instructions are provided to the device **101**, the device **101** determines the available venders that can provide the product (in accordance with any other vender criteria supplied) at step **355**. In doing so, the program may retrieve data of venders from local memory, a remote computer system, and/or transmit a request for such venders to a public,

private, or local (e.g., shopping complex) service registry (e.g., a UDDI implementation).

[0176] Determining whether a point of interest satisfies the criteria at step **360** may take one or more steps depending on the criteria, where the necessary information can be obtained, and other factors. For example, if the necessary information is in memory of the device **101**, no communication with the PI is necessary. Likewise, if the necessary information is in a service registry, it can be retrieved from the service registry instead of contacting the PI. In some instances, some combination of the memory, a service registry, and information requested from the PI may be required to determine whether the PI satisfies the criteria. In this example, a communication with the PI to obtain some of the information necessary for determining whether the PI satisfies the criteria is performed.

[0177] Once the available points of interest (e.g., venders who offer, or who may offer the product and meet other criteria such as location) are determined, the device **101** determines a destination for transmitting a request for the required information (addressing information) and for the format and protocol for communicating with the identified vender computer systems (communication parameters). This information may be transmitted from the service registry computer system in the form of the descriptor document (e.g., a WSDL document). Alternately, all of some of the data may be retrieved from local memory or a remote computer system at which the data was stored during a previous transaction.

[0178] Once the addressing and protocol information is determined, the device **101** generates a vender request for the desired action that is based on the product identifying information, the processing instructions, and the vender's communication parameters. In other words, the device **101** generates a vender request (which may be different for each vender) by formatting and configuring at least a portion of the processing instructions and/or product identifying information in a format and configuration that the vender's computer system can read (e.g., receive, interpret, and/or respond to). In this example, the instruction is to a request for a price and the product identifying information is the manufacturer and product model information and, in particular, data representing "manufacturer Calloway®, Big Bertha® driver."

[0179] Each formatted vender request is transmitted to the respective vender computer system according to the vender computer system's previously determined addressing, format and protocol information. In addition, the communication link and protocol may be different for each vender computer systems so that some links are via a 3G network and others are through a WLAN. (Note: the protocol information may dictate that a communication link first be established, which might include handshaking and other well-known communication protocol that does not form part of the request.)

[0180] The vender computer systems (VCSs) receive and process their respective requests, which in this example includes interpreting the request and searching a database for the price of the identified product. After the price is retrieved or otherwise determined, the price is transmitted to the device, preferably in XML format, to determine whether the vender satisfies the selection criteria at step **365**. Other data may also be transmitted such as availability, location data for the vender, taxes on purchase of the product, delivery charges for the product, available times for delivery or receipt (e.g., pick up) of the product, etc.

[0181] Some VCSs may not respond. Other VCSs may indicate that they do not have the desired product. Still other VCSs may transmit information indicating they are out of stock of the desired product. Thus, only those VCSs that respond with price of the product and indicating availability of the product (which may simply be indicated by the transmission of the price) are determined to be a PI fully satisfying the criteria at step **360**. Other applications of the present invention may employ other PI criteria (e.g., which may not include availability or price) such as located within a five mile radius, with certain store hours, certain vender, vender type, manufacturer products, with sales, the date, the time, any commercial characteristic(s), and/or any other determinable criteria.

[0182] Vender requests may be transmitted sequentially, after which the device **101** waits for a response before sending the next vender request or contemporaneously (vender requests are transmitted to each vender without waiting for responses from the first vender).

[0183] The device **101** receives and stores the response from each VCS and processes the data according to the processing instructions. In this example, the device **101** sorts the responses from the venders according to price and displays the data in order of ascending price. The displayed data preferably includes the price, vender identifying information and location information. Additional information may also be displayed such as availability (if the vender was not screened out based on availability), distance information, taxes on purchase of the product, delivery charges for the product, available times for receipt (e.g., pick up) of the product, and other data.

[0184] Upon viewing the presented data of one or more responses from the VCSs, the user supplies an input to the device **101** at step **370** that in this example is a command to transmit a request to purchase the product from a particular vender. In response, the device **101** communicates with vender at step **375** using the determined communication parameters and transmits a request to purchase the desired product. Thus, the device **101** transmits product identifying information, which may include a product number, name, model, quantity, size, color, duration (e.g., in the event of a rental), dates (in the case of travel tickets or reservations), and/or other product information. In addition, after receiving a request from the VCS, or at some other point in time (as determined by the protocol and format for the VCS) the device **101** exchanges payment information as described above. At the end of the transaction, the device **101** informs the user of the success of the transaction at step **380**, which may take the form of, or additionally include, information of the total amount of the transaction, a delivery/pickup location, a delivery/pickup time, and/or other data.

[0185] Alternately, when supplying the initial user input at step **350**, the user can input instructions to the device **101** to purchase the product from the vender who returns the lowest price, the lowest total price, lowest price and availability of product, or based on other data received from the vender(s). Given this instruction, the device **101** informs the user of the success of the transaction, but not display the results steps **365** thereby eliminating step **370**.

[0186] Another similar use of the above-described application is for hotel commerce. For example, the user—who is riding in an automobile or other vehicle—may wish to find the closest hotel meeting a given criteria (e.g., with availability and below a selected price). In response to the user request, the device **101** determines and presents a selection of the closest (e.g., the closest three) hotels that meet the criteria by means described above. The user then selects one of the hotels from which to request further information or to purchase a room rental.

[0187] Alternately, the user may already have a reservation with a hotel in which case the user preferably has previously input the destination to the device **101** and when the user (and device **101**) is within the predetermined distance of the destination hotel, the device **101** automatically (or after prompting the user for permission to check in) checks the user into the hotel as described below.

[0188] To rent a room or accomplish check-in, a communication link between the device **101** and hotel computer system (or a computer system acting on behalf of the hotel) is established by any means described herein. The type of wireless link may be any link that is suitable for the particular hotel and may be retrieved from memory, based on information in a service registry or other source. Thus, if the hotel accepts fax orders, a telephone communication link for faxing the order may be established. If the hotel vender accepts email, an email transmission is sent. If the hotel computer system offers Web services a SOAP transmission is employed to place the order for the product (e.g., the room).

[0189] If a reservation was previously made, after the communication link is established, the device **101** transmits user identifying information which includes the user's name, a confirmation number (in the case of a reservation), a telephone number, an account number, and/or any other information necessary for check in.

[0190] If a reservation was not previously made, room availability is determined and, if there is availability, a request to rent a room is transmitted (which may be transmitted in response to a user input). This request (or the request for availability) includes information about the length of the stay, number of guests, and the type of room requested (e.g., smoking versus non-smoking, the view, etc.).

[0191] After the request to rent a room is granted, the payment information is exchanged between the device **101** and the hotel computer system. If a reservation was previously made, the hotel computer system may simply use the payment information (e.g., credit card information) that was supplied when the reservation was made to obtain payment.

[0192] After payment information sufficient for check in is supplied to the hotel computer system, the hotel computer system transmits check in information to the device, which includes a room number and entry code. The entry code may be a number manually entered into the door by the user that unlocks the door or may be a multi-digit code that is wirelessly transmitted (preferably along with user or device authenticating data) from the device **101** to unlock the door via a wireless PAN.

[0193] In addition to receiving data permitting entry into the room, the hotel computer system transmits information sufficient to allow the device **101** to present options to the user allowing the user to purchase additional products. For example, a room service menu may be transmitted to the device **101** from which the user may place a food order. Other information allows the user, for example, to purchase tickets to shows or other entertainment, order movies, establish credit for gambling, and receive data for obtaining discounts for products or services.

[0194] When the user elects to check out, a link is established between the device **101** and the hotel computer system and the device **101** requests check out data, and receives and visually presents the bill to the user for review and approval. After receiving an input indicating approval from the user (e.g., receiving the final total amount of the bill), the device **101** finalizes payment by exchanging payment information (or indicating that previously supplied payment information should be used) and stores the information in memory. Thus, the present invention eliminates the need to stand in line during check in or check out.

[0195] It will be evident to one skilled in the art that this embodiment, with minor modifications, has numerous other applications including, but not limited to, the reservation and purchase of airline, train, bus, and watercraft tickets; the purchase of tickets to movies and other entertainment (such as sporting events, live plays, concerts, movies), paying tolls, golf tee times and green fees, purchasing fuel, and many other applications.

[0196] In addition to the above, the present invention may also be used to facilitate entry to a facility, event, or area, preorder products for entry; and supply facility or other information to the user at entry; and supply user information to the event computer system.

[0197] For example, after purchase of a ticket to a concert, sporting event, or other event, and typically well in advance of the day of the event, the ticket information, including the seat information (if necessary) and a unique entry code is stored in memory of the device. In addition, directions to the event, as well as directions to the user's seat may also be received and stored in memory the day of the event, at the time of the purchase, or some other time prior to the event.

[0198] When the user is within a predetermined distance of the event, a communication link is established between the device **101** and the event's entry control computer system (ECCS). The device **101** transmits the entry code to the ECCS, which then provides an acknowledgement to that user's entry code is valid as well as instructions for the best (or only) entrance the user should enter. To enter the facility, the user must have an entry code and provide an indication to the ECCS that the user has a valid entry code. To provide the indication, the device **101** may be simply display the valid entry code along with other authenticating information at the entrance of the facility. The displayed information may be a barcode that is displayed on the device's display and which is read with a barcode code reader as the user passes through the entrance.

[0199] Alternately, the device **101** simply transmits information of the user, such as the user's name, and the user simply shows his or her identification (e.g., driver's license) to personnel, or to an image input device connected to the ECCS, as the user enters. In another alternative, the device **101** transmits the entry code along with data that is consis-

tent with data in a barcode on a fixed medium such as a barcode that is on the user's identification (e.g., driver's license) which is scanned or read by a barcode reader as the user passes through the entryway. In the preferred embodiment, the device **101** transmits the entry code along with user authenticating information such as data of the user's fingerprint, iris, voice, face, or other substantially unique physical data. As the user enters, the transmitted user authenticating data is compared with the authenticating data of the person entering the facility (user's fingerprint, iris, voice, face, or other substantially unique physical data) to ensure that the person entering the facility is the user authorized to do so (i.e., there is a match of the transmitted data with the data received (scanned) as the person enters).

[**0200**] As another alternate to the preferred embodiment, the user authenticating information may be supplied to the ECCS at the time of the purchase of the tickets so that that there is no need for a communication between the device **101** and the ECCS at the time of entry to facilitate entry (i.e., the person entering need only supply the authenticating data when entering the facility such as, for example, permitting scanning of his or her fingerprint). In still another alternate means, the user's authenticating data (e.g., fingerprint data) and name is stored at a third party authenticating computer system which receives the fingerprint data (and user's name) from the ECCS and compares it with the stored data to confirm the identity of the user for whom the ticket was purchased.

[**0201**] The user may preorder food or drinks, as described above, and the ECCS determines the location of a food preparation center (e.g., a concession) that is reasonably close to the user's seat and, optionally, that can most easily prepare the food by the estimated arrival time (or closest thereto). The identity of the food preparation center and/or its location is then transmitted along with a food menu to the device **101**. In response to a food order, the ECCS transmits a time the user should arrive to pick up the food. Thus, such a system can reduce or eliminate waiting to enter the facility, waiting time to receive food, and counterfeit tickets.

[**0202**] In addition, the ECCS transmits a request and, in response, receives user information from devices carried by persons entering the facility, area, or event. The requested and supplied user information may include demographical data or any other desirable information. Similarly, any of the embodiments and applications disclosed herein (such as the fast food and hotel applications) may additionally include transmitting such data about the user from the device **101** to the remote computer system.

[**0203**] Through the use of the communications module, the device **101** may be programmed to communicate information with other person's using a device **101** of the present invention or another remote computer system. For example, upon receiving a user input indicating the user's desire to do so, the device **101** is programmed to query all other devices within communication of the device **101** for data, via the PAN transceiver (e.g., Bluetooth® network), via the WLAN transceiver, or within a predetermined distance. The query may be for any desirable data. For example, upon entering a business conference the user may "turn on" the feature and request the device **101** query all other devices for user information such as the information that would be present on a business card. The user may also make the request a selective query so that only data from users or devices meeting a certain criteria is requested and, if received, stored. For example, a user who is a sales representative may desire data from people who work for companies that are more likely to be potential customers and may not want data from other people or people who are already customers or competitors. In response to a request, the other user's device **101** transmits the requested data, a portion of the requested data, transmits a response that the request is denied, or does not respond.

[**0204**] Likewise, the user may input response instructions for responding to requests for data (queries) from other user devices **101**. For example, the user may not wish to transmit the requested data to devices **101** of users who are employed by companies who sell certain products or who are competitors. In doing so, the device **101** may be programmed to filter out certain requests (e.g., not respond) or respond with a communication indicating that the data request is denied. In addition, the user may elect to transmit only certain data (e.g., an email address but not a phone number), request only certain data, and only to respond if the requesting device **101** supplies certain data.

[**0205**] The communication criteria, which determines whether or not data is desired from the second user by the first user, may be any criteria and may include, for example; 1) user information of the other (second) user (e.g., company name, sex, age, birth date, address, job position, height, weight, ethnicity, income, and other demographical information); 2) device information of the other user's device (e.g., manufacturer or model), whether the other user has a service; 3) product data such as whether the user has any product or a particular product for sale, whether the other user wishes to buy any product or a particular product; 4) user activity data such as interests and hobbies of the other, frequent activities of the other user (e.g., skiing), past activities of the other user (e.g., where they have been), anticipated activities, and/or 5) other characteristics or desires of the other user—hereinafter collectively referred to as communication criteria data.

[**0206**] Communication criteria data (CCD) is entered into the device **101** by users in categories such as user information, user activities, products data, and other data, some of which may form part of the user profile. In addition, communication criteria data includes user activity data stored from the previous activities of the user such as the locations or venders visited and stored (e.g., stored by the location module) and/or information of products (e.g., transportation data) purchased (e.g., stored by the commerce module).

[**0207**] Querying of other user's devices may be performed periodically or upon entry to a geographical location (e.g., a room, building, vender, street, etc.), which is indicated by a transmission from an access point at, or within, the geographical location.

[**0208**] Communication may be accomplished with any suitable protocol such as HTTP/IP with predetermined name value pairs used for each category and a standard format for each value in each category. For example, Bdate may be a variable (name) representing the user's birthdate, which is paired with data representing the user's birthdate in the format of mm/dd/yyyy (e.g., bdate=02/15/1983). Queries to other devices **101** are preferably transmitted using the same format and submitted and converted to a SQL database by

the receiving device **101**. A successful query (a search that returns a valid result greater than zero) indicates that the other user has communication criteria data that matches the desired communication criteria data. In addition to the query, the transmission may include information relating to one more actions requested by the user upon a successful query. Alternately, a successful query may simply result in a transmission from the queried device **101** indicating that the query was successful and include information indicating what portion (or which query) was successful. For example, the query might transmit a query for CCD data that the user is over forty years of age and a male or over thirty years of age and a female. In the response, the queried device **101** transmits data indicating that the user is a male over forty years of age (an affirmative response) and may also, at the election of the user, transmit the user's age, which in this example is fifty-five. In addition, additional information is sufficient to establish a communication link (e.g., a network address for the successfully queried device) may also be provided. After receiving the communication indicating the query was successful, the requesting device **101** then transmits a request to the queried device. In response, the queried device **101** may transmit the requested or other information, prompt the user to take an action, prompt the user for information, prompt the user for permission to transmit information and/or otherwise respond.

[**0209**] The user of the device **101** can program the device **101** with response instructions (for example in the user profile) that determine how and whether the device **101** responds to queries and different types of requests.

[**0210**] Thus, the first device **101** (or other computer) transmits a request that includes a query for CCD to a second device **101**. The request itself may include certain CCD stored in the device **101** or the requested device **101** may respond with a request for CCD of the first device **101**. Upon determining that device **101** includes satisfying CCD data, any action may be requested (or requested in a subsequent transmission) (by either device **101**) such as requesting data from the user's device, transmitting data to the user's device, requesting information from the user, and/or requesting a service of the user. For example, at the request of the user, in an emergency a device **101** may transmit a query (and request) to other devices within communication range of the device **101** (e.g., via the WLAN) for a doctor, nurse, or police officer. Thus, only users who are a doctor, nurse, or police officer would be informed of the request by their device, which is preferably identified as an emergency request. The request, in this example, is a request to render assistance and may also include information relating to the location at which assistance is needed. Users of the device **101** can program their devices to respond differently to different requests (and at different times). Thus, the doctor or nurse may elect to program their device **101** to only accept requests that are emergency requests.

[**0211**] Some or all the communication criteria data may also be stored in a correlating computer system when the user enters a geographical area or travels within communication distance of the Area Computer System. The Area Computer System (ACS) may operate and/or communicate via a network associated with a facility (e.g., a shopping mall, a stadium, an entertainment arena) or geographical area (e.g., a MAN, an auction site, etc.)

[**0212**] The ACS receives and stores the communication criteria data, queries, and response instructions for each user device **101**. The ACS determines the user devices that have communication criteria data matching each user device query and transmits the data responsive to the queries of each device **101** and in accordance with the response instructions, which may optionally inform the user of the match. Thus, the ACS may retain and provide the communication criteria data to users after the user of the device **101** to which the communication criteria data has left the geographical location or requests the data. The ACS, thus, may also be used to transmit messages (e.g., emails) to all devices (or select devices having certain communication criteria data) that come within transmission range of the ACS.

[**0213**] As an example, as each user enters the area or facility, the user's CCD, queries, and response instructions are requested by and transmitted to the ACS. Internally to the ACS, the ACS then compares the CCD with all the previously stored queries of all the earlier arrived users. For each query to which the user's CCD satisfies, the ACS processes the user's response instructions to determine whether the user wishes to supply the requested data. For those queries to which the user wishes to respond, the ACS stores the requested CCD data in a data file corresponding to each requesting query. Next, the ACS compares the CCD of each earlier arrived user with the user's queries to determine the users' CCD to satisfy the user's query. After identifying each match, the ACS processes the response instructions associated with each set of CCD to determine whether the requested data should be supplied. For the requested data that is to be supplied, the ACS stores the CCD data in a data file corresponding to each query for the user. When the user leaves or requests the data file, the data file is transmitted to the device **101**.

[**0214**] In addition to exchanging data, the device **101** can take immediate actions based on the data received. For example, based on a first set of CCD meeting a CCD requirement set, the device **101** transmits (if programmed by the user to do so) a request for an appointment (e.g., for a telephone call, a lunch, a meeting, etc.) that may include the time periods that are available to the requesting device's user and the length of the desired appointment. In response, the requested device **101** determines whether its user has supplied permission to schedule such appointments and if not, transmits a response denying the request (or does not respond at all). If the device's user has provided an input (that is stored in memory) permitting the scheduling of such appointments, and the requesting device's information (e.g., its CCD data) satisfies the activity requirement criteria for the activity (i.e., scheduling the appointment), the device **101** selects an appointment time (e.g., such as the earliest) from the available time periods transmitted by the requestor or, if not transmitted, transmits time periods that are available for the requested device's user. The requesting device **101** then transmits a confirmation of the appointment if the requested device **101** transmits a time period selected from the time periods transmitted by the requesting device. If the requested device **101** transmits its available time periods, the requesting device **101** selects a time period and transmits information of the selected time period to the requested device **101**, which responds with a confirmation of receipt. In addition, the device **101** informs the user that a request has been made and may prompt the user for permission to make any appointment or an appointment for a particular

time. Information of the available time periods is preferably determined from data that is stored in memory and used, for example, by a calendar applications program. In addition, it is preferable that the requesting device **101** issues requests to interface software (e.g., in the communications module) that determines availability or other information as opposed to the requesting device **101** being given access to the data itself.

[0215] In addition to the above, the communication criteria data stored in the user's device **101** and the location of the user may also be used by remote computer systems, for example, to target advertising and provide the user with location relevant information.

[0216] One example of such a system employs an ACS designed to coordinate the delivery of advertising and content for the shopping complex. Referring to **FIG. 7**, the ACS establishes user location information at step **450**, determines transmission selection criteria (temporal data, CCD, targeting criteria, etc.) at step **455**, and selects and transmits an advertisement at step **460**. In addition, in some instances the ACS will receive information relating to the user's response (receipt, viewing, presentation, or action in response) to the transmission at step **465** and perform an incentive transaction at step **470**.

[0217] For example, upon entering a shopping complex (e.g., a mall), the ACS determines location data of the user carrying the device **101**. The ACS preferably determines the location (e.g., relative location) of the device **101** by determining which WLAN (or wireless PAN if the PAN includes addressable access points) access point through which the device **101** is communicating. **FIG. 2** is schematical representation of a facility **217** such as a shopping complex that includes a plurality of access points **230** that facilitate wireless communication between device **101** and the ACS **301**. The connections between the ACS and the access points **230** are not shown and may be wireless or wired (e.g., Ethernet). The dashed lines **235** surrounding each access point **230** represent the communication range of the associated access point **230**. In **FIG. 2**, the five access points with the largest communication ranges **235** are positioned in the parking area adjacent the facility.

[0218] The facility **217** includes a plurality of vender store locations **220**, each having an entrance **221**. In addition, the facility **217** includes a plurality of entrances **222** connected by one or more thoroughfares **223** that the visitors walk through to gain access to the vender store locations **220**.

[0219] Each access point (AP) **230** of this example has a separate network address so that data received from the user device **101** and provided to the ACS is determined by the ACS to have come from a particular AP **230**. Thus, knowing the AP **230** with which the device **101** is communicating, and the range of the AP **230** (if desired or necessary), the ACS can determine the approximate location of the user in the parking area, in a thoroughfare **223**, and/or in a vender store location **220**. In addition, as the device **101** communicates through a sequence of APs **230**, the ACS can determine a plurality of locations for the user and, therefore, determine anticipated location data for the user carrying the device. Anticipated location data may also be determined by determining intended activity (e.g., from CCD), receiving product purchase data from a VCS (indicating the user will be traveling to the vender), and/or receiving past GPS data. Thus, the selection of an advertisement based on location data may be a selection based on the current location data or anticipated location data.

[0220] The number, placement, and communication range of the APs **230** are design choices. If more accurate location data is desired, more access points **230**, perhaps with smaller communication ranges, may be used. While in this example embodiment, the location data is determined through an access point location method, alternate embodiments may simply request that the device **101** transmit location data that is determined by the device's GPS receiver or through other means. In addition, depending on the network and other design factors, the access points may or may not have overlapping communication ranges.

[0221] Preferably ACS bases the selection of the advertisement on location data of the user such as, for example, the current location of the user or the anticipated location of the user, which may relate to what door the user will likely enter, what vender the user will likely travel near or is near.

[0222] In addition, the device **101** preferably transmits select CCD to the ACS in response to a request from the ACS. Upon receiving the transmitted CCD from the device **101**, the ACS determines a selection of transmission(s), such as advertisement(s), for transmission to the device **101**, which may or may not also be selected based on location data. The selection of the advertisement may be based on any category or specific CCD data such as the user information (e.g., the user's employer, gender, age, birth date, address, job position, height, weight, ethnicity, income, and/or other demographical information); device information of the user's device **101** (e.g., manufacturer or model); product data (e.g., whether the user has any product or a particular product for sale, the identity of any product the user wishes to sell, whether the user wishes to buy any product or a particular product, the identity of any product the user wishes to buy); user activity data (e.g., whether the user has a particular interest or hobby, frequent activities of the user, past activities of the user (e.g., where they have been), anticipated activities); and/or other characteristics or desires of the other user.

[0223] In addition to or instead of being based on the CCD and/or location data, the advertisement may also be selected based on temporal data such as the time (e.g., morning versus afternoon), day (e.g., weekend versus weekday), or date (e.g., a holiday, birthday of the user's wife). The temporal data may be received from the device **101** (in response to a request), determined by the ACS, or some combination thereof.

[0224] Thus, ACS selects the advertisements based on location data, temporal data, and/or the CCD, from a plurality of advertisements for numerous venders stored in memory. Each advertisement stored in the ACS preferably includes targeting criteria used for selecting users to which the advertisement or all advertisements for a vender are transmitted. The targeting criteria may include any subset of location data, CCD and/or temporal data, but may also include other data (for example, data that is not available for a particular shopping complex).

[0225] Selection of the advertisements are based, at least in part, on the degree to which the targeting criteria of the advertisement matches the CCD, location data and/or tem-

poral data of the user. For example, ads for a particular vender, such as a coffee shop, may include targeting criteria that dictates that all users with location data that includes entering a particular door (and who, therefore, are likely to pass by the vender), and who enter prior to 11 AM (temporal data) are to receive an advertisement for coffee along with an electronic coupon offering a ten percent discount. Some advertisements may not have associated targeting criteria as the advertiser may not wish to target the advertisement, but instead have all users receive the advertisement. In addition, selection of an advertisement may or may not require a complete match of the targeting criteria with location data, CCD and/or temporal data (depending on the desire of the advertiser).

[0226] In addition to selecting the advertisement(s) based on the location data (if any), temporal data (if any) and/or the CCD (if any), and targeting criteria, the ACS may also select the advertisement based on the transmission value of the advertisement. The advertisements may have an associated transmission value (or bid price) that determines how much the advertiser (or other entity) is willing to pay to have the advertisement (or other transmission) transmitted to the user (who may or may not satisfy the targeting criteria) or to have the user respond to the advertisement (or other transmission). The transmission value for a particular vender (or in some cases for a specific transmission such as an advertisement) may be different depending on the advertisement, the CCD, the location data, the temporal data, the ad targeting criteria, and/or some combination of the aforementioned. For example transmission values may be different for different times of the day, locations, products, responses, and if based on different triggering events.

[0227] A response to an advertisement may include any desirable user action such as providing information to the ACS or vender (or VCS), purchasing a particular product, purchasing any product from the vender, entering a vender's store location, using a coupon, registering user information with the vender, or any other requested or desired action.

[0228] After the ACS selects the advertisement(s) based on the temporal data (if any) the CCD (if any), location data (if desired), and transmission value (if any), the ACS retrieves the advertisement(s) from memory and transmits the advertisement(s) to the user's device **101**. Upon reception at the device **101**, the device **101** determines whether the user wishes to accept the advertisement based on transmission filtering information stored in memory. The transmission filtering information may be supplied in, or derived from, the user profile or otherwise supplied by the user.

[0229] If the transmission filtering information does not filter out the advertisement, the device **101** produces a visual or audible alarm to inform the user that advertisements have been received. In some instances, which may depend on the user profile, the advertisement characteristics, and other considerations; the device **101** may not inform the user of the advertisement until a later time (e.g., when the user is leaving the shopping complex or traveling near the vender). Thus, even though transmitted at a particular time, the advertisement, in some cases, may not be presented to the user until conditions transmitted by the ACS indicate that the advertisement should be presented to the user.

[0230] Either automatically upon reception or upon request by the user, the user views the advertisements if they are visual advertisements and/or listens to the advertisements if they are audible advertisements. Some of the advertisements may simply include a notification of a sale in progress or notification of a new or existing product offering. Other advertisements may include a coupon that provides a discount for a purchase at a particular vender or for purchase of a particular product as an added effort to entice the user to visit the vender.

[0231] The coupon can be printed out and presented to the vender at the time of purchase of a product as is done with conventional coupons. Upon inputting a request to print the coupon (which is transmitted to the ACS), the ACS transmits identification of the closest printer in the shopping complex, and prints the coupon for the user or requests that the vender's computer system print the coupon for at the vender store location. Alternately, the coupon could be printed for the user as the user enters the vender's store location (with or without the advertisement having been transmitted) based on CCD and/or temporal data received by the vender computer system.

[0232] Preferably, however, the coupon is electronically transmitted from the device **101** to the point of sale system at checkout, which responds by discounting the product and alleviates the need to print the coupon. In either case, the point of sale (and/or device if the coupon is electronically presented) transmits information to the ACS indicating that the user used the coupon.

[0233] Preferably, the ACS transmits content such as audio content (e.g., music, new programming, talk shows, sports radio) that is received from a remote source, formatted for transmission to the device **101**, and transmitted to the select users. The users can transmit a request for the desired content as is well known in the art. Periodically, the ACS selects and transmits the advertisement according to the process herein described.

[0234] However, some users may still not wish to receive advertisements or other transmissions and consider them an annoyance. To provide incentives to the user to view and/or use the advertisements, the preferred embodiment provides a means for providing financial incentives to the user for viewing (listening to or looking at) advertisements. In providing such incentives it preferable that the user provide some indication to the device **101** that the user has viewed the advertisement and that the device **101** provide an indication to the ACS that the user has viewed advertisement or that the ACS has presented the advertisement to the user. For example, after viewing the advertisement the user may be requested to provide a user input, which may include scrolling down to the end of the advertising and actuating any user input (e.g., pushing any button), actuating a user input requested in the advertisement, answering a question, or in some way confirming the user's viewing of the advertisement(s). Incentives are also provided for responding to advertisements and/or taking requested or desired actions, which are preferably greater than incentives for viewing an advertisement or when the device **101** presents the advertisement.

[0235] After receiving an indication that the user has viewed the advertisement(s), that the advertisement(s) has been presented, that the user responded to an advertisement or taken desired or requested action (hereinafter collectively referred to as a user advertisement response), the ACS performs an incentive transaction.

[0236] The incentive transaction provides the user with some form of direct or indirect benefit such as financial gain. For example, the incentive transaction may include electronically transmitting funds to the user's bank account, crediting the user's credit card, crediting the user with frequent flier miles, crediting the user with credit card use award points (or other award points used for purchasing products), providing the user with CPU time for executing software, and/or providing the user with a gift certificate, a rebate, or a refund. The incentive transaction may include transferring funds or crediting funds to any payment account of any user as described above. Preferably, the incentive transaction reduces (or offsets) the user's monthly fee(s) for use of the device. The ACS may perform the incentive transaction immediately, at the end of the day, periodically, or at any suitable time or interval. In an alternate embodiment, the ACS stores the financial incentive data and periodically transmits it to a remote computer system, which performs the incentive transaction.

[0237] The user may be provided incentives to use a coupon, to visit a vender, to travel to a particular location (e.g., near a vender or group of venders), to use a particular thoroughfare (e.g., a hallway or a road when in an automobile), to test or try a product or service, to purchase a product, to purchase a product advertised, to purchase any product from a particular vender, to purchase any product from a advertised vender, to supply user profile data, to supply CCD, to answer a set of questions (i.e., a survey), to supply location data, to perform some other action, and/or supply or review other information. Preferably, the advertisement includes information sufficient to communicate to the user the value of the incentive transaction—which may be related to, based on, or equal to the transmission value (e.g., bid price) of the advertisement.

[0238] As discussed above, the user may elect to screen out advertisements by supplying transmission filtering information to the device. One type of transmission filtering information includes incentive value information. For example, the user may elect to not accept advertisements for which value of the associated incentive transaction results in an incentive value below a predetermined minimum value and/or may elect to only accept those advertisements that result in a certain type of benefit such as accepting ads resulting in a credit card credit, airline frequent flier miles, or gift certificate, but not accepting advertisements that offer a coupon or rebate.

[0239] Many WLAN, such as Wi-Fi networks, are free to users who have the ability to establish a connection. However, present invention facilitates providing compensation to the network owner for use of the network. Thus, just as advertisers may place bids for advertisements and their placements, use of a network, such as a Wi-Fi network, by a user can be made conditional on the user performing a desired activity such as accepting advertisements, viewing advertisements, supplying information (e.g., CCD), responding to advertisements, using the network for limited purposes (e.g., noncommercial, not transmitting advertisements), visiting a vender, traveling to or away from a particular location, and/or performing some other activity. Thus, when the user establishes a connection, the network computer system (e.g., the ACS) prompts the user to agree to the conditions for use of the network. When the ACS receives data indicating the user's consent, (transmitted from the device **101** as a result of a user input or determined from data in the user's profile), the ACS permits the device **101** to connect with and use the network.

[0240] Purchasing of products is preferably done via a wireless exchange of payment information as described above and would, therefore, reduce or eliminate the need for check-out personnel for the vender. Thus, the vender may provide incentives (resulting in the incentive transactions described above) to the user in response to the user paying for products via a wireless exchange of payment information instead of paying in a conventional manner.

[0241] The ACS preferably receives notification that the user has purchased a product from the VCS but may also receive the data through interception of the payment exchange data or from the device **101**. Preferably the notification includes information identifying the product (or type of product), the amount of the product, the vender, the user's location, and/or other product purchase information that is used to select one or more advertisements for retrieval and transmission to the user. For example, upon purchasing a tennis racket, the ACS may select, retrieve, and transmit an advertisement (which may include a coupon) for tennis balls or some other complementary or supplemental product. The advertised product may be offered by the same or a different vender. In addition, the advertisement selected, retrieved, and transmitted may advertise a vender that carries products that are complementary or supplemental to the product(s) purchased and/or that are in the same price range. In addition, the point of sale system (VCS) of the vender from whom the purchase is being made (or another vender) may transmit an advertisement to the user's device **101** for a product complementary or supplemental to the product purchased or for some other product offered by the vender (or other vender).

[0242] In addition, the ACS is also provided with ongoing CCD (e.g., activity data such as that of a purchase) and location data of the user (new data). The new data is transmitted to the ACS in response to a request transmitted by the ACS. Alternately or in addition thereto, the new data may be periodically transmitted to the ACS from the device **101** as requested by the ACS during an initial communication with the device. Alternately, the ACS may receive the location information from a fixed network node or a point of sale that is in communication range of the user's device **101** (meaning that the user is near the node or point of sale). Advertisements can then be selected, retrieved, and transmitted based on subsequent temporal data, location data, and CCD.

[0243] In addition or instead of receiving advertisements from the ACS, each vender may transmit advertisements to the device **101** and which may also be selected based on temporal data, location data, and/or the user's CCD. Thus, for example, as the user walks or drives near the vender's location, the vender's computer system (which may also be the vender's point of sale system) selects and transmits advertisement(s) to the user, which may include an electronic coupon and may also result in providing the user with incentives (i.e., an incentive transaction) as described above.

[0244] In addition, the ACS or vender's computer system may query the device **101** for demographical or other data about the user, which can be used to provide a statistical profile of person's more likely to purchase a particular

product, enter a vender's store, and/or otherwise provide information that might be used to determine advertising criteria.

[0245] The device **101** can also be used to provide data to a data collection computer system, which can then provide statistical data or other information based on the collected data to other systems. For example, the device **101** can supply data that provides statistical information of the visitors' ages, incomes, genders, and other information of persons with devices entering a particular geographical area, facility (e.g., shopping complex), vender store location or performing another activity (such as making a purchase, sell, exchanging information, etc.). This data could then be supplied to advertisers and/or used to select advertisers and/or advertisements and may form the basis for targeting criteria.

[0246] The device **101** can also be used to provide data, which is non-user specific. More specifically, the data collection computer system receives information of the number of users (e.g., drivers) within the geographical area or performing the selected activity. The received data may simply include location data, confirmation that the device **101** is within the geographical area or that the user has performed the activity. Additionally, the data may also include information relating to the users' ages, incomes, genders, items purchased, prices purchases, venders visited, venders from who product purchased. The received data is store in memory and may be used to provide various statistical information such as the average income, age data, gender breakdown, other demographical information, and other desirable statistical information as is well-known in the art. As discussed, not all persons will carry the device **101** or permit collection of the statistical data---even if the above described incentives are provided. Thus, in some instances it may be desirable or necessary to extrapolate information from the collected data. For example, if fifty percent of the persons in a given geographical area have the device **101** and permit the collection of data, then the estimated number of people in the area will be twice the number indicated by the collected data. Similar extrapolation and other statistical techniques well-known in the art can be used to provide other estimates such as to income, age data, gender, other demographical information, and other desirable statistical information.

[0247] The use in this technique can be used, for example, to determine how many users are traveling on a particular road, street, or highway or within a particular geographical area (e.g., a store, restaurant, facility, etc.). As with many such applications of this type for the present invention, the collected data is preferably extrapolated (because not all drivers have the device **101** or permit collection of the data) to estimate the number of drivers on the particular thoroughfare or used in combination with other data to arrive at the estimate. Thus, the data can used to determine the relative capacity of the thoroughfare as well as how fast the traffic is moving and need not utilize or request user specific data.

[0248] The data collection computer system may also act as a VCS that supplies information based on the collected data such as the number of people within the vender store location, the number of a particular type of product sold (and demographical data of the purchasers), number of products purchased by a users, and other vender collectable data. In addition, incentives, as described above, may also be provided to those users who permit the collection of such data.

[0249] Advertisements may also be presented to the user by a fixed presentation device for audio and/or visual presentation to the user. The advertisement can be selected and transmitted, as discussed herein, from the ACS or vender computer system (VCS) to the fixed presentation device or selected and presented by the fixed presentation device itself, which includes, or forms part, of a computer system. Referring to **FIG. 3**, as the user approaches a vender's location in a shopping complex, the VCS, through an access point **230***a* capable of communicating with devices positioned near the front of the store, establishes a communication link with the user's device **101**. Upon retrieving select CCD data, the VCS selects an advertisement according to one more of the methods described herein. The advertisement is transmitted (or played) and visually and/or audibly presented to the user on a video and/or audio output device **240***a-b* (e.g., television with speakers) at the front of the store so that the user can see and/or hear the advertisement without entering the store.

[0250] The advertisement, in this and other applications described herein, is preferably customized for the user and includes at least some of the user's CCD (user information) and/or vender stored user information.

[0251] For example, the advertisement preferably addresses the user by name by audibly stating, for example, "Good morning Mr. Johnson. Our dress slacks, which you previously purchased, are now on sale and your size is available. Please come in and have a free cup of coffee. In addition, as preferred customer we're giving you a coupon for an extra ten percent off the sale price." Simultaneous with the audio presentation, the display presents a visual presentation of the slacks the user previously purchased and which are on sale.

[0252] This fixed presentation device system may be especially suitable for use with a device **101** of the present invention that is embodied as a radio frequency identification (RFID) tag, which may take the form of a Smart Card and/or be attached to the user's key chain, belt, a clothing pin, or other easily carried form. The high frequency RFID systems (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) offer transmission ranges of more than 90 feet. Thus, the VCS system transmits an rf signal from access point **230***e*, which is received by the user device **101** embodied as an rf tag. In response, the RFID tag transmits the identification information through access point **230***e* to the VCS or other requesting system, which then retrieves Vender Stored User Information (VSUI) if any, selects an advertisement using one or more of the methods described herein, presents the advertisement to the carrier of the RFID tag via fixed presentation device **240***a*, and/or performs other functions. The RFID tag may be passive or active depending on the implementation of the system as is known in the art. Means for tracking the location of a moving RFID tag, such as one embodying the present invention, are well-known in the art and therefore, not repeated here. However, those skilled in the art will recognize that an RFID tag embodying a device **101** of the present invention can be used to determine the location of the user continuously, or at particular locations, throughout a facility, arena, shopping complex or other area.

[0253] Advertisements presented at fixed presentation devices may also be selected by selecting the most suitable

advertisement for presentation to a plurality of users. For example, if the advertisement selecting computer system (e.g. the VCS or ACS) determines that sixty percent of the persons who can view the advertisement are above thirty years of age (based on retrieved CCD data), the advertisement selecting computer system will select an advertisement with targeting criteria that is appropriate for that age group. The advertisement selecting computer system preferably selects the advertisement based on the CCD, temporal data, location data, transmission value, and/or based on data of persons who can view (see and/or hear) the presentation device, who are likely to view the presentation device (e.g., are within a predetermined range, not involved in other activities, have an unobstructed view, and/or other characteristics), who have shown an interest in viewing the advertisement, and/or based characteristic(s) of the persons or surroundings.

[0254] In addition, the number of advertisements and timing of the advertisement in all of the applications described herein—start, stop, and duration time—may also be based on CCD, temporal data, location data, whether they can view (see and/or hear) the presentation device, for how long they are likely to view the presentation device (e.g., are within a predetermined range, not involved in other activities, have an unobstructed view, and/or other characteristics), whether they have shown an interest in viewing the advertisement, transmission value, and/or based on some other activity, location, or characteristic of the person(s) or surroundings.

[0255] When the user views an advertisement (whether or not presented on a fixed presentation device **240***a*), the user can elect to receive additional information either from a fixed presentation device or another remote device. For example, if, in the above example, Mr. Johnson wishes to obtain more information, he can transmit, for example, a request to determine whether a particular color is available in his size. In response, the VCS transmits information for determining whether Mr. Johnson's size is available in the particular color, which is received and presented to the user.

[0256] Likewise, the fixed presentation device **240** might include notice of a coupon. The user can request electronic transmission or printing of the coupon by transmitting a request to the VCS (or ACS). Transmitting the request can entail simply actuating an actuator (e.g., a button) on the device, which establishes a Bluetooth communication link (via access point **230***e*) in which the coupon is automatically transmitted. Preferably, for those embodiments of the device **101** that include a display, the display includes information (e.g., information relating to the advertisement) regarding how to make the request.

[0257] In addition, some presentation devices (or VCSs) might transmit a request to download the coupon and the user simply provides an input to the device **101** as to whether the coupon should be accepted and stored. Similarly, some advertisements may include instructions for obtaining additional information (such as a coupon), which may include establishing a communication link with a predetermined destination (e.g., calling a phone number), or providing a password (e.g., which may be provided to enter a facility, used as a coupon, or for some other advertised activity).

[0258] For those embodiments of the present invention that are an RFID tag, the fixed presentation device **240** (or other external input device) may include a user input device (e.g., a keyboard, mouse, and/or microphone with appropriate voice recognition software) can be used by the user—as instructed by the presentation device **240**—to make the request such as retrieving the additional information, making a purchase, or performing some other action relating to the advertisement or advertised vender.

[0259] Finally, with the continuous or frequent receipt of advertisements, the memory of the device is likely to fill to capacity. Consequently, the present invention includes programming (which preferably forms part of the data management module) that provides a means for automatically managing the amount of memory available for storing advertising. Specifically, the device **101** includes programming that automatically deletes advertisements after a predetermined time period and/or when a predetermined amount of memory has been filled with advertisements in which case the oldest ads are deleted first. In addition, if the network advertising system is so designed, the device **101** deletes those advertisements that have not been refreshed within a predetermined time period. For example, venders within communication range (e.g., via a WLAN access point) periodically retransmit their advertisement and when the advertisement is not received for the predetermined time period, the device **101** deletes the ad. The vender may not retransmit the advertisement because the device **101** is out of communication range, the vender has set a maximum predetermined number of retransmissions for the advertisement or user, the vender has set a maximum amount of advertising resources (e.g., bid prices, bandwidth, or other resource) to be used for a user, and/or some other reason.

[0260] In addition, advertisement may also be deleted based on the location of the user so that advertisements for venders the furthest away are deleted first and/or advertisements for venders (or products) that offered at locations greater than a predetermined distance are deleted, or in a area (e.g., a shopping complex) in which the device **101** is no longer present or communicating. Location information of the vender associated with an advertisement may be included with the transmitted advertisement, or transmitted separately such as in map data.

[0261] Advertisements and or other transmissions may also be sent by other user devices as well and based on location data, temporal data, CCD, ad targeting criteria, and transmission value and may also include incentives and result in an incentive transaction. In addition, advertisements selected based on location data, CCD (including activities of the user), temporal data, and/or ad targeting criteria may be transmitted to the user at a later time or for presentation at a later time. For example, based on the location of a user in a shopping complex (standing near a vender for a predetermined time period), casino (e.g. standing near a gaming table for a predetermined time period), other facility, or area the ACS or VCS can transmit (e.g., via email) the selected advertisement for later receipt and, in the case of a coupon, use during a subsequent visit to the area.

[0262] The device **101** also includes software for finding a product within a vender location within a shopping mall. To do so, the device **101** transmits a request for the product or vender to the ACS (or other remote computer with access to the information) and receives a response with the requested information if the vender or product is present. In

addition or alternately, the device **101** transmits a request for the product or vender to the venders that are within the shopping complex and receives responses with the requested information if the vender is present or if from the venders having the product or other responsive information.

[0263] In addition, at the request of the user, the device **101** can transmit a list of items desired by the user to the vender computer system. In response, the vender computer system transmits an associated location for each item on the list (such as an aisle location) and optionally a price for each item and a total price for the list. The user can then use the device **101** to scan the bar code (or receive it through an rf ping) on each product as the user places the product in the cart. As the user leaves the vender store location (for example, when crossing the outgoing door threshold), the device **101** exchanges product and payment information with the vender computer system to facilitate payment for the products. As an alternative, the user can instruct the device **101** (e.g. by a voice input) to transmit the list of products to the vender prior to arriving. Vender personnel can then gather the products and prepare them for pick-up by the user or delivery.

[0264] The user can also instruct the device **101** (e.g. by a voice input) to transmit a request for other vender information from a remote computer system (which may or may not be the vender computer system), prior to arriving at a vender location. For example, the user can instruct the device **101** to request information relating to the volume of business currently present at the vender. In response, the computer system transmits responsive information such as the wait time for service or entry, the number of people present at (and/or inside) the vender store location, the percentage of maximum allowable number of patrons that are present, the average, mean, or estimated wait time to check out (e.g., purchase an product), the availability or probability of obtaining service (e.g., seating in a restaurant), the number of parties already waiting to be serviced (e.g., to be seated or to purchase a product), an audio or video data transmission of a pertinent portion of the vender location (e.g., the line to be seated), and/or the availability of a particular product. The vender information is preferably derived from conventional monitoring equipment, the point of sale system, and/or supplied to the remote computer system (such as the vender compute system) by a video camera or by vender personnel as needed. In response to receiving the vender information (or upon receiving satisfactory vender information), the user may instruct the device **101** to transmit a request for a product, a reservation, or other service.

[0265] In addition to the above, user or device specific information (vender stored user information or VSUI) can be stored in the VCS, the ACS, in another remote computer system, on the device, or some combination thereof. After the user returns to a particular location, the VCS can identify the user (or device) and retrieve the VSUI for that user (or device). Referring to **FIG. 8**, the steps include determining the identifying information at step **501**, collecting the VSUI at step **505**, and storing collected VSUI at step **510**. At a later time (e.g., when the user returns to the location), the steps include determining the identifying information at step **501**, retrieving the VSUI for that user (or device) at step **515** and taking action based on the retrieved VSUI at step **520**. The action taken at step **520** may include any desirable action such as selecting a particular advertisement as is discussed in more detail below.

[0266] In the preferred embodiment, the device and/or user is identified by a unique identifier already stored in the device **101** such as the devices telephone number, user's home telephone number, IP address, social security number, email address, and/or other identifying information. In addition, identification of the user and device **101** may be accomplished through device identifying information (e.g., a device serial number), device (or memory) manufacture make, and/or serial number, and where multiple users use the same device **101** (e.g., employees), user distinguishing information (e.g., the first name of the user or employee identification number) that allows the computer to distinguish between users. Information identifying the particular user, from a plurality of users, is preferably stored in memory and determined based on a username supplied by the particular user when the user turns on the device **101** or otherwise supplies it. In the preferred, there is no need to store data on the device **101** and the VCS simply retrieves information sufficient to identify the user from a storage device. Determination of identification information may or may not include information for identifying the user by name, but allows the VCS to store and retrieve data about the user and/or device as described in more detail below.

[0267] At step **501**, a communication link is established between the device **101** and the VCS and the VCS and identifying information is requested by the VCS and transmitted by the device **101** in response to the request. Alternately, establishing the link may provide sufficient identifying information to the VCS to alleviate the need to request identifying information (e.g., device identifying may be supplied when the communication link is established in the form of a Global ID other unique device identifying information).

[0268] In an alternate embodiment, a remote computer such as a VCS or ACS may request to store, and store data on the device. The request to store data (or for identifying information) can be included with a request to establish a communication link with the user device, when the user enters a geographical area (such as inside a store), when the user enters communication range of the VCS via a particular network (e.g., a WLAN), at the occurrence of an event (e.g., at purchase of an product from a vender), or any other time or place desirable.

[0269] For example, after the user enters the vender store location, and a communication link is established between the vender's computer system (e.g., the point of sale device) and the user's device **101** (e.g., via a WLAN), the vender's computer system transmits a request to store the VSUI in the memory of the device **101** (or a request for identifying information). The data that the vender requests to be stored preferably includes identifying information that is unique for that device **101** (device identifying information) and/or user (user identifying information) such as a unique number or code and can therefore be retrieved at a later time to identify the return of that device **101** and/or user and to retrieve VSUI data stored elsewhere. The VSUI is stored on the device **101** with a file name that is preferably unique to that vender (e.g., Acme Clothing Store), but may be unique to a particular company (e.g., a store chain or franchise such as

McDonalds®, Giant®, Safeway®, ABC Theaters, etc.), to that type of vender (e.g., restaurants, bank, clothing, shoe, sporting goods, etc.), shopping complex, product, geographical area (e.g., an auction site, county, etc.), to that user, to that device, and/or a particular service company or manufacturer (e.g., Nike®, Motorola®, Cingular®, etc.). Thus, one VCS may store multiple sets of data for any of the preceding identified categories of data or other data in one or more data files. Preferably, each file for a particular type of data is stored on each device **101** with the same (e.g., vendername.dat) or similar file name (e.g., vendernameXXXXXXXX.dat with the "X"s representing device or user specific data) so that the VCS, other VCSs, or ACS may identify the file and retrieve the data (e.g., when a subsequent communication link is established during, for example, a subsequent visit).

[0270] Once the identifying information is determined by either storing it on the device **101** or by retrieving it from the device **101** at step **501**, the VCS collects VSUI based on activities of the user at step **505**. The VCS stores information that the VCS collects in the VCS memory (or memory of another remote computer system) at step **510**. The VSUI is stored in a manner to allow the VCS to retrieve all of the VSUI when the identifying information is known. The VSUI is preferably stored in a database that is searchable and/or indexed by the identifying information.

[0271] The vender stored user information (VSUI) may include any data that the VCS can collect such as information about the user and/or device **101** such as information of the previous visit(s) (e.g., the date, time, day of the week, products purchased, amount purchased, etc.), advertisements that the user has responded to and/or viewed, offers that the user has responded to, format for communicating with the device, location data, any CCD, user response information, and/or any temporal data. In addition, the VSUI may include vender account information such the account number, the amount of credit the user has with the vender, and/or the balance of any account the user has with the vender. The data is preferably stored in a database of a central computer system (which may be remote) and may also, or instead, be stored in the memory of the VCS.

[0272] In addition or instead of the identifying information, the VSUI stored on the device **101** may also include other information about the user and/or device **101** such as information of the previous visit(s) (e.g., the date, time, day of the week, products purchased, amount purchased, etc.), payment information (payment account information such as credit card number(s), expiration date(s), and billing address(es), etc.) products purchased, format for communicating with the device, location data, vender account information such the account number, the amount of credit the user has with the vender, the balance of any account the user has with the vender any CCD, user response information, and/or any ad targeting data.

[0273] Prior to making a request to store and/or storing the VSUI on the device **101**, the VCS transmits a request for a file with a file name that, if present on the device **101**, would have the desired data (e.g., a file with a name of vender.dat). If no file with the requested filename is present, the device **101** transmits a response with information indicating that the requested file is not present. From the device response, the VCS can determined that new VSUI must be stored on the device **101** and proceeds to transmit a request to store VSUI on the device **101** along with the file name in which the data should be stored. As discussed, the VSUI stored on the device **101** preferably includes identifying information to identify that user and/or device.

[0274] If the file (e.g., vender.dat) exists, the device **101** transmits the data file, or a requested portion thereof, which preferably includes the identifying information, to the VCS. After receiving the information, the VCS transmits a request for the VSUI associated with that user and/or device **101** from the central computer system or, depending on the configuration of the embodiment, retrieves it from its own memory.

[0275] If the above embodiment in which no data is stored on the device **101** is employed, the received identifying information is likewise transmitted in a request to retrieve data associated with the identifying information. If no VSUI is present, the VCS determines that a new record corresponding to the received identifying information must be created to store VSUI for the user/device.

[0276] At step **520**, based, at least in part, on the VSUI, the VCS or ACS performs an action such as selecting and transmitting advertisement to a particular user or for presentation on a nearby presentation device (e.g., computer monitor and speakers), which may include a coupon, refund, rebate and/or other offer (e.g., an incentive) to selected users, notifying vender personnel that a preferred customer has arrived. In addition, at step **520** the VCS can supply vender personnel with VSUI or information based on the VSUI (e.g., information of what the products the user previously purchased, is likely to purchased, or that the user has indicated the user likes (e.g., in CCD or stated previously to vender personnel)), direct personnel to point out or offer for sale a particular product, and/or otherwise present advertising, communicate with vender personnel, offer products, or offer incentives to select users based, at least in part, on VSUI.

[0277] As discussed, if no data corresponding to the user and/or device **101** is present in memory, (when using either embodiment), it is determined by the VCS that the user has not been in communication with the VCS before and that a new data record must be established for the user and/or device **101**. Some users may not have any VSUI data stored because they have elected not to supply any (or very little), because they are a new visitor, or for other reasons. However, if there is little or no VSUI for a particular user, the VCS can present advertising, communicate with vender personnel, offer products, or offer incentives to select users (as described above) based, at least in part, on the VSUI, of other users. In other words, the VSUI, location data, and/or temporal data of a plurality of users may constitute a VSUI database, from which statistical processing can reveal trends, patterns, profiles, probabilities and other data for selecting advertising, communicating with vender personnel, offering products, and/or offering incentives to select users. For example, if only the user's address is known, the VCS may select advertisements for that user that have been successful, or which are more likely to be successful, for users living in the user's area (e.g., city, neighborhood, street, etc.). Likewise, the age and home address of the user may indicate that the user is likely to become a repeat customer and, consequently, the VCS transmits advertise-

ments with user incentives, whereas users who are not likely to become a repeat customer do not receive such incentives.

[0278] Regardless of the means for identifying the user and/or device, the VCS collects new VSUI and stores the new VSUI in memory, which is preferably in a remote central computer system. As discussed, the VSUI may include any data the VCS can collect such as any information about of the visit(s) (e.g., the date, time, day of the week, products purchased, amount purchased, etc.), ads that the user has responded to, offers that the user has responded to, format for communicating with the device, CCD (such as new or revised CCD), location data, and/or temporal data. In addition, the VSUI may update vender account information such as the account identifying information, the amount of credit the user has with vender, and/or the balance of any account the user has with the vender.

[0279] **FIG. 3** is schematical representation of a vender store location for providing the mobile e-commerce according to the present invention. The vender store location **220** includes an entrance **221**, a VCS **401***a*, and a plurality of access points **230***a-e* for providing a WLAN, with each having an associated communication range **235***a-e*. Each of the access points **230***a-e* is communicatively coupled to the VCS via a wired connection (although a wireless connection would work equally as well).

[0280] Each access point **230***a-e* of this example has a separate network address so that data received from the user device **101** and provided to the VCS is determined by the VCS **401** to have come from a particular AP **230**. Thus, knowing the AP **230** with which the device **101** is communicating, and the range of the AP **230** (if desired or necessary), the VCS **401** can determine the approximate location of the user in the vender store location **220**. In addition, as the device **101** communicates through a sequence of APs **230***a-e*, the VCS can determine a plurality of locations for the user and, therefore, determine an anticipated location for the user carrying the device **101**. Thus, an action, such as the selection of an advertisement based on location may be a selection based on the user's current location or anticipated location.

[0281] In this example embodiment, access point **230***c* is the access point located at the point of sale (e.g., where personnel remove tags), but any or all of the access points could be used to complete the commercial transaction as described herein (e.g., exchange payment information).

[0282] After the VCS **401** identifies the user (or device) at step **501**, the VSUI is retrieved at step **515**, the appropriate user transmission(s) is selected at step **520**, preferably based at least in part, on the VSUI, and transmitted. While the user is within transmission range of the VCS **401**, the VCS collects (step **505**) and stores additional VSUI (step **510**), and may transmit additional user transmissions to the user or store personnel (step **520**) based on VSUI and/or on the activities of the user while in the store (e.g., the user's location, user's repeated proximity to a location, user's duration at a location in the store, user's duration in the store, the user's purchase of (or intent to purchase) an product, and/or the user's time waiting to checkout, etc.).

[0283] Select or all of the collected VSUI is stored locally and transmitted (as desired by the vender) to a central computer system at the end of the user's visit. Preferably, the VCS periodically attempts communication with the user's device **101** (e.g., through numerous vender located LAN nodes) and determines the end of the user visit when a plurality (e.g., three) of attempts are unsuccessful. However, the VCS might also receive information from a sensing device that determines when the user has left the vender store location such as a ACS (which determines the user is in a different store or otherwise outside the vender store location), an entry way monitor (e.g., a short range PAN node) such as access point **230***d* that senses when the device **101** passes through the entry way of the vender store location (e.g., by communicating with the device **101** as it passes through communication zone **235***d* by requesting and receiving the identifying information). The sensing device might also be used to determine when a user enters the vender store location and thereby request and receive the identifying information from the device **101**.

[0284] When stored in a database of a central computer system, other venders of the same company (e.g., a store chain or franchise), of the same type of vender (e.g., restaurants, bank, clothing, shoe, sporting goods, etc.). in the same shopping complex, in the same geographical area (e.g., an auction site, county, etc.), and/or offering products of the same service company or manufacturer (e.g., Nike®, Motorola®, Cingular®, etc.) may retrieve the VSUI data, request information sufficient for selecting transmissions directed to the user (e.g., transmissions with ads), and/or request that the central computer system select an advertisement (or type of advertisement) for transmission or transmit a transmission itself.

[0285] Instead of the more fully featured embodiment of the present invention, the storage of VSUI data may be accomplished through the use of a radio frequency (rf) tag or radio frequency identification (RFID) (which may be powered or not powered). For example, the RFID includes user identifying information (e.g., a unique code) stored therein and transmits the identifying information in response to an rf ping from a remote device that is communicatively coupled to the VCS. Upon receiving the user identifying information, the VCS transmits a request for (or retrieves from memory) the VSUI data associated with the user who has been issued the RFID with the received identifying information. In addition, the RFID may be a Smart Card, which can store some VSUI such as account information as described above. The RFID can also be used to determine the location of the user according to the access point location method described herein. Therefore, many of the features described with respect to VSUI can be implemented with the use of a Smart Card.

[0286] The RFID can take the form of a generic credit card (e.g., a MasterCard®), a vender credit card (e.g., a Sears® credit card), or a discount card, which thereby provides an incentive for the user to carry the card when visiting the vender. Alternately, the user may have an RFID in the form of an integrated circuit implanted under the skin, which contains user identifying information, such as, or similar to, the Verichip® manufactured by Applied Digital Solutions of Palm Beach, Fla.

[0287] Another example application of the device **101** of the present invention is for facilitating an auction. In a traditional Internet auction, sellers offer and sell their products across a country or nation. After the sale, the seller must

mail or ship the product to the buyer and coordinate secure payment from the buyer and rarely have an opportunity to physically inspect the product for sale. In contrast, the present invention facilitates a localized auction in which the products offered for sale and the buyers are within a common or localized area. Thus, instead of having to mail or ship the product, the buyer can inspect it, collect it and, if necessary, provide payment for the product. The common or localized area of the localized auction ensures that the products offered for sale and the buyers are the within predetermined distance of each and, preferably, within a convenient distance for inspecting and collecting the product. In addition or alternately, the localized area may also ensure (in some auctions) that the buyers and sellers are within predetermined distance of each and, preferably, within a convenient distance for inspecting and collecting the product and, if desired, for providing payment for the product to the seller. Preferably, the localized area of the auction is defined as an area less than one square mile such as within a facility in which the products are offered, within a city block, on the grounds of an auction site, within communication of a WLAN that is used to facilitate the auction, and/or any area that permits the buyers to conveniently inspect and collect the products for sale (e.g., walking to the products). However, the localized area may be distributed with a plurality of users offering their products for auction from their respective homes. The localized area may also be fixed, as is conventional, or dynamic (changing in location and/or size over time). In addition, the localized area might be defined as a larger geographical area such as a county, a city, a state, or multi-state area in which users can drive via automobile to inspect and/or collect the products and is preferably less than a four hundred square miles (e.g., a twenty mile by twenty mile area), and more preferably less than one hundred square miles (e.g., a ten mile by ten mile area), and still more preferably less than twenty-five miles (e.g., a five mile by five mile area).

[0288] The auction preferably requires payment to enter the auction, which is preferably provided wirelessly as described above through the wireless exchange of payment information by the commerce module. In response to payment, at the request of the user, or upon entering the auction, the area computer system (ACS) facilitating the auction transmits bidder identifying information (e.g., a bidder number or name) to the device. The devices stores the received bidder identifying information and uses it when making bids so that the ACS (or other devices/computers) can identify the bidder. Alternately, the ACS may request, and the device **101** transmits, in response to the request, device and/or user identifying information such as the device ID or telephone number, which is thereafter used to identify the bidder. In addition, the device **101** may establish a credit line or provide information sufficient to allow the ACS to determine that the user has access to sufficient assets to satisfy (i.e., pay for) a successful bid at a given amount. Alternately, this financial information may be provided after the user places a bid.

[0289] In addition, as users enter an auction area, the user's device **101** transmits information relating to products the user wishes to sell at the auction (product information) if any, which may include a title, a name, a description, digital photographs, a minimum price, acceptable methods of payment, seller information, delivery information, a final bid time, a location (e.g., within the area) at which prospective buyers can inspect the product, and other information. The ACS receives and stores the product information and transmits the information to other users present at (or remote from) the facility. Users may elect to receive information about all products for sale, only certain types of products, and/or specific products and supplies the data to the device, which transmits the data to the ACS. The ACS stores and uses the data to determine when and what information is to be transmitted to each user. Users who receive the product information and who are remote from the facility can then elect to place bids remotely and travel to the auction area (e.g., to see the product or if they are the successful bidder to obtain the product).

[0290] User devices **101** also transmit bids to the ACS, which receives and stores each the bid and associated bidder identifying information (e.g., the user's telephone), and, in response, transmits information of the new highest bid to all the devices of all users who have previously bid on the product. In addition, the ACS transmits highest bid information and product information to users as they come within a predetermined distance of the location of the product for sale (which is preferably supplied by a WLAN). Users may also program their devices to incrementally outbid the highest bid for a particular product by a predetermined margin starting at a particular time and stopping when at a maximum bid and/or time is reached.

[0291] As discussed, prior to accepting a bid the ACS preferably receives payment information from the prospective buyer (the bidder) and confirms that the bidder has access to sufficient financial resources to make payment at the bid amount if the bidder's bid is successful and—if required by the seller—according to the seller's payment criteria (e.g., acceptable payment account). Confirmation of financial resources may be performed in any suitable manner, as discussed above with respect to the commerce module, such as sending a request to a remote computer system representing the payment account. Methods of confirming financial resources are well known in the art (such as that a credit card holder has sufficient credit prior to purchasing gas or checking into a hotel room) and are therefore not repeated in detail here.

[0292] If the bidder does not have sufficient resources to make payment for the bidder's bid amount, the ACS rejects the bid and transmits a notification of such to the bidder. If the bidder does have sufficient resources, the ACS preferably debits the payment account for the amount of the bid until the bidder is out bid at which time the ACS credits the payment account.

[0293] At the end of the bidding process the ACS notifies the purchaser that he or she was the successful bidder and notifies the seller of the identity of the buyer (e.g., by supplying the telephone number and name), the selling price and other information. The ACS may also exchange the payment information of the bidder with the seller by crediting the seller with the amount of the successful bid and which was previously debited from the bidder's payment account. Alternately, payment exchange data is exchanged between the buyer's and seller' devices. In either event, the transaction is completed quickly, may be paperless, and the seller need not fear that payment will not be received.

[0294] While the above example embodiment and application has been described in the context of an auction, the

present invention is equally applicable for facilitating a reverse auction in which bids are placed lower and lower to sell a service or product to one or a group of purchasers.

[0295] In addition, while the above example embodiment and application (auction and reverse auction) are described as being used in a facility, the present invention could be used in a much greater geographical area such as within a city block, a county, or city. Furthermore, while the above example embodiment and application employs an ACS, the users' devices could perform some or all of the functions described above as being performed by the ACS. In addition, portions of this and other embodiments herein may be applicable to facilitating transactions at flea markets, yard sales, estate sales, and traditional auctions (in which products are auctioned off by an auctioneer sequentially).

[0296] Another application for the present invention is establishing credit with a vender, merchant, or financial service provider. More particularly, the device **101** transmits the user's information necessary for completing the credit application to a remote computer system (e.g., the VCS). The credit information is preferably transmitted in response to a request from the remote computer system, which requests the specific data (e.g., a portion or all of the CCD). In response to the request, the device **101** prompts the user for permission to respond and, provided permission is granted with a user input, retrieves the data (e.g., preferably stored as CCD) from memory for transmission. The credit information preferably includes the user's name, birth date, address, social security number, income, and/or other relevant data.

[0297] Upon receiving satisfactory credit information, the remote computer system may create a credit line for the user. Whether the credit information is satisfactory or not may be determined by the remote computer itself (e.g., based on the income and/or other data) or by requesting additional information from a credit reporting computer system. To employ a credit reporting computer system to determine whether the credit information is satisfactory for providing credit, the remote computer system transmits a request for a credit score (or other data) for the user to a credit reporting computer system. The request includes the user information necessary for the request (e.g., the user's social number, birth date, name and information of the requester) to receive a valid response. Upon receiving a credit score or other data, the received data is used to determine whether credit should be provided to the user, how much credit should be provided, the terms of any credit provided (e.g., the interest rate, monthly payment, payment schedule, duration of loan, etc.), the amount assets to which the user has access, and/or other determinations. Information of the credit established is preferably transmitted to the device **101** where it is presented to the user and stored as CCD.

[0298] An authorized user may program the device **101** to monitor and/or restrict the use of the device **101** by one or more restricted users. For example, a parent may provide the child with a device **101** or share their device **101** with the child and program the device **101** to monitor and/or restrict the child's use of the device **101**, for example, for communications including emails, telephone calls, instant messaging, and/or long distance telephone calls. The restrictions (or limitations) may be based on various characteristics of the communication such as when the communication is initiated, who (or what device) the communication is with, the duration of the communication, the cumulatively duration of communications (e.g., per day), the type of communication (personal video communication, telephone communication, SMS, email, fax, radio or TV, etc.), and/or other characteristics. The device **101** may also be programmed to monitor and restrict the use of the device **101** to engage in commercial exchanges (i.e., make purchases or sell items). For example, the restrictions may be based on various characteristics of the commercial exchange such as when the exchange (sale or purchase) takes place, where the exchange takes place, the value of the exchange (e.g., a maximum limit), the cumulative value of the exchanges for a given time period (e.g., for the month or day), the particular vender, the type of vender, the product, the type of product, and/or other characteristics. Thus, the restrictions are stored in the device **101** and prevent the device **101** from being used in commercial exchanges, communications or for other uses for which a restriction exists (i.e., stored in memory).

[0299] In addition, the device **101** may be programmed to monitor the location of the user carrying the device, which may include what facilities the user enters, the address(es) visited, what venders the user visits, etc. The location may then be periodically transmitted to a remote computer system or a location notification can be transmitted to a remote destination if the user enters a restricted location (a location defined by the authorized user as being a location that the user should not enter and/or a notification transmitted). The data, which may be longitude and latitude, is preferably cross-referenced to a street address and more preferably further cross-referenced to the tenant name, owner name, or vender name for the address. In addition or alternate thereto, name and/or address data may be transmitted to the device **101** as the user enters or approaches the location (e.g., from a VCS).

[0300] In addition, the device **101** can be programmed to monitor the user devices **101** that are nearby the user's device **101**—i.e., within a predetermined distance such as within communication range (e.g., via a PAN or LAN) of the user's device **101**. Information of the nearby user devices—including information of the user such as the user's name, age, address, occupation and other CCD—may be received as a result of a query as described above. The device **101** can be programmed to periodically (or upon the occurrence of an event) make the query requested by the authorized user.

[0301] Furthermore, an authorized user may monitor live use data from the device **101**, which is the input to one or more of the input devices or output from one or more of the devices of the device. For example, the authorized user may request to monitor the input to video and/or audio inputs of the device. The authorized user receives a transmission from the device **101** with the video data and/or audio data captured by the video camera and/or microphone of the device **101**. The authorized user may also elect to monitor the voice commands, all sides of a telephone conversation, information of manual inputs (e.g., key board strokes), location information, images displayed on the display of the device **101**, communications transmitted and/or received, and any other data to which the CPU has access. The authorized user may elect to monitor all or any subset of such use data.

[0302] In addition, the use data may be monitored with or without the knowledge of the user. For example, the autho-

rized user may program the device **101** to begin to transmit the desired use data to a predetermined destination beginning at a particular time or upon occurrence of a triggering event (and without the knowledge of the user). Alternately, the authorized user may remotely transmit a request for use data to the device **101**, which includes information identifying the requestor as an authorized user so that, if it so desired, the device **101** does not inform the user that the request is being made or that use data is being collected or transmitted. This feature is accomplished in this example embodiment by establishing a communication link with the device **101** by transmitting an authorized user request to a separate address (e.g., telephone number) for the device **101** that is used by authorized users to make such requests and perform other authorized user actions. Alternately, the feature can be accomplished by including additional information in the request packet that is interpreted by the device **101** as a request for a communication link by an authorized user and, optionally, about which the user should not be informed (so that the ringer does not ring). In either or another method, the authorized user is preferably prompted for an authorization password or for other information ensuring that the requestor is authorized to perform the monitoring and/or impose restrictions. The authorized user can also program, or transmit a request to program the device **101** to collect and store the use data and to transmit the use data periodically, at a later time, and/or in response to occurrence of an event, as opposed to transmitting the data live. Thus, the authorized user can program the monitoring and restriction instructions remotely by establishing a communication link and transmitting an authorized user request or through voice commands (or manual input) prior to supplying the device **101** to the restricted user.

[0303] Imposition or removal of certain restrictions may also be dependent on the occurrence of an event such as the user arriving at a certain location, checking into a hotel, turning on the device, turning off the device, making a purchase, etc. This feature of the device **101** is also useful for employers to limit the use of the device **101** by the employer's employees.

[0304] The device **101** can store and transmit (immediately or at a later time) any activity or use of that the device **101** can monitor, such as the location of the device, communications, commercial exchanges, physiological sensed data, audible and visual inputs, and other inputs. The device **101** can be programmed to transmit the data to any remote computer system for storage, another device, a telephone, or a telephone message recording device. For example, when the user (e.g., a child) travels to a "restricted" area (e.g., a predetermined restaurant, any bar, a particular home, a predetermined address, and/or a vender or type of vender, etc.), the device **101** automatically establishes a voice communication link with a predetermined telephone number. After the communication link is established, the device **101** transmits a synthesized voice signal, for audible reception by the device **101** (e.g., a message machine) or person answering the telephone, that includes information that the user has entered a restricted area. Alternately, the device **101** may be programmed to transmit an email, a page, or other type of transmission that includes information that the user has entered a restricted area, attempted to use the device **101** in a restricted manner (a use for which a restriction has been programmed in the device), or has otherwise used, or attempted to use, the device **101** an unauthorized manner or in some unauthorized fashion. In addition, the programmed restrictions preclude the use of the device **101** in a restricted manner such as, for example, at a restricted location, for longer than a predetermined duration, for commercial exchanges greater than a predetermined value, for commercial exchanges at particular venders or types of venders, for commercial exchanges for particular products or types products, and/or in a manner that is inconstant with a stored restriction. The authorized user can also program the device **101** to inform the restricted user that a restriction has been placed on the requested action and that the user is not authorized to engage in the requested action.

[0305] Information of an attempted use for a restricted use (and/or non restricted uses) can be transmitted to the remote device immediately (at the time of the use), periodically, and/or at the request of another device **101** authorized to receive the stored data.

[0306] Thus, when the device **101** receives an input, which may be a user input as a request to perform an action, a transmission, or other data (such as location data), the programming of the device **101** determines whether the received data represents data to be monitored, a request for an action that is to be monitored or restricted, or data representing a triggering event. If the programming determines that the input is data to be monitored, a request for an action that is to be monitored or restricted, or data representing a triggering event, the device **101** monitors (stores, transmits, or both) the data, or prohibits (denies) the action according to the restriction and monitoring data stored in memory by the authorized user.

[0307] The user of a device **101** may also elect to provide remote computer systems (which may be other devices **101**) with select device information. For example, upon request from a remote computer system, or periodically, the device **101** transmits information such as the user's destination, the user's location, the user's mobility (whether the user is in a vehicle of transportation or not), select CCD, nearby user device information, user profile data, and/or information relating to communications, commercial exchanges, audible and visual inputs, and other inputs of the device. The received information is stored for further processing and/or review.

[0308] Preferably, the device information is provided to the requesting remote computer system from the device **101**. However, in alternate embodiments, the device **101** periodically (or in response to an event), transmits the data to a remote computer storage system (e.g., a web server) that stores the data. Other remote computer systems may retrieve the data from the remote computer storage system, which may be supplied to them in HTML or other suitable format. The user can also program the device **101** to transmit only selected information and to transmit different information to different requestors by inputting monitoring response instructions. If the information is being provided by a remote computer storage system, information sufficient to determine what information may be provided to what requestors (monitoring response instructions) is also provided to the remote computer storage system. The data may then be processed, for example, to map the location of the user over time.

[0309] As an example of the application, when the user is traveling in a vehicle and an incoming call is received, the

device **101** responds to the call by transmitting the current location of the user, the previous locations of the user, the intended destinations of the user, and/or the anticipated arrival time at the intended destination(s) (which was previously stored in memory). The user can program the device **101** to respond by inputting monitoring response instructions. The monitoring response instructions may dictate that the device **101** respond in the above manner to all callers, only callers from select addresses (e.g., phone numbers), not respond to such calls at all and/or respond in this manner at certain times of the day or certain days. This application may be used by a parent (or employer) to determine the current and previous locations of a child (or employee), and to determine the person's expected arrival time at the intended destination (e.g., home, work).

[0310] In addition, at the request of the user, the device **101**, as operated by its programming, informs the user when the user is not likely to at a predetermined destination prior to a predetermined time based on the user's current location, destination, the user's velocity (direction of travel and speed), and other factors (e.g., delays). In addition, the program operates the device **101** to periodically transmit a request for, and receive, information relating to traffic such as the location of delays, congestion back-ups, construction, accidents, and other relevant data that might impact the user's travel and/or arrival time. Upon receiving information that is likely to impact the user's travel time (e.g., when traveling a predetermined route), the device **101** also determines and informs the user of alternate routes that the user can travel in order to circumvent one or more delays.

[0311] While it is well known to forward calls received at a first telephone number to a second telephone number. The present invention also provides for emailing (or otherwise transmitting) information of the incoming communications, such as the callers telephone number, to the device **101** or a predetermined destination. Thus, a user can get notification of the calling phone number (which is collected via caller ID process) that calls the user's device **101**. The phone number is transmitted in an email (or page) that is collectable from the called device **101** and also includes the date and time of the call and whether the caller left a voice mail, which is also preferably retrievable from the device **101**. Thus, this feature may also be used by a parent (or employer) to monitor the source of incoming calls to the child (or employee). In addition, the device **101** can be programmed to receive emails (or otherwise transmit) information of the source of the incoming telephone calls to a remote system.

[0312] The device **101** also preferably includes programming for restricting the transmission of certain data based on input by an authorized user and/or manufacture provided restrictions. A transmission restriction can be associated with a directory (or folder), a file, an email, type of data, size of data file, or any other set of data. Transmission of data may be restricted based on the identity of the creator, the creating device, the data type, creation date/time, the transmission type (e.g., email, File Transfer Protocol, or other type), transmission time, destination (e.g., domain, IP address, telephone number, user, area code, exchange, or other address), transmitting device, transmitting user, destination device type (e.g., printer, device, computer system), communication link (e.g., wired, wireless, PAN, LAN, WAN), and/or any other criteria. For example, an employer may wish to restrict the transmission of certain (or all) company data by its employees. Thus, the employer may restrict transfer of data files (e.g., by email) to only email addresses with select domain names (e.g., the company's domain name).

[0313] The small size of handheld devices limits the selection of the available user inputs for selection and navigation of the available software. For example, browsing of the internet, which includes supplying information to forms and "clicking" on hyperlinks can be difficult without a keyboard or mouse. Voice inputs software, well-known in the art, allow input of data and commands to some applications (E.g., word processor applications) and allows the user to enter data into the address field of a conventional web browser. However, selecting a particular link on the web page through the use of a voice command can sometimes be more difficult. Thus, the present invention includes voice recognition software for supplying commands for navigation of the available software.

[0314] Often web pages employ the same text to identify multiple links and it is the surrounding text that allows the user to determine which link to select. The following is an example of a set of such links (the underlined words indicating a hyperlink):

[0315] 1. To join our club, click here.

[0316] 2. To buy a product, click here.

[0317] 3. To log in, click here.

[0318] Each of the above links transmits a request for a different web page. If the user speaks a voice command such as "Go to click here," the voice command software may be unable to determine which web page, identified by the above "click here" links, the user wishes to transmit a request for retrieval. Thus, the present invention allows the user to more easily select items of interest, such as hyperlinks, and provide data.

[0319] In one embodiment of the voice command software, a user, viewing the above links, would speak a voice command such as "Go to click here." In response, the voice command software hi-lights the first link (starting from the top) that is displayed on the display that corresponds to the voice command (in this example, comprised of the words "click here"), which may or may not be the first link on the web page that corresponds to the voice command (i.e., comprised of the words "click here"). Thus, if the user has scrolled down so that the first sentence above (i.e., 1. "To join our club, click here.") is not visible on the display, the voice control command software highlights the "click here" found in the second sentence above (i.e., 2. To buy a product, click here.) provided it is visible on the display.

[0320] If the highlighted link is the link the user wishes to select (e.g., transmit a request for retrieval of the web page), the user then states another voice command such as "Jump." If the highlighted link is not the link the user wishes to select (e.g., transmit a request for retrieval of the web page), the user then states another selection command, such as "Next," which instructs the voice command software to highlight the next link (proceeding down the web page) that corresponds to the voice command (in this example, comprised of the words "click here"). Likewise, if the user states another selection command, such as "Previous," the voice command highlights the previous link (proceeding up the web page)

that corresponds to the voice command (in this example, comprised of the words "click here"). To select the next or previous selection (e.g., a hyperlink), the voice command software may also need to scroll the document (e.g., web page) up or down to make the next or previous selection visible on the display. If the spoken selection that is the object of the command (e.g., the spoken hyperlink) is present only once on the display, the voice command software simply transmits a request for the document identified by the object (e.g., the hyperlink).

[0321] In addition or as alternative, the device **101** may include web page voice command priming software that annotates the web page to add identifying indicia to the page at all (or select) links or, alternately, overlays identifying indicia over all (or select) links displayed the display. For example, processing and annotation of the above sentences of a web page might result in the following:

[0322] 1. To join our club, click here—A.

[0323] 2. To buy a product, click here—B.

[0324] 3. To log in, click here—C.

[0325] To select a link the user simply speaks the voice command, and the link followed by the identifying indicia (e.g., "Go to click here B"). In this embodiment, the identifying indicia are characters following the links, but the software might display the associated identifying indicia anywhere (e.g., above, before, below the link), in any manner (e.g., underlining, bolding, or highlighting each in a different color), and/or with any indicia (e.g., letters, numbers, symbols, etc.).

[0326] As another example, the software overlays identifying indicia over duplicative links displayed on the display to allow the user to distinguish the link through a voice command. The identifying indicia may be an opaque overlay and positioned near the link or semi-transparent and positioned near or directly over the link. Some overlays may be desirable for some applications because they can be constructed without modification of the underlying document as is well-known in the art.

[0327] The alternative embodiment is also more easily used to select a hyperlinked graphics, which may not have any text (and therefore no text for the user to read out loud as the object of a voice command). Preferably, the linked graphic is surrounded along its edge with a colored border. Alternately or in addition, an overlay (or inserted indicia) can be used that includes, for example, text corresponding to the text present in the "alt" attribute of the HTMLimage tag (<img).

[0328] The identifying indicia may be supplied for all the links, only those links that have the same text (or other visible image), or select links displayed and is preferably added to duplicative links and graphics. While this feature has been described in the context of hyper links on a web page, it is equally applicable for selecting a particular one, from a plurality of form fields, pull down menus, scroll boxes, text boxes, form buttons, radio buttons, check boxes, and other data fields or selectable items as will be evident to one skilled in the art. Furthermore, the voice command priming software—especially through the implementation of overlays---can be used for applications other than web browsers such as spreadsheets, word processors, communication applications (e.g., email clients), and database applications.

[0329] As discussed, the device **101** preferably communicates with the computer system of one or more automobiles for which the device **101** has the correct authentication information (e.g., security codes) to interface. Once linked, the device **101** can receive and transmit data to the automobile to monitor and request the following: remotely unlock or lock the doors, start the engine, turn off the engine, turn on or off the interior and exterior lights (including the headlight, parking, and/or emergency lights), turn on or off the stereo system, control the heating system, air cooling system, window defrosting system, seat heating system, side mirror defrosting system; open the trunk, and communicate with the computer system of the vehicle(s). In addition, the device **101** communicates to monitor the air bag system, temperature (interior and engine), speed, location, direction, fuel, and other status and diagnostic information. Thus, the vehicle's speed and/or directional information may be communicated to the device **101** to determine location information and/or the device could communicate with a location module in the vehicle to determine the vehicle location.

[0330] The vehicle may house one or more of the modules described herein for the device **101** and/or may perform the functions of one or more of the modules described herein. For example, the vehicle may include the GPS receiver and provide location information to the device. In addition, the vehicle may have transceivers and/or receivers (e.g., TV, radio, etc.) that form part of the communications module, and communicate transmissions through the transceivers and/or receivers with the device **101** via a PAN. Likewise, the display system of the vehicle, which preferably includes an in-dash flat panel display, may function as the display device for the device. Alternately or in addition thereto, the automobile system includes a heads up display, which are known in the art, that displays visual images onto the windshield of the automobile. The heads up display may be programmed to display on the drivers side only select data when the vehicle is moving (e.g., direction information such as arrows indicating where to turn) and other kinds of data (i.e., text, maps, emails, web pages, stock quotes, sports scores, etc.) only when the vehicle is not moving, moving below a predetermined speed, parked, or when the engine is turned off to thereby reduce the distractions to the driver when driving. Likewise, the vehicle may include a print device to which the device **101** may transmit data for printing.

[0331] Furthermore, a device **101** of the present invention may be integral to the vehicle (although it would not be a handheld device) and/or distributed therein. Thus, for example, a remote user (e.g., an authorized user) of the device **101** integrated into the vehicle can transmit a request to monitor live (or receive previously stored) inputs of a video camera capturing where the vehicle is being driven (i.e., capturing images in front of the vehicle) and/or capturing images of activities inside the vehicle. Likewise, the remote user could be notified, as discussed above, upon the occurrence of certain events such as the vehicle traveling above a speed limit, traveling above a predetermined speed, traveling to a restricted location, a vehicle failure (e.g., mechanical failure or running out of fuel), deployment of an airbag, and/or traveling out of a predetermined area. The

remote user could also program restrictions to some of these events (e.g., to prevent the vehicle from traveling above a predetermined speed.) or prevent the purchase of certain products (e.g., products other than fuel).

[0332] To purchase fuel with such an integrated device, the user simply drives up to the fuel pump and the device **101** communicates with the access point or node of the fuel pump, which is preferably designed to only be able to communicate with a device that is within a predetermined distance of the fuel pump. The device **101** either integral to the automobile or carried by the user exchanges payment information and if desired, selects the fuel grade and/or the fuel amount. After the payment information is exchanged (or during the exchange), the user couples the appropriate fuel nozzle to the automobile fuel tank aperture and dispenses the fuel from the pump (and if not transmitted by the device **101** or if otherwise necessary selects the fuel grade and/or amount of fuel to be dispensed prior thereto). Thus, with the present invention there is no need to insert a credit card or debit card into the pump and provide associated user inputs (e.g., a pin number) and no need to wave a rf tag in front of the fuel pump as with prior art payment methods.

[0333] Software programs or agents are often designed to perform periodic processing such as periodically searching for various web sites for data meeting a specific criteria such as a job posting (job opportunity) that satisfies the person's job requirements such as having a particular title, particular responsibilities, a minimum salary, a particular geographical region or regions, a particular work shift, a particular number of hours per week, and/or be offered by a particular employer or type of employer. Other agents may search for the product with the lowest price (e.g., the cheapest computer meeting given characteristics or the lowest airline ticket for a given destination and departure), the vender with the lowest price (e.g., a stereo), the availability of a particular product, etc., as described above.

[0334] As is known in the art, agents available for searching job postings are offered by some, but not all, of the web sites that serve job postings. In essence, the web server storage device receives and stores the user's search criteria for use by the agent in subsequent searches when the user returns to the web site or performs searches with the search criteria periodically. However, an agent of a particular web site is useless for searching other web sites. Thus, an agent must be created and stored for each web site for which the user wishes to perform searches and that offers agents. In addition, for those sites that do not offer agents, the user must repeatedly run the search by manually entering the search criteria.

[0335] The present invention overcomes these deficiencies by creating and storing an agent for communicating with multiple web sites and processing the retrieved data. Preferably, the web sites offering the desired services (e.g., job postings) and the format and protocol for communicating with the web sites is determined using Web services as described above, but may be determined through any suitable method. In a particular, in this example the computer program implementing the agent of the present invention receives and stores the search criteria and searches the appropriate service registry or registries to identify the service providers. Alternately, the user may supply the service providers. Once identified, a descriptor document of the Web service offered by each provider is retrieved from the service registry. The computer program then binds to the service provider and runs the Web service to periodically perform (or upon request by the user) the desired search or other action. In addition, data for communicating with service providers not found in a service registry (e.g., name/value pairs, format and protocol data, etc.) may be supplied by the user or vender, stored, retrieved, and used by the agent to communicate with such service providers. Thus, the search function of the agent of the present invention performs the functions of a plurality of agents and also the function periodically performed by the user.

[0336] In response to the transmission from the agent, the agent then receives data from one or more service providers and stores and processes the received data. The processing performed may include any desirable processing including sorting based on user supplied criteria such as date of entry of the data (e.g., date of posting of the job offer), price, location (e.g., the closest provider), or other data. The processing preferably also includes eliminating duplicate responses. For example, multiple service providers may respond with the same data such as the same job posting. Thus, the computer program compares the data received by each service provider and displays duplicative data only once.

[0337] Other processing may also include retrieving additional information such as the web page or email address of the employer (or vender) posting the job offer (or product) that meets specific criteria—criteria that may be different, and more narrow, than the original search criteria. Thus, the agent may open a new browser and transmit a request for the employer's home web page or a vender's web page relating to the product and subsequently display the received web page for the user. Alternately or in addition, the agent may search the job posting (or product data) for an email address or other information, which is preferably identified with an XML tag.

[0338] The processing may also include transmitting data to an employer posting a job offer (or vender offering a particular product) when the job offer (or product meets) specific criteria—criteria that may be different, and more narrow, than the original search criteria. For example, if the job posting meets certain criteria, the agent may retrieve the user's resume from memory and transmit the resume via email (that also contains content such as a cover letter retrieved from memory) as an attachment to the employer. As another example, if the product is available or is below a particular price, the agent may retrieve payment data from memory and other information for purchase of the product (e.g., user's name, address, product identifying information, etc.) and transmit the data to the vender's computer system for purchase of the product. As discussed above, the format and protocol for communicating with the web site (i.e., the employer's or vender's web site) is preferably retrieved from a service registry or received from memory (e.g., stored from a previous communication or as a standard format).

[0339] In addition to periodically performing searches and processing the resulting data, the agent may be designed to transmit information to various computer systems. For example, there are a plurality of pay-per-click search engines, employment web sites, auction web sites, and other

similar computer system with which an agent of the present invention can be used. For example, one example embodiment of such an agent transmits a plurality of search terms and bid prices to a plurality of pay-per-click (PPC) search engines.

[0340] In addition, the agent periodically determines the relative position of the advertisement in a list returned as a result of submission of each search term (i.e., the search term's advertisement placement) at all of the PPC search engines. For example, the agent could transmit a search request to each PPC search engine for each term (e.g., in sequence). After receiving the response from a PPC search engine, the agent processes the received data (by parsing the received data which preferably includes XML tags) to determine the placement of the user's advertisement in the listing (e.g., whether the user's advertisement is first, above tenth, etc.). Alternately, the PPC search engine may have a Web service available for determining a search term's advertisement placement or determining all the search terms' advertisement placements for a given advertiser.

[0341] If the placement of the advertisement is below a predetermined threshold placement for that particular term (as stored by the user preferably), the agent then determines the bid price for the search term that would increase the placement of the user's advertisement to another predetermined placement (hereinafter referred to as the "revised bid price"), which may (or may not) be higher than the first predetermined threshold. The predetermined threshold placement (e.g., first, third, tenth, etc.) may be different for each search term and each search engine and also based on costs. In addition, the agent queries the user for input in certain circumstances such as when the bid price reaches a particular level (e.g., query the user for permission to further increase the bid price).

[0342] After the agent determines the revised bid price, the agent transmits data of the revised bid price for the search term to the PPC search engine to thereby increase the placement of the advertisement in the listing to the predetermined placement. In addition, the agent also determines the account balance with the PPC search engine and transmits payment data, or authorizes additional transfer of funds from previously supplied payment data, when the account balance falls below a predetermined threshold. Again, the agent may optionally query the user for permission to do so prior to transferring funds.

[0343] Similarly, another example embodiment of an agent periodically posts employment offerings to a plurality of employment web sites so that the employment postings remain near the top of the list when job seekers perform searches that return the employment offerings in descending order of the date of the posting (i.e., most recent job postings at the top).

[0344] Likewise, another example embodiment of an agent communicates with a plurality of auction sites to repeatedly search for particular products for sale. Similarly, the agent determines the bid price for a specific product (or type of product) and, based on the bid price (e.g., if the bid is not the user's bid and below a ceiling) transmits a higher bid on behalf of the user. The agent determines whether the current bid price is the user's bid by storing the previously submitted bids for each product in memory and comparing the retrieved data from the auction site with the stored data. Alternately, current bid price retrieved from the auction site includes information identifying the bidder such as the bidder's username. In addition, when the same or similar product is auctioned on a plurality of auction sites, the agent bids on the product with the lowest current bid price—thereby reducing the potential price paid by the user.

[0345] Thus, a multi-computer agent of the present invention can be used to find an apply for a job, to purchase a product, bid on a product, to rent an item including, but not limited to, a car, a home, a boat; to make reservations including, but not limited to, travel reservations, hotel reservations, golf tee time, event reservations (e.g., to an entertainment event such as a sporting event or concert), and perform other actions periodically, at the request of the user, or at other times.

[0346] The present invention may also be coupled to a print module that has the capability of imprinting indicia on a substrate, such as paper, cardboard, a wall, etc. For example, the print module may be a barcode writer for printing a barcode on a box, document, product, or other item. Preferably, the bar code prints on labels that are placed on items to be marked (marked items). The device **101** can print bar codes (or other indicia) with information relating to the marked item such as the marked item's contents, creator, date of creation, date of other event (e.g., receipt, shipping, opening,), destination, origin, price, terms for purchase, product identifying information, delivery location, vender, payment information, communication format and/or protocol data.

[0347] Because the information is imprinted on the indicia, a reading device may not need to retrieve the data from a database based on the barcode. If desired, however, the information may be used to retrieve additional data (e.g., a price, supplier, etc.).

[0348] In addition or alternately, the bar code can include information relating to a location at which information relating to the marked item (such as that described above) can be retrieved (e.g., an internet address, telephone) and/or where to purchase the marked item.

[0349] While the preferred embodiment employs a barcode, any imprinted indicia could be used that is sufficient to provide the desired information and that is readable by other devices.

[0350] The device **101** optionally include biosensors that monitor physiological conditions such as the user's heart rate, heart rhythm, blood pressure, temperature, blood alcohol content, blood sugar, and cholesterol as is well-known in the art, and can store the data, provide an alert to the user, and/or transmit the data (or an alert) to a remote system for storage and processing.

[0351] The present invention may also communicate with input devices wirelessly (e.g., via its WLAN transceiver). One such device from which user inputs may be received is a wireless pen. The pen acts a writing implement to wirelessly transmit data of the information written by the writer. In the preferred embodiment, sensors in the pen sense the rotation and direction of rotation of the roller. This information is wireless transmitted to the device **101** or other remote computer system, which processes the data with hand writing recognition software, which is well-known in the art. This embodiment is most suitable for writing, as

opposed to printing, in which the pen's roller is substantially continuously rolling throughout each word (as opposed to being lifted for each stroke as is done when printing). The sensor also detects when the user depresses the pen roller—such as when dotting an "i" or when adding punctuation. The transmitted data is stored for immediate or later processing as is desired and selected by the user.

[0352] Preferably, the recognition software also recognizes editing indicia written by the user such as line breaks and paragraph breaks. Alternately, the device **101** includes actuators (e.g., pressure sensitive buttons) that allow the user to supply inputs that indicate editing indicia such as the beginning or end of a paragraph.

[0353] In another embodiment, a remote voice recorder includes a wireless transceiver and transmits the recorded voice data to the device. In still another embodiment, the device **101** (which may take the form and function of a pen) includes a voice recorder, which transmits the recorded voice data to a remote computer system. In either alternate embodiment, the data may be transmitted as digital stored voice data or converted to text through conventional voice recognition software and subsequently transmitted.

[0354] The preferred embodiment of the present invention also includes an MP3 player and MP3 storage capabilities. Using the wireless or wired communication transceiver, MP3 data can be downloaded and stored in the device **101** and repeatedly audible produced to by the user as is well-known in the art. In addition, the device **101** permits MP3 compression of voice data that has been stored in memory, which can then be transmitted (wired or wirelessly) to a remote destination for processing and/or storage.

[0355] While the preferred embodiment of the present invention has been described in the context of a mobile communication device, many of applications of the present invention may be used with an embodiment that takes the form of a Smart Card. For example, those embodiments in which CCD is retrieved, payment information is exchanged, could be implemented with a Smart Card.

[0356] Another agent includes a print agent, which will, in response to a print request, locates the nearest printer accessible via a network, transmits the data to be printed to the nearest printer, and informs the user (e.g., on the display) of the location of the printer to which the data was sent. In addition, the agent can transmit data to be printed to a designated remote printer (such as at the user's home) for printing.

[0357] When an application of the present invention employs a service registry, the present invention may use a predetermined service registry—the address of which has been stored in the device. Alternately, the device **101** determines or identifies the appropriate service registry by performing a search in a database of service registries, which may form part of a service registry, web site, or other source. The "appropriate" service registry, in many applications, may hold information for providers in a particular geographical area, within a predetermined distance from the user, within a shopping complex, within an auction area, or providers meeting any other criteria.

[0358] The device **101** includes programming for performing other functions based on the location of the device. For example, based on inputs by the user and stored by the device **101**, the device **101** establishes a communication link with a computer system at the user's home to communicate with and/or control electrical devices (e.g., appliances, lights, computers, stereos, etc.) in the user's home, work, or other location. The device **101** preferably establishes the communication link automatically when the user is within a predetermined distance (or time) from the user's home, work, or other location. However, the user can also program the device **101** (by supplying user input) to establish the communication link when the user is at (or arrives at) a predetermined location such as on a particular street, in the user's driveway, in a particular parking lot, in a particular county, state, or city, at a particular vender, or other location.

[0359] As an example, the user can program the device **101** to transmit command signals to the user's home computer system to turn on the lights when the user arrives in the user's driveway. In this example, the communication link is preferably accomplished via a short range wireless LAN or PAN and may be established as soon as the device **101** (which may be carried in or integral to a vehicle) is within communication range of the of the home computer system. Other commands, for example, include turning on (or off) a coffee maker, a television, a video recording device, a stereo, a computer, air conditioning, heating, an oven, a stove, select lights (e.g., kitchen and outdoor lights), all lights, a garage door opener, a washer, a dryer, a door lock (to lock or unlock the door), and controlling any other device. The means for controlling electrical devices in the home are well-known in the art and, therefore, not repeated here.

[0360] The device **101** can also be programmed to control devices (e.g., turn a device on or off) when the user leaves a particular area (i.e., is no longer present in the area or is detected leaving the area), arrives at an area, is out of communication range via a first communication link such as a short range wireless LAN or WLAN (in which case the link for transmitting control signals is established with a second communication link such as a wireless WAN), or other activity associated with a location.

[0361] The device **101** can also be programmed to perform other activities upon arrival or departure from a particular area such as order food for delivery, ordering a movie (e.g., a movie on demand), performing some other action, and/or controlling some other action. In addition, the device **101** can also be programmed by the user to perform activities upon arrival or departure from a particular area that occurs during a particular window of time such as Monday through Friday, at lunch time, after seven o'clock, or during another time period.

[0362] In addition, the device **101** can also be programmed by the user to perform activities upon the occurrence of an arrival or departure from a particular area that occurs in conjunction with a triggering event. For example, if the user makes purchase (or purchase above a predetermined amount or above a predetermined number of products), such as at a grocery store, the device **101** transmits a notice to the user's residence (e.g., that is viewed by personnel at the apartment building) when the user is within a predetermined distance from the residence. Thus, personnel at the user's residence can prepare for, and meet the user when the user arrives, and assist the user in unloading the vehicle.

[0363] The programming for taking the action can be supplied by the manufacturer, by the user, or supplied by a

vender or other third party, or. For example, the user may supply data for controlling appliances in his or her home that is used by an application supplied by the manufacturer or third party software provider. In contrast, a VCS or other third party may transmit an application for storage on the device **101** that performs location based, time based, or activity based actions as well.

[**0364**] One example of a vender application receives location information (e.g., from the location module), and establishes a communication link with the VCS to request an advertisement when the user is within a predetermined distance of the vender store location (which may still be outside of the communication range of the shopping complex WLAN or VCS WLAN). The VCS then receives the request (and preferably the user or device identifying information), retrieves VSUI, selects an advertisement (e.g., based on VSUI, location data, temporal data, and/or received CCD), and transmits the advertisement to the device **101** for presentation to the user.

[**0365**] The application (which may be a third party application) can receive time data, location data, and/or other data and perform any desired action when conditions determined by the application indicate such action should be taken. Another example is an application that monitors the vehicle's odometer and notifies the user that an oil change is needed when the odometer indicates a predetermined distance has been traveled since the previous oil change. Another application automatically purchases (or orders) a product when time data, location data, and/or activity data satisfy predetermined criteria (e.g., a weekday, on a particular street, and no food purchases within previous three hours). Such an application is especially suitable for repeated purchases such as those performed by employees in the course of business. The items purchased (in this example application and others) may be determined by the device **101** which determines the desired quantity and combination of products (e.g. the desired inventory of office supplies or inventory of groceries), determining the current inventory of products, and ordering and purchasing the products sufficient to bring the current inventory to the desired inventory of products. The desired and current inventories can be retrieved from memory, retrieved from an external computer system, or some combination thereof.

[**0366**] Irrespective of the source of the application, depending on the parameters of the application such as the location, the desired action, and other factors, the device **101** may simply transmit information to the remote device that includes the location data along with, if necessary, data of a triggering event and/or time information. In this example, the receiving system is programmed to take the desired action such as controlling electrical devices in response to receiving the data. In the preferred embodiment, the device **101** and remote computer system cooperate together to achieve the desired result. For example, the device **101** transmits a request for the desired action while the remote computer system controls the appliances and presents the appropriate information to personnel to achieve the desired action. In an alternate embodiment, the device **101**, based on the location, the time, and/or any triggering event, transmits a request to the remote system (e.g., an appliance or ACS) to perform the action.

[**0367**] In addition to location, the device **101** includes programming to take an action when location data and one or more sensed inputs satisfy predetermined criteria. Thus, for example, the device **101** can be programmed (at the election of the user) to notify the user of the location of a gas station only when the fuel levels are below a predetermined level and the user is within one mile of a gas station. As another example, the device **101** can notify the user of the location of a blood pressure measuring machine when the device **101** determines that the user's blood pressure is above a predetermined value (e.g. as received from the physiological sensors described herein) and the user is within a predetermined distance of the blood pressure measuring machine. Thus, it will be evident to those skilled in the art that the presently described application of the device **101** can, at the election of the user, perform a desired action when one or more of location data, temporal data, activity data, and sensed input data satisfy criteria, which may be criteria supplied by the user, vender supplied criteria, and/or otherwise determined criteria.

[**0368**] In addition to the above, when the user arrives at an area, such as a facility, shopping mall, amusement park, conference, auction site, stadium, sports center, a communication link is preferably established between the device **101** and a remote computer system such as an ACS or ECCS. After establishment of the link, the remote computer system transmits data that includes information of the contents of the area to the device **101** for presentation to the user (e.g., in response to a request from the device). For example, upon arriving at a shopping mall, directory data including information of the venders and their locations is transmitted to the device **101** for use in finding particular stores. Thus, the user can input a request for a particular point of interest (e.g., a vender) and, in response, the device **101** searches the supplied data for the point of interest (e.g., the vender), and, if the point of interest is present, highlights the point of interest (e.g., the vender's store location) on a map of the area (e.g., shopping complex) presented on the display. In addition, the device **101** can provide directions, based on the received data, for traveling to the requested point of interest. The device **101** uses the data to display the location, and, if desired, provide directions to, restrooms, campsites, particular venders, exits, the user's vehicle, monuments, landmarks, and other points of interest. Preferably, the map data or other requested information is displayed along with advertising that is received by the device **101**. Preferably, the advertisement(s) is selected and transmitted according to one or more of the methods described herein.

[**0369**] In addition, in the example in which a vender is sought, when the vender is identified the user can instruct the device **101** to establish a communication link with the VCS (if necessary) and request the availability and price for a particular product according to the methods described above.

[**0370**] In some of the above described embodiments, the device **101** communicates with a service registry and numerous service providers. In an alternate embodiment, a service gateway computer system (SGCS) receives the requests (to identify particular service providers or communicate with service providers) from the device **101** via a WAP or XML request. The SGCS receives the request and performs the necessary actions to respond to the request thereby acting on behalf of the device **101**. Thus, the SGCS may perform the steps of searching a service registry for service providers (e.g., meeting selection criteria or offering a desired service

(requested by the device)), determining the communication parameters (format, protocol, etc.) for communicating with the service providers (which may be determined by retrieving the data from memory or requesting and receiving a descriptor document), transmitting requests to the service providers (for information or to purchase a product), receiving responses from service providers, processing the responses (e.g., sorting, eliminating duplicates or other processing), formatting the processed responses for transmission to the requesting device **101** (e.g., WAP), and transmitting the formatted processed response to the requesting device **101**. The SGCS may be the user's home computer system, a vehicle computer system, but is preferably a third party remote computer system that services numerous devices **101**. The SGCS preferably stores numerous descriptor documents and service provider information for numerous service providers and may also store the entire service registry for a given area.

[0371] In addition, the device **101** stores numerous forms (e.g., WAP) for making requests of the SGCS or of service providers. The forms are preferably downloaded from the SGCS or other source for repeated use by the device **101**. For example, one form might be designed to find the closest type of vender from the user's location. Thus, the form would ask for type of vender sought. The form itself would preferably include a hidden variable (which may simply identify the form) that instructs the SGCS to seek the closest vender of the type indicated by the user's input. In addition, information of the user's location is also determined, for example, by receiving the information from the device **101**, by receiving the information from a third party system (e.g., from a triangulating system), or determined in any other suitable manner. Another form included, for example, requests data for determining a vender offering a particular product in a given area and determining the lowest price. Thus, the form requests data of the product sought by the user. Still another form is for purchasing a product and therefore requests the product to be purchased from the user. Other information such as payment information may be supplied along with data from the form, or subsequently requested by the SGCS after the vender is determined based on the accepted method of payment for that vender (in which case the SGCS transmits the accepted types of payment and the payment method is selected by the device **101** (either automatically or based on user input) and the associated payment information transmitted to the SGCS or service provider). Some of all of the forms may be combined in one document.

[0372] Thus, the SGCS receives the data from the device **101** and generates a transmission (e.g., one or more service providers or the service registry) in a different format and, perhaps, employing a different protocol. Likewise, the SGCS receives data from one or more service providers in a first format (e.g., a SOAP transmission of XML), processes the data if necessary, and generates a transmission in a second format (e.g., WAP) for transmission to the device **101**, perhaps using a different protocol, and transmits the transmission to the device **101**. The SGCS may employ Web services (as described) as well other communications. Thus, the SGCS may act on behalf of the device, or plurality of devices, in the implementation of any of the embodiments described herein as will be evident to one skilled in the art.

[0373] As will be evident to one skilled in the art, the present invention has numerous applications. For example, a user carrying a device **101** configured according to one of the embodiments described herein can use the device **101** to purchase products from a vending machine (which may include a computer and also be connected to a network). Thus, a wireless link (e.g., a PAN) is established between the device **101** and the vending machine. The user may actuate buttons on the machine or select the product from list transmitted to the device **101** from the machine or from another remote computer system. After the selection is made, payment for the product is determined (by either the machine or the device) and is made by the device **101**. Payment information may be transmitted to the machine, which verifies the payment information. Alternately, information may received from the device **101** (which in this application may be an rf tag) for facilitating payment. The information may be user information, which is then used by the vending machine (or transmitted to a remote system and used by the remote system) to retrieve payment information and obtain payment. Alternately, the information may be account information, which is then used by the vending machine (or transmitted to a remote system and used by the remote system) to obtain payment.

[0374] In many applications of the present invention, the device **101** is described as establishing a communication link. As will be evident to those skilled in the art, in many instances the invention will work just as well if the remote system establishes (or initiates) the communication link or the device **101** establishes the link. In fact, the component that establishes a communication link may be dictated by network characteristics for the communication link, communication protocols, format, and/or standards. Thus, in many instances the invention will work just as well if the remote device (e.g., a computer) initiates the communication by, for example, transmitting data (e.g., map data) and/or transmitting a request (e.g., for CCD). In many instances, such as an always on connection, the communication link may be established when entering communication range with the network or remain from a previous connection and need not be established only to perform the subsequent communication.

[0375] As discussed above, the preferred embodiment of the device **101** embodying present invention is capable of receiving and producing audio signals for the user. For example, the user may elect to receive and listen to radio signals (e.g., AM, FM, or XM®), which may be transmitted from the original source or from a intermediate source such as the computer system of a shopping complex or other facility or area. In addition, the user may elect to receive a certain type of audio signal such as a certain type of music, a collection (e.g., sequence) of MP3 audio files, a news broadcast, sports, or talk radio. The means of selecting the transmission, the transmission source, and the transmission of the signal are known in the art and therefore not repeated here, but may be as simple as transmitting a request for the desired transmission.

[0376] In this example embodiment, the audio signal is transmitted via a WLAN from a facility computer system (e.g., the ACS of a shopping complex) and the user has elected to receive music. In between selections of music, the ACS transmits audio advertisements. However, one problem with audio advertisements is that often the user is doing

other things (e.g., driving, or shopping in this example) and does not have access to a writing implement and paper to write the advertisement information down. Thus, audio advertisements are often less effective for impulse buying than other forms of advertising.

[0377] In the present invention, the ACS transmits associated product data along with the advertisement content transmission. Thus, while data comprising the advertisement is transmitted, and received, stored, and audibly presented to the user, the product data associated with the advertisement is transmitted by the ACS and received and stored by the device **101**. Preferably, data packets representing product data that are received and stored (and later retrieved) are preferably distinguished based on data in a header (or subheader) identifying the data as product data. In an alternate embodiment, data identifying the beginning and/or end of an advertisement may also be transmitted.

[0378] Upon receiving an appropriate input from the user, programming of the device **101** retrieves the product data from memory for further processing. For example, during or after the user hears an advertisement, such as an advertisement offering a discount for a food item, the user supplies a user input (either vocally or manually) requesting action of the device **101**. The device **101** retrieves the product data from memory of the most recent three advertisements. In this example, the product data of the most recent advertisement—the food item—is displayed on the display. The user can select an advertised product for purchase, to obtain more information of the advertised product by providing another user input selecting desired product displayed.

[0379] In response, a communication link is established between the device **101** and the appropriate VCS. The device transmits a request to purchase to the advertised product selected by the user and also exchanges payment information (retrieved from memory) with the VCS to facilitate the purchase. If the purchased product is located close to the user, a time for delivery of the product may also be established (by either the device **101** based on location or by the VCS) such as fifteen minutes from now. The user is subsequently informed of the success (or failure) of the transaction.

[0380] The product data may be in any suitable format such as an HTML page, XML, a WAP page, SOAP, text, and/or any other suitable format. The product data may include any data desirable such as data for requesting more information, product identifying information, data for purchasing the product (e.g., price), acceptable payment account data, availability data, destination data for communicating with a ACS about the product, a web site, a web site product ordering processing page, a service registry address and vender identifying information, a full or partial descriptor document, and any other data that may enable the user to purchase or inquire about the advertised product or vender.

[0381] In response to the first user input, the device **101** can be programmed to purchase the product advertised in the most recent advertisement after receiving user confirmation or automatically without confirmation. In the automatic purchase mode, the user would only need to press a button or speak a command to purchase the product. After determining that a purchase is to be made, the device **101** transmits payment information, delivery information (e.g., if shipped to the user's home or work), user information (e.g., the user's name), and any other information necessary for purchasing the product. The format, protocol, and payment account data is selected according the particular product data and/or by any of the means described herein as will be evident to one skilled in the art.

[0382] In addition or instead of displaying information the three most recent advertisements (e.g., product names), the device **101** can audibly present the most recent advertisement to the user again so that the user can audibly confirm the correct advertisement has been identified by the device **101** before supplying an input to the device **101** to take action.

[0383] As will be evident to those skilled in the art, this application of the present invention is especially suitable for a device **101** that is integrated into a vehicle thereby allowing the driver to respond to advertisements while driving.

[0384] This application of the present invention may also be used with analog AM and FM radio transmissions in which the product data is modulated on a separate carrier signal or preferably on a subcarrier within the same signal. This application of the present invention may also be used with digital or analog television. Its application to digital television could be easily implemented in a manner similar to that of the digital signal described above as will be evident to one skilled in the art. For use with analog or digital television, the product data may be included in the closed caption portion of the television signal. The device **101** simply decodes the caption data as it is received, stores the decoded data, and retrieves the data to make the purchase (or perform another action) upon receiving the user request. Thus, a web address for purchasing a product may be included in the closed caption and used along with the payment information retrieved from memory to purchase the product in response to a user input.

[0385] As discussed, the image module, voice recorder module, voice recognition module, and commerce module cooperate to provide applications as well. The voice data files are processed to generate text representing the voice data, which is then stored in memory. The first step is accomplished through conventional voice recognition software, which converts spoken words into text (e.g., ASCII). Processing of voice through the use of voice recognition software is well-known in the art, commercially available, and the details thereof are, therefore, not repeated here.

[0386] The output of the voice recognition software is a text version of the spoken words. Next, the software parses the converted text to identify the word "website" and the word "stop." The text between the words "website" and "stop" (or after a pause) are then identified to be a web page address and is stored in memory as such. Words stored in the same data index that follow the word "stop", if any, are stored as a voice message indexed to the identified web page address.

[0387] The software also has the capability to go a step further (at the option of the user), by converting the entire voice message to text and parsing the text for particular words, which may represent commands. For example, after speaking the web address (and the word "stop" or pausing) the user then speaks "buy, card corporate American express, delivery home, shipping normal." The software parses this text, opens the default web browser to access the web

address that was stored and converted to the displayed text—(e.g., www.gifts.com\products\pn123242). This web address is the web page that a person would access to purchase a particular product (but could be any information provided by a vender to allow the user to purchase a particular product). After the word "stop" (or a pause) the software identifies the word "buy", which is recognized by the software to be the previously stored command to place an order. The next words are "card American Express," which identify which of the previously stored credit files (containing the appropriate credit card information such as credit card number, associated expiration date, billing address, and card name) to be used to make the purchase. Alternately, the commerce module may select the payment account as described above.

[0388] Portions of web pages that request information from users are often referred to as forms. The beginning of a form in HTML can be recognized by the use of the "form" command (e.g., <form method="POST" action="http://www.emailsarehere.com/ts/mf.pl">). As is well-known to those skilled in the art, the text in quotes after the word "action" indicates where the form (i.e., the user's device **101**) will send the requested information. Information that is being transmitted to the processing web page (i.e., the web page that receives the form data) is transmitted along with the request for the web page. For example, the device **101** might transmit "http://www.emails.com/scripts/mailform.pl? clients_email=john@somecompany.com" which passes the information "john@somecompany.com" as the variable "clients_email" to the processing web page (e.g., http://www.emails.com/scripts/mailform.pl).

[0389] Most web forms are written in HTML and typically use the same HTML command (the input command, e.g., "<input name=user size=25 maxlength=25>") to prompt the user for data. Likewise, the forms often use the same or similar variable labels for each requested piece of information. For example, for the person's name, HTML forms often use the label NAME or Last_Name, First_Name, and Middle_Initial. For the address, the forms often use ADDRESS, CITY, STATE, COUNTRY, and ZIPCODE. The software processes the web page and parses the web page for all the predetermined, stored labels that are used in common purchase forms. In other words, the software looks for the input command on the web page and then determines the variable label to which the user's input would be assigned (e.g., "name=user" would indicate the variable is "user") to determine what information is to be supplied.

[0390] The software then transmits the appropriate information for each variable label (i.e., name value pair) to the web page server (or other remote computer system), thus emulating the user filling out the form and clicking on the Submit button. In instances in which the software has been taught what information needs to be transmitted to a particular processing page, the software may not need to request the web page containing a form. Instead, the software simply transmits the necessary information to the processing web page. Alternately,. the transmission may be generated, formatted, and transmitted according to communication parameters and other data found in a descriptor document, which may be requested of, and transmitted from, a service registry thereby using Web services.

[0391] The software also parses the words "delivery home," which instructs the software to use the user's home address (previously stored in memory) as the address for delivery. Finally, the software parses the words "normal delivery," which instructs the software to request normal (or standard) delivery of the purchased item(s).

[0392] If not using an industry standard such as Web services, the software may be "trained" to interact with websites that have elaborate or unusual forms and/or which the user accesses frequently. For example, if a user often purchases books through Amazon.com®, the user may wish to train the software to interface with the Amazon.com® web site. To train the software the user accesses the website of Amazon.com® and selects a product for purchase. Next, the user puts the software in "watch" mode and provides user input indicating that the following information should be stored with a "buy book" command. The user then completes the forms to purchase the book and takes the software out of the "watch" mode. The software thus stores the number and address of the web page forms, the labels representing data that is requested by the web pages, the type of information that is supplied by the user (by comparing the information provided by the user (e.g., a credit card number) with the categories of user related stored information) and any other relevant necessary information. Subsequently, when the software receives the "buy book" command, the software will complete the Amazon.com® form(s) with a much greater likelihood of providing the correct information. The watch mode is especially applicable for use with websites that are frequently accessed such as for trading stock, making hotel, restaurant, or travel reservations, reserving golf tee times, and buying music, electronics, or books. Instead of actually accessing the forms, the software may (provided the web site is designed appropriately) simply send the required variable labels and associated information to the processing web page(s) that receives purchase information (e.g.,www.golfit.com/ph.cfm?pd=bigdriver).

[0393] In another application of the present invention, the image module is used to scan product and/or vender information. In addition, the audio input device is optionally (depending on the data scanned) used to provide a voice command for the associated scanned data such as a command to purchase the product or request additional information.

[0394] In operation, the user scans a print advertisement or other indicia (i.e., representing information) that the user wishes to store so that the user may access the web address when convenient to the user. Scanning activates the display, which prompts the user to enter voice data associated with the scanned data. If the user does not wish to enter any voice data, the user simply provides an input indicating so (e.g., pushing a button). If the user does wish to enter voice data, the user begins speaking. Generally, and as is well-known in the art, the speech storage is accomplished with a filter, amplifier, analog-to-digital converter, and stored in memory (e.g., RAM). The stored speech is indexed to be associated with the recently scanned text (i.e., stored at the same data index).

[0395] Once the image is normalized (if necessary), it is processed by character recognition software, which is used to convert the image to a text. Character recognition software is well-known in the art and the details thereof are not repeated here. The output of the character recognition software is text (e.g., the web page address) that corresponds to the scanned image.

[0396] After processing, the software determines if a command has been received (e.g., via voice or other input) and processes the command accordingly. The results of the processing (that may potentially include a request to take the received command) of presented to the user visually or audibly providing additional confidence to the user that the correct data was stored. As discussed, the command may require immediately establishing a wireless connection to the identified web site, purchasing a product, and/or requesting information about a product.

[0397] The scanned data may represent product identifying information and/or a destination for transmitting a request for more information about the product or for purchasing the product. However, the destination information may be retrieved from memory as a preferred vender for such products (such as with the "buy book" command described herein). As discussed above, the payment account is preferably selected by the commerce module and when the device **101** communicates with the desired destination payment information is exchanged to facilitate purchase of the product identified by the image data. In addition, the scanned data may also include data representing a command such as a command to purchase or a command to request additional information, which would thereby eliminate the need for the user to supply the command. Preferably, if the image scanned is not legible (e.g., not text but a bar code or other machine readable image) other data in the advertisement or elsewhere is provided to the user so that the user knows what action will be taken when the image data is scanned. In addition, the user can program the device to prompt the user for permission before taking any action resulting from a scanned image.

[0398] As discussed, the system of the present invention preferably customizes advertisements directed to users based on CCD, which in addition to identifying the user by name and other user data, also allows the broadcaster to customize advertisements to the user's likes, dislikes, financial qualifications and/or other qualifications. For example, if the user profile indicates that the user's favorite color is blue, the broadcaster can then customize an advertisement relating to a sports car to be an advertisement with a blue sports car instead of black sports car. Likewise, an advertisement advertising music may be customized to include the recent compilation of an artist that is liked by the user and, for example, of an artist that the user has previously purchased. Similarly, a restaurant advertisement can be customized to be that of restaurant of the type liked by the user (seafood) and that is local to the user and provided with the address of the restaurant. As another example, an advertisement relating to a timeshare (or house) of a greater expense may be transmitted to those user's known to have a high net worth or income or who are known to be financially qualified to purchase the product or feature a house that is priced near the user's maximum financial qualifications.

[0399] To accomplish this customizing, the ACS software processes the likes, dislikes, and qualifications of users to select advertisements for transmission to that user that are more likely to be of interest to the user (and/or for which the user is qualified to purchase) as discussed above.

[0400] The advertisements stored in the ACS are preferably identified in memory (e.g., a database) by a unique identifier along the targeting criteria. Each advertisement relating to a specific product (e.g., a car) is present in the bank in a multitude of variations of the advertisement, with each variation having different attributes. Once an advertisement product is selected (e.g., a sports car), the variations of advertisements for that product are compared to the likes, dislikes, and qualifications in the CCD. Using the above example, user "A" will receive a sports car advertisement depicting a blue sports car while others interested in sports cars may receive the same advertisement, but with the sports car being a different color.

[0401] When the user is viewing an advertisement, which may be a moving video, the user may click on a portion of the advertisement to purchase the product. Thus, by clicking anywhere in window that is displaying the advertisement (or alternately on a displayed "buy" icon), the device **101** automatically purchases the product in the advertisement (in a method such as described above).

[0402] Alternately, for some products (e.g., cars) the user may click on a "get information" icon transmitted by the ACS to have additional information transmitted to the buyer (such as the options, price, delivery time, taxes, etc.). The additional information is transmitted immediately and presented to the user in a separate window on the device **101**. At the user's discretion, the additional information may alternately be mailed to user, or emailed to the user.

[0403] For advertisements that advertise a plurality of products, portions of the display (which correlate to the image of the advertised product) may be clicked on by the user to purchase the product. In other words, images on the transmitted advertisement overlay hyperlinks (hot spots) that may be actuated by moving the pointing device (e.g., mouse cursor) to the image and clicking the pointing device. The hyperlink web address is the address of the web page for obtaining product information and/or for purchasing the product. Alternately, the user may select the advertisement with a voice command as described herein.

[0404] At the option of the user, the device may store advertisements for later retrieval to allow a user to think about a product before making the decision to purchase. All or only selected advertisements may be stored as desired by the user and indicated by a user input.

[0405] In addition to purchasing products in advertisements, the user may click on a product in a video presentation such as a movie to purchase a product. Because not all objects in a movie may be purchased, the user is preferably provided an "available for purchase" indication transmitted by the broadcaster. In the present embodiment, when the user places the pointing device (which may be the user's finger or a remote pointing device) over an object on the display that is available for purchase, the price of the object is displayed. When the user moves the pointing device over an object on the display that is not available for purchase, no price is displayed. When the user selects an object that is available for purchase, the device **101** places the object in a conventional shopping cart, which the user may review (and confirm the user's desire to purchase the products) at the end of the presentation. Likewise, the user may request additional information about products that are available for purchase. The user may pause the presentation or click on the moving video.

[0406] Optionally, the user may replay the stored transmission and modify the color or other attributes of the

product of interest before purchasing the product. In doing so, the device software examines the digital information representing the video. Those bits of information representing images that are not modifiable by the user are associated with an image selection code (e.g. preceded by "00") that indicates the image may not be modified. Those bits of information representing image data that is modifiable by the user is associated with an image selection code indicating that the image may be modified (e.g., preceded by a "01"). When the user selects an image (with the pointing device) that is identified as being modifiable, the software retrieves the selectable attributes (e.g., colors) that are stored (from the broadcast transmission) that are associated with that image selection code. Different images or products (e.g., cars) may have the same or different set of available selectable attributes. After selection of the desired attributes (e.g., color of blue), a portion of the video may be replayed which provides the selected image with selected attribute(s). In this embodiment, this is accomplished by replacing the data associated with the previously selected image selection code with data of the selected attribute for that object. As will be evident to those skilled in the art, the data stored in memory also includes object identifying information to identify the same object (e.g., a car) in various pages of memory and may also include feature identifying information to identify the same feature (e.g., hood or a portion of the object that is shaded (and the same color) or well illuminated) of the same object in different pages of memory. The method of modifying the attributes is the designer's choice and is based on the capabilities of the device **101**, the format of the broadcast transmission(s), the number and types of available attributes and many other factors that are recognizable to one skilled in the art. In general, however, the image to be modified must be discernible or selectable from other images so that data of the selected attribute can be replaced. This can be accomplished through the use of associated data codes (as described), using dedicated portions of memory for selected images, or using a discernible format for the data representing modifiable images.

[0407] Thus, one embodiment of this application of the present invention includes a system performing the steps of transmitting video data including an object to a user, said object having a feature, transmitting a plurality of attributes (such as colors) for said feature and wherein the transmitted video data is received and stored in memory of a user device. In addition, the data packets of information representing said object include a first set of bits in data packets of the video data transmission and data packets of information representing said feature include a second set of bits in data packets of the video data transmission (which may or may not form part of the first set of bits) and data packets representing said attribute of said feature comprise a third set of bits in said packet (which may or may not form part of said second set of bits) and wherein said user can select one of said plurality of attributes of said feature for presentation to the user. Upon selection by the user, the set of bits in said packet comprising said attribute of said feature a modified according to the user's selection. Furthermore, the presentation of the video data to the user presents the object as a moving object to the user such as in a digital television transmission (e.g., RealPlayer®) or Flash® presentation.

[0408] Another application of the present embodiment is virtual gambling. Many people enjoy gambling even though most people do no live near gambling establishments and people often travel great distances to participate in gambling. One alternative is online gaming, which is performed through software that generates the order of cards in a virtual deck of cards that the user plays. The computer generation of the virtual deck of cards (or other gaming device such as dice or roulette) is not, by many people, considered to be trustworthy and fair. In other words, many people do not trust virtual gaming in which a computer controls the device of chance (dice, cards, or roulette).

[0409] As an alternative to this type of virtual gambling, the present embodiment allows the user to gamble with a real device of chance. In this application, a user wishes to play blackjack. The device establishes a communication with the gaming computer system (GCS) and the user logs into the GCS and establishes credit with the broadcaster through any suitable means. The user is then assigned to a virtual chair at a blackjack table that has a minimum bet requirement and maximum allowable bet that are suitable to the user. Once assigned to the virtual chair, the device **101** receives transmissions from the GCS station that allows the user to see all the blackjack hands being played at the table. The transmission from a video camera is of a live person acting as a dealer and who deals cards to all the players (virtual or live) who are playing at that table. The device of chance (deck(s) of cards) are thus real cards. In essence, the transmission allows the user to see a video transmission of all the cards at the table as if the user were actually sitting at the table. The user expresses his or her decisions relating to the playing of the user's hand (e.g., betting, stay, hit, double down, split, or surrender) by clicking on the appropriate hyperlink (or button) on the display, which is transmitted from the GCS to the device **101** as HTML. The user's desire relating to play of the hand is then transmitted to the GCS, stored, and displayed to the dealer who responds accordingly (e.g., giving the user another card, etc.).

[0410] Likewise, the user makes wagers by providing input to the device, which is transmitted to the GCS station, stored, and presented to the dealer. Other players may, or optionally, may not know the amount being wagered by another virtual player. The GCS is preferably a web server and ideally located remotely from the dealer, with the dealer operating a local computer connected thereto.

[0411] To provide the true feeling of being present, the dealer's voice is also transmitted to all users as well as the voice of other virtual players. Alternately, instead of using the display and pointing device to transmit the user's decisions regarding wagering and playing of the hands, the user provides voice commands. The speech is transmitted to the GCS and received by the dealer who acts accordingly. Transmitting the audio to all players allows friends from different geographical locations to play and interact together as if they were in a real gambling establishment. Preferably, the speech is converted to a data signal that indicates the desire of the user and is displayed to the dealer.

[0412] At the end of a hand, the dealer supplies an input indicating which users are winners and which are users and the payout odds for each. The GCS stores the input and credits or debits the user's gambling account (which is stored in memory of the GCS) according to the dealer input.

[0413] This application is especially applicable to games of chance such as craps and roulette. Typically, the number of people that may engage in a craps or roulette game is

limited by the number of people who can physically gain access to the table to place a bet. In a virtual game as described above however, an unlimited number of people may receive a broadcast from a single roulette or craps table (i.e., the number is only limited to the number of broadcasts that can be transmitted by the broadcast station).

[0414] For example, in roulette, the user provides an input of the desired bets, which is then transmitted to the GCS where the data is stored. After a predetermined time period, no more bets are accepted and the roulette wheel is spun. When the roulette ball comes to rest in a number, the dealer supplies an input to the GCS indicating the number (and/or perhaps color) at which the ball came to rest. The GCS then credits the user accordingly by retrieving the numbers bet upon by each user and comparing those numbers with the winning number. Again, the live action of the roulette ball is transmitted live to the device **101** for presentation to the user.

[0415] Craps may similarly be the game of chance with users supplying data of his or bets (the amount and numbers) to the device which transmits the data to the GCS, which determines if the bet is valid (allowable) and stores the data. After the betting period is over, a player playing live at the table rolls the dice. The dealer supplies an input to the GCS indicating the numbers shown on the rolled die. The GCS then credits the users accordingly by retrieving the bets of each user and comparing those bets with the bets made by the user.

[0416] Thus, this application includes the steps of receiving and storing a bet amount from a user, receiving and storing a bet request from a user, transmitting a confirmation to the user (or a first presentation device) of the bet request and/or bet amount, transmitting to the user (or the first presentation device or a second presentation device) video data of the game of chance upon which the bet is made, receiving an input relating to the result of the game of chance, determining whether the user won the bet, crediting the betting account of the user if the user won the bet, determining whether the user lost the bet, debiting the betting account of the user if the user lost the bet. In addition, the steps of determining whether the user won or lost the bet, include retrieving the bet of the user and comparing the retrieved data with the input relating to the results of the bet. The method may additionally include the step of determining the odds for payout of a winning bet or debit amount in the case of a loss, which may be retrieved from memory or provided by a user input.

[0417] Furthermore, the game of chance may have an image input device, or other input device, for reading the cards of each player, the roulette ball results, or crap dice data which is then supplied to the GCS.

[0418] The transmission of the game of chance to the user may be via a WLAN, a wired LAN, or a television transmission (e.g., closed circuit) such as those found in casino hotels. Irrespective of the transmission of the game of chance, the input from the user can be transmitted via a WLAN, a wired LAN, or via a television network. As will be evident to one skilled in the art, the GCS and the transmitting the video of the game of chance may be separate devices and would not necessarily need to communicate with each other.

[0419] This application of the present invention allows the user to enjoy live gaming while in his room. For example, the user could view the game of chance on the in room television and receive and transmit gaming data (e.g., bet amounts, bet requests, etc.) via a device **101**. Alternately, the television or other presentation device in the room includes an input device (e.g., a remote control) for receiving the user's input and for receiving and transmitting gaming data. Alternately, the device **101** can be used in a restaurant to receive and transmit gaming data based on a video transmission that is presented to a plurality of users in the restaurant. In still another alternative, the device can be used to receive the video data and receive and transmit gaming data.

[0420] Many of the software modules and applications may not be necessary or desirable in some embodiments of the present invention. For example, some embodiments may not include an image module and, therefore, could not practice those applications that utilize the image module. Other embodiments may not include one more of the modules and/or software programs described herein and therefore, would not be able to practice those applications requiring the omitted modules and software programming. The applications of use, hardware, and software programs of the embodiment implementing the present invention is a design choice based on available processing power, external systems, cost, desired functions, and other factors as will be evident from this disclosure to one skilled in the art.

[0421] The system, method, apparatus, and computer program product of the present invention can preferably process any type of data including ASCII Text, binary data, such as streaming video, streaming-real-time audio, and image data. As is well-known in the art, buffering, and delayed presentation, may be used for some data streams. Appropriate software coding can readily be prepared by skilled programmers based on the teachings of the present disclosure, as will be apparent to those skilled in the relevant art(s). The present invention thus also includes a computer-based product which may be hosted on a storage medium and include instructions that can be used to program a computer to perform a process in accordance with the present invention. The storage medium can include, but is not limited to, any type of memory including a floppy disk, optical disk, CDROM, magneto-optical disk, ROMs, RAMs, EPROMs, EEPROMs, flash memory, magnetic or optical cards, or any type of media suitable for storing electronic instructions, either locally or remotely. Other examples of suitable memory include memory such as a SmartMedia® card, a CompactFlash® card, a Memory Stick®, a MultiMediaCard®, a DataPlay disc®, and a SecureDigital® card.

[0422] The foregoing has described the principles, embodiments, and modes of operation of the present invention. However, the invention should not be construed as being limited to the particular embodiments described above, as they should be regarded as being illustrative and not as restrictive. It should be appreciated that variations may be made in those embodiments by those skilled in the art without departing from the scope of the present invention.

[0423] As discussed, the infrastructure of the present invention includes both hardware and software. The details of the infrastructure are left to the designer and will vary depending on the costs and benefits, compatibility with existing technology (hardware and software) and systems,

the application(s), the particular embodiment, and various other factors. A multitude of variations and applications are described and components and methods (hardware or software) of any particular application can be readily used with the components and methods of other applications as will be readily ascertainable by one skilled in the art. In addition, components and methods providing the same or similar functionality of another disclosed component or method may be substituted. In fact, as technology progresses, one skilled in the art would expect that the components and methods disclosed (both hardware and software) to be replaced with faster, smaller, cheaper, more efficient and/or better components and methods having enhanced functions and more adaptable to particular applications.

[0424] Likewise, features described in one embodiment or application might be used with features described in another embodiment or application and still be within the scope of the invention. One example embodiment of a device **101** practicing the present invention includes hardware and computer programming (computer code segments) for performing the following steps:

[0425] determining location data for the device, which may be determined through the use of a GPS receiver, from a transmission from a nearby fixed or moving device, which may be a vehicle;

[0426] determining when the device is within a predetermined distance from a point of interest;

[0427] receiving and storing data for monitoring and restricting the use of the device;

[0428] receiving a request to perform an action;

[0429] determining that said requested action is a restricted use and prohibiting said action;

[0430] determining that said requested action is a monitored use and storing said action and transmitting data of said action;

[0431] determining one of a plurality networks through which to communicate;

[0432] monitoring and storing physiological conditions of the user;

[0433] transmitting data upon detection of location based data such as being with a predetermined distance of a point of interest, within a given area, on a particular street and said transmitting may first include establishing a communication link;

[0434] wirelessly receiving, storing, and presenting to a user, audio and/or visual data (e.g., a map or video content) from a facility (or area) upon arriving at a predetermined distance from the facility (or area);

[0435] receiving and storing a transmission that includes advertisement content and product data;

[0436] receiving a user input relating to the advertisement and, in response, retrieving the product data and taking action on said product data according to a user input;

[0437] receiving and storing authentication data;

[0438] transmitting authentication data to a remote computer system;

[0439] requesting authenticating data upon receiving a request to perform an action such as make a purchase;

[0440] storing a voice annotation with computer data file, such as an image file;

[0441] audibly producing a voice annotation upon receiving a user input of a request;

[0442] using a voice input as the file name and/or location (e.g., a transmission destination) for storing a computer data file such as an image file;

[0443] exchanging payment account information by selecting a payment account, transmitting payment information, and receiving a response;

[0444] contemporaneously maintaining a voice and data (e.g., internet) communication links through a connection that is wireless at the mobile device;

[0445] receiving a mobile telephone communication while presenting an audio presentation to the user an notifying the user of the received telephone communication through a vibratory alert and/or an audible alert;

[0446] audibly presenting an audio presentation to the user from a storage device in the device such as playing an MP3 file;

[0447] presenting a video presentation to the user from memory;

[0448] receiving and storing a user input such as a voice input and/or actuator input, wherein said input includes a command;

[0449] converting said voice input to text;

[0450] determining a command to perform based on a user input;

[0451] determining a target point of interest (such as a vender) meeting selection criteria which may based on a user input and/or stored data;

[0452] determining the available target points of interest in an area meeting the selection criteria;

[0453] determining which of the available target points of interest is closest; which may include determining the user location and determining the location of the available target points of interest, which may be relative or absolute locations, determining the distance between user location and the location of the available target points of interest, and determining an estimate of the time to travel to the available target points of interest;

[0454] determining the available points of interest in said area satisfying the selection criteria by receiving and processing information for determining whether said available points of interests satisfy the selection criteria from a plurality of said available points of interests; wherein said step of receiving is in response to transmitting a request for information for determining whether said available points of interests satisfy the selection criteria;

[0455] presenting information to the user of at least some of the available target points of interest meeting the selection criteria, which may include identifying the closest target point of interest to the user.

[0456] receiving an input from the user relating to at least an available target point of interest;

[0457] transmitting data to an available target point of interest (or data relating to said available target point of interest to a computer system) based on an input from the user; wherein said transmitted data is a request to purchase or a request for information receiving a response from an said available target point of interest (or the associated computer system) and presenting the user with information relating to the response;

[0458] determining service providers satisfying a criteria such as may supplied by, for example, searching a service registry, by searching memory, or by a user input;

[0459] determining and storing communication parameters for communicating with at least some of service providers comprising points of interest meeting a selection criteria;

[0460] generating requests, based on said communication parameters, for transmission to said at least some of said service providers comprising points of interest satisfying said first selection criteria, said request including information for determining whether said point of interests satisfy a second selection criteria;

[0461] transmitting said requests according to said communication parameters to said service providers comprising said points of interest meeting a selection criteria;

[0462] receiving a response from a plurality of said service providers comprising said points of interest to which a request was transmitted;

[0463] processing said responses, for example, according to instructions from a user by removing duplicates, sorting, purchasing product(s); determining a placement of an advertisement in the results of a search of a pay per click search engine and transmitting a revised bid price is said determined placement is below a predetermined placement;

[0464] generating a request to one of said points of interest responding to said requests based on said processing;

[0465] transmitting said request to said one of said points of interest responding to said requests;

[0466] presenting information to the user based on said processed responses;

[0467] transmitting a request to a plurality of service providers such as pay per click pay per click search engines, which may be performed periodically;

[0468] providing a heads up display for presenting information a window of the vehicle;

[0469] receiving a request for information relating to a location;

[0470] determining directions to said location;

[0471] displaying information for traveling to the location on the window via the heads up display and wherein said displayed information includes information for communicating a turn;

[0472] including an audio presentation of the directions;

[0473] receiving a document for presentation to the user;

[0474] determining a plurality of objects, such as hyperlinks, in the document that are displayed the substantially the same;

[0475] generating indicia for each of said plurality of objects, said indicia being different for each of said plurality of objects;

[0476] displaying said indicia for each of said plurality of objects and said document to the user;

[0477] receiving a voice input from the user that includes information of an indicia which is a request to retrieve a web page corresponding to said hyperlink;

[0478] determining that said input from the user corresponds to the one of said plurality of objects corresponding to said indicia.

[0479] transmitting a request for a web page associated with said hyperlink;

[0480] generating a request for first user data;

[0481] wirelessly transmitting second user data to said first user device;

[0482] transmitting said request for said first user data to said first user device; and

[0483] receiving a response to said request for first user data that is based on said second user data and storing said response from said first user device.

[0484] Other embodiments may include hardware and software for performing other steps described herein, a subset of these steps, or some combination thereof. For example, another example of an embodiment of a computer system practicing the present invention includes hardware and software (computer code segments) for performing the following steps:

[0485] receiving identification information from a mobile user device a first time;

[0486] storing said identification information in memory;

[0487] receiving product information of products within a predetermined area;

[0488] storing said product information;

[0489] receiving a bid for a product;

[0490] storing said bid,

[0491] transmitting a notification of said bid to a plurality of users having placed a bid on said product;

[0492] determining the successful bidder of said product;

[0493] transmitting information of said successful bid to said successful bidder;

[0494] transmitting a transmission to a presentation device for presentation to the user, said transmission including user information therein such as the user's name; said transmission being based on user information such as the user likes and dislikes;

[0495] determining the location of a user, which may be an absolute location, a relative location, or a determination that the user is within a give area such as within communication of an access point or two access points;

[0496] receiving user data;

[0497] determining temporal data;

[0498] selecting an advertisement based, at least in part, on the location of the user, said received user data, on temporal data, and/or a transmission value;

[0499] transmitting said advertisement for presentation to the user;

[0500] receiving information of a response to said transmitted advertisement;

[0501] performing an incentive transaction in response to receiving said information of said response;

[0502] collecting CCD information via a wireless communication;

[0503] storing said user information with said user identifying information;

[0504] determining that the user is in an area, which may be predefined and may be determined by communication with the user's device via one or more access points;

[0505] receiving identifying information of the user or device a second time;

[0506] retrieving vender stored user information based on said identifying information;

[0507] performing an action based on said retrieved vender stored user information, determined temporal data, and/or determined location data; and

[0508] selecting and transmitting data, such as an advertisement, based on said vender stored user information which may further be selected based on received CCD, determined temporal data, determined location data, and/or a transmission value;

[0509] Again, other embodiments may include hardware and software for performing other steps described herein, a subset of these steps, or some combination thereof.

[0510] While a preferred embodiment of the present invention has been described above, it should be understood that it has been presented by way of example only, and not limitation. Thus, the breadth and scope of the present invention should not be limited by the above described exemplary embodiment.

[0511] Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

1. A communications device sized to be carried on the user's person, comprising:

a processor;

a memory communicatively coupled to said processor;

a program code stored in said memory and executable by said processor;

an audio input device communicatively coupled to said processor;

an audio output device communicatively coupled to said processor;

a location module communicatively coupled to said processor and configured to determine information of the location of the device;

a mobile telephone network transceiver communicatively coupled to said processor and configured to wirelessly communicate via a mobile telephone network; and

a wireless area network transceiver communicatively coupled to said processor and configured to wirelessly communicate via a wireless area network.

2. The device of claim 1, wherein said wireless area network transceiver comprises a wireless local area network (LAN) transceiver.

3. The device of claim 2, further comprising a Bluetooth transceiver communicatively coupled to said processor.

4. The device of claim 1, further comprising a wireless personal area network (PAN) transceiver communicatively coupled to said processor.

5. The device of claim 1, wherein said location module comprises a global positioning system receiver.

6. The device of claim 1, wherein said program code comprises a code segment to:

store data of one or more restricted uses in said memory;

determine whether an attempted use of the device corresponds to a restricted use; and

prohibit the attempted use if the attempted use substantially corresponds to a restricted use.

7. The device of claim 6, wherein at least one of said restricted uses relates to providing payment for an article of commerce.

8. The device of claim 1, wherein said program code comprises a MP3 player.

9. The device of claim 1, further comprising a digital radio receiver communicatively coupled to said processor and configured to receive wireless digital radio broadcasts.

10. The device of claim 9, wherein said program code comprises a code segment to store a received digital radio broadcast in said memory; and

to audibly produce a stored radio broadcast in response to a user input.

11. The device of claim 9, wherein said program code comprises a MP3 player.

12. The device of claim 1, wherein said program code comprises a code segment to:

establish a wireless voice communication link via said mobile telephone network transceiver to communicate voice data;

establish a wireless data link via said wireless area network transceiver to communicate non-voice data; and

wherein said wireless voice communication link and said wireless data link exist contemporaneously to simultaneously provide voice and data communications.

13. The device of claim 1, wherein said program code comprises a code segment to select a wireless network for communications when a plurality of wireless networks are available for communications.

14. The device of claim 1, wherein said program code comprises a code segment to:

store location criteria in said memory;

determine the location of the device; and

wirelessly transmit a notification to a remote device if the location of the device substantially corresponds to the location criteria.

15. The device of claim 1, wherein said program code comprises a code segment to:

receive a wireless transmission of a request for user information;

determine whether to respond to the request based, at least in part, on a user preference stored in said memory; and

wirelessly transmit said requested user information upon an affirmative determination to respond.

16. The device of claim 1, wherein said program code comprises a code segment to:

store authentication criteria of a user in said memory;

store data of one or more restricted uses in said memory;

present a request for authentication from the user upon detection of a use corresponding to one of said restricted uses;

receive authentication information from the user;

determine whether the received authentication information satisfies said authentication criteria; and

prohibit said detected use if said authentication information does not satisfy said authentication criteria.

17. The device of claim 16, wherein at least one of said restricted uses relates to providing payment for an article of commerce.

18. The device of claim 1, wherein said program code comprises a code segment to:

receive a request related to a point of interest satisfying a criteria from a user;

determine the location of the device;

determine location information of points of interest satisfying the criteria;

select one or more points of interest satisfying the criteria based, at least in part, on the location of the points of interest relative to the location of the device; and

present information related to the location of the selected points of interest to the user.

19. The device of claim, 1 further comprising:

an image input device communicatively coupled to said processor and configured to receive image data; and

wherein said program code comprises a code segment to wirelessly transmit image data received via said image input device.

20. A method of using a communications device sized to be carried on the user's person, the method comprising:

determining location information of the device;

receiving image data via an image input device;

wirelessly transmitting the image data;

establishing a first wireless communication link via a wireless mobile telephone network; and

establishing a second wireless communication link via a wireless area network.

21. The method of claim 20, further comprising:

establishing a third wireless communication link via a wireless personal area network, and wherein the wireless area network comprises a wireless local area network (LAN).

22. The method of claim 20, wherein the image data includes motion video data.

23. The method of claim 20, further comprising:

storing restriction data of one or more restricted uses in a memory;

determining whether an attempted use of the device corresponds to a restricted use; and

prohibiting the attempted use when the attempted use substantially corresponds to a restricted use.

24. The method of claim 20, further comprising audibly producing a MP3 recording.

25. The method of claim 20, further comprising retrieving payment information from a memory and wirelessly transmitting said payment information to a remote apparatus configured to process said payment information.

26. The method of claim 20, further comprising audibly and visually producing an audio-video recording.

27. The method of claim 20, further comprising receiving and audibly producing a wireless digital radio broadcast.

28. The method of claim 20, further comprising:

receiving a wireless digital radio broadcast;

storing the radio broadcast in a memory; and

audibly producing the stored radio broadcast in response to a user input.

29. The method of claim 20, wherein said first wireless communication link communicates voice data, said second wireless communication link communicates non-voice data; and wherein said first wireless communication link and said second wireless communication link exist contemporaneously to simultaneously provide voice and data communications.

30. The method of claim 20, further comprising:

receiving second image data at the image input device; and

converting the second image data to text.

31. The method of claim 20, further comprising:

receiving an audio input at an audio input device as part of a mobile telephone call;

producing at an audio output device an audio output corresponding to voice data received wirelessly as part of the mobile telephone call;

storing in a memory data corresponding to the audio input received at the audio input device; and

storing in the memory data corresponding to the audio output produced at the audio output device.

32. The method of claim 20, further comprising converting voice data received at an audio input device to text.

33. The method of claim 20, further comprising:

storing location criteria in a memory;

wirelessly transmitting a notification to a remote device if the location of the device substantially corresponds to the location criteria.

34. The method of claim 20, further comprising:

receiving a wireless transmission of a request for user information; and

determining whether to respond to the request based, at least in part, on a user preference stored in memory; and

wirelessly transmitting the requested user information upon an affirmative determination to respond.

35. The method of claim 20, further comprising:

requesting authentication information from the user upon detection of a restricted use;

receiving authentication information from the user;

determining whether the authentication information satisfies a authentication criteria; and

prohibiting the detected use if the authentication information does not satisfy said authentication criteria.

36. The method of claim 35, wherein said restricted use relates to providing payment for an article of commerce.

37. The method of claim 20, further comprising:

receiving a request related to a point of interest satisfying a criteria from a user;

determining location information of points of interest satisfying the criteria;

selecting one or more points of interest satisfying the criteria based, at least in part, on the location of the points of interest relative to the location of the device; and

presenting information related to the location of the selected points of interest to the user.

38. The method of claim 20, further comprising:

storing the image data in a memory; and

annotating the image data stored in memory with location data based on said location information.

39. A method of using a communications device sized to be carried on the user's person, comprising:

establishing a first wireless communication link via a wireless mobile telephone network;

establishing a second wireless communication link a wireless LAN;

establishing a third communication link via a wireless PAN.

determining information of the location of the device;

receiving image data via an image input device;

storing the image data in memory;

wirelessly transmitting the image data;

audibly and visually producing an audio-video recording; and

audibly producing a MP3 recording.

* * * * *

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(54) **MULTI-MODEM SCHEDULING ON A COMMUNICATION DEVICE**

(75) Inventors: **Roberto Gautier**, Davie, FL (US); **James R. Wise**, Monroe, NC (US)

Correspondence Address:
CUENOT & FORSYTHE, L.L.C.
12230 FOREST HILL BLVD., SUITE 120
WELLINGTON, FL 33414

(73) Assignee: **MOTOROLA, INC.**, Schaumburg, IL (US)

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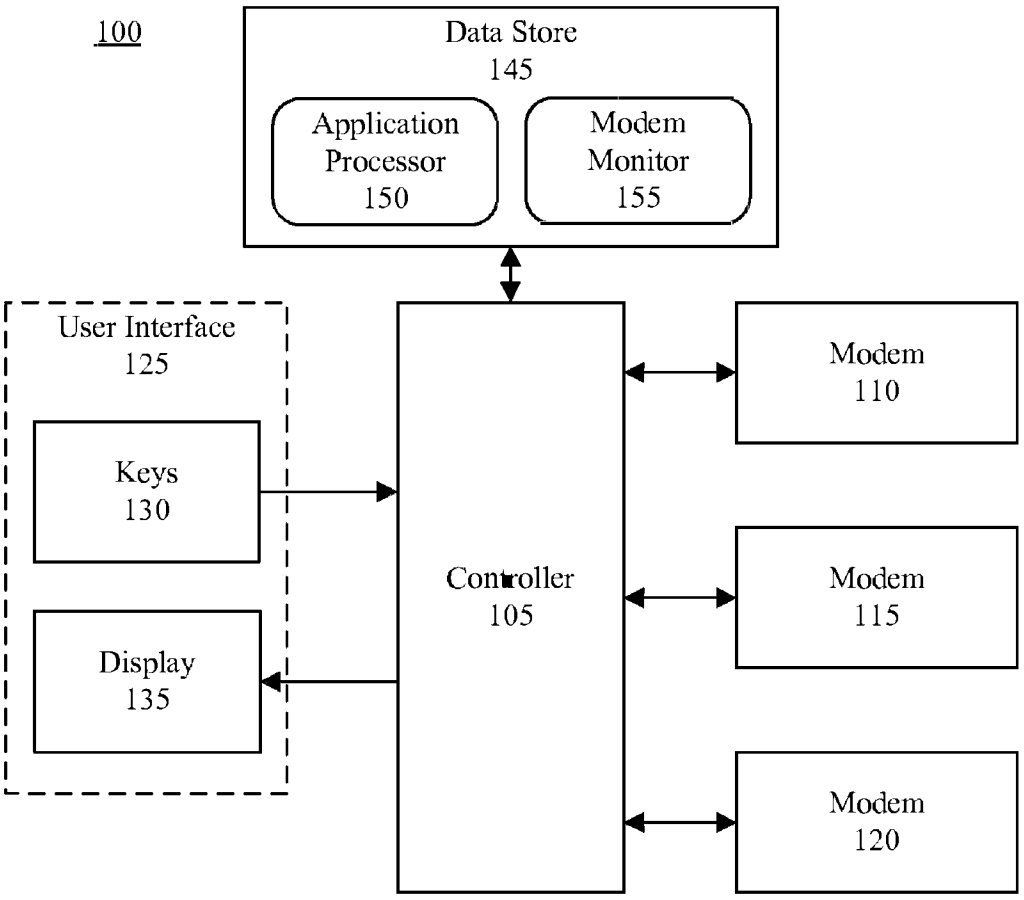
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(57) **ABSTRACT**

A method of managing a plurality of modems within a communication device can include determining that a plurality of modems within the communication device will concurrently transmit a network response to a received page (**415**). A modem selection value for each of the plurality of modems can be calculated (**425**). A time at which one or more of the plurality of modems transmits a network response can be modified according to the modem selection values of the plurality of modems (**440**).



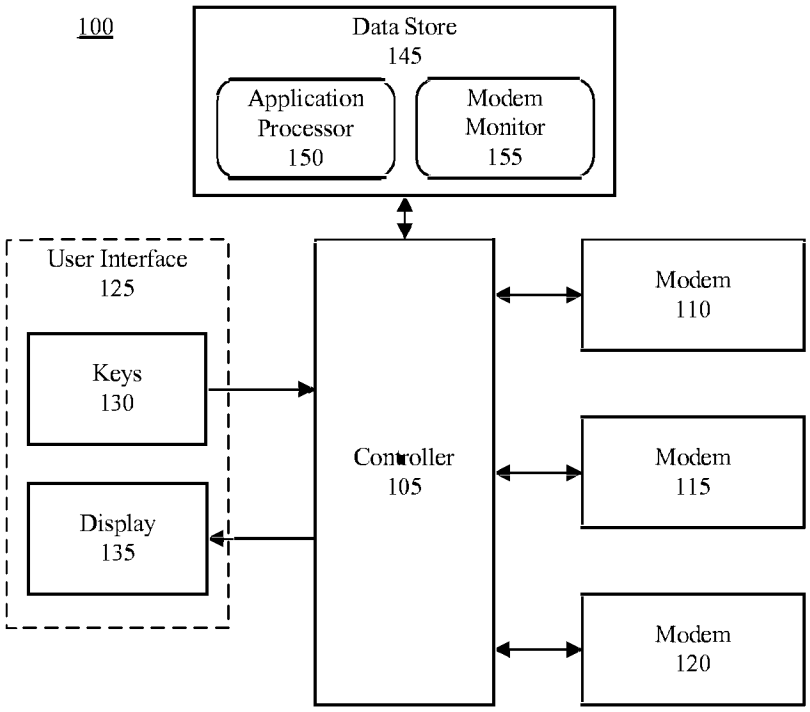

100
Data Store
145
Application Processor
150
Modem Monitor
155
User Interface
125
Keys
130
Display
135
Controller
105
Modem
110
Modem
115
Modem
120

FIG. 1

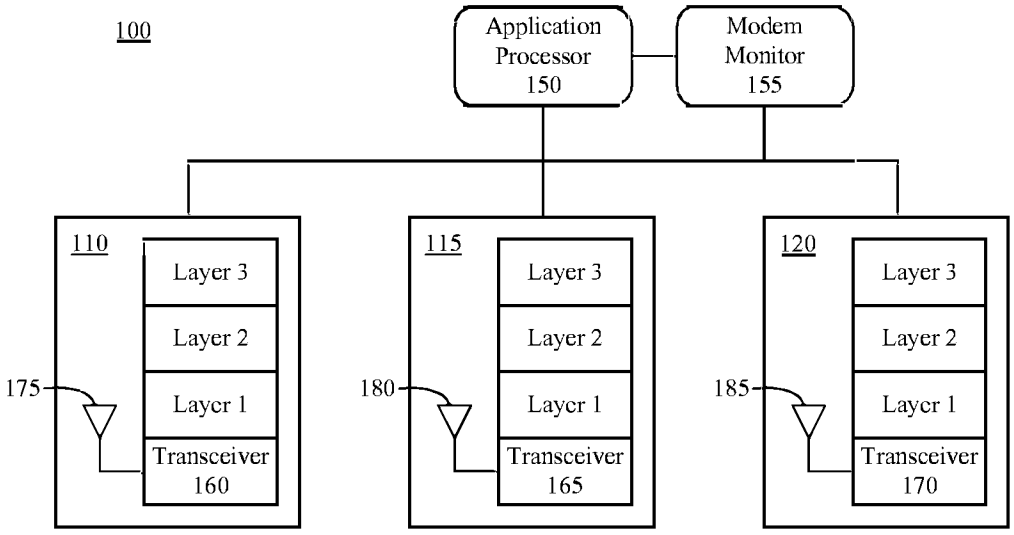

100
Application Processor
150
Modem Monitor
155
110
Layer 3
Layer 2
Layer 1
Transceiver
160
175
115
Layer 3
Layer 2
Layer 1
Transceiver
165
180
120
Layer 3
Layer 2
Layer 1
Transceiver
170
185

FIG. 2

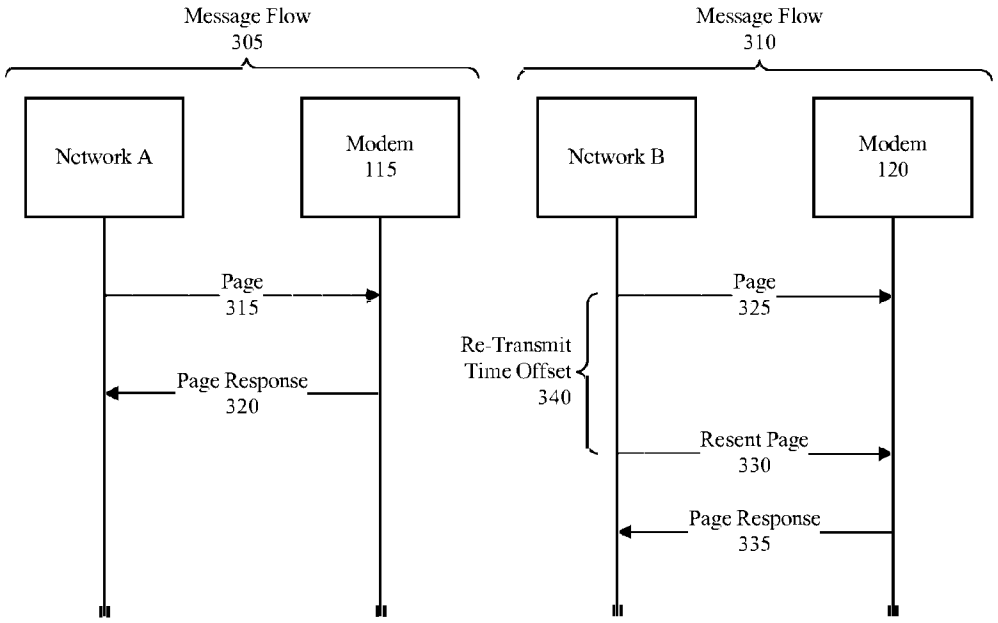

Message Flow
305
Message Flow
310
Network A
Modem
115
Network B
Modem
120
Page
315
Page Response
320
Re-Transmit
Time Offset
340
Page
325
Resent Page
330
Page Response
335

FIG. 3

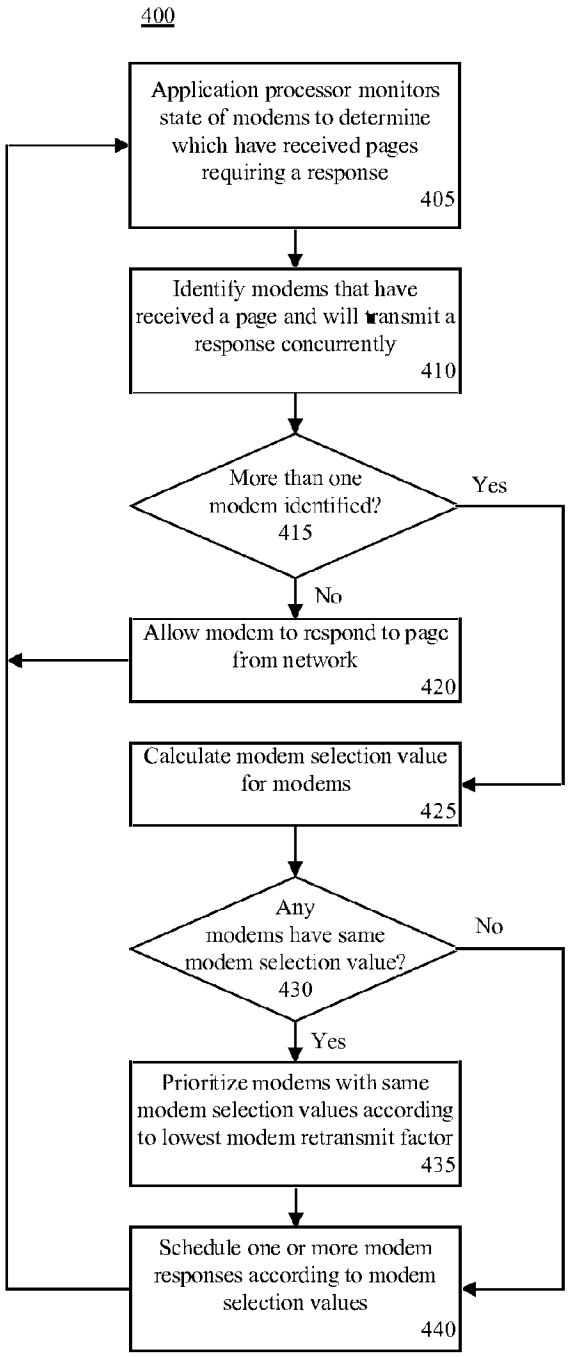

400
Application processor monitors state of modems to determine which have received pages requiring a response
405
Identify modems that have received a page and will transmit a response concurrently
410
More than one modem identified?
415
Yes
No
Allow modem to respond to page from network
420
Calculate modem selection value for modems
425
Any modems have same modem selection value?
430
No
Yes
Prioritize modems with same modem selection values according to lowest modem retransmit factor
435
Schedule one or more modem responses according to modem selection values
440

FIG. 4

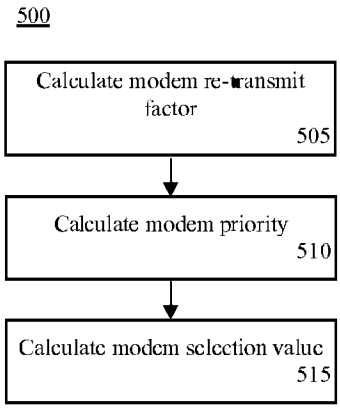

500
Calculate modem re-transmit factor
505
Calculate modem priority
510
Calculate modem selection value
515

FIG. 5

MULTI-MODEM SCHEDULING ON A COMMUNICATION DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention generally relates to communication devices that have a plurality of modems and, more particularly, to managing the operation of the modems.

[0003] 2. Background of the Invention

[0004] Many modern communication devices incorporate multiple modems to facilitate communication over more than one network. For example, some mobile stations, such as those available from Motorola, Inc. of Schaumburg, Ill., have begun to offer mobile stations capable of communicating over CDMA and iDEN networks. (Motorola and iDEN are trademarks of Motorola, Inc. in the United States, other countries, or both).

[0005] Other examples of communication devices having multiple modems can include mobile stations that communicate over mobile phone network(s) as well as over one or more short range wireless networks such as an IEEE 802 wireless network or a Bluetooth® wireless network. Mobile stations typically include Bluetooth modems for communicating with wireless peripheral devices such as earpieces and the like. The various modems within the communication device often operate concurrently and independently of one another.

[0006] Incorporating multiple modems within a single communication device can create significant power demands upon the battery. Each additional modem increases the power requirements of the device. Under normal circumstances, increased power demands are not problematic in terms of battery life. The current draw that occurs when more than one modem is active at the same time, however, can, in some cases, be so significant that the useful life of the battery is reduced.

SUMMARY OF THE INVENTION

[0007] One aspect of the present invention relates to a method of controlling modems of a communication device having a plurality of modems. The method can include determining that a plurality of modems within the communication device will concurrently transmit a network response to a received page and calculating a modem selection value for each of the plurality of modems. A time at which one or more of the modems transmits a network response can be modified according to the modem selection values of the plurality of modems.

[0008] Calculating a modem selection value can include computing the modem selection value for each modem of the plurality of modems according to a page type for the page to which each respective modem of the plurality of modems is to respond. The modem selection values further can be computed according to a page weight that is set according to the page type of the page to which each respective modem of the plurality of modems is to respond. Modem selection values also can be computed according to a modem type for each respective modem of the plurality of modems and/or a modem weight that is set according to the modem type of each of the plurality of modems.

[0009] Calculating a modem selection value further can include computing the modem selection value for each modem of the plurality of modems according to a number of times the page, to which each respective modem of the plurality of modems is to respond, will be transmitted by a network that sent the page. The modem selection value also can be computed according to a re-transmit time offset of a network that sent the page for each respective modem of the plurality of modems.

[0010] In one arrangement, the modem selection value for a selected modem "n" of the plurality of modems can be computed according to $(PT_n*PW_n)+(M_n*MW_n)-(NT_n*NRT_n)$, where PT_n denotes a page type of the page received by the selected modem, PW_n is a weight of the page that is set according to the page type, M_n indicates a type of the selected modem, MW_n indicates a weight assigned to the selected modem, NT_n indicates a number of times a network that sent the page to the selected modem will transmit the page, and NRT_n indicates a re-transmit time offset for the network that sent the page to the selected modem.

[0011] The time at which one or more of the plurality of modems transmits a network response can be modified by delaying a network response of a modem of the plurality of modems having a lower modem selection value to allow another modem of the plurality of modems having a higher modem selection value to transmit a network response. The time at which one or more of the plurality of modems transmits a network response also can be modified by sequentially enabling one of the plurality modems at a time while disabling each of the other ones of the plurality of modems according to decreasing modem selection values to allow the enabled modem to transmit a network response.

[0012] In the event that two or more modems of the plurality of modems have equal modem selection values, the method can include delaying a network response from the modem of the two modems that has a higher retransmission factor to allow the other modem of the two modems to transmit a network response.

[0013] Another aspect of the present invention relates to a communication device. The communication device can include a plurality of modems that communicate with different communication networks and a controller. The controller can be coupled to each of the plurality of modems and selectively enable different ones of the plurality of modems to transmit a network response according to assigned modem selection values such that, responsive to a received page, the plurality of modems do not concurrently transmit network responses.

[0014] The controller can calculate the modem selection value for each of the plurality of modems according to a page type of a page to which each respective modem of the plurality of modems is to respond or a weight assigned to each page according to the page type. The controller also can calculate the modem selection value for each of the plurality of modems according to a modem type for each respective modem of the plurality of modems, or a modem weight for each respective modem of the plurality of modems. Modem weight can be assigned according to modem type.

[0015] The controller can calculate the modem selection value for each of the plurality of modems according to a number of times a page, to which each respective modem of the plurality of modems is to respond, will be transmitted or a re-transmit time offset of the network that sent the page to which each respective modem of the plurality of modems is to respond.

[0016] In another arrangement, the controller can calculate a modem selection value for a selected modem "n" of a

plurality of modems of the communication device having received a page according to $(PT_n*PW_n)+(M_n*MW_n)-(NT_n*NRT_n)$ where PT_n denotes a page type for the page that was received by the selected modem, PW_n is a weight of the page that is set according to page type, M_n indicates a type of the selected modem, MW_n indicates a weight assigned to the selected modem, NT_n indicates a number of times a network will transmit the page to the selected modem, and NRT_n indicates a re-transmit time offset for the network that sent the page to the selected modem.

[0017] The controller can modify a time at which at least one of the plurality of modems transmits a network response according to the assigned modem selection values. The controller further can delay a network response of a modem of the plurality of modems having a lower modem selection value to allow another modem of the plurality of modems having a higher modem selection value to transmit a network response. In another arrangement, the controller can sequentially enable one of the plurality modems at a time while disabling each of the other ones of the plurality of modems according to decreasing modem selection values to allow the enabled modem to transmit a network response.

[0018] Another aspect of the present invention can include a machine readable storage being programmed to cause a machine to perform the various steps described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Preferred embodiments of the present invention will be described below in more detail, with reference to the accompanying drawings, in which:

[0020] FIG. **1** depicts a communication device that is useful for understanding the present invention;

[0021] FIG. **2** depicts another aspect of the communication device of FIG. **1** which is useful for understanding the present invention;

[0022] FIG. **3** depicts exemplary message flows which are useful for understanding the present invention;

[0023] FIG. **4** is a flowchart that is useful for understanding the present invention; and

[0024] FIG. **5** is a flowchart that is useful for understanding the present invention.

DETAILED DESCRIPTION

[0025] While the specification concludes with claims defining features of the invention that are regarded as novel, it is believed that the invention will be better understood from a consideration of the description in conjunction with the drawings. As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. Further, the terms and phrases used herein are not intended to be limiting but rather to provide an understandable description of the invention.

[0026] The present invention relates to managing and/or controlling modems in a communication device that includes a plurality of modems. Within such a device, operation of the modems can be controlled and arbitrated such that the modems are not concurrently active. More particularly, modems that receive a page from a network can be identified and scheduled so that the responses provided by each of the various modems of the communication device do not occur at the same time. The response from each respective modem can be scheduled so that one modem responds after another modem responds and no overlap occurs between the responses. Arbitrating when the modems respond to network inquiries can avoid the situation in which more than one modem is responding concurrently, which can adversely affect the useful life of a battery.

[0027] FIG. **1** depicts a block diagram of a communication device **100** that is useful for understanding the present invention. As shown, the communication device **100** can include a controller **105**, a plurality of modems **110**, **115**, and **120**, a user interface **125**, as well as a data storage device (data store) **145**. The communication device **100** can be any of a variety of different devices that have a plurality of modems, i.e., a computer system with multiple modems, a portable information processing system, such as a personal digital assistant, having a plurality of modems, or a mobile station having a plurality of modems. The particular type of device is not intended to limit the present invention so long as the device is configured to function with more than one modem as described herein.

[0028] The controller **105** can comprise, for example, one or more central processing units (CPUs), one or more digital signal processors (DSPs), one or more application specific integrated circuits (ASICs), one or more programmable logic devices (PLDs), a plurality of discrete components that can cooperate to process data, and/or any other suitable processing device. These components can be coupled together to perform various processing functions as described herein.

[0029] The modems **110**-**120**, as known, can modulate and demodulate signals to convert signals from one form to another for transmission over various communication networks (not shown). Each of the modems **110**-**120** can be configured to communicate over a different communication channel or protocol, as the case may be. In one aspect, the modem **110** can communicate data via IEEE 802 wireless communications, for example, 802.11 and 802.16 (WiMax), WPA, or WPA2. The modem **115**, can communicate data via GSM, TDMA, CDMA, WCDMA, or direct wireless communication. Modem **120** can communicate data via TCP/IP.

[0030] Fewer or additional modems can be included within the communication device **100**. For example, one or more additional modems can be included which communicate data over short range wireless communication links such as Bluetooth. It should be appreciated that the particular number of modems included within the communication device **100** is not intended to limit the present invention so long as the communication device **100** includes more than one modem. Further, the particular communication networks and protocols listed herein have been provided for purposes of illustration only and are not intended to limit the present invention.

[0031] The user interface **125** can include one or more keys **130** which can be disposed within a keypad, one or more programmable keys, or both. A programmable key refers to a key that can be used to initiate any of a variety of different programmatic actions within the communication device **100** according to the particular operating state in which the communication device **100** is disposed at the time

the programmable key is actuated or activated. The user interface **125** also can include a display **135**. Other mechanisms (not shown) for obtaining user input and providing feedback to a user can be provided in the user interface **125**. For example, the communication device **100** can include various sensors, audio input and output transducers, etc.

[0032] The data store **145** can include one or more storage devices, each of which can include a magnetic storage medium, an electronic storage medium, an optical storage medium, a magneto-optical storage medium, and/or any other storage medium suitable for storing digital information. In one arrangement, the data store **145** can be integrated into the controller **105**. In any case, the data store **145** can include, or store, an operating system (not shown), which can be executed by the controller **105**. The data store **145** further can include an application processor **150** and a modem monitor **155**. The application processor **150** and the modem monitor **155** can be implemented as computer programs that can be executed by the controller **105**. The application processor **150** and the modem monitor can execute within the application layer of the communication device **100**. The application processor **150**, when executed by the controller **105**, can perform the various functions and methods described herein.

[0033] The modem monitor **155** can monitor the state of the modems **110-120**. More particularly, the modem monitor **155** can communicate with the modems **110-120** to determine which modems **110-120**, if any, have received a page from a network. Upon receiving a page from a network, the modem having received the page typically provides a response. The modem monitor **155** can notify the application processor **150** of the state of the modems **110-120**. Accordingly, the application processor **150** can determine that those modems that have received a page from a network will send a response to the respective network.

[0034] As known, a page generally refers to an inquiry from a network. A page is indicative of an incoming communication to the communication device **100** and is sent from the network after a communication link has been established between the network and the communication device **100**. For example, a page can be sent from a network indicating that a call is being directed to the communication device **100**. In that case, the communication device **100** is already "on the network" in the sense that a communication link has previously been established between the network and the communication device **100**.

[0035] The application processor **150** can communicate with the modem monitor **155** and the modems **110-120** to arbitrate between the modems **110-120**. More particularly, the application processor **150** can schedule when each of the respective modems **110-120**, that have received a page, will respond. The response from each of the modems **110-120** can be coordinated by the application processor **150** in such a way that none of the responses overlap one another. That is to say, the responses provided by the modems **110-120** do not occur concurrently.

[0036] In operation, the modem monitor **155** can continually monitor the modems **110-120** to determine which modems have received a page from a network and provide that information to the application processor **150**. If more than one modem has received a page for which a response is to be sent, the application processor **150** can determine a schedule that the modems **110-120** will follow when sending the responses. In general, the application processor **150** can delay the response of one or more of the modems **110-120** according to a modem selection value that is calculated by the application processor **150** for each respective modem that has received a page and is in contention for responding.

[0037] FIG. **2** depicts an aspect of the communication device of FIG. **1** which is useful for understanding the present invention. More particularly, FIG. **2** illustrates a more detailed view of the application processor **150**, the modem monitor **155**, and the modems **110-120**. Each of the modems **110-120** can include a transceiver **160**, **165**, and **170** and an antenna **175**, **180**, and **185**, respectively as shown. Further, each modem **110-120** can include multiple layers of control software, i.e., layer 1, layer 2, and layer 3, as specified by the Open Systems Interconnection (OSI) reference model, where layers 1, 2, and 3 correspond to the physical, data link, and network layers respectively. It should be appreciated, however, that the complexity of the implementation can vary according to design constraints, the implementer, and/or other considerations.

[0038] FIG. **3** depicts exemplary message flows which are useful for understanding the present invention. Two message flows, referenced as message flow **305** and message flow **310**, are shown. Both message flows **305** and **310** are transacted with a same communication device such as the communication device described with reference to FIG. **1**. Message flow **305** takes place with a particular modem, e.g., modem **115**, of the communication device; and message flow **310** takes place with another modem, e.g., modem **120**, of the communication device.

[0039] For purposes of illustration, modem **115** can be a modem that communicates over a short range wireless communication network such as Bluetooth. Modem **120** can be a modem that communicates over a CDMA network. As noted, additional modems can be included and the particular number of modems within the communication device is not intended to limit the present invention. Modem **125** has been excluded for purposes of illustration.

[0040] As shown, a page **315** can be sent from network A to modem **115**. At or about the same time, a page **325** can be sent from network B to modem **120**. Each of the modems **115** and **120** can provide status information to the modem monitor (not shown), which in turn can provide information to the application processor (not shown). The modems **115** and **120** can provide operating state information to the modem monitor from time-to-time, periodically, responsive to a state change such as receiving a page, or responsive to a query from the modem monitor. The application processor can determine that modems **115** and **120** will be responding at or about the same time to pages **315** and **325** respectively. Modem **115** and **120** can operate independently of one another unless the application processor arbitrates between the two.

[0041] It should be appreciated that the particular time at which modem **115** and modem **120** receive pages **315** and **325** respectively need not be identical. For example, in one aspect, the application processor can include logic which determines that if pages **315** and **325** are received within a predetermined amount of time of one another, a likelihood exists that the response from each respective modem, without arbitration by the application processor, will overlap in time. That is, modem **115** and modem **120** will be sending responses at or about the same time, or concurrently.

[0042] In another arrangement, an internal timer can be set for modem **115** when page **315** is received that expires at

time "t+x". If modem **120** receives page **325** at time "t" and is going to respond at time "t+x", the application processor can determine which of modems **115** or **120** has the higher priority or whether one modem must respond to avoid a dropped link, such as in the case of a Bluetooth beacon.

[0043] The application processor can arbitrate between modem **115** and modem **120** causing modem **120** to delay its response to network B. Thus, as shown, modem **115** provides a page response **320** to network A. Modem **120**, rather than proceeding with a page response to network B after modem **115** has completed the transmission of page response **320**, can await a further page, referred to as a resent page **330**, from network B. In response to the resent page **330**, the modem **120** can send a page response **335** to network B.

[0044] In this example, the application processor can be aware of the number of times network B is configured to resend pages when no response is received from the communication device being paged. Further the application processor can be programmed with a re-transmit time offset **340** in reference to the amount of time between when page **325** and resent page **330** is sent from network B. It should be appreciated that the communications device can be programmed with a re-transmit time offset for each network with which the communication device is able to communicate. Accordingly, the application processor can determine that if modem **120** does not respond to page **325**, and instead awaits a further inquiry from network B, e.g., resent page **330**, modem **115** will have completed transmission of page response **320** by that time. Modem **120**, responding to resent page **330**, can transmit without overlapping with the transmission from modem **115**.

[0045] FIG. **4** is a flowchart presenting a method **400** that is useful for understanding the present invention. The method **400** can be performed by a communication device such as the device described with reference to FIG. **1**. The method **400** can begin in step **405** where the application processor monitors the state of modems to determine which modems have received pages requiring a response. The operating state of a modem can be provided to the application processor via the modem monitor. As used herein, the operating state of a modem can include, but is not limited to, information indicating whether the modem has received a page, the time such a page was received, the type of page received, the particular modem of the communication device that received the page, and the like.

[0046] In step **410**, the application processor can identify modems that have received a page and that will transmit a response to the page concurrently. As noted, in one aspect, such a determination can be made by identifying those modems that have received a page, for which a response has not yet been sent, within a predetermined amount of time of one another.

[0047] In step **415**, a determination can be made as to whether more than one modem was identified in step **410**. If more than one modem was identified, the application processor can determine that two or more modems are in contention for responding to the received pages in a manner that will overlap, i.e., concurrently. In that case, the method can proceed to step **425**. If only one modem was identified, the method can proceed to step **420**. In step **420**, the application processor can allow the modem to respond to the page from the network without interference. That is, the application processor can determine that there is no need for arbitration among modems and the modem can respond to the page in a conventional manner. After step **420**, the method can loop back to step **405** to continue processing.

[0048] Continuing with step **425**, the application processor can calculate a modem selection value for each of the modems identified in step **410**. Calculation of the modem selection value will be described herein in greater detail with reference to FIG. **5**. In general, the modem selection values can be determined according to various quantities relating to the operating state of the modems, attributes of the networks that have paged the modems, and the like. In step **430**, a determination can be made by the application processor as to whether any modems have a same modem selection value. If so, the method can proceed to step **440**. If not, the method can proceed to step **435**.

[0049] In step **435**, the set of modems that have a same modem selection value can be prioritized among themselves according to a modem re-transmit factor. The modem re-transmit factor, which will be described in further detail with reference to FIG. **5**, is a measure that is calculated with reference to the number of times a network is configured to re-transmit a page in the event no response is received from the communication device to which the page was sent and the re-transmit time offset used by that network. The modems can be prioritized such that the modem having the lowest modem re-transmit factor is given the highest priority, or enabled over the others. The modem having the highest modem re-transmit factor can be given the lowest priority of the set.

[0050] In step **440**, the application controller can schedule, or reschedule, as the case may be, one or more modem responses according to the modem selection values determined in step **430**. The modems can be scheduled such that highest priority is given to the modem with the highest modem selection value. Accordingly, the lowest priority can be given to the modem with the lowest modem selection value. Within the order established by the modem selection values, those modems, if any, having the same modem selection value can be prioritized, at least among themselves, according to the modem re-transmit factor for each such modem as determined in step **435**.

[0051] In general, modems can be permitted to respond in order of decreasing modem selection values. In one arrangement, for example, the modem with the highest modem selection value can be permitted to respond while the other modems are disabled or otherwise prevented from responding. The modem with the next highest modem selection value then can be allowed to respond while the other modems are disabled. The process, i.e., scheduling, can continue as described.

[0052] In another arrangement, the application processor can instruct modem(s) "do not respond". In that case, such modem(s) can refrain from providing a response to a received page. The application processor subsequently can instruct a modem to "respond", at which time the modem can respond to the page. Such an embodiment can be useful in cases where the application processor determines that the highest priority modem will complete a response prior to the time that a resent page is expected for a lower priority modem that is in contention with the highest priority modem. In that case, rather than waiting the full amount of time for the lower priority modem to receive a resent page, the application processor can instruct the lower priority modem to respond after the highest priority modem has

completed transmission of its network response. Further, an instruction to respond can be useful in cases where the modem has received a final or last page from the network and, thus, will not receive a subsequent resent page to trigger a response.

[0053] In another aspect, the application processor can provide an instruction to one or more modems indicating "do not respond to this page". In that case, the modem can refrain from responding to the current page, but respond to a next page without further prompting by the application processor. That is, when the page is resent to the modem due to a non-response condition, the modem will reply to the resent page. In this arrangement, the application controller relies upon the network capability for resending information to the modem and the re-transmit time offset of the network in scheduling the modem responses.

[0054] FIG. **5** is a flowchart presenting a method **500** that is useful for understanding another aspect of the present invention. More particularly, FIG. **5** illustrates one technique for determining the modem selection values for modems that are in contention for responding to a page from a network. The method **500** considers various parameters of the network with which the modem is responding as well as aspects of the modem and the type of page that has been received by the modem. In one aspect, FIG. **5** provides a technique for determining modem selection values as discussed in step **425** of FIG. **4**. Further, FIG. **5** illustrates one technique for calculating the modem re-transmit factor discussed in step **435** of FIG. **4**.

[0055] In step **505**, the modem re-transmit factor, denoted as Modem_RTF, can be calculated. In one aspect, the modem re-transmit factor for a selected modem "n" can be calculated as $Modem\_RTF_n=NT_n*NRT_n$, where NT_n can indicate the number of times a network transmitting a page to modem "n" will transmit the page in the event no response is received from the communication device, and NRT_n indicates the re-transmit time offset for network sending the page to modem "n". The values for NT_n and NRT_n can be pre-programmed into the communication device, i.e., as part of the application processor for the various networks with which the communication device can communicate. Thus, when a modem receives a page from a specified network, the parameters for that network, in terms of NT_n and NRT_n are known by the application processor.

[0056] In another arrangement, the communication device can be configured to query the network for the parameters needed to compute Modem_RTF. Since the parameters are typically network configurable, the parameters can change from time to time and under different circumstances. The communication device can query the network for the parameters. When a response from the network is received, the communication device can update the parameters stored therein according to the most recent parameters provided from the network.

[0057] In step **510**, a modem priority, denoted as Modem_PR can be calculated. In one aspect the modem priority for the selected modem "n" can be calculated as $Modem\_PR_n=(PT_n*PW_n)+(M_n*MW_n)$, where PT_n refers to a page type for a page received by the modem from the network that sent the page and PW_n refers to a predetermined page weight that is assigned to the page. The page weight can be assigned according to page type. M_n can indicate the particular modem of the communication device that received the page, and MW_n can refer to a predetermined weight assigned to the modem MT_n. The page type parameter PW_n allows the application processor to distinguish between pages received for calls as compared to pages received for text messages or other communications, for example. Different page types, relating to different forms of communication, can be distinguished. Each of these page types can be assigned a weight. Thus, pages for calls can be given more weight, i.e., considered more important, than pages for text messages.

[0058] Similarly, the modem parameter M_n, which indicates the particular modem for which the modem selection value is being calculated, allows the application processor to distinguish among the modems. The modem weight parameter MW_n allows the application processor to weight the modems of the communication device differently in terms of importance. Thus, the modem for communicating via Wimax, for example, can be given greater weight and importance than a modem configured for CDMA, or vice versa. The values needed to calculate Modem_PR, like those needed to calculate Modem_RTF, can be programmed into the communication device and/or the application processor.

[0059] In step **515**, a modem selection value for the selected modem "n" can be calculated by summing the modem re-transmit factor $Modem\_RTF_n$ with the modem priority $Modem\_PR_n$. Accordingly, the modem selection value, denoted as Modem_SEL, for a given modem "n" can be expressed as $Modem\_SEL_n=Modem\_RTF_n+Modem\_PR_n$. This further can be expressed in expanded form as $Modem\_SEL_n=(PT_n*PW_n)+(MT_n*MW_n)-(NT_n*NR_n)$. It should be appreciated that the method **500** can be performed for each respective modem that is considered to be in contention for responding as discussed with reference to FIG. **4**.

[0060] In another aspect, values calculated for modem selection as illustrated in FIG. **4** can be pre-programmed into the communication device in the form of a lookup table or other data structure. In that case, the application processor need not perform a real-time calculation for the values, but rather locate the proper modem selection value from the data structure.

[0061] In yet another aspect, the various weights discussed with reference to FIG. **5** can be varied according to the operating state of the communication device. In this manner, different modems can be favored and different page types can be favored according to the particular state in which the communication device is disposed. This allows the application processor to dynamically adjust to the environment in which the communication device is operated.

[0062] The embodiments disclosed herein are directed to managing and coordinating the operation of multiple modems within a communication device. The time at which various modems in the communication device respond to network inquiries can be varied and managed according to a combination of network parameters, modem parameters, and the type of inquiry, or page, that is received by the modems. Arbitrating when the modems respond to a page can avoid the situation in which more than one modem is concurrently responding, or active concurrently, which can adversely affect battery life.

[0063] The present invention can be realized in hardware, software, or a combination of hardware and software. The present invention can be realized in a centralized fashion in one processing system or in a distributed fashion where different elements are spread across several interconnected processing systems. Any kind of processing system or other

apparatus adapted for carrying out the methods described herein is suited. A typical combination of hardware and software can be a processing system with an application that, when being loaded and executed, controls the processing system such that it carries out the methods described herein. The present invention also can be embedded in an application product which comprises all the features enabling the implementation of the methods described herein and, which when loaded in a processing system, is able to carry out these methods.

[0064] The terms "computer program," "software," "application," variants and/or combinations thereof, in the present context, mean any expression, in any language, code or notation, of a set of instructions intended to cause a system having an information processing capability to perform a particular function either directly or after either or both of the following: a) conversion to another language, code or notation; b) reproduction in a different material form. For example, an application can include, but is not limited to, a subroutine, a function, a procedure, an object method, an object implementation, an executable application, an applet, a servlet, a source code, an object code, a shared library/dynamic load library and/or other sequence of instructions designed for execution on a processing system.

[0065] The terms "a" and "an," as used herein, are defined as one or more than one. The term "plurality," as used herein, is defined as two or more than two. The term "another," as used herein, is defined as at least a second or more. The terms "including" and/or "having," as used herein, are defined as comprising (i.e., open language).

[0066] This invention can be embodied in other forms without departing from the spirit or essential attributes thereof. Accordingly, reference should be made to the following claims, rather than to the foregoing specification, as indicating the scope of the invention.

What is claimed is:

1. Within a communication device, a method of managing a plurality of modems comprising:

determining that a plurality of modems within the communication device will concurrently transmit a network response to a received page;

calculating a modem selection value for each of the plurality of modems; and

modifying a time at which at least one of the plurality of modems transmits a network response according to the modem selection values of the plurality of modems.

2. The method of claim **1**, wherein calculating a modem selection value further comprises computing the modem selection value for each modem of the plurality of modems according to a page type for the page to which each respective modem of the plurality of modems is to respond.

3. The method of claim **2**, wherein calculating a modem selection value further comprises computing the modem selection value for each modem of the plurality of modems according to a page weight that is set according to the page type of the page to which each respective modem of the plurality of modems is to respond.

4. The method of claim **1**, wherein calculating a modem selection value further comprises computing the modem selection value for each modem of the plurality of modems according to a modem type for each respective modem of the plurality of modems.

5. The method of claim **4**, wherein calculating a modem selection value further comprises computing the modem selection value for each modem of the plurality of modems according to a modem weight that is set according to the modem type of each of the plurality of modems.

6. The method of claim **1**, wherein calculating a modem selection value further comprises computing the modem selection value for each modem of the plurality of modems according to a number of times the page, to which each respective modem of the plurality of modems is to respond, will be transmitted by a network that sent the page.

7. The method of claim **1**, wherein calculating a modem selection value further comprises computing the modem selection value for each modem of the plurality of modems according to a re-transmit time offset of a network that sent the page to each respective modem of the plurality of modems.

8. The method of claim **1**, wherein calculating a modem selection value further comprises computing the modem selection value of a selected modem "n" of the plurality of modems according to $(PT_n*PW_n)+(M_n*MW_n)-(NT_n*NRT_n)$, where PT_n denotes a page type of the page received by the selected modem, PW_n is a weight of the page that is set according to the page type, M_n indicates a type of the selected modem, MW_n indicates a weight assigned to the selected modem, NT_n indicates a number of times a network that sent the page to the selected modem will transmit the page, and NRT_n indicates a re-transmit time offset for the network that sent the page to the selected modem.

9. The method of claim **1**, wherein modifying a time at which at least one of the plurality of modems transmits a network response further comprises delaying a network response of a modem of the plurality of modems having a lower modem selection value to allow another modem of the plurality of modems having a higher modem selection value to transmit a network response.

10. The method of claim **1**, wherein modifying a time at which at least one of the plurality of modems transmits a network response further comprises sequentially enabling one of the plurality modems at a time while disabling each of the other ones of the plurality of modems, according to decreasing modem selection values, to allow the enabled modem to transmit a network response.

11. The method of claim **1**, wherein if two or more modems of the plurality of modems have equal modem selection values, modifying a time at which at least one of the plurality of modems transmits a network response further comprises delaying a network response from the modem of the two modems that has a higher retransmission factor to allow the other modem of the two modems to transmit a network response.

12. A communication device comprising:

a plurality of modems that communicate with different communication networks; and

a controller coupled to each of the plurality of modems, wherein the controller selectively enables different ones of the plurality of modems to transmit a network response according to assigned modem selection values such that, responsive to a received page, the plurality of modems do not concurrently transmit network responses.

13. The communication device of claim **12**, wherein the controller further calculates the modem selection value for each of the plurality of modems according to a page type of

a page to which each respective modem of the plurality of modems is to respond or a weight assigned to each page according to the page type.

14. The communication device of claim **12**, wherein the controller further calculates the priority for each of the plurality of modems according to a modem type for each respective modem of the plurality of modems or a modem weight for each respective modem of the plurality of modems that is assigned according to modem type.

15. The communication device of claim **12**, wherein the controller further calculates the modem selection value for each of the plurality of modems according to a number of times a page, to which each respective modem of the plurality of modems is to respond, will be transmitted by a network or a re-transmit time offset of the network that sent the page to which each respective modem of the plurality of modems is to respond.

16. The communication device of claim **12**, wherein the controller further calculates a modem selection value for a selected modem "n" of a plurality of modems of the communication device having received a page according to $(PT_n*PW_n)+(M_n*MW_n)-(NT_n*NRT_n)$, where PT_n denotes page type for the page received by the selected modem, PW_n is a weight of the page that is set according to page type, M_n indicates a type of the selected modem, MW_n indicates a weight assigned to the selected modem, NT_n indicates a number of times a network that sent the page to the selected modem will transmit the page, and NRT_n indicates a re-transmit time offset for the network that sent the page to the selected modem.

17. The communication device of claim **12**, wherein the controller modifies a time at which at least one of the plurality of modems transmits a network response according to the assigned modem selection values.

18. The communication device of claim **12**, wherein the controller delays a network response of a modem of the plurality of modems having a lower modem selection value to allow another modem of the plurality of modems having a higher modem selection value to transmit a network response.

19. The communication device of claim **12**, wherein the controller sequentially enables one of the plurality modems at a time while disabling each of the other ones of the plurality of modems according to decreasing modem selection values to allow the enabled modem to transmit a network response.

20. A machine readable storage, having stored thereon a computer program having a plurality of code sections for managing a plurality of modems of a communication device, the machine readable storage comprising:

code that determines that a plurality of modems within the communication device will concurrently transmit a network response to a received page;

code that calculates a modem selection value for each of the plurality of modems; and

code that modifies a time at which at least one of the plurality of modems transmits a network response according to the modem selection values of the plurality of modems.

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(71) Applicant *(for all designated States except US)*: **NOKIA CORPORATION** [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **SINIVAARA, Hasse** [FI/FI]; Tahkorinne 19 A 1, FIN-02760 Espoo (FI).

(74) Agent: **KOLSTER OY AB**; Iso Roobertinkatu 23, P.O.Box 148, FIN-00121 Helsinki (FI).

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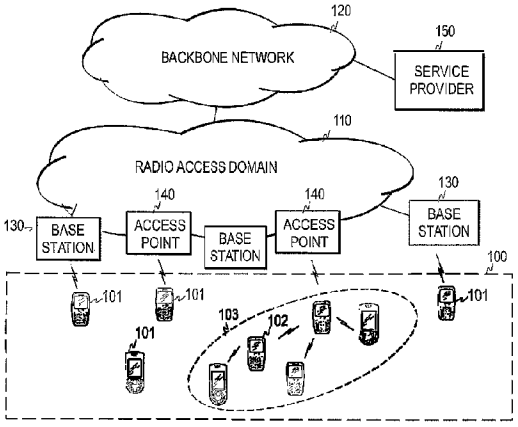
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[Continued on next page]

(54) Title: SELECTION OF RADIO RESOURCES IN A WIRELESS COMMUNICATION DEVICE



(57) Abstract: The invention relates to a method for selecting radio resources for a communication session in a wireless communication terminal. In order to facilitate the selection of quality of service between diversified terminals, terminal capabilities are described by a set of capability parameters, the set including at least one parameter indicative of the terminal's capabilities. Based on the set of capability parameters, a dedicated quality class set is defined for an application instance residing in the terminal, the quality class set including at least one quality class for the application instance. When a session is to be established between at least two application instances residing respectively in at least two terminals, at least one quality class is negotiated for the session, the at least one quality class being determined based on the dedicated quality class sets of the at least two application instances. Based on the negotiation, radio resources are then allocated for the session.

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SELECTION OF RADIO RESOURCES IN A WIRELESS COMMUNICATION DEVICE

Field of the Invention

The invention relates to selection of radio resources for a communication session in a wireless communication device.

Background of the Invention

The current development towards truly mobile computing and networking has brought on the evolvement of various access technologies that also provide the users with access to the Internet when they are outside their own home network. At present, wireless Internet access is typically based on either short-range wireless systems or mobile networks, or both.

Short-range wireless systems have a typical range of a few tens of meters to one hundred meters. They often combine with systems wired to the Internet and/or with a mobile network to provide communication over long distances. The category of short-range wireless systems includes wireless personal area networks (PANs) and wireless local area networks (WLANs). They have the common feature of operating in unlicensed portions of the radio spectrum, usually either in the 2.4 GHz Industrial, Scientific, and Medical (ISM) band or in the 5 GHz unlicensed band.

Wireless personal area networks are cost-effective and use low power wireless devices that have a typical range of about ten meters. The best-known example of wireless personal area network technology is Bluetooth, which uses the 2.4 GHz ISM band. It provides a peak air link speed of one Mbps, and power consumption low enough for use in personal, portable electronics such as PDAs and mobile phones. Wireless local area networks generally operate at higher peak speeds of about 2 to 100 Mbps and have a longer range, which requires greater power consumption.

The development referred to above has also brought on the evolvement of so-called ad-hoc networks, which offer unrestricted mobility without any underlying infrastructure. The nodes of an ad-hoc network are often mobile, in which case the network is called a mobile ad-hoc network (MANET). Unlike

traditional wireless networks, ad-hoc networks need not necessarily rest on an underlying infrastructure, such as base stations. Instead, the nodes rely on each other to keep the network connected. In an ad-hoc network, one or more nodes may therefore act as a router transmitting data/messages to other nodes of the network, and intermediate ad-hoc nodes may relay the data/messages between two nodes located far apart from each. Standalone ad-hoc networks are useful at least whenever it is impossible to use a fixed network infrastructure due to geographical, terrestrial, or time constraints, for example. Local ad-hoc networks can also be integrated into legacy networks, such as mobile networks. The dynamically changing topology of an ad-hoc network sets high requirements for the routing protocols used in the ad-hoc nodes. This is one reason why activities in the development of the ad-hoc networks have for the present related mainly to routing aspects.

Along with the above-discussed development, the number of radio technologies utilized in the terminals, and also the number of multimode (and multi-standard) wireless terminals will increase. With an increasing number of technologies used for networking, the diversity of the terminals will increase within future networks. For example, the trunk node o

the terminal.

The present invention seeks to accomplish a solution by means of which the above drawbacks may be alleviated or eliminated.

Summary of the Invention

The present invention seeks to devise a new mechanism for selecting the quality of service and the corresponding radio resources in a wireless communication device. The present invention further seeks to improve the user-friendliness of the device, while simultaneously ensuring efficient use of radio resources in a wireless communication environment. The selection of "radio resources" refers generally to the selections related to the radio technology, which need to be made to meet the selected quality of service. The selection of the radio resources may thus simply involve the selection of a connectivity standard for the session. However, as one radio technology may include several radio links, the selection may also involve the selection of the link(s). The selection of the radio resources may also include selection of the associated transmission and/or reception resources. This applies especially to terminals provided with only one short-range radio link. In case of single link terminals, the selection of the radio resources may thus involve the selection of the associated resources only, i.e. transmission and/or reception parameters, such as the modulation rate, the coding, the transmission power, or the reception thresholds.

The invention provides an application-level quality of service (QoS) selection, which may be automatic or semi-automatic. In the present invention, the capabilities of the device are described by a set of capability parameters indicative of the capabilities of the device itself. An application instance installed or being installed in the device utilizes the parameters to define a quality class set for itself. When a communication session is to be established between two application instances residing respectively in two different terminals, the quality class sets of the two application instances are utilized to define at least one common quality class for a communication session between the instances. A common quality class thus refers to a quality level that all the participating instances can use when communicating with another

terminal. The at least one common quality class may be selected automatically without user interaction or the preferences of the user may be taken into account, either directly by accessing a user profile stored in the terminal or by prompting the user to indicate his or her preferences. The radio resources to be allocated for the session are then selected in the terminals. The radio resources may be negotiated in connection with the negotiation of the at least one common quality class or the radio resources may be selected based on the at least one common quality class after the negotiation in each terminal.

Thus one embodiment of the invention is the provision of a method for selecting radio resources for a communication session in a wireless multimode communication device. The method includes the steps of describing device capabilities by a set of capability parameters, the set including at least one parameter indicative of the device's capabilities, and defining, based on the set of capability parameters, a dedicated quality class set for an instance of an application, the quality class set including at least one quality class for the instance, where the describing and defining steps are performed for at least two instances of the application, the at least two instances of the application residing respectively in at least two wireless communication devices. The method further includes the steps of negotiating at least one common quality class for a communication session between the at least two instances of the application, the at least one common quality class being determined based on the dedicated quality class sets of the at least two instances of the application, wherein the negotiating step is performed between at least two of the at least two wireless communication devices and allocating, based on the negotiating step, radio resources for the communication session, the allocating step being performed in the at least two wireless communication devices.

In another embodiment, the invention provides a wireless communication device. The device includes at least one short-range radio interface and a memory unit storing a set of capability parameters, the set including at least one parameter indicative of the device's capabilities. The device also includes an interface through which the set of capability parameters is readable from the memory unit for defining, based on the set of capability parameters, a quality class set for an application instance, the quality class set including at least one quality class. The device further includes negotiation means for

selecting at least one common quality class for a communication session to be established between the application instance and at least one external application instance having respectively at least one external quality class set, the negotiation means being configured to select the at least one common quality class based on the quality class set and the at least one external quality class set and allocating means, responsive to the negotiation means, for allocating radio resources for the communication session.

In one embodiment of the invention, the allocation means are further configured to select the radio resources based on the at least one common quality class selected.

In a still further embodiment, the invention provides a computer program product for a wireless communication device. The computer program product is stored on a computer readable storage media and configured, when being installed into the wireless communication device, to read a set of capability parameters from a wireless communication device, the set including at least one parameter indicative of the device's capabilities, and to define, based on the set of capability parameters, a dedicated quality class set including at least one quality class.

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Brief Description of the Drawings

In the following, the invention and many of its embodiments are described more closely with reference to the examples shown in FIG. **1** to **6** in the appended drawings, wherein:

FIG. **1** illustrates an example of a communication environment in which a terminal of the invention may operate;

FIG. **2** is a flow chart illustrating the operation of a terminal in one embodiment of the invention;

Fig. **3** is a flow chart illustrating one embodiment of the user interaction process shown in FIG. **2**;

FIG. **4** illustrates the architecture of one embodiment of a multimode terminal of the invention;

FIG. **5** is a flow chart illustrating the operation of a terminal in one embodiment

of the invention; and

FIG. **6** is schematic presentation of one embodiment of a multimode terminal according to the invention.

Detailed Description of the Invention

FIG. **1** shows an example of a general communication environment in which the present invention can be applied. The communication environment comprises three interacting domains: a user equipment domain **100**, an access domain **110** comprising several radio access networks, and a backbone domain **120** comprising a core network.

The above communication environment typically includes a mobile network and one or more short-range wireless networks. The mobile network may be based on the UMTS (Universal Mobile Telecommunication System) or on the GSM (Global System of Mobile communications) network architecture, for example. The short-range wireless network(s) may in turn be based on various technologies, such as Wireless Local Area Network (WLAN), Bluetooth or Ultra Wide Band (UWB) technology. The access domain may thus include base stations **130** (or node B elements) of the mobile network and access points **140** of the short-range wireless systems. The backbone domain includes a plurality of service providers **150**.

The User Equipment domain includes a plurality of mobile terminals **101**. In this context, it is assumed that the terminals are mostly multimode terminals. A multimode terminal here refers to a terminal that has at least two operation modes, i.e. at least two radio interfaces based on different connectivity standards. Although one operation mode may be provided for communicating with the mobile network, the terminal is also provided with one or more other operation modes, in which a short-range radio of the terminal may be active. The terminals typically have different states with respect to each operation mode, and the states allowed concurrently depend on the implementation of the terminal.

The mobile terminals may also form ad-hoc networks **103** in which the terminals may communicate directly with each other. The ad-hoc networks may be connected to a radio access network through one or more access

points of the access domain. Each ad-hoc network then comprises at least one trunk node **102**, which communicates with an access point of the radio access network, and at least one other ad-hoc node for which the trunk node acts as an access point or gateway. The said other nodes may be located at different distances from the trunk node, measured as the number of hops between the node and the trunk node, i.e. the trunk node does not have to have a direct connection to each of said other nodes, but the messages between the trunk node and an ad-hoc node being further than one hop apart from the trunk node are relayed by intermediate ad-hoc nodes.

Although the terminals may rest on network infrastructure in the above-described manner, the communication environment in which the invention can be applied may also be much simpler. For example, two or more terminals may form a simple ad-hoc network that does not have a connection to any network infrastructure and in which no sophisticated routing algorithms are used.

In the present invention, a terminal is provided with capability parameters describing the capabilities of the terminal, i.e. the performance of the terminal. As different radio technologies have different performances, the capability parameters depend on the outfitting of the terminal. The capability parameters may also describe several other factors indicative of the terminal's performance, such as the memory and processing capacities and the display type of the terminal.

An application instance installed or being installed in the terminal utilizes the capability parameters to define a set of quality classes for itself. Each application of a terminal may thus define a different set of quality classes, depending on the type of the application, i.e. on the performance requirements of the application. Furthermore, different instances of the same application may define different sets in two different terminals, since the terminals may be differently outfitted. One quality class indicates a quality requirement with respect to at least one quality factor, such as data rate, latency, latency variation, packet interval, etc, each quality class of an application instance being thus adapted to the capabilities of the terminal. Packet interval requirements may be used, for example, to indicate the level of power consumption; longer packet intervals allow the terminals more time for a power

save mode. The quality class may also indicate the corresponding radio technology, i.e. there may be several quality classes for the same quality factor value(s), each indicating a certain radio technology.

When a communication session is to be established, at least one quality class is negotiated for the session based on the quality class sets of the participating application instances and the radio resources are selected for the session based on the negotiation. It is thus assumed here that the application requires a connection to be established with at least one other terminal or network element storing an instance of the same application. Such an application may be a game or an application in which data streams, such as video streams are transferred, for example.

FIG. **2** illustrates one embodiment of the operation of a terminal for selecting at least one quality class and radio resources for a session to be established with another multimode terminal with a similar application. As mentioned above, the terminal is provided with a set of capability parameters describing the capabilities of the terminal, i.e. the performance of the terminal. When the application is installed into the terminal (step **200**), the installed application instance reads these terminal-specific parameters (step **201**) and defines a set of quality classes for itself based on the parameters (step **202**). The set includes one or more quality classes available for the application instance w

the selected quality mode to a set of quality classes, which is here termed a QoS set, since it is normally not the same set as the quality class set of the application instance, but rather a subset of the quality class set since the choice of the user typically limits the number of possible classes. The terminal then performs a QoS handshake with a communicating terminal (step **207**) to agree on at least one quality class common to the terminals to be used for the session and possibly also on the radio resources to be utilized. If the quality classes do not indicate the corresponding radio technology, the terminals may also agree on the radio technology in the handshake. Otherwise the terminals may select the radio resources based on the agreed quality class(es) after the handshake.

In one embodiment of the invention, a "minimum" radio technology is selected by means of which the agreed quality class is obtainable. The minimum radio technology here refers to the technology whose highest possible quality class is closest to the agreed quality class. When the selection has been made, the terminal activates the selected radio resources and the session may start (step **209**). If a quality class indicates a quality requirement with respect to one quality factor only, the terminals typically agree on several common quality classes to be used for the session. However, if one quality class indicates a quality requirement with respect to several quality factors, the terminals may also agree on a single common quality class for the session.

The selection of the radio resources may simply involve selection of the radio link to be used, or the selection may also involve selection of the associated resources, i.e. various transmission and/or reception parameters. Although the method of the invention is mainly intended for terminals with multiple radio technologies, it may also be used even if the terminals are provided with only one short-range radio link. Especially in this case the selection of the radio resources involves selection of the transmission and/or reception parameters.

In the above embodiment, the selection process was semi-automatic in the sense that a quality negotiation was performed with the user. However, the selection process may also be totally automatic. In one embodiment of the invention, an automatic selection process may be implemented so that the terminals agree on the said at least one common quality class using certain predetermined criteria, such as always selecting the highest quality class(es)

common to all instance-specific sets participating in the session. In another embodiment of the invention, an automatic selection process may be implemented by storing user preference data in the terminal and taking the data into account in the selection process. For example, the user may give the terminal instructions to agree on the quality class that allows the lowest possible battery consumption.

FIG. 3 illustrates an example of the quality negotiation performed with the user. As mentioned above, the quality class set of the application is not necessarily presented to the user as such, but the terminal may map the classes to "quality modes" to improve the user-friendliness of the process. For example, the terminal may display quality modes such as "low performance and low battery consumption", "medium performance and medium battery consumption", and "high performance and high battery consumption" to the user and ask the user to select one of these modes. The terminal may thus map the quality classes of the application instance to quality modes of the above kind (step **300**) and present the quality modes to the user (step **301**). When the user selects a mode, the terminal maps the selected mode back to a QoS set (step **303**). The QoS set is typically a subset of the quality class set, the subset being defined by the selection of the user. The QoS set, which indicates one or more quality classes, is sent to the opposite terminal during the handshake (cf. step **207**).

It is also possible to conduct another negotiation through the user interface for obtaining the user's approval for the selected radio technology prior to the activation of the radio. Alternatively, the user may just be informed of the radio technology selected for the session.

FIG. 4 illustrates the architecture of a multimode terminal **100** according to one embodiment of the invention. It is assumed here that the terminal comprises an interface **400** to a mobile network, such as a GSM or an UMTS network, and a plurality of short-range radio interfaces, such as a WLAN interface **401**, a Bluetooth interface **402**, and a UWB interface **403**. It is further assumed here that the terminal comprises a radio frequency identification (RFID) interface, which is used for the above-described QoS handshake in proximity communication. The RFID interface may form a RFID tag reader, which may also be capable of acting as a RFID tag.

Each radio interface is controlled by a corresponding control engine **410** to **413** that provides, for example, the Medium Access Control (MAC) services in the corresponding operation mode. An operation system layer **420** controls the different control engines and the states of the terminal. The operation system layer receives the selections made by the user in an application and controls the state and operation of the terminal accordingly. The operation system layer stores the capability parameters **450** of the terminal, and the application instance reads the capability parameters from the operation system layer in connection with its installation into the terminal. The operation system layer thus provides an interface through which the application instances may read the capability parameters. The instance-specific quality classes may be stored in the application layer. The application layer may also have access to user preference data stored in a profile database **470**.

The arrows and the underlined step numbers illustrate the above-described steps for agreeing on one or more quality classes with another terminal and for selecting radio resources corresponding to the quality class(es) agreed upon. When installed, the application instance reads (step **1**) the capability parameters from the operation system layer and defines (step **2**) a set of quality classes **460**. When the user of a first terminal **100** starts the application, the application presents (step **3**) the quality classes, or the quality modes corresponding to the quality classes, to the user. Based on the selection made by the user (step **4**), the application may then define (step **5**) the QoS set, which is then supplied to the RFID interface (step **6**). As mentioned above, the user interaction may also be omitted and the QoS set may be defined automatically based on the user preference data stored in the profile database.

The QoS set is transferred through the RFID interface (step **7**) to the opposite terminal **100'** where it is transferred through the opposite RFID interface to the application layer to be compared (step **8**) with the quality class set of the application instance in terminal **100'**. In response to the comparison, the opposite terminal returns a response to the first terminal. The messages transferred between the two terminals form a QoS handshake by means of which the terminals agree on at least one quality class and possibly also on the radio resources to be used for the connection (step **9**). As discussed above, the handshake may be utilized to select the radio resources or the

selection of the radio resources may be made after the handshake in each terminal. The radio interface corresponding to the selected radio resources is then activated through the device operation system layer and one of the control engines.

The opposite terminal may also return its QoS set to the first terminal without performing the comparison. The first terminal then selects the quality class and informs the opposite terminal of the selected quality class, if necessary. The above selection process may also be performed by entities below the application layer, i.e. it is not necessary to transfer the QoS data up to the application layer. The entity handling the selection process first obtains the QoS set from the opposite terminal and agrees on the quality class(es) and possibly also on the radio resources with a communicating terminal. The entity then gives a triggering signal to one of the control engines for activating the selected radio interface. The said entity also handles the selection of the transmission and/or the reception parameters, if such selections are to be made in order to meet the quality level agreed upon.

During the handshake, the terminals may operate in active RFID communication mode, for example, in which one terminal actively simulates a RFID tag reader and the other terminal actively simulates a RFID tag. The terminal may, for example, be in a RFID tag mode (transponder) by default but assume a RFID reader mode (interrogator) when the application is started. The reading of the tag (i.e. the QoS set) may then activate the application in the terminal acting as a RFID tag.

The QoS handshake may include two or more messages between the terminals, depending on how well the QoS set received matches the quality class set of the application instance in the opposite terminal. The opposite terminal may thus directly accept the QoS set received and the corresponding radio resources, or it may suggest another radio technology for the session, if its capabilities are insufficient for the QoS set received. As indicated above, the messages transferred between the terminals may include information about the radio resources available or selected currently, or the selected quality class(es) may unambiguously indicate the corresponding radio resources, whereby it is not necessary to identify the radio resources in the messages. Moreover, the quality classes of the QoS set may be indicated in

different ways in the messages, i.e. various identifiers identifying the quality classes available and/or the corresponding radio resources may be exchanged between the terminals.

The QoS handshake may also be performed through another short-range radio interface than the RFID interface, such as the Bluetooth interface. It is also possible that the QoS set is first read through the RFID interface and then the subsequent negotiation is performed through another interface.

The entities handling the selection process may also receive other input information that affects the quality class(es) and the radio resources to be selected. For example, the said entity may be informed through the device operation system layer that one or more terminals wish to join the session. A change in the number of the participants in a session may be one factor that causes a change in the radio technology used for the session.

The common quality class(es) may be renegotiated, if the conditions change during the session. One or more of the participating terminals may monitor, if a predetermined event occurs during the session, and initiate a renegotiation procedure when the event is detected. This event may be a renegotiation request from one of the participating terminals, for example. The terminals may monitor the quality of service and request a renegotiation, if the quality of service is not satisfactory. A user may also wish to change the current quality level in the middle of the session, in which case the corresponding terminal may send a renegotiation request. The predetermined event may also be the reception of a request from an external terminal, whose quality class set is incompatible with the common quality class(es), to join the on-going session. The term incompatible here refers to a quality class set including only quality classes by means of which the quality level corresponding to the prevailing common quality class(es) cannot be met or quality classes that require another radio technology before the quality level corresponding to the prevailing common quality class(es) can be met.

FIG. **5** illustrates an example of the operation of a terminal when receiving a QoS set from an external terminal wishing to join an on-going session between a group of two or more terminals. The wish may be detected as an external terminal reads the quality class set through the RFID interface, for example. When the QoS set is received from an external terminal (step **500**), the

terminal examines, whether the received QoS set is acceptable for the group (step **501**), either as such or after reselection of the common quality class(es). If this is not so, joining is denied (step **502**). If reselection is needed, a quality negotiation is performed within the group and at least one new quality class and radio resources are selected for the group now including a new terminal (steps **504** to **506**). The reselection may result in a change in the radio technology used.

If the number of terminals forming an ad-hoc network is greater than two, the common quality class(es) may be negotiated in various ways. For example, each terminal may negotiate one or more common quality classes separately with each of the other terminals, in which case different quality classes may be used between different terminals. In another embodiment, one terminal may collect the QoS sets and decide on one or more common quality classes to be used within the network. The negotiation thus also includes such an operation in which one terminal collects the necessary information and one-sidedly decides on the common quality class(es) and on the corresponding radio resources.

FIG. **6** is a schematic presentation of one embodiment of an ad-hoc terminal according to the invention. The core of the terminal is a control unit **600**, which is connected to various interfaces of the terminal. Generally, the interfaces of the terminal may be divided into two classes: interfaces for ad-hoc networks and interfaces for the network infrastructure. However, depending on the type of the ad-hoc terminal, it may be provided with ad-hoc interfaces only. The ad-hoc interfaces include one or more interfaces **610**, **611**, each offering the functionality needed to accomplish connectivity to an ad-hoc network of a particular type. As shown above, the terminal may further include one short-range radio interface **650**, such as a RFID interface, which is used for the QoS selection process only. Several ad-hoc interfaces are necessary, at least whenever the terminal acts as a trunk node that serves ad-hoc networks based on different technologies. For example, one ad-hoc network served may be based on WLAN technology, while another one may be based on Bluetooth or UWB technology.

The interfaces to the supporting infrastructure also include one or more interfaces **620**, **621**, each offering the functionality needed to accomplish

connectivity to a system (i.e. network infrastructure) of a particular type. For example, interface **611** may offer connectivity to a GSM or UMTS network, while interface **612** offers connectivity to a WLAN network.

The terminal normally also includes a card reader **605** into which an identity module, such as a (Universal Subscriber Module ((U)SIM), User Identity Module (UIM) or a (User) Integrated Circuit Card ((U)ICC) **606** can be inserted. The card reader and the memory unit are connected to the control unit in order that the control unit is able to read data from the identity module and from the memory unit and write data into the identity module and into the memory unit. In addition, the terminal includes user interface means **640** for using the terminal. The user interface means typically include a display and a keypad.

The memory unit **630** includes a memory area storing the above-described capability parameters. The application instances, also residing in the memory unit, read these capability parameters and generate a quality class set based on the parameters when executed for the first time by the control unit. As shown in the figure, the memory unit may thus store a dedicated quality class set for each application installed in the terminal, although two sets may be similar. The memory unit may also store the user preference data for the quality class selection. The memory unit may further include a selection database **660**, which the control unit may utilize for selecting the radio resources based on the quality class(es) agreed. The database includes selection rules or other data that associate the quality classes with the radio resources. The rules may be in the form of one or more tables that map the quality classes to the radio resources or in the form of a more sophisticated selection logic. The selection database may further include rules that the control unit may use for selecting the common quality class(es) during the handshake.

Although the invention was described above with reference to the examples shown in the appended drawings, it is obvious that the invention is not limited to these, but may be modified by those skilled in the art without departing from the scope and spirit of the invention. For example, the implementation of the functionalities of the invention in a terminal may vary in many ways depending, for example, on the radio interface through which a QoS handshake is performed. Furthermore, the application instance does not necessarily have to

be the entity that defines the quality class set, but the terminal may supply the set to the application instance after the instance has requested the set and supplied its requirements to the terminal.

Claims:

1. A method for selecting radio resources for a communication session in a wireless communication device, the method comprising the steps of:

- describing device capabilities by a set of capability parameters, the set including at least one parameter indicative of the device's capabilities;

- based on the set of capability parameters, defining a dedicated quality class set for an instance of an application, the dedicated quality class set including at least one quality class for the instance,

wherein the describing and defining steps are performed for at least two instances of the application, the at least two instances of the application residing respectively in at least two wireless communication devices; and

- negotiating at least one common quality class for a communication session between the at least two instances of the application, the at least one common quality class being determined based on the dedicated quality class sets of the at least two instances of the application, wherein the negotiating step is performed between at least two of the at least two wireless communication devices; and

- allocating, based on the negotiating step, radio resources for the communication session, the allocating step being performed in the at least two wireless communication devices.

2. A method according to claim **1**, wherein the negotiating step includes a step of transferring a quality of service set from a first wireless communication device to at least one second wireless communication device, wherein the quality of service set indicates at least one quality class of the dedicated quality class set of an instance of the application in the first wireless communication device and wherein the first and the at least one second communication device belong to the at least two wireless communication devices.

3. A method according to claim **2**, wherein the transferring step is performed via a radio frequency identification (RFID) interface of the first wireless communication device.

4. A method according to claim **2**, further comprising the steps of:

- mapping the dedicated quality class set to a group of quality modes;

- querying a user of the first wireless communication device to select one of the quality modes; and

- deducing the quality of service set from the quality mode selected by the user.

5. A method according to claim **1**, wherein the defining step is performed when the application is installed in the wireless communication device.

6. A method according to claim **1**, further comprising the steps of

- detecting, in one of the at least two wireless communication devices, the presence of at least one other of the at least two wireless communication devices; and

- initiating the negotiating step in response to the detecting step.

7. A method according to claim **1**, w

readable from the memory unit for defining, based on the set of capability parameters, a quality class set for an application instance, the quality class set including at least one quality class;

- negotiation means for selecting at least one common quality class for a communication session to be established between the application instance and at least one external application instance having respectively at least one external quality class set, the negotiation means being configured to select the at least one common quality class based on the quality class set and the at least one external quality class set; and

- allocating means, responsive to the negotiation means, for allocating radio resources for the communication session.

13. A wireless communication device according to claim **12**, wherein an application to be installed in the wireless communication device is configured to read the set of capability parameters from the memory unit.

14. A wireless communication device according to claim **12**, wherein the allocation means are operably connected to the at least one short-range radio interface for activating a short-range radio interface corresponding to the radio resources allocated for the communication session.

15. A wireless communication device according to claim **12**, wherein the negotiation means are configured to

- query a user of the wireless communication device to select a quality mode, the quality mode determining at least one of the at least one quality class;

- indicate the at least one of the at least one quality class to the at least one external application instance.

16. A wireless communication device according to claim **12**, wherein the negotiation means comprise a radio frequency identification (RFID) interface configured to indicate at least one of the at least one quality class to an external RFID device.

17. A wireless communication device according to claim **12**, wherein the negotiation means are further configured to negotiate the radio resources with at least one other wireless communication device containing, respectively, the at least one external application instance.

18. A wireless communication device according to claim **12**, wherein the allocation means are further configured to select the radio resources based

on the at least one common quality class.

19. A computer program product for a wireless communication device, the computer product being stored on a computer readable storage media and configured, when being installed into the wireless communication device, to

- read a set of capability parameters from a wireless communication device, the set including at least one parameter indicative of the device's capabilities; and

- define, based on the set of capability parameters, a dedicated quality class set including at least one quality class.

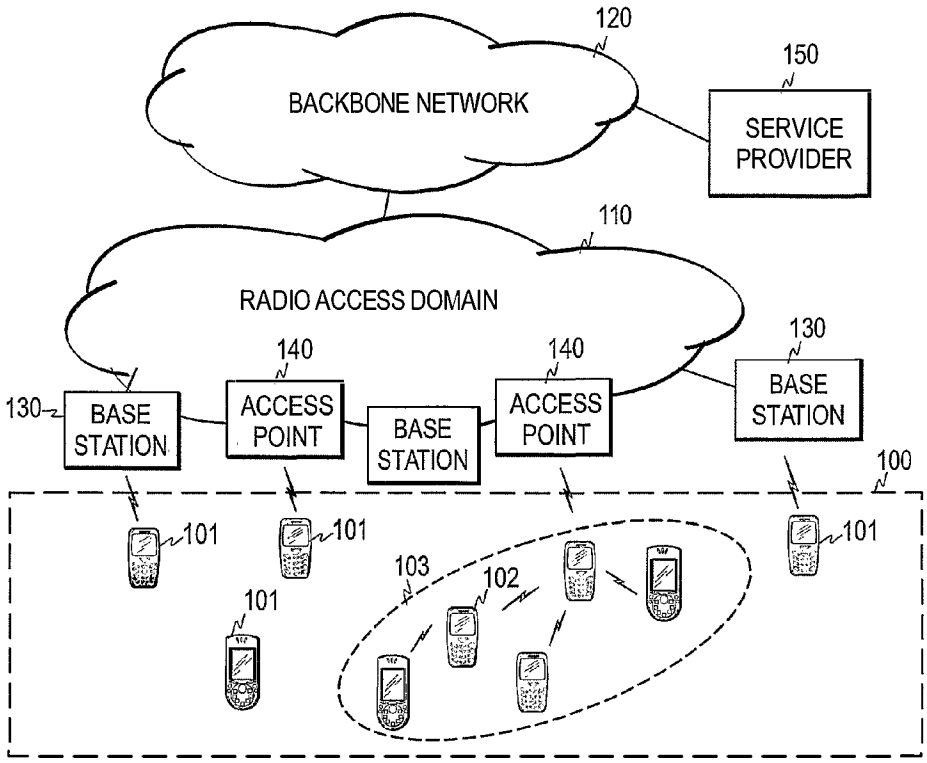

120
BACKBONE NETWORK
150
SERVICE PROVIDER
110
RADIO ACCESS DOMAIN
130
BASE STATION
140
ACCESS POINT
BASE STATION
140
ACCESS POINT
130
BASE STATION
100
101
101
101
101
103
102

FIG. 1

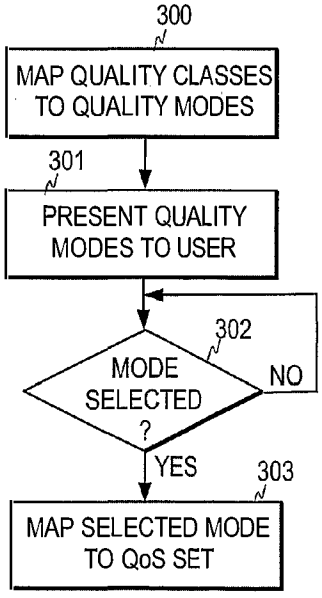

300
MAP QUALITY CLASSES TO QUALITY MODES
301
PRESENT QUALITY MODES TO USER
302
MODE SELECTED ?
NO
YES
303
MAP SELECTED MODE TO QoS SET

FIG. 3

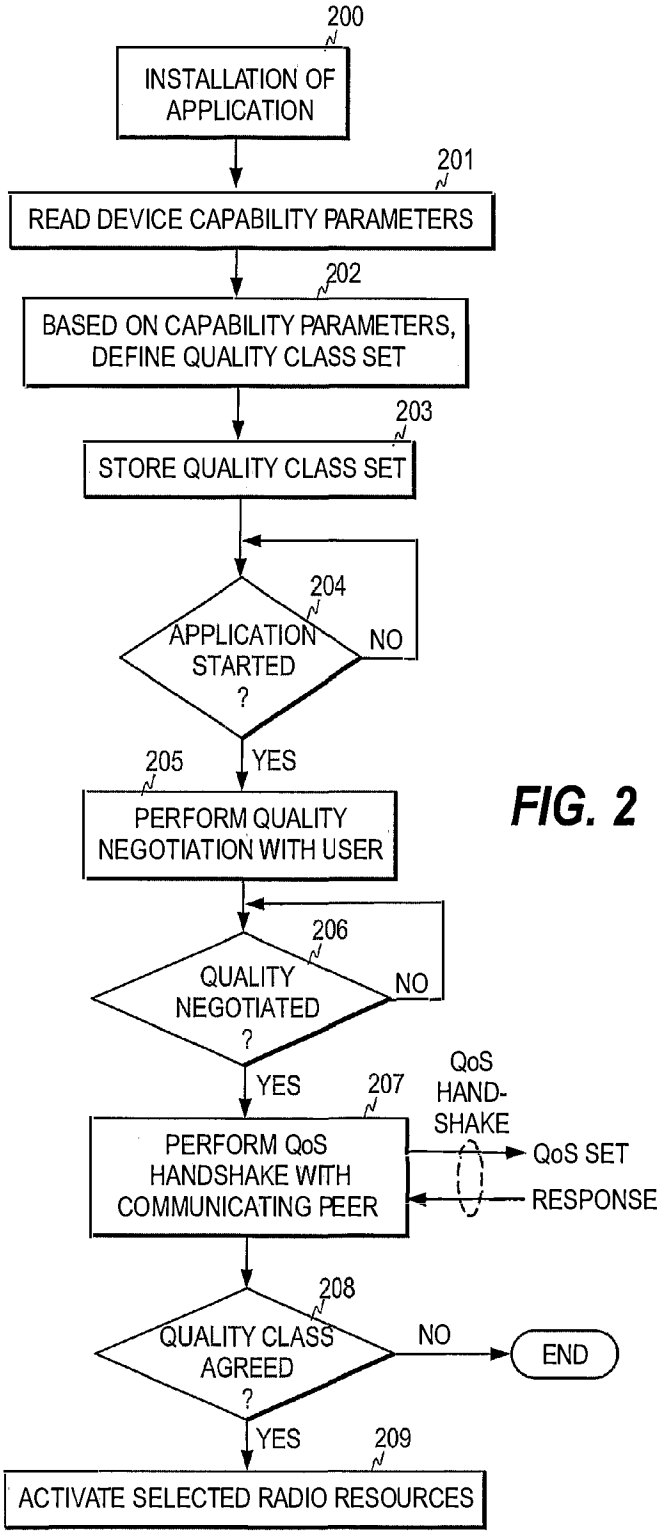

200
INSTALLATION OF APPLICATION
201
READ DEVICE CAPABILITY PARAMETERS
202
BASED ON CAPABILITY PARAMETERS, DEFINE QUALITY CLASS SET
203
STORE QUALITY CLASS SET
204
APPLICATION STARTED ?
NO
YES
205
PERFORM QUALITY NEGOTIATION WITH USER
206
QUALITY NEGOTIATED ?
NO
YES
207
QoS HAND-SHAKE
PERFORM QoS HANDSHAKE WITH COMMUNICATING PEER
QoS SET
RESPONSE
208
QUALITY CLASS AGREED ?
NO
END
YES
209
ACTIVATE SELECTED RADIO RESOURCES

FIG. 2

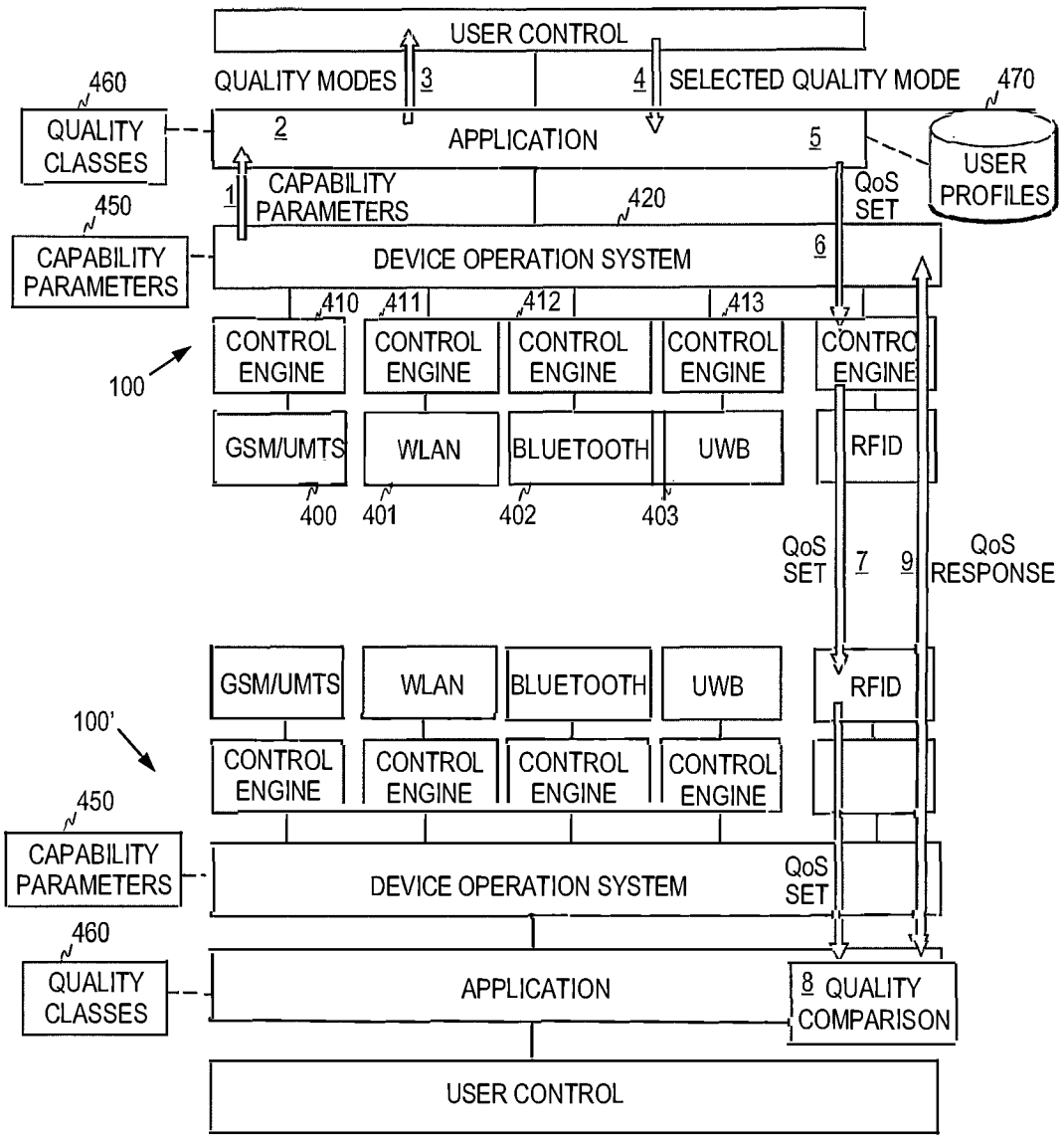

USER CONTROL
QUALITY MODES
3
4
SELECTED QUALITY MODE
470
460
QUALITY CLASSES
2
APPLICATION
5
USER PROFILES
1
CAPABILITY PARAMETERS
420
QoS SET
450
CAPABILITY PARAMETERS
DEVICE OPERATION SYSTEM
6
410
411
412
413
CONTROL ENGINE
CONTROL ENGINE
CONTROL ENGINE
CONTROL ENGINE
CONTRO ENGINE
100
GSM/UMTS
WLAN
BLUETOOTH
UWB
RFID
400
401
402
403
QoS SET
7
9
QoS RESPONSE
GSM/UMTS
WLAN
BLUETOOTH
UWB
RFID
100'
CONTROL ENGINE
CONTROL ENGINE
CONTROL ENGINE
CONTROL ENGINE
450
CAPABILITY PARAMETERS
DEVICE OPERATION SYSTEM
QoS SET
460
QUALITY CLASSES
APPLICATION
8 QUALITY COMPARISON
USER CONTROL

FIG. 4

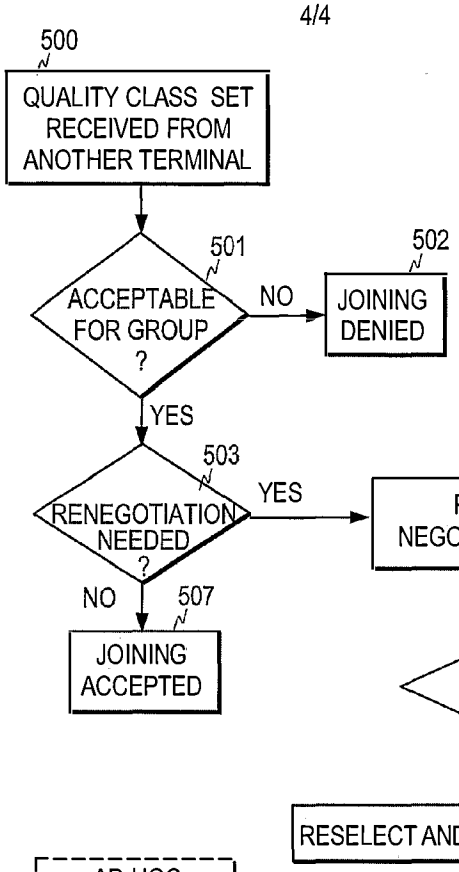

500
QUALITY CLASS SET RECEIVED FROM ANOTHER TERMINAL
501
ACCEPTABLE FOR GROUP ?
NO
502
JOINING DENIED
YES
503
RENEGOTIATION NEEDED ?
YES
504
PERFORM QUALITY NEGOTIATION WITHIN GROUP
NO
507
JOINING ACCEPTED
505
QUALITY CLASS AGREED ?
NO
YES
506
RESELECT AND ACTIVATE RADIO RESOURCES

FIG. 5

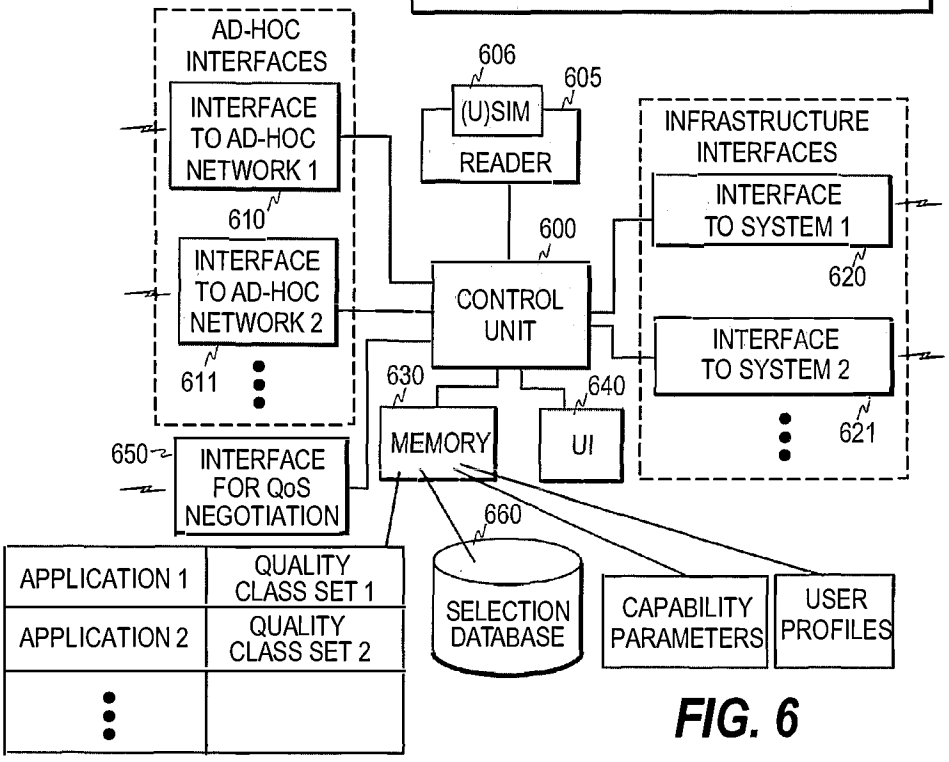

AD-HOC INTERFACES
INTERFACE TO AD-HOC NETWORK 1
610
INTERFACE TO AD-HOC NETWORK 2
611
606
(U)SIM
605
READER
600
CONTROL UNIT
630
MEMORY
640
UI
650
INTERFACE FOR QoS NEGOTIATION
INFRASTRUCTURE INTERFACES
INTERFACE TO SYSTEM 1
620
INTERFACE TO SYSTEM 2
621
660
SELECTION DATABASE
CAPABILITY PARAMETERS
USER PROFILES
APPLICATION 1
QUALITY CLASS SET 1
APPLICATION 2
QUALITY CLASS SET 2

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 2003/000975

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 7/24, H04Q 7/38, H04L 12/56
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)

IPC7: H04Q, H04B, H04L

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6693892 B1 (RINNE ET AL), 17 February 2004 (17.02.2004), paragraph (0031)-(0032),(0046) --	1,19
X	WO 03103235 A1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 11 December 2003 (11.12.2003), page 3, line 2 - page 4, line 2 --	1,19
A	WO 0169961 A1 (UNIVERSITY OF STRATHCLYDE), 20 Sept 2001 (20.09.2001), page 6, line 35 - page 7, line 18; page 11, line 2 - line 19, abstract --	1-19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 July 2004	21 -07- 2004
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Stefan Hansson / JA A Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (January 2004)

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				SE	1025728	T3	
				FI	104143	B	00/00/0000
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				SE	0201143	D	00/00/0000
WO	0169961	A1	20/09/2001	EP	1264503	A	11/12/2002
				GB	0006230	D	00/00/0000
				JP	2003527011	T	09/09/2003

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(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2005/0215284 A1

Su et al. (43) Pub. Date: Sep. 29, 2005

(54) COLLABORATIVE COEXISTENCE WITH DYNAMIC PRIORITIZATION OF WIRELESS DEVICES

(75) Inventors: **Ling Su**, Cupertino, CA (US); **Brima Ibrahim**, Aliso Viejo, CA (US)

Correspondence Address:
GARLICK HARRISON & MARKISON LLP
P.O. BOX 160727
AUSTIN, TX 78716-0727 (US)

(73) Assignee: **Broadcom Corporation**, Irvine, CA

(21) Appl. No.: **10/810,998**

(22) Filed: **Mar. 26, 2004**

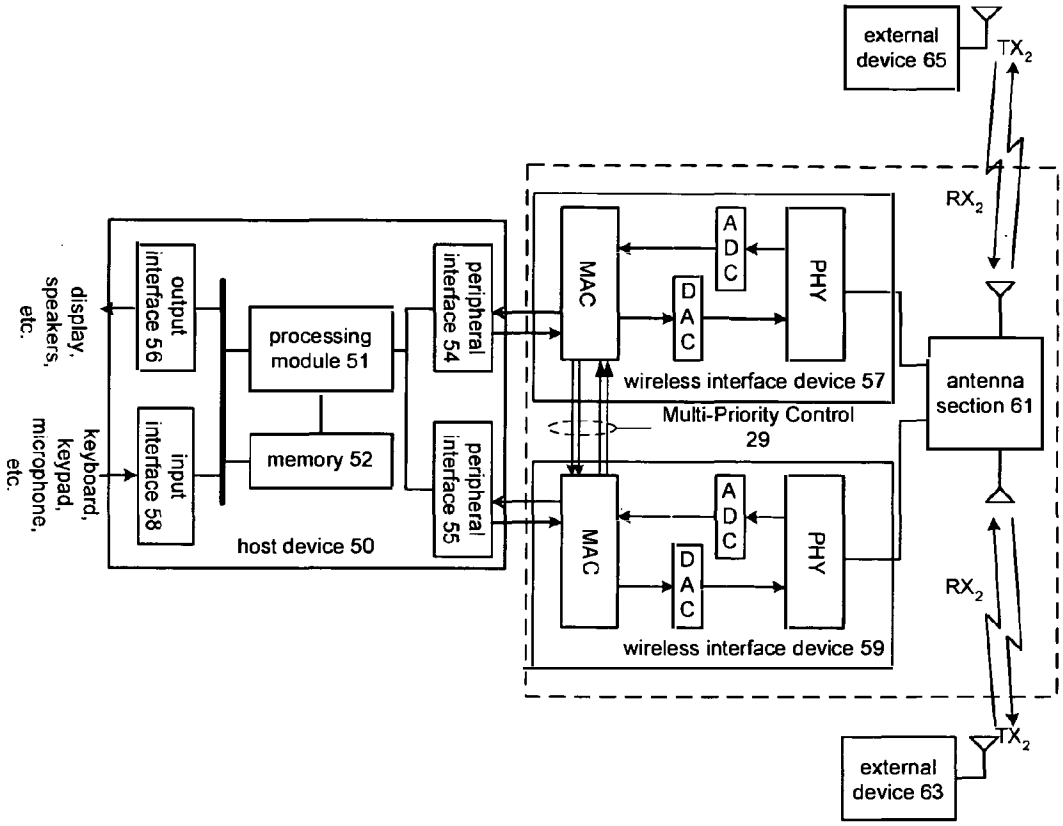
Publication Classification

(51) **Int. Cl.**[7] **H04Q 7/20**

(52) **U.S. Cl.** **455/556.2**

(57) **ABSTRACT**

A collaboration scheme for wireless communications devices implemented on a single CMOS integrated circuit is described. By providing a dynamically updateable, multiple-priority protocol, more differentiation between traffic types is provided and response time (latency) is reduced by adjusting the priority allocations between the devices when an application on one device requires greater throughput.



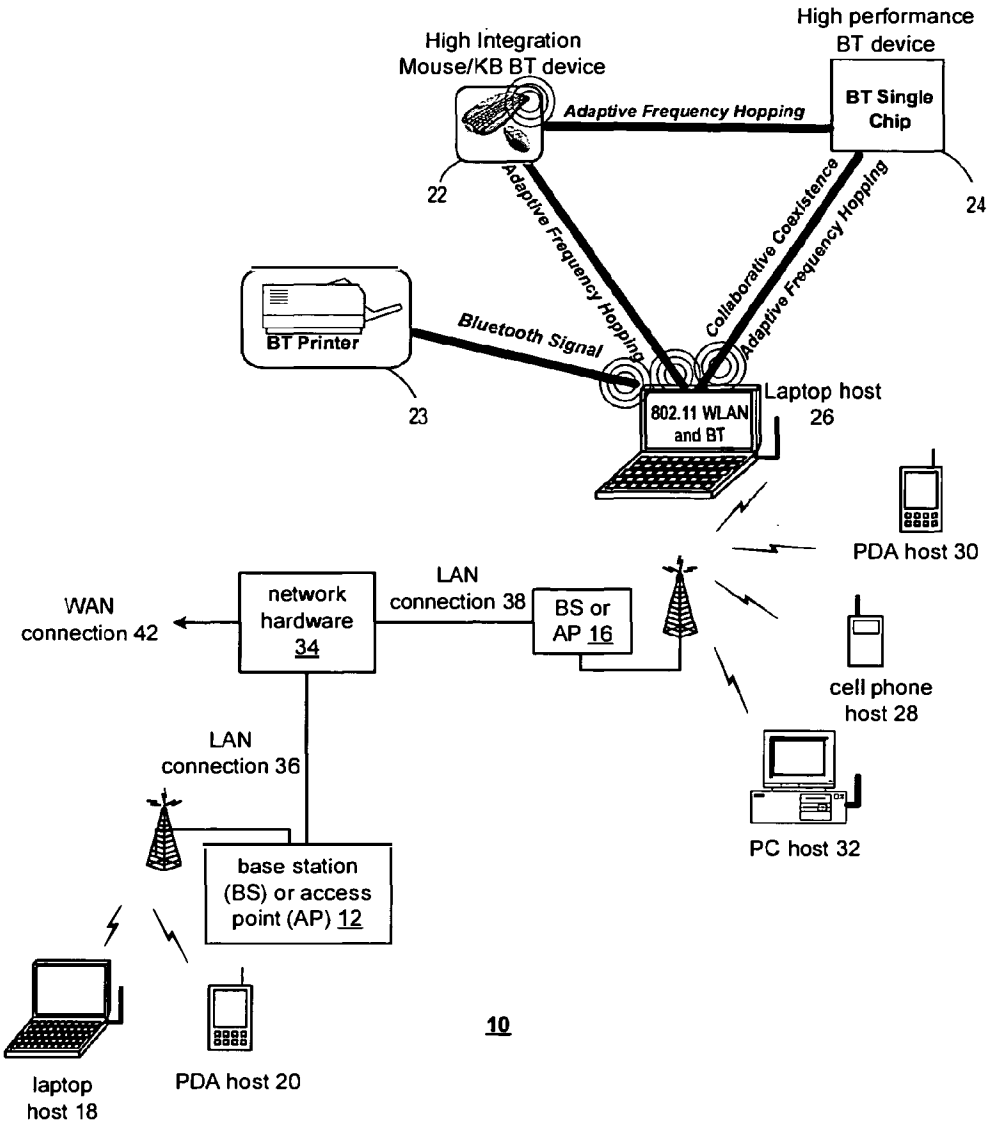

High Integration
Mouse/KB BT device
High performance
BT device
BT Single
Chip
Adaptive Frequency Hopping
22
24
Adaptive Frequency Hopping
Collaborative Coexistence
Adaptive Frequency Hopping
BT Printer
Bluetooth Signal
23
802.11 WLAN
and BT
Laptop host
26
PDA host 30
WAN
connection 42
network
hardware
34
LAN
connection 38
BS or
AP 16
cell phone
host 28
LAN
connection 36
PC host 32
base station
(BS) or access
point (AP) 12
10
laptop
host 18
PDA host 20

Figure 1

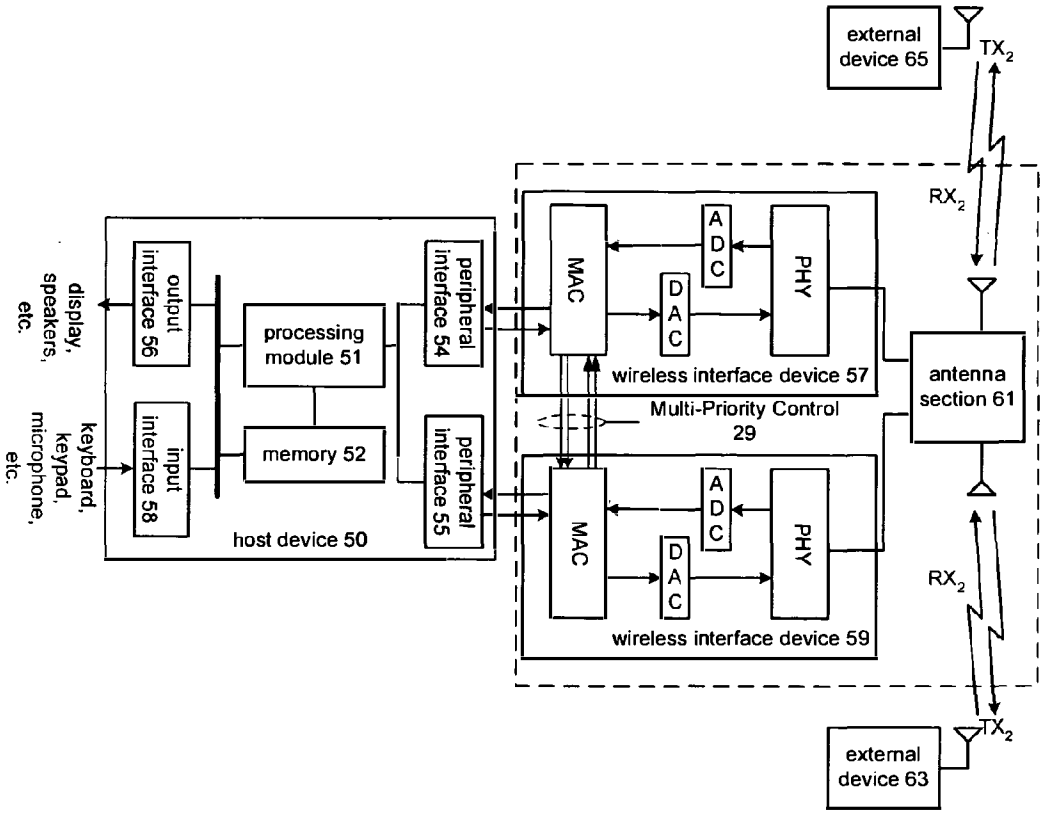

external device 65
TX2
RX2
display, speakers, etc.
keyboard, keypad, microphone, etc.
output interface 56
input interface 58
processing module 51
memory 52
peripheral interface 54
peripheral interface 55
host device 50
MAC
ADC
DAC
PHY
wireless interface device 57
Multi-Priority Control 29
wireless interface device 59
antenna section 61
RX2
TX2
external device 63

Figure 2

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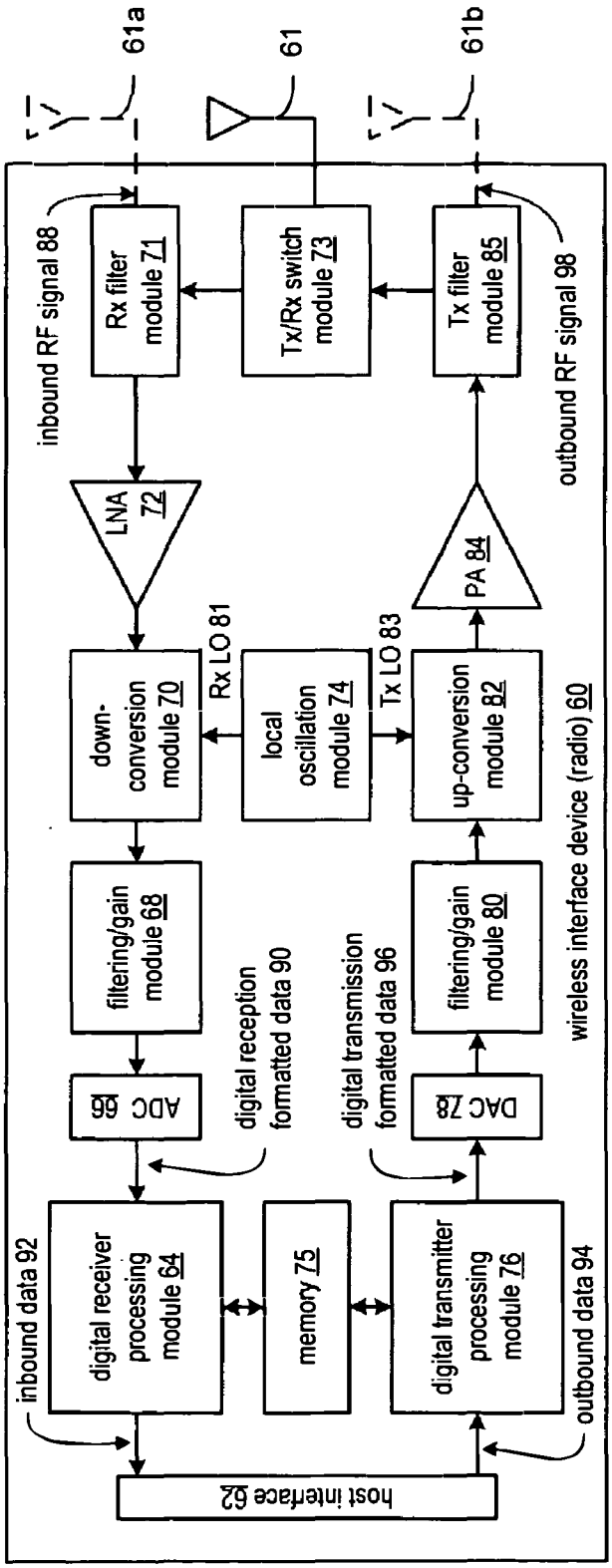


Figure 3

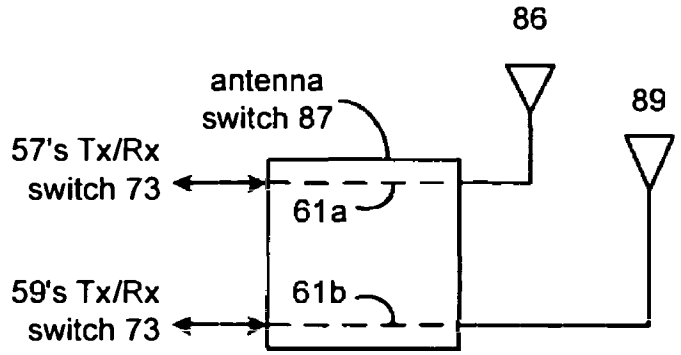


Figure 4

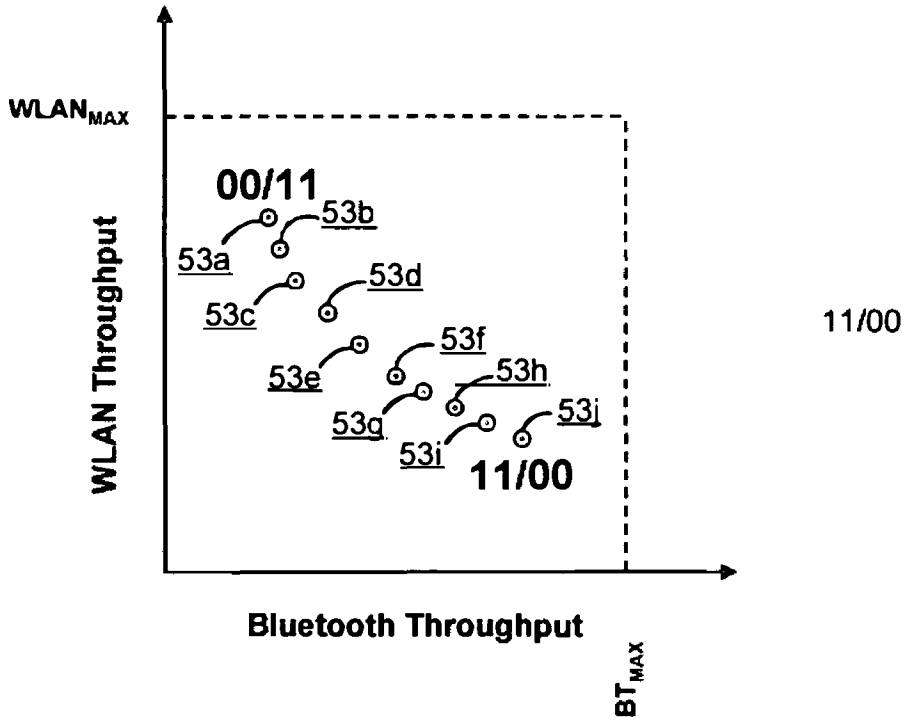


Figure 5

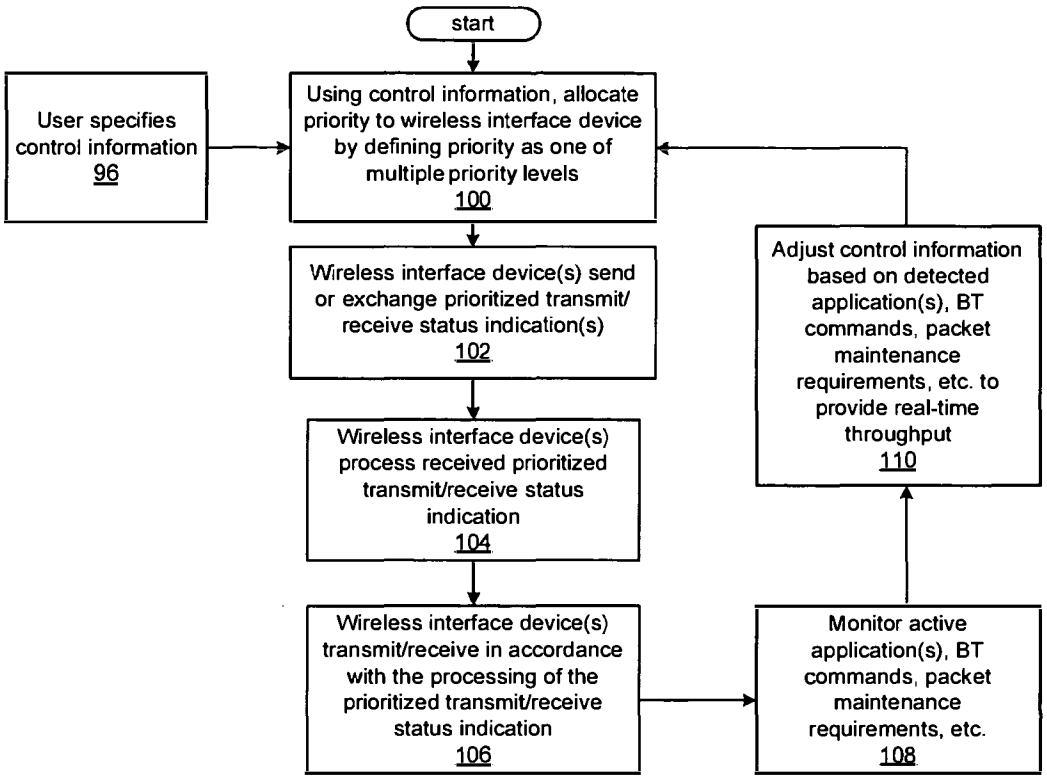
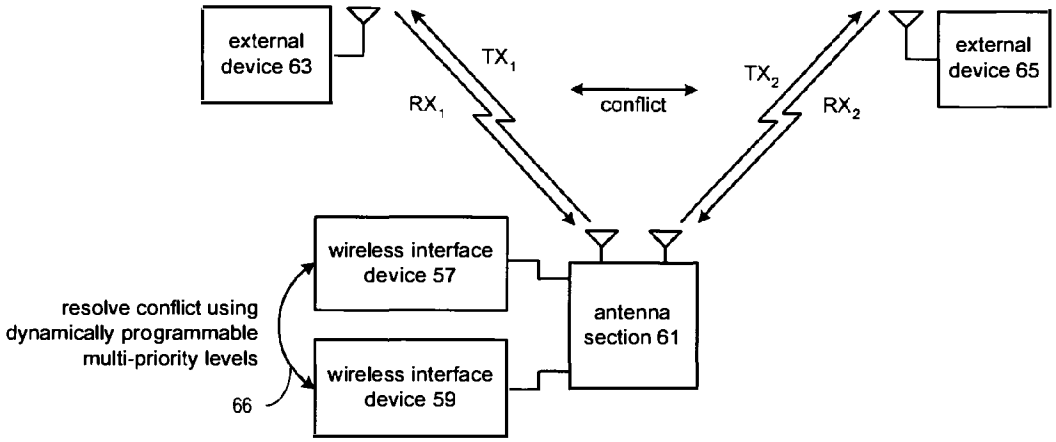

start
User specifies control information 96
Using control information, allocate priority to wireless interface device by defining priority as one of multiple priority levels 100
Wireless interface device(s) send or exchange prioritized transmit/ receive status indication(s) 102
Wireless interface device(s) process received prioritized transmit/receive status indication 104
Wireless interface device(s) transmit/receive in accordance with the processing of the prioritized transmit/receive status indication 106
Monitor active application(s), BT commands, packet maintenance requirements, etc. 108
Adjust control information based on detected application(s), BT commands, packet maintenance requirements, etc. to provide real-time throughput 110

Figure 6



Conflicts	Resolution
1) concurrent TXs	1) no change, delay one TX, reduce TX power of one or both, adjust frequency hopping, adjust priority
2) concurrent TX & RX	2) no change, delay TX, delay RX, reduce TX power, adjust frequency hopping, adjust priority
3) concurrent RXs	3) no change, delay one RX, adjust priority
4) host protocol	4) delay one communication in favor of the other
5) priority protocol	5) if conflict cannot be resolved by TX power reduction, adjust frequency hopping, apply priority to communications, adjust priority

Figure 7

COLLABORATIVE COEXISTENCE WITH DYNAMIC PRIORITIZATION OF WIRELESS DEVICES

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention is directed in general to wireless communication systems. In one aspect, the present invention relates to a method and system for providing cooperative data transmission between two or more wireless communication devices.

[0003] 2. Related Art

[0004] Communication systems are known to support wireless and wire-lined communications between wireless and/or wire-lined communication devices. Such communication systems range from national and/or international cellular telephone systems to the Internet to point-to-point in-home wireless networks. Each type of communication system is constructed, and hence operates, in accordance with one or more communication standards. For instance, wireless communication systems may operate in accordance with one or more standards including, but not limited to, IEEE 802.11, Bluetooth (BT), advanced mobile phone services (AMPS), digital AMPS, global system for mobile communications (GSM), code division multiple access (CDMA), local multi-point distribution systems (LMDS), multi-channel-multi-point distribution systems (MMDS) and/or variations thereof.

[0005] Depending on the type of wireless communication system, a wireless communication device (such as a cellular telephone, two-way radio, personal digital assistant (PDA), personal computer (PC), laptop computer, home entertainment equipment, etc.) communicates directly or indirectly with other wireless communication devices. For direct communications (also known as point-to-point communications), the participating wireless communication devices tune their receivers and transmitters to the same channel or channels (e.g., one of the plurality of radio frequency (RF) carriers of the wireless communication system) and communicate over the tuned channel(s). For indirect wireless communications, each wireless communication device communicates directly with an associated base station (e.g., for cellular services) and/or an associated access point (e.g., for an in-home or in-building wireless network) via an assigned channel. To complete a communication connection between the wireless communication devices, the associated base stations and/or associated access points communicate with each other directly, via a system controller, via the public switched telephone network, via the Internet, and/or via some other wide area network.

[0006] Wireless communication devices typically communicate with one another using a radio transceiver (i.e., receiver and transmitter) that may be incorporated in, or coupled to, the wireless communication device. The transmitter typically includes a data modulation stage, one or more frequency conversion stages and a power amplifier. The data modulation stage converts raw data into baseband signals in accordance with a particular wireless communication standard. The frequency conversion stages mix the baseband signals with one or more local oscillations to produce RF signals. The power amplifier amplifies the RF signals prior to transmission via an antenna. In direct conversion transmitters/receivers, conversion directly between baseband signals and RF signals is performed. The receiver is typically coupled to an antenna and includes a low noise amplifier, one or more frequency conversion stages, a filtering stage and a data recovery stage. The low noise amplifier receives inbound RF signals via the antenna and amplifies them. The frequency conversion stages mix the amplified RF signals with one or more local oscillations to convert the amplified RF signal into baseband signals or intermediate frequency (IF) signals. The filtering stage filters the baseband signals or the IF signals to attenuate unwanted out of band signals to produce filtered signals. The data recovery stage recovers raw data from the filtered signals in accordance with the particular wireless communication standard.

[0007] As the use of wireless communication devices increases, many wireless communication devices will include two or more radio transceivers, where each radio transceiver is compliant with any of a variety of wireless communication standards may be used with the exemplary communication systems described herein, including Bluetooth, IEEE 802.11(a), (b), (g) and others. For instance, a computer may include two radio transceivers, one for interfacing with a peripheral device (such as a keyboard or mouse) and another for interfacing with a wireless local area network (WLAN) interfacing. Even though the two radio transceivers are compliant with different wireless communication standards, they may occupy the same or similar frequency spectrum, and thus will interfere with each other's ability to receive inbound packets. For example, if one radio transceiver is compliant with Bluetooth and the other is compliant with IEEE 802.11(b) or IEEE 802.11(g), both radio transceivers would operate in the 2.4 GHz frequency range. In this example, if the Bluetooth radio transceiver is receiving a packet and the IEEE 802.11 radio transceiver begins transmitting a packet, the transmission may interfere with the Bluetooth radio transceiver's ability to accurately receive the packet. Similarly, if the IEEE 802.11 radio transceiver is receiving a packet and the Bluetooth radio transceiver begins transmitting a packet, the transmission by the Bluetooth radio may interfere with the IEEE 802.11 radio transceiver's ability to accurately receive the packet. In addition, concurrent transmission by both the IEEE 802.11 radio transceiver and the Bluetooth radio transceiver may cause interference, thus corrupting one or both transmissions.

[0008] Prior attempts to address this problem have implemented frequency domain collaboration techniques, such as adaptive frequency hopping (AHF), which is a driver level coordination of the device performance. One drawback associated with AHF is an interoperability requirement whereby all of the Bluetooth devices must be able to understand the AHF technique. Another difficulty is that it can be difficult to determine when to enable the AFH technique. There can also be a spectrum efficiency problem when, through MAC layer assistance, a current 802.11 channel is given to a Bluetooth device and the AFH explicitly skips the overlapped channel which could actually be reused if the WLAN device is not transmitting. In short, AHF does not, by itself, protect sufficiently against interference from concurrent transmission or reception. Another attempted solution is a time domain collaboration technique (also referred to as collaborative coexistence) which is a

MAC level coexistence protocol between Bluetooth and 802.11 devices using a simple prioritization MAC layer coexistence protocol, whereby two or four pins are used to couple the MAC modules, such as described in U.S. patent application Ser. No. _____ (entitled "Peer To Peer Wireless Communication Conflict Resolution"), which is incorporated herein by reference in its entirety. The initial versions of the Broadcom BCM4306 and BCM94306 products also implemented a simple two wire coexistence protocol using two levels of priority. While standard two wire coexistence techniques allow priority to be reserved for a specified wireless device (BT or WLAN), such techniques are not well optimized for real-time operations.

[0009] In addition to the complexity of the computational requirements for a communications transceiver, such as described above, the ever-increasing need for higher speed communications systems imposes additional performance requirements and resulting costs for communications systems. In order to reduce costs, communications systems are increasingly implemented using Very Large Scale Integration (VLSI) techniques. The level of integration of communications systems is constantly increasing to take advantage of advances in integrated circuit manufacturing technology and the resulting cost reductions. This means that communications systems of higher and higher complexity are being implemented in a smaller and smaller number of integrated circuits. For reasons of cost and density of integration, the preferred technology is CMOS. To this end, digital signal processing ("DSP") techniques generally allow higher levels of complexity and easier scaling to finer geometry technologies than analog techniques, as well as superior testability and manufacturability.

[0010] Therefore, a need exists for a method and apparatus that provides cooperation between two or more common band wireless communication devices to substantially eliminate interference caused by concurrent operations. In addition, a need exists for a method and apparatus that prioritizes competing data transmissions between wireless communication devices, such as Bluetooth and 802.11 devices. Moreover, a need exists for a method and apparatus that coordinates competing wireless data transmissions so that real time operations are not impaired. There is also a need for a better system that is capable of performing the above functions and overcoming these difficulties using circuitry implemented in integrated circuit form. Further limitations and disadvantages of conventional systems will become apparent to one of skill in the art after reviewing the remainder of the present application with reference to the drawings and detailed description which follow.

SUMMARY OF THE INVENTION

[0011] Broadly speaking, the present invention provides an improved method and system for reducing interference between competing wireless communication devices. Using a multi-priority coexistence protocol at the MAC layer, throughput on the devices may be fine tuned and dynamically updated to reduce or eliminate interference between wireless communication devices without affecting the latency and throughput requirements for either Bluetooth or 802.11-based applications. This may be accomplished using multiple, programmable priority levels for improving MAC level coordination which are dynamically assigned based on the throughput requirements for the devices that may be defined with reference to the active applications and/or user-specified performance requirements. For example, a multi-priority coexistence protocol is provided for dynamically protecting real-time human interface device (HID) traffic (such as Bluetooth-based mouse, keyboard, etc.) from 802.11 interference.

[0012] In accordance with various embodiments of the present invention, a method and apparatus provide for coordination of potentially conflicting wireless communications with a communication device by using multiple, dynamically updateable priority levels that are adjusted based on the detection of predetermined applications that are transmitting or receiving on the device. In a selected embodiment, the communication device includes wireless transceiver circuits, each of which has an assigned priority indication. Data receive/transmit operations on the transceiver circuits are ordered or coordinated by MAC layer modules in each circuit in accordance with the relative priorities of the priority indications. In a selected embodiment, the MAC layer modules are directly coupled by a priority control interface. For example, a first transceiver circuit with a higher priority is provided greater access to the receive/transmit operations than a second transceiver circuit with a lower priority. However, if a predetermined application (such as a HID driver, an audio-video application, or some other real-time data signal) is detected as transmitting or receiving on the second transceiver circuit, its priority is increased or incremented or maximized to a third priority indication and data is received or transmitted on the second transceiver circuit in accordance with the relative priority of the third priority indication to the first priority indication. With this technique, communication device may coordinate a first wireless interface device (i.e., a WLAN or 802.11 device) with a second wireless interface (i.e., a Bluetooth device) to dynamically adjust the transmit/receive priority to the second wireless interface if a predetermined application is detected or if a user-specified priority is assigned to the second wireless interface.

[0013] The objects, advantages and other novel features of the present invention will be apparent from the following detailed description when read in conjunction with the appended claims and attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** is a schematic block diagram of a wireless communication system in accordance with the present invention.

[0015] **FIG. 2** is a schematic block diagram of a wireless communication device in accordance with the present invention.

[0016] **FIG. 3** is a schematic block diagram of a wireless interface device in accordance with the present invention.

[0017] **FIG. 4** is a schematic block diagram of a selected embodiment of an antenna section in accordance with the present invention.

[0018] **FIG. 5** is a graphical representation of the dynamically programmable throughput options provided by having multiple priority levels in accordance with the present invention.

[0019] **FIG. 6** is a logic diagram of a method for cooperative transceiving between wireless interface devices in accordance with the present invention.

[0020] **FIG. 7** is a diagram illustrating cooperative transceiving between wireless interface devices of a host device in accordance with the present invention.

DETAILED DESCRIPTION

[0021] A method and apparatus for an improved wireless communication system is described. While various details are set forth in the following description, it will be appreciated that the present invention may be practiced without these specific details. For example, selected aspects are shown in block diagram form, rather than in detail, in order to avoid obscuring the present invention. Some portions of the detailed descriptions provided herein are presented in terms of algorithms or operations on data within a computer memory. Such descriptions and representations are used by those skilled in the field of communication systems to describe and convey the substance of their work to others skilled in the art. In general, an algorithm refers to a self-consistent sequence of steps leading to a desired result, where a "step" refers to a manipulation of physical quantities which may, though need not necessarily, take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It is common usage to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like. These and similar terms may be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussion, it is appreciated that throughout the description, discussions using terms such as processing, computing, calculating, determining, displaying or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and/or transforms data represented as physical, electronic and/or magnetic quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

[0022] **FIG. 1** illustrates a wireless communication system **10** in which embodiments of the present invention may operate. As illustrated, the wireless communication system **10** includes a plurality of base stations and/or access points **12, 16**, a plurality of wireless communication devices **18-32** and a network hardware component **34**. The wireless communication devices **18-32** may be laptop host computers **18** and **26**, personal digital assistant hosts **20** and **30**, personal computer hosts **32**, cellular telephone hosts **28** and/or wireless keyboards, mouse devices or other Bluetooth devices **22, 24**. The details of the wireless communication devices will be described in greater detail with reference to **FIGS. 2-7**.

[0023] As illustrated, the base stations or access points **12, 16** are operably coupled to the network hardware **34** via local area network connections **36, 38**. The network hardware **34** (which may be a router, switch, bridge, modem, system controller, etc.) provides a wide area network connection **42** for the communication system **10**. Each of the base stations or access points **12, 16** has an associated antenna or antenna array to communicate with the wireless communication devices in its area. Typically, the wireless communication devices register with a particular base station or access point **12, 16** to receive services from the communication system **10**. For direct connections (i.e., point-to-point communications), wireless communication devices communicate directly via an allocated channel. Regardless of the particular type of communication system, each wireless communication device includes a built-in radio and/or is coupled to a radio. The radio includes a highly linear amplifier and/or programmable multi-stage amplifier as disclosed herein to enhance performance, reduce costs, reduce size, and/or enhance broadband applications.

[0024] **FIG. 2** i

[0027] In operation, to avoid interference between the two or more wireless interface devices **57** and **59** of the wireless communication device, the MAC layer modules of each wireless interface device **57** and **59** communicate directly with one another to exchange multi-priority control signal information **29** to avoid concurrent transmission and/or reception of wireless transmissions with the corresponding external device if such concurrent transmission or reception would cause interference. As illustrated, the multi-priority control signals are exchanged using two or more pins or wires, though as will be appreciated, more or fewer connections may be used to exchange or transmit the control information if appropriate signaling techniques are used. The methods by which the MAC layer modules detect, adjust and/or set the control information may be executed by the processing module(s) and other transceiver module(s) included in the wireless interface devices **57**, **59**, or may alternatively be executed by the processing functionality in the host device **50**.

[0028] **FIG. 3** is a schematic block diagram of the signal processing modules included in a wireless interface device (i.e., a radio) **60** which includes a host interface **62**, digital receiver processing module **64**, an analog-to-digital converter (ADC) **66**, a filtering/attenuation module **68**, a down-conversion stage **70**, a receiver filter **71**, a low noise amplifier **72**, a transmitter/receiver switch **73**, a local oscillation module **74**, memory **75**, a digital transmitter processing module **76**, a digital-to-analog converter (DAC) **78**, a filtering/gain module **80**, a mixing up-conversion stage **82**, a power amplifier **84**, and a transmitter filter module **85**. The transmitter/receiver switch **73** is coupled to the antenna **61**, which may include two antennas **86**, **89** and an antenna switch **87** (as shown in **FIG. 4**) that is shared by the two wireless interface devices and is further shared by the transmit and receive paths as regulated by the transmit/receive switch **73**. Alternatively, the antenna section **61** may include separate antennas for each wireless interface device (as shown by direct connection lines **61***a*, **61***b*), where the transmit path and receive path of each wireless interface device shares the antenna. As one of ordinary skill in the art will appreciate, the antenna(s) may be polarized, directional, and/or physically separated to provide a minimal amount of interference.

[0029] Referring again to **FIG. 3**, the digital receiver processing module **64**, the digital transmitter processing module **76** and the memory **75** may be included in the MAC module and execute digital receiver functions and digital transmitter functions in accordance with a particular wireless communication standard. The digital receiver functions include, but are not limited to, digital frequency conversion, demodulation, constellation demapping, decoding and/or descrambling. The digital transmitter functions include, but are not limited to, scrambling, encoding, constellation mapping, modulation and/or digital baseband frequency conversion. The digital receiver and transmitter processing modules **64**, **76** may be implemented using a shared processing device, individual processing devices, or a plurality of processing devices. Such a processing device may be a microprocessor, micro-controller, digital signal processor, microcomputer, central processing unit, field programmable gate array, programmable logic device, state machine, logic circuitry, analog circuitry, digital circuitry and/or any device that manipulates signals (analog and/or digital) based on operational instructions. The memory **75** may be a single memory device or a plurality of memory devices. Such a memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory and/or any device that stores digital information. Note that when the processing module **64**, **76** implements one or more of its functions via a state machine, analog circuitry, digital circuitry and/or logic circuitry, the memory storing the corresponding operational instructions may be embedded with the circuitry comprising the state machine, analog circuitry, digital circuitry and/or logic circuitry.

[0030] When transmitting data, the wireless interface device **60** receives outbound data **94** from the host device via the host interface **62**. The host interface **62** routes the outbound data **94** to the digital transmitter processing module **76**, which processes the outbound data **94** to produce digital transmission formatted data **96** in accordance with a particular wireless communication standard, such as IEEE 802.11 (including all current and future subsections), Bluetooth, etc. The digital transmission formatted data **96** will be a digital base-band signal or a digital low IF signal, where the low IF typically will be in the frequency range of one hundred kilohertz to a few megahertz. Subsequent stages convert the digital transmission formatted data to an RF signal, and may be implemented as follows. The digital-to-analog converter **78** converts the digital transmission formatted data **96** from the digital domain to the analog domain. The filtering/gain module **80** filters and/or adjusts the gain of the analog signal prior to providing it to the mixing stage **82**. The mixing stage **82** directly converts the analog baseband or low IF signal into an RF signal based on a transmitter local oscillation clock **83** provided by local oscillation module **74**. Alternatively, the digital baseband signal **96** may be directly converted to an RF signal. The power amplifier **84** amplifies the RF signal to produce outbound RF signal **98**, which is filtered by the transmitter filter module **85**. The antenna section **61** transmits the outbound RF signal **98** to a targeted device such as a base station, an access point and/or another wireless communication device.

[0031] When receiving data, the wireless interface device **60** receives an inbound RF signal **88** via the antenna section **61**, which was transmitted by a base station, an access point, or another wireless communication device. The inbound RF signal is converted into digital reception formatted data; this conversion may be implemented as follows. The antenna section **61** provides the inbound RF signal **88** to the receiver filter module **71** directly or via the transmit/receive switch **73**, where the receiver filter **71** bandpass filters the inbound RF signal **88**. The receiver filter **71** provides the filtered RF signal to low noise amplifier **72**, which amplifies the signal **88** to produce an amplified inbound RF signal. The low noise amplifier **72** provides the amplified inbound RF signal to the mixing module **70**, which directly converts the amplified inbound RF signal into an inbound low IF signal or baseband signal based on a receiver local oscillation clock **81** provided by local oscillation module **74**. The down conversion module **70** provides the inbound low IF signal or baseband signal to the filtering/gain module **68**. The filtering/gain module **68** filters and/or gains the inbound low IF signal or the inbound baseband signal to produce a filtered inbound signal. The analog-to-digital converter **66** converts the filtered inbound signal from the analog domain to the digital domain to produce digital reception formatted data **90**. Alternatively,

the received RF signal may be directly converted to a baseband signal **90**. The digital receiver processing module **64** decodes, descrambles, demaps, and/or demodulates the digital reception formatted data **90** to recapture inbound data **92** in accordance with the particular wireless communication standard being implemented by wireless interface device. The host interface **62** provides the recaptured inbound data **92** to the host device (e.g., **50**) via the peripheral interface (e.g., **55**).

[0032] As will be appreciated, the wireless communication device of **FIG. 2** described herein may be implemented using one or more integrated circuits. For example, the host device **50** may be implemented on one integrated circuit, the digital receiver processing module **64**, the digital transmitter processing module **76** and memory **75** may be implemented on a second integrated circuit, and the remaining components of the radio **60** and/or antenna **61**, may be implemented on a third integrated circuit. As an alternate example, the radio **60** may be implemented on a single integrated circuit. As yet another example, the processing module **51** of the host device and the digital receiver and transmitter processing modules **64** and **76** may be a common processing device implemented on a single integrated circuit. Further, the memory **52** and memory **75** may be implemented on a single integrated circuit and/or on the same integrated circuit as the common processing modules of processing module **51** and the digital receiver and transmitter processing module **64** and **76**. In a selected embodiment, the present invention shows, for the first time, a fully integrated, single chip coexistence solution for competing wireless signals (such as 802.11a/bg and Bluetooth signals) with multiple priority levels where the allocation of priority may be dynamically updated in response to user input, detected application requirements, and other inputs, in order to meet or maintain communications requirements for a given wireless interface device in the face of potentially conflicting transmissions, all implemented in CMOS (Complementary Metal Oxide Semiconductor), as part of a single chip transceiver radio.

[0033] The present invention enables wireless communication devices (such as a Bluetooth device and a WLAN device) to communicate with one another by controlling the transceiving events to reduce or eliminate conflicts using dynamic, multiple priority levels that permit improved MAC coordination of the device operations. **FIG. 5** graphically depicts the various control signal permutations (e.g., **53***a*-**53***j*) that are available for selection by using multiple, dynamically selectable priority levels. In accordance with the present invention, an initially selected control signal (e.g., **53***b*) is used to allocate receiving and/or transmission priorities as between two wireless devices (e.g., a WLAN device **65** and a Bluetooth device **63**), but the control signal may be adjusted to another control signal (e.g., **53***h*) when higher throughput is required for the Bluetooth device **63**. A control signal change can be precipitated by a explicit user choice, upon detection of an active application (or its throughput requirements) that is attempting to transmit or receive data through a wireless interface device, by specific commands received in connection with a particular wireless protocol, or any other data transmission condition that allows or requires a different prioritization or transmission performance. As will be appreciated, the control signal may be dynamically adjusted in a variety of ways, including making adjustments periodically, in response to user input, at predetermined events or conditions, on a packet-by-packet basis, or on any other basis that permits changes in the performance requirements of a particular wireless transmission to be detected and accommodated.

[0034] Whether implemented as a two wire interface or four wire interface (as illustrated with multi-priority control lines **29** in **FIG. 2**), or any other type of interface, the present invention uses control signals on these interfaces, wires or pins to exchange multiple levels of prioritization information between the MAC layers in the wireless devices. For example, an interface may be used to provide four levels of priority to each device, with the highest priority being "**00**" and the lowest priority being "11." By setting or programming the values for these priority levels (e.g., **00**/11 **53***a*), one of the devices (e.g., the WLAN device **65**) is configured through the MAC layer for maximum throughput. On the other extreme, a different priority level signal (e.g., 11/**00** **53***j*) maximizes the throughput for the other device (e.g., the BT device **63**). Thus, different combinations of the priority information can be used to provide greater granularity in the MAC controls, which can be used to maximize the performance of both links.

[0035] As shown in **FIG. 5**, the multiple-priority protocol of the present invention allows more differentiation between traffic types than with simple priority-based protocols. As a result, not only throughput, but also response time (latency) can be guaranteed statistically. This capability makes it possible to co-locate a Bluetooth-based HID device with an 802.11 device on the same laptop computer, and to adjust the priority allocations between the devices when an application on one device requires greater throughput. Thus, the priority allocation enhancement provides for dynamic control of the priorities using programmable priority levels that can be used to protect real-time HID traffic (such as a Bluetooth-based mouse, keyboard, etc.) from WLAN interference (such as 802.11 signals).

[0036] In addition to providing multiple priority level combinations, the priority level for a given wireless interface device may be dynamically adjusted on a packet by packet basis, thereby permitting even greater control and improved performance. For example, through use of the dynamic multiple priority levels, the connection time for a first device (e.g., a Bluetooth device) can be reduced by assigning a high priority to the device. With one example of this approach, it is possible to reduce the latency between an HIDoff signal to a Bluetooth device and the beginning of character transmission latency to a second, WLAN device.

[0037] In a selected embodiment, a processing module (e.g., **64**, **76**) is used to generate and exchange priority information between MAC modules. Alternatively, the host device **50** may generate and allocate multi-level priority information using an algorithm or other processing techniques to define the priority level on a packet-by-packet basis. Wherever processed, the packet priority may be defined as a function of any data transmission condition that allows or requires a different prioritization or transmission performance, whether input by the user or detected or precipitated upon detection of an active application (or its throughput requirements) or specific commands received in connection with a particular wireless protocol, such as Synchronous Connection-Oriented (SCO) commands, Human Interface Device (HID) commands, or Link Manager Protocol (LMP) commands. Priority may also be

defined as a function of Quality of Service (QoS), such as proximity in time to the poll interval (T_{poll}), or as a function of the connection maintenance packet. In a selected embodiment, a priority allocation and/or adjustment algorithm may be selected by the host stack based on the applications being run on the wireless communication devices, on the profiles in use, on remote side capabilities and other wireless application-related information.

[0038] In a selected embodiment, one or more priority generating algorithms may be stored on the wireless interface device (e.g., **59**, **57**) in an electrically erasable programmable read only memory (EEPROM) and configurable via Over The Air Firmware Update (OTAFU), and the host application is used to control the algorithm selection. The algorithm or firmware can also be stored in on-chip RAM which can be loaded or configured by host driver software. With this approach, messaging schemes may be stored on, or processed by, the host device and used to control communication conflicts between wireless communication devices, such as WLAN and Bluetooth devices. For example, the present invention may be used to provide unique prioritization for each SCO link.

[0039] Turning now to **FIG. 6**, a method for cooperative transceiving between wireless interface devices is illustrated. The method begins at step **100**, where each wireless interface device uses control information (which has been specified at steps **96**, **108** or **110** as described below) to allocate device priority to a wireless interface device by selecting from multiple, available priority levels. At step **102**, at least one of the wireless interface devices provides a prioritized transmit/receive status indication to another wireless interface device, such as by using a priority control signal **29**. For example, one of the wireless interface devices that transceives data packets in accordance with a Bluetooth standard transmits a relatively low prioritized status indication, while the other wireless interface devices transceive data packets in accordance with an IEEE 802.11 standard transmits a relatively high prioritized status indication.

[0040] At step **104**, the prioritized status indication is processed to control and eliminate conflicts based on the devices' relative priorities, and at step **106**, the wireless interface devices transmit or receive a packet in accordance with the processing of the prioritized status indication. For example, the processing (step **104**) may determine when a first wireless interface device having a higher prioritized status indication is or will be receiving an inbound packet. This may be determined by a processing module in wireless interface device that compares its own priority level to the priority level transmitted by the other wireless interface device using the control signal interface **29**. By comparing the local and sensed prioritized status indications, transmission and reception may be controlled to give preference or priority to the higher priority device. For example, at the start of an atomic sequence, a local device may compare priority levels by checking the prioritized status indications (or control information) from a peer device and determining whether the local device can perform its transaction based on the following rules:

[0041] (1) If the peer prioritized status indication is higher than the local prioritized status indication, then the atomic sequence for the local device is delayed to next time epoch.

[0042] (2) If the peer prioritized status indication is lower than the local prioritized status indication, then the atomic sequence for the local device is transmitted or received (as the case may be).

[0043] (3) If the peer prioritized status indication equals the local prioritized status indication, then the atomic sequence for the local device is transmitted using a transmission protocol (such as randomized transceiving operations) that allows the local and peer devices to share the transmission channel or that gives priority to the handling of the atomic sequence by the local device fifty percent of the time.

[0044] Of course, other prioritization processing schemes could be used. For example, one device could be given priority if its prioritized status indication is equal to or greater than the peer device's prioritized status indication, and could be given a lower priority if its prioritized status indication is less than the peer device's prioritized status indication.

[0045] If prioritized status indication processing indicates that a first wireless interface device having a higher prioritized status indication is or will be receiving an inbound packet, then at step **106**, the other wireless interface device delays transmitting the outbound packet until the first wireless interface device has received the inbound packet. As will be appreciated, to minimize the time that one wireless interface device is receiving packets, and hence reduce the wait time, the packet size of inbound packets and outbound packets may be optimized in accordance with the particular wireless communication standard.

[0046] If the transmitting of the outbound packet would not interfere with the receiving of the inbound packet, then at step **106**, the other wireless interface device transmits the outbound packet while the inbound packet is being received. For example, the processing of the status indication may indicate that the other wireless interface device is compliant with the Bluetooth standard and may adaptively adjust its frequency hopping sequence to reduce interference with the other wireless interface device, in which case there is no interference and both devices may operate concurrently.

[0047] In yet another example of the processing of the prioritized status indications for two wireless interface devices transmitting outbound packets, the lower priority first wireless interface device determines (at step **104**) that the higher priority second wireless interface device is transmitting an outbound message. In this situation, the first wireless interface device (at step **106**) delays transmitting of the outbound packet until the second wireless interface device has transmitted the outbound packet unless interference would be minimal, in which case both devices may transmit simultaneously. However, if the prioritized status indication for the first wireless interface device is increased above the second wireless interface device (such as described herein when it is detected that packet data for the first device is used for low latency, real time applications), then at step **106**, the first device transmits while transmission on the second device is delayed.

[0048] As indicated in **FIG. 6**, the control information that is used to allocate device priority may be user-specified (as indicated at step **96**). For example, a user can enter control information to configure one of the wireless devices (e.g., a

Bluetooth device that is transmitting audio or video data or some other real time application) to have high throughput than another device. As another example of step **96**, a user may wish to expedite a data download operation over a WLAN device, in which case the user can specify that the wireless interface device for the WLAN device has a higher or even highest priority.

[0049] In addition or in the alternative, the prioritization allocations may be dynamically and automatically updated by monitoring the transmission activities or applications running on a wireless interface device (step **108**), and then adjusting the control information based on the detected activity (step **110**). For example, upon detecting (at step **108**) that a predetermined application (such as a Human Interface Devices (HID) application) is transmitting to or from a first wireless interface device (such as a Bluetooth device), the control information is adjusted (at step **110**) to give higher priority to the first wireless interface device. Control information adjustments can be made in response to other system events (such as the detection of BT commands, packet maintenance requirements, etc.) to provide real-time throughput by adjusting device prioritization. Depending upon designer preferences, the adjustments can be made periodically, in response to user input, at predetermined events or conditions, on a packet-by-packet basis, or on any other basis that permits changes in the performance requirements of a particular wireless transmission to be detected and accommodated.

[0050] As will be appreciated, the monitoring and adjustment steps **108**, **110** may be implemented as a series of discrete processing operations or consolidated into a single program operation. In addition, a variety of adjustment protocols may be followed to change the control information. For example, when a predetermined condition is detected at step **108**, the control information may be adjusted at step **110** to provide maximum priority for the wireless interface device that triggered the adjustment. Alternatively, an incrementation technique may be used to incrementally raise the priority for the wireless interface device that triggered the adjustment, one or more levels at a time. As yet another alternative, a target or threshold level of performance for the wireless interface device may be established whereby the control information is adjusted at step **110** to track to the target or threshold level in response to detected device performance. Other adjustment algorithms may be selected, based on user or designer preferences, to improve the overall wireless transmission performance in the face of dynamic application and transmission requirements.

[0051] **FIG. 7** is a diagram illustrating wireless interface devices (e.g., **57** and **59** in **FIG. 2**) associated with a host device (e.g., **50** in **FIG. 2**) that coordinates communications with two external wireless devices (e.g., **63** and **65** in **FIG. 2**). The wireless interface devices **57** and **59** and the external wireless devices **63** and **65** may communication using any type of standardized wireless communication including, but not limited to, IEEE 822.11 (a), (b), or (g), Bluetooth, GSM, CDMA, TDMA, LMPS, or MMPS. The external devices **63** and **65** may use the same or different wireless communication standard. When the external devices **63** and **65** use standards that occupy the same or similar frequency spectrums, a conflict between concurrent communications may occur. In other words, when the both external devices are communicating with the wireless interface devices **57** and **59** their respective communications may interfere with the other's communication, reducing the quality of service for one or both communications.

[0052] To resolve the conflict the wireless interface devices **57** and **59** coordinate the communications with their respective external devices **63** and **65** using dynamically programmable multi-priority levels **66**. As shown in the accompanying table of **FIG. 7**, when a conflict arises, the wireless interface devices **57** and **59** have a multitude of resolutions. For example, when both wireless interface devices **57** and **59** desire to concurrently transmit packets to their respective external devices **63** and **65** (i.e., any overlapping transmission), the wireless interface devices **57** and **59** determine whether a concurrent transmission would cause sufficient interference that would degrade one or both of the transmissions. If not, no change is required and the wireless interface devices **57**, **59** may concurrently transmit.

[0053] If, however, sufficient interference would exist, the wireless interface devices process the multi-priority level information **66** for each device to resolve the conflict by delaying one of the transmissions with respect to the other to avoid concurrent transmissions, reducing the transmit power for one or both of the concurrent transmissions, adjusting the frequency hopping of a Bluetooth compliant wireless interface device **57** or **59** and/or adjusting the prioritization allocation for the devices if required.

[0054] The wireless interface devices **57** and **59** may delay the transmissions based on a priority protocol, a host protocol, a default mechanism, an ad hoc mechanism, or a user defined ordering which takes into account the respective priorities assigned to the devices, where each device priority may be selected from multiple (at least three) dynamically programmable priority levels. In essence, the delaying of the concurrent transmissions removes the concurrency such that only one transmission is occurring at any given time. The delaying may be established by an equal or imbalanced staggering of the transmissions or by allowing one of the communications to complete before the other is serviced. For example, the host protocol may prohibit concurrent communications. As such, the communication with one of external devices that was initiated first will be completed before communication with the other external devices is serviced. As a further example of the delaying of concurrent transmissions, the priority protocol may dictate that user interface wireless devices (e.g., wireless keyboard, mouse, etc.) have priority over data transfer peripheral wireless devices (e.g., PDA, down loading data to a cell phone, a printer, etc.). The priority protocol may also prioritize real time communications (e.g., voice, audio, and/or video data) over data transfer communications. In addition, the priority protocol may indicate whether the concurrent transmissions are to be staggered or sequential. The user defined priority list may be based on the type of external devices. For example, the user may prioritize communications with his or her PDA over any other type of communications, followed by communications with the cell phone, etc. In this manner, the conflict resolution may be customized to the user's preferences.

[0055] As described herein, the priority as between two transmitting devices may be dynamically adjusted when one of the devices is transmitting data from an application that requires real time data, such as an audio or video application.

In addition to boosting the priority for wireless devices handling real time applications and the like, the priority level may also be downgraded once it is detected that the real time data application is no longer running or required. For example, the wireless devices may be returned to a target or default priority scheme once a high throughput application is finished.

[0056] As also indicated in the table in **FIG. 7**, when the conflict corresponds to one wireless interface device potentially transmitting data while the other wireless interface device is potentially receiving data, the wireless interface devices determine whether concurrent transmission and reception would cause significant interference. If not, the current transmission and reception is performed. If, however, significant interference would be produced, the wireless interface device may resolve the conflict by using the host protocol and/or priority protocol to delay the transmission to avoid the concurrency, delay the reception to avoid the concurrency, reduce the transmit power or adjust the frequency hopping of a Bluetooth device. In addition, the device priorities may be adjusted in response to detected conditions, such as active applications or detected throughput requirements for the wireless device, to give reception priority to one device over the transmission priority of another device, or vice versa.

[0057] When the conflict corresponds to concurrent receptions, the wireless interface devices determine whether such concurrency would cause significant interference. If not, the concurrent receptions are processed. If, however, significant interference would exist, one of the receptions may be delayed to avoid the concurrency or one of the external devices may be instructed to reduce its transmitting power. In addition, the device priorities may be adjusted in response to detected conditions, such as active applications or detected throughput requirements for the wireless device, to give reception priority to one device over another.

[0058] In accordance with the present invention, the control information (e.g., multi-priority control **29** in **FIG. 2**) may be passed between MAC modules of the wireless interface devices **57** and **59** using a four-wire interface or control, though a two-wire interface provides an improved pin count feature. Examples of two-wire and four-wire priority protocols that may be implemented are described in U.S. patent application Ser. No. _____ (entitled "Peer To Peer Wireless Communication Conflict Resolution" and incorporated herein by reference in its entirety). In a selected embodiment, the present invention provides an adjustment mechanism for monitoring transmission requirements for a given wireless communication device and changing the priority allocations to give the wireless communication device adequate priority (and resulting throughput performance) to satisfy the transmission requirements for that device.

[0059] As described herein and claimed below, a method and apparatus are provided for providing a dynamically updated and adjusted coexistence protocol for wireless interface devices using multiple priority levels to selectively adjust device throughput in response to changing transmission conditions or requirements. The new technique may be used to adjust device transmission performance in response to user-specified requirements and/or in response to detection of predetermined applications or commands being executing on the wireless device(s). In one implementation, a laptop computer communicates wirelessly with at least a Bluetooth peripheral device and a WLAN network device by controlling the MAC modules for the peripheral and network to adjust prioritization of the two devices using pairings of priority levels which may be selected from a plurality of available priority levels. For example, the WLAN might ordinarily be granted priority as between the two devices, but when a HID application runs on the Bluetooth device, the relative prioritization is adjusted using control information transmitted between the MAC layers to increase the priority of the Bluetooth device or to give the Bluetooth device priority over the WLAN device.

[0060] As will be appreciated, the present invention may be implemented in a computer accessible medium including one or more data structures representative of the circuitry included in the system described herein. Generally speaking, a computer accessible medium may include storage media such as magnetic or optical media, e.g., disk, CD-ROM, or DVD-ROM, volatile or non-volatile memory media such as RAM (e.g., SDRAM, RDRAM, SRAM, etc.), ROM, PROM, EPROM, EEPROM, etc., as well as media accessible via transmission media or signals such as electrical, electromagnetic, or digital signals, conveyed via a communication medium such as a network and/or a wireless link. For example, data structure(s) of the circuitry on the computer accessible medium may be read by a program and used, directly or indirectly, to implement the hardware comprising the circuitry described herein. For example, the data structure(s) may include one or more behavioral-level descriptions or register-transfer level (RTL) descriptions of the hardware functionality in a high level design language (HDL) such as Verilog or VHDL. The description(s) may be read by a synthesis tool which may synthesize the description to produce one or more netlist(s) comprising lists of gates from a synthesis library. The netlist(s) comprise a set of gates which also represent the functionality of the hardware comprising the circuitry. The netlist(s) may then be placed and routed to produce one or more data set(s) describing geometric shapes to be applied to masks. The masks may then be used in various semiconductor fabrication steps to produce a semiconductor circuit or circuits corresponding to the circuitry. Alternatively, the data structure(s) on computer accessible medium may be the netlist(s) (with or without the synthesis library) or the data set(s), as desired. In yet another alternative, the data structures may comprise the output of a schematic program, or netlist(s) or data set(s) derived therefrom. While a computer accessible medium may include a representation of the present invention, other embodiments may include a representation of any portion of the wireless communication device, transceiver circuitry and or processing modules contained therein.

[0061] While the system and method of the present invention has been described in connection with the preferred embodiment, it is not intended to limit the invention to the particular form set forth, but on the contrary, is intended to cover such alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims so that those skilled in the art should understand that they can make various changes, substitutions and alterations without departing from the spirit and scope of the invention in its broadest form.

What is claimed is:

1. In an integrated circuit wireless communication device having at least two wireless transceiver circuits, a method for coordinating potentially conflicting wireless communications, comprising:

assigning first and second priority indications to first and second wireless transceiver circuits, respectively, where each priority indication may be selected from a plurality of available priority indications;

receiving or transmitting data on the first wireless transceiver circuit in accordance with the relative priority of the first priority indication to the second priority indication;

detecting a predetermined application that configured to receive or transmit data on the second wireless transceiver circuit;

assigning a third priority indication to the second wireless transceiver circuit when the predetermined application is detected; and

receiving or transmitting data on the second wireless transceiver circuit in accordance with the relative priority of the third priority indication to the first priority indication.

2. The method of claim 1, wherein the first wireless transceiver circuit comprises a MAC layer module that is directly coupled to a MAC layer module of the second wireless transceiver circuit such that a priority indication may be transferred between the MAC layer modules.

3. The method of claim 1, wherein the third priority indication is a maximum priority indication that is available from the plurality of available priority indications.

4. The method of claim 1, wherein the third priority indication is greater than the second priority indication.

5. The method of claim 1, wherein the second wireless transceiver circuit comprises a Bluetooth application, and the predetermined application comprises a Human Interface Device driver.

6. The method of claim 1, wherein the receiving or transmitting data on the second wireless transceiver circuit in accordance with the relative priority of the third priority indication to the first priority indication comprises receiving or transmitting data on the second wireless transceiver circuit if the third priority indication has a higher priority than the first priority indication.

7. The method of claim 1, wherein the first priority indication comprises a user-specified priority indication for the first wireless transceiver circuit, such that the first wireless transceiver circuit is given priority in the reception or transmission of data relative to the second wireless transceiver circuit.

8. The method of claim 1, wherein the first wireless transceiver circuit comprises a WLAN wireless interface device, and wherein the second wireless transceiver circuit comprises a Bluetooth wireless interface device.

9. The method of claim 1, wherein the first wireless transceiver circuit comprises a first Bluetooth wireless interface device, and wherein the second wireless transceiver circuit comprises a second Bluetooth wireless interface device.

10. The method of claim 1, wherein the first wireless transceiver circuit is compliant with Bluetooth and the second wireless transceiver circuit is compliant with IEEE 802.11(b) or IEEE 802.11(g).

11. An apparatus for coordinating wireless communications, comprising:

a first wireless interface circuit for performing receiving or transmitting operations of a first type of wireless communication having a first priority level selected from a first plurality of priority levels;

a second wireless interface circuit for performing receiving or transmitting operations of a second type of wireless communication having a second priority level selected from a second plurality of priority levels;

an interface coupling the first and second wireless interface circuits for transmitting priority levels between the first and second wireless interface circuits; and

a controller for coordinating the operations of the first or second wireless interface circuits in relation to a relative priority of the first and second priority levels, said controller comprising priority level adjustment logic for adjusting a priority level in response to detecting a predetermined condition.

12. The apparatus of claim 11, wherein the first wireless transceiver circuit is compliant with Bluetooth and the second wireless transceiver circuit is compliant with IEEE 802.11.

13. The apparatus of claim 11, wherein the controller comprises a MAC layer module.

14. The apparatus of claim 11, wherein the controller comprises a first MAC layer module in the first wireless interface circuit and a second MAC layer module in the second wireless interface circuit.

15. The apparatus of claim 11, wherein the predetermined condition comprises a request to receive or transmit real time data over the second wireless interface circuit.

16. The apparatus of claim 11, wherein the predetermined condition comprises real-time human interface device (HID) traffic being transmitted or received on the second wireless interface circuit, and wherein the priority level adjustment logic increments the second priority level.

17. The apparatus of claim 11, wherein the predetermined condition comprises a user-specified priority level being entered for the second wireless interface circuit, and wherein the priority level adjustment logic increments the second priority level above the first priority level in response to detecting the user-specified priority level.

18. The apparatus of claim 11, wherein the predetermined condition comprises audio-video traffic being transmitted or received on the second wireless interface circuit, such that the controller protects the second wireless interface circuit from interference caused by the first wireless interface circuit by adjusting the second priority level to a maximum level and adjusting the first priority level to a minimum level.

19. An apparatus for implementing a dynamic collaboration protocol, comprising:

first means for sending or receiving a first wireless signal having a first allocated priority, comprising a first MAC layer module;

second means for sending or receiving a second wireless signal having a second allocated priority, comprising a second MAC layer module;

means for adjusting the second allocated priority to be higher than the first allocated priority if real-time human interface device (HID) traffic is detected on the second means; and

means for interfacing the first and second MAC layer modules to coordinate throughput performance of the first and second means such that whichever of the first or second means has a higher allocated priority is given higher throughput performance.

20. The apparatus of claim 19, wherein the second wireless signal comprises a packet signal, and wherein the means for adjusting the second allocated priority evaluates each packet of the packet signal to detect if real-time human interface device (HID) traffic is present on the second means.

* * * * *

EXHIBIT 1018

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(54) DEVICE, SYSTEM AND METHOD OF COORDINATION AMONG MULTIPLE TRANSCEIVERS

(76) Inventors: **Giora Rayzman**, Rishon LeZion (IL); **Oren Kaidar**, Binyamina (IL); **Miriam Ratner**, Ramat-Gan (IL)

Correspondence Address:
PEARL COHEN ZEDEK LATZER, LLP
1500 BROADWAY, 12TH FLOOR
NEW YORK, NY 10036 (US)

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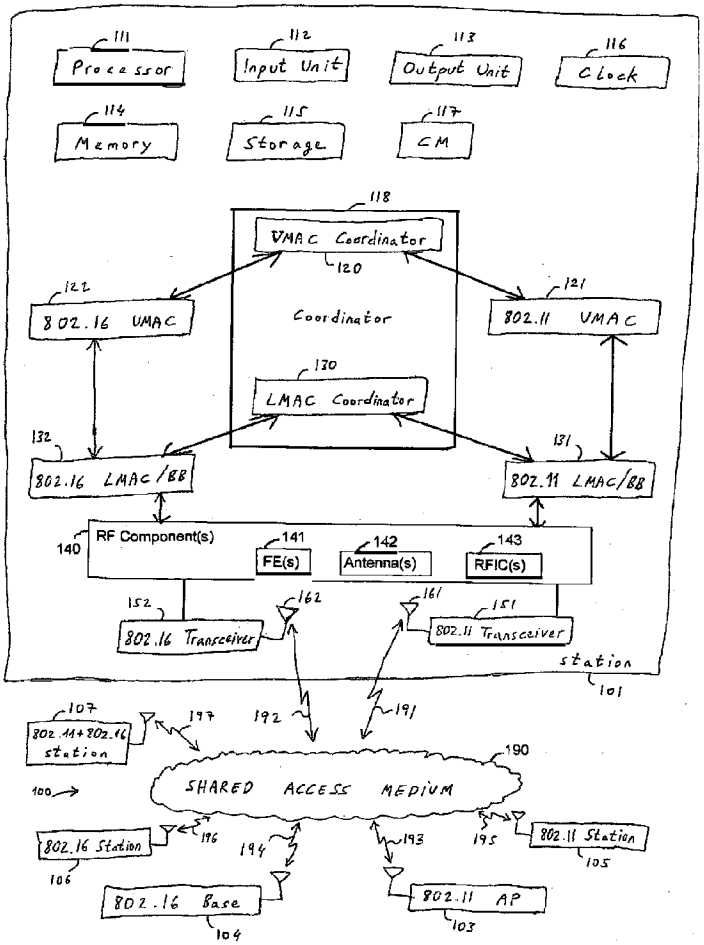
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(57) **ABSTRACT**

Some embodiments of the invention provide devices, systems and methods of coordination among multiple transceivers. For example, an apparatus in accordance with an embodiment of the invention includes: a first wireless transceiver able to operate in accordance with a first, non-scheduled, wireless communication protocol; a second wireless transceiver able to operate in accordance with a second, scheduled, wireless communication protocol; and a communication coordinator to allocate one or more first time slots for communication by said first transceiver, and to allocate one or more second time slots, which do not overlap said first time slots, for communication by said second transceiver.



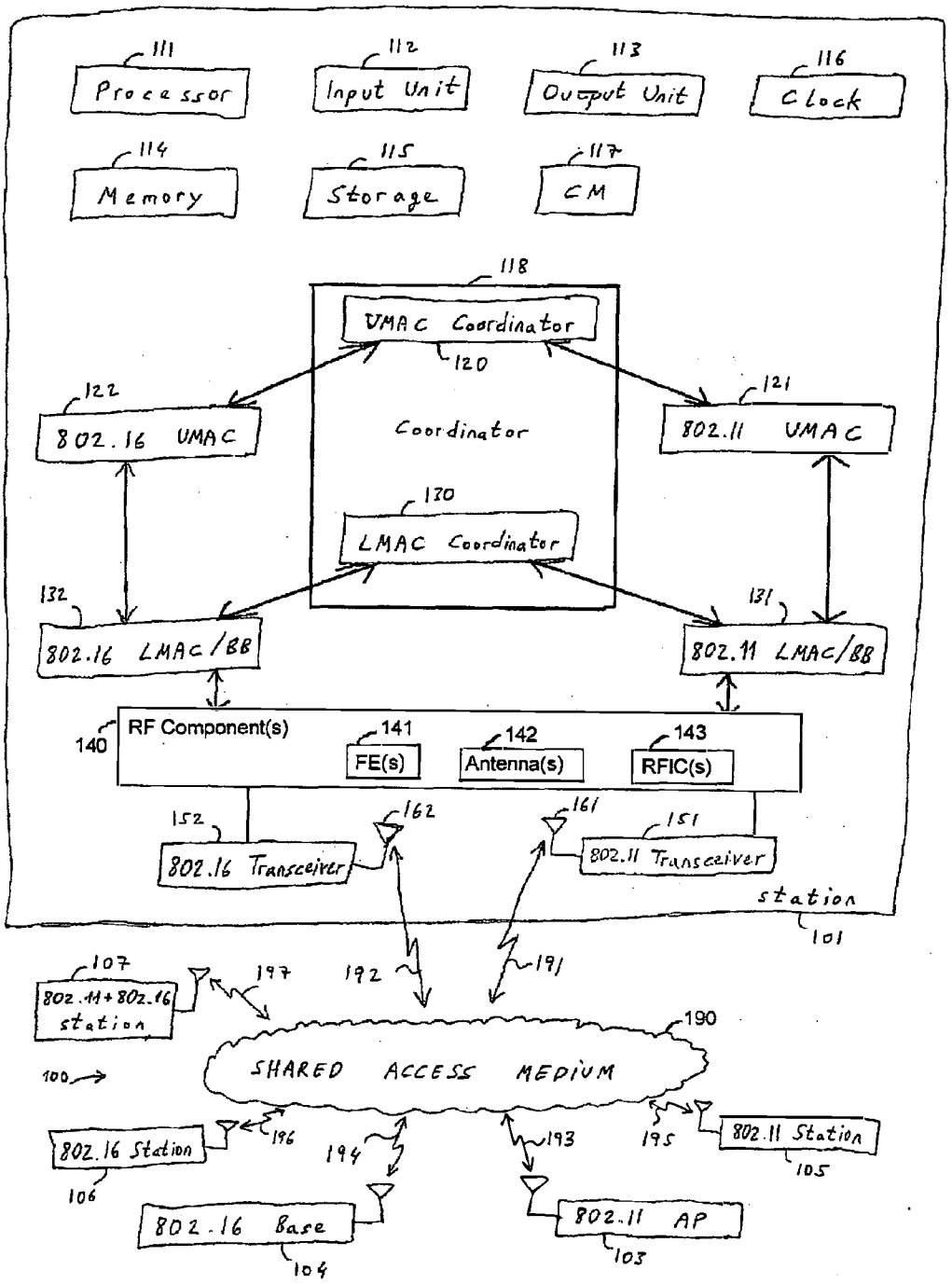

111
Processor
112
Input Unit
113
Output Unit
116
Clock
114
Memory
115
Storage
117
CM
118
VMAC Coordinator
120
Coordinator
122
802.16 UMAC
121
802.11 UMAC
130
LMAC Coordinator
132
802.16 LMAC/BB
131
802.11 LMAC/BB
140
RF Component(s)
141
FE(s)
142
Antenna(s)
143
RFIC(s)
152
802.16 Transceiver
162
161
151
802.11 Transceiver
station
101
107
802.11+802.16 station
197
192
191
190
SHARED ACCESS MEDIUM
100
802.16 Station
196
194
193
195
802.11 Station
105
106
802.16 Base
104
802.11 AP
103

FIG. 1

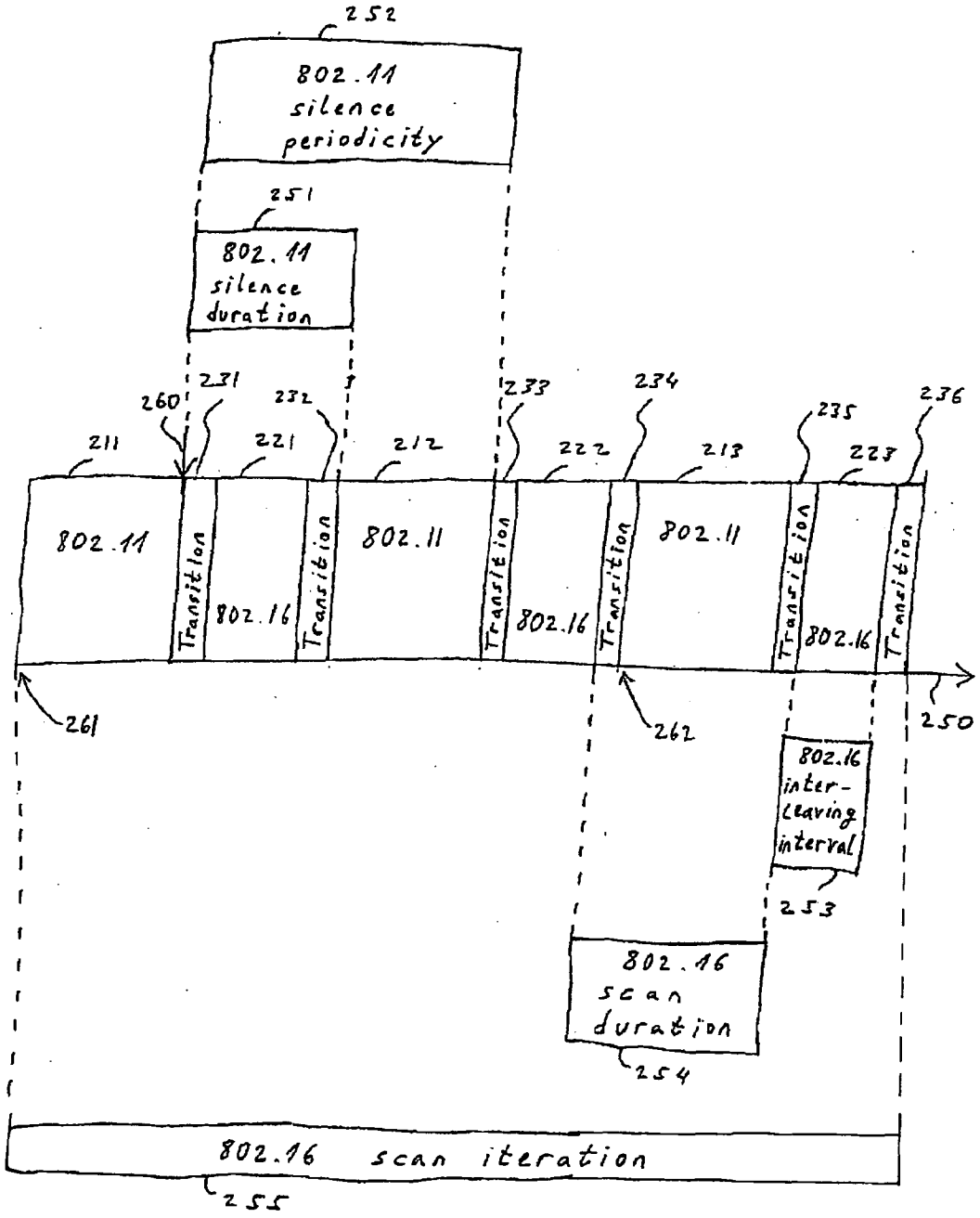

252
802.11 silence periodicity
251
802.11 silence duration
260
231
232
233
234
235
236
211
221
212
222
213
223
802.11
Transition
802.16
Transition
802.11
Transition
802.16
Transition
802.11
Transition
802.16
Transition
261
262
250
802.16 inter-leaving interval
253
802.16 scan duration
254
802.16 scan iteration
255

FIG. 2

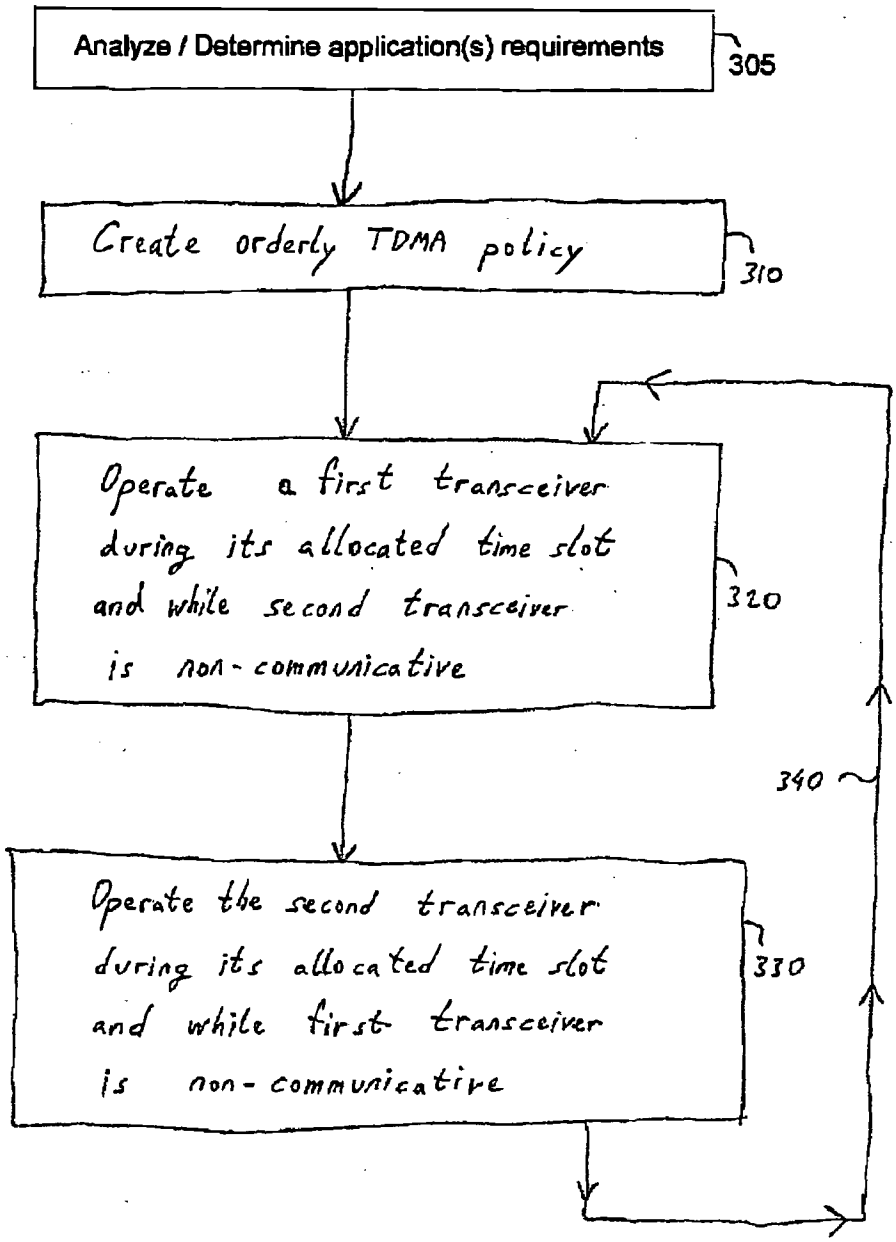

Analyze / Determine application(s) requirements
305
Create orderly TDMA policy
310
Operate a first transceiver during its allocated time slot and while second transceiver is non-communicative
320
340
Operate the second transceiver during its allocated time slot and while first transceiver is non-communicative
330

FIG. 3

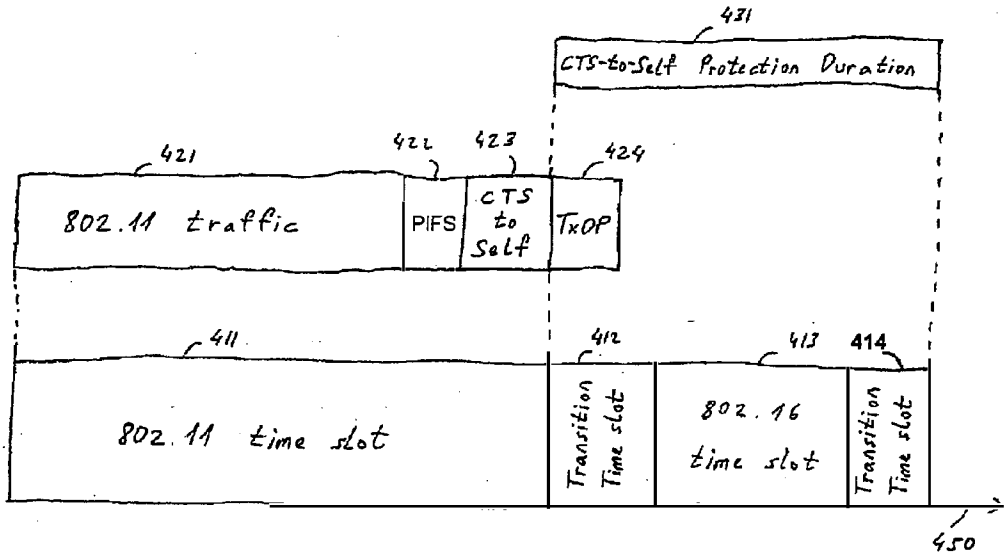

431
CTS-to-Self Protection Duration
421
422
423
424
802.11 traffic
PIFS
CTS to Self
TxOP
411
412
413
414
802.11 time slot
Transition Time slot
802.16 time slot
Transition Time slot
450

FIG. 4

DEVICE, SYSTEM AND METHOD OF COORDINATION AMONG MULTIPLE TRANSCEIVERS

BACKGROUND OF THE INVENTION

[0001] In the field of wireless communications, a hybrid wireless communication station may include multiple wireless transceivers, for example, a first wireless transceiver able to operate in accordance with a first wireless communication standard or protocol, and a second transceiver able to operate in accordance with a second wireless communication standard or protocol.

[0002] Transmission or reception of wireless communication signals by the first transceiver may interfere with concurrent communication by the second transceiver.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as to organization and method of operation, together with features and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanied drawings in which:

[0004] FIG. **1** is a schematic block diagram illustration of a wireless communication system utilizing coordination among multiple transceivers in accordance with an embodiment of the invention;

[0005] FIG. **2** is a schematic timing diagram of wireless communication signals in accordance with an embodiment of the invention;

[0006] FIG. **3** is a schematic flow-chart of a method of coordination among multiple transceivers in accordance with an embodiment of the invention; and

[0007] FIG. **4** is a schematic timing diagram of wireless communication signals in accordance with another embodiment of the invention.

[0008] It will be appreciated that for simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity. Further, where considered appropriate, reference numerals may be repeated among the figures to indicate corresponding or analogous elements.

DETAILED DESCRIPTION OF THE INVENTION

[0009] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, units and/or circuits have not been described in detail so as not to obscure the invention.

[0010] Embodiments of the invention may be used in a variety of applications. Some embodiments of the invention may be used in conjunction with various devices and systems, for example, a transmitter, a receiver, a transceiver, a transmitter-receiver, a wireless communication station, a wireless communication device, a wireless Access Point (AP), a modem, a wireless modern, a personal computer, a desktop computer, a mobile computer, a laptop computer, a notebook computer, a tablet computer, a server computer, a handheld computer, a handheld device, a Personal Digital Assistant (PDA) device, a handheld PDA device, a network, a wireless network, a Local Area Network (LAN), a Wireless LAN (WLAN), a Metropolitan Area Network (MAN), a Wireless MAN (WMAN), a Wide Area Network (WAN), a Wireless WAN (WWAN), devices and/or networks operating in accordance with existing IEEE 802.11, 802.11a, 802.11b, 802.11e, 802.11g, 802.11h, 802.11i, 802.11n, 802.16, 802.16d, 802.16e standards and/or future versions and/or derivatives and/or Long Term Evolution (LTE) of the above standards, a Personal Area Network (PAN), a Wireless PAN (WPAN), units and/or devices which are part of the above WLAN and/or PAN and/or WPAN networks, one way and/or two-way radio communication systems, cellular radio-telephone communication systems, a cellular telephone, a wireless telephone, a Personal Communication Systems (PCS) device, a PDA device which incorporates a wireless communication device, a Multiple Input Multiple Output (MIMO) transceiver or device, a Single Input Multiple Output (SIMO) transceiver or device, a Multiple Input Single Output (MISO) transceiver or device, a Multi Receiver Chain (MRC) transceiver or device, a transceiver or device having "smart antenna" technology or multiple antenna technology, or the like. Some embodiments of the invention may be used in conjunction with one or more types of wireless communication signals and/or systems, for example, Radio Frequency (RF), Infra Red (IR), Frequency-Division Multiplexing (FDM), Orthogonal FDM (OFDM), Time-Division Multiplexing (TDM), Time-Division Multiple Access (TDMA), Extended TDMA (E-TDMA), General Packet Radio Service (GPRS), Extended GPRS, Code-Division Multiple Access (CDMA), Wideband CDMA (WCDMA), CDMA 2000, Multi-Carrier Modulation (MDM), Discrete Multi-Tone (DMT), Bluetooth™, ZigBee™, or the like. Embodiments of the invention may be used in various other apparatuses, devices, systems and/or networks.

[0011] Although embodiments of the invention are not limited in this regard, discussions utilizing terms such as, for example, "processing,""computing,""calculating,""determining,""establishing", "analyzing", "checking", or the like, may refer to operation(s) and/or process(es) of a computer, a computing platform, a computing system, or other electronic computing device, that manipulate and/or transform data represented as physical (e.g., electronic) quantities within the computer's registers and/or memories into other data similarly represented as physical quantities within the computer's registers and/or memories or other information storage medium that may store instructions to perform operations and/or processes.

[0012] Although embodiments of the invention are not limited in this regard, the terms "plurality" and "a plurality" as used herein may include, for example, "multiple" or "two or more". The terms "plurality" or "a plurality" may be used throughout the specification to describe two or more components, devices, elements, units, parameters, or the like. For example, "a plurality of stations" may include two or more stations.

[0013] Although embodiments of the invention are not limited in this regard, the term "reduced power mode" as used herein may include, for example, an idle mode, a standby mode, a power conservation mode, a power save mode, an efficiency mode, a "sleep" mode, a semi-operational mode, a semi-active mode, a partially-active mode, or other modes of operations in which a component (e.g., a transceiver or a sub-unit thereof) is not fully operational and/or active.

[0014] Although portions of the discussion herein may relate, for demonstrative purposes, to a first transceiver able to operate in accordance with IEEE 802.11 standard (or a derivative thereof), and a second transceiver able to operate in accordance with IEEE 802.16 standard (or a derivative thereof), embodiments of the invention are not limited in this regard, and may be used in accordance with various other types of transceivers and combination thereof, including, for example, Zigbee transceivers, cellular communication transceivers, or the like.

[0015] FIG. **1** schematically illustrates a block diagram of a wireless communication system **100** utilizing coordination among multiple transceivers in accordance with an embodiment of the invention. System **100** may include one or more wireless communication stations, for example, a station **101**. System **100** may optionally include other wireless devices, for example, an Access Point (AP) **103**, e.g., able to operate in accordance with IEEE 802.11 standard; and a base station **104**, e.g., able to operate in accordance with IEEE 802.16 standard. System **100** may further, optionally, include other wireless communication stations, for example, a station **105** able to operate in accordance with IEEE 802.11 standard, and a station **106** able to operate in accordance with IEEE 802.16 standard.

[0016] In some embodiments, for example, station **101** may be a hybrid wireless communication device, e.g., a station including multiple wireless transceivers able to operate in accordance with multiple, respective, wireless communication standards or protocols, e.g., synchronic and/or asynchronous standards or protocols, scheduled and/or non-scheduled standards or protocols, managed and/or non-managed standards or protocols, burstable and/or non-burstable standards and/or protocols, or the like. For example, in one embodiment, station **101** may include a wireless transceiver **151** able to operate in accordance with IEEE 802.11 standard, and a wireless transceiver **152** able to operate in accordance with IEEE 802.16 standard. In another embodiment, for example, station **101** may include a single hybrid wireless transceiver, for example, able to alternately operate in accordance with a two or more wireless communication standards or protocols (e.g., IEEE 802.11 standard and IEEE 802.16 standard). Other suitable standards or protocols may be used.

[0017] System **100** may optionally include more than one hybrid devices, e.g., in addition to station **101**. For example, system **100** may further include a hybrid station **107** able to communicate in accordance with IEEE 802.11 standard and in accordance with IEEE 802.16 standard.

[0018] Station **101**, AP **103**, base station **104**, station **105**, station **106** and station **107** may communicate using a shared access medium **190**, for example, through wireless communication links **191**-**197**.

[0019] In some embodiments, system **100** may be or may include one or more wireless communication networks, for example, an a-synchronic or asynchronous wireless network, a synchronic wireless network, a managed wireless network, a non-managed wireless network, a burstable wireless network, a non-burstable wireless network, a scheduled wireless network, a non-scheduled wireless network, or the like. For example, in one embodiment, AP **103** and transceiver **151** of station **101** may be able to operate in accordance with a first wireless communication standard, e.g., IEEE 802.11 standard, which may be a-synchronic, asynchronous, burstable, non-managed, non-scheduled, or the like; whereas base station **104** and transceiver **152** of station **101** may be able to operate in accordance with a second wireless communication standard, e.g., IEEE 802.16 standard, which may be synchronic, managed, scheduled, or the like.

[0020] Station **101** may include, for example, a processor **111**, an input unit **112**, an output unit **113**, a memory unit **114**, and a storage unit **115**. Station **101** may further include multiple wireless transceivers, for example, transceivers **151** and **152**, and one or more antennas, for example, antennas **161** and **162**. Station **101** may optionally include other suitable hardware components and/or software components. In some embodiments, the components of station **101** may be enclosed in, for example, a common housing, packaging, or the like.

[0021] Processor **111** may include, for example, a Central Processing Unit (CPU), a Digital Signal Processor (DSP), a microprocessor, a controller, a chip, a microchip, one or more circuits, an Integrated Circuit (IC), or any other suitable multi-purpose or specific processor or controller. Processor **111** may, for example, process signals and/or data transmitted and/or received by station **101**.

[0022] Input unit **112** may include, for example, a keyboard, a keypad, a mouse, a touch-pad, a stylus, a microphone, or other suitable pointing device or input device. Output unit **113** may include, for example, a Cathode Ray Tube (CRT) monitor or display unit a Liquid Crystal Display (LCD) monitor or display unit, a screen, a monitor, a speaker, or other suitable display unit or output device.

[0023] Memory unit **114** may include, for example, a Random Access Memory (RAM), a Read Only Memory (ROM), a Dynamic RAM (DRAM), a Synchronous DRAM (SD-RAM), a Flash memory, a volatile memory, a non-volatile memory, a cache memory, a buffer, a short term memory unit, a long term memory unit, or other suitable memory units or storage units. Storage unit **115** may include, for example, a hard disk drive, a floppy disk drive, a Compact Disk (CD) drive, a CD-ROM drive, or other suitable removable or non-removable storage units. Memory unit **114** and/or storage unit **115** may, for example, store data transmitted and/or received by station **101**.

[0024] Transceiver **151** and/or transceiver **152** may include, for example, a wireless Radio Frequency (RF) transceiver able to transmit and/or receive wireless RF signals, e.g., through antenna **161** and/or antenna **162**, respectively. In some embodiments, for example, transceiver **151** and/or transceiver **152** may be implemented using a transmitter, a receiver, a transmitter-receiver, or one or more units able to perform separate or integrated functions of transmitting and/or receiving wireless communication signals, blocks, frames, transmission streams, packets, messages and/or data. In one embodiment, for example, two or

more transceivers of station **101** (e.g., transceivers **151**-**152**) may be implemented using a single component, e.g., a dual-transceiver card or modem, a multiple-transceiver card or modem, or the like. Additionally or alternatively, for example, transceivers **151**-**152** of station **101** may optionally be otherwise collocated within a single common modem, card, packaging, housing, wireless communication unit, wireless communication component, station, apparatus, or the like.

[0025] Antenna **161** and/or antenna **162** may include an internal and/or external RF antenna, for example, a dipole antenna, a monopole antenna, an omni-directional antenna, an end fed antenna, a circularly polarized antenna, a micro-strip antenna, a diversity antenna, or any other type of antenna suitable for transmitting and/or receiving wireless communication signals, blocks, frames, transmission streams, packets, messages and/or data.

[0026] In some embodiments, station **101** may utilize an orderly Time-Division Multiple Access (TDMA) scheme to coordinate between multiple collocated transceivers, e.g., between the operation of transceiver **151** and the operation of transceiver **152**, for example, to avoid or reduce interference among the multiple transceivers. The orderly TDMA scheme may optionally be implemented using a Communication Manager (CM) **117** which may optionally be included in station **101**. In some embodiments, CM **117** may be implemented using a hardware component (e.g., a controller, part of transceivers **151** and/or **152**, part of processor **111**, a stand-alone unit, or the like) and/or a software component (e.g., a stand-alone software component, an application, a driver, a portion of an Operating System (OS) of station **101**, or the like). CM **117** may, for example, perform one or more operations to coordinate between the operation of transceiver **151** and the operation of transceiver **152**.

[0027] In some embodiments, station **101** may utilize an orderly TDMA scheme having an orderly absence mechanism, such that station **101** may be absent from a first wireless network (e.g., IEEE 802.11 network) while station **101** operates in a second wireless network (e.g., IEEE 802.16 network), or vice versa. For example, at a first time slot, transceiver **151** of station **101** may operate (e.g., in accordance with IEEE 802.11 standard) and communicate with AP **103**, whereas transceiver **152** of station **101** may not operate and may not communicate with base station **104**. Similarly, at a second time slot, transceiver **152** of station **101** may operate (e.g., in accordance with IEEE 802.16 standard) and communicate with base station **104**, whereas transceiver **151** of station **101** may not operate and may not communicate with AP **103**.

[0028] In some embodiments, for example, the orderly TDMA scheme may allow station **101** and/or base station **104** to determine in advance (e.g., prior to the first time slot), that station **101** and/or transceiver **152** are expected to be absent from the second network (e.g., the 802.16 network) during the first time slot; accordingly, substantially no transmission may be performed to or by transceiver **152** during the first time slot. Similarly, the orderly TDMA scheme may allow station **101** and/or AP **103** to determine in advance (e.g., prior to the second time slot), that station **101** and/or transceiver **151** are expected to be absent from the first network (e.g., the 802.11 network) during the second time slot; accordingly, substantially no transmission may be performed to or by transceiver **151** during the second time slot.

[0029] Reference is made to FIG. **2**, which schematically illustrates a demonstrative example of a timing diagram of wireless communication signals in accordance with an embodiment of the invention. A horizontal axis **250** may indicate, for example, timing of wireless communication signals transmitted or received by station **101** of FIG. **1**. For example, blocks **211**-**213** may indicate time slots in which wireless communication signals are transmitted and/or received by transceiver **151** of FIG. **1** (e.g., the IEEE 802.11 transceiver); blocks **221**-**223** may indicate time slots in which wireless communication signals are transmitted and/or received by transceiver **152** of FIG. **1** (e.g., the IEEE 802.16 transceiver); and optional blocks **231**-**236** may indicate optional transition time slots, e.g., time periods in which transceiver **151** and transceiver **152** do not transmit and do not receive wireless communication signals.

[0030] As illustrated in FIG. **2**, an orderly TDMA scheme may alternate between time slots allocated for different types of communication. For example, a time slot in which a first communication standard is used (e.g., block **211**, corresponding to IEEE 802.11 standard) may be followed by a time slot in which a second communication standard is used (e.g., block **221**, corresponding to IEEE 802.16 standard). Then, the time slot in which the second communication standard is used (e.g., block **221**, corresponding to IEEE 802.16 standard) may be followed by a time slot in which the first communication standard is used (e.g., block **212**, corresponding to IEEE 802.11 standard), and so on. In some embodiments, a time slot reserved for IEEE 802.11 communication may not overlap with a time slot reserved for IEEE 802.16 communication, and vice versa.

[0031] In some embodiments, during a time slot reserved for IEEE 802.16 communication, the IEEE 802.16 transceiver may be in communicative mode (e.g., may transmit signals and/or may receive signals, may be operational, may be active, or the like), whereas the IEEE 802.11 transceiver may be in non-communicative mode (e.g., may be non-operational, may be absent from the network, may be in reduced power mode, may not transmit signals, may not receive signals, may be inactive, or the like). Similarly, during a time slot reserved for IEEE 802.11 communication, the IEEE 802.11 transceiver may be in communicative mode (e.g., may transmit signals and/or may receive signals, may be operational, may be active, or the like), whereas the IEEE 802.16 transceiver may be in non-communicative mode (e.g., may be non-operational, may be absent from the network, may be in reduced power mode, may not transmit signals, may not receive signals, may be inactive, or the like).

[0032] Optionally, transition time slots may be used in between two communication time slots. For example, a transition time slot (block **231**) may be used between a time slot in which a first communication standard is used (e.g., block **211**, corresponding to IEEE 802.11 standard) and a time slot in which a second wireless communication standard is used (e.g., block **221**, corresponding to IEEE 802.16 standard). Similarly, a transition time slot (block **232**) may be used between a time slot in which the second communication standard is used (e.g., block **221**, corresponding to

IEEE 802.16 standard) and a time slot in which the first wireless communication standard is used (e.g., block **212**, corresponding to IEEE 802.11 standard), and so on.

[0033] In one embodiment, transition time slots may have a constant length; for example, the length of transition time slot **231** may be substantially equal to the length of transition time slot **232**. In another embodiment, transition time slots may have various lengths; for example, the length of transition time slots that follow a communication time slot of a first standard, may be different from the length of transition time slots that follow a communication time slot of a second standard.

[0034] Referring again to FIG. **1**, station **101** may optionally include a coordinator **118** to coordinate between the operations of transceivers **151-152**. Coordinator **118** may be implemented, for example, as part of CM **117**, as part of transceivers **151-152**, as a combination of transceivers **151** and **152**, as part of upper Media Access Control (MAC)s **121-122** described herein, as part of lower MAC/BaseBands **131-132** described herein, as a combination of upper MAC **121** and/or upper MAC **122** and/or lower MAC/BB **131** and/or lower MAC/BB **132**, as a separate sub-unit of station **101**, using software components and/or hardware components, or the like. In some embodiments, the components of coordinator **118** may correspond to various components of transceivers **151-152** or station **101**, such that, for example, components of coordinator **118** may correspond to a high-level architecture of transceivers **151-152** or other components of station **101**. In some embodiments coordinator **118** may optionally include one or more parts or sub-units of the RF components **140** described herein, e.g., one or more parts or sub-units of RF components **140** which may be shared between transceivers **151-152**, or one or more components used exclusively by transceiver **151** or exclusively by transceiver **152**.

[0035] Coordinator **118** may include, for example, an upper MAC coordinator **120**, e.g., a master driver or a coordination application able to define a policy (e.g., a coordination policy, a sharing policy, or the like) used by the orderly TDMA scheme. Coordinator **118** may further include, for example, a lower MAC coordinator **130** able to perform the coordination and/or synchronization operations between transceivers **151-152**. The upper MAC coordinator **120** may control, or may communicate with, a first upper MAC **121** (e.g., IEEE 802.11 upper MAC) corresponding to transceiver **151**; and may control, or may communicate with, a second upper MAC **122** (e.g., IEEE 802.16 upper MAC) corresponding to transceiver **152**. Similarly, lower MAC coordinator **130** may control, or may communicate with, a first lower MAC/BB **131** (e.g., IEEE 802.11 lower MAC/BB) corresponding to transceiver **151**; and may control, or may communicate with, a second lower MAC/BB **132** (e.g., IEEE 802.16 lower MAC/BB) corresponding to transceiver **152**. The IEEE 802.11 lower MAC/BB **131** may be able to communicate with the IEEE 802.11 upper MAC **121**; similarly, the IEEE 802.16 lower MAC/BB **132** may be able to communicate with the IEEE 802.16 upper MAC **122**. In some embodiments, the IEEE 802.11 upper MAC **121** and/or the lower MAC/BB **131** may be included in, or may be operatively associated with, the IEEE 802.11 transceiver **151**; whereas the IEEE 802.16 upper MAC **122** and/or the lower MAC/BB **132** may be included in, or may be operatively associated with, the IEEE 802.16 transceiver **152**.

[0036] The lower MAC/BBs **131-132** may utilize one or more shared and/or separate (e.g., exclusive or non-shared) RF components **140**, e.g., one or more shared or separate front-ends **141**, one or more shared or separate antennas **142**, one or more shared or separate RF Integrated Circuits (RFICs) **143**, or the like. In one embodiment, for example, lower MAC/BBs **131-132** may utilize a shared RF component **140**, (for example, shared antenna(s) **142**), e.g., since according to the orderly TDMA scheme, lower MAC/BB **131** may not communicate while lower MAC/BB **132** communicates, and lower MAC/BB **132** may not communicate while lower MAC/BB **131** communicates. For example, one or more protocol mechanisms may be used by coordinator **118** to allow transceiver **151** to orderly abandon a first wireless network (e.g., IEEE 802.11 network) when transceiver **152** is expected to communicate in a second wireless network (e.g., IEEE 802.16 network) in accordance with the orderly TDMA scheme, or vice versa. Accordingly, for example, only one of transceivers **151-152** may utilize the shared RF component(s) **140** at a certain time slot. In another embodiment, lower MAC/BB **131** may utilize a first set of RF components **140**, whereas lower MAC/BB **132** may utilize a second, separate, set of RF components **140**.

[0037] Although FIG. **1** shows, for demonstrative purposes and for clarity of description, transceivers **151-152**, lower MAC/BBs **131-132** and upper MACs **121-122** as separate components or modules, embodiments of the invention are not limited in this regard. For example, in some embodiments, some components of station **101** may be implemented using "physical" units, whereas other components of station **101** may be implemented using "logical" units or modules. In one embodiment, for example, transceiver **151** may include lower MAC/BB **131**, may optionally include upper MAC **121**, and may further optionally include one or more parts of RF component(s) **140**; similarly, for example, transceiver **152** may include lower MAC/BB **132**, may optionally include upper MAC **122**, and may further optionally include one or more parts of RF component(s) **140**. Other implementations of separate, integrated and/or combined units, physical units and/or logical modules may be used.

[0038] In some embodiments, the orderly TDMA scheme may not allow simultaneous or concurrent IEEE 802.11 and IEEE 802.16 communication, or may allow either exclusive IEEE 802.11 communication or exclusive IEEE 802.16 communication at a certain time slot. In other embodiments, the orderly TDMA scheme may allow simultaneous or concurrent IEEE 802.11 and IEEE 802.16 communication, for example, by scheduling such communications in a non-overlapping time-division. In some embodiments, for example, IEEE 802.16 communication may be performed substantially simultaneously and/or concurrently with IEEE 802.11 communication, or vice versa, e.g., if non-shared RF component(s) **140** are utilized, if exclusive or separate RF component(s) **140** are utilized, and/or if RF component(s) **140** allow sharing during concurrent IEEE 802.11 and IEEE 802.16 communications.

[0039] Upper MAC coordinator **120** may define the coordination policy, for example, based on an analysis of requirements and/or characteristics of one or more applications which may be executed by station **101**, e.g., taking into account the priority required by such application(s), taking into account the Quality of Service (QoS) required by such

applications, taking into account the type of such application(s) (e.g., a Voice Over Internet Protocol (VoIP) application, an Internet browsing application, or the like), taking into account the bandwidth required by such application(s) and/or other suitable parameters or criteria. The coordination policy may be dynamically re-defined or modified, e.g., periodically, upon demand, when a pre-defined condition is met, or the like. The policy may indicate, for example, an orderly TDMA such that only one of transceivers **151**-**152** may utilize the RF component(s) **140** at a certain time slot, or that only one of lower MAC/BBs **131**-**132** may utilize the RF component(s) **140** at a certain time slot.

[**0040**] The coordination policy may include, for example, one or more parameters corresponding to the operation of transceivers **151**-**152**, the operation of lower MAC/BBs **131**-**132**, and/or the utilization of RF component(s) **140** (e.g., shared RF component(s) **140**) by lower MAC/BBs **131**-**132**. The definition of the coordination policy may take into account, for example, sharing cycle or meta-frame information, the requirements or parameters of one or more applications executed by station **101** (e.g., a vocoder cycle used for VoIP conversations by a VoIP application), or the like. The coordination policy may define, for example, that a first time slot may be allocated for exclusive communication of transceiver **151**, a second time slot may be allocated for exclusive communication of transceiver **152**, and so on; optionally utilizing transition time slots to separate between communication time slots. In some embodiments, additionally or alternatively, the coordination policy may optionally include or define other attributes or parameters, for example, a size of a cycle used for alternate communications of transceiver **151** and transceiver **152** (e.g., a "super-cycle" or a combined cycle), a size or a percentage (e.g., of the combined cycle) of time slots reserved for alternate communications of transceiver **151** and transceiver **152**, definitions or attributes to resolve a conflict or to establish precedence or priority in case of overlapping time slots, a list or time slots, or the like.

[**0041**] In some embodiments, for example, the orderly TDMA scheme may utilize orderly absence from a first wireless network, while being active and operational in a second network; the orderly TDMA scheme may provide to a user of station **101** a perception that the user is concurrently fully active on both the first and second networks, e.g., without disrupting the QoS required by the user or by applications executed by station **101**.

[**0042**] In some embodiments, transceivers **151** and **152** may be synchronized or co-synchronized, e.g., may share a common timing mechanism, or may have or may utilize a timing synchronization mechanism. For example, in one embodiment, transceivers **151** and **152** may be operatively connected to a clock **116**, e.g., of station **101** and/or of processor **111**, which may provide a common timing mechanism for transceivers **151** and **152**. In another embodiment, for example, software-based and/or hardware-based synchronization mechanisms may be used to synchronize between transceivers **151** and **152**, or between lower MAC/BBs **131**-**132**.

[**0043**] The lower MAC/BB **131** may define or set one or more parameters, which may be examined or analyzed by the lower MAC/BB **132**, or vice versa, e.g., utilizing the lower MAC coordinator **130**. For example, parameters set by lower MAC/BB **131** may include: a limitation parameter indicating a beginning of an access of lower MAC/BB **131** to the RF component(s) **140**; a duration parameter indicating the duration of the access of the lower MAC/BB **131** to the RF component(s) **140**; a guard time parameter indicating a time period required for lower MAC/BB **131** to be brought out of a reduced power mode prior to operation; a priority parameter indicating a priority of the current operation, e.g., with respect to the wireless network; and/or other parameters. In some embodiments, for example, the value of the guard time parameter may be taken into account when calculating whether or not lower MAC/BB **131** has a sufficient time slot to be brought out of a reduced power mode and then to perform a communication operation.

[**0044**] In some embodiments, for example, the priority parameter may be used to determine which one of lower MAC/BBs **131**-**132** may utilize the RF component(s) **140** when both lower MAC/BBs **131**-**132** contend for using the RF component(s) **140** during the same time slot or during overlapping time slots; for example, operations may be assigned priority values which may be mapped to a common scale (e.g., a scale of 1 to 4), and a resolution may be made based on the scaled level of priority; optionally, a global conflict resolution parameter (e.g., determined by the upper MAC coordinator **120** and defined as part of the coordination policy) may be used to resolve concurrent contentions for RF component(s) **140** by lower MAC/BBs **131**-**132**. In some embodiments, an orderly TDMA scheme may suffice to substantially eliminate concurrent contentions for RF component(s) **140** by lower MAC/BBs **131**-**132**, for example, utilizing the orderly absence from the wireless network as indicated by the limitation parameter, the duration parameter and the guard time parameter.

[**0045**] In some embodiments, transceiver **151** may examine the set of parameters of transceiver **152**, to determine an upcoming time slot in which transceiver **152** is expected to be absent from the wireless network (e.g., an upcoming time slot in which transceiver **152** is not expected to transmit and/or receive signals), such that transceiver **151** may operate (e.g., transmit and/or receive signals, utilizing the RF component(s) **140**) during that upcoming time slot. Until that upcoming time slot, transceiver **151** or one or more sub-units thereof may be in a reduced power mode. Optionally, transceiver **151** may enter the reduced power mode after exchanging one or more required protocol messages with AP **103**, for example, such that signals are not transmitted to transceiver **151** and are not expected to be received from transceiver **151** during its reduced power period.

[**0046**] Similarly, transceiver **152** may examine the set of parameters of transceiver **151**, to determine an upcoming time slot in which transceiver **151** is expected to be absent from the wireless network (e.g., an upcoming time slot in which transceiver **151** is not expected to transmit and/or receive signals), such that transceiver **152** may operate (e.g., transmit and/or receive signals, utilizing the RF component(s) **140**) during that upcoming time slot. Until that upcoming time slot, transceiver **152** or one or more sub-units thereof may be in a reduced power mode. Optionally, transceiver **152** may enter the reduced power mode after exchanging one or more required protocol messages with base station **104**, for example, such that signals are not

transmitted to transceiver **152** and are not expected to be received from transceiver **152** during its reduced power period.

[0047] At the beginning of the time slot allocated for communication of transceiver **151**, or shortly prior to that time slot (e.g., a time period prior to the allocated time slot to allow transceiver **151** to be brought out of its reduced power mode), transceiver **151** (or one or more components thereof which are in a reduced power mode) may be brought out of reduced power mode, and transceiver **151** may communicate (e.g., transmit and/or receive signals) during that time slot. Additionally, during that time slot, transceiver **152** may not transmit and/or receive signal, and may optionally be in reduced power mode.

[0048] FIG. **3** is a schematic flow-chart of a method of coordination among wireless transceivers in accordance with an embodiment of the invention. Operations of the method may be implemented, for example, by system **100** of FIG. **1**, by station **101** of FIG. **1**, and/or by other suitable transceivers, units, stations, devices, and/or systems.

[0049] As indicated at box **305**, the method may include, for example, analyzing one or more application(s) executed by a wireless communication device or by a computing system (e.g., including or utilizing station **101** of FIG. **1**), e.g., to determine requirements (e.g., bandwidth requirements, QoS requirements, or the like) of such application(s).

[0050] As indicated at box **310**, the method may include, for example, creating an orderly TDMA policy between a first transceiver able to operate in accordance with a first wireless communication standard or protocol (e.g., IEEE 802.11 standard) and a second (e.g., collocated in a common device) transceiver able to operate in accordance with a second wireless communication standard or protocol (e.g., IEEE 802.16 standard). This may optionally include, for example, creating a priority policy, for example, to avoid or resolve a conflict or to establish precedence or priority in case of overlapping time slots. The creation of the orderly TDMA policy may be based on, or may take into account, the analysis or determination of requirements of one or more application(s).

[0051] As indicated at box **320**, the method may include, for example, operating the first transceiver during a first time slot allocated for its communication according to the orderly TDMA policy, and/or during a time interval in which the second transceiver is non-communicative or absent from its wireless network, and/or during a partial or complete time interval freed-up by the second transceiver for communication of the first transceiver. During the first time slot, the second transceiver may not communicate, may be non-operational, and/or may be in reduced power mode.

[0052] As indicated at box **330**, the method may include, for example, operating the second transceiver during a second time slot allocated for its communication according to the orderly TDMA policy, and/or during a time interval in which the first transceiver is non-communicative or absent from its wireless network, and/or during a partial or complete time interval freed-up by the first transceiver for communication of the second transceiver. During the second time slot, the first transceiver may not communicate, may be non-operational, and/or may be in reduced power mode.

[0053] As indicated by arrow **340**, the method may include, for example, repeating some or all of the above operations, e.g., alternating between communication by the first transceiver while the second transceiver is non-communicative, and communication by the second transceiver while the first transceiver is non-communicative.

[0054] Optionally, a transition time slot may be utilized between the alternating communication time slots, for example, between the operation of box **320** and the operation of box **330**, and/or between the operation of box **330** and the repeated operation of box **320**.

[0055] Other operations or sets of operations may be used in accordance with embodiments of the invention.

[0056] Referring again to FIG. **1**, station **101** may operate as a "muting" or "silencing" manager able to "mute" (e.g., able to silence) one or more other IEEE 802.11 stations (e.g., IEEE 802.11 station **105**) during time slots allocated for IEEE 802.16 communication (e.g., of transceiver **152**, of base station **104**, or of IEEE 802.16 station **106**). For example, station **101** may "mute" (e.g., may silence) IEEE 802.11 station **105** (e.g., using a suitable IEEE 802.11 mechanism), and may further "mute" (e.g. may further silence) its IEEE 802.11 transceiver **151** during a time slot reserved for IEEE 802.16 according to the orderly TDMA scheme. In some embodiments, for example, station **101**, operating as a "muting" or "silencing" manager, may instruct one or more other IEEE 802.11 stations to avoid IEEE 802.11 communication (e.g., transmission and/or reception) during time slots reserved for IEEE 802.16 communication; based on the "muting" or "silencing" instruction or indication received from station **101**, the other IEEE 802.11 stations may avoid communication during time slots reserved for IEEE 802.16 communication. In some embodiments, station **101** may utilize its IEEE 802.11 transceiver to "mute" or silence one or more other IEEE 802.11 stations; and after the silencing or "muting" of the other IEEE 802.11 station(s) is achieved or acknowledged, station **101** may then "mute" or silence its IEEE 802.11 transceiver.

[0057] In some embodiments, for example, station **101** may transmit (e.g., using its IEEE 802.11 transceiver **151**) to station **105** an indication that a certain time slot is reserved for IEEE 802.16 communication, and that station **105** is required to avoid IEEE 802.11 communication, or be non-communicative, during such time slots. The indication may be, for example, a particular indication related to one or more time slots reserved for IEEE 802.16 communication; or may be a general indication which may notify station **105** of characteristics of repeating time slots which are reserved for IEEE 802.16 communication. In one embodiment, station **101** may transmit one or more suitable IEEE 802.11 messages, control messages and/or indications in order to "mute" or "silence" other IEEE 802.11 stations during the time slots reserved for IEEE 802.16 communication; for example, station **101** may transmit "quiet period" control messages, in accordance with IEEE 802.11 standard and/or its derivatives, in order to instruct other IEEE 802.11 stations about the required ""silence period". In another embodiment, station **101** may transmit messages, control messages and/or indications which may not be in accordance with IEEE 802.11 standard, e.g., may utilize out-of-band control signals and/or proprietary signals, in order to "mute" or "silence" other IEEE 802.11 stations during the time slots reserved for IEEE 802.16 communication.

[0058] In some embodiments, for example, station **101** may operate as a "muting" or "silencing" manager and may

announce or notify to other stations in its IEEE 802.11 cell (e.g., to station **105**) one or more properties of a "silence period", in which substantially the entire IEEE 802.11 cell (e.g., including station **105**) is required or requested to be non communicative, and which corresponds to a time slot reserved by the orderly TDMA scheme to IEEE 802.16 communication. The notification may be performed, for example, using a dedicated transmission from station **101** to station **105**, or using a general transmission by **101** to other IEEE 802.11 devices, e.g., utilizing a beacon frame or a probe response. In some embodiments, for example, station **101** may operate as an IEEE 802.11 Access Point (AP) in order to coordinate the communication of substantially the entire IEEE 802.11 cell (e.g., including other IEEE 802.11 devices) with the orderly TDMA scheme used by station **101**. For example, station **101** may define a "silence period" across the IEEE 802.11 cell, which may correspond to a time slot reserved for IEEE 802.16 communication and a transition time from IEEE 802.11 communication to IEEE 802.16 communication and vice versa, and in which other IEEE 802.11 devices across the IEEE 802.11 cell may not communicate.

[0059] The notification of the "silence period" may be in accordance with IEEE 802.11 standard, and may include one or more attributes or parameters, for example, a "silence period start time" parameter indicating a time stamp in which a transition begins from IEEE 802.11 communication to IEEE 802.16 communication, or indicating a time stamp corresponding to an ending of a time slot allocated for IEEE 802.11 communication, or indicating a time stamp corresponding to a beginning of a time slot allocated for IEEE 802.16 communication. The "silence period" notification may further include a "silence duration" parameter, indicating the length of the "silence period" (block **251** in FIG. **2**), e.g., corresponding to a length of a time slot allocated for IEEE 802.16 communication as well as two transition time slots (e.g., a first transition time slot prior to the IEEE 802.16 slot, and a second transition time slot following the IEEE 802.16 time slot). The beginning of the IEEE 802.11 "silence period" is indicated by arrow **260** in FIG. **2**.

[0060] The "silence period" notification may further include a "silence periodicity" parameter, corresponding to the length of a combined cycle (e.g., "super-cycle") (block **252** in FIG. **2**) that includes a time slot allocated for IEEE 802.11 communication and a time slot allocated for IEEE 802.16 communication, and may further optionally include two transition time slots, namely, a first transition time slot following the IEEE 802.11 time slot, and a second transition time slot following the IEEE 802.16 time slot; the "periodicity" parameter may correspond, for example, to a time period between the beginning of a first "silence period" and the beginning of a consecutive "silence period".

[0061] Station **105** may receive the "silence period" notification, and based on the received parameters, may be non-communicative and/or non-operational and/or in reduced power mode during the required "silence period". For example, station **105** may avoid transmitting and/or receiving signals in accordance with IEEE 802.11 standard during the required "silence period(s)" as instructed or indicated by station **101**, thereby allowing IEEE 802.16 communication during such "silence period(s)" of the IEEE 802.11 devices of system **100**.

[0062] In some embodiments, the IEEE 802.11 "silence period" may be implemented with regard to substantially all frequency bands in which an IEEE 802.11 may operate, e.g., the 2.4 GHz band used by IEEE 802.11b transceivers and IEEE 802.11g transceivers, as well as the 5 GHz band and/or the 5.2 GHz band used by IEEE 802.11a and/or IEEE 802.11n transceivers.

[0063] Optionally, station **101** may request that other IEEE 802.16 devices of system **100** (e.g., the IEEE 802.16 base station **104**, and optionally the IEEE 802.16 station **106** using out-of-band and/or proprietary control messages) communicate using the IEEE 802.16 during the time slots allocated for IEEE 802.16 communication, and avoid transmitting and/or receiving information using the IEEE 802.16 standard during the time slots reserved for IEEE 802.11 communication. For example, in some embodiments, the IEEE 802.16 transceiver **152** of station **101** may transmit a periodic scan request (and/or a sleep request) including a "scan duration" parameter corresponding to a length of a time slot allocated for IEEE 802.11 communication as well as two transition time slots, e.g., a first transition time slot prior to the IEEE 802.11 slot, and a second transition time slot following the IEEE 802.11 time slot (indicated by block **254** in FIG. **2**). In other embodiments, for example, the IEEE 802.16 transceiver **152** of station **101** may transmit a sleep request with similar parameters (e.g., an "initial sleep window" instead of a "scan duration" parameter) and/or other IEEE 802.16 protocol messages (e.g., an idle mode initiation request) to request an orderly absence from the IEEE 802.16 network during the time slot(s) reserved for IEEE 802.11 communication.

[0064] Additionally or alternatively, a periodic scan request (or other IEEE 802.16 control messages, a sleep request, an idle request, or the like) transmitted by the IEEE 802.16 transceiver **152** of station **101** may include an "interleaving interval" parameter corresponding to the length of a time slot allocated for IEEE 802.16 communication (block **253** in FIG. **2**); and a "scan iteration" parameter corresponding to an estimated time of a combined cycle (e.g., "super-cycle") of IEEE 802.16 and IEEE 802.11 communication, e.g., measured in seconds or minutes and including multiple IEEE 802.16 time slots and multiple IEEE 802.11 time slots (block **255** in FIG. **2**). In some embodiments, for example, after one or more "scan iterations", one or more of the communication parameters may be modified by station **101**, e.g., based on bandwidth requirements or other requirements of applications executed by station **101**.

[0065] An orderly TDMA scheme in accordance with some embodiments of the invention may be utilized in addition to, or instead of, other orderly TDMA mechanisms and/or priority-based TDMA schemes. In one embodiment, for example, a priority-based TDMA mechanism may be implemented such that a priority is raised sufficient time in advance, e.g., to allow exchange of protocol messages which may be required by the mechanism.

[0066] In some embodiments, an orderly TDMA scheme may be used to avoid or reduce RF interference between collocated wireless transceivers, e.g., transceivers **151** and **152**. In other embodiments, an orderly TDMA scheme may be used to avoid or reduce RF interference between neighboring transceivers, e.g., station **105** and transceiver **151** of

station **101**, or station **106** and transceiver **152** of station **101**. In some embodiments, for example, the coordinated silencing of IEEE 802.11 devices may optionally reduce mutual interference among various different IEEE 802.11 devices.

[**0067**] In some embodiments, optionally, an IEEE 802.11 Independent Basic Service Set (IBSS) cell (an "ad-hoc network") may be created, joined, maintained and/or managed by station **101**, e.g., an IBSS cell including the IEEE 802.11 transceiver **151** of station **101** and the IEEE 802.11 station **105**. Although two stations **101** and **105** are shown for demonstrative purposes, more than two IEEE 802.11 stations may be included in the IEEE 802.11 IBSS cell. In some embodiments, station **101** may enforce one or more IBSS cell parameters on the IBSS cell; such enforcement may optionally be, for example, in accordance with an orderly TDMA scheme used by station **101**, or independent of (and not requiring) such orderly TDMA scheme.

[**0068**] Station **101** may be required to be substantially concurrently active in both an IEEE 802.16 network (e.g., using transceiver **152** of station **101**, which may communicate with base station **104**) and the IEEE 802.11 IBSS cell (e.g., using transceiver **151** of station **101**, which may communicate with station **105** over the IBSS cell). Station **101** may periodically be absent from the IEEE 802.11 IBSS cell and, alternately, may periodically be absent from the IEEE 802.16 network, e.g., in accordance with an orderly TDMA scheme. For example, prior to leaving the IEEE 802.11 IBSS cell, station **101** may notify one or more other stations of the IBSS cell (e.g., station **105**) of the expected absence of station **101** from the IBSS network cell.

[**0069**] The IEEE 802.11 IBSS cell may operate without utilizing a central management device for the IBSS cell. For example, a station initiating the IBSS cell may define one or more parameters or attributes of the IBSS cell, e.g., a beacon interval or an Ad-hoc Traffic Indication Message (ATIM) window (e.g., alerting a station in a "sleep" mode that a packet awaits delivery), QoS parameters, or the like. Subsequent IEEE 802.11 stations that join the IBSS cell may adopt the IBSS cell parameters defined by the IBSS cell initiator, and may operate accordingly.

[**0070**] In some embodiments, for example, IEEE 802.11 station **105** may initiate an IBSS cell, and station **101** (e.g., using transceiver **151**) may join the IBSS cell. However, the IBSS cell parameters defined by station **105** may not allow station **101** to operate in accordance with its orderly TDMA scheme which allocates certain time slots for IEEE 802.11 communication (using transceiver **151**) and other time slots form IEEE 802.16 communication (using transceiver **152**). Additionally or alternatively, the IBSS cell parameters defined by station **105** may require a relatively high performance overhead by station **101**, which operates in both the IEEE 802.11 IBSS cell and the IEEE 802.16 network.

[**0071**] In some embodiments, station **101** may set, modify or re-define one or more parameters of the IEEE 802.11 IBSS cell, such that the operation of the IBSS cell is in accordance with an orderly TDMA scheme used by one or more hybrid devices (e.g., station **101** having transceivers **151** and **152**) able to operate in the IEEE 802.16 network and the IEEE 802.11 IBSS cell. The setting or modification of the IBSS cell parameter(s) may allow, for example, improved performance of the hybrid device(s) (e.g., station **101**), may reduce overhead for such hybrid device(s), and/or may reduce overhead for transition of the hybrid device(s) from IEEE 802.11 communication to IEEE 802.16 communication or vice versa.

[**0072**] For example, station **101** may join an IEEE 802.11 IBSS cell created by station **105**, and may check whether the IBSS cell parameters allow station **101** to operate efficiently in both the IEEE 802.11 IBSS cell and the IEEE 802.16 network. If the checking result is positive, station **101** may maintain the IBSS cell parameters substantially unmodified. In contrast, if the checking result is negative, station **101** may modify or re-define one or more of the IBSS cell parameters, such that the modified IBSS cell parameters allow station **101** to operate efficiently in both the IEEE 802.11 IBSS cell and the IEEE 802.16 network. For example, if the checking result is negative, the joining station (e.g., station **101**) may initiate a new IBSS cell having a Timing Synchronization Function (TSF) value greater than the value of the current TSF of the IBSS cell; the newly initiated IBSS cell may have the parameters required to implement the orderly TDMA scheme. The setting of the new, greater, TSF value may force the previous IBSS cell to coalesce to the newly-initiated IBSS cell, e.g., using an IBSS coalescing method, e.g., such that two IBSS cells having the same Service Set Identifier (SSID) coalesce into a single IBSS cell which is the IBSS cell having the greater TSF value.

[**0073**] In other embodiments, station **101** (and not, for example, station **105**) may initiate the IEEE 802.11 IBSS cell. In such initiation, station **101** may set or define IBSS cell parameters that allow station **101** to operate efficiently in both the IEEE 802.11 IBSS cell and the IEEE 802.16 network. In some embodiments, optionally, station **101** may periodically check whether the IBSS cell parameters allow station **101** to operate efficiently in both the IEEE 802.11 IBSS cell and the IEEE 802.16 network; and if the checking result is negative, station **101** may modify or re-define one or more of the IBSS cell parameters.

[**0074**] In some embodiments, for example, station **101** may transmit, using IEEE 802.11 transceiver, a Clear To Send (CTS) to Self (CTS-to-Self) frame, e.g., in order to protect a time slot reserved for IEEE 802.16 communication according to the orderly TDMA scheme in use. The duration of the time period protected by the CTS-to-Self frame may include, for example, a time slot reserved for IEEE 802.16 communication, a transition time slot prior to the IEEE 802.16 time slot, and a short guard time of Transmission Opportunity (TxOP). The TxOP parameter may be enforced by station **101** (e.g., operating as a "master" of the IBSS cell) as an IBSS cell-wide parameter, for example, to avoid lengthy transmission(s) by other IEEE 802.11 stations.

[**0075**] In some embodiments, for example, the enforced TxOP parameter may prevent a lengthy IEEE 802.11 transmission beginning prior to the guard time and extending into the transition time slot or into the time slot reserved for IEEE 802.16 communication. In some embodiments, for example, a short TxOP time period (e.g., minimal or relatively short) may be set by station **101**, in order to limit the length of a single continuous transmission of another IEEE 802.11 station participating in the IEEE 802.11 IBSS cell. For example, a relatively short TxOP time period may be set and enforced by station **101**, e.g., to accommodate the orderly TDMA scheme in use, and/or to ensure that a transmission

by an IEEE 802.11 station does not prolong, extend or exceed into a time slot reserved for IEEE 802.16 communication. In some embodiments, the short TxOP may allow station **101** to gain control of the IEEE 802.11 network prior to the beginning of the IEEE 802.16 time slot. The duration of protection obtained by the CTS-to-Self frame may be calculated by station **101**, for example, based on one or more of the "silence period" parameters defining a requested "silence period" of the IEEE 802.11 IBSS cell, e.g., the start time of the silence period (e.g., the beginning of the time slot reserved for IEEE 802.16 communication), the duration of the silence period, the periodicity of the silence period, or the like.

[0076] In some embodiments, station **101** may transmit the CTS-to-Self frame towards the end of a time slot reserved for IEEE 802.11 communication, e.g., after a Priority Inter-Frame Space (Priority IFS or PIFS) waiting time, a complete PIFS waiting time, or only a portion of a PIFS waiting time (e.g., immediately prior to the end of the PIFS waiting time). For example, in some embodiments, the CTS-to-Self frame may be transmitted by transceiver **151** of station **101** prior to the end of the PIFS waiting time, e.g., to ensure that the station **101** transmits prior to other IEEE 802.11 stations which may contend for the shared access medium **190**. In some embodiments, the CTS-to-Self frame may be transmitted by station **101** a PIFS time after the shared access medium **190** is freed, or substantially immediately prior to the ending of the PIFS time, thereby allowing station **101** to gain control and/or priority of the freed shared access medium **190**.

[0077] In some embodiments, for example, a TxOP value may be set by station **101** to enforce a maximal transmission length across the IBSS cell; based on the TxOP value, a time period (e.g., which may equal to the TxOP value) prior to the beginning of a subsequent IEEE 802.16 time slot, stations of the IEEE 802.11 IBSS cell may begin to seek an end of the IEEE 802.11 transmission; substantially a FIPS time after the end of the IEEE 802.11 transmission, the CTS-to-Self frame may be transmitted by station **101**.

[0078] In some embodiments, station **101** may set the IBSS cell parameters such that a beacon interval may be a time period corresponding to a combined cycle of IEEE 802.11 and IEEE 802.16, or to an integer multiple of such combined cycle. For example, a combined cycle may include a time slot allocated for IEEE 802.11 communication, a transition time slot, a time slot allocated for IEEE 802.16 communication, and another time slot. For example, arrow **261** in FIG. **2** indicates the timing of a first beacon signal (e.g., indicating a first Targeted Beacon Transmission Time (TBTT)), whereas arrow **262** in FIG. **2** indicates the timing of a second, subsequent, beacon signal (e.g., indicating a second, subsequent, TBTT).

[0079] In some embodiments, station **101** may optionally transmit (using IEEE 802.11 transceiver **151**) a "quiet" information element, e.g., included in a periodical beacon signal. The value of the "quiet" information element may correspond to a time slot allocated to IEEE 802.16 communication and two transition time slots. The "quiet" information element may include one or more parameters to represent one or more attributes of the required "silence period", for example, a silence duration parameter (block **251** of FIG. **2**), a silence periodicity parameter (block **252** of FIG. **2**), and/or other parameters.

[0080] In some embodiments, a synchronization mechanism may be used among multiple hybrid stations of the IBSS cell, for example, to select a station that may act as a "master", may determine the cycle of IEEE 802.11 and IEEE 802.16 communications, may determine and set the IBSS cell parameters according to an orderly TDMA scheme in use. The synchronization may be used, for example, to allow multiple hybrid stations (e.g., station **101** and station **107**) to utilize both IEEE 802.11 communication and IEEE 802.16 communication in accordance with an orderly TDMA scheme which may be uniform across the IBSS cell.

[0081] For example, one of the hybrid stations, e.g., station **101**, may operate as a "master" station, whereas other stations (e.g., other hybrid stations) of the IBSS cell may operate as "slave" stations (e.g., station **107**). The master station **101** may set the IBSS cell parameters, may transmit the CTS-to-Self frames (e.g., to protect the IEEE 802.16 time slots from IEEE 802.11 communication), and may set "silence period" parameters utilized in IEEE 802.16 communications. The master station **101** may perform these settings, for example, upon initiation of the IBSS cell by the master station **101**. In some embodiments, for example, only one station in the IEEE 802.11 IBSS cell (for example, only station **101**, and not station **107**) may transmit CTS-to-Self frames. Other hybrid stations (e.g., station **107**) may utilize the parameters set by master station **101**, and may synchronize or modify their operation based on the parameters set by master station **101**.

[0082] In some embodiments, a recovery mechanism may be used, for example, to recover from a failure or loss of CTS-to-Self frame, or to recover when the IBSS cell initiator or "master" (e.g., station **101**) leaves the IBSS cell. For example, the remaining hybrid devices of the IBSS cell (e.g., station **107** and other hybrid stations) may utilize a random or pseudo-random back-off procedure until the scheduled beginning of the subsequent time slot reserved for IEEE 802.16 communication. One of the remaining hybrid devices (e.g., the first of the remaining hybrid devices to end its back-off procedure) may send the first CTS-to-Self frame, and may operate as a "master" station for the IBSS cell.

[0083] If the hybrid station that previously operated as a "master", e.g., station **101**, is communicative again (e.g., if station **101** did not leave the IBSS cell, but rather, the CTS-to-Self frame failed or was lost), then station **101** may no longer operate as a "master" station, since another hybrid station (e.g., station **107**) operates as a "master" station. For example, station **101** may receive a CTS-to-Self frame corresponding to the IEEE 802.16 communication time slot, which may be transmitted by station **107**; and station **101** may thus determine that station **107** operates as a "master" station for the IBSS cell.

[0084] Although portions of the discussion herein may relate, for demonstrative purposes, to transmission of CTS-to-Self frames and/or to utilizing a TxOP parameter, other suitable mechanisms or protocol mechanisms may be used in accordance with embodiments of the invention to implement operation according to an orderly TDMA scheme.

[0085] Reference is made to FIG. **4**, which schematically illustrates a timing diagram of wireless communication signals in accordance with another embodiment of the invention. A horizontal axis **450** may indicate, for example, timing of wireless communication signals transmitted or

received by station **101** of FIG. **1**. For example, block **411** may indicate a time slot reserved for IEEE 802.11 communication (e.g., using transceiver **151** of FIG. **1**), block **412** may indicate a transition time slot, block **413** may indicate a time slot reserved for IEEE 802.16 communication (e.g., using transceiver **152** of FIG. **1**), and block **414** may indicate another transition time slot.

[0086] The time slot reserved for IEEE 802.11 communication (block **411**) may include multiple portions, for example, corresponding to blocks **421**-**423**. For example, the time slot reserved for IEEE 802.11 communication may include a first portion (block **421**) in which data is transmitted and/or received using IEEE 802.11 standard; a second portion (block **422**) corresponding to a PIFS waiting time; and a third portion (block **423**) in which a CTS-to-Self frame may be transmitted.

[0087] Block **431** indicates the duration of the protection of IEEE 802.16 communication achieved by the CTS-to-Self frame mechanism, e.g., the time period in which substantially no IEEE 802.11 may be performed; this time period (block **431**) may correspond, for example, to the total of the duration of the IEEE 802.16 time slot (block **413**), the duration of the first transition time slot (block **412**), the duration of the second transition time slot (block **414**), and the duration of the TxOP guard time (block **424**).

[0088] Some embodiments of the invention may be implemented by software, by hardware, or by any combination of software and/or hardware as may be suitable for specific applications or in accordance with specific design requirements. Embodiments of the invention may include units and/or sub-units, which may be separate of each other or combined together, in whole or in part, and may be implemented using specific, multi-purpose or general processors or controllers, or devices as are known in the art. Some embodiments of the invention may include buffers, registers, stacks, storage units and/or memory units, for temporary or long-term storage of data or in order to facilitate the operation of a specific embodiment.

[0089] Some embodiments of the invention may be implemented, for example, using a machine-readable medium or article which may store an instruction or a set of instructions that, if executed by a machine, for example, by system **100** of FIG. **1**, by station **101** of FIG. **1**, by processor **111** of FIG. **1**, or by other suitable machines, cause the machine to perform a method and/or operations in accordance with embodiments of the invention. Such machine may include, for example, any suitable processing platform, computing platform, computing device, processing device, computing system, processing system, computer, processor, or the like, and may be implemented using any suitable combination of hardware and/or software. The machine-readable medium or article may include, for example, any suitable type of memory unit (e.g., memory unit **114** or storage unit **115**), memory device, memory article, memory medium, storage device, storage article, storage medium and/or storage unit, for example, memory, removable or non-removable media, erasable or non-erasable media, writeable or re-writeable media, digital or analog media, hard disk, floppy disk, Compact Disk Read Only Memory (CD-ROM), Compact Disk Recordable (CD-R), Compact Disk Re-Writeable (CD-RW), optical disk, magnetic media, various types of Digital Versatile Disks (DVDs), a tape, a cassette, or the like. The instructions may include any suitable type of code, for example, source code, compiled code, interpreted code, executable code, static code, dynamic code, or the like, and may be implemented using any suitable high-level, low-level, object-oriented, visual, compiled and/or interpreted programming language, e.g., C, C++, Java, BASIC, Pascal, Fortran, Cobol, assembly language, machine code, or the like.

[0090] While certain features of the invention have been illustrated and described herein, many modifications, substitutions, changes, and equivalents may occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

What is claimed is:

1. An apparatus comprising:

a first wireless transceiver able to operate in accordance with a first, non-scheduled, wireless communication protocol;

a second wireless transceiver able to operate in accordance with a second, scheduled, wireless communication protocol; and

a communication coordinator to allocate one or more first time slots for communication by said first transceiver, and to allocate one or more second time slots, which do not overlap said first time slots, for communication by said second transceiver.

2. The apparatus of claim 1 wherein, during the first time slot the first transceiver is in operational mode and the second transceiver is in non-operational mode, and wherein during the second time slot the second transceiver is in operational mode and the first transceiver is in non-operational mode.

3. The apparatus of claim 1, wherein said communication coordinator is to alternate between said first time slots and said second time slots in accordance with an orderly Time-Divisional Multiple Access scheme.

4. The apparatus of claim 3, wherein said communication coordinator is to allocate one or more transition time slots in between said first and second time slots, and wherein said first and second transceivers are both non-operational during said one or more transition time slots.

5. The apparatus of claim 1, further comprising a shared Radio Frequency wireless communication component, wherein the first wireless transceiver is able to access said shared Radio Frequency wireless communication component during the first time slots, and wherein the second wireless transceiver is able to access said shared Radio Frequency wireless communication component during the second time slots.

6. The apparatus of claim 5, wherein the first transceiver is to indicate to the second transceiver a start of an access by the first transceiver to said shared Radio Frequency wireless communication component, and a duration of said access.

7. The apparatus of claim 1, wherein the first transceiver is to transmit a silence period notification indicating a request to withhold communication by one or more other wireless communication devices in accordance with said first wireless communication protocol during the second time slot.

8. The apparatus of claim 7, wherein said silence period notification comprises:

a silence duration parameter indicating a duration of said second time slot; and

a silence periodicity parameter indicating a period of repetition of the second time slot.

9. The apparatus of claim 4, wherein the second transceiver is to transmit a periodic scan request including a scan duration parameter and an interleaving interval parameter, wherein the scan duration parameter corresponds to a duration of one of said first time slot and two of said transition time slots, and wherein the interleaving interval parameter corresponds to a duration of one of said second time slots.

10. The apparatus of claim 9, wherein the periodic scan request further comprises a scan iteration parameter corresponding to an estimated time allocated for a communication session including one or more of said first time slots and one or more of said second time slots.

11. The apparatus of claim 1, wherein the first wireless transceiver is to transmit during at least one of said first time slots a Clear-to-send To Self frame to withhold communication in accordance with the first wireless communication protocol during at least one of said second time slots.

12. The apparatus of claim 1, wherein the first transceiver is to set one or more parameters of an Independent Basic Service Set in accordance with the first wireless communication protocol, the one or more parameters indicating that a transceiver of another apparatus that is capable of operating in accordance with the first wireless communication protocol is requested to withhold communication during the second time slot.

13. The apparatus of claim 12, wherein the one or more parameters comprise a Transmission Opportunity parameter corresponding to a guard time prior to a beginning of the second time slot, and wherein based on the Transmission Opportunity parameter the first wireless transceiver is to cease a transmission in accordance with the first wireless communication standard prior to a beginning of the second time slot.

14. The apparatus of claim 1, wherein said non-communicative mode is a reduced power mode.

15. The apparatus of claim 5, wherein said shared Radio Frequency wireless communication component comprises a shared Radio Frequency antenna able to transmit and receive wireless communication signals.

16. The apparatus of claim 1, wherein said first wireless communication protocol is IEEE 802.11 standard and said second wireless communication protocol is IEEE 802.16 standard.

17. A method comprising:

allocating one or more first time slots for communication by a first wireless transceiver able to operate in accordance with a first, non-scheduled, wireless communication protocol; and

allocating one or more second time slots, which do not overlap said first time slots, for communication by a second wireless transceiver collocated with the first transceiver in a common wireless communication station, the second transceiver able to operate in accordance with a second, scheduled, wireless communication protocol.

18. The method of claim 17, further comprising:

during one of said first time slots, transmitting a protocol message indicating to another transceiver able to operate in accordance with said first wireless communication protocol that the first transceiver is expected to be non-operational during at least one of said second time slots.

19. The method of claim 17, further comprising:

periodically transmitting in accordance with said first wireless communication protocol a beacon at time intervals corresponding to an integer multiple of a cycle including one of said first time slots, one of said second time slots, and two of said transition time slots.

20. The method of claim 17, further comprising:

transmitting in accordance with said first wireless communication protocol a Clear-to-send To Self frame at a time within a guard period prior to the beginning of one of said second time slots, said time corresponding a Priority Inter-Frame Space after a shared access medium is freed.

21. The method of claim 17, further comprising:

transmitting in accordance with said first wireless communication protocol a beacon including a notification of a silence period; and

transmitting in accordance with said first wireless communication protocol a Clear-to-send To Self frame to enforce silence during said silence period in a wireless communication network able to operate in accordance with said first wireless communication protocol.

22. The method of claim 17, further comprising:

joining the first transceiver into a first Independent Basic Service Set in accordance with said first wireless communication protocol; and

checking whether a parameter of the first Independent Basic Service Set is in accordance with an orderly Time-Division Multiple Access scheme used by the first transceiver.

23. The method of claim 22, further comprising:

if it is determined that the parameter of the first Independent Basic Service Set is not in accordance with said orderly Time-Division Multiple Access scheme, initiating a second Independent Basic Service Set in accordance with the first wireless communication protocol, wherein a Service Set Identifier of the second Independent Basic Service Set is identical to the Service Set Identifier of the first Independent Basic Service Set, and wherein a Timing Synchronization Function value of the second Independent Basic Service Set is greater than a Timing Synchronization Function value of the first Independent Basic Service Set.

24. A wireless communication system comprising:

a wireless communication station comprising:

a dipole antenna to transmit and receive wireless communication signals;

a first wireless transceiver able to operate in accordance with a first, non-scheduled, wireless communication protocol;

a second wireless transceiver able to operate in accordance with a second, scheduled, wireless communication protocol; and

a communication coordinator to allocate one or more first time slots for communication by said first transceiver, and to allocate one or more second time slots, which do not overlap said first time slots, for communication by said second transceiver.

25. The wireless communication system of claim 24, wherein during the first time slot the first transceiver is in operational mode and the second transceiver is in non-operational mode, and wherein during the second time slot the second transceiver is in operational mode and the first transceiver is in non-operational mode.

26. The wireless communication system of claim 24, wherein said communication coordinator is to alternate between said first time slots and said second time slots in accordance with an orderly Time-Divisional Multiple Access scheme.

27. The wireless communication system of claim 26, wherein said communication coordinator is to allocate one or more transition time slots in between said first and second time slots, and wherein said first and second transceivers are both non-operational during said one or more transition time slots.

28. The wireless communication system of claim 24, wherein said wireless communication station further comprises a shared Radio Frequency wireless communication component, wherein the first wireless transceiver is able to access said shared Radio Frequency wireless communication component during the first time slots, and wherein the second wireless transceiver is able to access said shared Radio Frequency wireless communication component during the second time slots.

* * * * *

EXHIBIT 1019

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(54) **MULTI-FUNCTION WIRELESS TERMINAL**

(75) Inventor: **Yigal Bitran**, Ramat Hasharon (IL)

Correspondence Address:
ABELMAN, PRAYNE & SCHWAB
666 3rd Avenue
New York, NY 10017-5612

(73) Assignee: **Altair Semiconductor**

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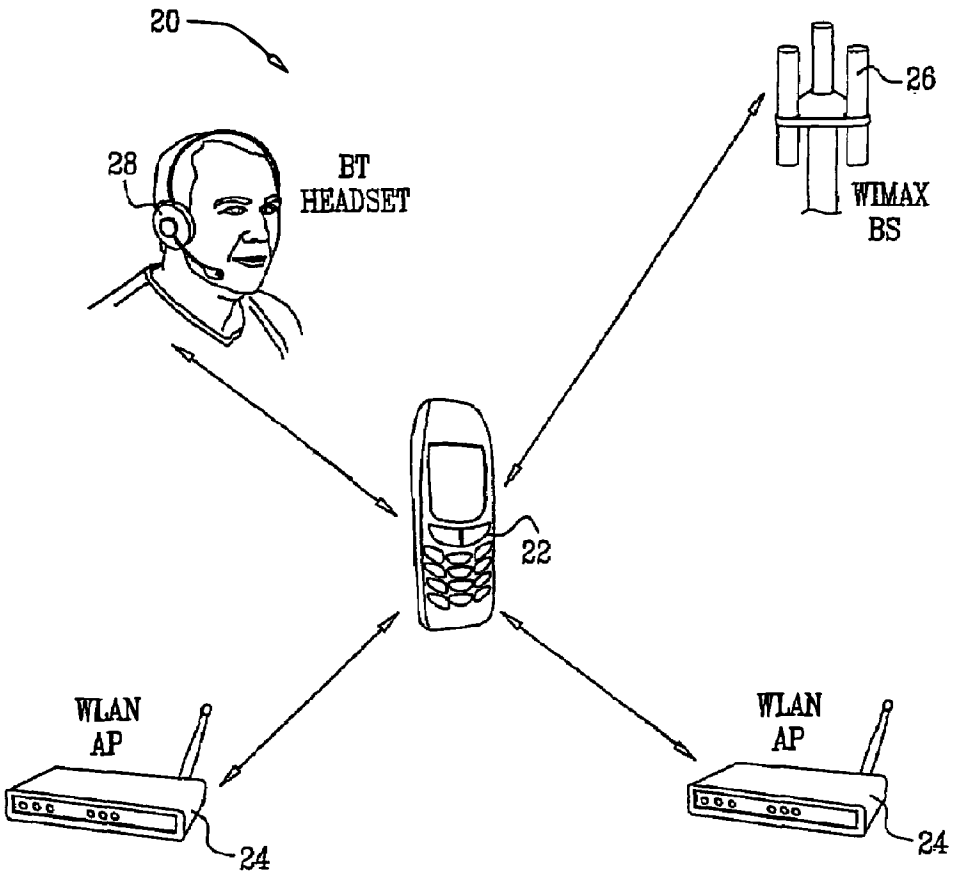
H04Q 7/20	(2006.01)
H04M 1/00	(2006.01)
H04B 1/38	(2006.01)

(52) **U.S. Cl.** **455/509**; 455/451; 455/552.1; 455/557

(57) **ABSTRACT**

A communication method includes establishing a first communication session over a first connection between a wireless terminal and a base station (BS) of a long-range wireless data network, which operates in accordance with a first protocol that defines a sequence of time frames. Based on the time frames defined by the BS, time slots are allocated for establishing a second communication session over a second connection between the wireless terminal and a peripheral wireless device, which operates in accordance with a second, short-range time-slotted communication protocol different from the first protocol.

Time intervals are allocated within the time frames for communication between the BS and the wireless terminal over the first connection, such that the allocated time intervals are interleaved with and do not overlap the allocated time slots. The first and second communication sessions are concurrently conducted in the allocated time intervals and the assigned time slots, respectively.



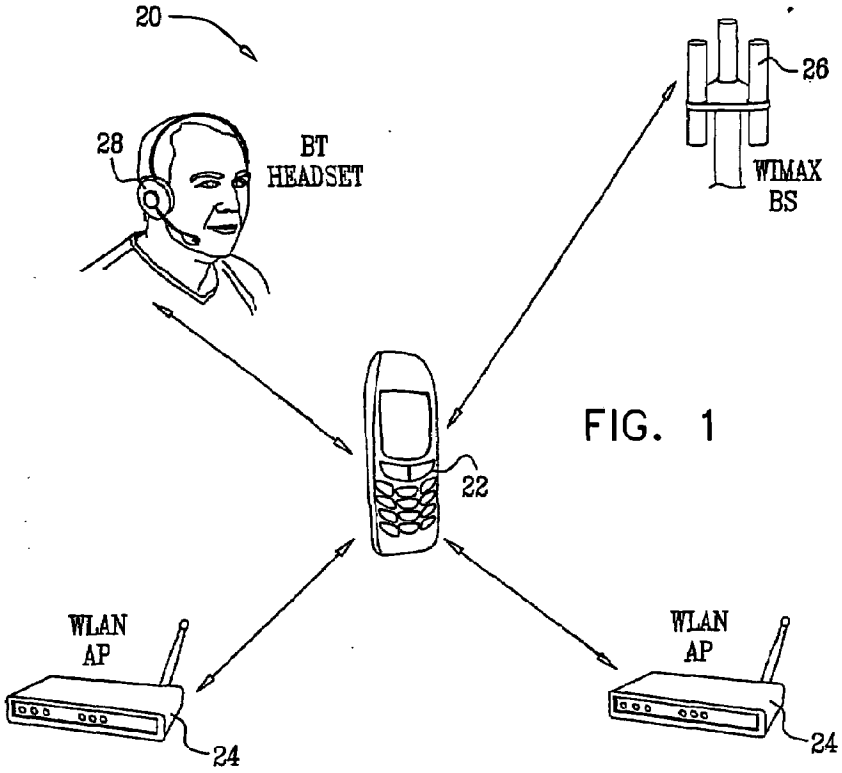

20
26
28
BT
HEADSET
WIMAX
BS
22
WLAN
AP
24
WLAN
AP
24

FIG. 1

FIG. 2

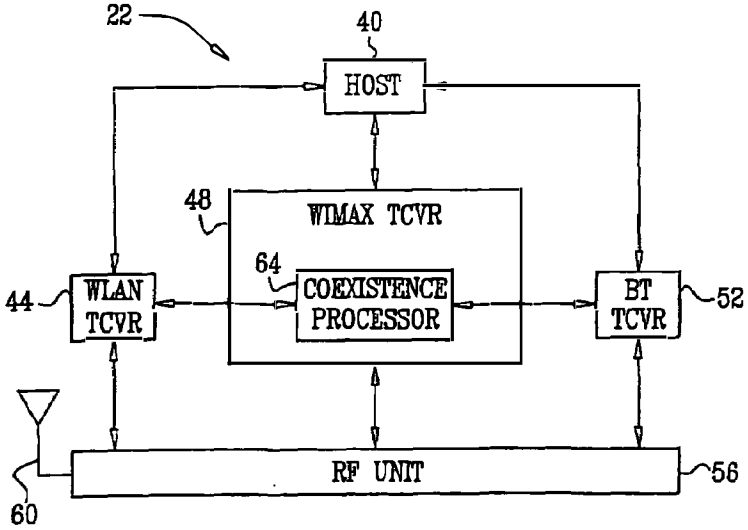

22
40
HOST
48
WIMAX TCVR
64
COEXISTENCE
PROCESSOR
44
WLAN
TCVR
BT
TCVR
52
RF UNIT
56
60

FIG. 3

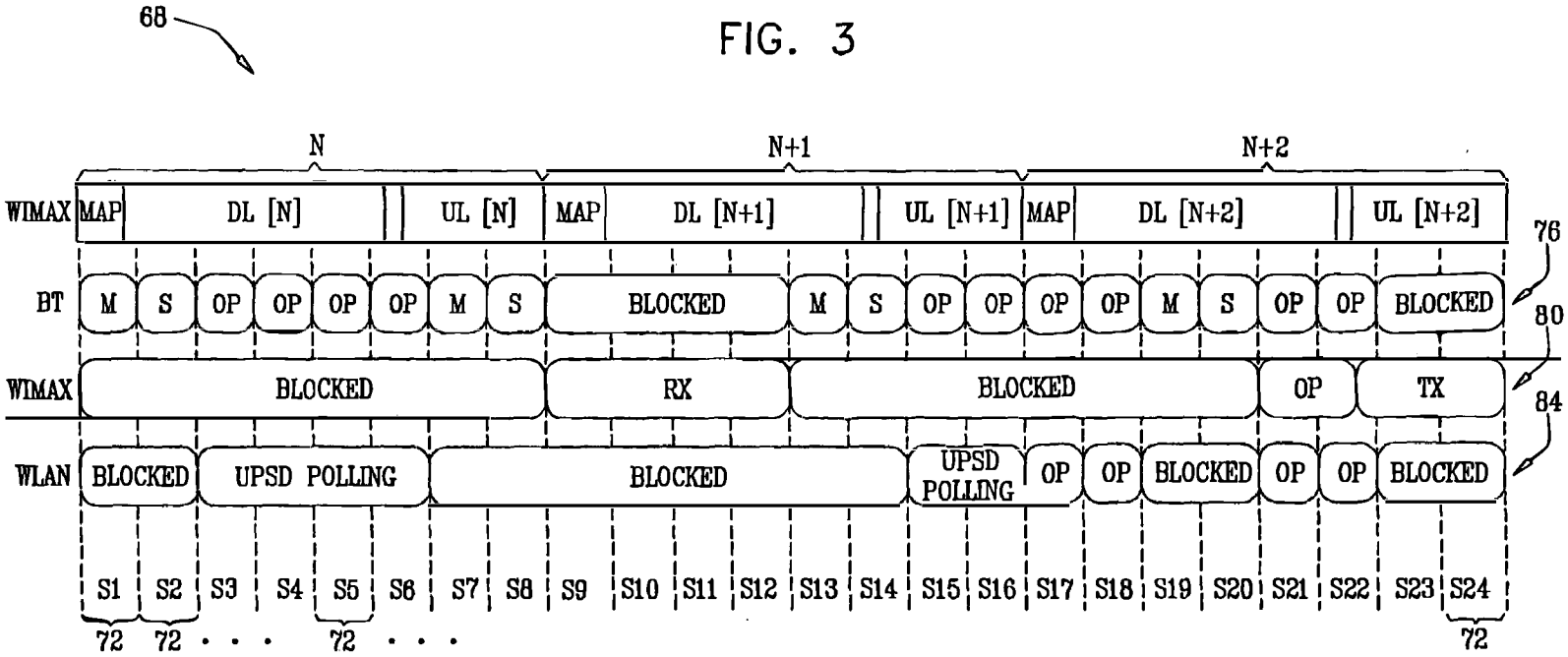

68
N
N+1
N+2
WIMAX
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UL [N]
MAP
DL [N+1]
UL [N+1]
MAP
DL [N+2]
UL [N+2]
76
BT
M
S
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OP
OP
OP
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S
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M
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OP
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TX
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WLAN
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72

FIG. 4

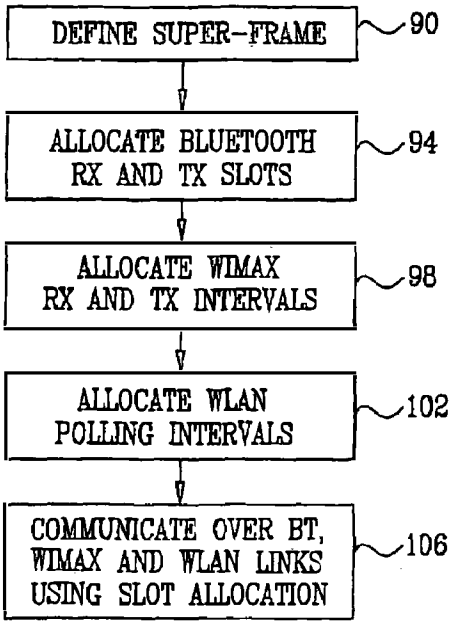

DEFINE SUPER-FRAME
90
ALLOCATE BLUETOOTH RX AND TX SLOTS
94
ALLOCATE WIMAX RX AND TX INTERVALS
98
ALLOCATE WLAN POLLING INTERVALS
102
COMMUNICATE OVER BT, WIMAX AND WLAN LINKS USING SLOT ALLOCATION
106

FIG. 5

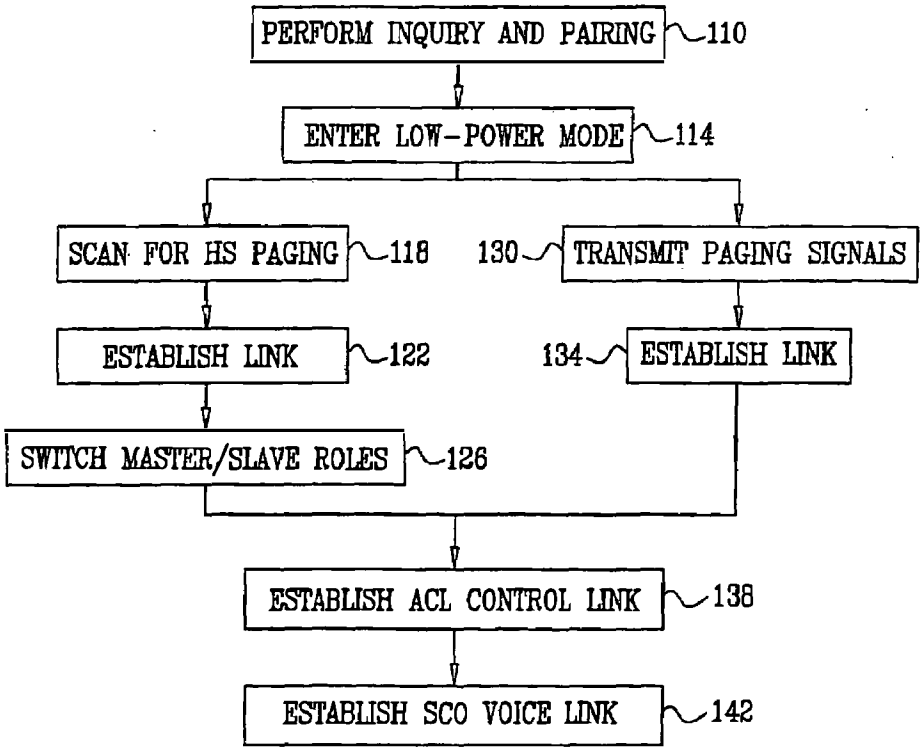

PERFORM INQUIRY AND PAIRING
110
ENTER LOW-POWER MODE
114
SCAN FOR HS PAGING
118
ESTABLISH LINK
122
SWITCH MASTER/SLAVE ROLES
126
130
TRANSMIT PAGING SIGNALS
134
ESTABLISH LINK
ESTABLISH ACL CONTROL LINK
138
ESTABLISH SCO VOICE LINK
142

FIG. 6

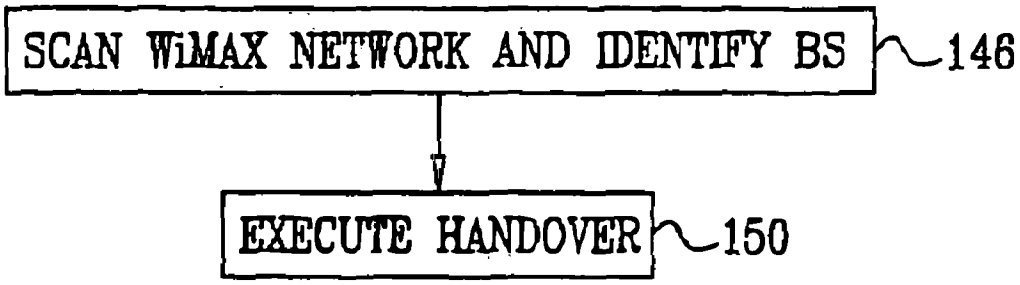
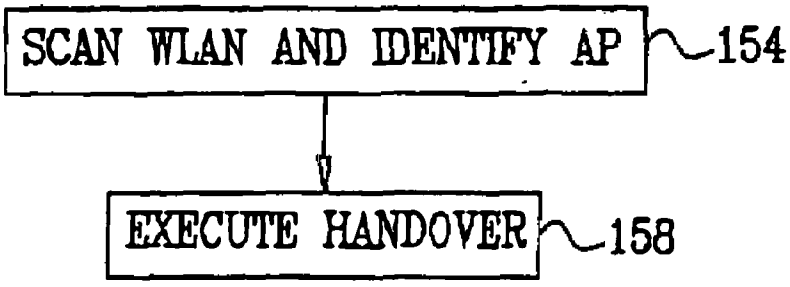

SCAN WiMAX NETWORK AND IDENTIFY BS
146
EXECUTE HANDOVER
150

FIG. 7


SCAN WLAN AND IDENTIFY AP
154
EXECUTE HANDOVER
158

MULTI-FUNCTION WIRELESS TERMINAL

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application 60/803,192, filed May 25, 2006, which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to wireless communications, and specifically to wireless terminals capable of operating using multiple different communication protocols.

BACKGROUND OF THE INVENTION

[0003] Wireless local area networks (WLANs) have gained broad popularity. The original IEEE 802.11 WLAN standard was designed to enable communications at 1-2 Mbps in a band around 2.4 GHz. More recently, IEEE working groups have defined the 802.11a, 802.11b, 802.11e, 802.11g, 802.11n and other extensions to the original standard, in order to enable higher data rates. In the context of the present patent application and in the claims, the term "802.11" is used to refer collectively to the original IEEE 802.11 standard and all its variants and extensions, unless specifically noted otherwise. WLAN is also sometimes referred to as Wi-Fi®.

[0004] WiMAX (Worldwide Interoperability for Microwave Access) is a new technology for wireless packet data communications, which is similar in concept to IEEE 802.11, but has, a number of enhancements designed to improve performance and range. The original WiMAX standard, IEEE 802.16, specified WiMAX in the 10-66 GHz range. More recently, IEEE 802.16a added support for the 2-11 GHz range, and IEEE 802.16e (approved as IEEE 802.16-2005) extended WiMAX to mobile applications, using an enhanced orthogonal frequency division multiple access (OFDMA) modulation scheme. In the context of the present patent application and in the claims, the term "802.161" is used to refer collectively to the original IEEE 802.16 standard and all its variants and extensions, unless specifically noted otherwise.

[0005] Bluetooth® wireless technology is a short-range communication technology intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. The latest Bluetooth specification, entitled "Specification of the Bluetooth System, Core Version 2.0+Enhanced Data Rate (EDR)," November, 2004, defines a uniform structure for a wide range of devices to connect and communicate with each other. This specification, as well as additional information regarding Bluetooth, is available at www.bluetooth.com. In the context of the present patent application and in the claims, the term "Bluetooth Core Specification" is used to refer collectively to the Version 2.0 specification, to its variants and extensions and to earlier versions of the specification, unless specifically noted otherwise.

[0006] WLAN, WiMAX and Bluetooth systems often operate in adjacent or overlapping frequency bands, and thus may potentially interfere with one another. This interference is particularly severe when WLAN, WiMAX and/or Bluetooth devices are collocated in a single wireless terminal.

[0007] Several methods and devices are known in the art for enabling the coexistence of WLAN and Bluetooth communication in the same wireless terminal. For example, Texas Instruments, Inc. (Dallas, Tx.) offers a hardware and software solution that allows users to run Bluetooth and 802.11a/b/g mobile WLAN simultaneously. The software monitors WLAN and Bluetooth traffic patterns and, when both 802.11 and Bluetooth require bandwidth, the software uses multiplexing techniques to allocate the bandwidth S for simultaneous functions. Additional information regarding this solution is available at focus.ti.com/general/docs/wtbu/wtbuproductcontent.tsp?templateId=6123&navigationId=12022&contentId=4655.

[0008] As another example, NXP Semiconductors (Eindhoven, Netherlands) provides another hardware and software solution, which enables Bluetooth and WLAN coexistence using packet transmission arbitration techniques. Details regarding this solution are available at www.nxp.com/products/connectivity.

SUMMARY OF THE INVENTION

[0009] There is therefore provided, in accordance with an embodiment of the present invention, a method for communication, including:

[0010] establishing a first communication session over a first connection between a wireless terminal and a base station (BS) of a long-range wireless data network, which operates in accordance with a first protocol that defines a sequence of time frames;

[0011] allocating time slots, based on the time frames defined by the BS, for establishing a second communication session over a second connection between the wireless terminal and a peripheral wireless device, which operates in accordance with a second, short-range time-slotted communication protocol different from the first protocol;

[0012] allocating time intervals within the time frames for downlink and uplink transmission between the BS and the wireless terminal over the first connection such that the allocated time intervals are interleaved with and do not overlap the allocated time slots; and

[0013] concurrently conducting the first and second communication sessions in the allocated time intervals and the assigned time slots, respectively.

[0014] In some embodiments, the long-range wireless data network includes a WiMAX network that operates in accordance with an IEEE 802.16 standard, and the second connection operates in accordance with a Bluetooth Core Specification. The second protocol may operate in accordance with at least one of a Synchronous Connection-Oriented (SCO) mode and an Asynchronous Connectionless Link (ACL) mode of the Bluetooth core specification.

[0015] In another embodiment, the method further includes establishing a third communication session over a third connection with an access point (AP) of a wireless local area network (WLAN) in accordance with a third protocol different from the first and second protocols, during time periods that do not overlap the time slots of the first connection and the time intervals of the second connection, and conducting the third communication session concurrently with the first and second sessions.

[0016] In yet another embodiment, the third protocol includes a protocol in which the time periods used by the third communication session are initiated by the wireless terminal, and establishing the third communication session

includes selecting the time periods by the wireless terminal so as not to overlap the time slots of the first connection and the time intervals of the second connection. The WLAN may operate in accordance with an IEEE 802.11 standard. In some embodiments, the third connection operates in accordance with an Unscheduled Power Save Delivery (UPSD) mode of the IEEE 802.11 standard. In a disclosed embodiment, additional optional time slots are allocated to one of the first, second and third connections when not previously allocated to another of the first, second and third connections.

[0017] In another embodiment, establishing the first communication session includes handing over the wireless terminal from the WLAN to the long-range wireless data network while the third communication session is in progress. Additionally or alternatively, establishing the third communication session includes handing over the wireless terminal from the long-range wireless data network to the WLAN while the third communication session is in progress.

[0018] In yet another embodiment, allocating the time slots based on the time frames includes synchronizing the allocated time slots with the time frames defined by the BS. In an embodiment, the second communication session includes a voice connection between the wireless terminal and the peripheral device, and allocating the time slots for the second communication session includes allocating the time slots at regular intervals. Additionally or alternatively, allocating the time intervals within the time frames includes notifying the BS that the wireless terminal is not available to communicate with the BS outside the allocated time intervals.

[0019] In some embodiments, establishing the second communication session includes initially establishing the second connection such that a timing of the time slots is determined by the peripheral device, and subsequently causing the timing of the time slots to be determined by the wireless terminal, so as to enable the time slots to be synchronous with the time frames of the first protocol defined by the BS. Causing the timing of the time slots to be determined by the wireless terminal may include invoking a Master-Slave Switching (MSS) procedure defined in the second protocol. Alternatively, causing the timing of the time slots to be determined by the wireless terminal includes aborting establishment of the second connection by the wireless terminal after receiving an address of the peripheral device, and initiating a paging procedure by the wireless terminal using the received address, so as to re-establish the second connection with the timing of the time slots determined by the wireless terminal.

[0020] In another embodiment, establishing the second communication session includes carrying out an inquiry procedure by the wireless terminal in order to identify the peripheral device, and coordinating the allocated time slots and time intervals during the inquiry procedure. In yet another embodiment, establishing the second communication session includes transmitting synchronization transmissions from the wireless terminal to the peripheral device in a low-power mode of the second protocol, and giving a priority to the synchronization transmissions over the time intervals of the first connection.

[0021] In still another embodiment, establishing the second communication session includes transmitting paging transmissions between the wireless terminal and the peripheral device for establishing the second connection, while coordinating the exchange of the paging transmissions with the time intervals of the first connection. Establishing the second communication session may include defining a subset of the time frames of the first connection as reduced-availability frames, notifying the BS that the wireless terminal is not available to communicate with the BS during the reduced-availability frames, and giving a priority to establishing the second communication session during the reduced-availability frames.

[0022] There is additionally provided, in accordance with an embodiment of the present invention, a wireless communication terminal, including:

[0023] a radio frequency (RF) unit; and

[0024] a baseband processing circuit, which is coupled to cause the RF unit to transmit and receive signals over the air so establish a first communication session over a first connection with a base station (BS) of a long-range wireless data network, which operates in accordance with a first protocol that defines a sequence of time frames, and to establish a second communication session over a second connection between the wireless terminal and a peripheral wireless device, which operates in accordance with a second, short-range time-slotted communication protocol different from the first protocol; and

[0025] a coexistence processor, which is arranged to allocate time slots based on the time frames defined by the BS, for the second session and to allocate time intervals within the time frames for downlink and uplink transmission between the BS and the wireless terminal over the first connection such that the allocated time intervals are interleaved with and do not overlap the allocated time slots, so as to concurrently conduct the first and second communication sessions in the allocated time intervals and the assigned time slots, respectively.

[0026] In some embodiments, the baseband processing circuit includes first, second and third transceivers, which are respectively arranged to communicate with the BS, the peripheral device and the AP, and the coexistence processor is connected to the transceivers using respective coexistence interfaces and is arranged to allocate the time intervals, time slots and time periods by signaling to the transceivers over the coexistence interfaces.

[0027] In another embodiment, the baseband processing circuit includes a first sub-circuit including the second and third transceivers, and a second sub-circuit including the first transceiver and the coexistence processor, and the coexistence processor is arranged to control the second and third transceivers using the coexistence interfaces, which are connected between the first and second sub-circuits.

[0028] The present invention will be more fully understood from the following detailed description of the embodiments thereof, taken together with the drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] FIG. **1** is a schematic, pictorial illustration showing a system for wireless communications, in accordance with an embodiment of the present invention;

[0030] FIG. **2** is a block diagram that schematically shows elements of a multi-function wireless terminal, in accordance with an embodiment of the present invention;

[0031] FIG. **3** is a diagram showing coexisting allocations of Bluetooth, WiMAX and WLAN time slots in a multi-

function wireless terminal, in accordance with an embodiment of the present invention;

[0032] FIG. **4** is a flow chart that schematically illustrates a method for multi-function communication in a wireless terminal, in accordance with an embodiment of the present invention;

[0033] FIG. **5** is a flow chart that schematically illustrates a method for Bluetooth link establishment, in accordance with an embodiment of the present invention;

[0034] FIG. **6** is a flow chart that schematically illustrates a method for handing over a wireless terminal from a WLAN to a WiMAX network, in accordance with an embodiment of the present invention; and

[0035] FIG. **7** is a flow chart that schematically illustrates a method for handing over a wireless terminal from a WiMAX network to a WLAN, in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

OVERVIEW

[0036] E

call over either the WLAN or the WiMAX network, the voice is transmitted to and from headset **28**. As another example, terminal **22** may be engaged in a data session, such as a Voice over IP (VoIP) session, over the WLAN or the WiMAX network, with the session being relayed to an adjacent laptop or other computing device using a Bluetooth link.

[0049] In all of these scenarios, as well as various other possible scenarios, there are occasions when all three communication connections (WiMAX, WLAN and Bluetooth) are being used simultaneously. For example, the terminal may be handed over from the WLAN to the WiMAX network or vice versa, during a voice call that uses headset **28**. At other times, the terminal may hold a call over one network, relay the voice or data of the call to the Bluetooth device, while simultaneously scanning the other network.

[0050] Thus, there exist various scenarios in which terminal **22** communicates over the WLAN, the WiMAX network and the Bluetooth link simultaneously. On the other hand, all three protocols often operate in similar, sometimes overlapping frequency bands, such as in the 2.3-2.5 GHz band. Unless strictly coordinated, WLAN, WiMAX and Bluetooth transmissions may severely interfere with one another, especially when their transmitters and receivers are collocated in a single communication terminal.

[0051] Interference would occur, for example, if the terminal were to transmit using two or more different protocols at the same time, or transmit using one protocol while attempting to receive using another protocol. The methods and systems described herein coordinate the timing of transmission and reception of terminal **22** over the WLAN, WiMAX and Bluetooth links. As a result, wireless terminal **22** is able to communicate with WLAN AP **24**, WiMAX BS **26** and Bluetooth **28** simultaneously without mutual interference.

[0052] As will be shown below, terminal **22** communicates over a single link out of the three at any given time. The simultaneous operation of the different protocols is carried out by using the different protocols in alternate time slots in a coordinated manner. Thus, the term "simultaneous communication," as used in the present patent application and in the claims, refers to the ability to maintain simultaneous and uninterrupted communication connections, processes or sessions over the WiMAX, WLAN and Bluetooth links, without mutual interference among these processes.

[0053] FIG. **2** is a block diagram that schematically shows elements of wireless terminal **22**, in accordance with an embodiment of the present invention. Terminal **22** comprises a host processor **40**, which is connected to a WLAN transceiver **44**, a WiMAX transceiver **48** and a Bluetooth transceiver **52**. Transceivers **44**, **48** and **52** respectively carry out the WLAN, WiMAX and Bluetooth baseband processing functions. All three transceivers are connected to a radio frequency (RF) unit **56**, which comprises the RF receiver and transmitter circuitry for transmitting and receiving the signals of the different protocols. RF unit **56** is connected to an antenna **60**, which transmits and receives RF signals of the three protocols to and from the WLAN AP, WiMAX BS and Bluetooth peripheral device.

[0054] The terminal comprises a coexistence processor **64**, which coordinates and synchronizes the WLAN, WiMAX and Bluetooth communication of terminal **22**. In the example of FIG. **2**, processor **64** is part of WiMAX transceiver **48**. Alternatively, the coexistence processor may comprise a separate unit, or be integrated with any other component of terminal **22**.

[0055] The configuration of terminal **22** shown in FIG. **2** is an exemplary configuration, which is shown purely for the sake of conceptual clarity. The methods and systems described herein are applicable in any other suitable terminal configuration. For example, the WLAN, WiMAX and Bluetooth transceivers may comprise separate devices or be integrated into a single device. The RF unit may comprise a single module that serves all three protocols, or may comprise three separate RF modules, one module for serving each protocol. Further alternatively, the terminal may comprise three separate RF/baseband units, each serving a single protocol and comprising both baseband and RF elements. Regardless of the specific configuration of terminal **22**, the three transceivers can be viewed collectively as a single baseband processing circuit, which carries out the baseband functions of coordinated WLAN, WiMAX and Bluetooth operation.

[0056] In some embodiments, the terminal may comprise known WLAN and Bluetooth baseband transceivers that use a known WLAN/Bluetooth coordination scheme, such as the schemes cited in the Background section above. These coordination schemes typically synchronize the WLAN and Bluetooth protocols using proprietary interfaces between the WLAN and Bluetooth baseband transceivers. In these embodiments, coexistence processor **64** can be connected between the WLAN and Bluetooth transceivers, as shown in FIG. **2**, and be configured to emulate the proprietary interfaces between them. Using this configuration, WLAN, WiMAX and Bluetooth coordination can be implemented substantially without modification to the WLAN and Bluetooth transceivers.

[0057] The WLAN, WiMAX and Bluetooth transceivers may be implemented in hardware, such as using one or more application-specific integrated circuits (ASICs). Some baseband functions may also be implemented in software. The RF unit may be implemented using radio frequency integrated circuits (RFICs) and/or discrete components. In some embodiments, coexistence processor **64** may comprise a general-purpose processor, which is programmed in software to carry out the functions described herein. The software may be downloaded to the processor in electronic form, such as over a network. Alternatively, the functions of processor **64** may be implemented in hardware, or using a combination of hardware and software elements.

[0058] In some cases, some of the circuitry of RF unit **56** can be shared between two or more of the WLAN, WiMAX and Bluetooth transceivers. Alternatively, each transceiver may use its own dedicated RF hardware. Some aspects of sharing the transceiver resources of a wireless terminal among different protocols are described, for example, in a U.S. patent application entitled "Dual-Function Wireless Data Terminal," filed Dec. 12, 2006, which is assigned to the assignee of the present patent application and is incorporated herein by reference.

Coexisting Bluetooth, WiMAX and WLAN Slot Allocations

[0059] In order to avoid interference between the WLAN, WiMAX and Bluetooth transmission and reception, terminal **22** transmits and receives in a predefined sequence of time slots, which is described in detail below.

[0060] For the sake of clarity, the description initially addresses steady-state operation, in which the terminal has already established its connection with the appropriate WLAN AP, WiMAX BS and Bluetooth device. The methods and systems described herein are nevertheless applicable to other operational modes of the three standards. Variations and applicability to other operational modes and processes, such as various link establishment procedures, are addressed further below.

[0061] FIG. **3** is a diagram showing coexisting allocations of Bluetooth, WiMAX and WLAN time slots in terminal **22**, in accordance with an embodiment of the present invention. When the WiMAX, WLAN and Bluetooth links are already established, Bluetooth operation is assumed to use the High-quality Voice **3** (HV**3**) Synchronous Connection-Oriented (SCO) mode, as defined in the Bluetooth standard cited above. WLAN operation is assumed to use the Unscheduled Power Save Delivery (UPSD) mode, as defined in the IEEE 802.11 standard.

[0062] Terminal **22** communicates in accordance with a super-frame **68**, which is repeated cyclically. Super-frame **68** comprises twenty-four time slots **72**, denoted S**1** . . . S**24**. Each time slot **72** is 625 μS long, a duration that is selected to match the 625 μS duration of Bluetooth time slots. Each super-frame is 15 mS long. The 15 mS duration of the super-frame is selected because it corresponds to twenty-four Bluetooth slots, as well as to three 5 mS WiMAX frames. The three WiMAX frames in the super-frame are denoted N, N+1 and N+2.

[0063] Some of time slots **72** are reserved for a particular link out of the WiMAX, WLAN and Bluetooth links. Other time slots are defined as bandwidth opportunities, or optional slots, in which the terminal can communicate using one of the links, as long as no other link already uses the slot.

[0064] In some cases, the individual WLAN, WiMAX and/or Bluetooth transceivers may not be aware of the structure of the super-frame shown in FIG. **3**. In these cases, the individual transceivers are controlled on a slot-by-slot basis by processor **64**, which coordinates their transmission and reception periods according to the super-frame structure. In order to align the timing of all three transceivers, the time base of the WiMAX transceiver is used as a reference, and the time bases of the Bluetooth and WLAN transceivers are configured to track it.

[0065] The coexistence processor enables each transceiver to use its designated time slots using "busy" interfaces or lines, also referred to herein as coexistence interfaces. In each time slot **72**, the coexistence processor indicates to each transceiver whether the current slot is free or busy using this interface. Processor **64** may indicate to a particular transceiver that a slot is busy either when the super-frame structure defines the slot as blocked for use in the particular protocol, or when the slot is an optional slot that was already seized by another transceiver. The processor may schedule the use of optional time slots among the transceivers using a Round-Robin priority mechanism or using any other suitable method.

[0066] When a particular transceiver requests to communicate, it polls its "busy" interface in order to determine whether it is allowed to use the current time slot. If allowed, the transceiver in question sets the interface to "busy." When the transmission is complete, the transceiver releases the interface.

[0067] A slot allocation **76** defines the time slots assigned to Bluetooth operation. The assignment of Bluetooth slots takes precedence over the other two protocols. Bluetooth slots are defined at frequent, regular intervals, since the Bluetooth protocol has little flexibility in defining slot patterns. Moreover, precedence is given to Bluetooth transmissions in order to reduce the latency and jitter of the voice carried over the Bluetooth link.

[0068] In the Bluetooth link configuration, terminal **22** (or, more specifically, the Bluetooth transceiver of terminal **22**) is assumed to be the master and headset **28** is assumed to be the slave, so that the timing of the Bluetooth link can be determined by terminal **22**. Being the master, terminal **22** controls the timing of the Bluetooth slots and aligns them with the timing of the super-frame. When the Bluetooth link is initially set up with the headset being the master, the master and slave roles can be reversed using master-slave switching (MSS) or link disconnect/connect procedures, which are defined in the Bluetooth standard.

[0069] In the Bluetooth SCO HV**3** mode, terminal **22** and headset **28** transmit and receive in adjacent time slots. In the present example, each side of the Bluetooth link transmits once every six time slots. The terminal transmits to the headset in slots S**1**, S**7**, S**13** and S**19** marked as "M," and the headset transmits to the terminal in slots S**2**, S**8**, S**14** and S**20** marked as "S." Slots S**9** . . . S**12** and S**23** . . . S**24** are blocked for Bluetooth operation, in order to enable access to the other protocols.

[0070] Slots S**3** . . . S**6**, S**15** . . . S**18** and S**21** . . . S**22** are defined as optional bandwidth opportunities, or optional slots, in which Bluetooth information can be transmitted if the slot is free. The optional slots can be used, for example, for non-voice information, such as for exchanging data packets with an additional Bluetooth-enabled laptop computer.

[0071] A slot allocation **80** defines the time slots assigned to WiMAX operation. In WiMAX, downlink and uplink bandwidth (i.e., WiMAX subcarriers and symbol intervals) is allocated using a MAP message, which is transmitted by the WiMAX BS at the beginning of each WiMAX frame. The MAP message comprises downlink MAP and uplink MAP messages. The downlink MAP allocates bandwidth in the current WiMAX frame, whereas the uplink MAP allocates bandwidth in the next frame. For example, the MAP message transmitted in the WiMAX frame denoted N+1 allocates the downlink bandwidth of frame N+1 and the uplink bandwidth of frame N+2.

[0072] The super-frame structure is defined so that the terminal is able to receive MAP messages from the BS. Furthermore, time slots for WiMAX uplink transmission are allocated so that they coincide with the uplink periods of the WiMAX frames.

[0073] In the present example, slots S**9** . . . S**12** of each super-frame are allocated for WiMAX downlink operation (WiMAX reception at the terminal). As can be seen in FIG. **3**, these slots correspond to the first 2.5 mS of WiMAX frame N+1. The terminal is able to receive the MAP message transmitted in frame N+1, as well as data bursts, during this 2.5 mS period. Since the downlink MAP defines allocations for the current frame, the BS is expected to send any data bursts addressed to terminal **22** during the first 2.5 mS of the second frame of the super-frame.

[0074] In some embodiments, the WiMAX BS is aware of the fact that terminal **22** is a multi-function terminal that

operates in accordance with a 15 mS super-frame structure. The BS is also aware of the timing of the super-frame, and transmits bandwidth allocations for this terminal only in the MAP messages of the second WiMAX frame in each super-frame. In particular, the BS sends uplink allocations for frame N+2 in the MAP message of frame N+1. Therefore, the end portion of frame N+2 (i.e., slots **S23** and **S24**, and sometimes some or all of slots **S21** and **S22**) are allocated to possible WiMAX uplink operation (WiMAX transmission from the terminal). Note that the beginning of the interval reserved for WiMAX uplink does not necessarily coincide with the timing of slots **72**.

[0075] Slots **S1** . . . **S8** and **S13** . . . **S20** (i.e., WiMAX frame N, the second half of frame N+1 and the first half of frame N+2) are blocked to WiMAX operation, and the BS is assumed to be aware of these blocked time intervals. Thus, the BS refrains from transmitting downlink data and allocating uplink bandwidth to the terminal during these periods.

[0076] In alternative embodiments, the WiMAX BS need not be aware of the super-frame structure and timing used by terminal **22**. For example, the terminal (or, more specifically, the WiMAX transceiver of the terminal) may switch to sleep mode during the periods that are blocked to WiMAX operation, and notify the BS of this fact. The terminal can use class **2** sleep mode, as defined in the IEEE 802.16e standard, for this purpose.

[0077] A slot allocation **84** defines the time slots assigned to WLAN operation. The WLAN connection between terminal **22** and AP **24** is assumed to use the UPSD mode. Operation in the UPSD mode is chosen because it gives the terminal control over the timing of transmission and reception, thus enabling the terminal to coordinate the timing of its WLAN link with the timing of the Bluetooth and WiMAX links.

[0078] In the UPSD mode, the terminal (or, more specifically, the WLAN transceiver of the terminal) is in sleep mode by default. The terminal controls the timing in which it wakes up, transmits, receives and returns to sleep. Whenever the terminal wakes up to transmit an uplink transmission, it polls the WLAN AP in order to receive any pending downlink data. If the pending downlink data exceeds the capacity of the allocated time slots, the terminal receives and acknowledges only part of the data. The terminal typically signals the AP to stop sending additional downlink data by refraining from sending uplink acknowledgments. The unacknowledged data is buffered by the AP until bandwidth is available. The terminal can also wake up in order to synchronize with the AP and to transmit and receive WLAN management traffic.

[0079] As can be seen in the figure, slots **S3** . . . **S6** and **S51** . . . **S16** are dedicated to WLAN uplink and downlink operation. Slots **S17** . . . **S18** and **S21** . . . **S22** are defined as optional bandwidth (OP) slots. Slots **S1** . . . **S2**, **S7** . . . **S14**, **S19** . . . **S20** and **S23** . . . **S24** are blocked to WLAN operation.

[0080] The super-frame structure shown in FIG. **3** is an exemplary structure. Any other suitable slot allocation, which gives a first precedence to the Bluetooth link and assigns WiMAX slots that coincide with the uplink and downlink regions of the WiMAX frames, can also be used.

[0081] FIG. **4** is a flow chart that schematically illustrates a method for multi-function communication in wireless terminal **22**, in accordance with an embodiment of the present invention. The method begins by predefining the super-frame structure, at a frame definition step **90**. Terminal **22** and sometimes WiMAX BS **26** are notified of the super-frame structure.

[0082] Coexistence processor **64** in terminal **22** carries out the allocation of the different slot types. Processor **64** allocates transmit and receive slots for the Bluetooth link, at a Bluetooth allocation step **94**. The processor allocates WiMAX uplink and downlink slots, at a WiMAX allocation step **98**, and WLAN polling slots, at a WLAN allocation step **102**.

[0083] Using the allocated slots, terminal **22** communicates simultaneously and without mutual interference with AP **24**, BS **26** and headset **28** over the WLAN, WiMAX and Bluetooth links, respectively, at a communication step **106**.

Bluetooth Link Establishment

[0084] The description above addressed the steady-state situation, in which the WiMAX, WLAN and Bluetooth links are already established. The description that follows describes the operation of terminal **22** during the establishment, or set-up, of the Bluetooth link. As noted above, the Bluetooth protocol is relatively inflexible in terms of slot patterns. Therefore, precedence is typically given to this link, and the WiMAX and WLAN links use the remaining time resources.

[0085] FIG. **5** is a flow chart that schematically illustrates a method for Bluetooth link establishment, in accordance with an embodiment of the present invention. The method begins with the Bluetooth transceiver in terminal **22** initiating an inquiry procedure, as defined in the Bluetooth standard, at an inquiry step **110**. The inquiry procedure attempts to discover the Bluetooth-enabled devices in the vicinity of the terminal. In some cases, once one or more Bluetooth-enabled devices are discovered, the user typically selects a particular device with which to pair.

[0086] According to the inquiry procedure, the terminal sends trains of identification (ID) packets on several Bluetooth frequencies, in order to discover neighboring Bluetooth devices, without prior knowledge of their timing and hopping sequences. Each ID packet train comprises an alternating sequence of transmit and receive 625 μS time slots. The sequence has a nominal duration of 10.24 sec.

[0087] Coexistence processor **64** coordinates the transmission of the ID packet trains with the WiMAX operation of the terminal, in order to prevent the WiMAX link from being dropped, and to prevent the terminal from missing responses from the discovered Bluetooth devices. It is assumed that during terminal-initiated Bluetooth inquiry, the WiMAX applications running in the terminal are either idle or can tolerate temporary link suspension, as long as the link does not drop.

[0088] In some embodiments, the coexistence processor synchronizes the timing of the Bluetooth slots used for inquiry with the timing of the WiMAX frames. Since the terminal initiates the inquiry, procedure, it is free to choose the timing of its transmission and reception. Synchronizing the Bluetooth slots and WiMAX frames is performed so that the terminal is able to occasionally receive downlink transmissions from the WiMAX BS during the 10.24 sec inquiry procedure. The terminal is thus able to maintain synchronization with the WiMAX BS and to perform on-going channel measurements, such as Carrier to Interference and Noise Ratio (CINR) measurements.

[0089] For example, the coexistence processor may set the timing of the Bluetooth inquiry process, so that the beginning of each WiMAX frame coincides with a Bluetooth receive slot. Such synchronization is possible because a 5 ms WiMAX frame has the same length as eight 625 μS Bluetooth slots. Given this synchronization, the terminal is able to receive the first six symbols of the WiMAX frame, which include the downlink preamble. The terminal uses the received preamble to maintain its synchronization with the WiMAX BS.

[0090] In some embodiments, the terminal can define certain WiMAX frames as periods of reduced availability, and notify the BS that the terminal will be unable to participate in active WiMAX communications during these frames. Other frames are defined as having full availability, during which the WiMAX link has precedence over the Bluetooth link. For example, the terminal can have reduced availability for two successive WiMAX frames, followed by two frames of availability, and so on.

[0091] It is usually advantageous to define the period of full availability as lasting at least two WiMAX frames because, as noted above, uplink resources are allocated by the BS MAP message one frame in advance. The terminal sends a reduced availability message to the WiMAX BS, notifying the BS that it will not be able to communicate during a certain number of frames. The terminal can use several alternative methods for coordinating the reduced availability periods with the BS, such as by entering sleep mode, using handover scanning messages or using newly-defined MAC management messages. These methods are described in greater detail further below.

[0092] Since the WiMAX link takes precedence two full-availability WiMAX frames at a time, between two and four Bluetooth transmit slots may be lost during this period. In order to compensate for this loss, the repetition factor of the Bluetooth inquiry transmissions can be increased.

[0093] According to the Bluetooth standard, responses from discovered Bluetooth devices are delayed by a random back-off. During periods of full WiMAX availability, the Bluetooth transceiver refrains from transmitting, but can keep its receiver activated to receive these delayed responses.

[0094] Following the inquiry/pairing procedure, terminal **22** and headset **28** enter a low-power mode, at a low-power operation step **114**. In the low-power modes, the link remains idle until the terminal or the headset have information to transfer. In some embodiments, the Bluetooth link is idle, and performs no communication between the terminal and the headset. In other cases, the terminal and headset perform occasional transmissions in order to maintain its synchronization, so that the link is ready to become active when needed.

[0095] For example, the link may enter a park mode, as defined in the Bluetooth standard. In park mode, assuming terminal **22** is defined as the master, the terminal periodically sends broadcast beacon frames to the headset, in order to maintain its synchronization. These broadcast frames are given priority over the WiMAX transmission and reception.

[0096] Alternatively, the link may enter a sniff mode, as defined in the Bluetooth standard. In sniff mode, again assuming terminal **22** is the master, the terminal maintains synchronization with the headset by performing occasional, relatively infrequent polling of the headset. Operation in sniff mode is similar to ACL mode operation, as described below.

[0097] Note that low-power modes are not necessarily supported by all Bluetooth-enabled terminals. Therefore, low-power operation step **114** may be omitted in some cases. In general, however, it is usually advantageous to reduce the time needed for link establishment by employing the sniff or park modes, in order to reduce the probability of interference between the Bluetooth and WiMAX links.

[0098] Establishment of an active Bluetooth link can be initiated by terminal **22** or by headset **2**B. Steps **118**-**126** below refer to headset-initiated link establishment, while steps **130**-**134** below refer to terminal-initiated link establishment.

[0099] Bluetooth transceiver **52** in terminal **22** may initiate a page scan procedure, as defined in the Bluetooth standard, in order to detect link establishment attempts initiated by neighboring Bluetooth devices, at a page scan step **118**. In a typical page scan procedure, the Bluetooth transceiver activates its receiver for a scan window of 32 Bluetooth slots, i.e., for 20 ms, corresponding to four WiMAX frames. The terminal opens a scan window periodically, every 1.28-2.56 seconds.

[0100] In some embodiments, coexistence processor **64** synchronizes the page scan windows with the WiMAX frames. The synchronization prevents WiMAX transmissions of the terminal from interfering with Bluetooth reception. The synchronization also prevents interference to WiMAX reception, which may be caused by Bluetooth transmissions that are part of the link establishment, once the page scan is successful.

[0101] In some cases, the WiMAX connections that are active in terminal **22** during the Bluetooth page scan procedure do not have real-time requirements. Such connections may comprise, for example, Non-Real-Time Polling Service (nrtPS) or Best Effort (BE) basic service connections. In these cases, the terminal can suspend the WiMAX traffic flow for the duration of the scan, such as by entering a reduced availability period using any of the techniques described above. The reduced availability parameters requested from the BS should ensure that active periodic control loops continue to operate with a higher priority over the Bluetooth page scan.

[0102] In other cases, the active WiMAX connections comprise real-time connections such as Unsolicited Grant Service (UGS), Real Time Polling Service (rtPS) and Extended Real Time Polling service (ertPS) connections. In these cases, the WiMAX transmissions associated with the real-time connections can be given priority over the Bluetooth page scan. The duration of the page scan can be increased to compensate for Bluetooth slots and/or frequencies that may be blocked by the WiMAX transmissions.

[0103] In some embodiments, the frequencies used for reception in the Bluetooth page scan procedure can be determined in coordination with the WiMAX transmission frequencies, so that both can coexist simultaneously without interruption of the page scan. This technique reduces the time duration in which the Bluetooth receiver is active, and thus extends the battery life of the terminal.

[0104] For example, coexistence processor **64** can synchronize the timing of page scan window with the beginning of the WiMAX frames. The coexistence processor monitors the WiMAX transmission frequencies being used, and

selects Bluetooth scan frequencies that are expected to have low interference from the WiMAX transmissions. The duration of the page scan window can be adjusted so that, over time, all Bluetooth paging frequencies are scanned.

[0105] In order to further improve the reliability of the page scan procedure, the terminal can cause the Bluetooth device (e.g., headset **28**) to increase its page repetition frequency. For example, the terminal can report a page scan mode R**1** or R**2** in the SR field of the Frequency Hopping Synchronization (FHS) packets it transmits to the Bluetooth device. This method can also be applied as part of a terminal-initiated paging procedure.

[0106] If the page scan procedure is successful, i.e., if the terminal receives a page transmission from a neighbor Bluetooth device, a Bluetooth link is established between them, at a headset-initiated link establishment step **122**. The link establishment procedure has a typical length of approximately 3.75 ms, during which the Bluetooth link is usually given priority over the WiMAX link.

[0107] When the headset-initiated link establishment procedure is completed, the link is set up with the headset as the master and the terminal as the slave. As noted above, such a situation does not enable the coexistence processor to synchronize the timing of the Bluetooth link to the WiMAX frames, and should therefore be avoided. Thus, the terminal initiates a procedure that reverses the master-slave roles, at a master-slave reversal step **126**. In some embodiments, the terminal can reverse the master-slave roles and become the master by aborting the link establishment procedure immediately after receiving an FHS packet from headset **28**, a message that contains the Bluetooth address of the headset.

[0108] Following reception of the FHS packet, and typically after a delay of at least four slots, the terminal transmits a page to headset **28**, using the address extracted from the FHS message, at a high repetition factor. This technique assumes that the headset is configured to enter the page scan mode in response to the terminal aborting the link establishment procedure. In such a case, the page transmitted by the terminal will be successfully received by the headset, resulting in a Bluetooth link in which the terminal is the master.

[0109] Alternatively, the terminal can use any other suitable method for reversing the master-slave roles of the terminal and the headset, such as the MSS feature defined in the Bluetooth standard, provided the particular headset supports this feature.

[0110] When the link establishment procedure is initiated by terminal **22**, Bluetooth transceiver **52** initiates a paging procedure in order to establish a Bluetooth link with headset **28**, at a paging step **130**. As defined in the Bluetooth standard, the terminal sends trains of ID packets on a subset of the Bluetooth frequencies, attempting to contact the headset.

[0111] The duration of the ID packet train is thirty-two Bluetooth slots, i.e., 20 ms. The train is repeated at least 128 times in the R**1** page scan mode and at least 256 times in the R**2** page scan mode. The total duration of the ID packet train can thus reach up to 2.56 seconds in the R**1** mode and 5.12 seconds in the R**2** mode. The page procedure is repeated until successful completion (i.e., until the headset responds with an ID packet) or until the maximum duration of the page elapses.

[0112] In some embodiments, coexistence processor **64** coordinates the page transmissions with the WiMAX operation of terminal **22**. The coordination prevents the transmitted Bluetooth ID packets from blocking the WiMAX downlink reception, and also prevents WiMAX uplink transmission from blocking the reception of page responses (ID packets) from the headset.

[0113] For example, the terminal may first establish a Bluetooth link with the headset, and only then proceed to establishing an actual voice connection over the WiMAX link. This order enables alerting the user via headset **28** over the Bluetooth link (e.g., by playing a suitable dial tone), while avoiding interference to the WiMAX link from the Bluetooth paging procedure.

[0114] Similarly to the mechanism used in the inquiry procedure described in step **110** above, the terminal may synchronize the paging transmissions with the WiMAX frames by (1) synchronizing the Bluetooth slots with the beginning of the WiMAX frame and (2) using a repetitive pattern of reduced availability and full availability WiMAX frames. As described above, the terminal can have reduced availability for two successive WiMAX frames, followed by two frames of full availability, and so on. During the full-availability frames, the WiMAX link is given priority over the Bluetooth link. Because of the reduced-availability frames, up to eight Bluetooth transmit slots may be lost in each four-frame period.

[0115] The terminal can notify the BS of the periods of reduced availability using any suitable method, such as by entering sleep mode, using handover scanning or using a newly-defined MAC management message. These methods are described further below.

[0116] When headset **28** successfully receives a page transmission from terminal **22**, the headset responds and a link establishment procedure is initiated, at a terminal-initiated link establishment step **134**. As described above, link establishment usually spans six Bluetooth slots, i.e., 3.75 ms. Typically, the Bluetooth link is given priority over the WiMAX link during this procedure, by allowing Bluetooth transmissions and avoiding WiMAX uplink transmissions.

[0117] Having established a Bluetooth link, initiated either by terminal **22** or by headset **28**, the terminal and headset first communicate using an Asynchronous Connectionless Link (ACL) mode, as defined in the Bluetooth standard, at an ACL communication step **138**. Unlike the SCO mode, which is a connection-oriented mode that is typically used for transferring voice, the ACL mode is a connectionless, packet-switched mode that is used primarily to transfer packet data. The ACL communication at step **138** is typically used for negotiating the parameters of an SCO voice link to be set up.

[0118] The ACL link may be established with terminal **22** serving as the master, such as when the link is initiated by a paging procedure executed by the terminal. In this case, the timing of the Bluetooth link is controlled by the terminal. Since the ACL mode does not reserve transmission slots, the coexistence processor can assign Bluetooth slots to the ACL link as needed, as long as the slots are not used by the WiMAX or WLAN links. Coexistence processor **64** can assign the Bluetooth slots using the "busy" interface with the Bluetooth transceiver. The WiMAX frames and the Bluetooth ACL slots are synchronized, so that the beginning of each WiMAX frame coincides with a Bluetooth transmission slot.

[0119] Alternatively, an ACL link may be established with terminal **22** serving as the slave and headset **28** serving as the master, such as when the link is initiated by a paging procedure executed by the headset. As noted above, when the Bluetooth link is initially established with terminal **22** as the slave, the terminal initiates a master-slave switching (MSS) procedure in order to become the master. If the headset does support MSS, the terminal may abort the link establishment procedure and begin paging the headset, similarly to the role-reversal method in the page scan procedure. As a result, the link is re-established with terminal **22** as master.

[0120] Since establishing the Bluetooth link with the headset as master usually results from an action performed by the user (e.g., switching on a Bluetooth-enabled headset), it is desirable to reduce the length of the procedure. Thus, the Bluetooth link is typically given priority over the WiMAX link. In other words, until the link is established, the coexistence processor prevents the slots allocated to the Bluetooth link from being used by the WiMAX link.

[0121] Having negotiated the SCO link parameters, the terminal and headset establish an SCO link, at an SCO link establishment step **142**. Communication at this stage is typically performed in accordance with the super-frame structure of FIG. **3** above.

[0122] In some cases, however, the terminal may continue to operate in the ACL mode, in which case step **142** is omitted. Such a scenario may occur, for example, when the Bluetooth link is used for relaying data rather than voice, such as when the Bluetooth-enabled device comprises a computing device that communicates with terminal **22**.

[0123] Alternatively, the ACL mode can be used to exchange packetized voice between the terminal and the headset. For example, the data packets exchanged in the ACL mode may comprise VoIP packets or packets that carry voice using any other suitable encapsulation method or protocol.

Coordination of Reduced Availability Periods

[0124] As noted above, in some of the link establishment procedures, the terminal defines certain WiMAX frames as reduced availability frames, and provides this information to the WiMAX BS. The BS takes this information into account and refrains from sending MAP messages and downlink data to the terminal during these frames. Several methods can be employed by the terminal in order to coordinate the reduced availability periods with the BS. Reduced availability notification methods are also described in the U.S. patent application "Dual-Function Wireless Data Terminal," cited above.

[0125] For example, when both the terminal and BS support Power Saving Class type **2**, as defined in the IEEE 802.16e standard, the terminal can send a sleep mode request (SLP-REQ) message to the BS, indicating that it intends to enter sleep mode in a particular frame. The BS responds with a SLP-RESP message. In some embodiments, an additional information element can be added to the SLP-REQ message, in order to indicate to the BS that the sleep mode request is related to a coexistence scenario. The new information element is typically encoded as a type-length value (TLV) field.

[0126] SLP-REQ and SLP-RESP messages are associated with the individual transport connections that are currently supported by the terminal, and not with the terminal as a whole. The connections may be grouped according to Paging Saving Classes. When the terminal has a large number of connections, the sleep request messages may become long and may consume significant air interface resources.

[0127] In an alternative embodiment, the terminal may coordinate reduced availability frames with the BS using handover scanning messages. The terminal can transmit a scan request (MOB-SCN-REQ) message, requesting the BS to allow it a predetermined time interval to scan for an alternative BS. The BS responds with a MOB-SCN-RESP message that indicates the allocated scanning time interval. During the allocated scanning interval, the BS refrains from sending downlink data to the terminal, since it assumes that the terminal is engaged in receiving another BS.

[0128] For example, when the Bluetooth link used by the terminal is an SCO link, the terminal can request an allocation of a scanning interval having a duration of one frame, an interleaving interval of two frames, and a scan iteration value set to zero (i.e., indefinitely).

[0129] As in sleep mode operation, an additional TLV-encoded information element can be added to the MOB-SCN-REQ message, in order to indicate to the BS that the scan request is related to a coexistence scenario.

[0130] Further alternatively, the terminal may coordinate the reduced availability frames with the BS by defining dedicated 802.16 management messages, denoted COEXIST-REQ and COEXIST-RESP. The COEXIST-REQ message, which should be supported by the BS, requests that the BS refrain from communicating with the terminal during a particular time period due to a coexistence event.

WiMAX-WLAN Handover Scenarios

[0131] Methods for handing over a wireless terminal between a WLAN and a WiMAX network are described, for example, in the U.S. patent application "Dual-Function Wireless Data Terminal," cited above. The following description addresses the coordination of handover procedures in terminal **22** from the WLAN to the WiMAX network or vice versa, with a possibly-active Bluetooth link.

[0132] FIG. **6** is a flow chart that schematically illustrates a method for handing over terminal **22** from the WLAN to the WiMAX network in the presence of a Bluetooth link, in accordance with an embodiment of the present invention. The method begins with terminal **22** performing a WiMAX scanning procedure, at a WiMAX scanning step **146**. The WiMAX scanning procedure attempts to identify a WiMAX BS with which it is able to communicate. WiMAX scanning is often performed while the terminal is actively communicating over the WLAN link. Assuming a suitable WiMAX BS is identified, the terminal registers with the identified BS, preferably while maintaining its WLAN sessions active. The handover in from WLAN to WiMAX is generally time-critical, since the WLAN the terminal may rapidly roam out of the WLAN coverage area and drop the WLAN link.

[0133] In WiMAX scanning, the terminal passively receives and performs measurements on the transmissions of the WiMAX BS. These reception periods should be coordinated with the WLAN and Bluetooth transmissions of the terminal, so as to avoid mutual interference. Since the timing of WLAN transmissions is often unpredictable, the terminal gives higher priority to the WiMAX scanning periods over WLAN transmissions, thus suspending the WLAN link for short periods. Coexistence processor typically uses the "busy" interfaces described above for suspending the

WLAN link. Since the WLAN link may carry real-time applications such as Voice over IP (VoIP), in some embodiments WiMAX scanning periods are limited to 5 ms in every 20 ms time interval. This limitation is sufficient for performing a single measurement on a single WiMAX frequency once every 20 ms.

[0134] Once the terminal identifies a valid WiMAX BS signal, e.g., by detecting the preamble transmitted by the BS, the terminal receives Downlink Channel Descriptor (DCD) messages, which further identify the BS. In order to receive the DCD messages, the terminal attempts to receive the initial symbols of every subsequent WiMAX frame. As a result, the terminal acquires the timing of the WiMAX BS. The terminal suspends its WLAN transmissions for the first 1 ms or less, in every 5 ms WiMAX frame, in order to receive the preamble, downlink MAP and uplink MAP messages. This suspension ratio can usually be tolerated by the active WLAN sessions of the terminal.

[0135] As noted above, a Bluetooth link may be active in parallel to the handover procedure. When the Bluetooth link comprises an ACL link, its transmissions are usually asynchronous and sporadic. Thus, WiMAX scanning is given priority over Bluetooth ACL transmissions, and ACL transmissions are suspended during WiMAX scanning intervals.

[0136] When the Bluetooth link comprises an SCO link, on the other hand, the Bluetooth transmissions are synchronous and should not be delayed. SCO transmissions occur every 3.75 ms, in comparison with the 5 ms WiMAX frames. Thus, in every **15** ms period (the common multiple of 3.75 ms and 5 ms) there are at least two instances in which reception of the beginning of the WiMAX frame is not blocked by Bluetooth SCO transmissions.

[0137] In some embodiments, the terminal may increase the number of WiMAX scanning attempts in order to compensate for the possible interference caused by Bluetooth SCO transmissions. For example, the terminal may perform three or more measurement attempts for every WiMAX frequency assignment.

[0138] Once the terminal identified the WiMAX BS and acquired its timing, it performs the actual handover procedure, at a WiMAX handover execution step **150**. WiMAX handover execution comprises multiple exchanges of control and data messages over the WiMAX link. This exchange of messages should comply with the timing of the WiMAX BS.

[0139] In some embodiments, WiMAX transmission and reception are given priority over both WLAN and Bluetooth ACL communication during handover execution. The timing of WiMAX transmission and reception periods in each WiMAX frame is known to the WiMAX transceiver of the terminal in advance. Coexistence processor **64** typically suspends the WLAN and Bluetooth ACL transmissions during the periods in which the preamble, FCH, downlink MAP and uplink MAP are received from the WiMAX BS. The coexistence processor also suspends WLAN and Bluetooth ACL transmission during time intervals, which are allocated to the terminal by the BS for uplink and downlink communication. The time intervals during which WLAN and Bluetooth ACL operation is suspended are typically short and sporadic, and therefore do not cause data loss or significant performance degradation.

[0140] When a Bluetooth SCO link is active during handover execution, the WiMAX link is typically given priority over the SCO link, since WiMAX handover execution is a one-time event that is critical to the continuity of user sessions. The WiMAX link is thus given priority until the terminal and WiMAX BS coordinate the reduced availability periods between them, as described above.

[0141] In some cases, the Bluetooth SCO link can be established before WiMAX timing is acquired by the terminal. Thus, it is not always possible to synchronize the WiMAX and Bluetooth SCO links. In the absence of synchronization between the WiMAX and Bluetooth SCO links, coexistence can be achieved using the dedicated COEXIST-REQ and COEXIST-RESP messages described above. The COEXIST-REQ message may comprise parameters as the time offset of the Bluetooth timing with respect to the WiMAX timing, a relation between SCO transmissions and the WiMAX frame number and the SCO period (Tsco). Using these parameters, the BS is able to estimate periods of reduced availability of the terminal that are caused by Bluetooth SCO transmissions. The BS can then schedule WiMAX transmissions in accordance with the estimated terminal availability.

[0142] FIG. **7** is a flow chart that schematically illustrates a method for handing over terminal **22** from the WiMAX network to the WLAN in the presence of a Bluetooth link, in accordance with an embodiment of the present invention. The method begins with the terminal initiating a WLAN scanning procedure, attempting to identify a WLAN AP with which the terminal can communicate, at a WLAN scanning step **154**. WLAN scanning is often performed while the terminal is actively communicating over the WiMAX link. Once a suitable AP is identified, the terminal associates and optionally authenticates with the AP. Existing WiMAX sessions should be preserved during the handover procedure. Once the active sessions are re-established via the WLAN AP, the terminal may de-register from the WiMAX network and deactivate its WiMAX link.

[0143] The handover from WiMAX to WLAN is generally not as time-critical as the handover in the opposite direction, since WLAN hotspots are usually contained within the WiMAX coverage area. In some cases, the handover from WiMAX to WLAN affects the continuity of the active sessions, such as when the user moves from an outdoor WiMAX coverage area into an indoor WLAN hotspot, in which the WiMAX coverage is poor.

[0144] WLAN scanning may comprise passive or active scanning. In passive scanning, the terminal listens on selected frequency channels and attempts to receive beacon frames, which are transmitted periodically by the WLAN AP. A typical beacon transmission period is 100 ms, and the terminal should typically remain on each frequency channel for at least twice this period in order to receive beacon frames with sufficient probability.

[0145] In active WLAN scanning, on the other hand, the terminal solicits AP responses by sending Probe Request frames. The AP responds with Probe Response frames. WLAN certification procedures recommend that the AP responds to Probe Requests within 5 ms. As a result, active scanning is usually significantly faster than passive scanning. A typical scanning time is on the order of 10 ms per attempt per frequency channel. Given the active and passive scanning time constants, the terminal preferably uses active WLAN scanning when the WiMAX link is active.

[0146] Before beginning active scanning, the terminal coordinates reduced availability periods with the WiMAX BS, as described above. Using the coordinated reduced

availability periods, the terminal suspends its WiMAX transmissions for two successive WiMAX frames, or 10 ms. In each suspension period, the terminal performs a single probe of one WLAN frequency channel. Each WLAN frequency channel is probed at least twice to increase the probability of detecting the AP.

[0147] When a Bluetooth ACL link is active during WLAN scanning, the Bluetooth ACL transmissions are similarly suspended during the 10 ms WLAN scanning period. When a Bluetooth SCO link is active during WLAN scanning, SCO transmissions are give priority over the WLAN scanning attempts. Since the SCO transmissions, occurring at 3.75 ms periods, may interfere with reception of AP responses, this prioritization may reduce the probability of detecting the WLAN AP. In order to compensate for the reduced probability, the terminal may increase the number of WLAN probe attempts.

[0148] Once the WLAN AP is identified, the terminal executes the actual handover procedure, at a WLAN handover execution step **158**. The WLAN handover execution procedure comprises an exchange of multiple management and data messages between the terminal and the AP. Although these transmissions are usually not time-critical, the entire handover procedure may take up to several seconds, particularly when the AP uses WPA-1*x* authentication. Since the WLAN message exchange is usually not time-critical, the WiMAX and Bluetooth links are usually given priority over the WLAN link during handover execution.

[0149] Since WLAN packets of the active user sessions are not duplicated between the WLAN and WiMAX links during handover execution, the user sessions and their associated Quality-of-Service (QoS) flows are typically re-established on the WLAN link after the WiMAX link is terminated. Once the active user sessions are re-established over the WLAN link, the terminal de-registers from the WiMAX network using known IEEE 802.16 management messages.

[0150] In some cases, the terminal may perform handover from WiMAX to WLAN while the WiMAX link is in idle mode. In these cases, and particularly since associating with the WLAN may take considerable time, it is desirable that the terminal be able to receive pages from the WiMAX network during the handover procedure. Thus, the terminal can suspend the WLAN link during idle mode listening periods. Bluetooth ACL transmissions can be similarly suspended during the idle mode listening periods.

[0151] When a Bluetooth SCO link is active, the SCO transmissions are usually given priority over the WiMAX link, thus reducing the probability of successfully receiving a page and potentially extending the paging procedure. Nevertheless, this degradation can be tolerated in most scenarios.

[0152] Although the embodiments described herein mainly address coordination of WiMAX, WLAN and Bluetooth links in a single communication terminal, the principles of the present invention can also be used in coexistence between only two of these protocols. Generally, the methods and systems described herein can be used for coordinating the transmissions of any suitable long-range base-station protocol with any suitable local, short-range protocol. Furthermore, these principles may also be applied in coexistence schemes involving other sorts of wireless protocols, such as Ultra-WideBand (UWB) protocols, the protocols defined by the Third Generation Partnership Project (3GPP) Long Term Evolution (LTE), 3GPP2 Evolution-Data Optimized (EVDO) Rev C (UMB) and the IEEE 802.20 High Speed Mobile Broadband Wireless Access (MBWA) specifications.

[0153] It will thus be appreciated that the embodiments described above are cited by way of example, and that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention includes both combinations and sub-combinations of the various features described hereinabove, as well as variations and modifications thereof which would occur to persons skilled in the art upon reading the foregoing description and which are not disclosed in the prior art.

1. A method for communication, comprising:

establishing a first communication session over a first connection between a wireless terminal and a base station (BS) of a long-range wireless data network, which operates in accordance with a first protocol that defines a sequence of time frames;

allocating time slots, based on the time frames defined by the BS, for establishing a second communication session over a second connection between the wireless terminal and a peripheral wireless device, which operates in accordance with a second, short-range time-slotted communication protocol different from the first protocol;

allocating time intervals within the time frames for downlink and uplink transmission between the BS and the wireless terminal over the first connection such that the allocated time intervals are interleaved with and do not overlap the allocated time slots; and

concurrently conducting the first and second communication sessions in the allocated time intervals and the assigned time slots, respectively.

2. The method according to claim **1**, wherein the long-range wireless data network comprises a WiMAX network that operates in accordance with an IEEE 802.16 standard, and wherein the second connection operates in accordance with a Bluetooth Core Specification.

3. The method according to claim **2**, wherein the second protocol operates in accordance with at least one of a Synchronous Connection-Oriented (SCO) mode and an Asynchronous Connectionless Link (ACL) mode of the Bluetooth core specification.

4. The method according to claim **1**, and comprising establishing a third communication session over a third connection with an access point (AP) of a wireless local area network (WLAN) in accordance with a third protocol different from the first and second protocols, during time periods that do not overlap the time slots of the first connection and the time intervals of the second connection, and conducting the third communication session concurrently with the first and second sessions.

5. The method according to claim **4**, wherein the third protocol comprises a protocol in which the time periods used by the third communication session are initiated by the wireless terminal, and wherein establishing the third communication session comprises selecting the time periods by the wireless terminal so as not to overlap the time slots of the first connection and the time intervals of the second connection.

6. The method according to claim **4**, wherein the WLAN operates in accordance with an IEEE 802.11 standard.

7. The method according to claim 4, and comprising allocating additional optional time slots to one of the first, second and third connections when not previously allocated to another of the first, second and third connections.

8. The method according to claim 4, wherein the third connection operates in accordance with an Unscheduled Power Save Delivery (UPSD) mode of the IEEE 802.11 standard.

9. The method according to claim 4, wherein establishing the first communication session comprises handing over the wireless terminal from the WLAN to the long-range wireless data network while the third communication session is in progress.

10. The method according to claim 4, wherein establishing the third communication session comprises handing over the wireless terminal from the long-range wireless data network to the WLAN while the third communication session is in progress.

11. The method according to claim 1, wherein allocating the time slots based on the time frames comprises synchronizing the allocated time slots with the time frames defined by the BS.

12. The method according to claim 1, wherein the second communication session comprises a voice connection between the wireless terminal and the peripheral device, and wherein allocating the time slots for the second communication session comprises allocating the time slots at regular intervals.

13. The method according to claim 1, wherein allocating the time intervals within the time frames comprises notifying the BS that the wireless terminal is not available to communicate with the BS outside the allocated time intervals.

14. The method according to claim 1, wherein establishing the second communication session comprises initially establishing the second connection such that a timing of the time slots is determined by the peripheral device, and subsequently causing the timing of the time slots to be determined by the wireless terminal, so as to enable the time slots to be synchronous with the time frames of the first protocol defined by the BS.

15. The method according to claim 14, wherein causing the timing of the time slots to be determined by the wireless terminal comprises invoking a Master-Slave Switching (MSS) procedure defined in the second protocol.

16. The method according to claim 14, wherein causing the timing of the time slots to be determined by the wireless terminal comprises aborting establishment of the second connection by the wireless terminal after receiving an address of the peripheral device, and initiating a paging procedure by the wireless terminal using the received address, so as to re-establish the second connection with the timing of the time slots determined by the wireless terminal.

17. The method according to claim 1, wherein establishing the second communication session comprises carrying out an inquiry procedure by the wireless terminal in order to identify the peripheral device, and coordinating the allocated time slots and time intervals during the inquiry procedure.

18. The method according to claim 1, wherein establishing the second communication session comprises transmitting synchronization transmissions from the wireless terminal to the peripheral device in a low-power mode of the second protocol, and giving a priority to the synchronization transmissions over the time intervals of the first connection.

19. The method according to claim 1, wherein establishing the second communication session comprises transmitting paging transmissions between the wireless terminal and the peripheral device for establishing the second connection, while coordinating the exchange of the paging transmissions with the time intervals of the first connection.

20. The method according to claim 1, wherein establishing the second communication session comprises defining a subset of the time frames of the first connection as reduced-availability frames, notifying the BS that the wireless terminal is not available to communicate with the BS during the reduced-availability frames, and giving a priority to establishing the second communication session during the reduced-availability frames.

21. A wireless communication terminal, comprising:

a radio frequency (RF) unit; and

a baseband processing circuit, which is coupled to cause the RF unit to transmit and receive signals over the air so as to establish a first communication session over a first connection with a base station (BS) of a long-range wireless data network, which operates in accordance with a first protocol that defines a sequence of time frames, and to establish a second communication session over a second connection between the wireless terminal and a peripheral wireless device, which operates in accordance with a second, short-range time-slotted communication protocol different from the first protocol; and

a coexistence processor, which is arranged to allocate time slots based on the time frames defined by the BS, for the second session and to allocate time intervals within the time frames for downlink and uplink transmission between the BS and the wireless terminal over the first connection such that the allocated time intervals are interleaved with and do not overlap the allocated time slots, so as to concurrently conduct the first and second communication sessions in the allocated time intervals and the assigned time slots, respectively.

22. The terminal according to claim 21, wherein the long-range wireless data network comprises a WiMAX network that operates in accordance with an IEEE 802.16 standard, and wherein the second connection operates in accordance with a Bluetooth Core Specification.

23. The terminal according to claim 22, wherein the second protocol operates in accordance with at least one of a Synchronous Connection-Oriented (SCO) mode and an Asynchronous Connectionless Link (ACL) mode of the Bluetooth core specification.

24. The terminal according to claim 21, wherein the baseband processing circuit is further arranged to establish a third communication session over a third connection with an access point (AP) of a wireless local area network (WLAN) in accordance with a third protocol different from the first and second protocols, and wherein the coexistence processor is arranged to allocate time periods for the third communication session that do not overlap the time slots of the first connection and the time intervals of the second connection, so as to conduct the third communication session concurrently with the first and second sessions.

25. The terminal according to claim 24, wherein the third protocol comprises a protocol in which the time periods used by the third communication session are initiated by the wireless terminal, and wherein the coexistence processor is

arranged to select the time periods so as not to overlap the time slots of the first connection and the time intervals of the second connection.

26. The terminal according to claim **24**, wherein the WLAN operates in accordance with an IEEE 802.11 standard.

27. The terminal according to claim **24**, wherein the coexistence processor is arranged to allocate additional optional time slots to one of the first, second and third connections when not previously allocated to another of the first, second and third connections.

28. The terminal according to claim **24**, wherein the third connection operates in accordance with an Unscheduled Power Save Delivery (UPSD) mode of the IEEE 802.11 standard.

29. The terminal according to claim **24**, wherein the baseband processing circuit and the coexistence processor are arranged to hand over the wireless terminal from the WLAN to the long-range wireless data network while the third communication session is in progress.

30. The terminal according to claim **24**, wherein the baseband processing circuit and the coexistence processor are arranged to hand over the wireless terminal from the long-range wireless data network to the WLAN while the third communication session is in progress.

31. The terminal according to claim **24**, wherein the baseband processing circuit comprises first, second and third transceivers, which are respectively arranged to communicate with the BS, the peripheral device and the AP, and wherein the coexistence processor is connected to the transceivers using respective coexistence interfaces and is arranged to allocate the time intervals, time slots and time periods by signaling to the transceivers over the coexistence interfaces.

32. The terminal according to claim **31**, wherein the baseband processing circuit comprises a first sub-circuit comprising the second and third transceivers, and a second sub-circuit comprising the first transceiver and the coexistence processor, and wherein the coexistence processor is arranged to control the second and third transceivers using the coexistence interfaces, which are connected between the first and second sub-circuits.

33. The terminal according to claim **31**, wherein the coexistence processor is arranged to synchronize the allocated time slots with the time frames defined by the BS.

34. The terminal according to claim **21**, wherein the second communication session comprises a voice connection between the wireless terminal and the peripheral device, and wherein the coexistence processor is arranged to allocate the time slots of the second connection at regular intervals.

35. The terminal according to claim **21**, wherein the baseband processing circuit is arranged to notify the BS that the wireless terminal is not available to communicate with the BS outside the allocated time intervals.

36. The terminal according to claim **21**, wherein the baseband processing circuit is arranged to initially establish the second connection such that a timing of the time slots is determined by the peripheral device, and to subsequently cause the timing of the time slots to be determined by the wireless terminal, so as to enable the time slots to be synchronous with the time frames of the first protocol defined by the BS.

37. The terminal according to claim **36**, wherein the baseband processing circuit is arranged to cause the timing of the time slots to be determined by the wireless terminal by invoking a Master-Slave Switching (MSS) procedure defined in the second protocol.

38. The terminal according to claim **36**, wherein the baseband processing circuit is arranged to cause the timing of the time slots to be determined by the wireless terminal by aborting establishment of the second connection by the wireless terminal after receiving an address of the peripheral device, and initiating a paging procedure by the wireless terminal using the received address, so as to re-establish the second connection with the timing of the time slots determined by the wireless terminal.

39. The terminal according to claim **21**, wherein the baseband processing circuit is arranged to carry out an inquiry procedure in order to identify the peripheral device, and wherein the coexistence processor is arranged to coordinate the allocated time slots and time intervals during the inquiry procedure.

40. The terminal according to claim **21**, wherein the baseband processing circuit is arranged to transmit synchronization transmissions to the peripheral device in a low-power mode of the second protocol, and wherein the coexistence processor is arranged to give a priority to the synchronization transmissions over the time intervals of the first connection.

41. The terminal according to claim **21**, wherein the baseband processing circuit is arranged to exchange paging transmissions between the wireless terminal and the peripheral device for establishing the second connection, and wherein the coexistence processor is arranged to coordinate the exchange of the paging transmissions with the time intervals of the first connection.

42. The terminal according to claim **21**, wherein the coexistence processor is arranged to define a subset of the time frames of the first connection as reduced-availability frames, to notify the BS that the wireless terminal is not available to communicate with the BS during the reduced-availability frames, and to give a priority to establishing the second communication session during the reduced-availability frames.

* * * * *

EXHIBIT 1020

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(54) SYSTEM FOR MANAGING RADIO MODEMS

(75) Inventors: **Mika Kasslin**, Espoo (FI); **Mauri Honkanen**, Tampere (FI); **Jukka Reunamaki**, Tampere (FI); **Paivi M. Ruuska**, Tampere (FI); **Hannu E. Laine**, Espoo (FI); **Miika O. Laaksonen**, Espoo (FI)

Correspondence Address:
MORGAN & FINNEGAN, L.L.P.
3 WORLD FINANCIAL CENTER
NEW YORK, NY 10281-2101

(73) Assignee: **NOKIA CORPORATION**, Espoo (FI)

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H04B 1/40 (2006.01)

(52) **U.S. Cl.** **455/557**

(57) **ABSTRACT**

A system for managing the operation of a plurality of radio modems contained within the same WCD. One or more of the plurality of radio modems may be a dual-mode radio modem enabled to communicate using at least two separate radio protocols concurrently. The operation of the one or more dual-mode modems may be managed by resources encompassed in a radio modem interface coupled to, or integrated within, the dual-mode radio modem. These management resources may receive information from the operating system level of the WCD and from the at least two radio modem stacks utilizing the resources of the dual mode radio modem in order to coordinate the operation of the at least two radio protocols concurrently active in the modem.

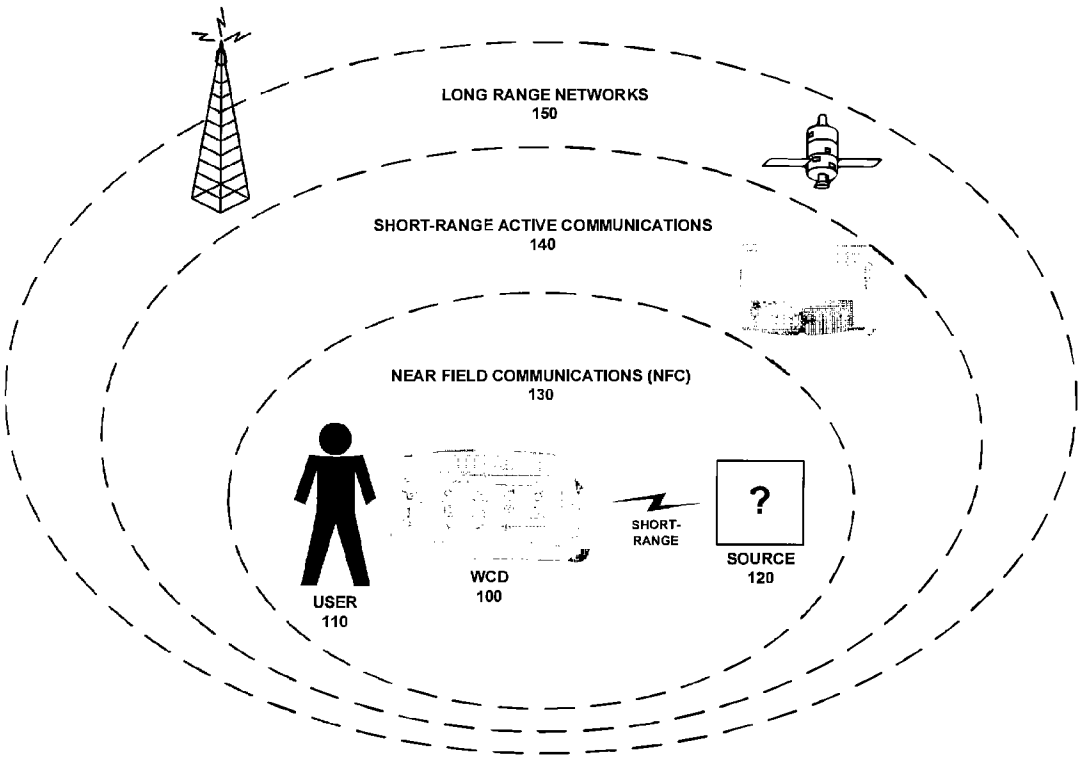


FIG. 1

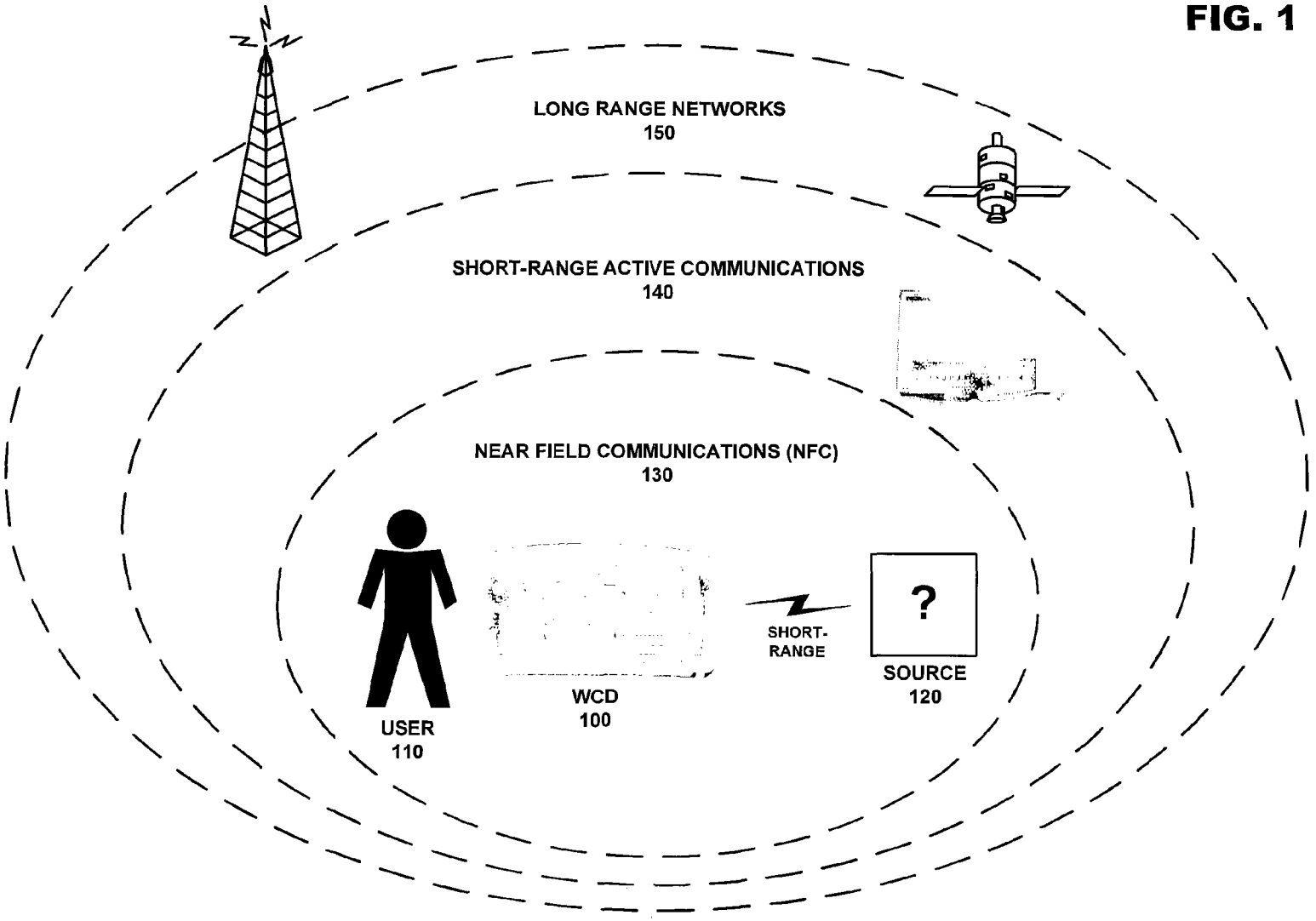

LONG RANGE NETWORKS
150
SHORT-RANGE ACTIVE COMMUNICATIONS
140
NEAR FIELD COMMUNICATIONS (NFC)
130
USER
110
WCD
100
SHORT-
RANGE
?
SOURCE
120

FIG. 2

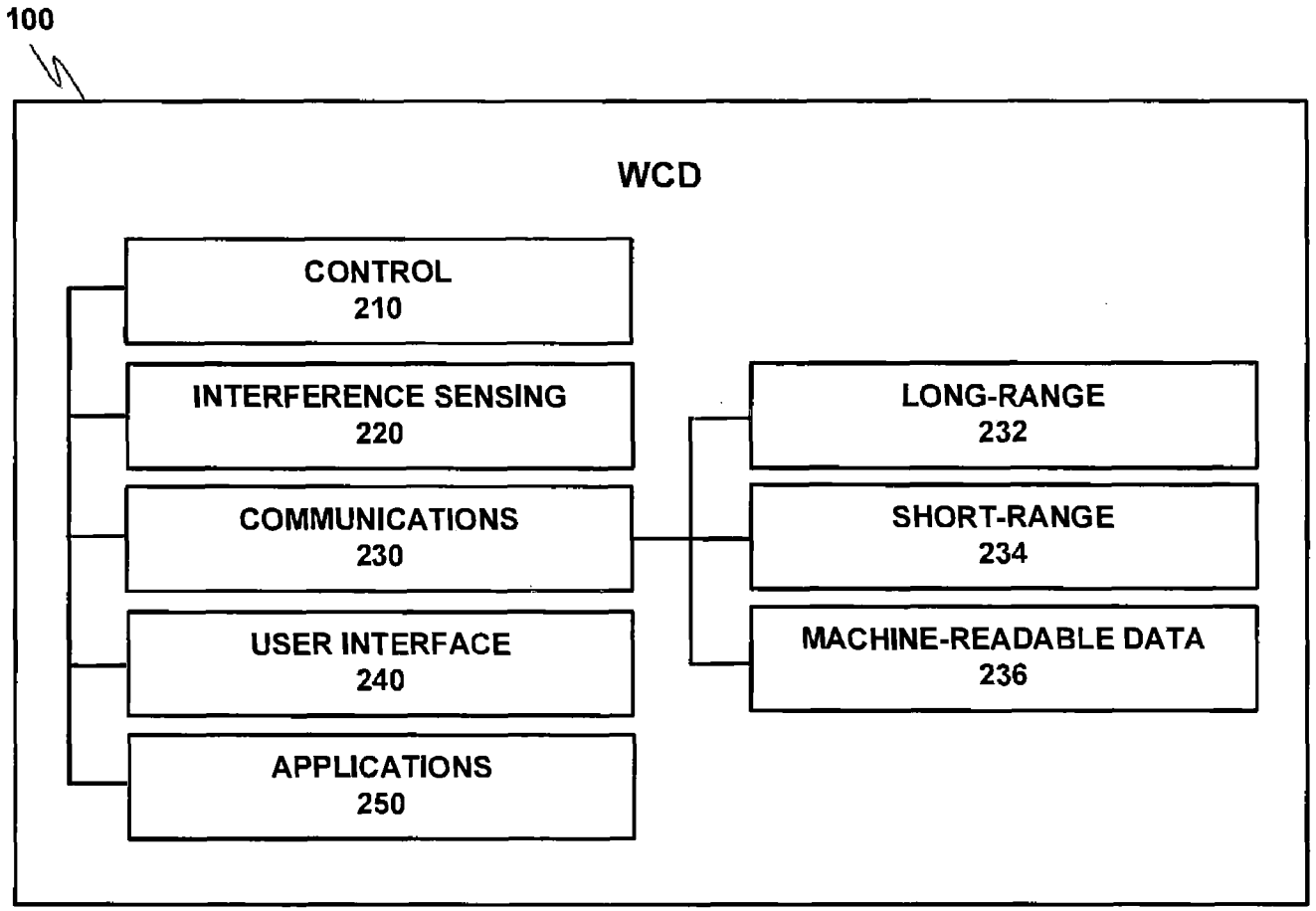

100
WCD
CONTROL
210
INTERFERENCE SENSING
220
COMMUNICATIONS
230
USER INTERFACE
240
APPLICATIONS
250
LONG-RANGE
232
SHORT-RANGE
234
MACHINE-READABLE DATA
236

FIG. 3

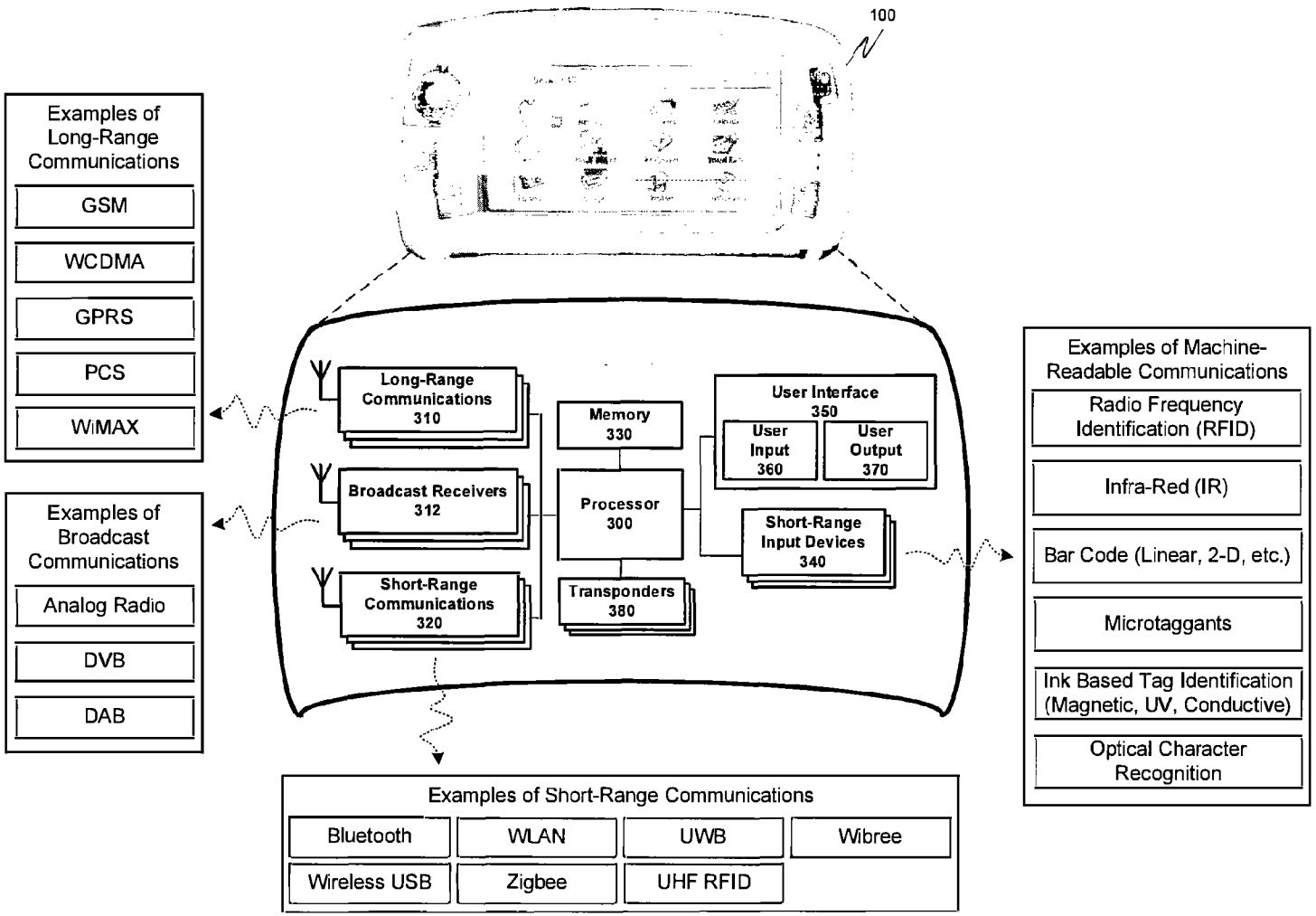
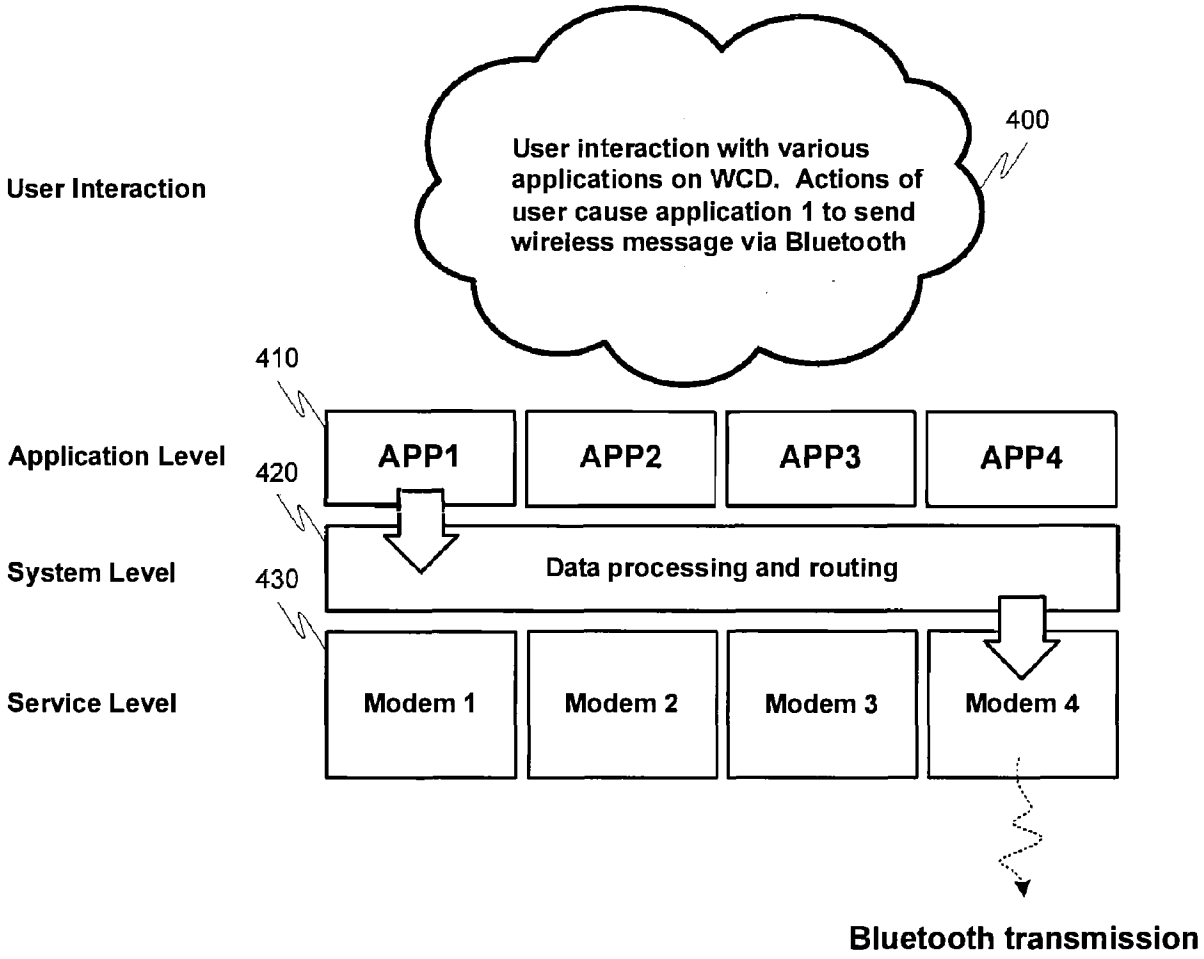

100
Examples of Long-Range Communications
GSM
WCDMA
GPRS
PCS
WiMAX
Examples of Broadcast Communications
Analog Radio
DVB
DAB
Long-Range Communications 310
Broadcast Receivers 312
Short-Range Communications 320
Memory 330
Processor 300
Transponders 380
User Interface 350
User Input 360
User Output 370
Short-Range Input Devices 340
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
Examples of Short-Range Communications
Bluetooth
WLAN
UWB
Wibree
Wireless USB
Zigbee
UHF RFID

FIG. 4


User Interaction
User interaction with various applications on WCD. Actions of user cause application 1 to send wireless message via Bluetooth
400
410
Application Level
APP1
APP2
APP3
APP4
420
System Level
Data processing and routing
430
Service Level
Modem 1
Modem 2
Modem 3
Modem 4
Bluetooth transmission

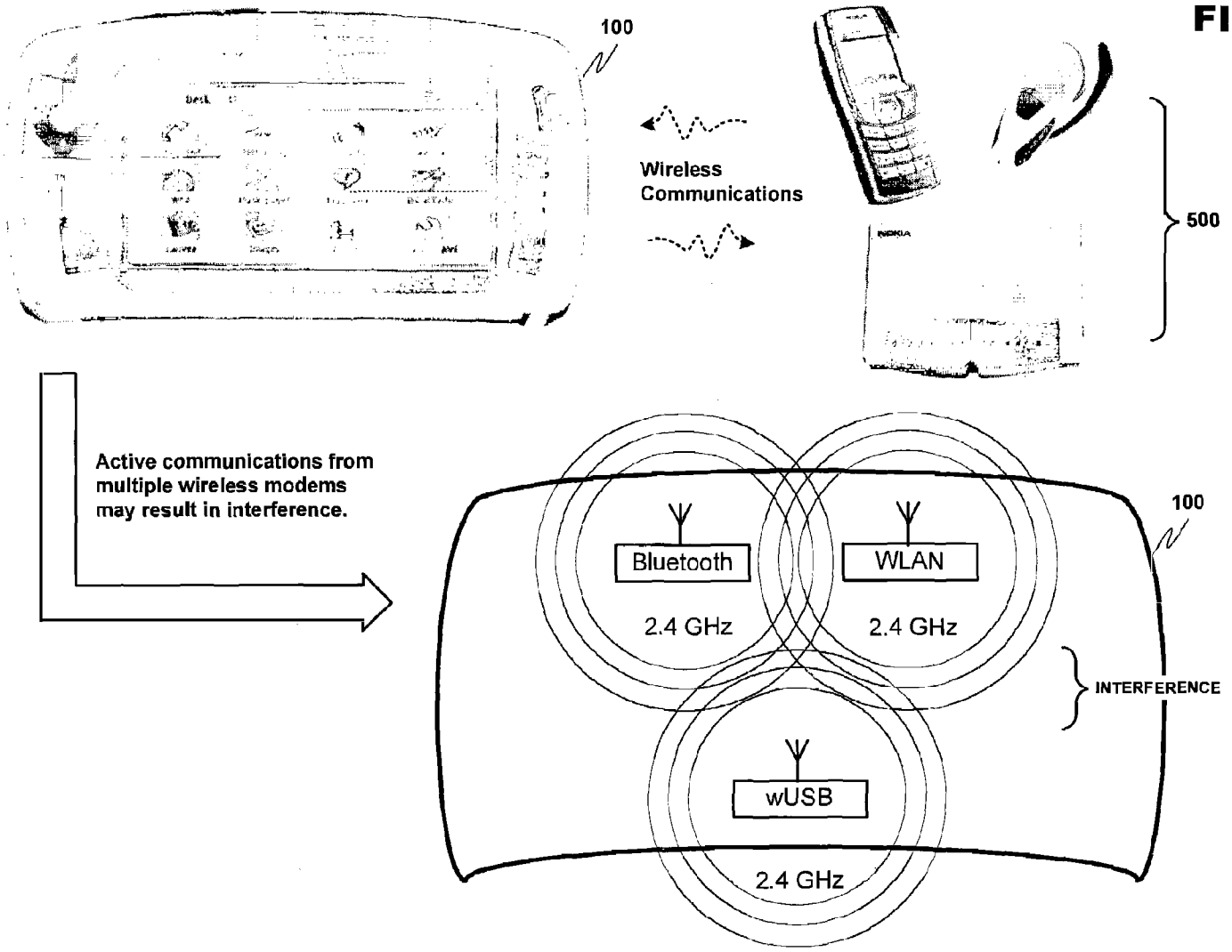

100
Wireless
Communications
500
Active communications from
multiple wireless modems
may result in interference.
Bluetooth
WLAN
2.4 GHz
2.4 GHz
100
INTERFERENCE
wUSB
2.4 GHz

FIG. 5

FIG. 6A

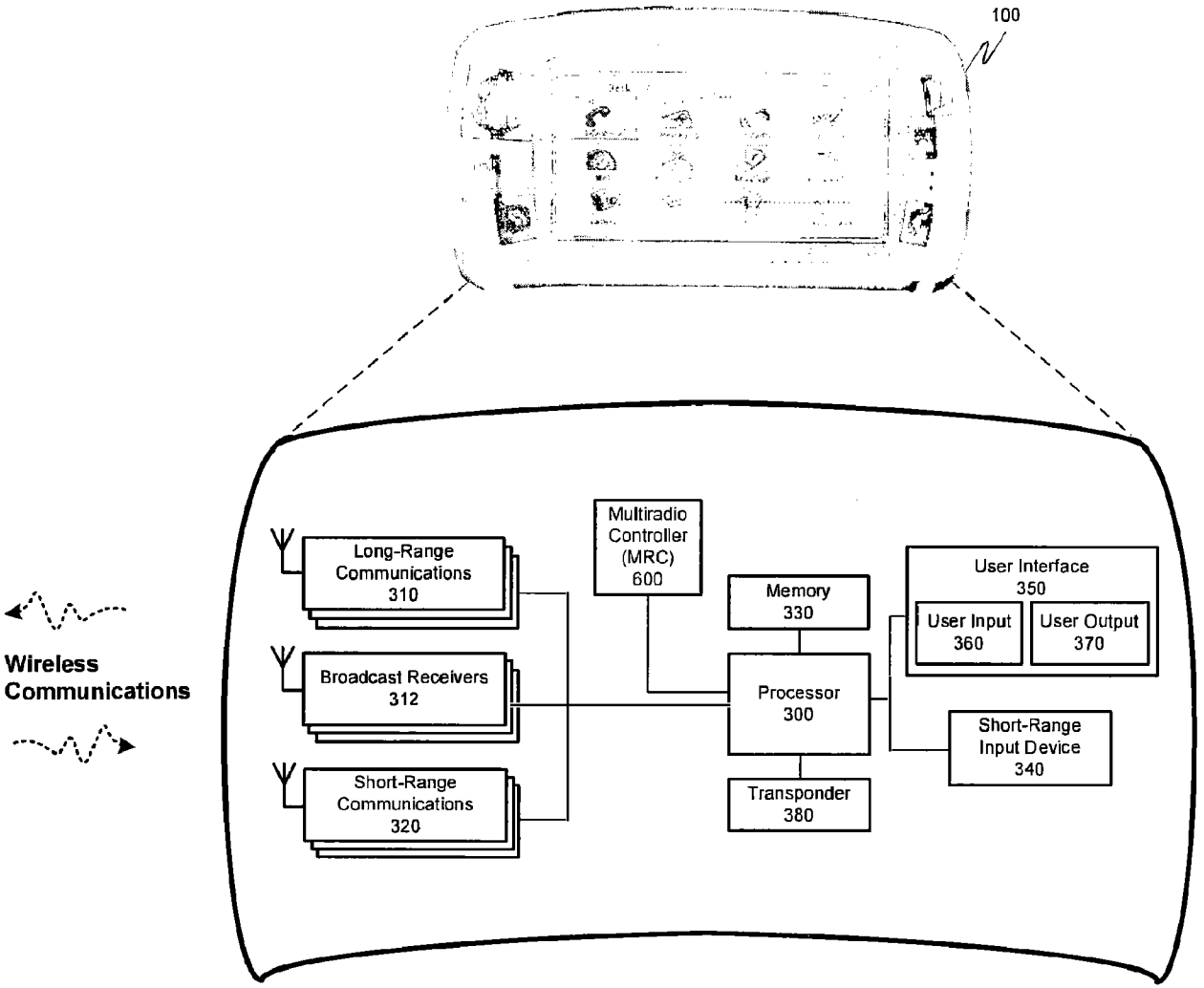
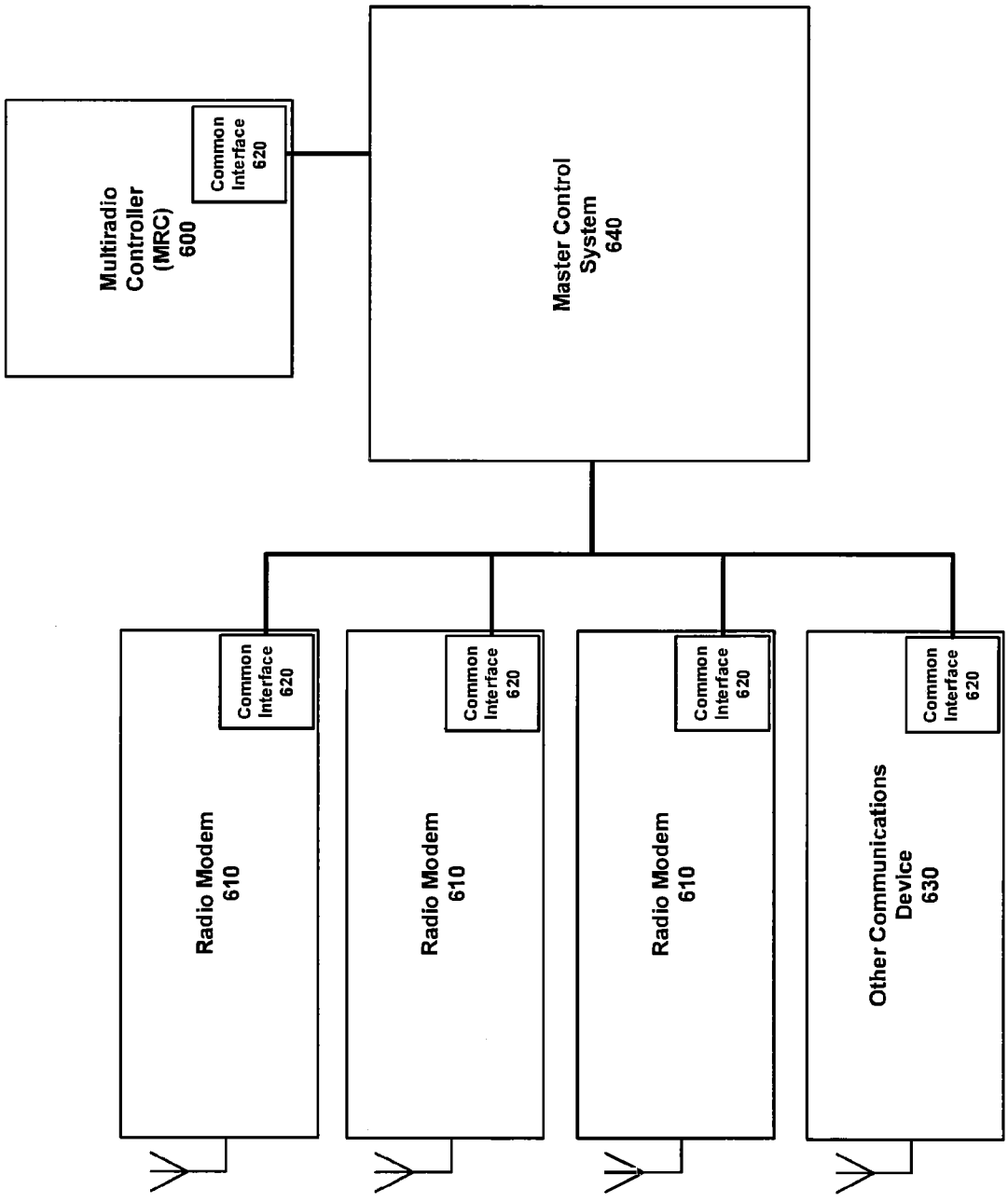

100
Wireless Communications
Long-Range Communications 310
Broadcast Receivers 312
Short-Range Communications 320
Multiradio Controller (MRC) 600
Memory 330
Processor 300
Transponder 380
User Interface 350
User Input 360
User Output 370
Short-Range Input Device 340

FIG. 6B



Samsung - Exhibit 1006 - Page 709

FIG. 6C

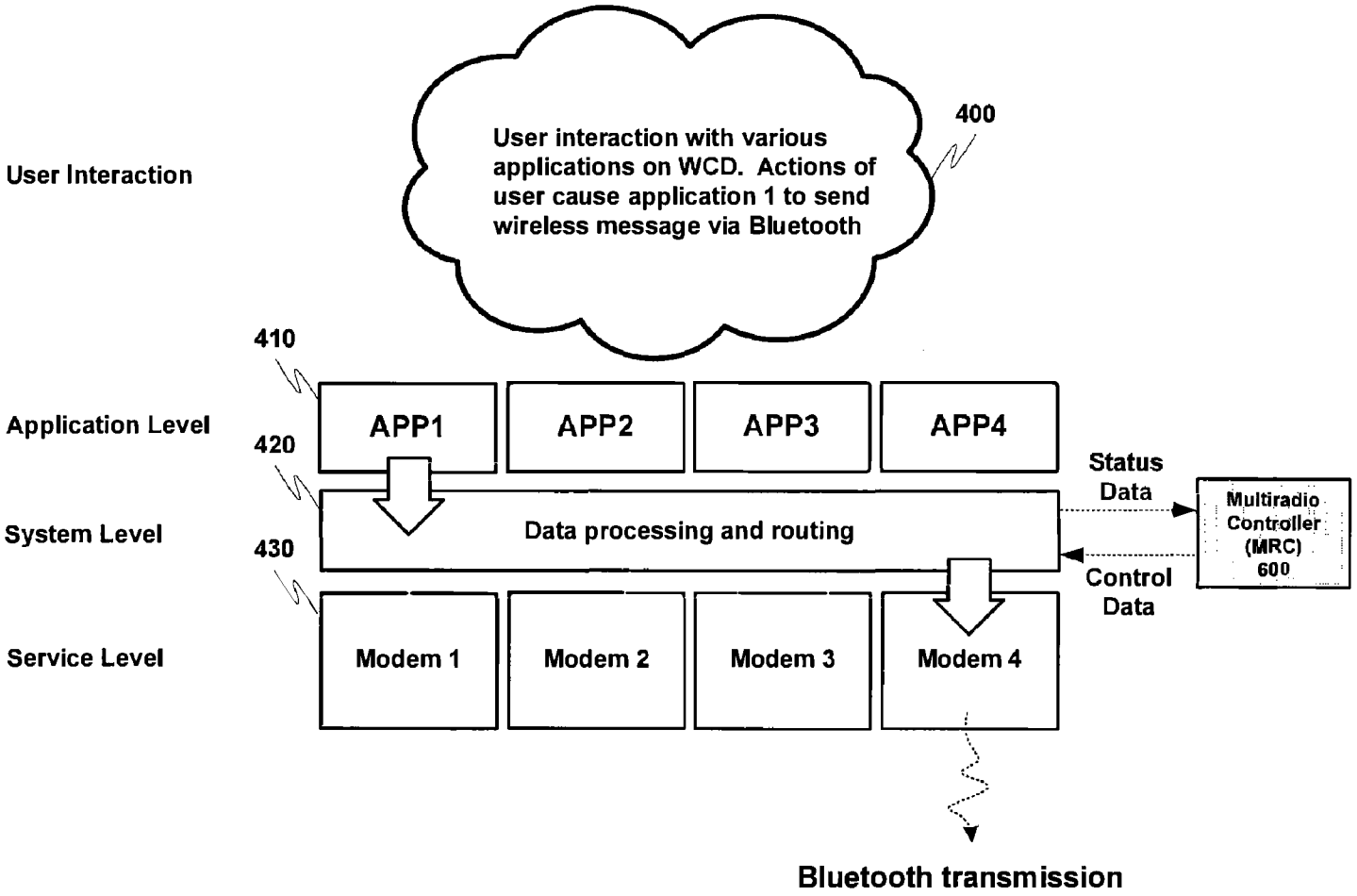

User Interaction
User interaction with various applications on WCD. Actions of user cause application 1 to send wireless message via Bluetooth
400
410
Application Level
APP1
APP2
APP3
APP4
420
System Level
Data processing and routing
Status Data
Control Data
Multiradio Controller (MRC) 600
430
Service Level
Modem 1
Modem 2
Modem 3
Modem 4
Bluetooth transmission

FIG. 7A

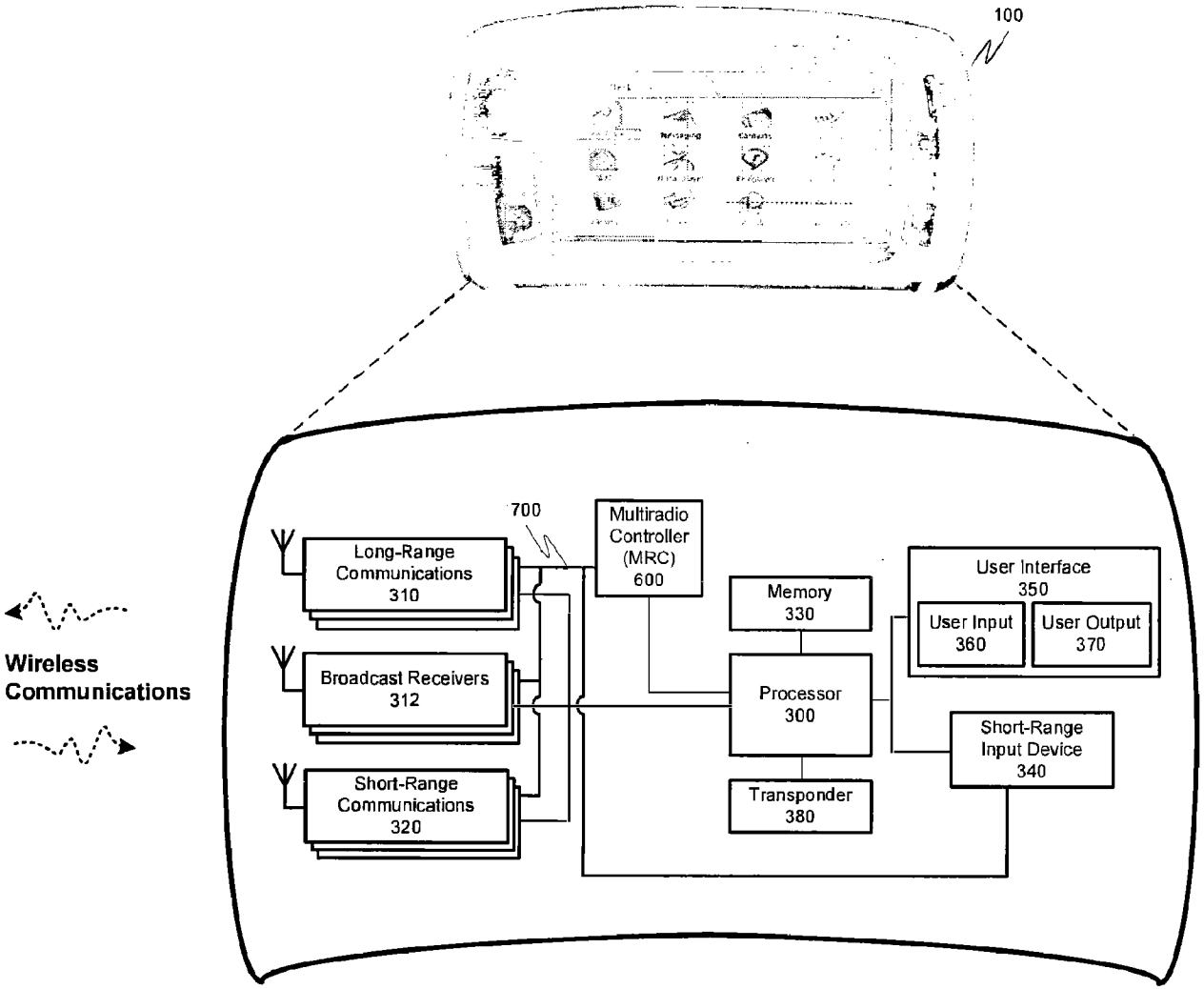

100
700
Multiradio Controller (MRC) 600
Long-Range Communications 310
Broadcast Receivers 312
Short-Range Communications 320
Memory 330
Processor 300
Transponder 380
User Interface 350
User Input 360
User Output 370
Short-Range Input Device 340
Wireless Communications

FIG. 7B

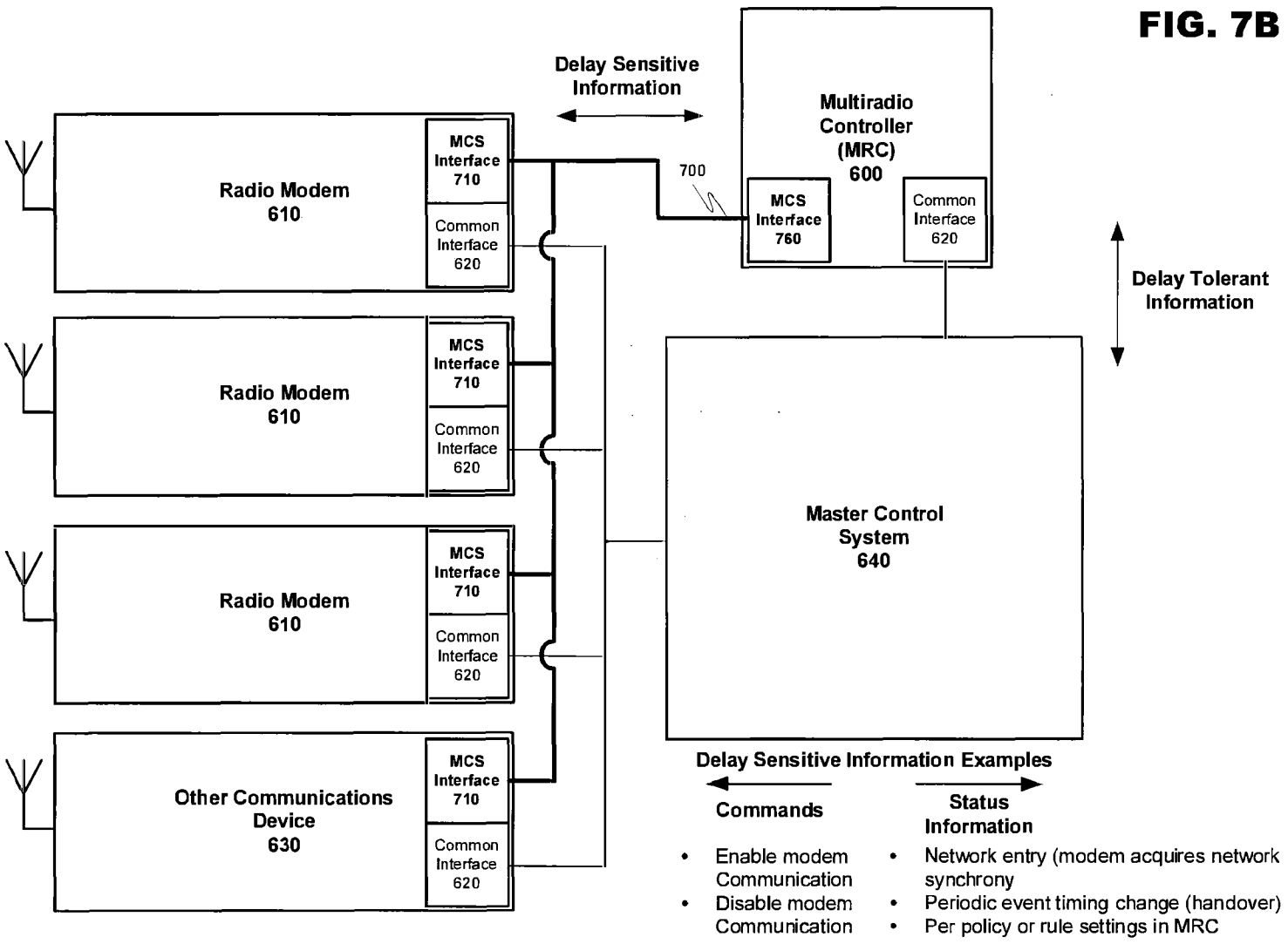

Delay Sensitive Information
Multiradio Controller (MRC) 600
MCS Interface 760
Common Interface 620
700
Radio Modem 610
MCS Interface 710
Common Interface 620
Radio Modem 610
MCS Interface 710
Common Interface 620
Radio Modem 610
MCS Interface 710
Common Interface 620
Other Communications Device 630
MCS Interface 710
Common Interface 620
Delay Tolerant Information
Master Control System 640
Delay Sensitive Information Examples
Commands
• Enable modem Communication
• Disable modem Communication
Status Information
• Network entry (modem acquires network synchrony
• Periodic event timing change (handover)
• Per policy or rule settings in MRC

FIG. 7C

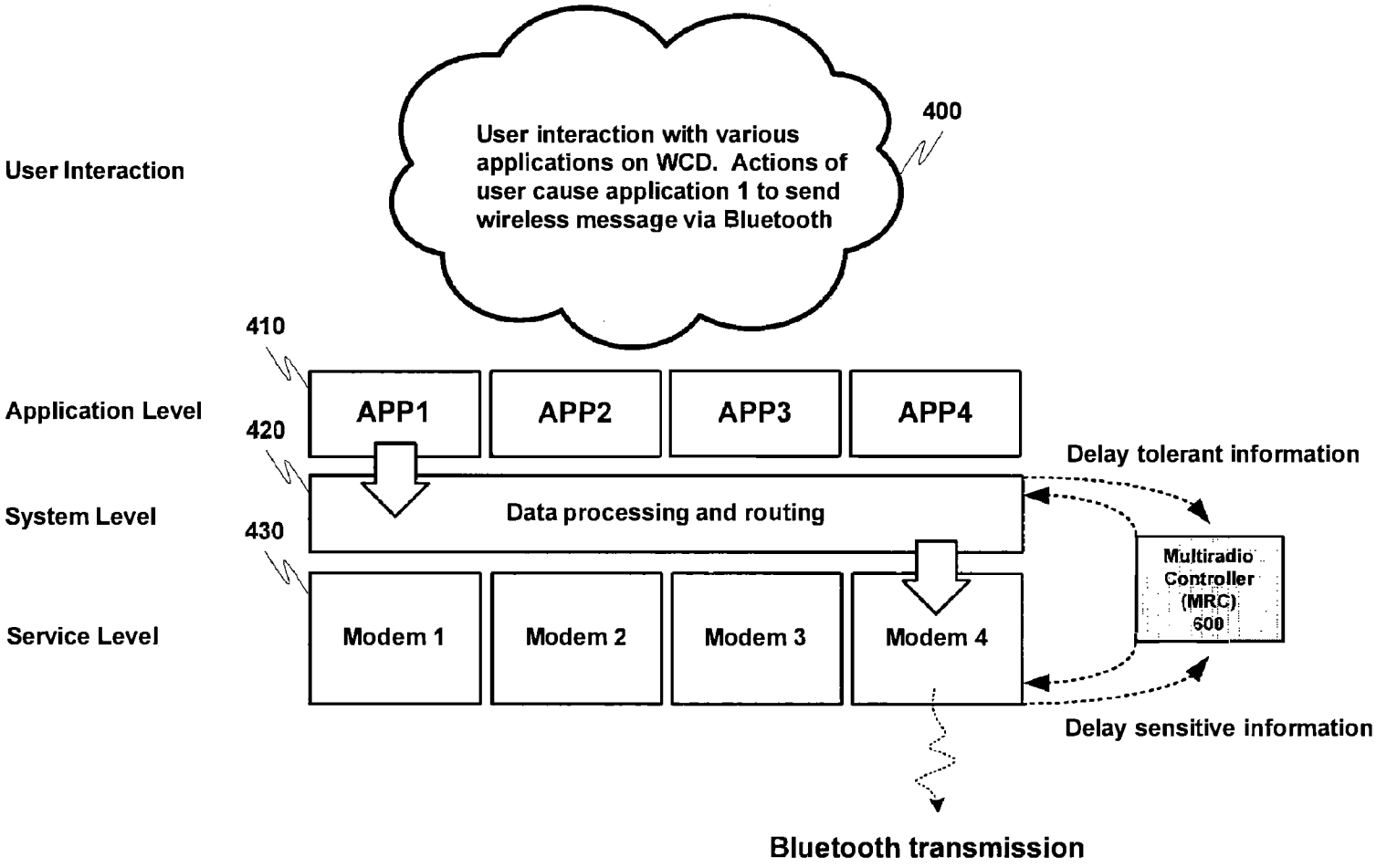

User Interaction
User interaction with various applications on WCD. Actions of user cause application 1 to send wireless message via Bluetooth
400
Application Level
410
APP1
APP2
APP3
APP4
System Level
420
Data processing and routing
Service Level
430
Modem 1
Modem 2
Modem 3
Modem 4
Delay tolerant information
Multiradio Controller (MRC) 600
Delay sensitive information
Bluetooth transmission

FIG. 8A

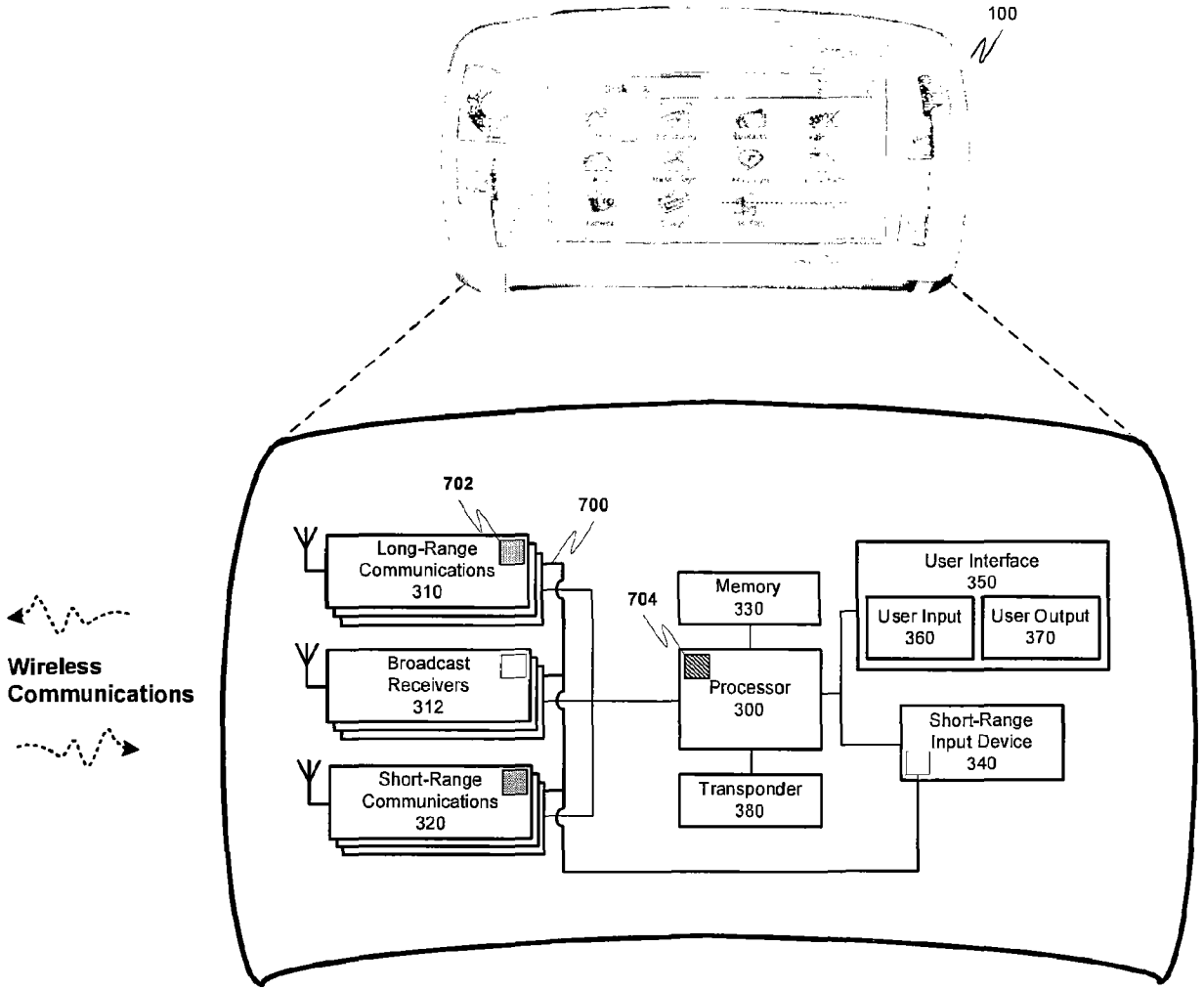

100
702
700
Long-Range Communications 310
Broadcast Receivers 312
Short-Range Communications 320
704
Memory 330
Processor 300
Transponder 380
User Interface 350
User Input 360
User Output 370
Short-Range Input Device 340
Wireless Communications

FIG. 8B

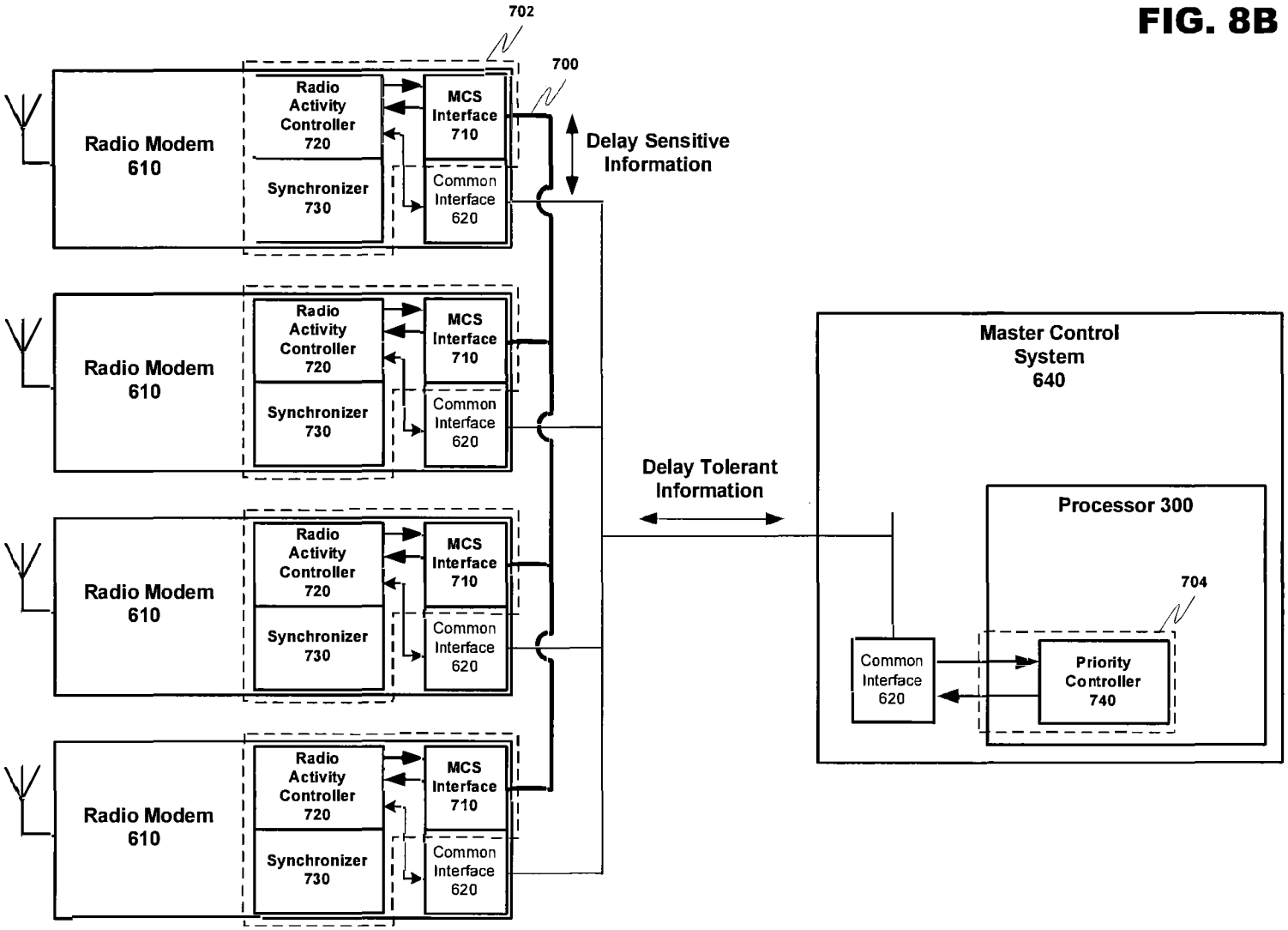

702
700
Radio Modem 610
Radio Activity Controller 720
Synchronizer 730
MCS Interface 710
Common Interface 620
Delay Sensitive Information
Delay Tolerant Information
Master Control System 640
Processor 300
704
Priority Controller 740

FIG. 8C

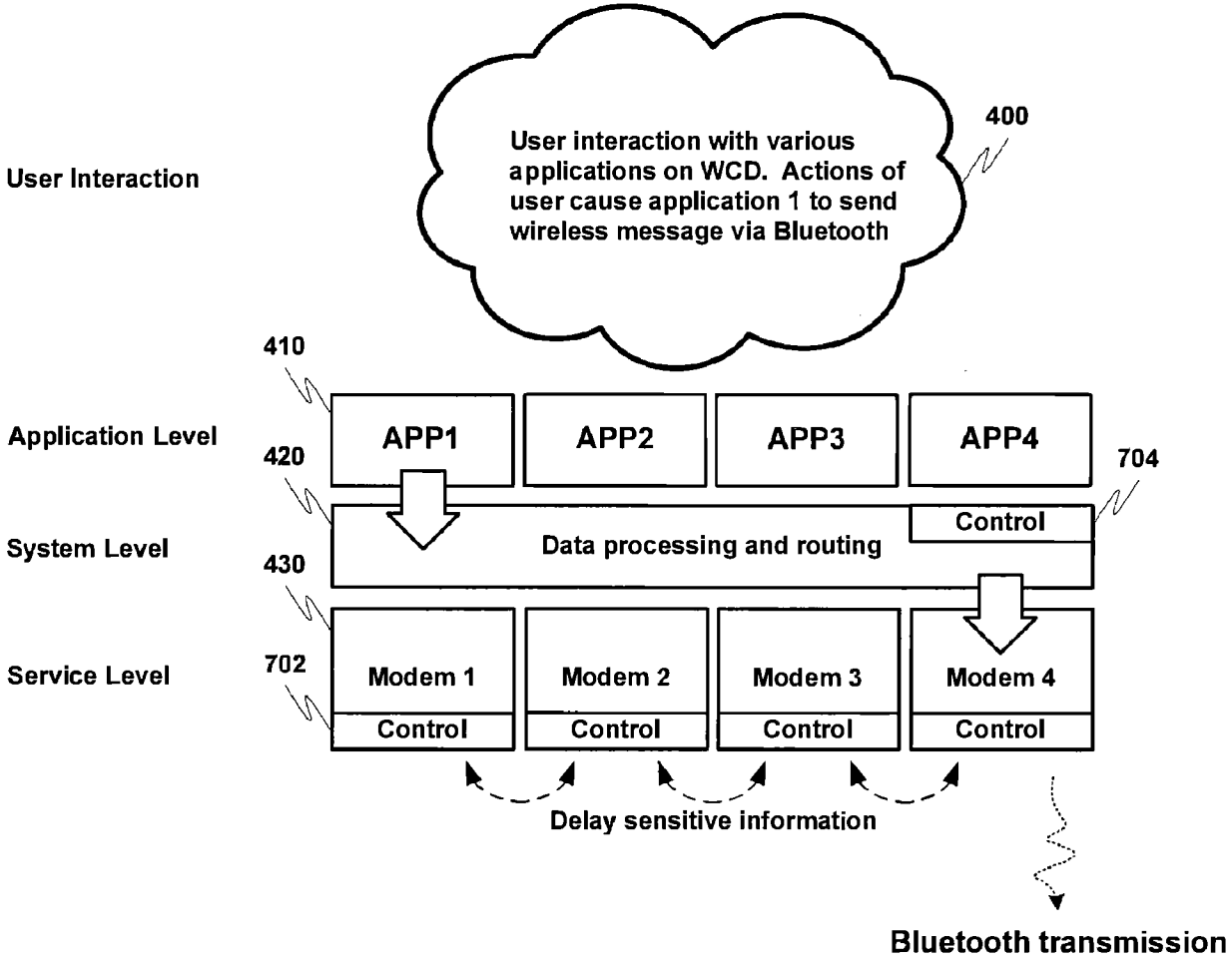

User Interaction
User interaction with various applications on WCD. Actions of user cause application 1 to send wireless message via Bluetooth
400
Application Level
410
APP1
APP2
APP3
APP4
System Level
420
704
Control
Data processing and routing
Service Level
430
702
Modem 1
Modem 2
Modem 3
Modem 4
Control
Control
Control
Control
Delay sensitive information
Bluetooth transmission

FIG. 9A

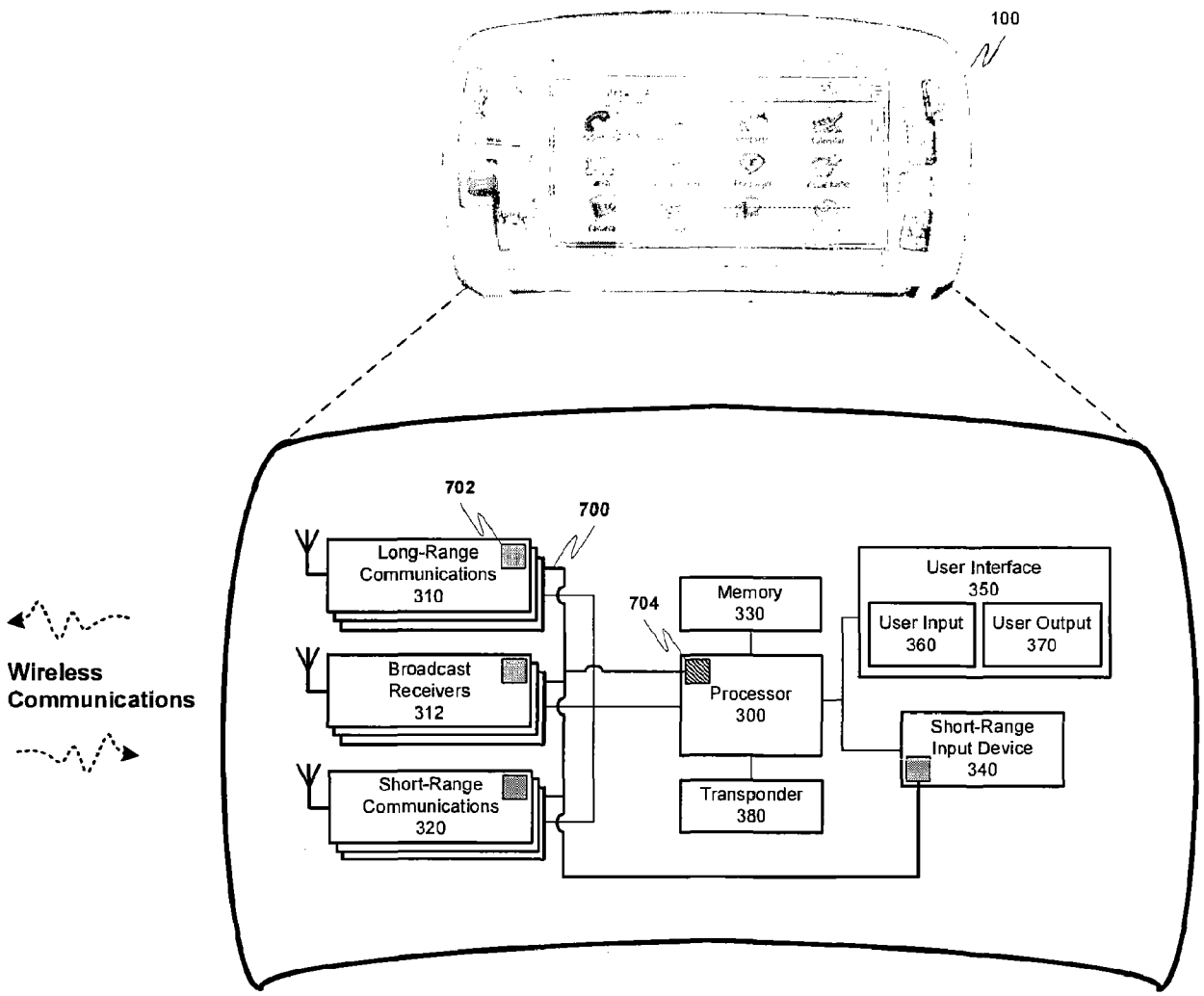

100
702
700
Long-Range Communications 310
Broadcast Receivers 312
Short-Range Communications 320
704
Memory 330
Processor 300
Transponder 380
User Interface 350
User Input 360
User Output 370
Short-Range Input Device 340
Wireless Communications

FIG. 9B

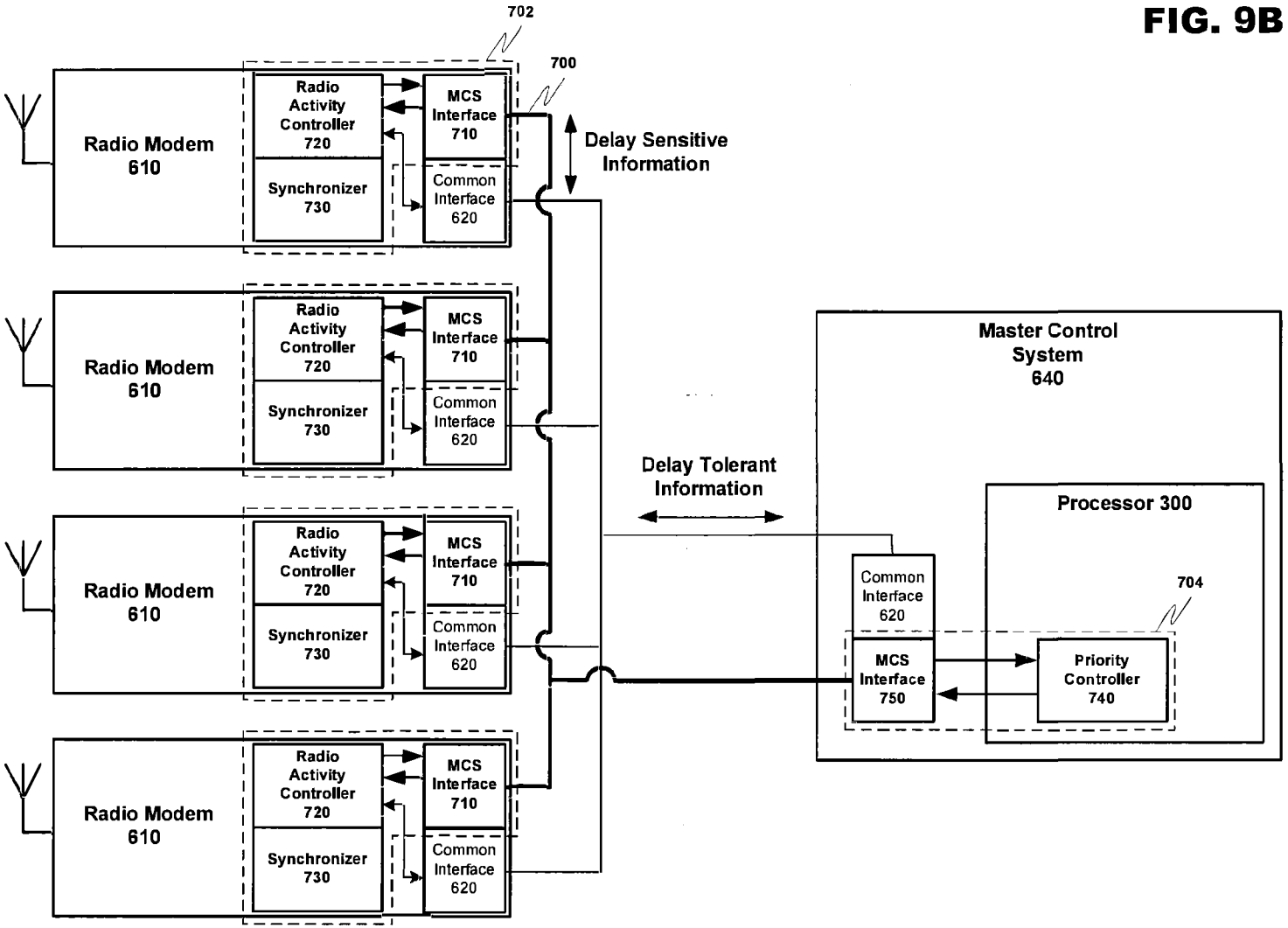

702
700
Radio Modem 610
Radio Activity Controller 720
MCS Interface 710
Synchronizer 730
Common Interface 620
Delay Sensitive Information
Delay Tolerant Information
Master Control System 640
Processor 300
704
Common Interface 620
MCS Interface 750
Priority Controller 740

FIG. 9C

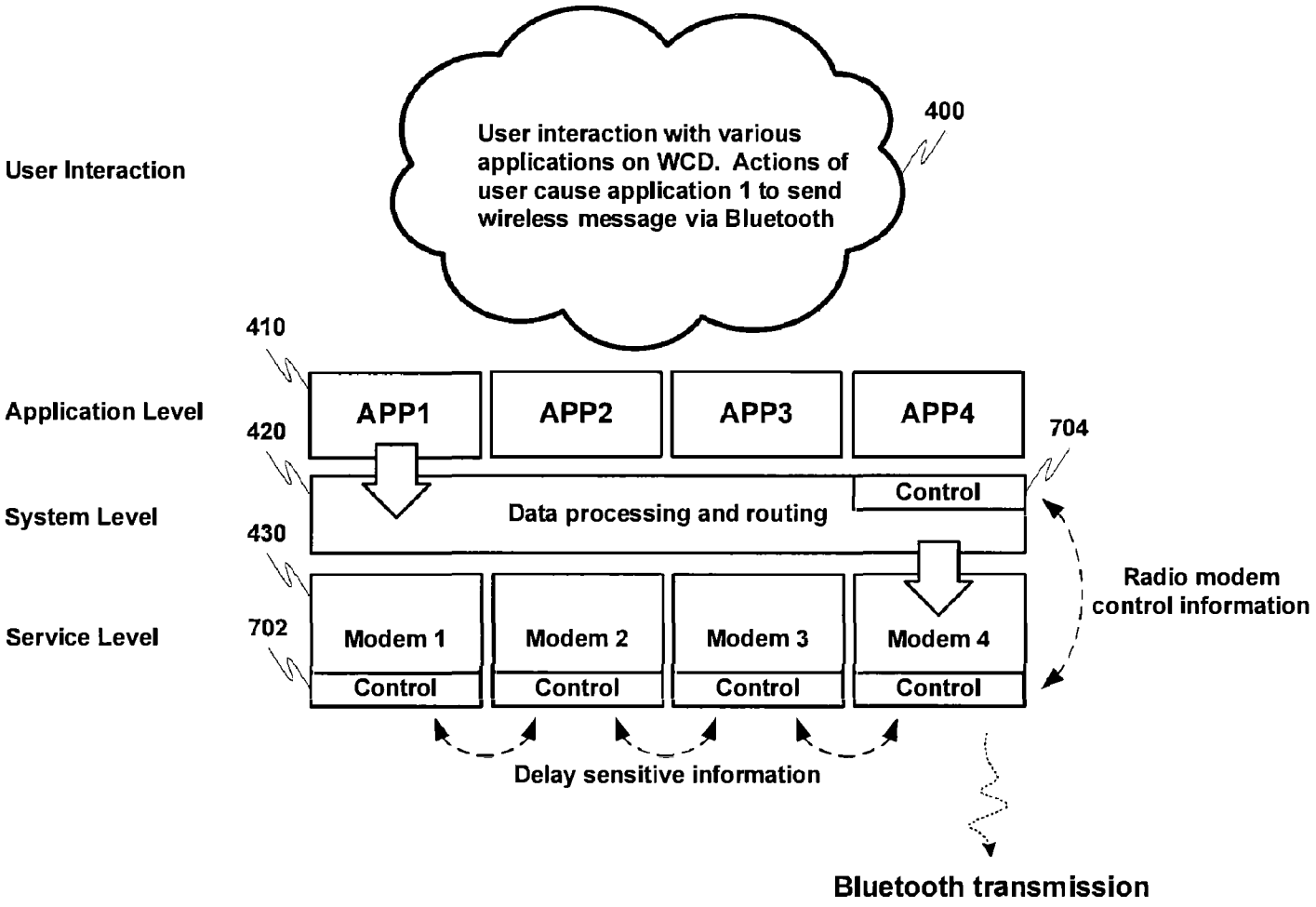
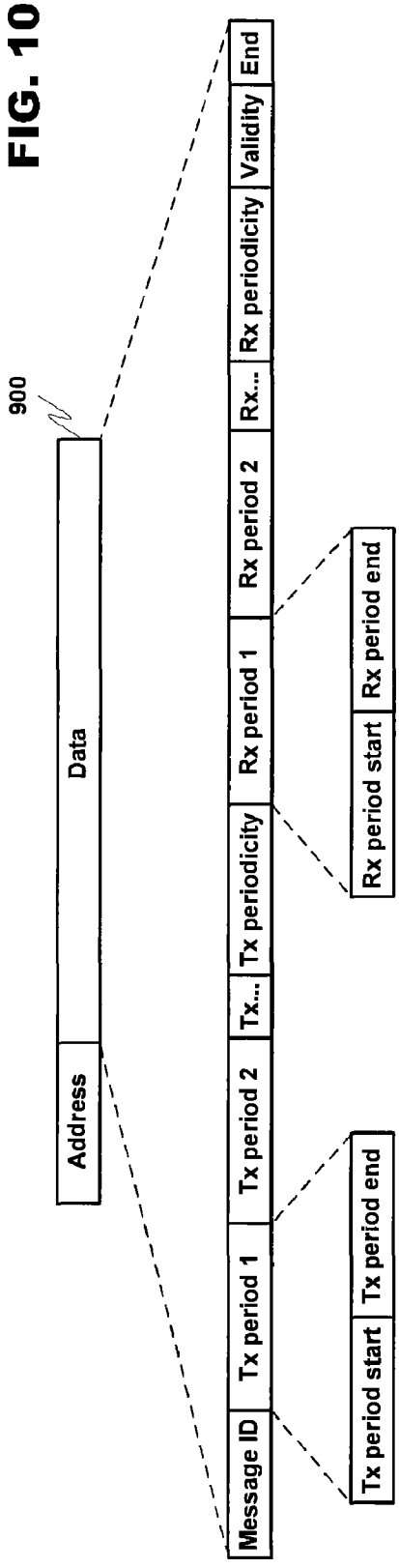

User Interaction
User interaction with various applications on WCD. Actions of user cause application 1 to send wireless message via Bluetooth
400
Application Level
410
APP1
APP2
APP3
APP4
System Level
420
Data processing and routing
Control
704
Service Level
430
702
Modem 1
Modem 2
Modem 3
Modem 4
Control
Control
Control
Control
Radio modem control information
Delay sensitive information
Bluetooth transmission

FIG. 10



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FIG. 11A

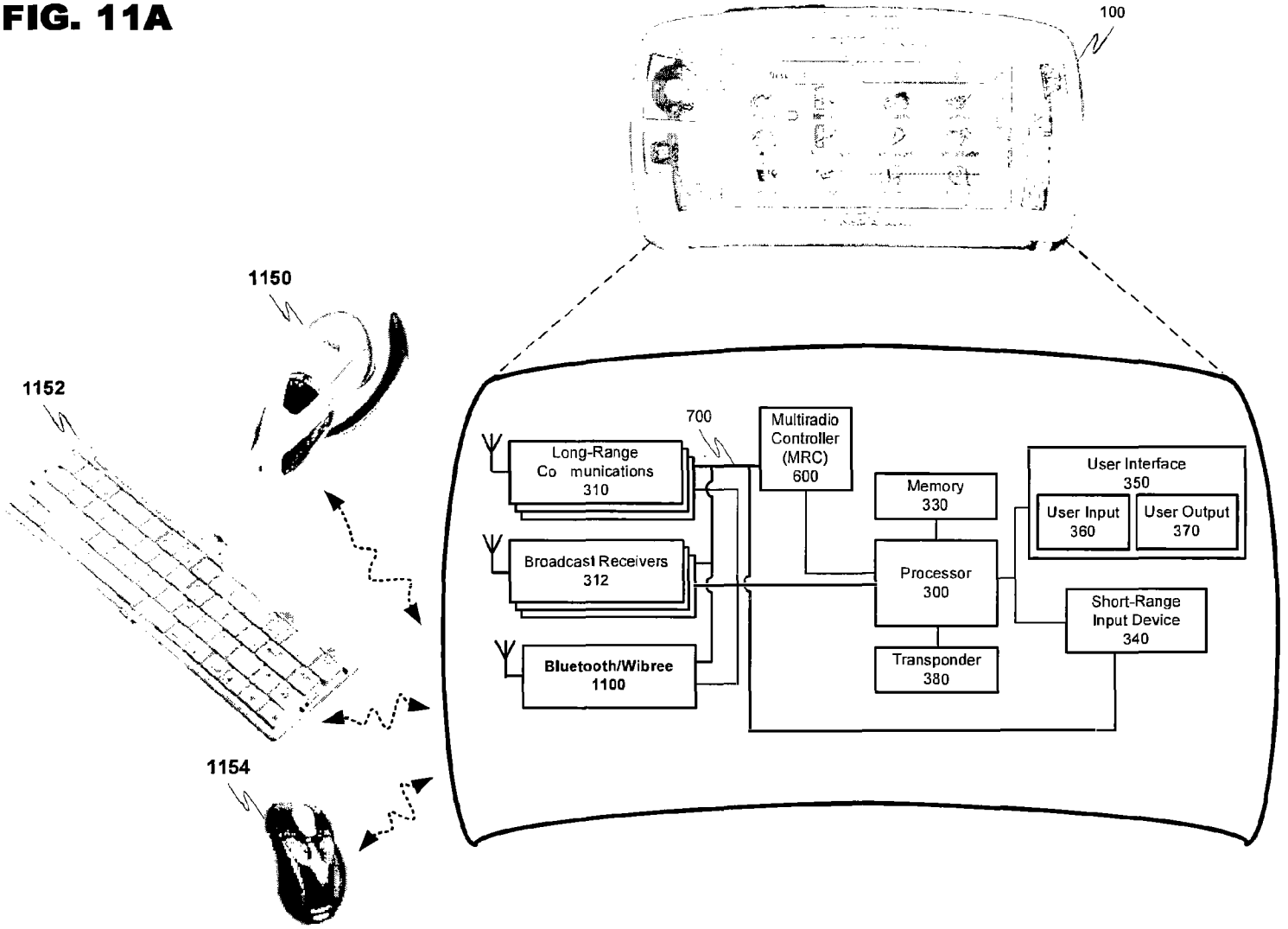

100
1150
1152
1154
700
Multiradio Controller (MRC) 600
Long-Range Co munications 310
Broadcast Receivers 312
Bluetooth/Wibree 1100
Memory 330
Processor 300
Transponder 380
User Interface 350
User Input 360
User Output 370
Short-Range Input Device 340

FIG. 11B

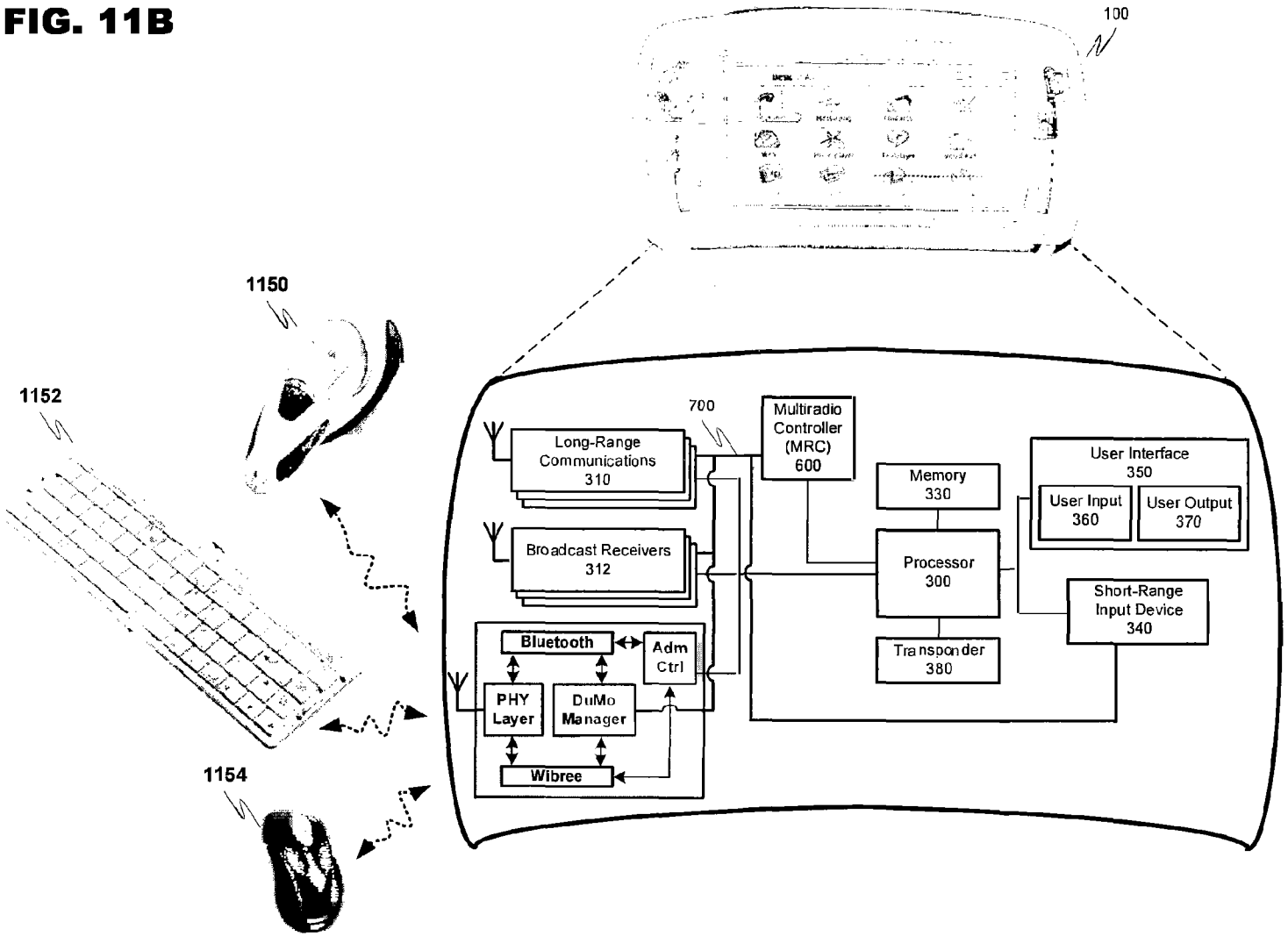

100
1150
1152
1154
700
Multiradio Controller (MRC) 600
Long-Range Communications 310
Broadcast Receivers 312
Bluetooth
Adm Ctrl
PHY Layer
DuMo Manager
Wibree
Memory 330
Processor 300
Transponder 380
User Interface 350
User Input 360
User Output 370
Short-Range Input Device 340

FIG. 12A

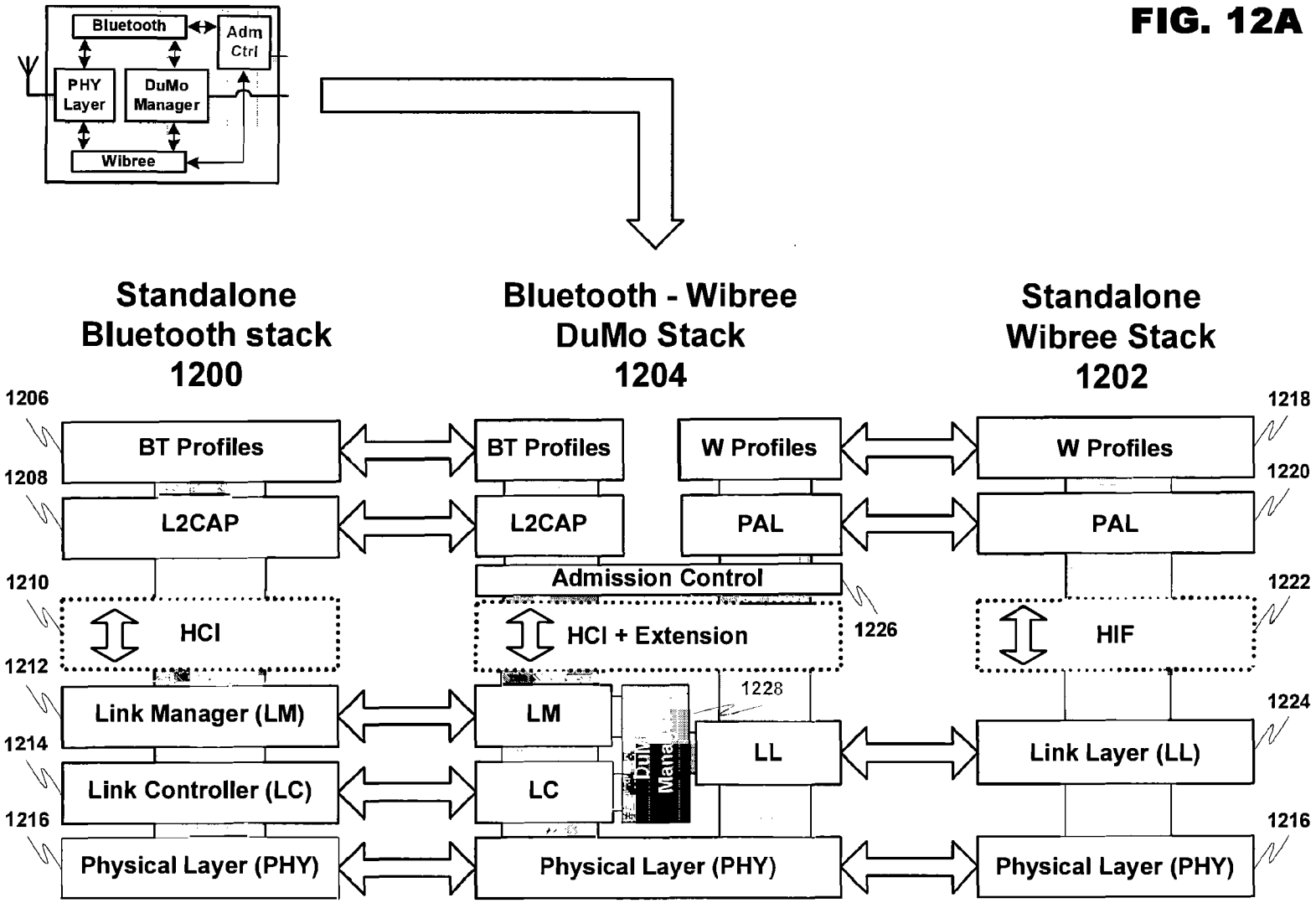

Bluetooth
Adm Ctrl
PHY Layer
DuMo Manager
Wibree
Standalone Bluetooth stack 1200
Bluetooth - Wibree DuMo Stack 1204
Standalone Wibree Stack 1202
1206
BT Profiles
BT Profiles
W Profiles
W Profiles
1218
1208
L2CAP
L2CAP
PAL
PAL
1220
Admission Control
1210
HCI
HCI + Extension
1226
HIF
1222
1212
1228
Link Manager (LM)
LM
LL
Link Layer (LL)
1224
1214
Link Controller (LC)
LC
1216
Physical Layer (PHY)
Physical Layer (PHY)
Physical Layer (PHY)
1216

FIG. 12B

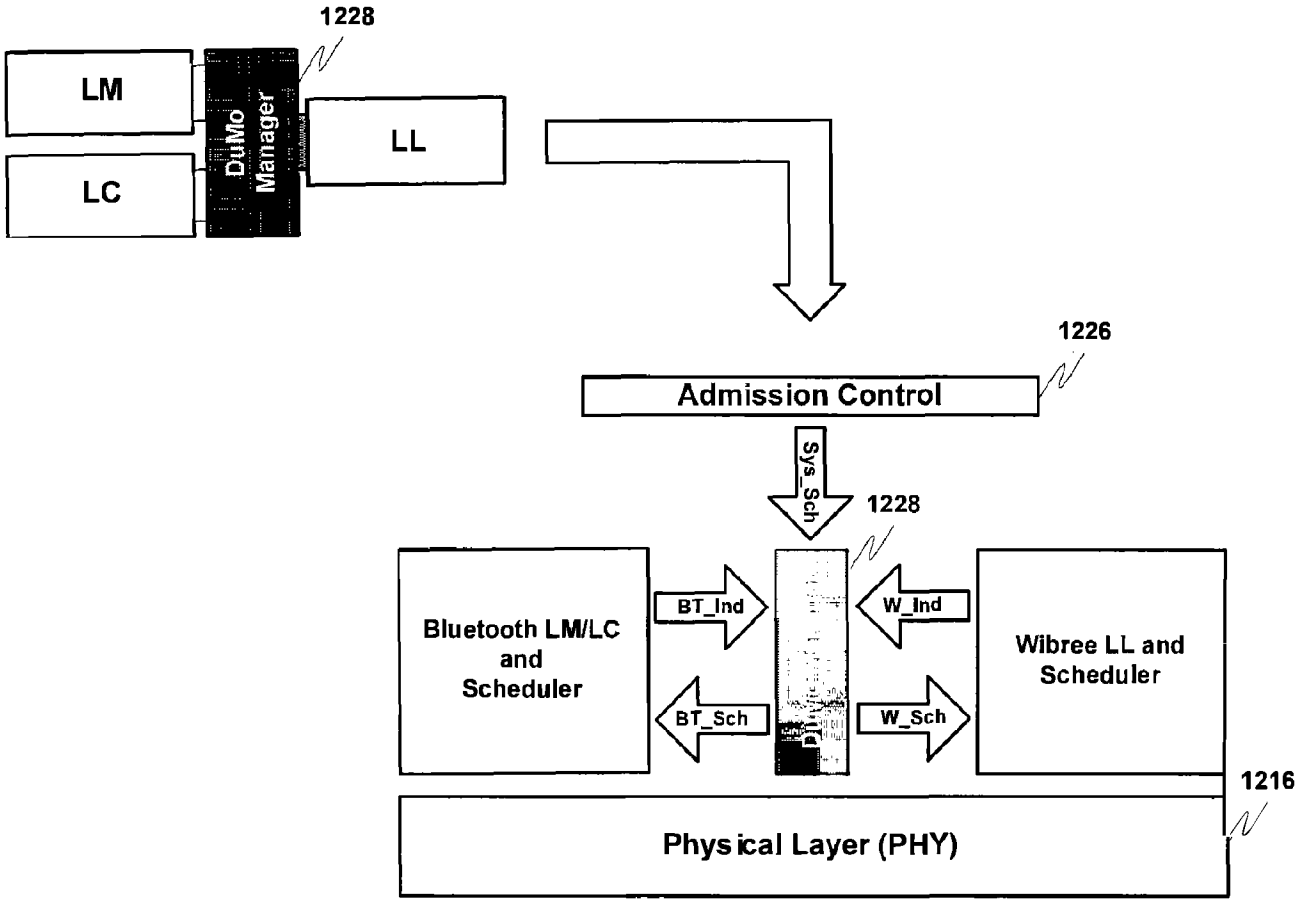

1228
LM
LC
DuMo Manager
LL
1226
Admission Control
Sys_Sch
1228
Bluetooth LM/LC and Scheduler
BT_Ind
BT_Sch
W_Ind
W_Sch
Wibree LL and Scheduler
1216
Physical Layer (PHY)

FIG. 13

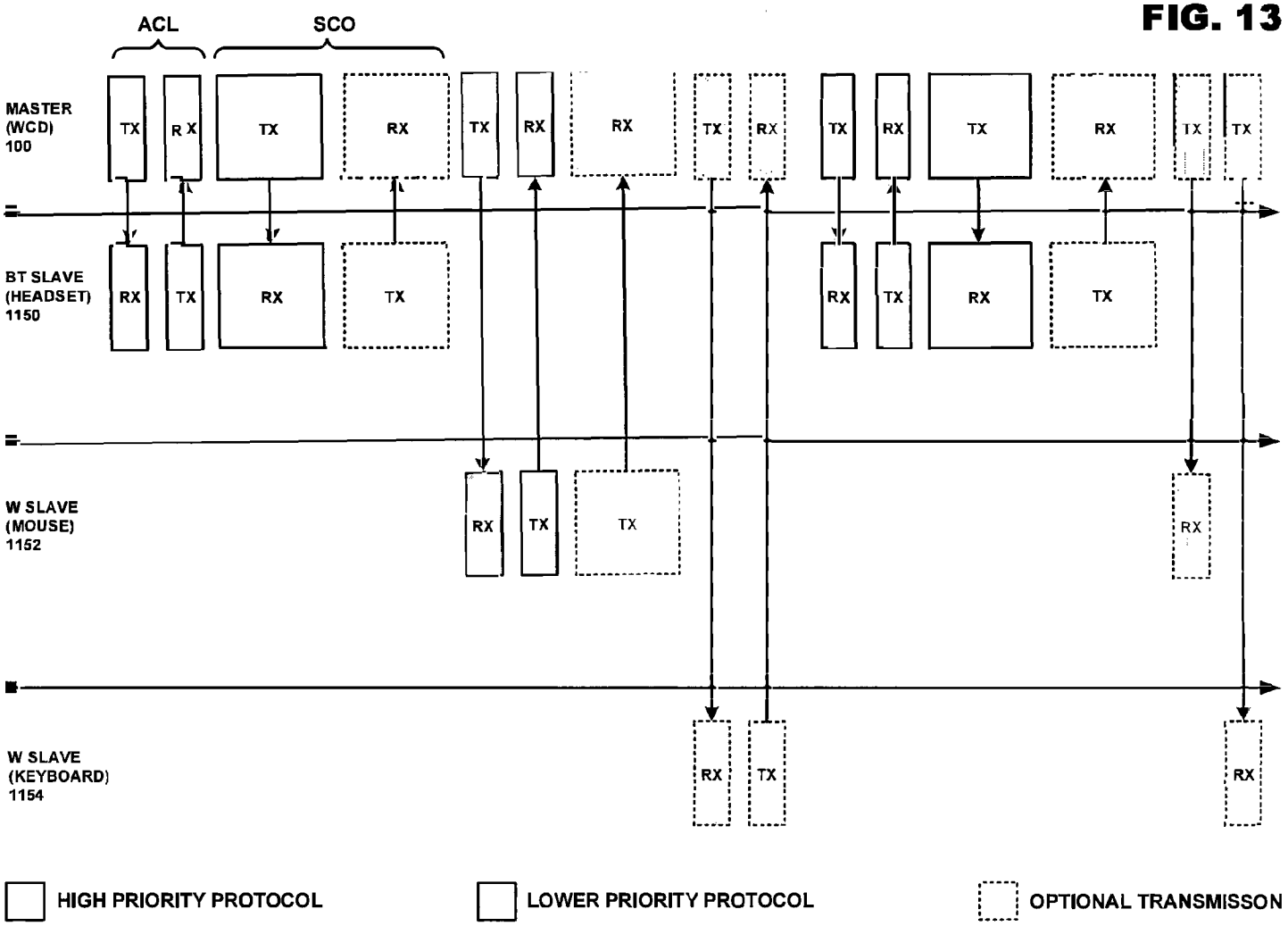
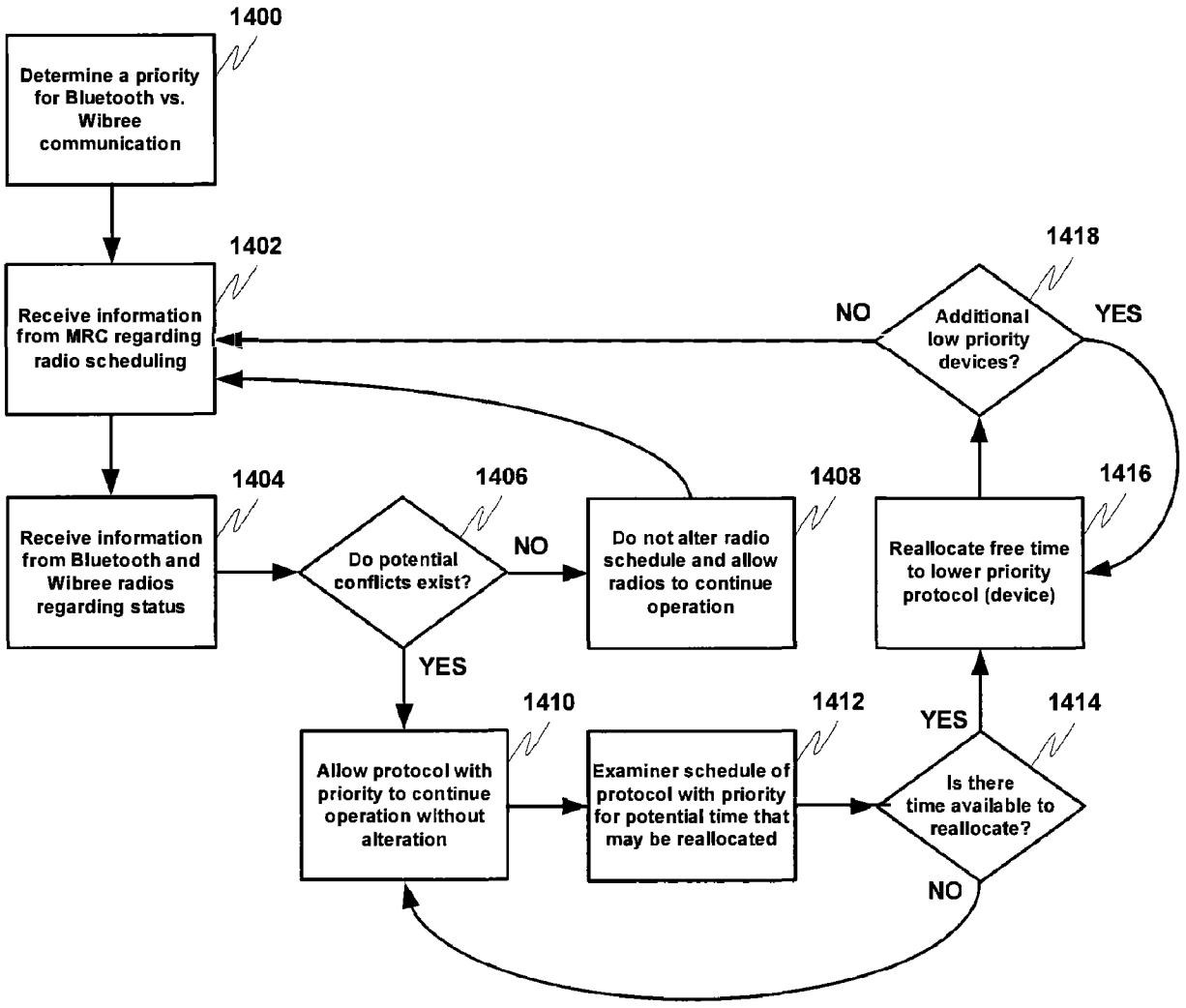

ACL
SCO
MASTER (WCD) 100
BT SLAVE (HEADSET) 1150
W SLAVE (MOUSE) 1152
W SLAVE (KEYBOARD) 1154
TX
RX
HIGH PRIORITY PROTOCOL
LOWER PRIORITY PROTOCOL
OPTIONAL TRANSMISSON

FIG. 14


1400
Determine a priority for Bluetooth vs. Wibree communication
1402
Receive information from MRC regarding radio scheduling
1404
Receive information from Bluetooth and Wibree radios regarding status
1406
Do potential conflicts exist?
NO
YES
1408
Do not alter radio schedule and allow radios to continue operation
1410
Allow protocol with priority to continue operation without alteration
1412
Examiner schedule of protocol with priority for potential time that may be reallocated
1414
Is there time available to reallocate?
YES
NO
1416
Reallocate free time to lower priority protocol (device)
1418
Additional low priority devices?
NO
YES

SYSTEM FOR MANAGING RADIO MODEMS

BACKGROUND OF INVENTION

[0001] 1. Field of Invention

[0002] The present invention relates to a system for managing one or more radio modems imbedded in a wireless communication device, and more specifically, to managing at least one dual-mode radio modem so it may communicate using at least two radio protocols concurrently.

[0003] 2. Description of Prior Art

[0004] Modern society has quickly adopted, and become reliant upon, handheld devices for wireless communication. For example, cellular telephones continue to proliferate in the global marketplace due to technological improvements in both the quality of the communication and the functionality of the devices. These wireless communication devices (WCDs) have become commonplace for both personal and business use, allowing users to transmit and receive voice, text and graphical data from a multitude of geographic locations. The communication networks utilized by these devices span different frequencies and cover different transmission distances, each having strengths desirable for various applications.

[0005] Cellular networks facilitate WCD communication over large geographic areas. These network technologies have commonly been divided by generations, starting in the late 1970s to early 1980s with first generation (1G) analog cellular telephones that provided baseline voice communication, to modem digital cellular telephones. 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. This network provides voice communication and also supports the transmission of textual data via the Short Messaging Service (SMS). SMS allows a WCD to transmit and receive text messages of up to 160 characters, while providing data transfer to packet networks, ISDN and POTS users at 9.6 Kbps. The Multimedia Messaging Service (MMS), an enhanced messaging system allowing for the transmission of sound, graphics and video files in addition to simple text, has also become available in certain devices. Soon emerging technologies such as Digital Video Broadcasting for Handheld Devices (DVB-H) will make streaming digital video, and other similar content, available via direct transmission to a WCD. While long-range communication networks like GSM are a well-accepted means for transmitting and receiving data, due to cost, traffic and legislative concerns, these networks may not be appropriate for all data applications.

[0006] Short-range wireless networks provide communication solutions that avoid some of the problems seen in large cellular networks. Bluetooth™ is an example of a short-range wireless technology quickly gaining acceptance in the marketplace. A Bluetooth™ enabled WCD transmits and receives data at a rate of 720 Kbps within a range of 10 meters, and may transmit up to 100 meters with additional power boosting. A user does not actively instigate a Bluetooth™ network. Instead, a plurality of devices within operating range of each other will automatically form a network group called a "piconet". Any device may promote itself to the master of the piconet, allowing it to control data exchanges with up to seven "active" slaves and 255 "parked" slaves. Active slaves exchange data based on the clock timing of the master. Parked slaves monitor a beacon signal in order to stay synchronized with the master, and wait for an active slot to become available. These devices continually switch between various active communication and power saving modes in order to transmit data to 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), and UHF RFID. All of these wireless mediums have features and advantages that make them appropriate for various applications.

[0007] More recently, manufacturers have also begun to incorporate various resources for providing enhanced functionality in WCDs (e.g., components and software for performing close-proximity wireless information exchanges). Sensors and/or readers may be used to read visual or electronic information into a device. A transaction may involve a user holding their WCD in proximity to a target, aiming their WCD at an object (e.g., to take a picture) or sweeping the device over a printed tag or document. Machine-readable technologies such as radio frequency identification (RFID), Infra-red (IR) communication, optical character recognition (OCR) and various other types of visual, electronic and magnetic scanning are used to quickly input desired information into the WCD without the need for manual entry by a user.

[0008] Device manufacturers are continuing to incorporate as many of the previously indicated exemplary communication features as possible into wireless communication devices in an attempt to bring powerful, "do-all" devices to market. Devices incorporating long-range, short-range and machine readable communication resources also often include multiple wireless mediums or radio protocols for each category. A multitude of wireless media options may assist a WCD in quickly adjusting to its environment, for example, communicating both with a WLAN access point and a Bluetooth™ peripheral device, possibly (and probably) at the same time.

[0009] Given the large array communication features that may be compiled into a single device, it is foreseeable that a user will need to employ a WCD to its full potential when replacing other productivity related devices. For example, a user may use a multifunction WCD to replace traditional tools such as individual phones, facsimile machines, computers, storage media, etc. which tend to be more cumbersome to both integrate and transport. In at least one use scenario, a WCD may be communicating simultaneously over numerous different wireless mediums. A user may utilize multiple peripheral Bluetooth™ devices (e.g., a headset and a keyboard) while having a voice conversation over GSM and interacting with a WLAN access point in order to access the Internet. Problems may occur when these concurrent transactions cause interference with each other. Even if a communication medium does not have an identical operating frequency as another medium, a radio modem may cause extraneous interference to another medium. Further, it is possible for the combined effects of two or more simultaneously operating radios to create intermodulation effects to another bandwidth due to harmonic effects. These disturbances may cause errors resulting in the required retransmission of lost packets, and the overall degradation of performance for one or more communication mediums.

[0010] While a WCD may engage in wireless communication with a multitude of other devices concurrently, in some instances a resource constraint may arise where two or

more of the peripheral devices are communicating using radio protocols that are implemented into a single radio modem in the WCD. Such a scenario may occur, for example, when both a Bluetooth™ device and a Wibree™ device are being used concurrently. Wibree™ is an open standard industry initiative extending local connectivity to small devices with technology that increases the growth potential in these market segments. Wibree™ technology may complement close range communication with Bluetooth™-like performance in the 0-10 m range with a data rate of 1 Mbps. Wibree™ is optimized for applications requiring extremely low power consumption, small size and low cost. Wibree™ may be implemented either as standalone chip or as Bluetooth™-Wibree™ dual-mode chip. More information can be found on the Wibree™ website: www.wibree.com. Due to the similarity of these two radio protocols, a WCD may only include one radio modem assigned to handle communication for both wireless mediums. One radio modem attempting to communicate with multiple devices using separate radio protocols, also known as a dual-mode radio modem, may experience communication errors due to the collision of messages from the peripheral devices. Wireless communication devices are usually only scheduled only within their own radio protocol, and therefore, may be unaware that other simultaneous transactions may be occurring in a dual-mode radio modem over another radio protocol. Technology is now emerging to enable a WCD to schedule communications amongst a plurality of modems integrated within the same device, however, this control strategy may not necessarily benefit a dual-mode radio modem where the conflicts are not known at the operating system level, but only by the modem itself.

[0011] What is therefore needed is a management strategy and system for a dual-mode modem that may receive both information from an operating system-level communication manager in a WCD and also from different radio protocol stacks utilizing the dual-mode modem in order to coordinate communications between the concurrently operating radio protocols. In addition, any coordination between the radio protocols should include synchronizing the periodic timing and/or scheduling of the protocols so as to avoid potential communication collisions.

SUMMARY OF INVENTION

[0012] The present invention includes at least a method, device, mode, controller and computer program for managing the operation of a plurality of radio modems contained w

tributed multiradio control system in accordance with at least one embodiment of the present invention.

[0028] FIG. **8**B discloses a more detailed structural diagram of FIG. **8**A including the distributed multiradio control system and the radio modems.

[0029] FIG. **8**C discloses an exemplary operational description of a wireless communication device including a distributed multiradio control system in accordance with at least one embodiment of the present invention.

[0030] FIG. **9**A discloses an exemplary structural description of a wireless communication device including a distributed multiradio control system in accordance with an alternative embodiment of the present invention.

[0031] FIG. **9**B discloses a more detailed structural diagram of FIG. **9**A including the distributed multiradio control system and the radio modems.

[0032] FIG. **9**C discloses an exemplary operational description of a wireless communication device including a distributed multiradio control system in accordance with the alternative embodiment of the present invention disclosed in FIG. **9**A.

[0033] FIG. **10** discloses an exemplary information packet usable with at least one embodiment of the present invention.

[0034] FIG. **11**A discloses an example of multiple wireless peripheral devices attempting to communicate concurrently with a dual-mode radio modem in accordance with at least one embodiment of the present invention.

[0035] FIG. **11**B discloses an example of multiple wireless peripheral devices attempting to communicate concurrently with a dual-mode radio modem including operational enhancements in accordance with at least one embodiment of the present invention.

[0036] FIG. **12**A discloses further detail regarding the example of FIG. **11**B regarding operational enhancements for managing the operation of a dual-mode modem in accordance with at least one embodiment of the present invention.

[0037] FIG. **12**B discloses further detail regarding the example of FIG. **12**A regarding information flow in operational enhancements for managing the operation of a dual-mode modem in accordance with at least one embodiment of the present invention.

[0038] FIG. **13** discloses an exemplary timeline for communications occurring between a wireless communication device and peripheral devices communicating over different radio protocols utilizing the a dual-mode modem in accordance with at least one embodiment of the present invention.

[0039] FIG. **14** discloses a flowchart for an exemplary process by which the present invention may operate a dual-mode radio modem utilizing at least two radio protocols communicating concurrently in accordance with at least one embodiment of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENT

[0040] While the invention has been described in preferred embodiments, 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 Over Different Communication Networks

[0041] A WCD may both transmit and receive information over a wide array of wireless communication networks, each with different advantages regarding speed, range, quality (error correction), security (encoding), etc. These characteristics will dictate the amount of information that may be transferred to a receiving device, and the duration of the information transfer. FIG. **1** includes a diagram of a WCD and how it interacts with various types of wireless networks.

[0042] In the example pictured in FIG. **1**, user **110** possesses WCD **100**. This device may be anything from a basic cellular handset to a more complex device such as a wirelessly enabled palmtop or laptop computer. Near Field Communication (NFC) **130** includes various transponder-type interactions wherein normally only the scanning device requires its own power source. WCD **100** scans source **120** via short-range communication. A transponder in source **120** may use the energy and/or clock signal contained within the scanning signal, as in the case of RFID communication, to respond with data stored in the transponder. These types of technologies usually have an effective transmission range on the order of ten feet, and may be able to deliver stored data in amounts from 96 bits to over a megabit (or 125 Kbytes) relatively quickly. These features make such technologies well suited for identification purposes, such as to receive an account number for a public transportation provider, a key code for an automatic electronic door lock, an account number for a credit or debit transaction, etc.

[0043] The transmission range between two devices may be extended if both devices are capable of performing powered communication. Short-range active communication **140** includes applications wherein the sending and receiving devices are both active. An exemplary situation would include user **110** coming within effective transmission range of a Bluetooth™, WLAN, UWB, WUSB, etc. access point. In the case of Wibree™, a network may automatically be established to transmit information to WCD **100** possessed by user **110**. Wibree™ may be used for battery-powered devices, such as wireless sensors, since its power consumption is low. A Wibree™ device may use the advertisement mode to more rapidly establish the initial connection to WCD **100**. This data may include information of an informative, educational or entertaining nature. The amount of information to be conveyed is unlimited, except that it must all be transferred in the time when user **110** is within effective transmission range of the access point. This duration may be extremely limited if the user is, for example, strolling through a shopping mall or walking down a street. Due to the higher complexity of these wireless networks, additional time is also required to establish the initial connection to WCD **100**, which may be increased if many devices are queued for service in the area proximate to the access point. The effective transmission range of these networks depends on the technology, and may be from some 30 ft. to over 300 ft. with additional power boosting.

[0044] Long-range networks **150** are used to provide virtually uninterrupted communication coverage for WCD **100**. Land-based radio stations or satellites are used to relay various communication transactions worldwide. While these systems are extremely functional, the use of these systems is

often charged on a per-minute basis to user **110**, not including additional charges for data transfer (e.g., wireless Internet access). Further, the regulations covering these systems may cause additional overhead for both the users and providers, making the use of these systems more cumbersome.

II. Wireless Communication Device

[0045] As previously described, the present invention may be implemented using a variety of wireless communication equipment. Therefore, it is important to understand the communication tools available to user **110** before exploring the present invention. For example, in the case of a cellular telephone or other handheld wireless devices, the integrated data handling capabilities of the device play an important role in facilitating transactions between the transmitting and receiving devices.

[0046] FIG. **2** discloses an exemplary modular layout for a wireless communication device usable with the present invention. WCD **100** is broken down into modules representing the functional aspects of the device. These functions may be performed by the various combinations of software and/or hardware components discussed below.

[0047] Control module **210** regulates the operation of the device. Inputs may be received from various other modules included within WCD **100**. For example, interference sensing module **220** may use various techniques known in the art to sense sources of environmental interference within the effective transmission range of the wireless communication device. Control module **210** interprets these data inputs, and in response, may issue control commands to the other modules in WCD **100**.

[0048] Communications module **230** incorporates all of the communication aspects of WCD **100**. As shown in FIG. **2**, communications module **230** may include, for example, long-range communications module **232**, short-range communications module **234** and machine-readable data module **236** (e.g., for NFC). Communications module **230** 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 recipient devices within the transmission range of WCD **100**. Communications module **230** may be triggered by control module **210**, or by control resources local to the module responding to sensed messages, environmental influences and/or other devices in proximity to WCD **100**.

[0049] User interface module **240** includes visual, audible and tactile elements which allow the user **110** to receive data from, and enter data into, the device. The data entered by user **110** may be interpreted by control module **210** to affect the behavior of WCD **100**. User-inputted data may also be transmitted by communications module **230** to other devices within effective transmission range. Other devices in transmission range may also send information to WCD **100** via communications module **230**, and control module **210** may cause this information to be transferred to user interface module **240** for presentment to the user.

[0050] Applications module **250** incorporates all other hardware and/or software applications on WCD **100**. These applications may include sensors, interfaces, utilities, interpreters, data applications, etc., and may be invoked by control module **210** to read information provided by the various modules and in turn supply information to requesting modules in WCD **100**.

[0051] FIG. **3** discloses an exemplary structural layout of WCD **100** according to an embodiment of the present invention that may be used to implement the functionality of the modular system previously described in FIG. **2**. Processor **300** controls overall device operation. As shown in FIG. **3**, processor **300** is coupled to at least communications sections **310**, **320** and **340**. Processor **300** may be implemented with one or more microprocessors that are each capable of executing software instructions stored in memory **330**.

[0052] Memory **330** may include random access memory (RAM), read only memory (ROM), and/or flash memory, and stores information in the form of data and software components (also referred to herein as modules). The data stored by memory **330** may be associated with particular software components. In addition, this data may be associated with databases, such as a bookmark database or a business database for scheduling, email, etc.

[0053] The software components stored by memory **330** include instructions that can be executed by processor **300**. Various types of software components may be stored in memory **330**. For instance, memory **330** may store software components that control the operation of communication sections **310**, **320** and **340**. Memory **330** may also store software components including a firewall, a service guide manager, a bookmark database, user interface manager, and any communication utilities modules required to support WCD **100**.

[0054] Long-range communications **310** performs functions related to the exchange of information over large geographic areas (such as cellular networks) via an antenna. These communication methods include technologies from the previously described 1G to 3G. In addition to basic voice communication (e.g., via GSM), long-range communications **310** may operate to establish data communication sessions, such as General Packet Radio Service (GPRS) sessions and/or Universal Mobile Telecommunications System (UMTS) sessions. Also, long-range communications **310** may operate to transmit and receive messages, such as short messaging service (SMS) messages and/or multimedia messaging service (MMS) messages.

[0055] As a subset of long-range communications **310**, or alternatively operating as an independent module separately connected to processor **300**, transmission receiver **312** allows WCD **100** to receive transmission messages via mediums such as Digital Video Broadcast for Handheld Devices (DVB-H). These transmissions may be encoded so that only certain designated receiving devices may access the transmission content, and may contain text, audio or video information. In at least one example, WCD **100** may receive these transmissions and use information contained within the transmission signal to determine if the device is permitted to view the received content.

[0056] Short-range communications **320** is responsible for functions involving the exchange of information across short-range wireless networks. As described above and depicted in FIG. **3**, examples of such short-range communications **320** are not limited to Bluetooth™, Wibree™, WLAN, UWB and Wireless USB connections. Accordingly, short-range communications **320** performs functions related to the establishment of short-range connections, as well as processing related to the transmission and reception of information via such connections.

[0057] Short-range input device **340**, also depicted in FIG. **3**, may provide functionality related to the short-range scanning of machine-readable data (e.g., for NFC). For example, processor **300** may control short-range input device **340** to generate RF signals for activating an RFID transponder, and may in turn control the reception of signals from an RFID transponder. Other short-range scanning methods for reading machine-readable data that may be supported by short-range input device **340** are not limited to IR communication, linear and 2-D (e.g., QR) bar code readers (including processes related to interpreting UPC labels), and optical character recognition devices for reading magnetic, UV, conductive or other types of coded data that may be provided in a tag using suitable ink. In order for short-range input device **340** to scan the aforementioned types of machine-readable data, the input device may include optical detectors, magnetic detectors, CCDs or other sensors known in the art for interpreting machine-readable information.

[0058] As further shown in FIG. **3**, user interface **350** is also coupled to processor **300**. User interface **350** facilitates the exchange of information with a user. FIG. **3** shows that user interface **350** includes a user input **360** and a user output **370**. User input **360** may include one or more components that allow a user to input information. Examples of such components include keypads, touch screens, and microphones. User output **370** allows a user to receive information from the device. Thus, user output portion **370** may include various components, such as a display, light emitting diodes (LED), tactile emitters and one or more audio speakers. Exemplary displays include liquid crystal displays (LCDs), and other video displays.

[0059] WCD **100** may also include one or more transponders **380**. This is essentially a passive device that may be programmed by processor **300** with information to be delivered in response to a scan from an outside source. For example, an RFID reader mounted in an entryway may continuously emit radio frequency waves. When a person with a device containing transponder **380** walks through the door, the transponder is energized and may respond with information identifying the device, the person, etc. In addition, a reader may be mounted (e.g., as discussed above with regard to examples of short-range input device **340**) in WCD **100** so that it can read information from other transponders in the vicinity.

[0060] Hardware corresponding to communications sections **310**, **312**, **320** and **340** provide for the transmission and reception of signals. Accordingly, these portions may include components (e.g., electronics) that perform functions, such as modulation, demodulation, amplification, and filtering. These portions may be locally controlled, or controlled by processor **300** in accordance with software communication components stored in memory **330**.

[0061] The elements shown in FIG. **3** may be constituted and coupled according to various techniques in order to produce the functionality described in FIG. **2**. One such technique involves coupling separate hardware components corresponding to processor **300**, communications sections **310**, **312** and **320**, memory **330**, short-range input device **340**, user interface **350**, transponder **380**, etc. through one or more bus interfaces (which may be 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 device, gate array, ASIC, multi-chip module, etc. programmed to replicate the functions of the stand-alone devices. In addition, each of these components is coupled to a power source, such as a removable and/or rechargeable battery (not shown).

[0062] The user interface **350** may interact with a communication utilities software component, also contained in memory **330**, which provides for the establishment of service sessions using long-range communications **310** and/or short-range communications **320**. The communication utilities component may include various routines that allow the reception of services from remote devices according to mediums such as the Wireless Application Medium (WAP), Hypertext Markup Language (HTML) variants like Compact HTML (CHTML), etc.

III. Exemplary Operation of a Wireless Communication Device Including Potential Interference Problems Encountered

[0063] FIG. **4** discloses a stack approach to understanding the operation of a WCD in accordance with at least one embodiment of the present invention. At the top level **400**, user **110** interacts with WCD **100**. The interaction involves user **110** entering information via user input **360** and receiving information from user output **370** in order to activate functionality in application level **410**. In the application level, programs related to specific functionality within the device interact with both the user and the system level. These programs include applications for visual information (e.g., web browser, DVB-H receiver, etc.), audio information (e.g., cellular telephone, voice mail, conferencing software, DAB or analog radio receiver, etc.), recording information (e.g., digital photography software, word processing, scheduling, etc.) or other information processing. Actions initiated at application level **410** may require information to be sent from or received into WCD **100**. In the example of FIG. **4**, data is requested to be sent to a recipient device via Bluetooth™ communication. As a result, application level **410** may then call resources in the system level to initiate the required processing and routing of data.

[0064] System level **420** processes data requests and routes the data for transmission. Processing may include, for example, calculation, translation, conversion and/or packetizing the data. The information may then be routed to an appropriate communication resource in the service level. If the desired communication resource is active and available in the service level **430**, the packets may be routed to a radio modem for delivery via wireless transmission. There may be a plurality of modems operating using different wireless mediums. For example, in FIG. **4**, modem **4** is activated and able to send packets using Bluetooth™ communication. However, a radio modem (as a hardware resource) need not be dedicated only to a specific wireless medium, and may be used for different types of communication depending on the requirements of the wireless medium and the hardware characteristics of the radio modem.

[0065] FIG. **5** discloses a situation wherein the above described exemplary operational process may cause more than one radio modem to become active. In this case, WCD **100** is both transmitting and receiving information via wireless communication over a multitude of mediums. WCD **100** may be interacting with various secondary devices such as those grouped at **500**. For example, these devices may include cellular handsets communicating via long-range wireless communication like GSM, wireless

headsets communicating via Bluetooth™, Internet access points communicating via WLAN, etc.

[0066] Problems may occur when some or all of these communications are carried on simultaneously. As further shown in FIG. **5**, multiple modems operating simultaneously may cause interference for each other. Such a situation may be encountered when WCD **100** is communicating with more than one external device (as previously described). In an exemplary extreme case, devices with modems simultaneously communicating via Bluetooth™, WLAN and wireless USB would encounter substantial overlap since all of these wireless mediums operate in the 2.4 GHz band. The interference, shown as an overlapping portion of the fields depicted in FIG. **5**, would cause packets to be lost and the need for retransmission of these lost packets. Retransmission requires that future time slots be used to retransmit lost information, and therefore, overall communication performance will at least be reduced, if the signal is not lost completely. The present invention, in at least one embodiment, seeks to manage problematic situations where possibly conflicting communications may be occurring simultaneously so that interference is minimized or totally avoided, and as a result, speed and quality are maximized.

IV. A Wireless Communication Device Including a Multiradio Controller

[0067] In an attempt to better manage communication in WCD **100**, an additional controller dedicated to managing wireless communication may be introduced. WCD **100**, as pictured in FIG. **6**A, includes a multiradio controller (MRC) **600** in accordance with at least one embodiment of the present invention. MRC **600** is coupled to the master control system of WCD **100**. This coupling enables MRC **600** to communicate with radio modems or other similar devices in communications modules **310** **312**, **320** and **340** via the master operating system of WCD **100**. While this configuration may in some cases improve overall wireless communication efficiency for WCD **100**, problems may occur when WCD **100** becomes busy (e.g., when the control system of WCD **100** is employed in multitasking many different simultaneous operations, both communication and non-communication related).

[0068] FIG. **6**B discloses in detail at least one embodiment of WCD **100**, which may include multiradio controller (MRC) **600** introduced in FIG. **6**A in accordance with at least one embodiment of the present invention. MRC **600** includes common interface **620** by which information may be sent or received through master control system **640**. Further, each radio modem **610** or similar communication device **630**, for example an RFID reader for scanning machine-readable information, may also include some sort of common interface **620** for communicating with master control system **640**. As a result, all information, commands, etc. occurring between radio modems **610**, similar devices **630** and MRC **600** are conveyed by the communication resources of master control system **640**. The possible effect of sharing communication resources with all the other functional modules within WCD **100** will be discussed with respect to FIG. **6**C.

[0069] FIG. **6**C discloses an operational diagram similar to FIG. **4** including the effect of MRC **600** in accordance with at least one embodiment of the present invention. In this system MRC **600** may receive operational data from the master operating system of WCD **100**, concerning for example applications running in application level **410**, and status data from the various radio communication devices in service level **430**. MRC **600** may use this information to issue scheduling commands to the communication devices in service level **430** in an attempt to avoid communication problems. However, problems may occur when the operations of WCD **100** are fully employed. Since the various applications in application level **410**, the operating system in system level **420**, the communication devices in service level **430** and MRC **600** must all share the same communication system, delays may occur when all aspects of WCD **100** are trying to communicate on the common interface system **620**. As a result, delay sensitive information regarding both communication resource status information and radio modem **610** control information may become delayed, nullifying any beneficial effect from MRC **600**. Therefore, a system better able to handle the differentiation and routing of delay sensitive information is required if the beneficial effect of MRC **600** is to be realized.

V. A Wireless Communication Device Including a Multiradio Control System

[0070] FIG. **7**A introduces MRC **600** as part of a multiradio control system (MCS) **700** in WCD **100** in accordance with at least one embodiment of the present invention. MCS **700** directly links the communication resources of modules **310**, **312**, **320** and **340** to MRC **600**. MCS **700** may provide a dedicated low-traffic communication structure for carrying delay sensitive information both to and from MRC **600**.

[0071] Additional detail is shown in FIG. **7**B. MCS **700** forms a direct link between MRC **600** and the communication resources of WCD **100**. This link may be established by a system of dedicated MCS interfaces **710** and **760**. For example, MCS interface **760** may be coupled to MRC **600**. MCS Interfaces **710** may connect radio modems **610** and other similar communication devices **630** to MCS **700** in order to form an information conveyance for allowing delay sensitive information to travel to and from MRC **600**. In this way, the abilities of MRC **600** are no longer influenced by the processing load of master control system **640**. As a result, any information still communicated by master control system **640** to and from MRC **600** may be deemed delay tolerant, and therefore, the actual arrival time of this information does not substantially influence system performance. On the other hand, all delay sensitive information is directed to MCS **700**, and therefore is insulated from the loading of the master control system.

[0072] The effect of MCS **700** is seen in FIG. **7**C in accordance with at least one embodiment of the present invention. Information may now be received in MRC **600** from at least two sources. System level **420** may continue to provide information to MRC **600** through master control system **640**. In addition, service level **430** may specifically provide delay sensitive information conveyed by MCS **700**. MRC **600** may distinguish between these two classes of information and act accordingly. Delay tolerant information may include information that typically does not change when a radio modem is actively engaged in communication, such as radio mode information (e.g., GPRS, Bluetooth™, WLAN, etc.), priority information that may be defined by user settings, the specific service the radio is driving (QoS, real time/non real time), etc. Since delay tolerant information changes infrequently, it may be delivered in due course by master control system **640** of WCD **100**. Alternatively,

delay sensitive (or time sensitive) information includes at least modem operational information that frequently changes during the course of a wireless connection, and therefore, requires immediate update. As a result, delay sensitive information may need to be delivered directly from the plurality of radio modems **610** through the MCS interfaces **710** and **760** to MRC **600**, and may include radio modem synchronization information. Delay sensitive information may be provided in response to a request by MRC **600**, or may be delivered as a result of a change in radio modem settings during transmission, as will be discussed with respect to synchronization below.

VI. A Wireless Communication Device Including a Distributed Multiradio Control System

[0073] FIG. **8**A discloses an alternative configuration in accordance with at least one embodiment of the present invention, wherein a distributed multiradio control system (MCS) **700** is introduced into WCD **100**. Distributed MCS **700** may, in some cases, be deemed to provide an advantage over a centralized MRC **600** by distributing these control features into already necessary components within WCD **100**. As a result, a substantial amount of the communication management operations may be localized to the various communication resources, such as radio modems **610**, reducing the overall amount of control command traffic in WCD **100**.

[0074] MCS **700**, in this example, may be implemented utilizing a variety of bus structures, including the I^2C interface commonly found in portable electronic devices, as well as emerging standards such as SLIMbus that are now under development. I^2C is a multi-master bus, wherein multiple devices can be connected to the same bus and each one can act as a master through initiating a data transfer. An I^2C bus contains at least two communication lines, an information line and a clock line. When a device has information to transmit, it assumes a master role and transmits both its clock signal and information to a recipient device. SLIMbus, on the other hand, utilizes a separate, non-differential physical layer that runs at rates of 50 Mbits/s or slower over just one lane. It is being developed by the Mobile Industry Processor Interface (MIPI) Alliance to replace today's I^2C and I^2S interfaces while offering more features and requiring the same or less power than the two combined.

[0075] MCS **700** directly links distributed control components **702** in modules **310**, **312**, **320** and **340**. Another distributed control component **704** may reside in master control system **640** of WCD **100**. It is important to note that distributed control component **704** shown in processor **300** is not limited only to this embodiment, and may reside in any appropriate system module within WCD **100**. The addition of MCS **700** provides a dedicated low-traffic communication structure for carrying delay sensitive information both to and from the various distributed control components **702**.

[0076] The exemplary embodiment disclosed in FIG. **8**A is described with more detail in FIG. **8**B. MCS **700** forms a direct link between distributed control components **702** within WCD **100**. Distributed control components **702** in radio modems **610** may, for example, consist of MCS interface **710**, radio activity controller **720** and synchronizer **730**. Radio activity controller **720** uses MCS interface **710** to communicate with distributed control components in other radio modems **610**. Synchronizer **730** may be utilized to obtain timing information from radio modem **610** to satisfy synchronization requests from any of the distributed control components **702**. Radio activity controller **702** may also obtain information from master control system **640** (e.g., from distributed control component **704**) through common interface **620**. As a result, any information communicated by master control system **640** to radio activity controller **720** through common interface **620** may be deemed delay tolerant, and therefore, the actual arrival time of this information does not substantially influence communication system performance. On the other hand, all delay sensitive information may be conveyed by MCS **700**, and therefore is insulated from master control system overloading.

[0077] As previously stated, a distributed control component **704** may exist within master control system **640**. Some aspects of this component may reside in processor **300** as, for example, a running software routine that monitors and coordinates the behavior of radio activity controllers **720**. Processor **300** is shown to contain priority controller **740**. Priority controller **740** may be utilized to monitor active radio modems **610** in order to determine priority amongst these devices. Priority may be determined by rules and/or conditions stored in priority controller **740**. Modems that become active may request priority information from priority controller **740**. Further, modems that go inactive may notify priority controller **740** so that the relative priority of the remaining active radio modems **610** may be adjusted accordingly. Priority information is usually not considered delay sensitive because it is mainly updated when radio modems **610** and their connections and/or services activate/deactivate, and therefore, does not frequently change during the course of an active communication connection in radio modems **610**. As a result, this information may be conveyed to radio modems **610** using common interface system **620** in at least one embodiment of the present invention.

[0078] At least one effect of a distributed control MCS **700** is seen in FIG. **8**C. System level **420** may continue to provide delay tolerant information to distributed control components **702** through master control system **640**. In addition, distributed control components **702** in service level **430**, such as modem activity controllers **720**, may exchange delay sensitive information with each other via MCS **700**. Each distributed control component **702** may distinguish between these two classes of information and act accordingly. Delay tolerant information may include information that typically does not change when a radio modem is actively engaged in communication, such as radio mode information (e.g., GPRS, Bluetooth™, WLAN, etc.), priority information that may be defined by user settings, the specific service the radio is driving (QoS, real time/non real time), etc. Since delay tolerant information changes infrequently, it may be delivered in due course by master control system **640** of WCD **100**. Alternatively, delay sensitive (or time sensitive) information may include at least modem operational information that frequently changes during the course of a wireless connection, and therefore, requires immediate update. Delay sensitive information needs to be delivered directly between distributed control components **702**, and may include radio modem synchronization and activity control information. Delay sensitive information may be provided in response to a request, or may be delivered as a result of a change in radio modem, which will be discussed with respect to synchronization below.

[0079] MCS interface **710** may be used to (1) Exchange synchronization information, and (2) Transmit identification or prioritization information between various radio activity controllers **720**. In addition, as previously stated, MCS interface **710** is used to communicate the radio parameters that are delay sensitive from a controlling point of view. MCS interface **710** can be shared between different radio modems (multipoint) but it cannot be shared with any other functionality that could limit the usage of MCS interface **710** from a latency point of view.

[0080] The control signals sent on MCS **700** that may enable/disable a radio modem **610** should be built on a modem's periodic events. Each radio activity controller **720** may obtain this information about a radio modem's periodic events from synchronizer **730**. This kind of event can be, for example, frame clock event in GSM (4.615 ms), slot clock event in BT (625 us) or targeted beacon transmission time in WLAN (100 ms) or any multiple of these. A radio modem **610** may send its synchronization indications when (1) Any radio activity controller **720** requests it, (2) a radio modem internal time reference is changed (e.g. due to handover or handoff). The latency requirement for the synchronization signal is not critical as long as the delay is constant within a few microseconds. The fixed delays can be taken into account in the scheduling logic of radio activity controller **710**.

[0081] The radio modem activity control is based on the knowledge of when the active radio modems **610** are about to transmit (or receive) in the specific connection mode in which the radios are currently operating. The connection mode of each radio modem **610** may be mapped to the time domain operation in their respective radio activity controller **720**. As an example, for a GSM speech connection, priority controller **740** may have knowledge about all traffic patterns of GSM. This information may be transferred to the appropriate radio activity controller **720** when radio modem **610** becomes active, which may then recognize that the speech connection in GSM includes one transmission slot of length 577 μs, followed by an empty slot after which is the reception slot of 577 μs, two empty slots, monitoring (RX on), two empty slots, and then it repeats. Dual transfer mode means two transmission slots, empty slot, reception slot, empty slot, monitoring and two empty slots. When all traffic patterns that are known a priori by the radio activity controller **720**, it only needs to know when the transmission slot occurs in time to gain knowledge of when the GSM radio modem is active. This information may be obtained by synchronizer **730**. When the active radio modem **610** is about to transmit (or receive) it must check every time whether the modem activity control signal from its respective radio activity controller **720** permits the communication. Radio activity controller **720** is always either allowing or disabling the transmission of one full radio transmission block (e.g. GSM slot).

VII. A Wireless Communication Device Including an Alternative Example of a Distributed Multiradio Control System

[0082] An alternative distributed control configuration in accordance with at least one embodiment of the present invention is disclosed in FIG. **9**A-**9**C. In FIG. **9**A, distributed control components **702** continue to be linked by MCS **700**. However, now distributed control component **704** is also directly coupled to distributed control components **702** via an MCS interface. As a result, distributed control component **704** may also utilize and benefit from MCS **700** for transactions involving the various communication components of WCD **100**.

[0083] Referring now to FIG. **9**B, the inclusion of distributed control component **704** onto MCS **700** is shown in more detail. Distributed control component **704** includes at least priority controller **740** coupled to MCS interface **750**. MCS interface **750** allows priority controller **740** to send information to, and receive information from, radio activity controllers **720** via a low-traffic connection dedicated to the coordination of communication resources in WCD **100**. As previously stated, the information provided by priority controller **740** may not be deemed delay sensitive information, however, the provision of priority information to radio activity controllers **720** via MCS **700** may improve the overall communication efficiency of WCD **100**. Performance may improve because quicker communication between distributed control components **702** and **704** may result in faster relative priority resolution in radio activity controllers **720**. Further, the common interface system **620** of WCD **100** will be relieved of having to accommodate communication traffic from distributed control component **704**, reducing the overall communication load in master control system **640**. Another benefit may be realized in communication control flexibility in WCD **100**. New features may be introduced into priority controller **740** without worrying about whether the messaging between control components will be delay tolerant or sensitive because an MCS interface **710** is already available at this location.

[0084] FIG. **9**C discloses the operational effect of the enhancements seen in the current alternative embodiment of the present invention on communication in WCD **100**. The addition of an alternative route for radio modem control information to flow between distributed control components **702** and **704** may both improve the communication management of radio activity controllers **720** and lessen the burden on master control system **640**. In this embodiment, all distributed control components of MCS **700** are linked by a dedicated control interface, which provides immunity to communication coordination control messaging in WCD **100** when the master control system **640** is experiencing elevated transactional demands.

[0085] An example message packet **900** is disclosed in FIG. **10** in accordance with at least one embodiment of the present invention. Example message packet **900** includes activity pattern information that may be formulated by MRC **600** or radio activity controller **720**. The data payload of packet **900** may include, in at least one embodiment of the present invention, at least Message ID information, allowed/disallowed transmission (Tx) period information, allowed/disallowed reception (Rx) period information, Tx/Rx periodicity (how often the Tx/Rx activities contained in the period information occur), and validity information describing when the activity pattern becomes valid and whether the new activity pattern is replacing or added to the existing one. The data payload of packet **900**, as shown, may consist of multiple allowed/disallowed periods for transmission or reception (e.g., Tx period 1, 2 . . .) each containing at least a period start time and a period end time during which radio modem **610** may either be permitted or prevented from executing a communication activity. While the distributed example of MCS **700** may allow radio modem control activity to be controlled real-time (e.g., more control messages with finer granularity), the ability to include multiple

allowed/disallowed periods into a single message packet **900** may support radio activity controllers **720** in scheduling radio modem behavior for longer periods of time, which may result in a reduction in message traffic. Further, changes in radio modem **610** activity patterns may be amended using the validity information in each message packet **900**.

[0086] The modem activity control signal (e.g., packet **900**) may be formulated by MRC **600** or radio activity controller **720** and transmitted on MCS **700**. The signal includes activity periods for Tx and Rx separately, and the periodicity of the activity for the radio modem **610**. While the native radio modem clock is the controlling time domain (never overwritten), the time reference utilized in synchronizing the activity periods to current radio modem operation may be based on one of at least two standards. In a first example, a transmission period may start after a pre-defined amount of synchronization events have occurred in radio modem **610**. Alternatively, all timing for MRC **600** or between distributed control components **702** may be standardized around the system clock for WCD **100**. Advantages and disadvantages exist for both solutions. Using a defined number of modem synchronization events is beneficial because then all timing is closely aligned with the radio modem clock. However, this strategy may be more complicated to implement than basing timing on the system clock. On the other hand, while timing based on the system clock may be easier to implement as a standard, conversion to modem clock timing must necessarily be implemented whenever a new activity pattern is installed in radio modem **610**.

[0087] The activity period may be indicated as start and stop times. If there is only one active connection, or if there is no need to schedule the active connections, the modem activity control signal may be set always on allowing the radio modems to operate without restriction. The radio modem **610** should check whether the transmission or reception is allowed before attempting actual communication. The activity end time can be used to check the synchronization. Once the radio modem **610** has ended the transaction (slot/packet/burst), it can check whether the activity signal is still set (it should be due to margins). If this is not the case, the radio modem **610** can initiate a new synchronization with MRC **600** or with radio activity controller **720** through synchronizer **730**. The same happens if a radio modem time reference or connection mode changes. A problem may occur if radio activity controller **720** runs out of the modem synchronization and starts to apply modem transmission/reception restrictions at the wrong time. Due to this, modem synchronization signals need to be updated periodically. The more active wireless connections, the more accuracy is required in synchronization information.

VIII. Radio Modem Interface to Other Devices

[0088] As a part of information acquisition services, the MCS interface **710** needs to send information to MRC **600** (or radio activity controllers **720**) about periodic events of the radio modems **610**. Using its MCS interface **710**, the radio modem **610** may indicate a time instance of a periodic event related to its operation. In practice these instances are times from which one can calculate when radio modem **610** is active and may be preparing to communicate or communicating. Events occurring prior to or during a transmission or reception mode may be used as a time reference (e.g., in case of GSM, the frame edge may be indicated in a modem that is not necessarily transmitting or receiving at that moment, but we know based on the frame clock that the modem is going to transmit [x]ms after the frame clock edge). Basic principle for such timing indications is that the event is periodic in nature. Every incident needs not to be indicated, but the MRC **600** may calculate intermediate incidents itself. In order for that to be possible, the controller would also require other relevant information about the event, e.g. periodicity and duration. This information may be either embedded in the indication or the controller may get it by other means. Most importantly, these timing indications need to be such that the controller can acquire a radio modem's basic periodicity and timing. The timing of an event may either be in the indication itself, or it may be implicitly defined from the indication information by MRC **600** (or radio activity controller **720**).

[0089] In general terms these timing indications need to be provided on periodic events like: schedule broadcasts from a base station (typically TDMA/MAC frame boundaries) and own periodic transmission or reception periods (typically Tx/Rx slots). Those notifications need to be issued by the radio modem **610**: (1) on network entry (i.e. modem acquires network synchrony), (2) on periodic event timing change e.g. due to a handoff or handover and (3) as per the policy and configuration settings in the multiradio controller (monolithic or distributed).

[0090] In at least one embodiment of the present invention, the various messages exchanged between the aforementioned communication components in WCD **100** may be used to dictate behavior on both a local (radio modem level) and global (WCD level) basis. MRC **600** or radio activity controller **720** may deliver a schedule to radio modem **610** with the intent of controlling that specific modem, however, radio modem **610** may not be compelled to conform to this schedule. The basic principle is that radio modem **610** is not only operating according to multiradio control information (e.g., operates only when MRC **600** allows) but is also performing internal scheduling and link adaptation while taking MRC scheduling information into account.

IX. Peripheral Devices Communicating to a Dual-Mode Modem

[0091] Referring now to FIG. **11**A, an exemplary scenario is disclosed, wherein WCD **100** is in active wireless communication with peripheral devices **1150**-**1154**. The use of the phrase "peripheral devices" is not intended to limit the present invention, and is used only to represent any device external to WCD **100** also capable of wirelessly communicating with WCD **100**. Such devices may include wireless headset **1150** communicating via Bluetooth™ communication, wireless keyboard **1152** communicating via Wibree™ communication, and wireless mouse **1154** also communicating via Wibree™ communication. All of these peripheral devices may, at least in this example, communicate with a single dual-mode radio modem **1100** in WCD **100**. It is foreseeable that user **110** may be conducting a telephone conversation over headset **1150** while typing on keyboard **1152** and interacting with mouse **1154** at the same time. Given a scenario wherein at least two or more peripheral devices are conducting concurrent communication with dual-mode modem **1100**, the possibility of experiencing communication collisions is increased. As a result, a strategy for managing the operation of these radio protocols is needed to optimize performance while preserving quality.

[0092] FIG. **11**B includes an exemplary implementation of at least one embodiment of the present invention. Again, in this example the three previous peripheral devices are attempting concurrent communication with WCD **100** through dual-mode radio modem **1100**. However, radio modem **1100** may now include local control resources for managing both "radios" (e.g., software based radio control stacks) attempting to use the physical layer (PHY) resources of dual-mode radio modem **1100**. In this example, dual-mode radio modem **1100** includes at least two radio stacks or radio protocols (labeled "Bluetooth" and "Wibree") that may share the PHY layer resources (e.g., hardware resources, antenna, etc.) of dual-mode radio modem **1100**. 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 a hardware form (e.g., logic device, 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 **1100**. The interaction of these control resources with the radio protocols utilizing dual-mode radio modem **1100** is explained below.

[0093] With respect to FIG. **12**A, an exemplary combination of two separate radio protocol stacks into a single combined entity controlled locally by at least an admission control **1226** and a DuMo manager **1228** is now disclosed. Initially, two example standalone stacks are shown to establish the individual elements that may be incorporated into an integrated dual-mode entity. Standalone Bluetooth™ stack **1200** includes elements that may convey information from a system level to a physical layer where it may be transmitted wireless to another device. At the top level, BT Profiles **1206** include at least a description of a known peripheral device which may be connected wirelessly to WCD **100**, or an application that may utilize Bluetooth™ in order to engage in wireless communication with a peripheral device. Bluetooth™ profiles of other devices may be established through a pairing procedure wherein identification and connection information for a peripheral device may be received by WCD **100** through a polling process and then saved in order to expedite the connection to the device at a later time. After the application and/or target peripheral device (or devices) is established, any information to be sent must be prepared for transmission. L2CAP level **1208** includes at least a logical link controller and adaptation protocol. This protocol supports higher level protocol multiplexing packet segmentation and reassembly, and the conveying of quality of service information. The information prepared by L2CAP level **1208** may then be passed to an application-optional host controller interface (HCI) **1210**. This layer may provide a command interface to the lower link manager protocol (LMP) layers, link manager (LM) **1212** and link controller (LC) **1214**. LM **1212** may establish the link setup, authentication, link configuration and other protocols related to establishing a wireless link between two or more devices. Further, LC **1214** may manage active links between two or more devices by handling low-level baseband protocols. Wireless communication may then be established and conducted using the hardware (modem, antenna, etc.) making up physical layer (PHY) **1216**. Of course, the above identified layers of Bluetooth™ stack **1200** 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 device.

[0094] The layers in the standalone Wibree™ stack are similar to the elements previously described. However, due to the relative simplicity of Wibree™ when compared to Bluetooth™, there are actually less layers utilized to achieve wireless communication. W Profiles **1218**, similar to the profiles used in Bluetooth™, are used to specify applications that may use Wibree™ for communication and peripheral devices with which a Wibree™ modem may wirelessly communicate. The profile adoption layer (PAL) **1220** may be used to prepare the information for transmission via wireless communication. HIF layer **1222** may provide an interface between the upper layers communicating with applications and schedulers in WCD **100**, and the lower layers of the Wibree™ stack which establish and maintain the links to peripheral devices. Lower layers of the Wibree™ stack may further include at least link layer (LL) **1224**. LL **1224** may both establish and maintain wireless communications with other wireless enabled devices through the use of Physical Layer (PHY) **1216**, which is common to Bluetooth™ and Wibree™ radio protocols using dual-mode modem **1100**. Wibree™ LL **1224**, however, differs significantly from LM **1211** and LC **1214** in Bluetooth™, and as a result, may have a substantial effect on the functioning of DuMo manager **1228**.

[0095] The central stack in FIG. **12**A is an exemplary combined Bluetooth™ and Wibree™ DuMo Stack **1204** usable for managing communication in a dual-mode radio modem **1100**. In this example, the elements previously described for both Bluetooth™ stack **1200** and Wibree™ stack **1202** are shown combined in a parallel structure linked by admission control **1226** and DuMo manager **1228**. Admission control **1226** may act as a gateway for the dual-mode radio modem **1100** by filtering out both Bluetooth™ and Wibree™ requests from the operating system of WCD **100** that may result in conflicts. Scheduling information may also be provided by MRC **600**, wherein certain periods of operation are allocated to dual-mode radio modem **1100** 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 combined protocol stacks and also to DuMo manager **1228** for further processing. However, if scheduling information from MRC **600** is critical (delay-sensitive), it may be sent through MCS **700** via a direct connection to DuMo Manager **1228**. The information received by DuMo manager, and the processing involved in managing the operation of the radio protocols, is discussed below with regard to FIG. **12**B.

[0096] FIG. **12**B discloses in more detail an exemplary DuMo manager **1228** in accordance with at least one embodiment of the present invention. DuMo manager may receive information used in the determination of a "revised" schedule or sub-schedule for radio protocols utilizing the PHY layer **1216** of dual-mode modem **1100** (given that there may already be a schedule for the dual-mode radio modem **1100** in view of other radio modems **610** as created by MRC **600**). Some information received by DuMo manager **1228** may come through upper layers, such as through admission control **1226**. This information may include at least scheduling information (Sys_Sch) for the dual-mode modem **1100** as compared to other active radio modems **610** in WCD **100** (per MRC **600**). As previously stated above, the urgency

involved with delay-sensitive information, including some scheduling information, may require it to be delivered from MRC **600** directly to DuMo manager **1228** via MCS **700**. Other information may include indication information from the Bluetooth™ radio stack (BT_Ind) and indication information from the Wibree™ radio stack (W_Ind) of the current state of each radio protocol. Indication information may include the current state of the modem with regard to each radio protocol (e.g., whether the dual-mode radio modem **1100** is actively receiving information or transmitting information from a certain protocol), whether there is information queued to send for either protocol, the urgency of the information to send for each protocol, etc. This indication information is used by DuMo manager **1228** to determine scheduling (e.g., BT_Sch and W_Sch) for the individual radios of the dual-mode modem so that dual-mode radio modem **1100** may share time between various protocols without experiencing communication errors. In making these scheduling decisions, DuMo manager **1228** must operate in accordance with the orders, parameters and/or instructions given by admission control **1226**.

X. Scheduling Strategy

[0097] FIG. **13** discloses exemplary timing and scheduling diagrams for at least two radio protocols usable in accordance with at least one embodiment of the present invention. An example of radio protocols that may reserve time in the manner disclosed in FIG. **13** are Bluetooth™ and Wibree™ (as previously discussed), however, the present invention is not limited exclusively to any particular wireless communication medium. The example shows blocks of time reserved for transmitting (TX) and receiving (RX) one or more packets between a master device and three slave devices. In the case of Bluetooth™ and Wibree™, communication packets may include at least three parts: an access code, a header and payload. These packets may be organized into at least two classifications based on functionality. In Bluetooth™, Asynchronous Connectionless Link (ACL) transactions may create an asynchronous (packet-switched) connection between two devices created on the LMP level. ACL packets transmitted to establish a connection may be, for example, polling packets, which may contain only an access code and a header. When a slave device receives a poll packet, it must acknowledge receipt to the master by answering immediately with a similar abbreviated transmission to the master device. After a link is established between master and slave through ACL communication, Synchronous Connection Oriented (SCO) communication may occur. A SCO link is a circuit-switched connection for reserved bandwidth communications (e.g., voice information). SCO packets do not include a cyclic redundancy check (CRC) and are never retransmitted. SCO links may only be established after an ACL link has already established the initial connection between devices.

[0098] In the example disclosed in FIG. **13**, the Bluetooth™ master may initiate ACL communication through the sending of a polling packet to a slave. This initial information exchange may occur on a periodic basis, and may operate in what is commonly called a "sniff" mode since any ACL communication is coordinated so that the slave device knows when to "sniff" for any new transmission from a master device. Operating using a coordinated sniff mode may result in a power savings in both the devices since the master and slave will only be actively transmitting and/or receiving during a planned period when communication may occur. It is important to note that a Bluetooth™ master may communicate to one or more slaves simultaneously. As a result, a slave must receive and interpret the entire polling packet in order to determine if the information being advertised is directed to the particular slave. If this information does pertain to slave, it will respond to the master. The ACL phase of the exchange may be completed when the master receives a response from the slave acknowledging that it is ready to receive the advertised SCO information. As further shown in FIG. **13**, a SCO link may then commence with the master and slave exchanging information. This transaction may continue until the next instance of the sniff period. In the disclosed example, the master device has no additional information to send to the client during the next sniff period. Since the slave does not know the full extent of any information to be transmitted from the master device, the slave maintains preparedness in a reception mode until the next sniff period, wherein more information is now ready to be sent from the master to the slave device.

[0099] In at least one example of the present invention, a transaction initiated with the BT Slave (headset **1150**) is established by ACL communication which is followed by a SCO transaction. Bluetooth™ communication is the radio protocol having the highest priority in this example. This priority is defined further by the legend at the bottom of the figure, which discloses that white packets are for the high priority protocol, shaded packets indicate communication to a lower priority protocol, and that packets with a broken outline are optional transmissions (e.g., there may be additional information to transmit if there is more data in the queue to be transacted and if time permits). During the next sniff period no additional information is scheduled to be transacted between WCD **100** and headset **1150**. In accordance with at least one embodiment of the present invention, DuMo **1228** may utilize this time for communication over Wibree™ to one or both of the W Slaves (e.g., mouse **1152** and keyboard **1154**). Time is shown being allocated first to mouse **1152**, wherein an ACL transaction occurs followed by mouse **1152** sending SCO information to dual-mode radio modem **1100**. Unused time is also diverted to keyboard **1154**, allowing some information to be exchanged before the start of the next Bluetooth™ sniff period. After the second set of ACL and SCO transactions for headset **1150**, more unused communication time may be diverted for the Wibree™ devices. In this case, there is no response from either mouse **1152** or keyboard **1154** to the poll from WCD **100**. It is up to the admission control **1226** of dual-mode radio modem **1100** to determine connection and radio parameters for both Bluetooth™ and Wibree™ so that they may be scheduled by DuMo manager **1228**. As an example, admission control **1226** may be required to determine a possible advertisement interval and sniff interval of a Wibree™ radio protocol so that the Wibree™ radio protocol may operate in-between active Bluetooth™ slots.

[0100] A flow chart showing an exemplary process for managing operations in a dual-mode radio modem **1100** when at least two radio protocols are being utilized is shown in FIG. **14**. In step **1400** a priority is determined between Bluetooth™ and Wibree™ communication. The priority may be set in a variety of ways. For example, priority may be set at the application level by an application utilizing a certain radio protocol (e.g., a certain transaction, like the

sending of a credit card number, may be deemed high priority). Further, the priority may be set at the system level by a user-set configuration or by a controller, such as MRC **610**, based on the message traffic assigned to a particular radio protocol or the ability of a radio protocol to operate without conflicting with other active wireless mediums. The priority may also be set at the dual-mode radio modem **1100** level. Typically it is up to admission control **1226** to set the priorities within the dual-mode modem as per the application and user requirements. Admission control **1226** and/or DuMo manager **1228** may monitor the message buffer for the radio protocols and may reprioritize a radio protocol if the number of pending messages exceeds a predetermined limit, or if the messages queued for a particular protocol exceed an age limit (e.g., messages have been waiting to be sent for too long).

[0101] In step **1402**, DuMo manager **1228** may receive information from MRC regarding scheduling for the dual-mode radio modem **1100**. This information may be combined with information received from the Bluetooth™ and Wibree™ radio stacks in step **1404** and may be used to determine how to allocate the time between radio protocols. In step **1406** a determination may be made as to whether potential communication conflicts exist in the communications as scheduled. If no potential communication errors exist, then in step **1408** the radio protocols may be allowed to communicate as scheduled by the system (e.g., by MRC **600**) and the cycle may begin again with more information being supplied to admission control **1226** and/or DuMo manager **1228**. If potential communication conflicts do exist, then in step **1410** the protocol that is considered highest priority may be allowed to continue operation without alteration by local control resources in dual-mode radio modem **1100**. However, DuMo manager **1228** may also examine the communication schedule of the highest priority protocol in order to determine whether potential unused time may be reallocated (step **1412**). In such instances, the time may be previously reserved for the high priority protocol, but in actuality, there will be no active communication occurring during this period. The analysis searching for unused time will continue in step **1414** until any "free" time is found. The unused time may be allocated to devices that are communicating using a lower priority radio protocol in steps **1416** and **1418**. The process may then resume from step **1402** when new scheduling information may be sent to admission control **1226** and/or DuMo manager **1228** from the system level (e.g., from MRC **600** via MCS **700**).

[0102] The present invention is an improvement over existing systems in at least one benefit that may be realized in operational management that may be provided for a dual-mode radio modem. This operational management may allow one radio modem to concurrently communicate over at least two radio protocols while preserving both performance and quality. As a result, a small number of physical radio modems may be employed to simultaneously communicate over a larger number of radio protocols in a wireless communication device.

[0103] Accordingly, it will be apparent to persons skilled in the relevant art that various changes in form a and detail can be made therein without departing from the spirit and scope of the invention. This the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed:

1. A wireless communication device, comprising:
- a radio modem enabled to communicate via at least two radio protocols, the radio modem including a radio modem interface; and
- a controller, coupled to at least the radio modem interface, the controller being enabled to coordinate activity periods for the at least two radio protocols so that the radio modem is enabled to communicate using the at least two radio protocols concurrently.

2. The device of claim **1**, wherein the wireless communication device includes a plurality of radio modems, each modem further including a radio modem interface.

3. The device of claim **1**, wherein the two radio protocols are Bluetooth™ and Wibree™.

4. The device of claim **1**, wherein the controller is integrated into the radio modem interface.

5. The device of claim **1**, wherein the controller includes at least a Dual Mode (DuMo) manager.

6. The device of claim **5** wherein the DuMo manager is enabled to coordinate the operation of the at least two protocols in the radio modem.

7. The device of claim **6**, wherein the controller further includes an Admission control enabled to assign at least radio and connection parameters so that the DuMo manager can coordinate the operation of the at least two radio protocols to operate without collisions.

8. The device of claim **1**, wherein coordinating the activity of the at least two protocols includes scheduling the at least two protocols so that the at least two protocols do not attempt to conduct wireless transactions during the same activity period.

9. A method in a wireless communication device, comprising:
- receiving information regarding a schedule for at least two radio protocols that share a dual-mode radio modem;
- receiving information regarding a status for the least two radio protocols that share the dual-mode radio modem;
- determining, for the at least two radio protocols, a higher priority radio protocol and a lower priority radio protocol;
- determining, in the schedule information of the higher priority radio protocol, time that will not be used for communication; and
- allocating the time that will not be used for communication in the higher priority protocol to be used for communication in the lower priority radio protocol.

10. The method of claim **9**, wherein the information regarding a schedule for at least two radio protocols is received from a multiradio controller in the wireless communication device.

11. The method of claim **9**, where the information regarding a schedule for at least two radio protocols is based on scheduling for all radio modems in the wireless communication device.

12. The method of claim **9**, wherein the information regarding a status for at least two radio protocols is received from radio protocol stacks corresponding to each of the at least radio protocols.

13. The method of claim 12, wherein the information regarding a status for at least two radio protocols includes information related to at least one of the current status of the dual mode-radio modem, a current message queue for each radio protocol stack and a priority level for the messages pending for each radio protocol stack.

14. The method of claim 9, wherein determining a higher priority radio protocol and a lower priority radio protocol includes obtaining radio protocol priority information from at least one of an application level of the wireless communication device, an operating system level of the wireless communication device, a user-specified configuration in the wireless communication device and the dual-mode radio modem.

15. The method of claim 9, wherein determining time that will not be used for communication by the higher priority radio protocol includes determining when the higher priority radio protocol will not be using the dual-mode radio modem.

16. The method of claim 9, wherein allocating the time that will not be used for communication in the higher priority protocol to be used for communication in the lower priority radio protocol includes allowing the lower priority protocol to use the dual-mode radio modem during the time that will not be used by the higher priority protocol.

17. A computer program product comprising a computer usable medium having computer readable program code embodied in said medium for managing a wireless communication device, comprising:

a computer readable program code for receiving information regarding a schedule for at least two radio protocols that share a dual-mode radio modem;

a computer readable program code for receiving information regarding a status for the least two radio protocols that share the dual-mode radio modem;

a computer readable program code for determining, for the at least two radio protocols, a higher priority radio protocol and a lower priority radio protocol;

a computer readable program code for determining, in the schedule information of the higher priority radio protocol, time that will not be used for communication; and

a computer readable program code for allocating the time that will not be used for communication in the higher priority protocol to be used for communication in the lower priority radio protocol.

18. The computer program product of claim 17, wherein the information regarding a schedule for at least two radio protocols is received from a multiradio controller in the wireless communication device.

19. The computer program product of claim 17, where the information regarding a schedule for at least two radio protocols is based on scheduling for all radio modems in the wireless communication device.

20. The computer program product of claim 17, wherein the information regarding a status for at least two radio protocols is received from radio protocol stacks corresponding to each of the at least radio protocols.

21. The computer program product of claim 20, wherein the information regarding a status for at least two radio protocols includes information related to at least one of the current status of the dual mode-radio modem, a current message queue for each radio protocol stack and a priority level for the messages pending for each radio protocol stack.

22. The computer program product of claim 17, wherein determining a higher priority radio protocol and a lower priority radio protocol includes obtaining radio protocol priority information from at least one of an application level of the wireless communication device, an operating system level of the wireless communication device, a user-specified configuration in the wireless communication device and the dual-mode radio modem.

23. The computer program product of claim 17, wherein determining time that will not be used for communication by the higher priority radio protocol includes determining when the higher priority radio protocol will not be using the dual-mode radio modem.

24. The computer program product of claim 17, wherein allocating the time that will not be used for communication in the higher priority protocol to be used for communication in the lower priority radio protocol includes allowing the lower priority protocol to use the dual-mode radio modem during the time that will not be used by the higher priority protocol.

25. A mode of operation for a dual-mode radio modem in a wireless communication device, comprising:

receiving information in a controller regarding a schedule for at least two radio protocols that share a dual-mode radio modem;

receiving information in the controller regarding a status for the least two radio protocols that share the dual-mode radio modem;

determining, for the at least two radio protocols, a higher priority radio protocol and a lower priority radio protocol;

determining, in the schedule information of the higher priority radio protocol, time that will not be used for communication; and

allocating the time that will not be used for communication in the higher priority protocol to be used for communication in the lower priority radio protocol.

26. The mode of claim 25, wherein the information regarding a schedule for at least two radio protocols is received from a multiradio controller in the wireless communication device.

27. The mode of claim 25, where the information regarding a schedule for at least two radio protocols is based on scheduling for all radio modems in the wireless communication device.

28. The mode of claim 25, wherein the information regarding a status for at least two radio protocols is received from radio protocol stacks corresponding to each of the at least radio protocols.

29. The mode of claim 28, wherein the information regarding a status for at least two radio protocols includes information related to at least one of the current status of the dual mode-radio modem, a current message queue for each radio protocol stack and a priority level for the messages pending for each radio protocol stack.

30. The mode of claim 25, wherein determining a higher priority radio protocol and a lower priority radio protocol includes obtaining radio protocol priority information from at least one of an application level of the wireless communication device, an operating system level of the wireless communication device, a user-specified configuration in the wireless communication device and the dual-mode radio modem.

31. The mode of claim **25**, wherein determining time that will not be used for communication by the higher priority radio protocol includes determining when the higher priority radio protocol will not be using the dual-mode radio modem.

32. The mode of claim **25**, wherein allocating the time that will not be used for communication in the higher priority protocol to be used for communication in the lower priority radio protocol includes allowing the lower priority protocol to use the dual-mode radio modem during the time that will not be used by the higher priority protocol.

33. A radio modem controller, comprising:

a radio modem controller coupled to a radio modem interface, the radio modem interface being part of a radio modem enabled to communicate via at least two radio protocols; and

the controller being enabled to coordinate activity periods for the at least two radio protocols so that the radio modem is enabled to communicate using the at least two radio protocols concurrently.

34. The controller of claim **33**, wherein the radio modem controller is integrated into the radio modem interface.

35. A dual-mode radio modem, comprising:

At least a controller for performing method steps including:

receiving information in the controller regarding a schedule for at least two radio protocols that share a dual-mode radio modem;

receiving information in the controller regarding a status for the least two radio protocols that share the dual-mode radio modem;

determining, for the at least two radio protocols, a higher priority radio protocol and a lower priority radio protocol;

determining, in the schedule information of the higher priority radio protocol, time that will not be used for communication; and

allocating the time that will not be used for communication in the higher priority protocol to be used for communication in the lower priority radio protocol.

36. A chipset, comprising:

a radio modem controller coupled to a radio modem interface, the radio modem interface being part of a radio modem enabled to communicate via at least two radio protocols; and

the controller being enabled to coordinate activity periods for the at least two radio protocols so that the radio modem is enabled to communicate using the at least two radio protocols concurrently.

* * * * *

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Kiukkonen et al. (43) Pub. Date: Jul. 19, 2007

(54) METHOD FOR AVOIDING INTERFERENCE FROM A CELLULAR TRANSMITTER TO THE 2.4/5GHZ ISM BAND

(76) Inventors: **Niko Kiukkonen**, Veikkola (FI); **Jari Junell**, Vantaa (FI)

Correspondence Address:
MORGAN & FINNEGAN, LLP
3 World Financial Center
New York, NY 10281-2101 (US)

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H03D 1/04 (2006.01)

(52) **U.S. Cl.** **375/346**

(57) **ABSTRACT**

A method, terminal, and computer program are disclosed to reduce radio interference in a wireless communications device having a combination of a wireless telephone unit, such as a GSM cellular phone, and a short range wireless communications unit, such as a WLAN communications unit or a Bluetooth communications unit. An interference avoidance subsystem in the wireless communications device is connected between the GSM frequency hopping logic and the Bluetooth frequency hopping logic. Bluetooth frequency hopping information and time domain operation information are input from the Bluetooth frequency hopping logic to the interference avoidance subsystem. GSM frequency hopping information and time domain operation information are input from the GSM frequency hopping logic to the interference avoidance subsystem. The interference avoidance subsystem then uses this input data to calculate the interference probability between co-existing Bluetooth received signals and GSM transmitted signals. The interference avoidance subsystem then compares the calculated interference probability with the required Bluetooth packet error rate limit for the current application. If the interference probability exceeds the required Bluetooth packet error rate limit, the interference avoidance subsystem sends a signal to the Bluetooth frequency hopping logic to change the Bluetooth frequencies.

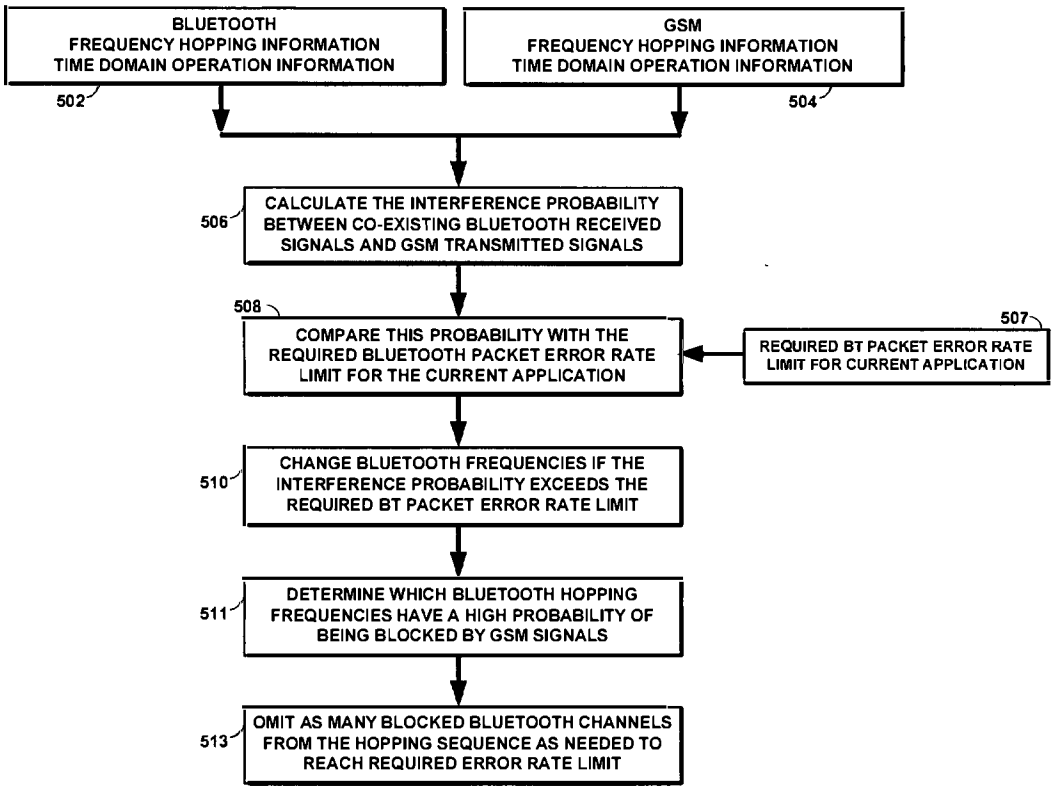
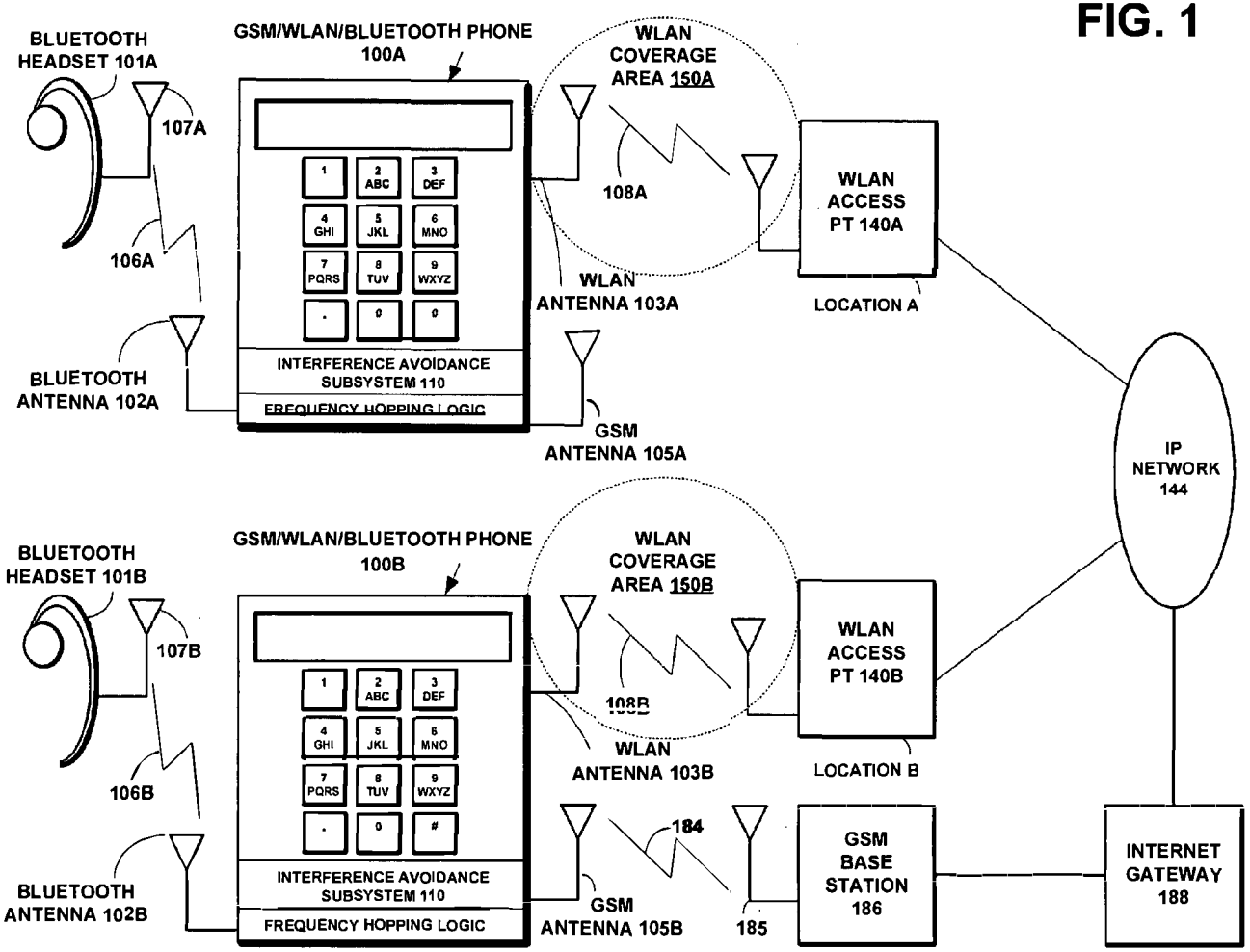


FIG. 1


BLUETOOTH HEADSET 101A
107A
106A
BLUETOOTH ANTENNA 102A
GSM/WLAN/BLUETOOTH PHONE 100A
INTERFERENCE AVOIDANCE SUBSYSTEM 110
FREQUENCY HOPPING LOGIC
WLAN COVERAGE AREA 150A
108A
WLAN ANTENNA 103A
GSM ANTENNA 105A
WLAN ACCESS PT 140A
LOCATION A
IP NETWORK 144
BLUETOOTH HEADSET 101B
107B
106B
BLUETOOTH ANTENNA 102B
GSM/WLAN/BLUETOOTH PHONE 100B
INTERFERENCE AVOIDANCE SUBSYSTEM 110
FREQUENCY HOPPING LOGIC
WLAN COVERAGE AREA 150B
108B
WLAN ANTENNA 103B
GSM ANTENNA 105B
184
185
WLAN ACCESS PT 140B
LOCATION B
GSM BASE STATION 186
INTERNET GATEWAY 188

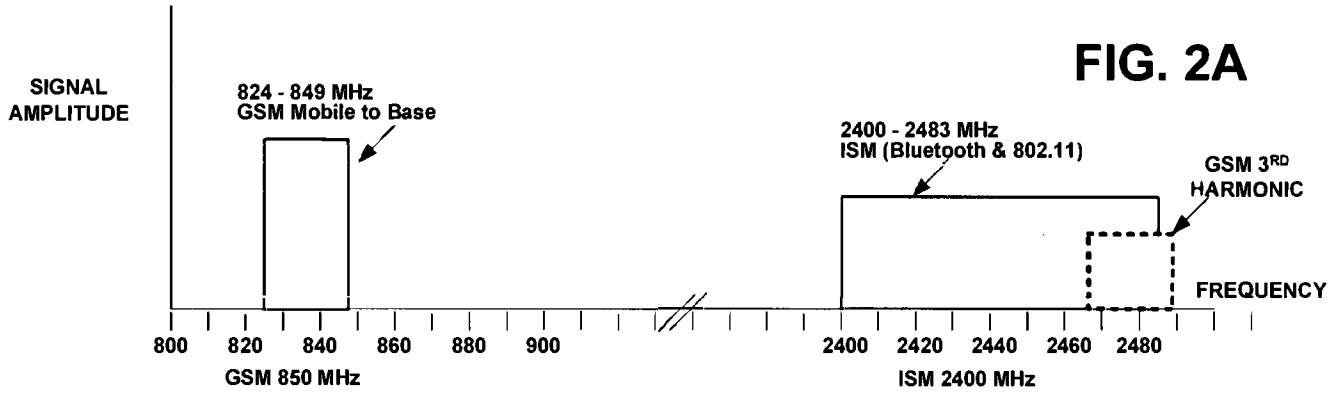

SIGNAL AMPLITUDE
824 - 849 MHz
GSM Mobile to Base
2400 - 2483 MHz
ISM (Bluetooth & 802.11)
GSM 3RD HARMONIC
FREQUENCY
800
820
840
860
880
900
2400
2420
2440
2460
2480
GSM 850 MHz
ISM 2400 MHz

FIG. 2A

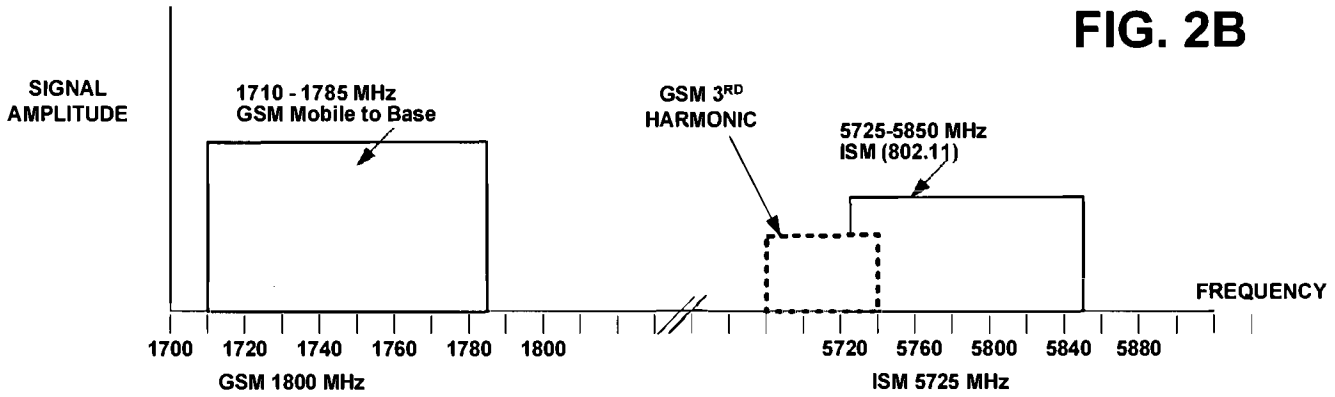

SIGNAL AMPLITUDE
1710 - 1785 MHz
GSM Mobile to Base
GSM 3RD HARMONIC
5725-5850 MHz
ISM (802.11)
FREQUENCY
1700
1720
1740
1760
1780
1800
5720
5760
5800
5840
5880
GSM 1800 MHz
ISM 5725 MHz

FIG. 2B

FIG. 3

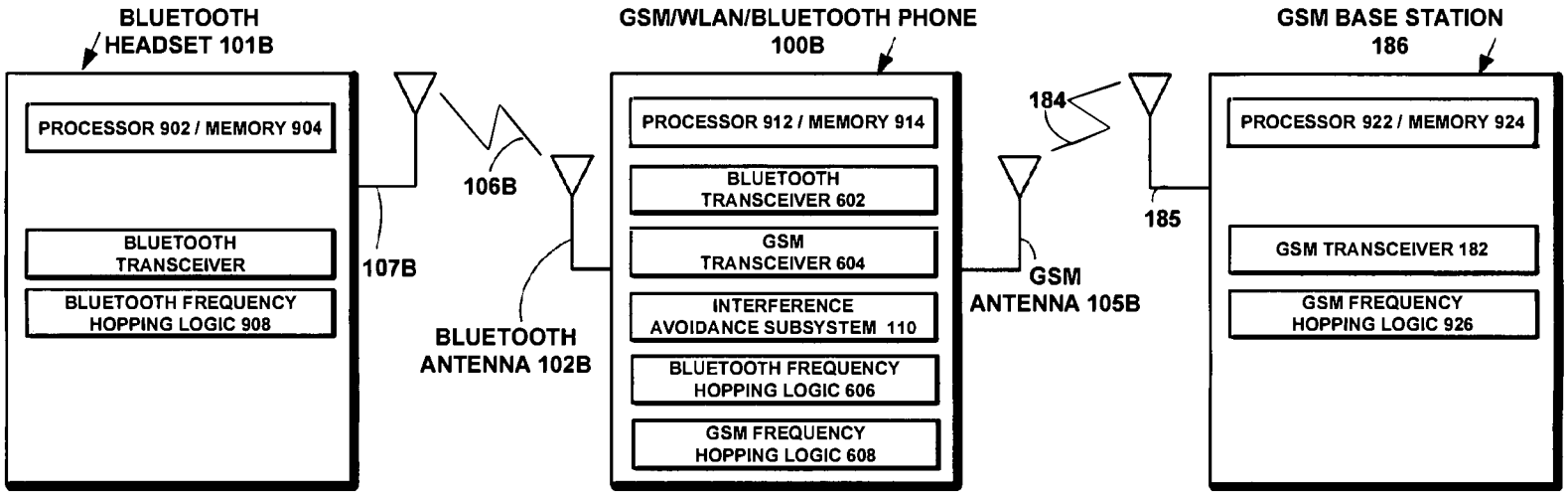

BLUETOOTH HEADSET 101B
PROCESSOR 902 / MEMORY 904
BLUETOOTH TRANSCEIVER
BLUETOOTH FREQUENCY HOPPING LOGIC 908
107B
106B
BLUETOOTH ANTENNA 102B
GSM/WLAN/BLUETOOTH PHONE 100B
PROCESSOR 912 / MEMORY 914
BLUETOOTH TRANSCEIVER 602
GSM TRANSCEIVER 604
INTERFERENCE AVOIDANCE SUBSYSTEM 110
BLUETOOTH FREQUENCY HOPPING LOGIC 606
GSM FREQUENCY HOPPING LOGIC 608
184
GSM ANTENNA 105B
185
GSM BASE STATION 186
PROCESSOR 922 / MEMORY 924
GSM TRANSCEIVER 182
GSM FREQUENCY HOPPING LOGIC 926

FIG. 4

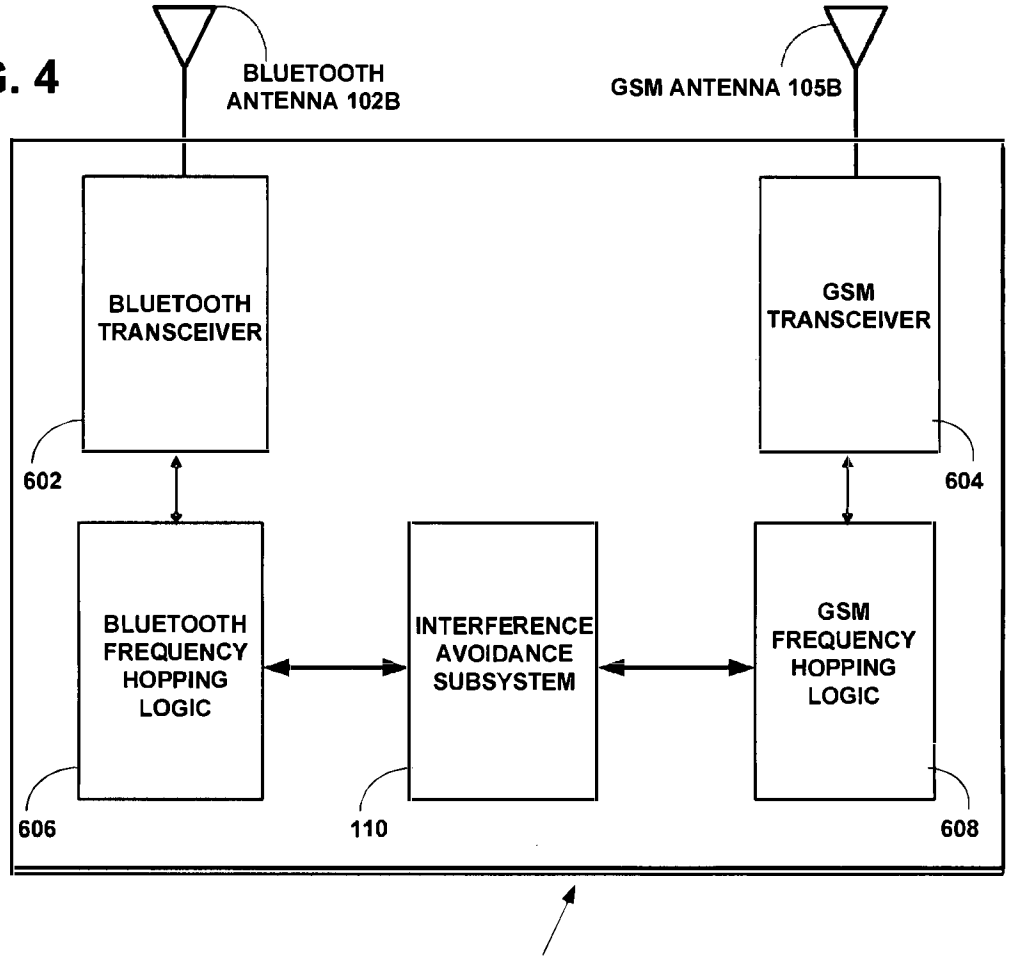
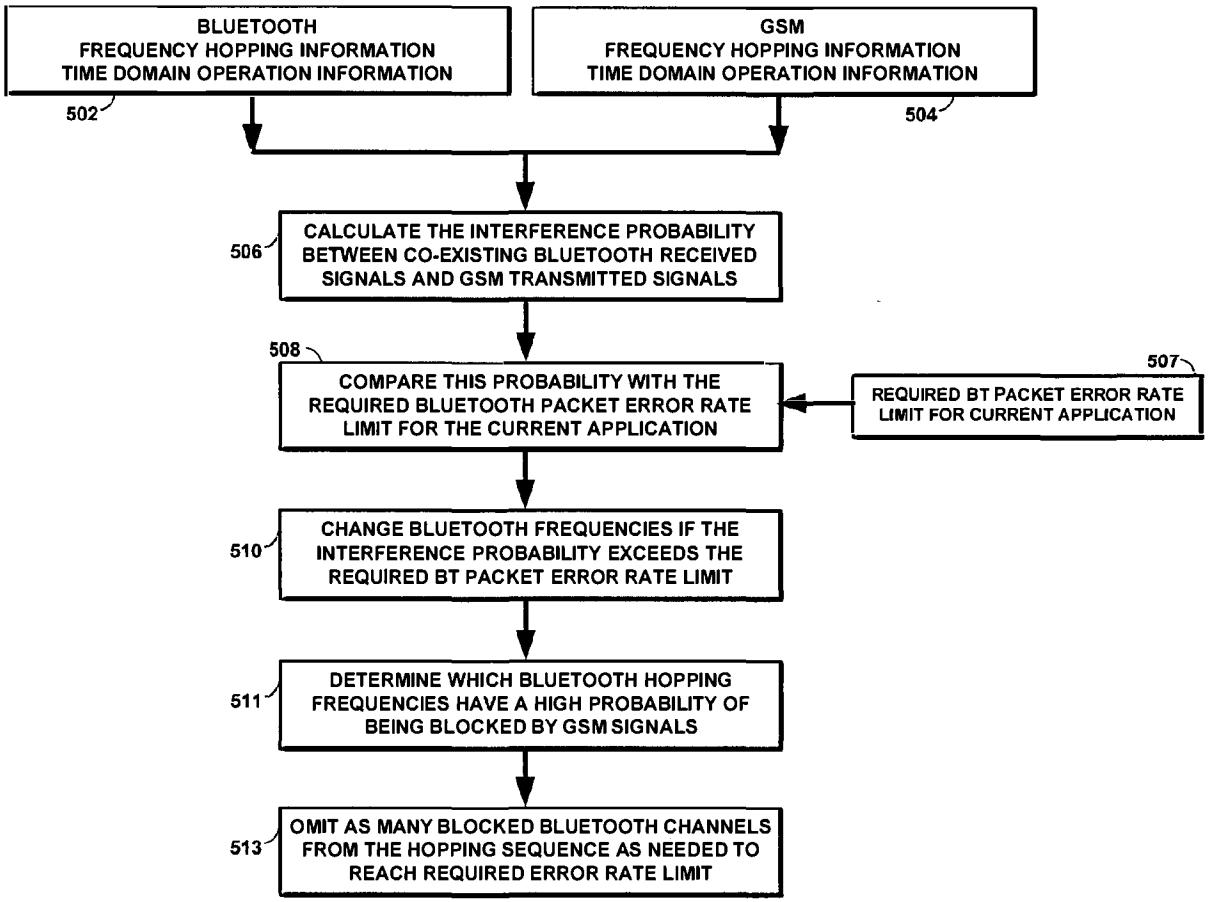

BLUETOOTH ANTENNA 102B
GSM ANTENNA 105B
BLUETOOTH TRANSCEIVER
GSM TRANSCEIVER
602
604
BLUETOOTH FREQUENCY HOPPING LOGIC
INTERFERENCE AVOIDANCE SUBSYSTEM
GSM FREQUENCY HOPPING LOGIC
606
110
608
GSM/WLAN/BLUETOOTH PHONE 100B

FIG. 5


BLUETOOTH
FREQUENCY HOPPING INFORMATION
TIME DOMAIN OPERATION INFORMATION
502
GSM
FREQUENCY HOPPING INFORMATION
TIME DOMAIN OPERATION INFORMATION
504
506
CALCULATE THE INTERFERENCE PROBABILITY BETWEEN CO-EXISTING BLUETOOTH RECEIVED SIGNALS AND GSM TRANSMITTED SIGNALS
508
COMPARE THIS PROBABILITY WITH THE REQUIRED BLUETOOTH PACKET ERROR RATE LIMIT FOR THE CURRENT APPLICATION
507
REQUIRED BT PACKET ERROR RATE LIMIT FOR CURRENT APPLICATION
510
CHANGE BLUETOOTH FREQUENCIES IF THE INTERFERENCE PROBABILITY EXCEEDS THE REQUIRED BT PACKET ERROR RATE LIMIT
511
DETERMINE WHICH BLUETOOTH HOPPING FREQUENCIES HAVE A HIGH PROBABILITY OF BEING BLOCKED BY GSM SIGNALS
513
OMIT AS MANY BLOCKED BLUETOOTH CHANNELS FROM THE HOPPING SEQUENCE AS NEEDED TO REACH REQUIRED ERROR RATE LIMIT

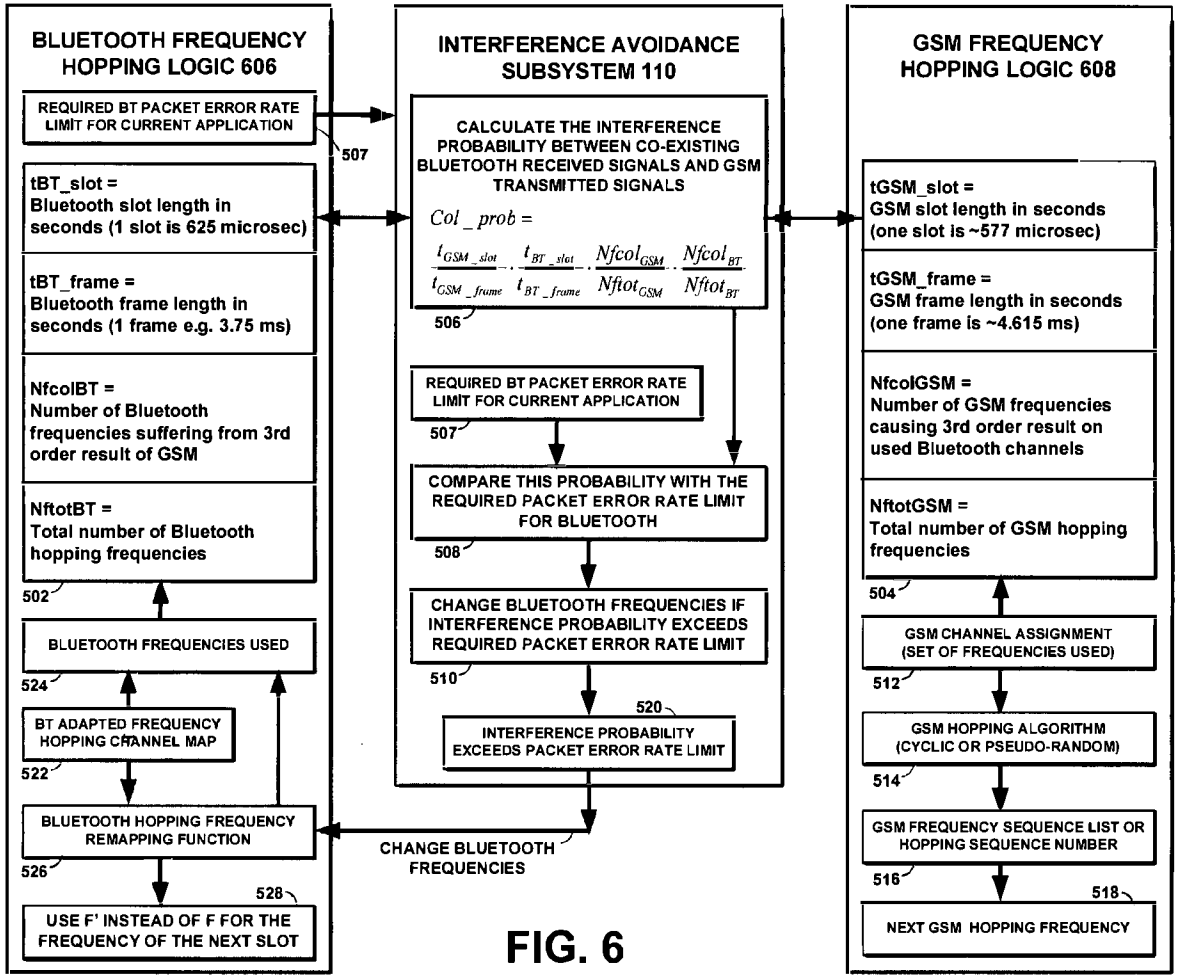

BLUETOOTH FREQUENCY HOPPING LOGIC 606
REQUIRED BT PACKET ERROR RATE LIMIT FOR CURRENT APPLICATION
507
tBT_slot = Bluetooth slot length in seconds (1 slot is 625 microsec)
tBT_frame = Bluetooth frame length in seconds (1 frame e.g. 3.75 ms)
NfcolBT = Number of Bluetooth frequencies suffering from 3rd order result of GSM
NftotBT = Total number of Bluetooth hopping frequencies
502
BLUETOOTH FREQUENCIES USED
524
BT ADAPTED FREQUENCY HOPPING CHANNEL MAP
522
BLUETOOTH HOPPING FREQUENCY REMAPPING FUNCTION
526
528
USE F' INSTEAD OF F FOR THE FREQUENCY OF THE NEXT SLOT
INTERFERENCE AVOIDANCE SUBSYSTEM 110
CALCULATE THE INTERFERENCE PROBABILITY BETWEEN CO-EXISTING BLUETOOTH RECEIVED SIGNALS AND GSM TRANSMITTED SIGNALS
$Col\_prob = \frac{t_{GSM\_slot}}{t_{GSM\_frame}} \cdot \frac{t_{BT\_slot}}{t_{BT\_frame}} \cdot \frac{Nfcol_{GSM}}{Nftot_{GSM}} \cdot \frac{Nfcol_{BT}}{Nftot_{BT}}$
506
REQUIRED BT PACKET ERROR RATE LIMIT FOR CURRENT APPLICATION
507
COMPARE THIS PROBABILITY WITH THE REQUIRED PACKET ERROR RATE LIMIT FOR BLUETOOTH
508
CHANGE BLUETOOTH FREQUENCIES IF INTERFERENCE PROBABILITY EXCEEDS REQUIRED PACKET ERROR RATE LIMIT
510
520
INTERFERENCE PROBABILITY EXCEEDS PACKET ERROR RATE LIMIT
CHANGE BLUETOOTH FREQUENCIES
GSM FREQUENCY HOPPING LOGIC 608
tGSM_slot = GSM slot length in seconds (one slot is ~577 microsec)
tGSM_frame = GSM frame length in seconds (one frame is ~4.615 ms)
NfcolGSM = Number of GSM frequencies causing 3rd order result on used Bluetooth channels
NftotGSM = Total number of GSM hopping frequencies
504
GSM CHANNEL ASSIGNMENT (SET OF FREQUENCIES USED)
512
GSM HOPPING ALGORITHM (CYCLIC OR PSEUDO-RANDOM)
514
GSM FREQUENCY SEQUENCE LIST OR HOPPING SEQUENCE NUMBER
516
518
NEXT GSM HOPPING FREQUENCY

FIG. 6

FIG. 7A

GSM:				
TX slots	1	2	3	4
Slot length	577	1154	1731	2308
Frame length	4615	4615	4615	4615
Hopping freqs	25	25	25	25
Collision freqs	19	19	19	19

BT:				
RX slots	1	2	3	4
Slot length	625	1250	1875	2500
Frame length	3750	3750	3750	3750
Hopping freqs	20	20	20	20
Collision freqs	10	10	10	10

Number of	GSM TX slots			
BT RX slots	1	2	3	4
1	0.792%	1.584%	2.376%	3.167%
2	1.584%	3.167%	4.751%	6.335%
3	2.376%	4.751%	7.127%	9.502%
4	3.167%	6.335%	9.502%	12.669%

FIG. 7B

BT:				
RX slots	1	2	3	4
Slot length	625	1250	1875	2500
Frame length	3750	3750	3750	3750
Hopping freqs	40	40	40	40
Collision freqs	10	10	10	10

	GSM TX slots			
BT RX slots	1	2	3	4
1	0.396%	0.792%	1.188%	1.584%
2	0.792%	1.584%	2.376%	3.167%
3	1.188%	2.376%	3.563%	4.751%
4	1.584%	3.167%	4.751%	6.335%

FIG. 7C

BT:				
RX slots	1	2	3	4
Slot length	625	1250	1875	2500
Frame length	3750	3750	3750	3750
Hopping freqs	79	79	79	79
Collision freqs	10	10	10	10

	GSM TX slots			
BT RX slots	1	2	3	4
1	0.200%	0.401%	0.601%	0.802%
2	0.401%	0.802%	1.203%	1.604%
3	0.601%	1.203%	1.804%	2.406%
4	0.802%	1.604%	2.406%	3.207%

FIG. 7D

FIG. 8A

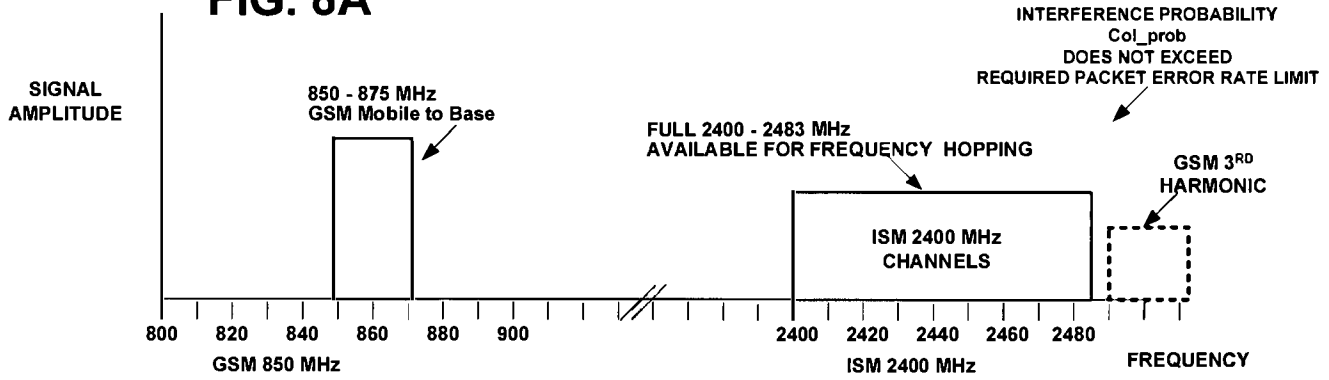

SIGNAL AMPLITUDE
850 - 875 MHz GSM Mobile to Base
INTERFERENCE PROBABILITY Col_prob DOES NOT EXCEED REQUIRED PACKET ERROR RATE LIMIT
FULL 2400 - 2483 MHz AVAILABLE FOR FREQUENCY HOPPING
GSM 3RD HARMONIC
ISM 2400 MHz CHANNELS
800 820 840 860 880 900
2400 2420 2440 2460 2480
GSM 850 MHz
ISM 2400 MHz
FREQUENCY

FIG. 8B

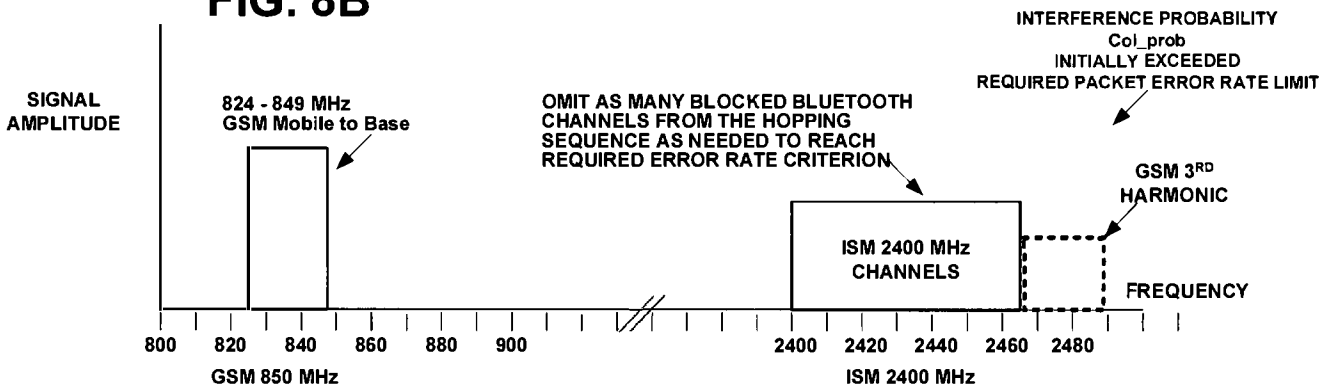

SIGNAL AMPLITUDE
824 - 849 MHz GSM Mobile to Base
INTERFERENCE PROBABILITY Col_prob INITIALLY EXCEEDED REQUIRED PACKET ERROR RATE LIMIT
OMIT AS MANY BLOCKED BLUETOOTH CHANNELS FROM THE HOPPING SEQUENCE AS NEEDED TO REACH REQUIRED ERROR RATE CRITERION
GSM 3RD HARMONIC
ISM 2400 MHz CHANNELS
FREQUENCY
800 820 840 860 880 900
2400 2420 2440 2460 2480
GSM 850 MHz
ISM 2400 MHz

FIG. 9

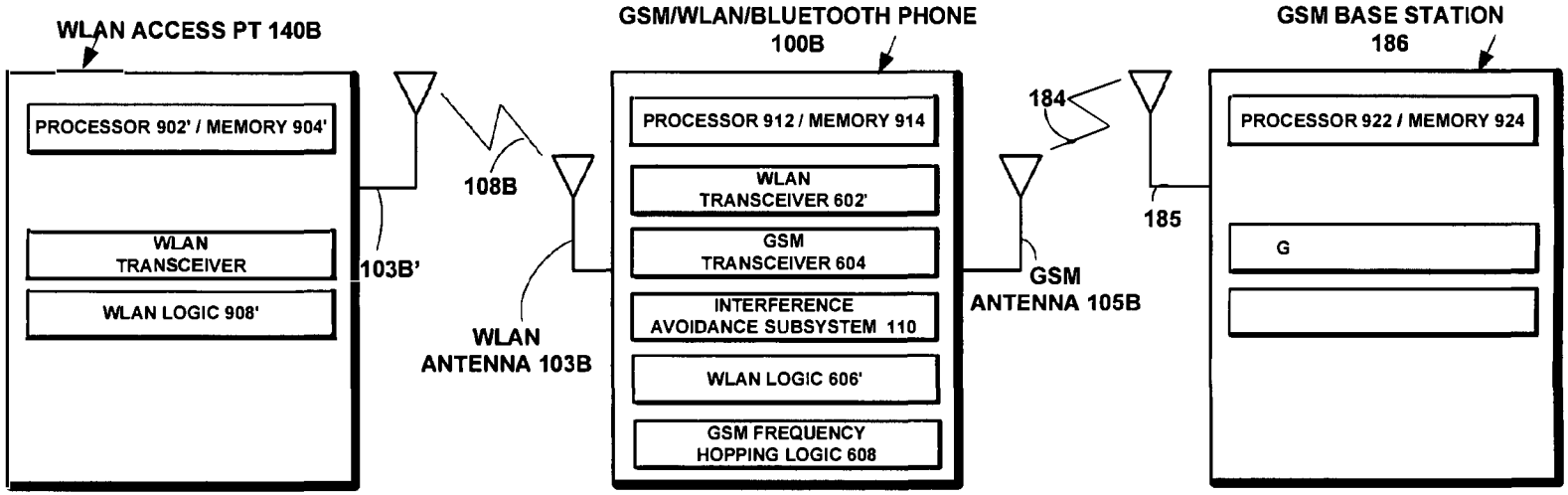

WLAN ACCESS PT 140B
PROCESSOR 902' / MEMORY 904'
WLAN TRANSCEIVER
WLAN LOGIC 908'
103B'
108B
WLAN ANTENNA 103B
GSM/WLAN/BLUETOOTH PHONE 100B
PROCESSOR 912 / MEMORY 914
WLAN TRANSCEIVER 602'
GSM TRANSCEIVER 604
INTERFERENCE AVOIDANCE SUBSYSTEM 110
WLAN LOGIC 606'
GSM FREQUENCY HOPPING LOGIC 608
184
GSM ANTENNA 105B
185
GSM BASE STATION 186
PROCESSOR 922 / MEMORY 924
G

FIG. 10

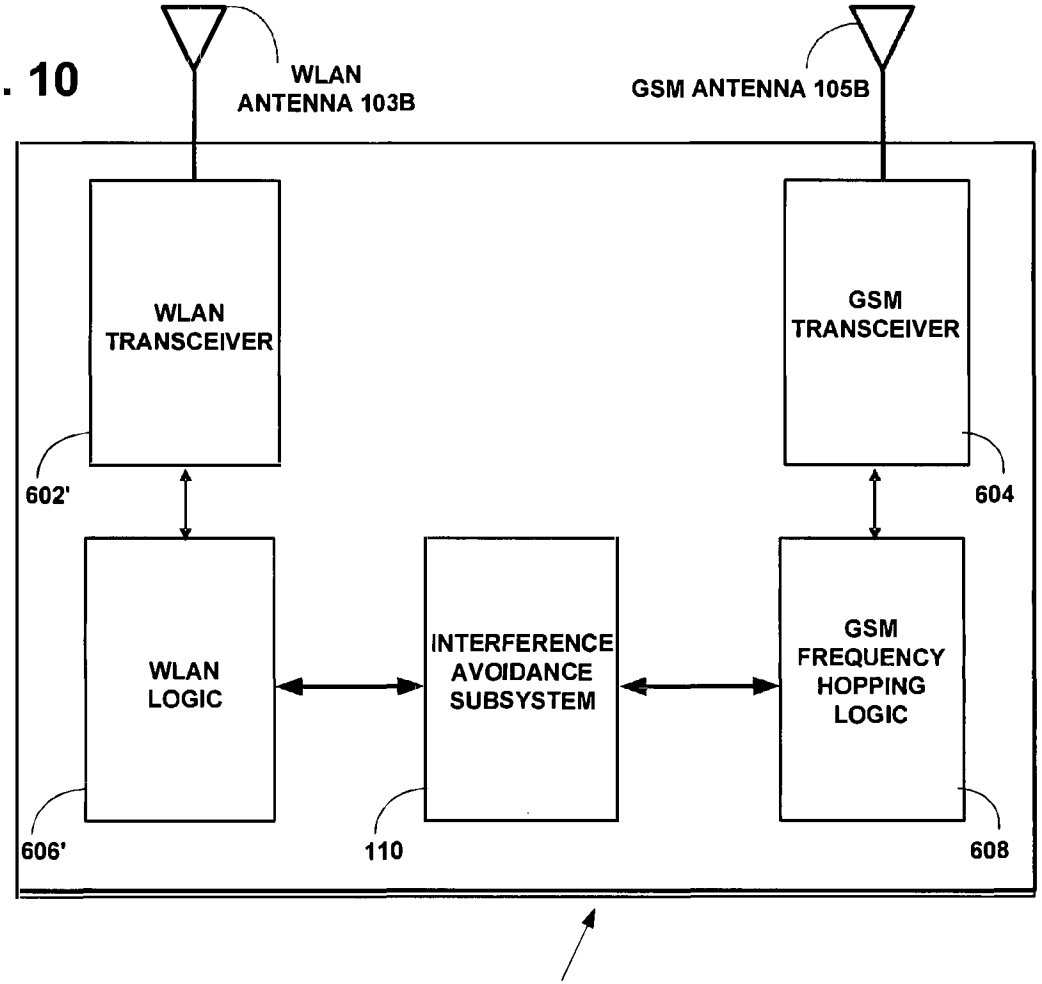

WLAN
ANTENNA 103B
GSM ANTENNA 105B
WLAN
TRANSCEIVER
GSM
TRANSCEIVER
602'
604
WLAN
LOGIC
INTERFERENCE
AVOIDANCE
SUBSYSTEM
GSM
FREQUENCY
HOPPING
LOGIC
606'
110
608
GSM/WLAN/BLUETOOTH PHONE 100B

FIG. 11

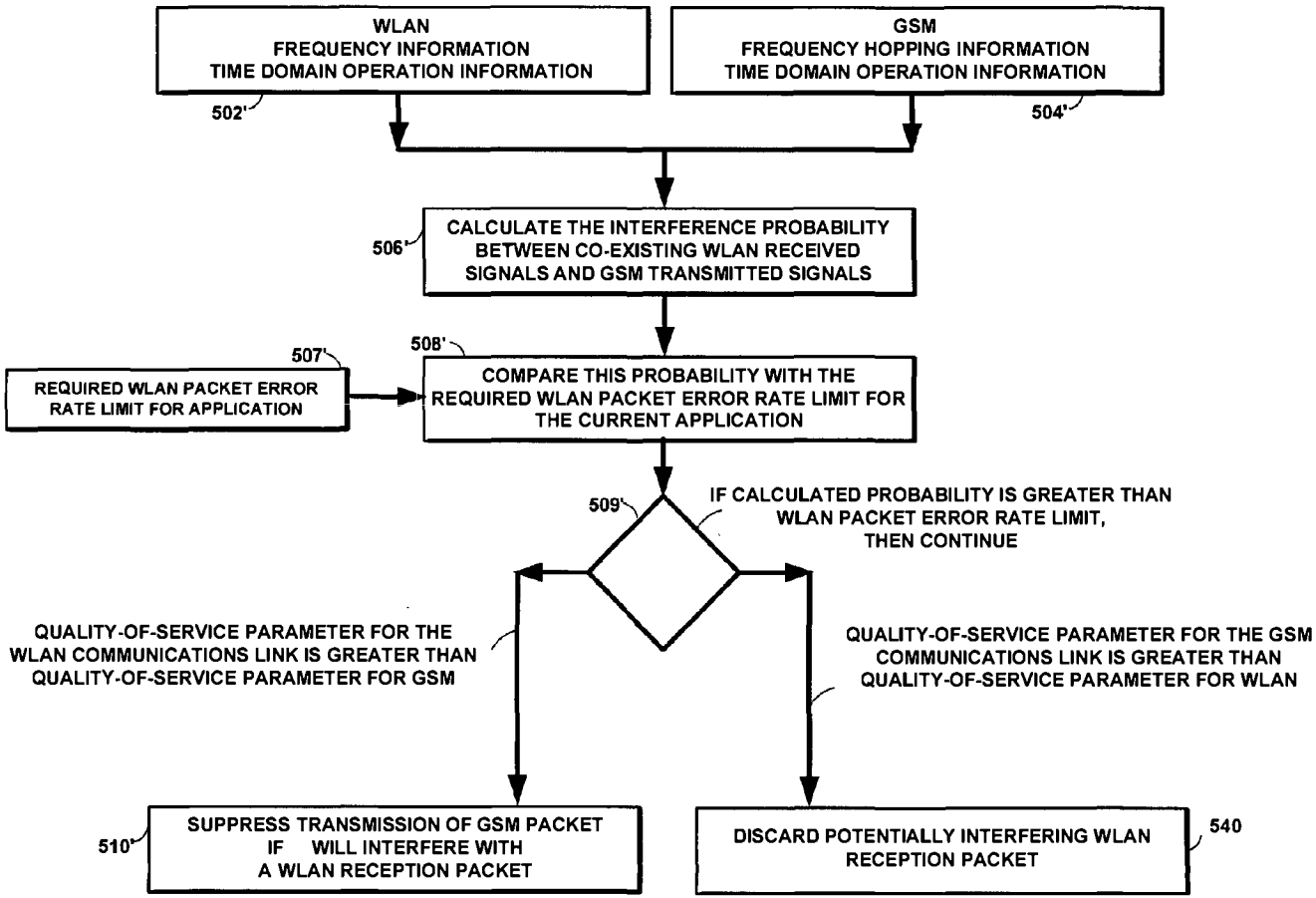

WLAN
FREQUENCY INFORMATION
TIME DOMAIN OPERATION INFORMATION
502'
GSM
FREQUENCY HOPPING INFORMATION
TIME DOMAIN OPERATION INFORMATION
504'
506'
CALCULATE THE INTERFERENCE PROBABILITY BETWEEN CO-EXISTING WLAN RECEIVED SIGNALS AND GSM TRANSMITTED SIGNALS
507'
REQUIRED WLAN PACKET ERROR RATE LIMIT FOR APPLICATION
508'
COMPARE THIS PROBABILITY WITH THE REQUIRED WLAN PACKET ERROR RATE LIMIT FOR THE CURRENT APPLICATION
509'
IF CALCULATED PROBABILITY IS GREATER THAN WLAN PACKET ERROR RATE LIMIT, THEN CONTINUE
QUALITY-OF-SERVICE PARAMETER FOR THE WLAN COMMUNICATIONS LINK IS GREATER THAN QUALITY-OF-SERVICE PARAMETER FOR GSM
QUALITY-OF-SERVICE PARAMETER FOR THE GSM COMMUNICATIONS LINK IS GREATER THAN QUALITY-OF-SERVICE PARAMETER FOR WLAN
510'
SUPPRESS TRANSMISSION OF GSM PACKET IF WILL INTERFERE WITH A WLAN RECEPTION PACKET
DISCARD POTENTIALLY INTERFERING WLAN RECEPTION PACKET
540

FIG. 12A

GSM:				
TX slots	1	2	3	4
Slot length	577	1154	1731	2308
Frame length	4615	4615	4615	4615
Hopping freqs	25	25	25	25
Collision freqs	19	19	19	19

WLAN:				
RX slots	1	2	3	4
Slot length	200	300	400	500
Frame length	20000	20000	20000	20000
Hopping freqs	1	1	1	1
Collision freqs	1	1	1	1

	GSM TX slots			
WLAN RX length [us]	1	2	3	4
200	0.095%	0.190%	0.285%	0.380%
300	0.143%	0.285%	0.428%	0.570%
400	0.190%	0.380%	0.570%	0.760%
500	0.238%	0.475%	0.713%	0.950%

FIG. 12B

METHOD FOR AVOIDING INTERFERENCE FROM A CELLULAR TRANSMITTER TO THE 2.4/5GHZ ISM BAND

FIELD OF THE INVENTION

[0001] The invention disclosed broadly relates to improvements in mobile terminals having combined functions of cellular telephone with Wireless LAN and/or Bluetooth interfaces, for reducing interference in simultaneous signal handling of cellular telephone and either WLAN or Bluetooth signals.

BACKGROUND OF THE INVENTION

[0002] The GSM (Global System for Mobile Communications) System

[0003] GSM-900 and GSM-1800 are used in most of the world. GSM-900 uses 890-915 MHz to send information from the Mobile Station to the Base Transceiver Station (uplink) and 935 -960 MHz for the other direction (downlink), providing 124 RF channels spaced at 200 kHz. Duplex spacing of 45 MHz is used. GSM-1800 uses 1710 -1785 MHz to send information from the Mobile Station to the Base Transceiver Station (uplink) and 1805 -1880 MHz for the other direction (downlink), providing 299 channels. Duplex spacing is 95 MHz. GSM-1800 is also called PCS in Hong Kong and the United Kingdom.

[0004] GSM-850 and GSM-1900 are used in the United States, Canada, and many other countries in the Americas. GSM-850 is also sometimes called GSM-800. GSM-850 uses 824-849 MHz to send information from the Mobile Station to the Base Transceiver Station (uplink) and 869 -894 MHz for the other direction (downlink). GSM-1900 uses 1850 -1910 MHz to send information from the Mobile Station to the Base Transceiver Station (uplink) and 1930-1990 MHz for the other direction (downlink). Despite the close number, GSM 850 is not compatible with GSM 900; a phone that only has GSM 850 cannot work on a GSM 900 network, and vice-versa.

GSM Frequency Hopping

[0005] A GSM base station and its GSM mobile stations in a cell average their signal propagation characteristics over all the available frequencies of the cell by employing slow frequency hopping (SFH). In SFH, the operating frequency is changed only with every TDMA frame. The hopping rate is one hop per TDMA frame (4.6 millisecond) or 217 hops per second. The frequency change in SFH can be handled by the synthesizers in the GSM mobile station, which are also required to alter their operating frequency even more often than once per TDMA frame to enable them to monitor adjacent cells, as well as perform frequency hopping.

[0006] Frequency hopping is an option for the GSM base station in each individual cell. However, a GSM mobile station is required to switch to a frequency-hopping mode when its GSM base station tells it to do so. Originally, the GSM system was designed so that the mobile would perform the frequency hopping operation when the channel became marginal, such as when it moved toward the edge of a cell or as it entered an area of high interference. Currently, GSM networks utilize frequency hopping all the time, not only in the case of interference. The GSM base station controller assigns to the mobile a full set of RF channels rather than a single RF channel. The GSM mobile performs the frequency hopping operation on the assigned set of frequencies to satisfy the command from the base station.

[0007] Different hopping algorithms can be assigned to the GSM mobile station with the channel set. One is cyclic hopping, in which hopping is performed through the assigned frequency list from the first frequency, the second frequency, the third, and so on until the list is repeated. The other general algorithm is (pseudo) random hopping, in which hopping is performed in a random way through the frequency list. There are 63 different random hopping sequences that can be assigned to the GSM mobile. When the GSM base station requires the mobile station to assume SFH operation, the GSM mobile station is advised of the channel assignment (a set of channels) and which one of the hopping algorithms it should use with an appropriate frequency-hopping sequence number (HSN).

The Unlicensed 2.4 GHz ISM Band

[0008] The two methods for radio frequency modulation in the unlicensed 2.4 GHz ISM band are frequency-hopping spread spectrum (FHSS) and direct-sequence spread spectrum (DSSS). Bluetooth uses FHSS while Wireless LAN 802.11b/g/a (commonly known as Wi-Fi) use DSSS/OFDM. All of these technologies operate in the ISM frequency band (2.400 to 2.483 GHz), which is available worldwide.

[0009] Bluetooth

[0010] The best-known example of wireless personal area network (PAN) technology is the Bluetooth Standard, which operates in the 2.4 GHz ISM band. 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, *Bluetooth Specification Including Core*, Volume 1.2, Nov. 5, 2003, (hereinafter "Bluetooth 1.2 Specification") describes the principles of Bluetooth device operation and includes a description of adaptive frequency hopping. *Specification of the Bluetooth Systemy, Covered Core Package*, version: 2.0+EDR, issued 4 Nov. 2004 (hereinafter "Bluetooth 2.0 Specification") further describes the principles of Bluetooth device operation and includes a further description of adaptive frequency hopping. Bluetooth Specifications are available from the Bluetooth Special Interest Group at the web site www.bluetooth.com. Bluetooth devices are designed to find other Bluetooth devices and access points within their ten meter radio communications range.

[0011] Bluetooth operates in the ISM frequency band starting at 2.402 GHz and ending at 2.483 GHz in the USA, and Europe. There are 79 RF channels of 1 MHz width defined. The air interface is based on an antenna power of 1 mW (0 dBi gain). The signal is modulated using binary Gaussian Frequency Shift Keying (GFSK). The raw data rate is defined at 1 Mbits/s. A Time Division Multiplexing (TDM) technique divides the channel into 625 microsecond slots. Transmission occurs in packets that occupy an odd number of slots (up to 5). Each packet is transmitted on a different hop frequency with a maximum frequency hopping rate of 1600 hops/s.

[0012] Two or more units communicating on the same channel form a piconet, where one unit operates as a master and the others (a maximum of seven active at the same time) act as slaves. A channel is defined as a unique pseudo-

random frequency hopping sequence derived from the master device's 48-bit address BD_ADDR and its Bluetooth clock value. Slaves in the piconet synchronize their timing and frequency hopping to the master upon connection establishment. In the connection mode, the master controls the access to the channel using a polling scheme where master and slave transmissions alternate. A slave packet always follows a master packet transmission

[0013] Bluetooth Frequency Hopping

[0014] Adaptive frequency hopping is a new feature introduced in the Bluetooth Core Specification 1.2, Section 2.The adapted piconet physical channel are uses at least 20 RF channels. Adapted piconet physical channels can be used for connected devices that have adaptive frequency hopping (AFH) enabled. There are two distinctions between basic and adapted piconet physical channels. The first is that the same channel mechanism that makes the slave frequency the same as the preceding master transmission. The second aspect is that the adapted piconet physical channel may be based on less than the full 79 frequencies of the basic piconet physical channel. Bluetooth devices use a hopping kernel that controls an adapted set of hop locations used by adaptive frequency hopping (AFH). The basic, legacy channel hopping sequence which has a very long period length, which does not show repetitive patterns over a short time interval, and which distributes the hop frequencies equally over the 79 MHz during a short time interval. An adapted channel hopping sequence is derived from the basic channel hopping sequence which uses the same channel mechanism and may use fewer than 79 frequencies. The adapted channel hopping sequence is only used in place of the basic channel hopping sequence, not the hopping sequences for inquiry or paging functions. When the adapted channel hopping sequence is selected, the AFH_channel_map is an input to the frequency selection. The AFH_channel_map indicates which channels are used and which are unused. The output, RF channel index, constitutes a pseudo-random sequence. The RF channel index is mapped to RF channel frequencies The selection scheme chooses a segment of 32 hop frequencies spanning about 64 MHz and visits these hops in a pseudo-random order. Next, a different 32-hop segment is chosen, etc. When the basic channel hopping sequence is selected, the output constitutes a pseudo-random sequence that slides through the 79 hops. The RF frequency remains fixed for the duration of the packet. The RF frequency for the packet is derived from the Bluetooth clock value in the first slot of the packet. When the adapted channel hopping sequence is used, the pseudo-random sequence contains only frequencies that are in the RF channel set defined by the AFH_channel_map input. The adapted sequence has similar statistical properties to the non-adapted hop sequence. In addition, the slave responds with its packet on the same RF channel that was used by the master to address that slave. Thus, the RF channel used for the master to slave packet is also used for the immediately following slave to master packet. The output addresses a bank of 79 registers loaded with the synthesizer code words corresponding to the hop frequencies 0 to 78.The adapted hop selection kernel is based on the basic hop selection kernel. The inputs to the adapted hop selection kernel are the same as for the basic hop system kernel except that the input AFH_channel_map is used. The AFH_channel_map indicates which RF channels are used and which are unused. When hop sequence adaptation is enabled, the number of used RF channels may be reduced from 79 to some smaller value N. All devices are capable of operating on an adapted hop sequence (AHS) with $20 \leq N \leq 79$, with any combination of used RF channels within the AFH_channel_map that meets this constraint. Adaptation of the hopping sequence is achieved through two additions to the basic channel hopping sequence. Unused RF channels are re-mapped uniformly onto used RF channels. That is, if the hop selection kernel of the basic system generates an unused RF channel, an alternative RF channel out of the set of used RF channels is selected pseudo-randomly. The used RF channel generated for the master-to-slave packet is also used for the immediately following slave-to-master packet. When the adapted hop selection kernel is selected, the basic hop selection kernel is initially used to determine an RF channel. If this RF channel is unused according to the AFH_channel_map, the unused RF channel is re-mapped by the re-mapping function to one of the used RF channels. If the RF channel determined by the basic hop selection kernel is already in the set of used RF channels, no adjustment is made. The hop sequence of the (non-adapted) basic hop equals the sequence of the adapted selection kernel on all locations where used RF channels are generated by the basic hop. This property facilitates non-AFH slaves remaining synchronized while other slaves in the piconet are using the adapted hopping sequence. The re-mapping function is a post-processing step to the selection kernel. The output of the basic hop selection kernel is an RF channel number that ranges between 0 and 78.This RF channel will either be in the set of used RF channels or in the set of unused RF channels. When an unused RF channel is generated by the basic hop selection mechanism, it is re-mapped to the set of used RF channels. The index is then used to select the re-mapped channel from a mapping table that contains all of the even used RF channels in ascending order followed by all the odd used RF channels in ascending order. In the basic and adapted channel hopping sequences, the clock bits to use in the basic or adapted hopping sequence generation are always derived from the master clock, CLK. The address bits are derived from the Bluetooth device address of the master.

[0015] IEEE 802.11 Wireless LAN Standard

[0016] Wireless local area networks (WLAN) cover a larger radio communications range of up to one hundred meters. Examples of wireless local area network technology include the IEEE 802.11 Wireless LAN Standard, which also operates in the 2.4 GHz ISM band. The IEEE 802.11 Wireless LAN Standard is published in three parts as IEEE 802.11-1999; IEEE 802.11a-1999; and IEEE 802.11b-1999, which are available from the IEEE, Inc. web site http://grouper.ieee.org/groups/802/11.

[0017] The IEEE 802.11 standard calls for four different PHY specifications: frequency hopping (FH) spread spectrum, direct sequence (DS) spread spectrum, infrared (IR), and orthogonal frequency division multiplex (OFDM). The transmit power for DS and FH devices is defined at a maximum of 1 W and the receiver sensitivity is set to −80 dBm. Antenna gain is limited to 6 dBi maximum. Under FH, each station's signal hops from one modulating frequency to another in a predetermined pseudo-random sequence. Both transmitting and receiving stations are synchronized and follow the same frequency sequence. There are 79 channels defined in the (2.4000 -2.4835) GHz region spaced 1 MHz apart. The time each radio dwells on each frequency depends

on each individual implementation and government regulation. The basic access rates of 1 and 2 Mbits/s use multilevel Gaussian frequency shift keying (GFSK).

[0018] The IEEE 802.11 b specification sets up 11 channels within the 2.4-GHz band, centered between 2.412 and 2.462 GHz. Although the IEEE 802.11 standard includes a frequency hopping (FH) spread spectrum protocol, it is typically applied using only a single channel frequency.

[0019] Combined Cellular Telephone, an Integrated WLAN 802.11b, and a Bluetooth

[0020] The newest mobile telephones and personal digital assistants combine a cellular telephone, an Integrated WLAN 802.11b, and a Bluetooth personal area network functionality into a single, portable package. A problem is that the cellular transmission at the Cell band's lowest 3.5 MHz frequency block (824-827 MHz) causes a 3rd order harmonic to result on top of the uppermost frequencies of the 2.4 GHz ISM band. GSM transmissions, for instance, are blocking the 10 MHz frequency block (2470-2480 MHz) at the top end of the ISM band. This ISM band is used in terminals for both Bluetooth and WLAN radio transmission and reception. Similarly, GSM1800/PCS1900 transmissions in the USA, create a 3rd harmonic signal that blocks 5 GHz ISM band reception (WLAN, 802.11a).

[0021] The ISM band utilization is heavily increasing. The new services like VoWLAN, (voice over WLAN) are utilizing the same frequencies as Bluetooth and, for example, microwave ovens. In addition, the WLAN and Bluetooth usage scenarios are typically sharing the same physical location (such as an office environment). The problem is that the available unregulated frequencies at 2.4 GHz are running out. There is currently a 79 MHz allocation out of which each WLAN access point is utilizing 20 MHz slice. Bluetooth adaptive frequency hopping requires at least 20 times a 1 MHz channel to operate. The prior art solution is continuously losing approximately 13% of Bluetooth channel capacity by restricting the usage of the 10 uppermost channels, even though the collision probability is low or nil. Another problem arises with certain WLAN protocols, where no frequency hopping is utilized. The cellular telephone transmitters are interfering with both the 2.4 GHz and 5 GHz WLAN operation.

[0022] Currently the situation is handled in the case of Bluetooth, by totally restricting the usage of the ten uppermost channels in case of the GSM850 signal being present in the same product. The ten uppermost Bluetooth frequencies are blocked without any check as to whether there is actually an interfering GSM signal present. The blocking of Bluetooth frequencies is based on the adaptive frequency hopping utilized in Bluetooth to avoid interference, such as from the 3rd harmonic of GSM signals or the co-existence with WLAN signals. There are other prior art solutions where the frequency hopping is controlled to use bad channels for less critical packets and good channels for critical packets, requiring a complex decision logic.

[0023] What is needed in the art is an improved method to reduce interference in simultaneous GSM cellular, WLAN and/or Bluetooth signal handling in a combined communications package.

SUMMARY OF THE INVENTION

[0024] A method, terminal, and computer program are disclosed for a wireless communications device having a combination of a wireless telephone unit, such as a GSM cellular phone, and a short range wireless communications unit, such as a WLAN communications unit or a Bluetooth communications unit. The wireless telephone unit and Bluetooth communications unit use frequency hopping spread spectrum techniques to reduce interference from extraneous radio sources. The WLAN communications unit typically uses only a single channel frequency out of several available channels. Since the units are in close proximity to one-another in the wireless communications device, mutual radio interference can occur, either by the direct overlapping of the spectra of the wireless telephone unit with the short range wireless communications unit or by overlapping of the harmonic frequencies of one unit with the spectrum of the other unit.

[0025] This problem is solved in one embodiment of the invention by an interference avoidance subsystem in the wireless communications device, which is connected between the wireless telephone unit's frequency hopping logic and the short range wireless communications unit's logic. Frequency information and time domain operation information are input from the short range wireless communications unit logic to the interference avoidance subsystem. Frequency hopping information and time domain operation information are input from the wireless telephone unit's frequency hopping logic to the interference avoidance subsystem. The interference avoidance subsystem then uses this input data to calculate the interference probability between co-existing signals received by the short range wireless communications unit and signals transmitted from the wireless telephone unit. The interference avoidance subsystem then compares the calculated interference probability with the required error rate limit for the short range wireless communications unit. If the interference probability exceeds the required error rate limit, the interference avoidance subsystem sends a signal to either the short range wireless communications unit or to the wireless telephone unit to make a change to one of the co-existing signals.

[0026] One example that is addressed by the invention is the combination of a Bluetooth communications unit and a GSM cellular telephone unit in the wireless communications device. In the lower end of the GSM frequency spectrum, the third harmonic frequency of the range of 824-849 MHz for a GSM Mobile to Base transmission overlaps up to ten of the highest frequency Bluetooth channels in the ISM frequency spectrum of 2400-2483 MHz. Since the transmitted GSM telephone signals are stronger than received Bluetooth signals, interference occurs when the GSM signals frequency hop in the lower end of the GSM frequency spectrum and are transmitted while Bluetooth signals frequency hop and are received in the ten highest frequency channels in the ISM frequency spectrum.

[0027] This problem is solved in one embodiment of the invention by an interference avoidance subsystem in the wireless communications device, which is connected between the GSM frequency hopping logic and the Bluetooth frequency hopping logic. Bluetooth frequency hopping information and time domain operation information are input from the Bluetooth frequency hopping logic to the interference avoidance subsystem. GSM frequency hopping information and time domain operation information are input from the GSM frequency hopping logic to the interference avoidance subsystem. The interference avoidance

subsystem then uses this input data to calculate the interference probability between co-existing Bluetooth received signals and GSM transmitted signals. The interference avoidance subsystem then compares the calculated interference probability with the required Bluetooth packet error rate limit for the current application. If the interference probability exceeds the required Bluetooth packet error rate limit, the interference avoidance subsystem sends a signal to the Bluetooth frequency hopping logic to change the Bluetooth frequencies. The interference avoidance subsystem calculates the probability of interference a priori. The interference avoidance subsystem uses this principle to limit the Bluetooth hopping frequencies by determining which channels are blocked by the GSM harmonics and then omitting as many of the blocked Bluetooth channels from the hopping sequence as needed to reach the required error rate criterion.

[0028] In another embodiment of the invention, the interference avoidance subsystem performs a loop to progressively remove the top frequency Bluetooth channels and to recalculate the interference probability until the magnitude of the interference probability is sufficiently reduced so as to not exceed the required error rate limit.

[0029] Another example that is addressed by the invention is the combination of a WLAN communications unit and a GSM cellular telephone unit in the wireless communications device. Although the IEEE 802.11 standard includes a frequency hopping (FH) spread spectrum protocol, it is typically applied using only a single channel frequency selected out a several available channels, so that the WLAN communications link does not engage in frequency hopping. In the case where the WLAN communications unit of the wireless communications device is not operating in a frequency hopping mode, the method of the invention operates, for example, as follows. The interference avoidance subsystem calculates the interference probability between co-existing WLAN received signals and GSM transmitted signals with the WLAN hopping frequencies set equal to one. If the calculated interference probability is greater than the predefined error probability or packet error rate limit, then the interference avoidance subsystem signals the WLAN communications unit to discard the WLAN reception packet. This results in the WLAN communications unit not transmitting an acknowledgement packet back to the sender. Typically, the WLAN protocol will then require the sender to retransmit the packet, which most probably will not occur simultaneously with following GSM transmissions and will be correctly received. The number of GSM hopping frequencies used by the interference avoidance subsystem in calculating the interference probability with WLAN signals is similar to that previously discussed above in the case of Bluetooth. The GSM hopping frequencies used in calculating the interference probability the depend on the GSM operator frequency allocation and the number of frequencies in the hopping sequence causing an intermodulation distortion (IMD) result on top of the WLAN reception.

[0030] In another embodiment of the invention, only if the received packet is detected by the WLAN communications unit as being corrupted, will the packet be discarded. If the reception packet detected by the WLAN communications unit is not corrupted, then the received packet may be suspected of containing erroneous data. Optionally, the WLAN communications unit can discard the WLAN reception packet in this case, as well, and force a retransmission of the packet from the sender. In still another embodiment, the WLAN communications unit can direct a received WLAN packet that is suspected of containing erroneous data, into a suspicious-packet-buffer for additional error checking or tagging.

[0031] In another embodiment of the invention where the WLAN communications link does not engage in frequency hopping, interference with a WLAN reception packet is avoided by the interference avoidance subsystem signaling the GSM communications unit to suppress transmission a GSM packet if it will interfere with the WLAN reception packet.

[0032] Further in accordance with another embodiment of the invention, the interference avoidance subsystem can compare a Quality-of-Service parameter for the WLAN communications link with a Quality-of-Service parameter for the GSM link to determine whether potentially interfering WLAN reception packets should be discarded, as opposed to an alternative mode of the interference avoidance subsystem signaling the GSM communications unit to suppress transmission a GSM packet if it will interfere with a WLAN reception packet.

[0033] In another embodiment of the invention, the short range wireless communications unit can input a received signal quality value in the calculation of the interference probability, for signals received by the short range wireless communications unit.

[0034] In another embodiment of the invention, the interference avoidance subsystem can calculate an instant when the interference will occur. In response, the interference avoidance subsystem will change one of the co-existing signals at that instant if the interference probability exceeds the required error rate limit.

[0035] The resulting invention can be applied to interference between the frequency spectra of WLAN communication units such as the IEEE 802.11a, b, and/or g, and GSM cellular telephone units, both of which are in the same wireless communications device. The invention can also be applied to interference between the frequency spectra of WLAN communication units such as the IEEE 802.11a, b, and/or g, and Bluetooth communication units, both of which are in the same wireless communications device.

DESCRIPTION OF THE FIGURES

[0036] FIG. **1** is a network diagram showing a GSM/WLAN/Bluetooth wireless communications device having a combination of a GSM cellular telephone transceiver, a WLAN transceiver, and a Bluetooth transceiver, the wireless communications device being wirelessly connected to a Bluetooth headset, to a WLAN access point, and to a GSM base station, according to an embodiment of the present invention.

[0037] FIG. **2**A is a diagram of the frequency spectrum for a 824-849 MHz GSM Mobile to Base transmission and the overlap of its third harmonic with the frequency spectrum for a 2400-2483 MHz ISM (Bluetooth & 802.11) transmission, according to an embodiment of the present invention.

[0038] FIG. **2**B is a diagram of the frequency spectrum for a 1710-1785 MHz GSM Mobile to Base transmission and

the overlap of its third harmonic with the frequency spectrum for a 5725-5850 MHz ISM (802.11) transmission, according to an embodiment of the present invention.

[0039] FIG. **3** is a network diagram that shows the wireless network relationship of the Bluetooth Headset, the GSM/WLAN/Bluetooth wireless communications device, and the GSM Base Station, according to an embodiment of the present invention.

[0040] FIG. **4** is a functional block diagram of the GSM/WLAN/Bluetooth wireless communications device, including an interference avoidance subsystem connected between a GSM frequency hopping logic and a Bluetooth frequency hopping logic, according to an embodiment of the present invention.

[0041] FIG. **5** is a flow diagram of the operation of the interference avoidance subsystem in the GSM/WLAN/Bluetooth wireless communications device for received Bluetooth signals, according to an embodiment of the present invention.

[0042] FIG. **6** is a more detailed functional block diagram of the GSM/WLAN/Bluetooth wireless communications device, showing how the interference avoidance subsystem interacts with the Bluetooth frequency hopping logic and the GSM frequency hopping logic to carry out the operation of the flow diagram of FIG. **5**, according to an embodiment of the present invention.

[0043] FIGS. **7**A to **7**D are tables showing the calculated interference probability computed by the interference avoidance subsystem for the case where the wireless communications device transmits a GSM signal using a 5 MHz operator frequency allocation (TX: 824-829 MHz) for hopping (25 channels) and the wireless communications device receives Bluetooth signals at various example hopping frequencies (min 20, max 79), according to an embodiment of the present invention.

[0044] FIG. **8**A is a diagram of the frequency spectrum for a 850-875 MHz GSM Mobile to Base transmission, showing that there is no overlap of its third harmonic with the frequency spectrum for signals received in the 2400-2483 MHz ISM (Bluetooth & 802.11) spectrum and thus, in this case, the interference probability computed by the interference avoidance subsystem does not exceed the required Bluetooth packet error rate limit, and therefore the full 2400 to 2483 MHz ISM spectrum is available for Bluetooth frequency hopping, according to an embodiment of the present invention.

[0045] FIG. **8**B is a diagram of the frequency spectrum for a 824-849 MHz GSM Mobile to Base transmission, showing that there is an overlap of its third harmonic with the frequency spectrum for signals received in the 2400-2483 MHz ISM (Bluetooth & 802.11) spectrum and thus, in this overlapped case, the interference probability computed by the interference avoidance subsystem exceeds the required packet error rate limit, and therefore the process shown in the flow diagram of FIG. **5** limits the Bluetooth hopping frequencies by calculating which channels are blocked by the GSM harmonics and then omitting as many of the blocked Bluetooth channels from the hopping sequence as needed to reach the required error rate criterion, according to an embodiment of the present invention.

[0046] FIG. **9** is a network diagram that shows the wireless network relationship of the WLAN access point, the GSM/WLAN/Bluetooth wireless communications device, and the GSM Base Station, according to an embodiment of the present invention.

[0047] FIG. **10** is a functional block diagram of the GSM/WLAN/Bluetooth wireless communications device, including an interference avoidance subsystem connected between a GSM frequency hopping logic and a WLAN frequency hopping logic, according to an embodiment of the present invention.

[0048] FIG. **11** is a flow diagram of the of the operation of the interference avoidance subsystem in the GSM/WLAN/Bluetooth wireless communications device for WLAN received signals without frequency hopping, according to an embodiment of the present invention.

[0049] FIGS. **12**A and **12**B are tables showing the calculated interference probability computed by the interference avoidance subsystem for the case where the wireless communications device transmits a GSM signal using a 5 MHz operator frequency allocation (TX: 824-829 MHz) for hopping (25 channels) and the wireless communications device receives WLAN VoIP signals, according to an embodiment of the present invention.

DISCUSSION OF THE PREFERRED EMBODIMENT

[0050] FIG. **1** is a network diagram showing a GSM/WLAN/Bluetooth wireless communications device **100**B having a combination of a GSM cellular telephone unit, a WLAN communications unit, and a Bluetooth communications unit. The wireless communications device **100**B is wirelessly connected via Bluetooth antenna **102**B to a Bluetooth headset **101**B and its antenna **107**B over wireless path **106**B. The wireless communications device **100**B is wirelessly connected via WLAN antenna **103**B to a WLAN access point **140**B in WLAN coverage area **150**B over wireless path **108**B. The wireless communications device **100**B is wirelessly connected via GSM antenna **105**B to a GSM base station **186** and its antenna **185** over wireless path **184**, according to an embodiment of the present invention. A similar second GSM/WLAN/Bluetooth wireless communications device **100**A is shown wirelessly connected via Bluetooth antenna **102**A to a Bluetooth headset **101**A and its antenna **107**A over wireless path **106**A and connected via WLAN antenna **103**A to a WLAN access point **140**A in WLAN coverage area **150**A over wireless path **108**A. The wireless communications device **100**B in FIG. **1** includes the microbrowser, a key pad, interference avoidance subsystem **110**, and frequency hopping logic. The WLAN access points **140**A and **140**B are connected to the internet **144**, which is connected in turn to the WAP protocol internet gateway **188**, which in turn is connected to the GSM access point **186**.

[0051] FIG. **2**A is a diagram of the frequency spectrum for a 824-849 MHz GSM Mobile to Base transmission and the overlap of its third harmonic with the frequency spectrum for a 2400-2483 MHz ISM (Bluetooth & **802.11**) transmission, according to an embodiment of the present invention. The combination of a Bluetooth communications unit and a GSM cellular telephone unit in the wireless communications device can create radio interference in certain frequency hopping combinations. In the lower end of the GSM fre-

quency spectrum, the third harmonic frequency of the range of 824-849 MHz for a GSM Mobile to Base transmission overlaps up to ten of the highest frequency Bluetooth channels in the ISM frequency spectrum of 2400-2483 MHz. Since the transmitted GSM telephone signals are stronger than received Bluetooth signals, interference occurs when the GSM signals frequency hop in the lower end of the GSM frequency spectrum and are transmitted while Bluetooth signals frequency hop and are received in the ten highest frequency channels in the ISM frequency spectrum.

[0052] FIG. **2**B is a diagram of the frequency spectrum for a 1710-1785 MHz GSM Mobile to Base transmission and the overlap of its third harmonic with the frequency spectrum for a 7525-5850 MHz ISM (802.11) transmission, according to an embodiment of the present invention.

[0053] FIG. **3** is a network diagram that shows the wireless network relationship of the Bluetooth Headset **101**B, the GSM/WLAN/Bluetooth wireless communications device **100**B and the GSM Base Station **186**, according to an embodiment of the present invention. The Bluetooth Headset **101**B includes a processor **902** that executes program instructions stored in the memory **904** to carry out the functions of the Bluetooth Headset **101**B. The Bluetooth Headset **101**B also includes a Bluetooth transceiver and Bluetooth frequency hopping logic **908**. The GSM/WLAN/Bluetooth wireless communications device **100**B includes a processor **912** that executes program instructions stored in the memory **914** to carry out the functions of the wireless communications device **100**B. The wireless communications device **100**B also includes a Bluetooth transceiver **602**, a GSM transceiver **604**, interference avoidance subsystem **110**, Bluetooth frequency hopping logic **606**, and GSM frequency hopping logic **608**.The GSM Base Station **186** includes a processor **922** that executes program instructions stored in the memory **924** to carry out the functions of the GSM Base Station **186**.The GSM Base Station **186** also includes a GSM transceiver **182** and GSM frequency hopping logic **926**.The GSM frequency hopping logic **608** in the wireless communications device **100**B is required to switch to a frequency-hopping mode when the GSM Base Station **186** tells it to do so. Currently, GSM networks utilize frequency hopping all the time, not only in case of interference. The GSM frequency hopping logic **608** in the wireless communications device **100**B performs the frequency hopping operation when the GSM base station **186** controller commands it to do so. When the GSM base station **186** commands the wireless communications device **100**B to turn on frequency hopping, it assigns the wireless communications device **100**B a full set of RF channels rather than a single RF channel. The GSM frequency hopping logic **608** in the wireless communications device **100**B performs the frequency hopping operation on the assigned set of frequencies to satisfy the command from the base station.

[0054] FIG. **4** is a functional block diagram of the GSM/WLAN/Bluetooth wireless communications device **100**B, including an interference avoidance subsystem **110** connected between he GSM frequency hopping logic **608** and the Bluetooth frequency hopping logic **606**, according to an embodiment of the present invention. Bluetooth transceiver **602** and GSM transceiver **604** are also shown. Bluetooth frequency hopping information and time domain operation information are input from the Bluetooth frequency hopping logic **606** to the interference avoidance subsystem **110**. GSM frequency hopping information and time domain operation information are input from the GSM frequency hopping logic **608** to the interference avoidance subsystem **110**. The interference avoidance subsystem **110** then uses this input data to calculate the interference probability between co-existing Bluetooth received signals and GSM transmitted signals. The interference avoidance subsystem **110** then compares the calculated interference probability with the required Bluetooth packet error rate limit for the current application. For example, in a Bluetooth speech coding application using 64 kb/s Continuously Variable Slope Delta (CVSD) modulation, acceptable speech quality can be obtained even with 1-3% bit error rate (BER). In contrast, Bluetooth coding for data traffic can tolerate a higher bit-error rate, since data packets that are determined to be in error can be retransmitted. If the interference probability exceeds the required Bluetooth packet error rate limit, the interference avoidance subsystem **110** sends a signal to the Bluetooth frequency hopping logic **606** to change the Bluetooth frequencies.

[0055] FIG. **5** is a flow diagram of the operation of the interference avoidance subsystem **110** in the GSM/WLAN/Bluetooth wireless communications device **100**B for received Bluetooth signals, according to an embodiment of the present invention. The steps of the flow diagram represent programmed sequences of operational instructions which, when executed by computer processor **912** in the wireless communications device **100**B, carry out the methods of one embodiment of the invention.

[0056] In step **502**, Bluetooth frequency hopping information and time domain operation information are input from the Bluetooth frequency hopping logic to the interference avoidance subsystem.

[0057] In step **504**, GSM frequency hopping information and time domain operation information are input from the GSM frequency hopping logic to the interference avoidance subsystem.

[0058] In step **506**, the interference avoidance subsystem then uses this input data to calculate the interference probability between co-existing Bluetooth received signals and GSM transmitted signals.

[0059] In step **508**, the interference avoidance subsystem then compares the calculated interference probability with the required Bluetooth packet error rate limit for the current application, from step **507**.

[0060] Instep **510**, if the interference probability exceeds the required Bluetooth packet error rate limit, the interference avoidance subsystem sends a signal to the Bluetooth frequency hopping logic to change the Bluetooth frequencies (also referred to as channels).

[0061] The interference avoidance subsystem **110** calculates the probability of interference a priori. The interference avoidance subsystem **110** uses this principle to limit the Bluetooth hopping frequencies by determining in step **511** which channels in the hopping sequence have a high probability of being blocked by the GSM harmonics and then omitting in step **513** as many of the blocked Bluetooth channels from the hopping sequence as needed to reach the required error rate criterion.

[0062] Alternately, the interference avoidance subsystem can optionally perform a loop from step **510** back to step

502, to progressively remove the top frequency Bluetooth channels and to recalculate the interference probability until the magnitude of the interference probability is sufficiently reduced so as to not exceed the required error rate limit.

[0063] In another embodiment of the invention, the interference avoidance subsystem **110** can progressively restore some or all of the top frequency Bluetooth channels if the recalculation of the interference probability shows that the magnitude of the interference probability is reducing so as to be significantly less than the required Bluetooth error rate limit. This can occur, for example, if the GSM channel assignments are changed by the GSM base station, thereby moving the interfering GSM spectrum so that it no longer overlaps the ISM spectrum.

[0064] In another embodiment of the invention, the short range wireless communications unit can input a received signal quality value in the calculation of the interference probability, for signals received by the short range wireless communications unit.

[0065] In another embodiment of the invention, the interference avoidance subsystem can calculate an instant when the interference will occur. In response, the interference avoidance subsystem will change one of the co-existing signals at that instant if the interference probability exceeds the required error rate limit.

[0066] FIG. **6** is a more detailed functional block diagram of the GSM/WLAN/Bluetooth wireless communications device, showing how the interference avoidance subsystem **110** interacts with the Bluetooth frequency hopping logic **606** and the GSM frequency hopping logic **608** to carry out the operation of the flow diagram of FIG. **5**, according to an embodiment of the present invention.

[0067] In step **502**, Bluetooth frequency hopping information and time domain operation information are input from the Bluetooth frequency hopping logic **606** to the interference avoidance subsystem 110 m as follows:

[0068] tBT_slot=Bluetooth slot length in seconds (one slot is 625 microsecs)

[0069] tBT_frame=Bluetooth frame length in seconds (one frame is e.g. 3.75 ms)

[0070] NfcolBT=Number of Bluetooth channels suffering from 3rd order result of GSM

[0071] NftotBT=Total number of Bluetooth hopping channels.

[0072] The Bluetooth adapted frequency channel map **522** normally provides the 32 channels to be used out of the 79 possible channels, over which to perform normal frequency hopping, as defined in the Bluetooth Specification, Vol. 1.2. Normally, these 32 channels from the Bluetooth adapted frequency channel map **522** are passed to the Bluetooth Frequencies Used Register in step **524** and in turn passed to step **502**.

[0073] In step **504**, GSM frequency hopping information and time domain operation information are input from the GSM frequency hopping logic **608** to the interference avoidance subsystem **110**, as follows.

[0074] tGSM_slot=GSM slot length in seconds (one slot is ~577 microsecs)

[0075] tGSM_frame=GSM frame length in seconds (one frame is ~4.615 ms)

[0076] NfcolGSM=Number of GSM channels causing 3rd order result on used Bluetooth channels

[0077] NftotGSM=Total number of GSM hopping channels.

[0078] The data in step **504** is provided by the GSM channel assignment step **512**, which identifies the set of frequencies used in the GSM frequency hopping operation. The GSM hopping algorithm step **514** can be either cyclic or pseudo-random. A GSM frequency sequence list in step **516** is used in the cyclic hopping algorithm. A GSM hopping sequence number in step **516** is used in the pseudo-random hopping algorithm. The output of the GSM hopping algorithm yields the next GSM hopping frequency in step **518**.

[0079] In step **506**, the interference avoidance subsystem then uses this input data to calculate the interference probability, Col_prob, between co-existing Bluetooth received signals and GSM transmitted signals, as follows.

$$\text{Col\_prob} = \frac{t_{\text{GSM\_slot}}}{t_{\text{GSM\_frame}}} \cdot \frac{t_{\text{BT\_slot}}}{t_{\text{BT\_frame}}} \cdot \frac{Nfcol_{GSM}}{Nftot_{GSM}} \cdot \frac{Nfcol_{BT}}{Nftot_{BT}}$$

[0080] In step **508**, the interference avoidance subsystem **110** then compares the calculated interference probability, Col_prob, with the required Bluetooth packet error rate limit for the current application, from step **507**.

[0081] Instep **510**, if the interference probability, Col_prob, exceeds the required Bluetooth packet error rate limit, the interference avoidance subsystem **110** sends a signal from step **520** to step **526** in the Bluetooth frequency hopping logic **606** to remap the Bluetooth hopping frequency.

[0082] The interference avoidance subsystem **110** and the Bluetooth frequency hopping logic **606** limits the Bluetooth hopping frequencies by calculating which channels are blocked by the GSM harmonics and then omitting as many of the blocked Bluetooth channels from the hopping sequence as needed to reach the required error rate criterion.

[0083] The Bluetooth adapted frequency channel map **522** normally provides the 32 channels to be used out of the 79 possible channels, over which to perform normal frequency hopping, as defined in the Bluetooth Specification, Vol. 1.2. Normally, these 32 channels from the Bluetooth adapted frequency channel map **522** are passed to the Bluetooth Frequencies Used Register in step **524** and in turn passed to step **502**. However, when the interference avoidance subsystem **110** sends a signal from step **520** to step **526** in the Bluetooth frequency hopping logic **606** to remap the Bluetooth hopping frequency, the remapped channels from Bluetooth hopping frequency remapping function **526** change the data in step **502**.The remapped channels from Bluetooth hopping frequency remapping function **526** are passed to the Bluetooth Frequencies Used Register in step **524** and in turn are passed to step **502** to be used in the next calculation of the interference probability, Col_prob.

[0084] In Bluetooth adapted frequency hopping (AFH) operation, the possibility of altering used channels in the

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Bluetooth hopping sequence depends on whether the Bluetooth communications unit is operating as a master or slave. In the case of operating as a master, it can update the AFH_channel_map—parameter. This parameter contains a list of used and unused frequencies. The interference avoidance subsystem **110** can set the channels suffering the interference as unused-channels. In the case of the Bluetooth communications unit operating as a slave, the operation is more complex. The master can be programmed to selectively request the slave to report its good and bad channels using the AFH_classification_slave—parameter. Typically this is done during the connection setup phase. The slave can then report the channels suffering the interference as bad channels. The master can be programmed to selectively utilize the channel report from slave.

[**0085**] FIGS. **7**A to **7**D are tables showing the calculated interference probability, Col_prob, computed by the interference avoidance subsystem **110** for the case where the wireless communications device **100**B transmits a GSM signal using a 5 MHz operator frequency allocation (TX: 824-829 MHz) for hopping (25 channels) and the wireless communications device receives Bluetooth signals at various example hopping frequencies (min 20, max 79), according to an embodiment of the present invention. The collision probability in case where all 79 Bluetooth frequencies are available is 0.2% in case of single slot transmission. If the packet error requirement for speech link is, e.g. 3%, the 0.2% alleviation does not justify the blocking of the uppermost Bluetooth channels. When there are, e.g. WLAN access points utilizing the same frequency region as Bluetooth, some channels are not usable. In this case, Bluetooth may end up using only a minimum set of hopping frequencies (**20**) leading to 0.8% collision probability. This negatively affects the 3% total packet error rate, meaning that it is useful at this point to start limiting the used Bluetooth frequencies. Similar calculations can be made for all combinations of slot numbers, packet error rates, hopping frequencies, etc.

[**0086**] FIG. **8**A is a diagram of the frequency spectrum for a 850-875 MHz GSM Mobile to Base transmission, showing that there is no overlap of its third harmonic with the frequency spectrum for signals received in the 2400-2483 MHz ISM (Bluetooth & 802.11) spectrum and thus, in this case, the interference probability computed by the interference avoidance subsystem does not exceed the required Bluetooth packet error rate limit, and therefore the full 2400 to 2483 MHz ISM spectrum is available for Bluetooth frequency hopping, according to an embodiment of the present invention.

[**0087**] FIG. **8**B is a diagram of the frequency spectrum for a 824-849 MHz GSM Mobile to Base transmission, showing that there is an overlap of its third harmonic with the frequency spectrum for signals received in the 2400-2483 MHz ISM (Bluetooth & 802.11) spectrum and thus, in this overlapped case, the interference probability computed by the interference avoidance subsystem exceeds the required packet error rate limit. The interference avoidance subsystem calculates the probability of interference a priori. The interference avoidance subsystem uses this principle to limit the Bluetooth hopping frequencies by calculating which channels are blocked by the GSM harmonics and then omitting as many of the blocked Bluetooth channels from the hopping sequence as needed to reach the required error rate criterion, according to an embodiment of the present invention.

[**0088**] FIG. **9** is a network diagram that shows the wireless network relationship of the WLAN access point **140**B, the GSM/WLAN/Bluetooth wireless communications device **100**B, and the GSM Base Station **186**, according to an embodiment of the present invention. The WLAN access point **140**B includes a processor **902'** that executes program instructions stored in the memory **904'** to carry out the functions of the WLAN access point **140**B. The WLAN access point **140**B includes a WLAN transceiver and a WLAN logic **908'**. The GSM/WLAN/Bluetooth wireless communications device **100**B includes a processor **912** that executes program instructions stored in the memory **914** to carry out the functions of the wireless communications device **100**B. The wireless communications device **100**B also includes a WLAN transceiver **602'**, a GSM transceiver **604**, interference avoidance subsystem **110**, WLAN logic **606'**, and GSM frequency hopping logic **608**.The GSM Base Station **186** includes a processor **922** that executes program instructions stored in the memory **924** to carry out the functions of the GSM Base Station **186**. The GSM Base Station **186** also includes a GSM transceiver **182** and GSM frequency hopping logic **926**.

[**0089**] FIG. **10** is a functional block diagram of the GSM/WLAN/Bluetooth wireless communications device **100**B, including an interference avoidance subsystem **110** connected between the GSM frequency hopping logic **608** and the WLAN logic **606'**, according to an embodiment of the present invention. WLAN transceiver **602'** and GSM transceiver **604** are also shown. WLAN frequency hopping information and time domain operation information are input from the WLAN logic **606'** to the interference avoidance subsystem **110**. GSM frequency hopping information and time domain operation information are input from the GSM frequency hopping logic **608** to the interference avoidance subsystem **110**. The interference avoidance subsystem **110** then uses this input data to calculate the interference probability between co-existing WLAN received signals and GSM transmitted signals. The interference avoidance subsystem **110** then compares the calculated interference probability with the required WLAN packet error rate limit for the current application. For example, in a WLAN speech coding application, acceptable speech quality generally requires a lower bit error rate (BER) than WLAN coding for data traffic, since data packets that are determined to be in error can be retransmitted. If the interference probability exceeds the required WLAN packet error rate limit, the interference avoidance subsystem **110** sends a signal to the WLAN logic **606'** to change the WLAN frequencies.

[**0090**] FIG. **11** is a flow diagram of the of the operation of the interference avoidance subsystem **110** in the GSM/WLAN/Bluetooth wireless communications device **100**B for received WLAN signals that do not engage in frequency hopping, according to an embodiment of the present invention. In the case where the WLAN communications unit of the wireless communications device is not operating in a frequency hopping mode, the method of the invention operates, for example, as follows.

[**0091**] The steps of the flow diagram represent programmed sequences of operational instructions which, when

executed by computer processor **912** in the wireless communications device **100**B, carry out the methods of one embodiment of the invention.

[0092] In step **502'**, WLAN frequency information and time domain operation information are input from the WLAN logic **606'** to the interference avoidance subsystem **110**. The WLAN packet length in seconds depends on the connection parameters and is defined case by case. The same applies also for the WLAN packet repetition rate In step **502'**, WLAN frequency information and time domain operation information are input from the WLAN logic **606'** to the interference avoidance subsystem **110** as follows:

[0093] tWL_slot=WLAN slot length in seconds

[0094] tWL_frame=WLAN frame length in seconds

[0095] NfcolWL=Number of WLAN frequencies suffering from 3rd order result of GSM

[0096] NftotWL=Total number of WLAN hopping frequencies (in this example=1).

[0097] In step **504'**, GSM frequency hopping information and time domain operation information are input from the GSM frequency hopping logic **608** to the interference avoidance subsystem **110**, as follows.

[0098] tGSM_slot=GSM slot length in seconds (one slot is ~**577** microsec)

[0099] tGSM_frame=GSM frame length in seconds (one frame is ~4.615 ms)

[0100] NfcolGSM **32** Number of GSM frequencies causing 3rd order result on used WLAN channels

[0101] NftotGSM **32** Total number of GSM hopping frequencies (in this example=25).

[0102] In step **506'**, the interference avoidance subsystem then uses this input data to calculate the interference probability, Col_prob, between co-existing WLAN received signals and GSM transmitted signals, as follows:

$$\text{Col\_prob} = \frac{t_{\text{GSM\_slot}}}{T_{\text{GSM\_frame}}} \cdot \frac{T_{\text{WL\_slot}}}{T_{\text{WL\_frame}}} \cdot \frac{Nfcol_{GSM}}{Nftot_{GSM}} \cdot \frac{Nfcol_{WL}}{Nftot_{WL}}$$

[0103] The interference avoidance subsystem **110** calculates the interference probability between co-existing WLAN received signals and GSM transmitted signals with the WLAN hopping frequencies set equal to one. The number of GSM hopping frequencies used by the interference avoidance subsystem in calculating the interference probability with WLAN signals is similar to that previously discussed above in the case of Bluetooth. The GSM hopping frequencies used in calculating the interference probability the depend on the GSM operator frequency allocation and the number of frequencies in the hopping sequence causing an intermodulation distortion (IMD) result on top of the WLAN reception.

[0104] In step **508'**, the interference avoidance subsystem **110** then compares the calculated interference probability, Col_prob, with the required WLAN packet error rate limit for the current application, from step **507'**. Step **509'**, if the calculated probability is greater than the WLAN packet error rate limit, then the process continues, otherwise no change is made to reduce interference.

[0105] In accordance with another embodiment of the invention, in step **509'**the interference avoidance subsystem can compare a Quality-of-Service (QoS) parameter for the WLAN communications link with a Quality-of-Service parameter for the GSM link to determine whether potentially interfering WLAN reception packets should be discarded in step **510'**, as opposed to an alternative mode of the interference avoidance subsystem signaling in step **540** to the GSM communications unit to suppress transmission a GSM packet if it will interfere with a WLAN reception packet.

[0106] In step **509'**, if the calculated interference probability is greater than the predefined error probability or packet error rate limit, then the interference avoidance subsystem **110** signals the WLAN communications unit to discard the WLAN reception packet in step **510'**. Step **510'** can be augmented by discarding the WLAN packet if the received packet is detected by the WLAN communications unit as being corrupted. The discarding step **510'** results in the WLAN communications unit not transmitting an acknowledgement packet back to the sender, WLAN access point **140**B. Typically, the WLAN protocol will then require the sender to retransmit the packet, which most probably will not occur simultaneously with following GSM transmissions and will be correctly received by the WLAN communications unit. If the reception packet detected by the WLAN communications unit is not corrupted, then the received packet may be suspected of containing erroneous data. Optionally, in step **510'**, the WLAN communications unit can discard the WLAN reception packet in this case, as well, and force a retransmission of the packet from the sender. Another option is for the WLAN communications unit to direct a received WLAN packet that is suspected of containing erroneous data, into a suspicious-packet-buffer for additional error checking or tagging.

[0107] In another embodiment of the invention shown in FIG. **11**, where the WLAN communications link does not engage in frequency hopping, interference with a WLAN reception packet is avoided by the interference avoidance subsystem signaling in step **540** to the GSM communications unit to suppress transmission a GSM packet if it will interfere with the WLAN reception packet.

[0108] In an alternate embodiment of the invention, the GSM hopping frequencies can be changed to reduce the interference. The GSM frequencies can be changed if the interference probability exceeds the required WLAN packet error rate limit. In an alternate embodiment of the invention, step **540** can loop back to step **504'** to progressively change the interfering frequency GSM channels and recalculate the interference probability until the magnitude of the interference probability is sufficiently reduced so as to not exceed the required WLAN error rate limit. This enables avoiding transmitting in certain GSM channels due to interference with WLAN reception. The packet error rate of particular service can be taken into account by allocating e.g. 10% budget of the total packet error rate to the interference.

[0109] FIGS. **12**A and **12**B are tables showing the calculated interference probability computed by the interference avoidance subsystem for the case where the wireless communications device transmits a GSM signal using a 5 MHz operator frequency allocation (TX: 824-829 MHz) for hop-

ping (25 channels) and the wireless communications device receives WLAN VoIP signals, according to an embodiment of the present invention.

[0110] The resulting invention has the following advantages:

[0111] Much better utilization of available frequencies

[0112] Enhanced capacity, especially in case of crowded 2.4GHz ISM-band

[0113] Adaptive operation

[0114] Takes into account the service packet error requirements in the interference avoidance

[0115] Easy to implement, no complex decision logic needed

[0116] Better user experience

[0117] The basic idea can be utilized to many different radio combinations causing interoperability problems

[0118] Although specific embodiments of the invention have been disclosed, a person skilled in the art will understand that changes can be made to the specific embodiments without departing from the spirit and scope of the invention.

What is claimed is:

1. A method in a wireless communications device to reduce interference between a wireless telephone unit and a short range wireless communications unit contained therein, comprising:

inputting frequency information and time domain operation information from the short range wireless communications unit;

inputting frequency hopping information and time domain operation information from the wireless telephone unit;

calculating an interference probability between co-existing signals received by the short range wireless communications unit and transmitted from the wireless telephone unit;

comparing the calculated interference probability with a required error rate limit for the short range wireless communications unit; and

changing one of the co-existing signals in either the short range wireless communications unit or the wireless telephone unit if the interference probability exceeds the required error rate limit.

2. The method of claim 1, which further comprises:

inputting frequency hopping information from the short range wireless communications unit;

determining which hopping frequencies in a hopping sequence of said short range wireless communications unit have a high probability of being blocked by signals transmitted from the wireless telephone unit; and

omitting the blocked hopping frequencies from the hopping sequence to reach the required error rate limit.

3. The method of claim 2, which further comprises:

said short range wireless communications unit is a Bluetooth communications device and said wireless telephone unit is a GSM telephone.

4. The method of claim 1, which further comprises:

said short range wireless communications unit is a WLAN communications device and said wireless telephone unit is a GSM telephone.

5. The method of claim 1, which further comprises:

said short range wireless communications unit is a WLAN communications device using only a single channel frequency to receive a WLAN signal;

discarding a received WLAN signal if said calculated interference probability is greater than the required error rate limit.

6. The method of claim 5, which further comprises:

said discarding occurring only if the received WLAN signal is corrupted.

7. The method of claim 1, which further comprises:

said short range wireless communications unit is a WLAN communications device using only a single channel frequency to receive a WLAN signal;

suppressing transmission a signal from said wireless telephone unit if said calculated interference probability is greater than the required error rate limit.

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

said short range wireless communications unit is a WLAN communications device using only a single channel frequency to receive a WLAN signal;

comparing a Quality-of-Service parameter for the received WLAN signal with a Quality-of-Service parameter for a signal to be transmitted from said wireless telephone unit;

discarding said received WLAN signal if said Quality-of-Service parameter for said wireless telephone unit signal is greater than said Quality-of-Service parameter for said received WLAN signal; and

suppressing transmission a said wireless telephone unit signal if said Quality-of-Service parameter for said wireless telephone unit signal is less than said Quality-of-Service parameter for said received WLAN signal.

9. The method of claim 1, which further comprises:

inputting a received signal quality value in said calculation of the interference probability, for signals received by said short range wireless communications unit.

10. The method of claim 1, which further comprises:

calculating an instant when said interference will occur; and

changing one of the co-existing signals at said instant if the interference probability exceeds the required error rate limit.

11. A wireless communications device, comprising:

a wireless telephone unit contained in a wireless communications device

a short range wireless communications unit contained in the wireless communications device;

an interference avoidance subsystem contained in the wireless communications device, coupled to the wireless telephone unit and the short range wireless communications unit;

said short range wireless communications unit inputting frequency information and time domain operation information to the interference avoidance subsystem;

said wireless telephone unit inputting frequency hopping information and time domain operation information to the interference avoidance subsystem;

said interference avoidance subsystem calculating an interference probability between co-existing signals received by the short range wireless communications unit and transmitted from the wireless telephone unit;

said interference avoidance subsystem comparing the calculated interference probability with a required error rate limit for the short range wireless communications unit; and

said interference avoidance subsystem changing one of the co-existing signals in either the short range wireless communications unit or the wireless telephone unit if the interference probability exceeds the required error rate limit.

12. The device of claim 11, which further comprises:

said short range wireless communications unit inputting frequency hopping information to the interference avoidance subsystem;

said interference avoidance subsystem determining which hopping frequencies in a hopping sequence of said short range wireless communications unit have a high probability of being blocked by signals transmitted from the wireless telephone unit; and

said short range wireless communications unit omitting the blocked hopping frequencies from the hopping sequence to reach the required error rate limit.

13. The device of claim 12, which further comprises:

said short range wireless communications unit is a Bluetooth communications device and said wireless telephone unit is a GSM telephone.

14. The device of claim 11, which further comprises:

said short range wireless communications unit is a WLAN communications device and said wireless telephone unit is a GSM telephone.

15. The device of claim 11, which further comprises:

said short range wireless communications unit is a WLAN communications device using only a single channel frequency to receive a WLAN signal;

said interference avoidance subsystem discarding a received WLAN signal if said calculated interference probability is greater than the required error rate limit.

16. The device of claim 15, which further comprises:

said discarding occurring only if the received WLAN signal is corrupted.

17. The device of claim 11, which further comprises:

said short range wireless communications unit is a WLAN communications device using only a single channel frequency to receive a WLAN signal;

said interference avoidance subsystem suppressing transmission a signal from said wireless telephone unit if said calculated interference probability is greater than the required error rate limit.

18. The device of claim 11, which further comprises:

said short range wireless communications unit is a WLAN communications device using only a single channel frequency to receive a WLAN signal;

said interference avoidance subsystem comparing a Quality-of-Service parameter for the received WLAN signal with a Quality-of-Service parameter for a signal to be transmitted from said wireless telephone unit;

said interference avoidance subsystem discarding said received WLAN signal if said Quality-of-Service parameter for said wireless telephone unit signal is greater than said Quality-of-Service parameter for said received WLAN signal; and

said interference avoidance subsystem suppressing transmission a said wireless telephone unit signal if said Quality-of-Service parameter for said wireless telephone unit signal is less than said Quality-of-Service parameter for said received WLAN signal.

19. The device of claim 11, which further comprises:

said short range wireless communications unit inputting a received signal quality value in said calculation of the interference probability, for signals received by said short range wireless communications unit.

20. The device of claim 11, which further comprises:

said interference avoidance subsystem calculating an instant when said interference will occur; and

said interference avoidance subsystem changing one of the co-existing signals at said instant if the interference probability exceeds the required error rate limit.

21. A computer program product for a wireless communications device to reduce interference between a wireless telephone unit and a short range wireless communications unit contained therein, comprising:

a computer readable medium;

program code in the computer readable medium for inputting frequency information and time domain operation information from the short range wireless communications unit;

program code in the computer readable medium for inputting frequency hopping information and time domain operation information from the wireless telephone unit;

program code in the computer readable medium for calculating an interference probability between co-existing signals received by the short range wireless communications unit and transmitted from the wireless telephone unit;

program code in the computer readable medium for comparing the calculated interference probability with a required error rate limit for the short range wireless communications unit; and

program code in the computer readable medium for changing one of the co-existing signals in either the short range wireless communications unit or the wireless telephone unit if the interference probability exceeds the required error rate limit.

22. The computer program product of claim 21, which further comprises:

program code in the computer readable medium for inputting frequency hopping information from the short range wireless communications unit;

program code in the computer readable medium for determining which hopping frequencies in a hopping sequence of said short range wireless communications unit have a high probability of being blocked by signals transmitted from the wireless telephone unit; and

program code in the computer readable medium for omitting the blocked hopping frequencies from the hopping sequence to reach the required error rate limit.

23. The computer program product of claim 22, which further comprises:

said short range wireless communications unit is a Bluetooth communications device and said wireless telephone unit is a GSM telephone.

24. The computer program product of claim 21, which further comprises:

said short range wireless communications unit is a WLAN communications device and said wireless telephone unit is a GSM telephone.

25. The computer program product of claim 21, which further comprises:

said short range wireless communications unit is a WLAN communications device using only a single channel frequency to receive a WLAN signal;

program code in the computer readable medium for discarding a received WLAN signal if said calculated interference probability is greater than the required error rate limit.

26. The computer program product of claim 25, which further comprises:

said discarding occurring only if the received WLAN signal is corrupted.

27. The computer program product of claim 21, which further comprises:

said short range wireless communications unit is a WLAN communications device using only a single channel frequency to receive a WLAN signal;

program code in the computer readable medium for suppressing transmission a signal from said wireless telephone unit if said calculated interference probability is greater than the required error rate limit.

28. The computer program product of claim 21, which further comprises:

said short range wireless communications unit is a WLAN communications device using only a single channel frequency to receive a WLAN signal;

program code in the computer readable medium for comparing a Quality-of-Service parameter for the received WLAN signal with a Quality-of-Service parameter for a signal to be transmitted from said wireless telephone unit;

program code in the computer readable medium for discarding said received WLAN signal if said Quality-of-Service parameter for said wireless telephone unit signal is greater than said Quality-of-Service parameter for said received WLAN signal; and

program code in the computer readable medium for suppressing transmission a said wireless telephone unit signal if said Quality-of-Service parameter for said wireless telephone unit signal is less than said Quality-of-Service parameter for said received WLAN signal.

29. The computer program product of claim 21, which further comprises:

program code in the computer readable medium for inputting a received signal quality value in said calculation of the interference probability, for signals received by said short range wireless communications unit.

30. The computer program product of claim 21, which further comprises:

program code in the computer readable medium for calculating an instant when said interference will occur; and

program code in the computer readable medium for changing one of the co-existing signals at said instant if the interference probability exceeds the required error rate limit.

* * * * *

EXHIBIT 1022

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(54) MULTI-FUNCTION TELEPHONE

(76) Inventors: Manoj Sindhwani, Oakhill, VA (US); Thomas F. Flanagan, Springfield, VA (US)

Correspondence Address:
TEXAS INSTRUMENTS INCORPORATED
P O BOX 655474, M/S 3999
DALLAS, TX 75265

(21) Appl. No.: 10/789,036

(22) Filed: Feb. 27, 2004

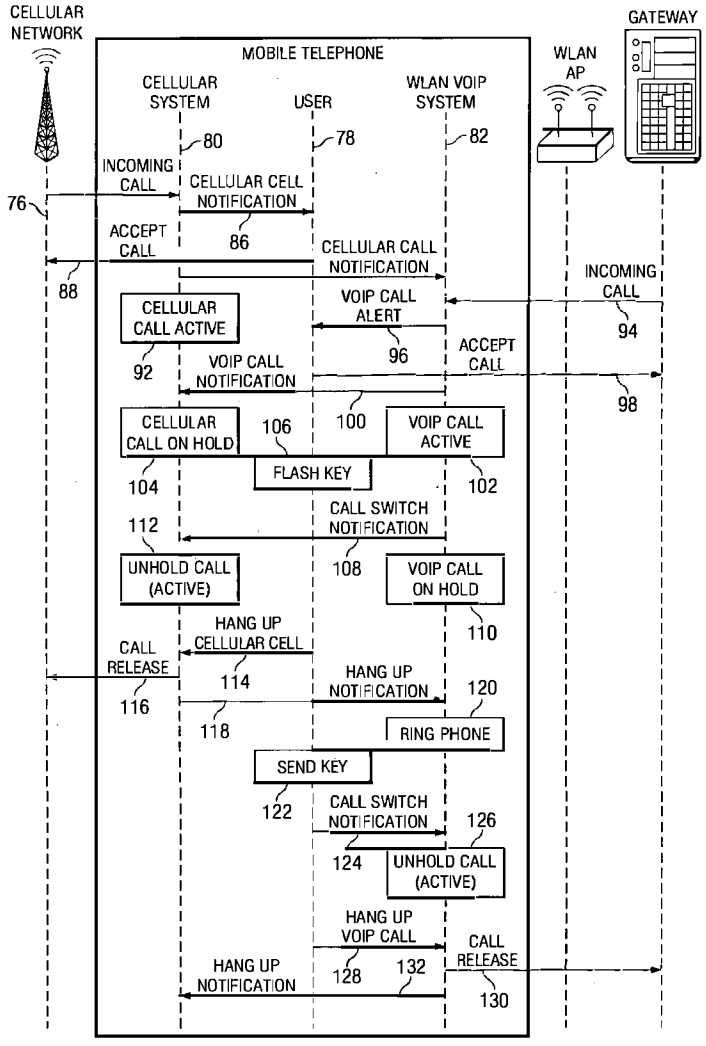
Publication Classification

(51) Int. Cl.[7] H04L 12/28

(52) U.S. Cl. 370/352; 370/254

(57) ABSTRACT

A wireless mobile telephone for connecting to multiple networks that includes a cellular module for routing calls through a cellular telephone network, a wireless network module, operably connected to the cellular module, for routing calls on a wireless local area network (WLAN). The mobile telephone provides simultaneous connectivity to a cellular network and a WLAN and automatically detects and configures the mobile telephone to the WLAN when the mobile telephone enters a WLAN broadcast area using pre-programmed operating profiles for each different WLAN.



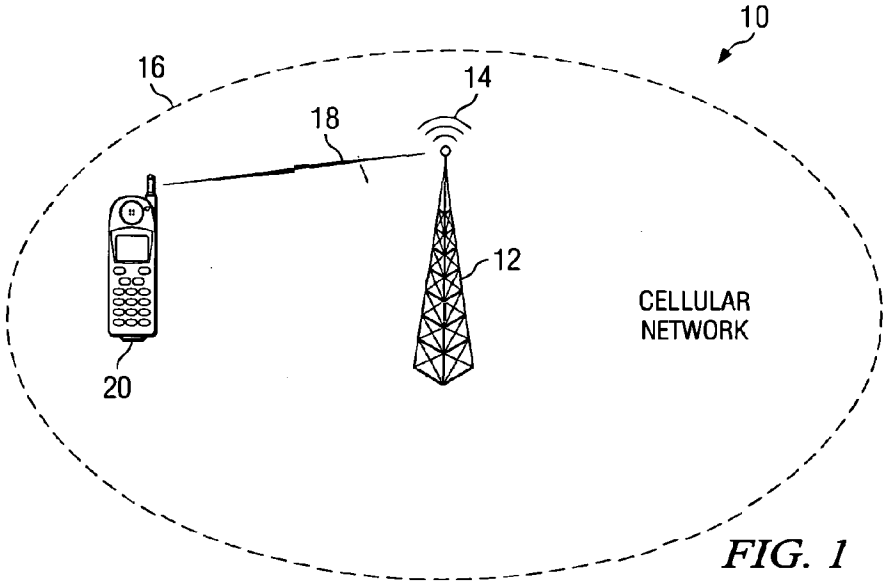

10
16
14
18
12
CELLULAR
NETWORK
20

FIG. 1

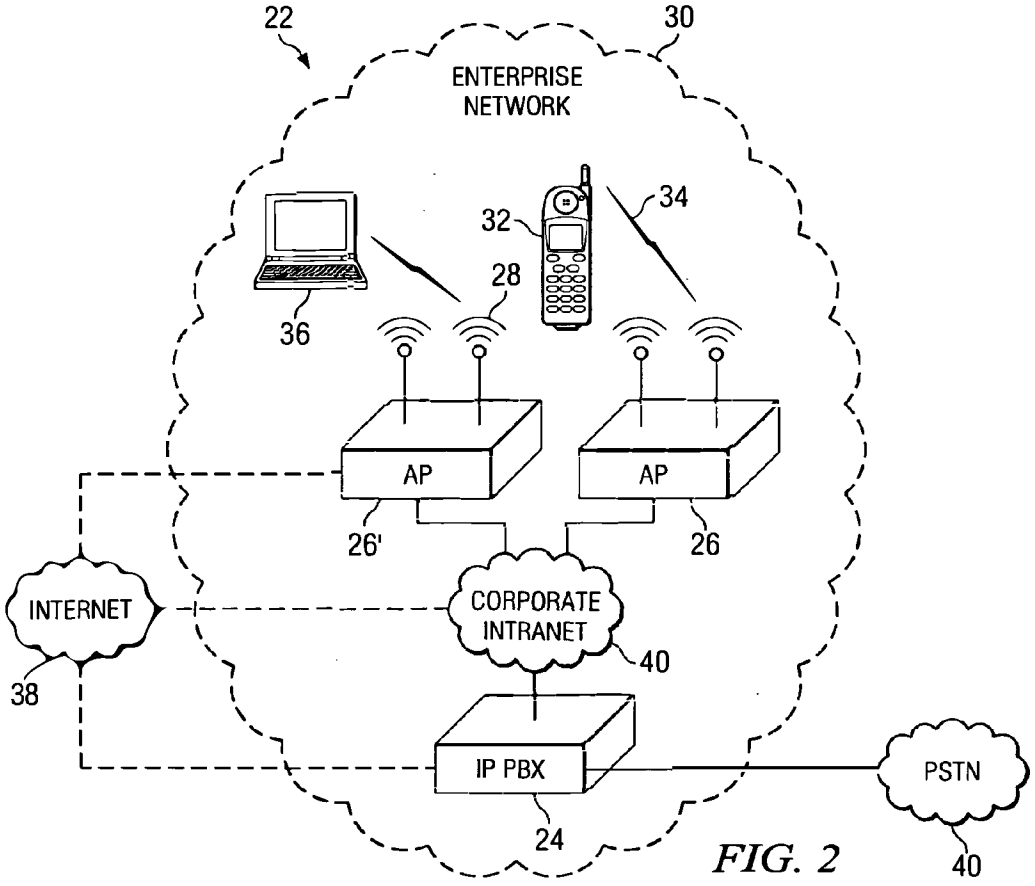

22
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ENTERPRISE
NETWORK
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34
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36
AP
AP
26'
26
INTERNET
CORPORATE
INTRANET
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38
IP PBX
PSTN
24
40

FIG. 2

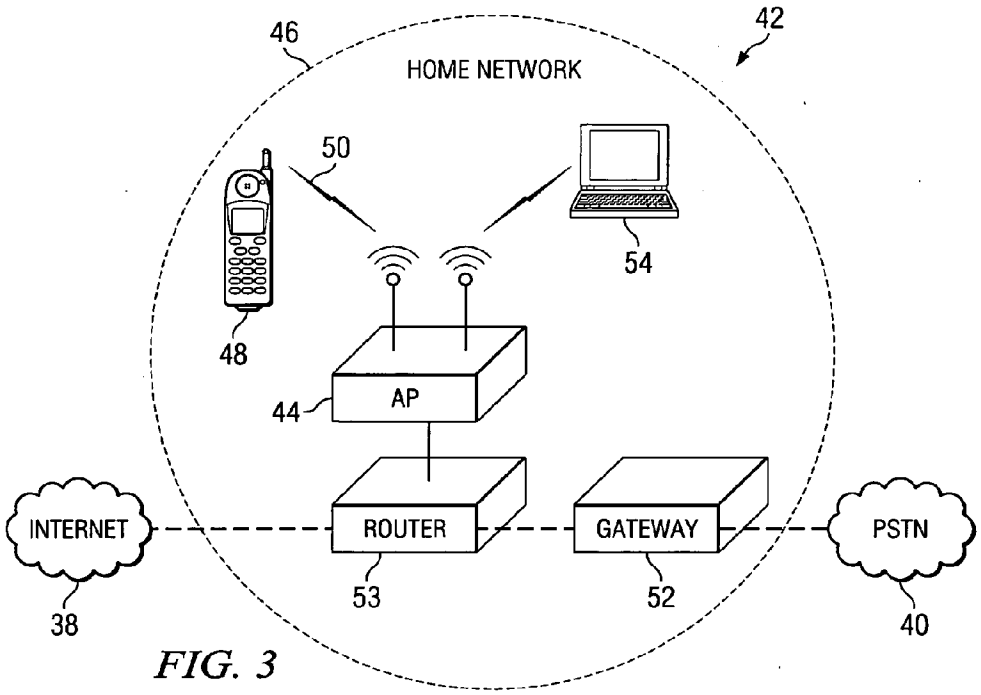

46
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HOME NETWORK
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AP
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INTERNET
ROUTER
GATEWAY
PSTN
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52
38
40

FIG. 3

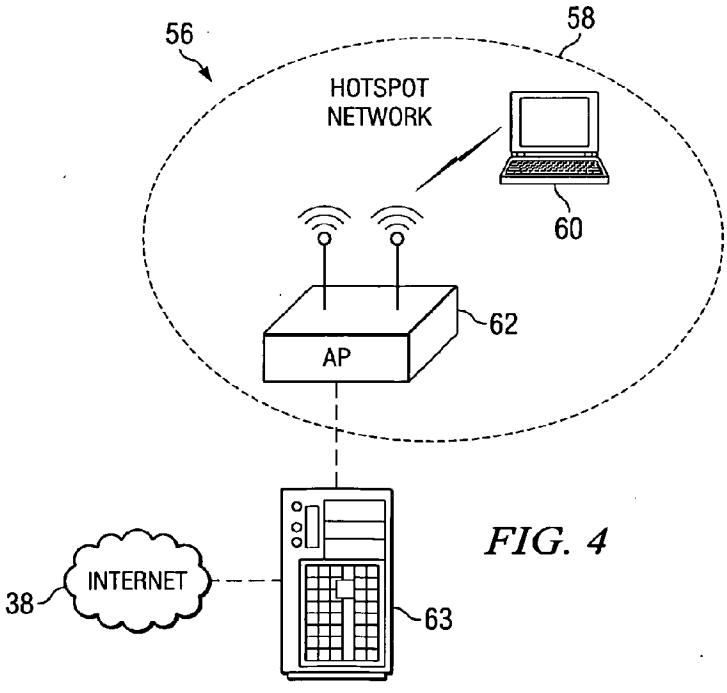

56
58
HOTSPOT
NETWORK
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AP
INTERNET
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FIG. 4

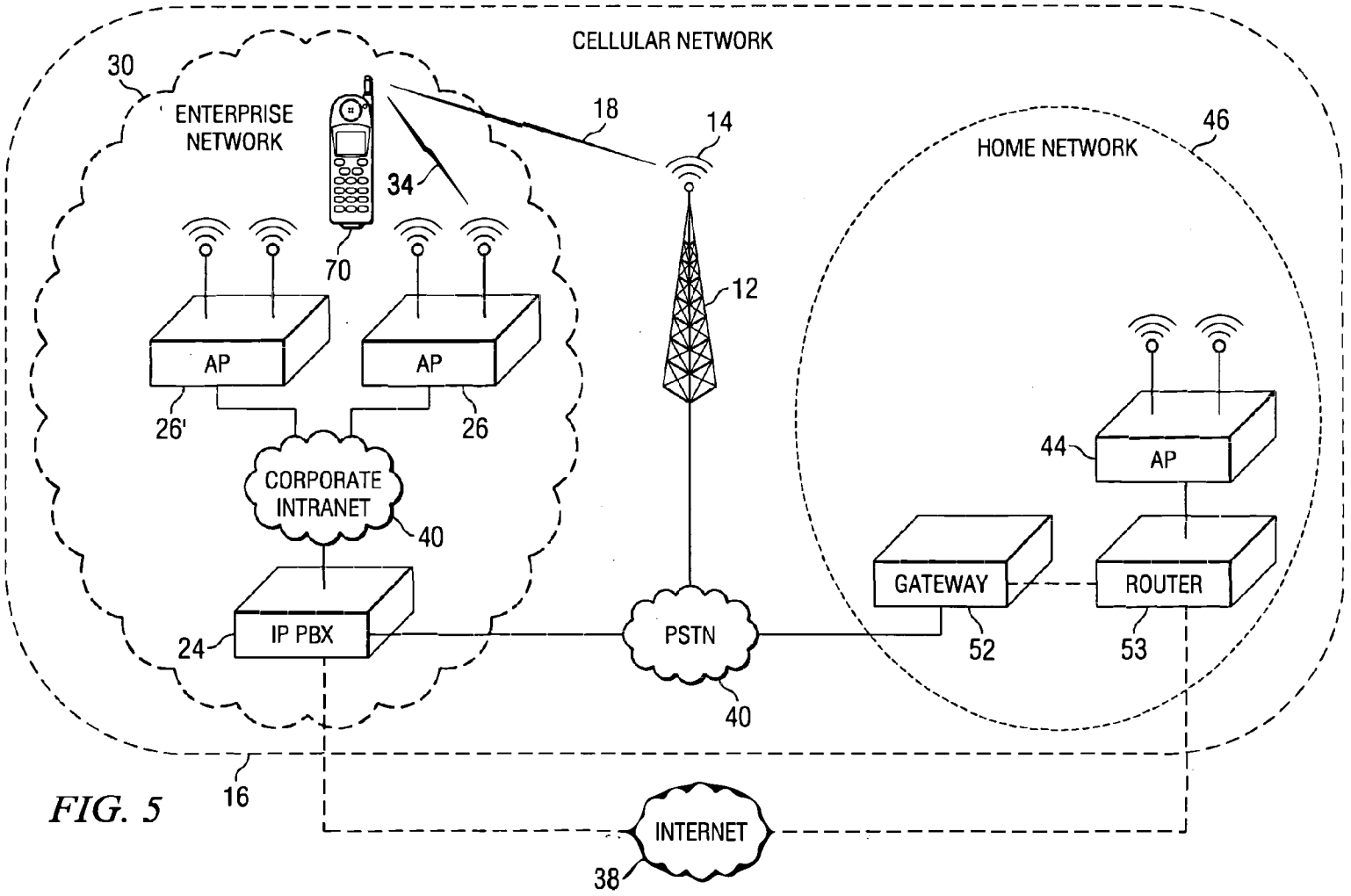

CELLULAR NETWORK
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ENTERPRISE NETWORK
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HOME NETWORK
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CORPORATE INTRANET
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44
AP
GATEWAY
ROUTER
IP PBX
24
PSTN
52
53
40
16
INTERNET
38

FIG. 5

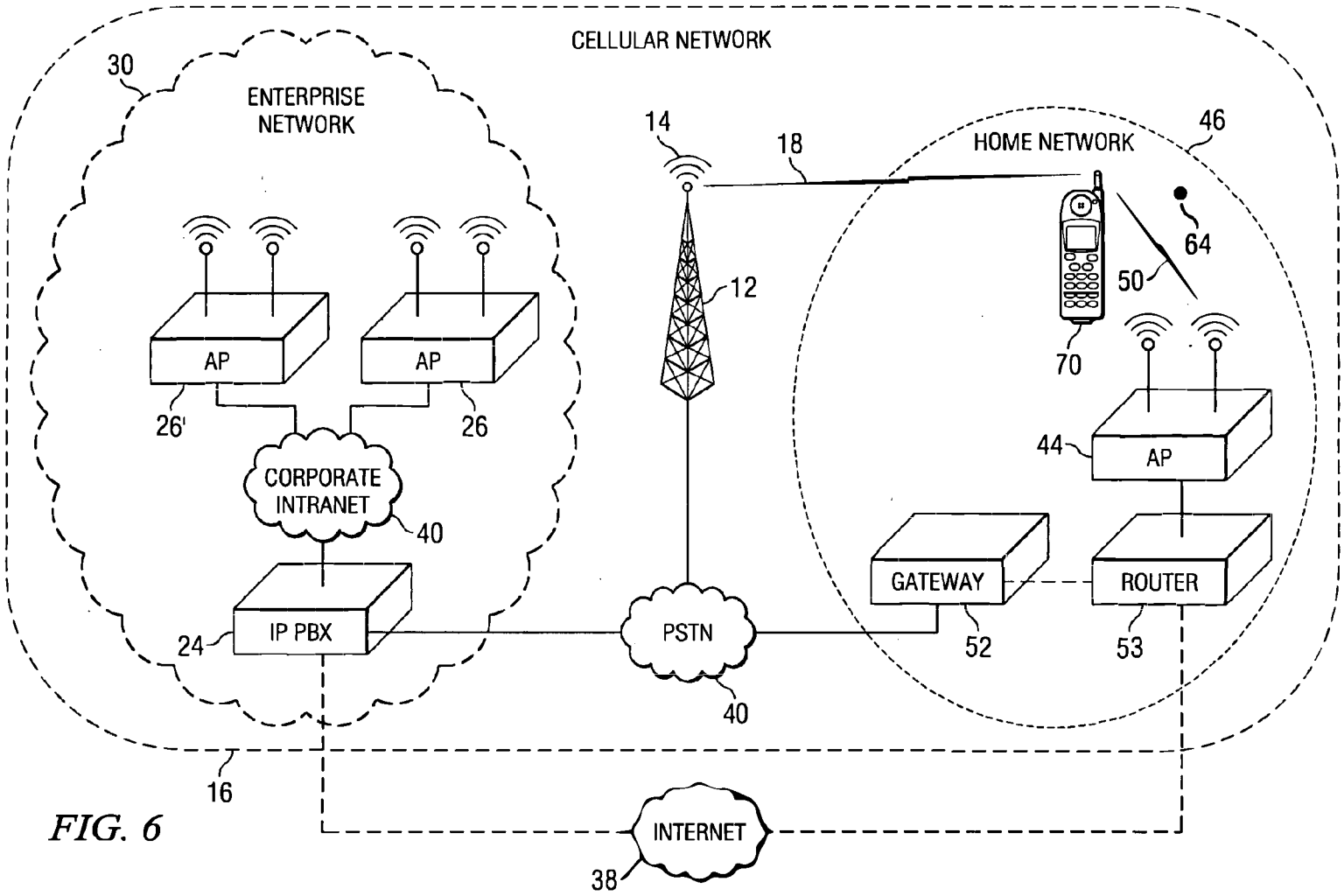

CELLULAR NETWORK
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ENTERPRISE NETWORK
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HOME NETWORK
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AP
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70
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CORPORATE INTRANET
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GATEWAY
ROUTER
IP PBX
24
PSTN
52
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INTERNET
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FIG. 6

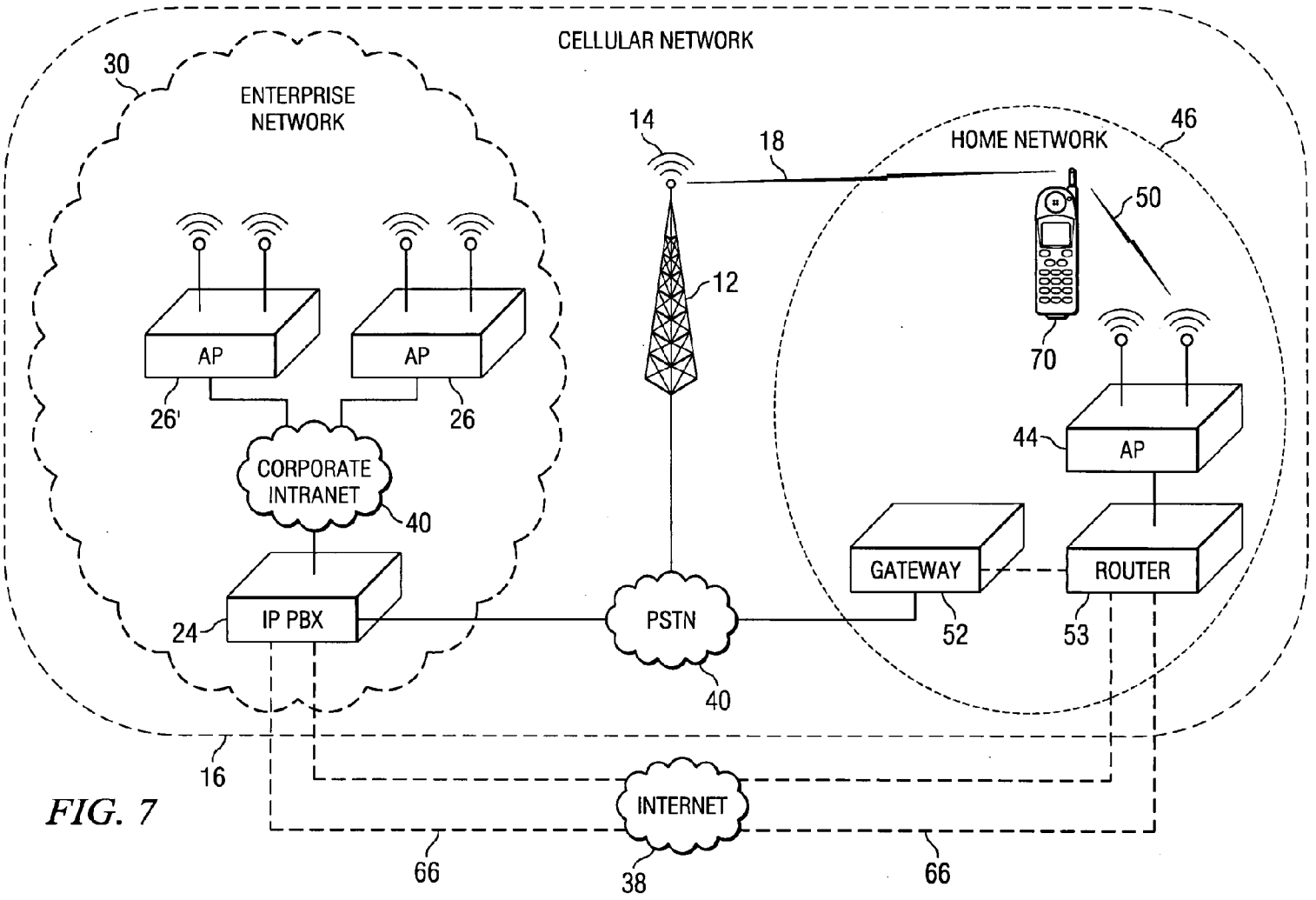

CELLULAR NETWORK
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HOME NETWORK
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AP
26'
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70
44
AP
CORPORATE INTRANET
40
GATEWAY
ROUTER
IP PBX
24
PSTN
52
53
40
16
INTERNET
66
38
66

FIG. 7

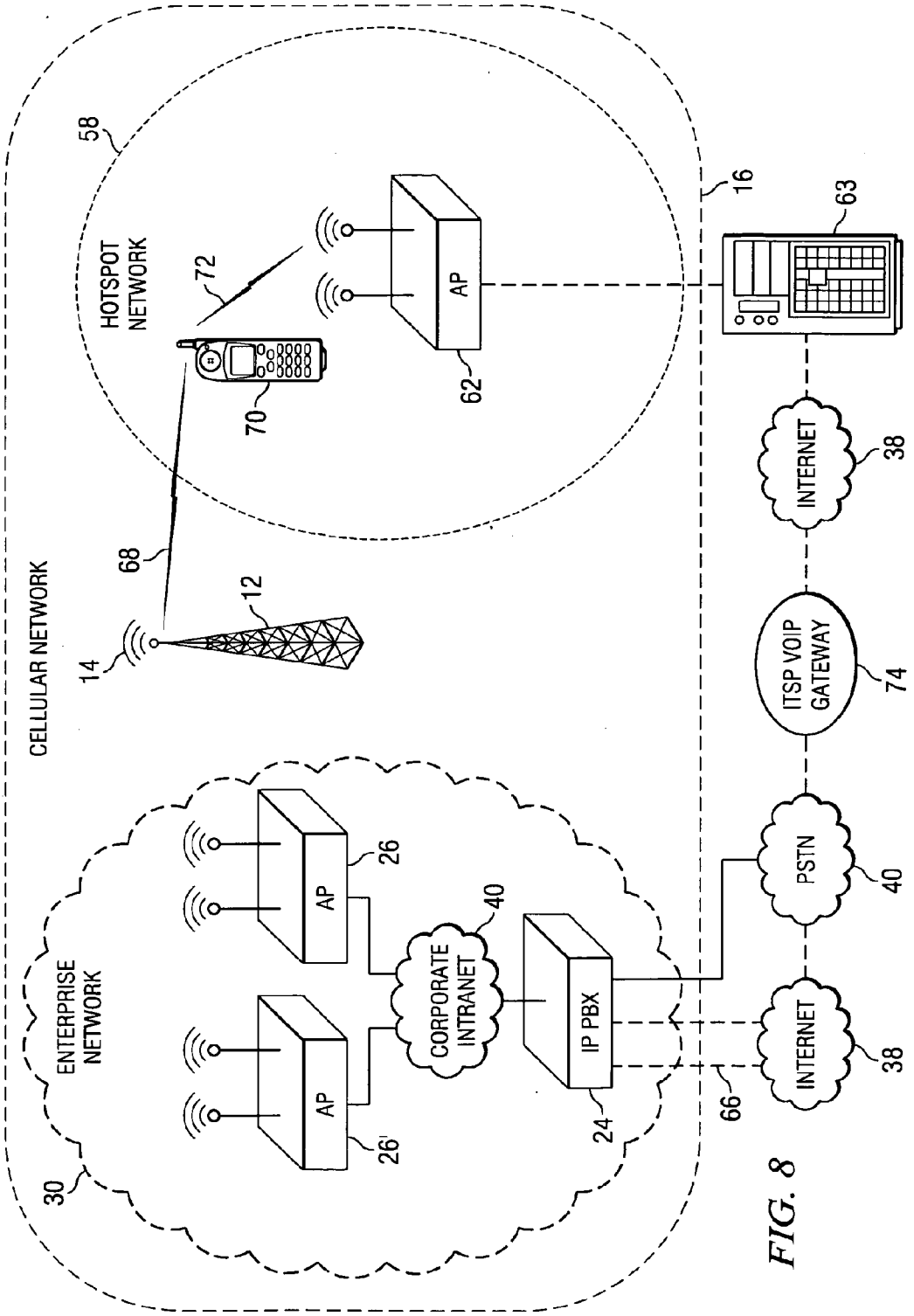
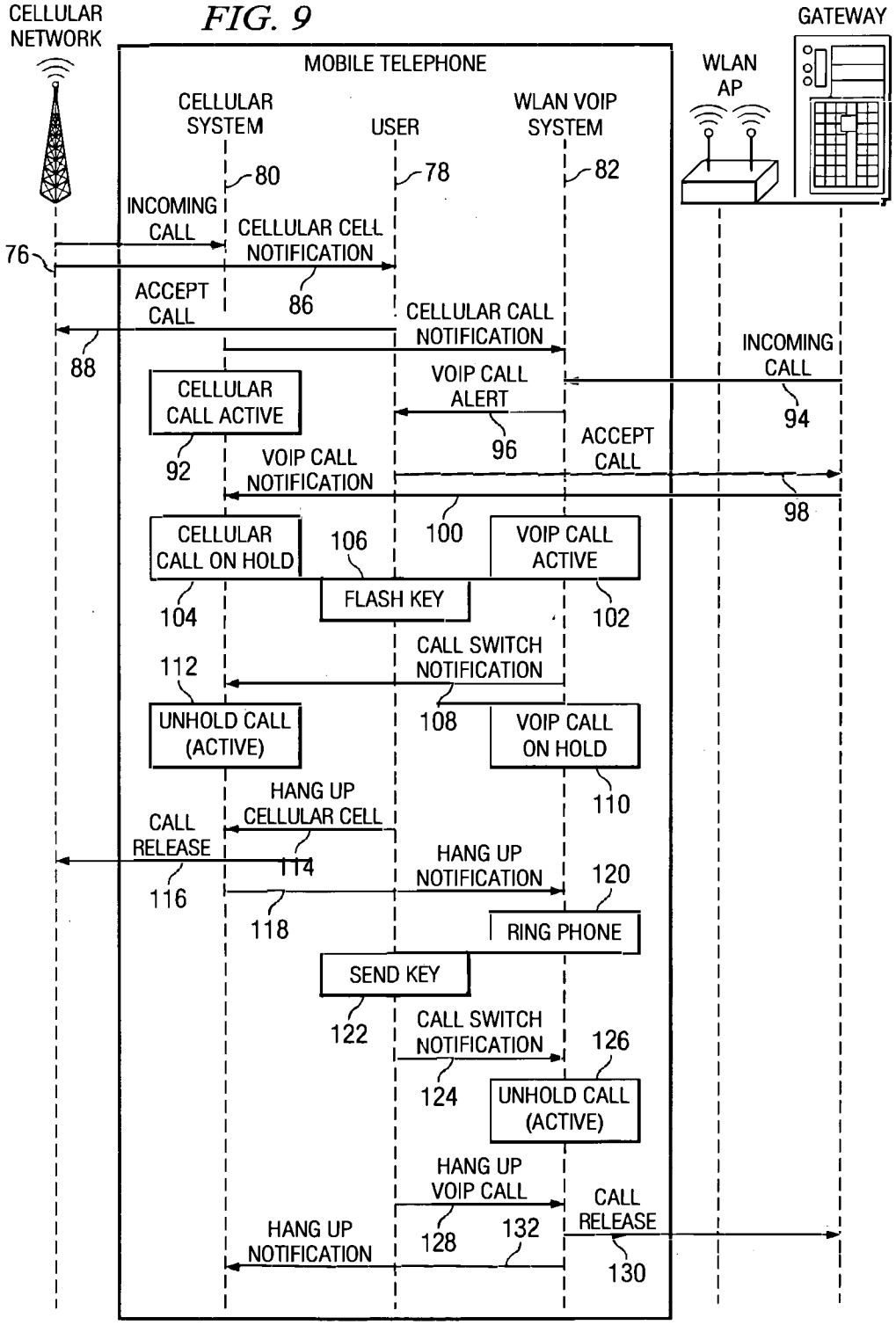


FIG. 8

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FIG. 9


CELLULAR NETWORK
MOBILE TELEPHONE
GATEWAY
WLAN AP
CELLULAR SYSTEM
USER
WLAN VOIP SYSTEM
80
78
82
INCOMING CALL
CELLULAR CELL NOTIFICATION
76
86
ACCEPT CALL
CELLULAR CALL NOTIFICATION
88
INCOMING CALL
94
CELLULAR CALL ACTIVE
VOIP CALL ALERT
96
92
VOIP CALL NOTIFICATION
ACCEPT CALL
98
100
CELLULAR CALL ON HOLD
106
VOIP CALL ACTIVE
FLASH KEY
104
102
CALL SWITCH NOTIFICATION
112
108
UNHOLD CALL (ACTIVE)
VOIP CALL ON HOLD
110
HANG UP CELLULAR CELL
CALL RELEASE
114
116
HANG UP NOTIFICATION
120
118
RING PHONE
SEND KEY
122
CALL SWITCH NOTIFICATION
126
124
UNHOLD CALL (ACTIVE)
HANG UP VOIP CALL
CALL RELEASE
HANG UP NOTIFICATION
128
132
130

MULTI-FUNCTION TELEPHONE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] None

FIELD OF THE INVENTION

[0002] The present invention relates generally to a mobile telephone that supports multiple protocols over multiple telephony and data networks.

BACKGROUND OF THE INVENTION

[0003] The family of wireless, or mobile, telephones include cellular telephones, wireless office phones, cordless telephones, and Internet Protocol (IP) phones.

[0004] The traditional wireless telephone used in many homes is a cordless telephone. Cordless telephones transmit and receive radio signals from a base station that is connected directly to a publicly switched telephone network (PSTN) line. Cordless telephones can send and receive radio signals with analog or digital frequency modulation protocols. Modern cordless telephones have the capabilities of switching frequencies automatically to avoid interference with other cordless phones and to avoid interference caused by electronic devices such as computers. Cordless telephone systems have a range of radio signal transmission typically in the hundreds of feet from a base station.

[0005] Cellular networks were initially installed with analog transmissions using AMPS protocols. Modern cellular networks have developed into digital formats using protocols such as global services for mobile communications (GSM) and code division multiple access (CDMA). **FIG. 1** illustrates a schematic diagram of a cellular telephone network **10**. A base transceiver station (BTS) **12** may broadcast radio frequency (RF) signals **14** towards a general area or in all surrounding areas of the BTS, which is represented by area **16** in the schematic. Cellular telephone network systems utilize wireless communication channels **18**, or paths, between a mobile telephone **20** and a radio antennae on a base station tower **12**. Cellular transmission antennas are commonly placed on a base station tower **12** or high-rise structures to support a regional or nationwide cellular network. Packetized voice data (voice packets) **18** are transferred to the PSTN. A BTS **12** may have a maximum RF signal **15** transmission distance ranging from approximately five to ten miles or more from a transmission **12**, which varies depending upon numerous factors including interference with structures, topography, or foliage, transmitting power, and signal attenuation. By placing multiple transmitters in the cellular network, telephone calls may be seamlessly passed from one transmitting tower to another through a "handoff" procedure.

[0006] A land-based type of local telephone system used by businesses, hospitals, and schools is called a private branch exchange (PBX). A PBX is private telephone system switch that serves a digital or analog telephone network within a specific location, such as an office building or campus. A PBX can route telephone calls within the PBX network. PBX switches also route calls externally to the PSTN. Each on-site telephone is wired to the PBX switch instead of an external PSTN line. The advantage of a PBX system is that numerous telephones can share far fewer PSTN trunk lines to place and receive external calls.

[0007] A wireless PBX network uses unlicenced frequencies and has the capability of internal dialing from one wireless telephone directly to other wireless telephones on the network as well as dialing out to the PSTN. Wireless PBX telephone handsets must be custom manufactured to incorporate unique features of a particular PBX system and are therefore not widely used. Wireless PBX phones require base stations with broadcasting and receiving antennas placed throughout an office building and in outdoor areas between buildings. The base stations are wired to specialized hardware and software within a PBX system.

[0008] Similar to roaming features on a cellular network, calls on a wireless PBX system are transferred between base stations/access points (APs)when the mobile handset is moved out of range of a current base station/AP and towards a base station/AP with a stronger signal. Handsets for wireless PBX systems have an upper range transmission range of approximately 150 feet, depending upon interferences.

[0009] An additional wireless phone system is the Digital Enhanced Cordless Telecommunications (DECT) phone. DECT is a standard for international digital radio access for cordless telephones. It is based on TDMA (time division multiple access) protocols and offers heightened security and low interference. The signal range for a DECT phone is approximately 50 to 300 meters, depending upon interferences. A DECT phone can operate using a base station in a home or office or from a network of several base stations. For example, a DECT phone can act as a PBX extension within an office. DECT handsets can communicate with other DECT phones through the base station. DECT technology has been combined with GSM to create a dual mobile handset where calls to a phone can be routed through either the DECT base station or through a mobile GSM network.

[0010] Telephone handsets can be integrated into local area networks that have network entities like proxy servers, media gateway controllers (MGC), media access gateways, or gatekeepers to route calls from the handset through a gateway using packet telephony under voice over Internet Protocols (VoIP). A media access gateway works in coordination with an MGC to connect the physical links of the LAN to external networks, including the PSTN, and for controlling media stream conversions between protocols of different systems as required.

[0011] A wireless local area network (WLAN) links wireless network devices up to a few hundred yards in distance, which makes WLANS useful for mobile network access in office buildings, warehouses, hospitals, and campuses. WLANs utilize RF signals or light signals to connect mobile devices to each other or to a centralized controller and transmit data between the physical devices. In 1997 the IEEE published standards for WLANs under the title of 802.11. The 802.11 standards contain different protocols that may use unlicenced 2.4 GHz and 5 GHz radio bands to transmit packet data. IEEE 802.11 enables mobile stations (e.g., endpoints) to communicate through a wireless network interface card directly with each other or with other stations through an access point. An access point is a centralized gateway providing message and power management and access to an external LAN and/or the Internet. IEEE 802.11

access products are sold with personal computers (e.g., wireless NICs), computer peripherals, print servers, and mobile devices such as laptops and personal digital assistants (PDAs).

[0012] There are a plurality of 802.11 standards that each use different frequency bands and have varying data transmission speeds. The original IEEE 802.11 standard supported wireless interfaces operating at speeds of up to 2 megabyte per second (Mbps) in the 2.4 GHz radio band. By using different modulation techniques, IEEE 802.11b raised the data transmission rates to 11 Mbps, while 802.11a supports up to 54 Mbps transmission rates at a 5 GHz frequency. The IEEE 802.11g is developing standards for data transmission rates of 54 Mbps at the 2.4 GHz frequency.

[0013] **FIG. 2** illustrates a schematic diagram of an 802.11 enterprise network **22** that may be used to implement a wireless telephone system. An IP PBX switch **24** serves as a centralized gateway for processing voice calls placed through the network. Two wireless access points **26** (and **26'**) are connected to an internal corporate Intranet **40**, which is connected to IP PBX **24**. The Internet **38** may be accessed through APs **26** and **26'**, through intranet **40**, and through IP PBX **24**. Each AP **26** has a range of RF broadcast signals **28** represented by area **30**. A wireless mobile telephone **32** can transmit and receive digital voice signals **34** through one or more APs **26** to the IP PBX **24**. A wireless telephone **32** can place calls through the IP PBX switch **24** to the PSTN **40** or the call may be routed through the Internet **38**, or other type of LAN, to a remote receiver. Multiple APs **26**, **26'** provide an enterprise wide footprint that can be accessed by a wireless handset **32**, depending upon natural signal attenuation of a broadcast signal and intereferences. An enterprise network typically has multiple APs distributed throughout an office or between multiple buildings so that the handset may be operated nearly anywhere in the network broadcast area **30**. Therefore, a wireless handset can operate/function within an office with multiple APs or between APs in multiple office buildings with seamless handoffs between the different APs in the same network. Since the 802.11 network is traditionally a data network, a wireless endpoint, such as laptop computer **36**, may access the Internet **38** through an AP **26'**. In such a configuration, an enterprise 802.11 data network **22** is leveraged for VoIP calls and wireless data access by a wireless endpoint such as mobile phones or wireless network interface card in a computer **36**.

[0014] The diagram in **FIG. 3** illustrates the general assumption that an 802.11 wireless home network rarely has more than one AP **44** per household. AP **44** connects to router **53**, which connects to either Internet **38** or connects to PSTN **40** through gateway **52**. In a home network **42**, RF broadcast signal area **46** is typically adequate from a single AP **44** unless a larger area of coverage is desired. In such a case, extender technology may be used to expand coverage, but using an expander would be the exceptional case. A wireless handset **48** sends voice signals **50** to an AP **44** that is networked into VOIP gateway **52**. The VOIP gateway **52** sends voice signals to either the Internet **38** or to the PSTN **40**. Laptop computer **54** may also connect to the Internet **38** through AP **44**.

[0015] Many retail locations, airports, and coffee shops throughout the United States now provide "hotspot" wireless networks. **FIG. 4** illustrates a hotspot network **56** with RF signal coverage area **58**. Hotspots are typically 802.11 WLAN carriers that may be accessed through a wireless endpoint **60** that connects to an AP **62**. The user is authenticated through an authentication server **63**, such as a RADIUS server, in order to access Internet **38** through a subscription with an Internet service provider.

[0016] Conventional solutions to wireless voice networks include a single telephone that can theoretically roam between both an 802.11 WLAN network and a cellular network the two networks to place and receive calls, and a handset can detect when the user is within range of a signal from either network, with one network preferred over another depending on user preferences. Providing seamless roaming between a wireless LAN using VOIP protocols and a cellular network (e.g., to move from a wireless LAN network signal using IP protocols to a cellular network signal), however, creates complicated technical issues. Complex internetworking challenges between cellular and wireless LAN protocols have to be resolved. Further, cellular telephone network standards may have to be modified as well. The result is that the handset disconnects from a current network and must re-route a call to a completely different network with different protocols and different call setup procedures. Cellular network service providers will most likely be reluctant to embrace a system that disconnects from their cellular networks to place and receive calls, resulting in loss of revenue. The decision tree to determine when such a handoff or roam should occur, the need for interoperability between different cellular carriers and LAN-based networks, combined with irritation to a user who wishes to maintain a call in progress, are all problems with such a system.

SUMMARY

[0017] The present invention overcomes the limitations of conventional cellular and wireless IP phones by offering a dual mode telephone that supports multiple protocols without needing seamless roaming between different networks and different network carriers. While the conventional approach to a wireless IP phone with multiple network capabilities is to roam between multiple networks, the present invention maintains connectivity by maintaining separate channels to all available networks simultaneously. A user may choose which network to use for outgoing calls, for example cellular network or a VOIP call on an 802.11 enterprise network. The exemplary mobile phone can terminate VOIP or cellular calls depending on the availability of each respective network's RF signal coverage area.

[0018] The exemplary mobile phone can automatically sense when the user is located in a particular network broadcast signal area and perform call setup operations for each type of network. When the mobile phone enters a wireless LAN coverage area at the user's home, the mobile phone assumes the functionality of a home cordless telephone, able to send and receive calls with the user's home telephone number. When the mobile phone is located within wireless IP PBX coverage area at a user's place of work or business, the mobile phone assumes the functionality of a wireless PBX telephone and is able to handle calls to and from the work phone number associated with the IP PBX. Additionally, when the mobile telephone is located within a hotspot broadcast coverage area, the exemplary mobile phone can provide call service through the Internet using national VOIP carriers.

[0019] If the mobile phone geographically moves out of a VOIP wireless LAN coverage area or IP PBX coverage area, the user may still make and receive calls using a conventional cellular service provider. Further, when multiple coverage areas are available, such as when a mobile phone is located within an 802.11 coverage area and cellular network area, the mobile phone is capable of making or receiving calls from both networks. If a user is within a cellular coverage area while also within a wireless LAN or IP PBX coverage area, then the phone automatically acquires the capabilities for making an receiving calls on all available networks. When a user travels outside of a wireless LAN or IP PBX coverage area but remains within a cellular coverage area, the mobile phone senses that the only network available is the cellular network and automatically assumes the functionality of a cellular phone to handle calls through a cellular service provider.

[0020] Advantages to the multi-function telephone include there is no need to resolve complex protocol internetworking that is problematic when attempting to handoff a wireless call from a cellular carrier to a VOIP wireless network, and vice-versa. The present invention does not require modification of VOIP network protocols or cellular network protocols. The mobile phone operates within existing protocols on both type of networks and can be upgraded to reflect new or changed protocols. The cellular telephone identity of the present invention is always operational and ready to send and receive cellular-type calls regardless of whether the mobile phone is in a wireless LAN broadcast coverage area. The same mobile phone can provide wireless telephone services as a user's home, work, and cellular network area.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Preferred embodiments of the invention are discussed hereinafter in reference to the drawings, in which:

[0022] **FIG. 1** illustrates a schematic diagram of a cellular telephone network.

[0023] **FIG. 2** illustrates a schematic diagram of an enterprise wireless network.

[0024] **FIG. 3** illustrates a schematic diagram of a wireless home network.

[0025] **FIG. 4** illustrates a schematic diagram of a hotspot network.

[0026] **FIG. 5** illustrates a schematic diagram of the mobile phone in an enterprise and cellular network environment.

[0027] **FIG. 6** illustrates a schematic diagram of the mobile phone in a home and cellular network environment.

[0028] **FIG. 7** illustrates a schematic diagram of the mobile phone in a cellular and virtual private network environment.

[0029] **FIG. 8** illustrates a schematic diagram of the mobile phone in hotspot and cellular network environment.

[0030] **FIG. 9** illustrates a functional diagram the mobile phone in an overlapping cellular and ITU 802.11 network.

[0031] **FIG. 10** illustrates a functional flow diagram of operational functions of a mobile phone accepting calls from a cellular network and a wireless LAN.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0032] **FIG. 5** is a schematic diagram of the mobile telephone **70** of the preferred exemplary embodiment operating within a multi-network environment. The mobile telephone **70** connects simultaneously to wireless enterprise network **22** or wireless home network **42** and cellular telephone network **10**, depending on the location of the phone and coverage area of each network, and is configured to handle calls through either the cellular network **10** or a wireless network simultaneously. Each network transmits voice signals using separate protocols for each distinctive network, for example voice over Internet protocols (VOIP) for packet-based IP enterprise network **22** and home network **42** and appropriate codecs for cellular telephone networks such as global services for mobile communications (GSM) protocols.

[0033] Mobile phone **70** is a universal wireless handset containing a cellular operation mode that can route calls under cellular protocols and a VOIP mode that can route calls under VOIP protocols. In **FIG. 5**, mobile phone **70** is located within cellular telephone network **10**. Base station tower **12** broadcasts and receives RF signals **14** up to broadcast area **16**. RF signals **14** include downlink and uplink voice channels, such as channel **18** that is received by mobile phone **70**. In this mode, mobile phone **70** operates as a traditional cellular telephone.

[0034] Mobile phone **70** is also located within enterprise network **22**. An enterprise network typically is employed by a large commercial office, industrial complex, or academic facility. Enterprise network **22** is an IEEE 802.11 wireless local area network (WLAN) network. For implementing voice capability, a wireless LAN may use multiple access points and multiple access technologies (e.g., 802.11 a/g) to minimize interference and increase capacity and coverage. An enterprise 802.11 network **22** is leveraged for VOIP: the network comprises multiple APs that provide an enterprise wide footprint. The exemplary handset can "roam" between APs, allowing a user to move freely within the network coverage area. While "roaming" is defined as the ability for a cellular phone customer to automatically make and receive calls when the cellular handset has geographically moved outside of a service provider's home network coverage area and use an alternate network operated by a different service provider, "roaming" between APs refers to a same concept to move the exemplary IP phone between different APs on the same or alternate networks. Enterprise-wide mobility allows affordable mobile connectivity to a large population of employees and can provide enterprise IP-PBX features on a mobile phone such as voice mail, conferencing, transfer, and extension dialing. No additional hardware or software is necessary other than the mobile phone if the enterprise has an 802.11 enabled VOIP capability.

[0035] In enterprise network **22**, access points (APs) **26** and **26'** broadcast RF signals up to the limits of broadcast area **30**. Access points **26**, **26'** are networked to a personal branch exchange (PBX) switch that uses IP protocols to place a voice call either through the public system telephone network (PSTN) **40** or over the Internet **38**. An enterprise network typically has a plurality of APs distributed throughout one or more floors of an office building or between office buildings in a complex. Mobile phone **70** connects to an

access point **26** on the wireless network over an RF channel **34** that is transmitted using 802.11 protocols. Calls placed and received from mobile phone **70** through IP PBX **24** are routed through either the Internet **38** or other network or may be routed directly to the PSTN **40** depending on the type of call and configuration of IP PBX **24**. The routing of calls out of enterprise network **22** is controlled by IP PBX **24**, however, calls placed using VOIP would be routed to a remote VOIP gateway or telephone over a packet network, such as Internet **38**.

[**0036**] The mobile phone **70** provides simultaneous connectivity to a cellular **10** and a VOIP 802.11 wireless network. Hardware/software within the phone **70** automatically senses when a specific network is within transmission range and sets up the phone appropriately for the specific network thereby preparing the phone for use without user interaction. The mobile phone **70** can accept and place multiple calls using multiple channels over different wireless network systems simultaneously without traditional roaming between networks using a single uplink channel. In this mode, complex network interoperation and signaling that would otherwise be necessary to "roam" between cellular and an 802.11 network are avoided. Conventional roaming is the ability for a cellular customer to automatically make and receive calls when the cellular handset has geographically moved outside of a service provider's home network coverage area and uses an alternate network operated by a different service provider. Here, roaming includes the ability to move seamlessly between different types of networks (e.g., 802.11 hifi and cellular networks). The capability of placing a voice call with a specific protocol using a certain network is independent of one another. In the exemplary embodiment, the mobile phone **70** not only distinguishes between a VOIP call over an 802.11 network and a voice call over a cellular network but also provides simultaneous connectivity to cellular and 802.11 networks using separate channels and hardware/software that recognizes the difference between call procedures for an enterprise business network **22**, public cellular network **10**, and home network **42**.

[**0037**] The exemplary mobile phone serves as a VOIP wireless LAN phone if cellular telephone service is unavailable or the signal is degraded by high interference. Conversely, the mobile phone serves as a traditional cellular wireless phone if a VOIP wireless LAN is unavailable. However, the exemplary mobile phone can stay connected to a cellular network if a user chooses and as long as a signal of sufficient strength is received by the phone from the cellular BTS. When more than one type of network is available such as in an 802.11 area and cellular network area, the mobile phone may stay connected to both networks and allow the user to select the network in which an outgoing call is placed.

[**0038**] When a user carrying mobile telephone **70** is located in a strictly cellular network coverage area **16**, only calls using the user's cellular network service are possible. The cellular network service configured to phone **70** may be any of the commercial cellular or PCS services available in the marketplace. When mobile phone **70** is located within range of enterprise network RF coverage area **30** but also within cellular RF coverage area **16**, it is capable of performing call VOIP setup procedures using, for example, Session Initiation Protocol (SIP), H.323 or ITU G.711 protocols, and sending the call over RF channel **34** through IP PBX **24** and simultaneously transmitting and receiving cellular calls through tower **12** over cellular channel **18**. The mobile phone **70** is may stay connected to both networks, unless the signal is out of range and too weak to receive, so that calls from either network system can be placed and received by using a switching feature on the mobile phone **70**. Further, the mobile phone **70** recognizes the presence of an enterprise WLAN network, associates/registers with IP PBX **24**, and sets up VOIP configurations appropriately. This way, the user may enter 802.11 network **22** at his or her place of business or employment and begin receiving calls from the user's business or work telephone number without disconnecting from the telephone's **70** cellular telephone number.

[**0039**] **FIG. 6** illustrates a schematic diagram of the mobile phone **70** moved out of range of enterprise network **22** and into and area that includes both cellular network coverage area **16** and of home network **42** coverage area **46** while maintaining simultaneous service connections. Home network **42** is an 802.11 network with a wireless AP **44** networked to a voice over IP gateway **52**. Gateway **52** is connected to the PSTN **40** and/or Internet **38**. The mobile phone **70** senses the home network environments and automatically configures dialing and transmission protocols for the home network including IP address and phone numbers recognized by gateway **52**. A further user preference may preset which network is used as a default, such as always dial from a wireless LAN in the enterprise **22** or home **42** network when the signal from each respective has sufficient strength.

[**0040**] When a user enters a zone covered by more than one network, the phone senses the user's location and can notify a user's PBX on an enterprise network and home gateway on a home 802.11 network to route calls placed to those numbers to the mobile phone's current location. Routing of calls for cellular networks occurs through a cellular service provider. If calls are received from different networks simultaneously, a user may place one call on hold and answer the second call by performing a call waiting switch on the handset. If the user is engaged in a call that is placed over a cellular network, the user may place the cellular call on hold and answer the rerouted office call received over the 802.11 WLAN system. The remote caller on the cellular channel does not know that the mobile phone user has switched to an entirely different network. The cellular call has simply been placed on hold for later retrieval. No handoffs are performed between voice channels or service providers, therefore multiple calls are placed with minimal routing interaction by cellular or IP service providers.

[**0041**] Because of the auto discovery feature, the mobile phone may simultaneously enter modes as a WLAN phone (e.g., hotspots/802.11x networks), wireless PBX phone (e.g., enterprise network), and a cellular telephone, whenever the phone is moved within range of each respective network. Each mode of the mobile phone can operate with minimal cooperation from an Internet gateway or PBX controller since the control of the voice channels occurs at the handset, not the gateways or ITSPs. The user must enter profiles for the mobile phone that match each different type of network with which the mobile phone **70** will interact. These profiles include setup commands and network-specific parameters. The profiles are saved into memory and may be activated

manually by a user upon the phone sensing a new network or automatically by the phone. Upon discovery and auto-configuration of a network parameters, the mobile phone searches internally for the correct profile to match the network. A display on the mobile phone may show a list of all the possible networks that are accessible for placing and receiving calls and the protocols available for sending calls over each of those networks.

[0042] Thus, referring again to **FIG. 6**, when a user moves mobile phone **70** out of enterprise network coverage area **30** moves and into the home network the coverage area **46**, the handset will automatically sense and detect the home network broadcast signal from the AP and interface with gateway **52** to send and receive VOIP calls. As long as the phone **70** remains in a signal broadcast areas covered by the cellular network **16** and the home network **46**, the telephone can receive calls or place calls over either network. If mobile phone **70** moves out of cellular network coverage area **16** but remains within home network coverage area **46** (e.g., area **64** in **FIG. 6**), the phone **70** continues to route calls to gateway **52** using 802.11 and VOIP protocols through AP **44**.

[0043] The exemplary embodiment therefore provides a wireless telephone handset that does not disconnect from a cellular network, senses the presence of an appropriate WLAN network (e.g., 802.11x network) and initiates the process to obtain access to the WLAN network. In this example, the user does not switch between different networks, nor does the mobile phone **70** perform a "handoff" procedure between service providers for a wireless LAN and cellular network. Therefore, the same mobile phone becomes an extension of a wireless IP PBX office phone from a user's workplace when the user is accessing the user's enterprise network or the mobile phone becomes an extension of a home telephone when the user is in the user's home WLAN network coverage area.

[0044] A virtual private network (VPN) may also be employed to provide connectivity between a home network or remote small office network and a main enterprise network comprising an IP PBX. As a further example of connectivity of the present invention, **FIG. 7** illustrates a schematic diagram of mobile phone **70** located home network area **46** and cellular network area **16**. Enterprise network **22** is connected to the user's home VOIP gateway **52** through via a virtual private network (VPN) **66** between enterprise network **22** and home network **42**. VPN **66** provides IP connectivity through Internet **38** to enterprise network's IP PBX **24**. Mobile phone **70** transmits through access point **62** and the call is received through IP PBX **24** at enterprise network **22** allowing a user to access custom PBX features at the user's place of business. Calls received on a work phone number at enterprise network **22** may also be routed from IP PBX **24** to the mobile phone **70** via gateway **52** and AP **44** on the home network **42** without dialing additional numbers, allowing the phone to operate as a seamless extension of a business phone. When the mobile phone **70** is moves from home network area **46** and into the enterprise network area **30**, the mobile phone **70** can automatically establish a connection to IP PBX **24** and signal gateway **52** to route home-based calls to IP PBX **24** through the VPN **66**, thereby allowing the mobile phone **70** to operate as a home phone extension. Whether connecting over a VPN or standard broadband connection from a home or small office, the mobile handset offers cost savings and flexibility using VOIP through the Internet and keeping a single mobile phone for home, office, and cellular telephone calls.

[0045] The schematic diagram of **FIG. 8** illustrates a "hotspot" network, enterprise network, and cellular network having overlapping RF broadcast coverage areas **58**, **30**, and **16**, respectively. Hotspot network **56** uses 802.11 protocols and broadcasts RF signals from AP **62** over network coverage area **58**. AP is connected to the Internet **38** and uses RADIUS server **63** to authenticate users. A remote information technology service provider (ITSP) VOIP gateway **74** is also connected to Internet **38**. When mobile telephone **70** enters hotspot broadcast area **58** is auto-senses the AP **62** and connects through Internet **38** to gateway **74** while simultaneously remaining on channel **68** to cellular network **10** if the phone **70** remains within network area **16**. Voice packets containing VOIP payloads are automatically transmitted to gateway **74** performing call setup procedures. The gateway provides coding and decoding protocols to transmit voice signals to a remote gateway or to the PSTN **40**. A user may set a preference to send and receive all calls, when possible, over the hotspot network, thereby reducing the number of minutes, and expense, spent on a cellular network service provider. By using a national ITSP that carries VOIP calls to the telephone's IP address at hotspot **56**, a user can also have all calls forwarded from a home 802.11 network **42** or enterprise network IP PBX **24** to mobile phone **70**.

[0046] The enterprise network is connected to the user's ITSP VOIP gateway **74** via a virtual private network (VPN) **66**. VPN **66** provides IP connectivity through Internet **38** to enterprise network's IP PBX **24**.

[0047] When the mobile phone automatically senses whether the 802.11 network is a home or business network of the user, software in the mobile phone may load preset profiles. Profiles are preprogrammed by the user, containing configurations for the a home access point and VOIP gateway, PBX and IP PBX for use at an office building, and configurations for public hotspots. Profiles can include the type of VOIP codecs for voice compression and hi or low fidelity settings. The mobile phone **70** can display the type of profile and codec settings currently in use by the mobile or codecs that are available for switching based upon the receiving phone or phone system's capabilities.

[0048] When mobile phone is outside of a WLAN network coverage area, the phone searches for available WLANs by sending probe requests and probe responses. When a compatible WLAN is detected, the phone matches the information from the WLAN with one of the stored network profiles. When an WLAN signal is detected, the mobile phone sends an association request to the transmitting AP, and the AP responds back with an association response. Once the response is received, the mobile phone starts an authentication process with the authentication server for the WLAN. As one skilled in the art will know, there are a number of possible authentication processes available for WLAN networks, such as 802.1x, Wi-Fi Protected Access (WPA) or static keys like WEP (Wired Equivalent Privacy). Wi-Fi Protected Access is a specification for a security enhances for data protection/encryption and access control/authentication for WLAN networks. The authentication server is accessible through the AP. An example of an authentication process is the IETF's Extensible Authentication Protocol

(EAP) for 802.1x. The authentication exchange is performed between the mobile phone and the authentication server through an authenticator that acts only as a bridge. From the mobile phone to the authenticator, the protocol is defined as EAP over LANs (EAPOL) or EAP over wireless (EAPOW). On the back-end, the protocol used in RADIUS. The 802.1x authentication occurs after association, an AP is the facilitator of the message exchange between an authentication server and the mobile phone.

[0049] After registration with an authentication server, the mobile phone registers with a VOIP server on the Internet. Registration with a VOIP server registers the mobile phone's location, using a current IP address or other location data, with the phone's telephone number. This procedure provides the phone's VOIP server with a location of the mobile phone so that the server may direct calls made to the phone's telephone number. For example, when a mobile phone enters a hotspot zone, authenticates through a RADIUS server, and registers with an online VOIP server, the VOIP server associates the mobile phone's IP address at the specific hotspot location with the mobile phone's telephone number so that a user may begin to receive calls at the hotspot location.

[0050] **FIG. 9** is an exemplary message flow diagram demonstrating a cellular and a VOIP call to the preferred mobile phone. Cellular system **80** of the mobile phone **70** is active when the mobile phone is within range of a cellular network **76**. Likewise, WLAN VOIP System **82** of the mobile phone is active when the phone is within range of a WLAN **72**, such as an 802.11x network. Gateway **74** is a VOIP gateway used to transmit voice packets through the Internet or other data network. In the example, an incoming cellular call **84** is received by cellular system **80**, which executes a normal call setup procedure. Cellular system issues an alert **86** the user **78** with a caller ID and other relevant information that the cellular call **84** is received. User **78** decides to accept the call **88** in a typical fashion, such as pressing a "send" key on the phone's keypad. After the call is accepted, the cellular system **80** sends a notification **90** to the VOIP System **82** of the incoming call acceptance and assumes control of a microphone and speaker on phone **70**. The cellular call is then in an active state **92**. A similar procedure occurs if the first call received is from the VOIP gateway **74**. The VOIP system **82** would receive the call and sends a notification to the cellular system **80** of the incoming call acceptance and assume control of a microphone and speaker.

[0051] While cellular call is still active **92**, the VOIP system **82** receives an incoming call notification **94** from gateway **74** and executes a normal call setup procedure. VOIP system **82** is aware of the active cellular call **92** and sends an alert **96** to user **78** of a "call waiting from VOIP" instead of a normal incoming call alert. The user decides to accept the VOIP call **98** in a normal fashion, such as pressing a "send" key on the phone's keypad. The VOIP system **82** sends notification **100** to inform cellular system **80** of the accepted VOIP call and then assumes control of the microphone and speaker. The cellular system **80** executes a call hold procedure and places the cellular call on hold **104** while VOIP call is active **102**. A similar procedure occurs if the VOIP system **82** is active and receives a cellular call. In such a case, a "call waiting from Cell" message could appear instead of a normal incoming call alert.

[0052] During the VOIP call, user **78** presses the equivalent of a "flash" key **106** on mobile phone **70** to switch back to the cellular call, which causes the VOIP system **82** to inform cellular system **80** with a notification **108** and pass control of the microphone and speaker to cellular system **80**. VOIP system **82** then executes a call hold procedure and places the VOIP call on hold **110**. The cellular system **80** executes a procedure to "unhold"**112** the cellular call. Afterwards, user **78** completes the cellular call and hangs up **114**. The cellular system executes a call release scenario **116** and informs the VOIP system with a hang up notification **118**. Upon notification **118**, VOIP system **82** assumes control of the microphone and speaker in the phone **70** and rings the phone again **120**. This process is similar to how the PSTN handles call waiting. In a traditional phone, if a user hangs up one line while a second line that was placed on call waiting is still active, the phone will ring to notify the user that the waited call is still on hold.

[0053] User **78** presses a "send" key and notification **124** is sent to VOIP system **82** to switch to the VOIP call, upon which the VOIP system executes a procedure to unhold **126** the VOIP call and make the call active. The user then hangs up the VOIP call **128** and the VOIP system **82** executes a call release procedure **130** to gateway **74**. The VOIP system **82** then informs cellular system **80** with a hang up notification **132** and places the speaker and microphone into an idle state.

[0054] The exemplary sequence will be similar regardless of whether the cellular system **80** or the VOIP system **82** receives the first incoming call. A call waiting procedure is used in either scenario, when one call is cellular and one call is VOIP. Further, the procedure is comparable if both of the incoming calls are cellular or both incoming calls are VOIP. If the mobile phone **70** already has two active calls (e.g., one active VOIP call and one active cellular call), and a third incoming call is received by either system, the system handling the new incoming call will execute a procedure as if the user did not want to answer an incoming "call waiting" call.

[0055] The exemplary mobile phone benefits cellular carriers by fully leveraging cellular telephone network coverage and mobility. Rate of use will increase because a user is more likely to keep the mobile phone with him or her at all times since the phone acts as an extension of a home phone and an office phone. The user will also be less likely to turn the phone off when at home if the mobile phone also acts as the dedicated home telephone. Further, there are no infrastructure changes and capital investments in software programming needed in the various networks since the VOIP over 802.11 and cellular network hardware and software is contained within the mobile phone's handset.

[0056] As one skilled in the art will recognize, the different networks used with mobile phone **70** are not exclusive for the present invention. For example, an enterprise network containing a wireless PBX telephone system may use different connectivity protocols than 802.11, and home or hotspot network may use different IP protocols, such as Bluetooth®. While conventional telephones disconnect from networks or attempt handoffs between networks as they move into and out of overlapping wireless network coverage areas, the exemplary telephone overlaps all of the wireless networks that are available and can indicate to a

user the type of wireless network and strength of a signal from each network. The user may then select one network to send a call but receive a call simultaneously through a different network, depending on which network signals are available, all without obtaining approval from a third party service provider.

[0057] Because many varying and different embodiments may be made within the scope of the inventive concept herein taught, and because many modifications may be made in the embodiments herein detailed in accordance with the descriptive requirements of the law, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

What is claimed:

1. A mobile telephone for connecting to multiple wireless networks, comprising:

a cellular module for handling a call through a cellular telephone network; and

a wireless network module, operably connected to said cellular module, for handling a call through a wireless local area network (WLAN),

wherein said cellular module and said wireless network module transmit simultaneously, and

said mobile telephone detects a WLAN access point and loads an operating WLAN profile for said wireless network module that configures said mobile telephone to site-specific WLAN network parameters.

2. The mobile telephone of claim 1, wherein said profile comprises at least one of a plurality of parameters saved into a memory of said mobile phone of voice compression protocols and Internet Protocol network addresses.

3. The mobile telephone of claim 1, wherein said profile is one of a plurality of profiles which comprise configuration parameters for a plurality of wireless networks comprising a plurality of wireless network locations.

4. The mobile telephone of claim 1, wherein said cellular module handles said calls using cellular network protocols, and

said wireless network module handles said calls on said WLAN using voice over Internet protocols.

5. The mobile phone of claim 1, wherein, when said mobile phone enters a broadcast area of a wireless private branch exchange (PBX) network, said wireless network module senses said wireless PBX and loads a profile specific to said wireless PBX which enables said mobile phone to send and receive calls using a telephone number associated with said wireless PBX.

6. The mobile phone of claim 1, wherein, when said operating profile is loaded into said wireless network module, said wireless network module matches a network address from said profile with said WLAN, allowing said mobile telephone to transmit said call using said telephone number through said WLAN.

7. The mobile telephone of claim 1, wherein, when the mobile phone enters a home WLAN, said wireless network module senses said home WLAN, loads a profile specific to said home WLAN which configures said mobile phone for sending and receiving calls using a home telephone number.

8. The mobile telephone of claim 1, wherein the wireless network module senses broadcast signals from a plurality of different WLANs and loads one of a plurality of said profiles to configure voice over Internet Protocols for said mobile telephone that are pre-configured for each said WLAN.

9. The mobile telephone of claim 7, wherein, when said mobile telephone enters a hotspot network broadcast area, said wireless network module senses said hotspot network and loads one of a plurality of said profiles to configure said mobile telephone to send and receive calls through said hotspot network using appropriate voice over Internet protocols.

10. The mobile telephone of claim 1, wherein said mobile phone cannot handoff a call between said cellular network and said WLAN.

11. The mobile telephone of claim 1, wherein, when said telephone is located in an overlapping cellular network and WLAN area, said cellular module detects said cellular network and loads a cellular module profile to configure said mobile telephone to send and receive calls on said cellular network, and

said wireless network module scans for WLAN signals and matches WLAN parameters with a stored profile that configures said mobile phone to access said WLAN using an authorization procedure that is active on said WLAN and registers said mobile telephone with a gateway on a network connected to said WLAN.

12. The mobile telephone of claim 1, wherein, when said phone receives both said cellular network call and said WLAN call, said phone may switch between the two calls using a call waiting procedure.

13. A mobile telephone for connecting to multiple wireless networks, comprising:

a cellular system that routes calls under cellular protocols;

a wireless network system, operably connected to said cellular module, that routes calls under voice over Internet protocol (VOIP) protocols through a wireless local area network (WLAN); and

a memory system, operably connected to said wireless network system, for saving a plurality of profiles network configuration parameters for said mobile telephone that match each different type of said WLAN with which said mobile telephone interacts,

wherein said cellular system and said wireless network system are configured to route calls simultaneously, and

said mobile telephone detects a specific WLAN and loads at least one of said profiles matching said specific WLAN.

14. The mobile telephone of claim 13, wherein each of said profiles comprises at least one of a plurality of parameters saved into a memory of said mobile phone of voice compression protocols and Internet Protocol network addresses.

15. The mobile phone of claim 13, wherein, when said mobile phone enters a broadcast area of a wireless private branch exchange (PBX) network, said wireless network system detects said wireless PBX and loads one of said profiles specific to said wireless PBX which enables said mobile phone to send and receive calls using a telephone number associated with said wireless PBX.

16. The mobile phone of claim 13, wherein, when one of said profiles loads into said wireless network system, said wireless network system matches a network address from said profile with said WLAN, allowing said mobile telephone to route calls through said WLAN.

17. The mobile telephone of claim 13, wherein said mobile phone cannot handoff a call between said cellular network and said WLAN.

18. The mobile telephone of claim 13, wherein, when said mobile telephone is located in an overlapping cellular network and WLAN are, said cellular system detects said cellular network and loads a cellular system profile to configure said mobile telephone to send and receive calls on said cellular network, and

said wireless network system scans WLAN signals and matches WLAN parameters with a stored profile that configures said mobile phone to access said WLAN using an authorization procedure that is active on said WLAN and registers said mobile telephone with a gateway on a network connected to said WLAN.

* * * * *

EXHIBIT 1023

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(54) SYSTEM AND METHOD FOR CARRYING A WIRELESS BASED SIGNAL OVER WIRING

(75) Inventors: **Ami Hazani**, Ra'anana (IL); **Shlomo Butbul**, Ra'anana (IL); **Yehuda Binder**, Hod Hasharon (IL)

Correspondence Address:
BROWDY AND NEIMARK, P.L.L.C.
624 NINTH STREET, NW
SUITE 300
WASHINGTON, DC 20001-5303 (US)

(73) Assignee: **Serconet Ltd.**, Ra'anana (IL)

(21) Appl. No.: **11/066,442**

(22) Filed: **Feb. 28, 2005**

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May 6, 2004 (IL) 161869

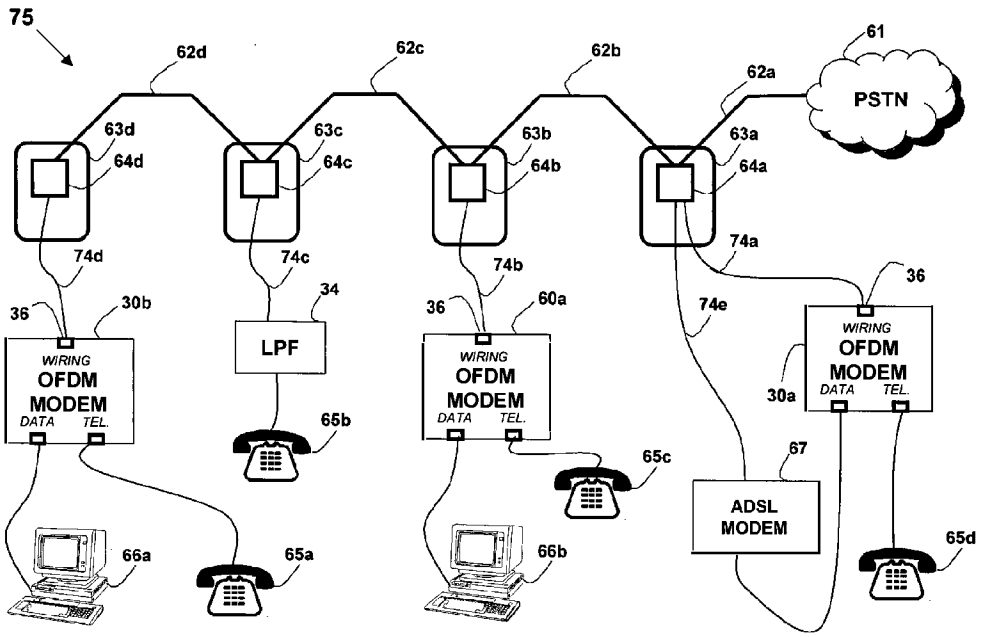
Publication Classification

(51) **Int. Cl.**[7] **H04L 12/66**; H04J 1/00; H04H 1/04

(52) **U.S. Cl.** **370/485**; 370/487

(57) **ABSTRACT**

A device, network and method wherein a standard wireless modem is coupled to wiring for carrying a wireless baseband signal that may be OFDM based, and may be directly generated by the wireless IF modem, or extracted from the modem RF signal. The wiring may be a building utility wiring, such as telephone, AC power or CATV wiring. The baseband signal is carried simultaneously with the utility service signal over the utility wiring using Frequency Division Multiplexing. The device may be enclosed with a data unit, a standalone dedicated enclosure, within an outlet or as a plug-in outlet adapter. Data units may couple the device by a wiring port such as standard data connector, or via wireless connection. The device may be locally powered or via a power signal carried over the wiring. This abstract is not intended to limit or construe the scope of the claims.



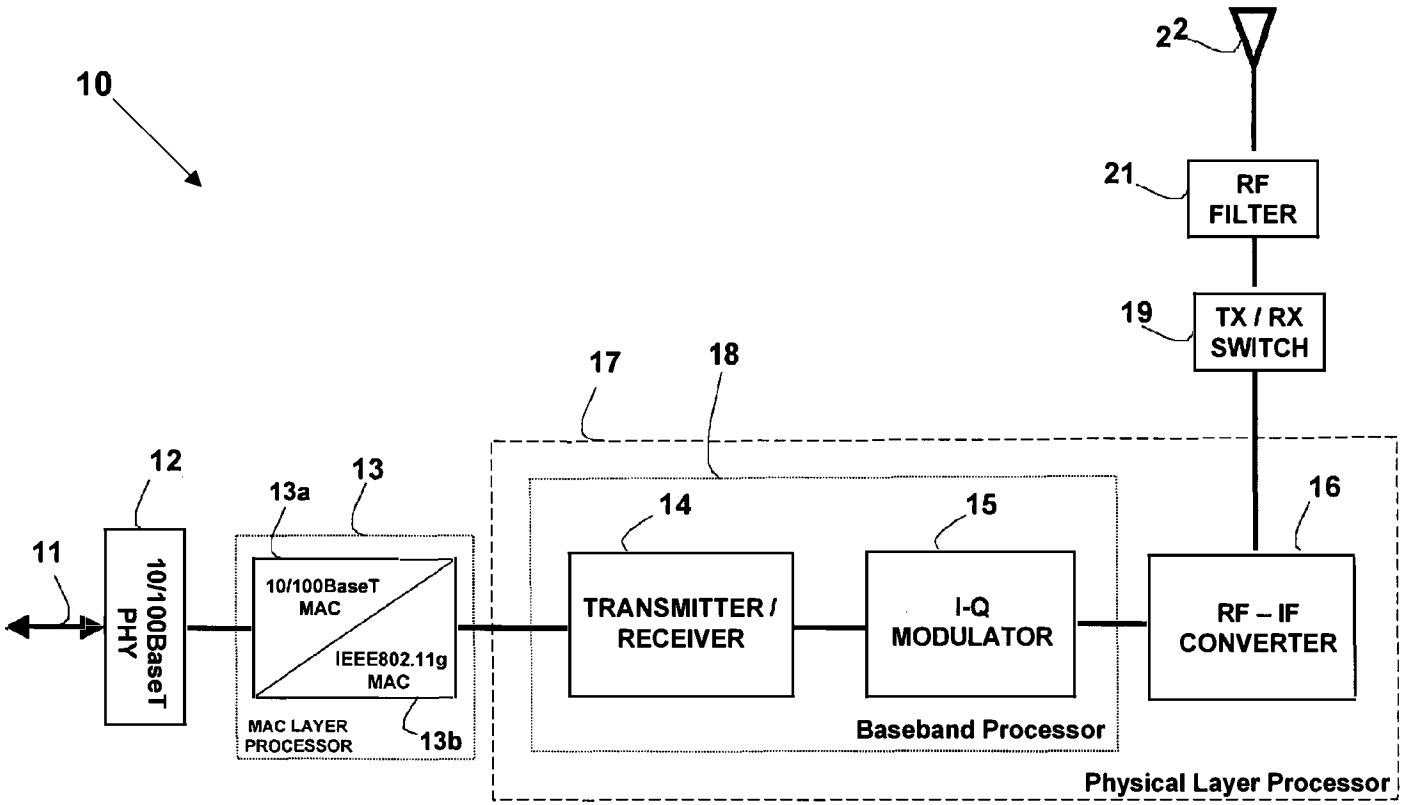


Figure 1 (Prior Art)

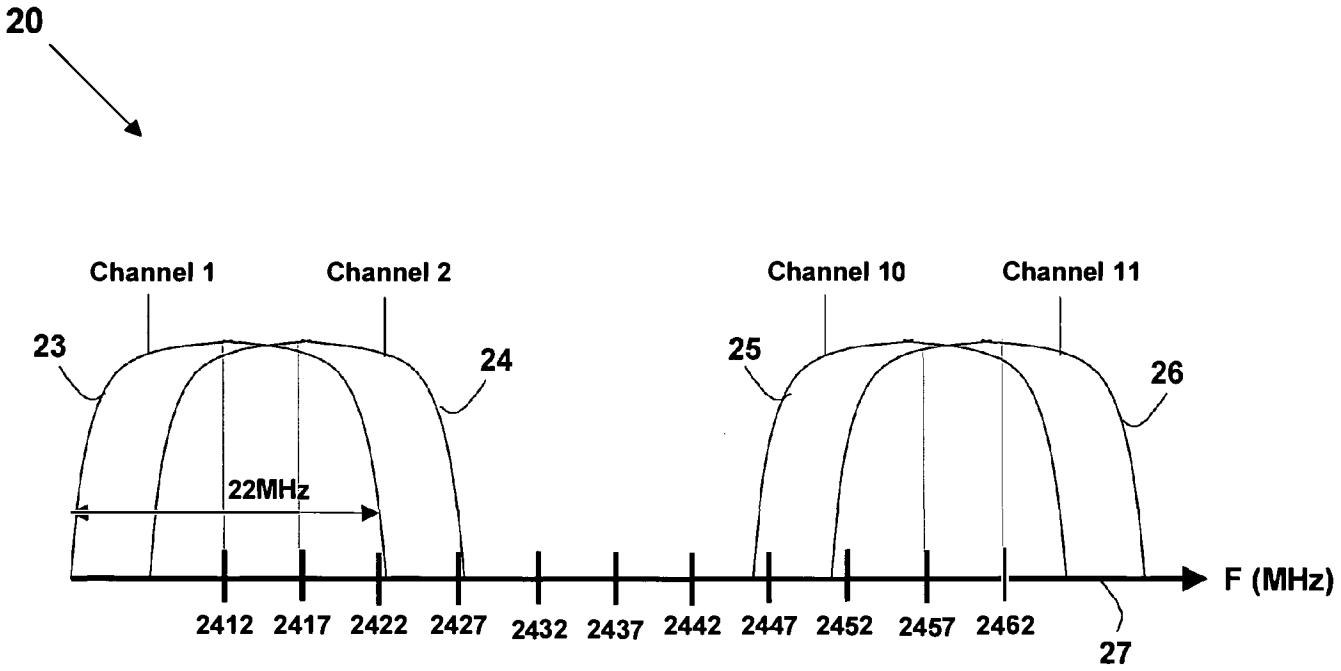


Figure 2 (Prior Art)

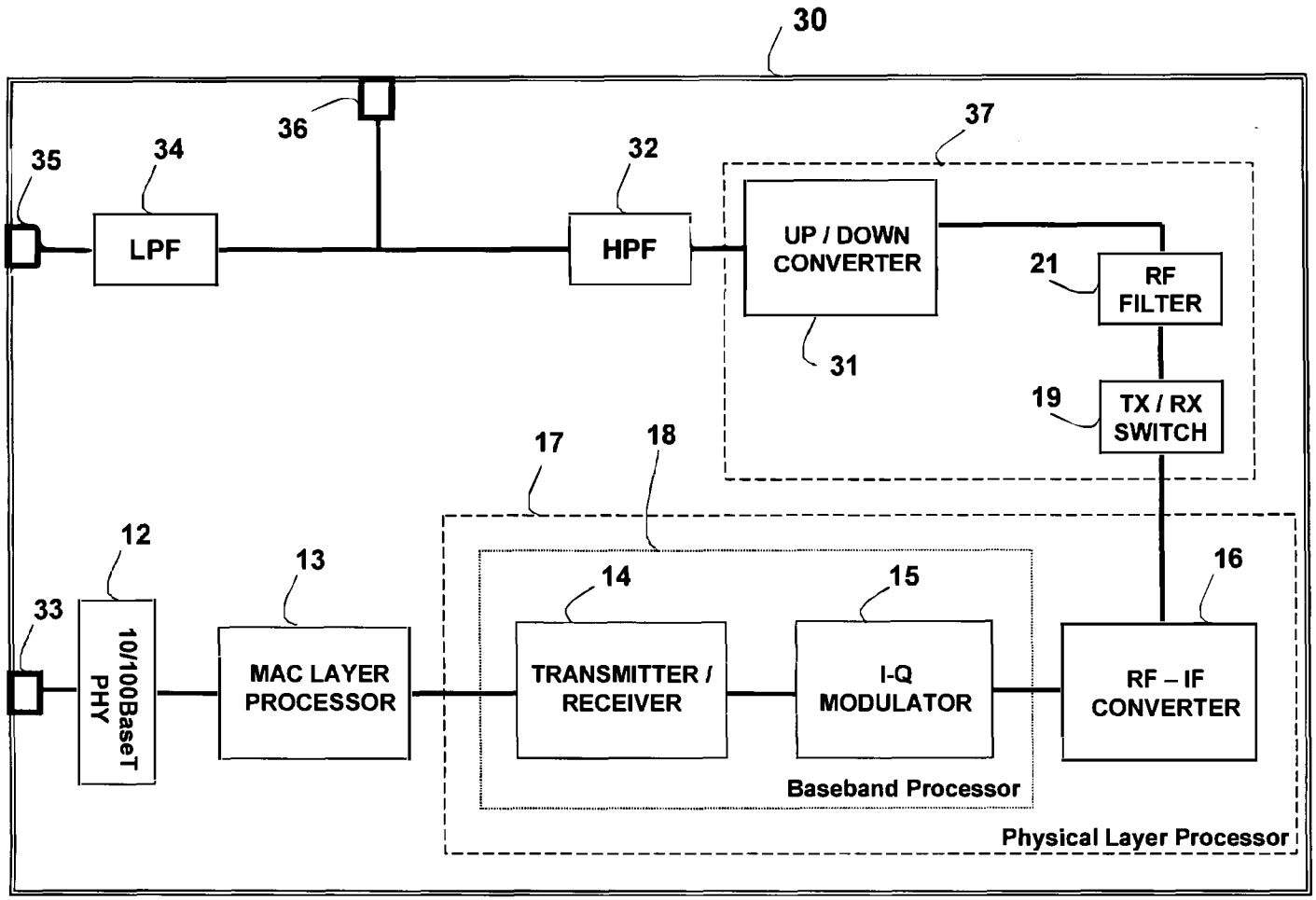

30
36
37
35
34
32
LPF
HPF
UP / DOWN CONVERTER
21
RF FILTER
31
19
TX / RX SWITCH
17
18
12
13
14
15
16
33
10/100BaseT PHY
MAC LAYER PROCESSOR
TRANSMITTER / RECEIVER
I-Q MODULATOR
RF – IF CONVERTER
Baseband Processor
Physical Layer Processor

Figure 3

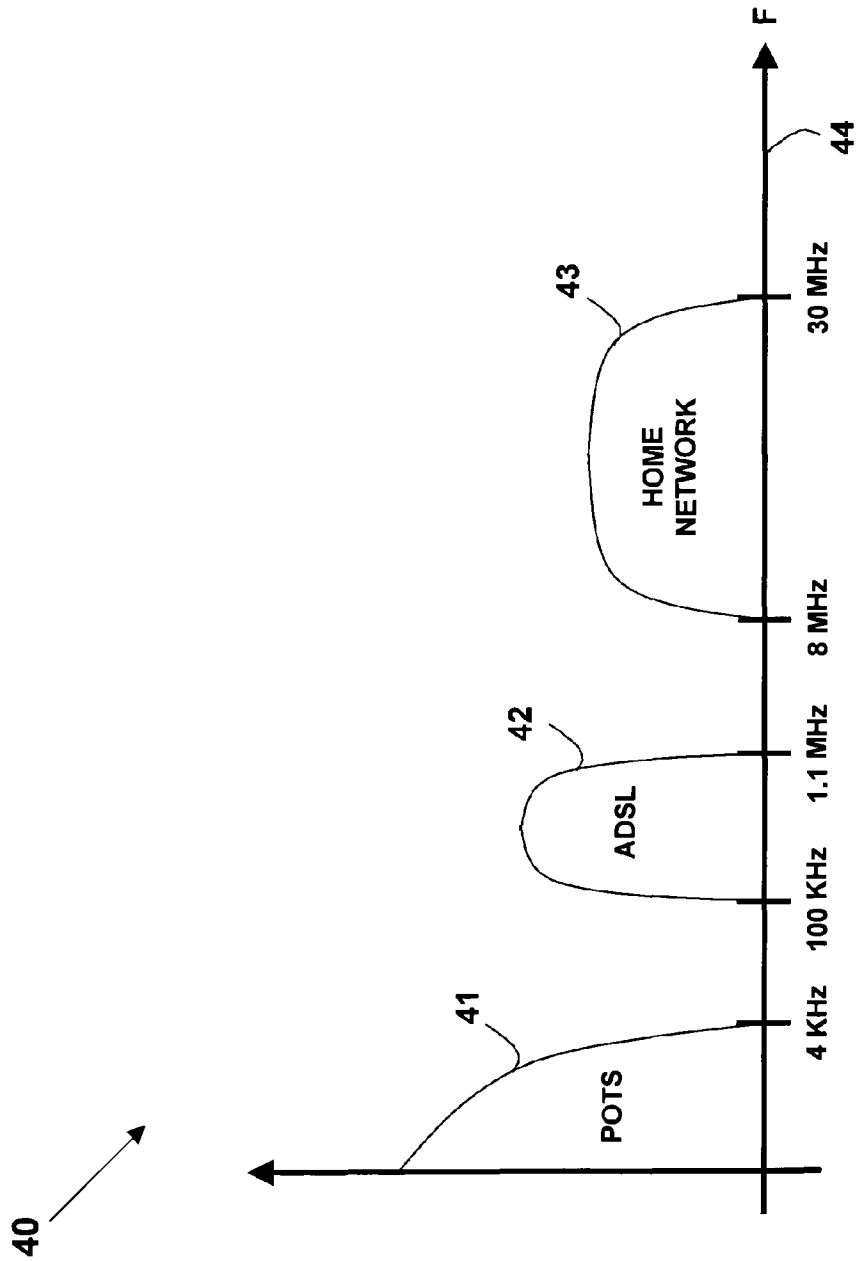

40
41
POTS
4 KHz
42
ADSL
100 KHz
1.1 MHz
43
HOME NETWORK
8 MHz
30 MHz
44
F

Figure 4

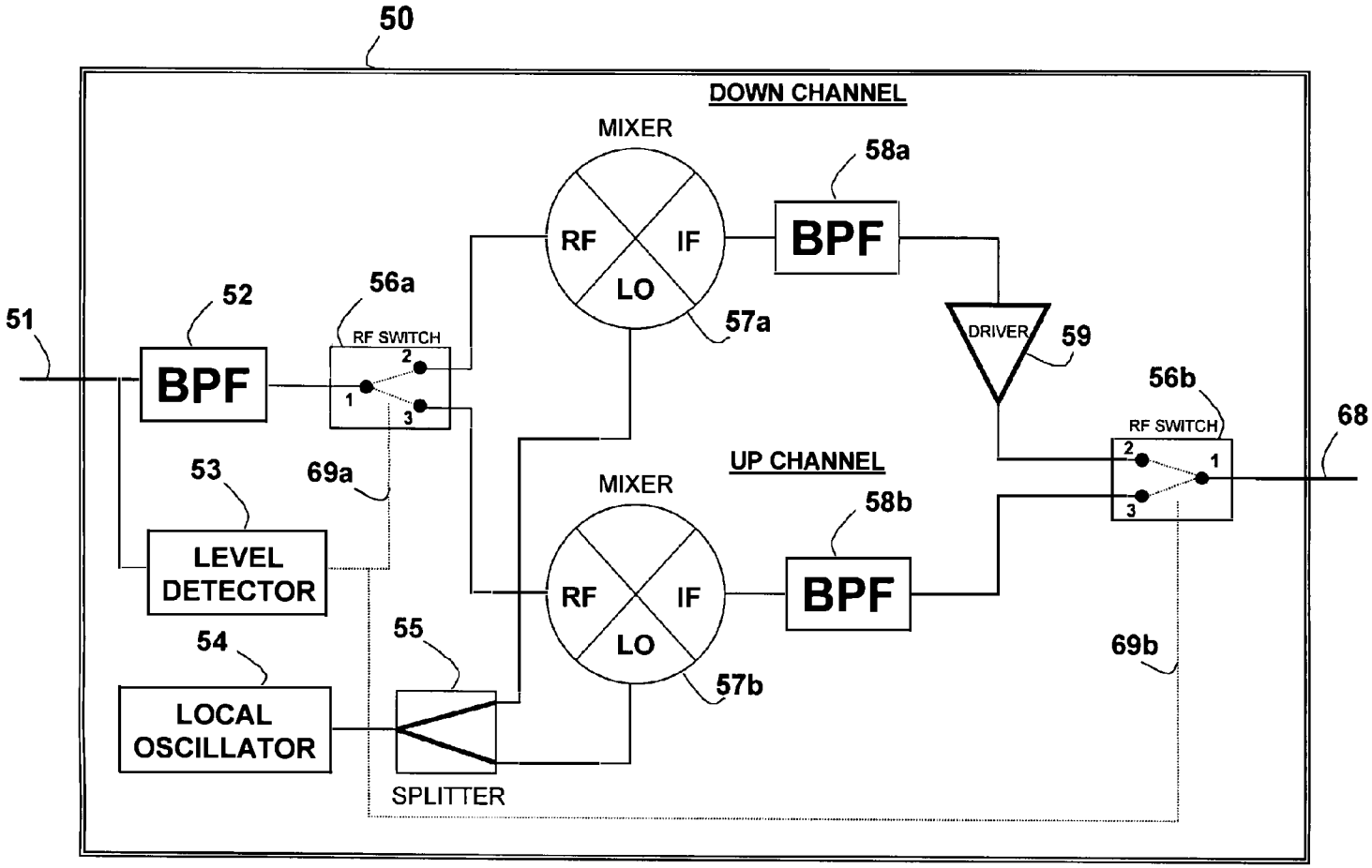

50
DOWN CHANNEL
MIXER
58a
RF
IF
LO
BPF
57a
DRIVER
59
51
52
56a
RF SWITCH
BPF
2
1
3
56b
RF SWITCH
68
UP CHANNEL
MIXER
53
69a
58b
LEVEL DETECTOR
RF
IF
LO
BPF
54
55
69b
57b
LOCAL OSCILLATOR
SPLITTER

Figure 5

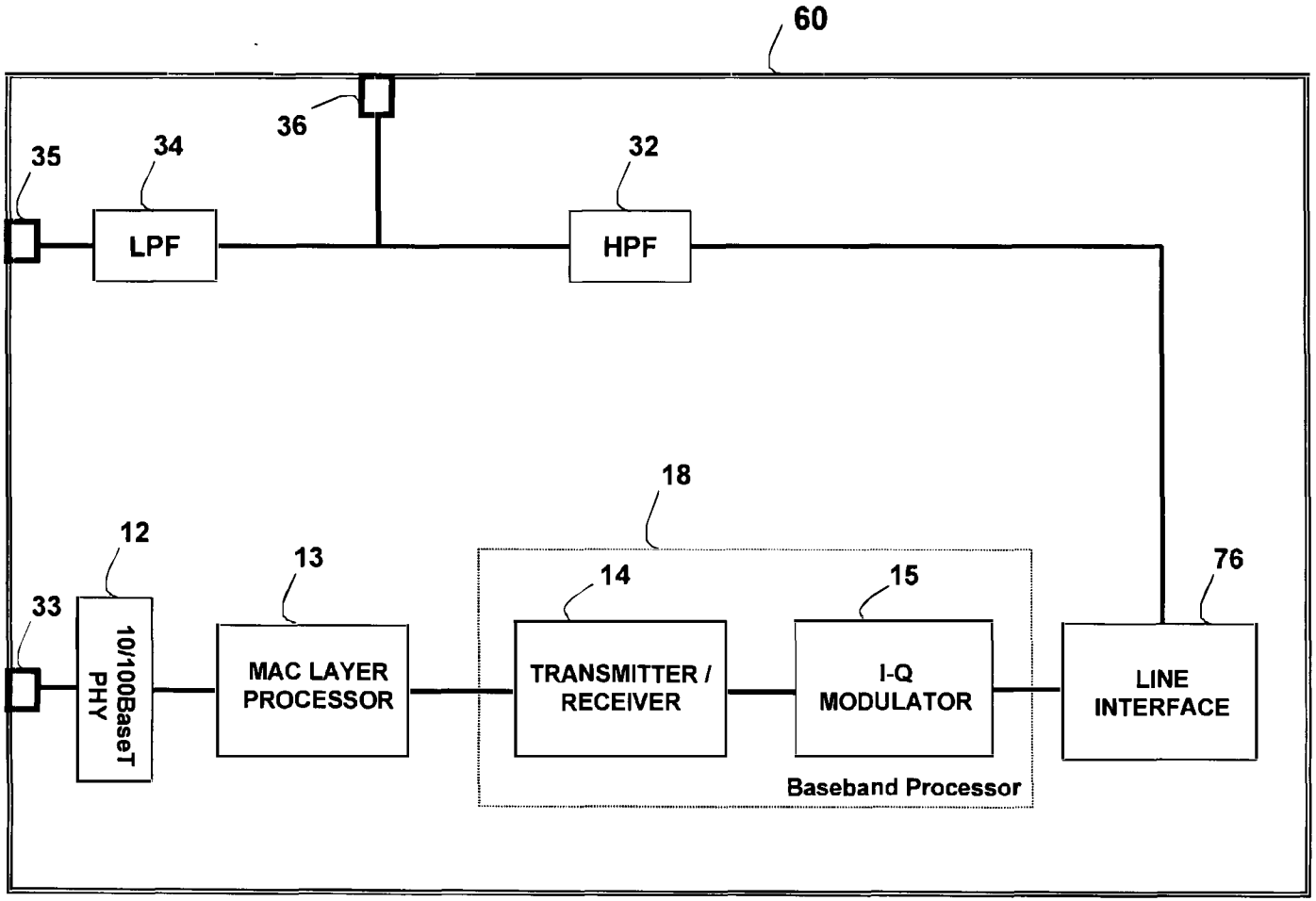

60
36
35
34
32
LPF
HPF
18
12
13
14
15
76
33
10/100BaseT PHY
MAC LAYER PROCESSOR
TRANSMITTER / RECEIVER
I-Q MODULATOR
LINE INTERFACE
Baseband Processor

Figure 6

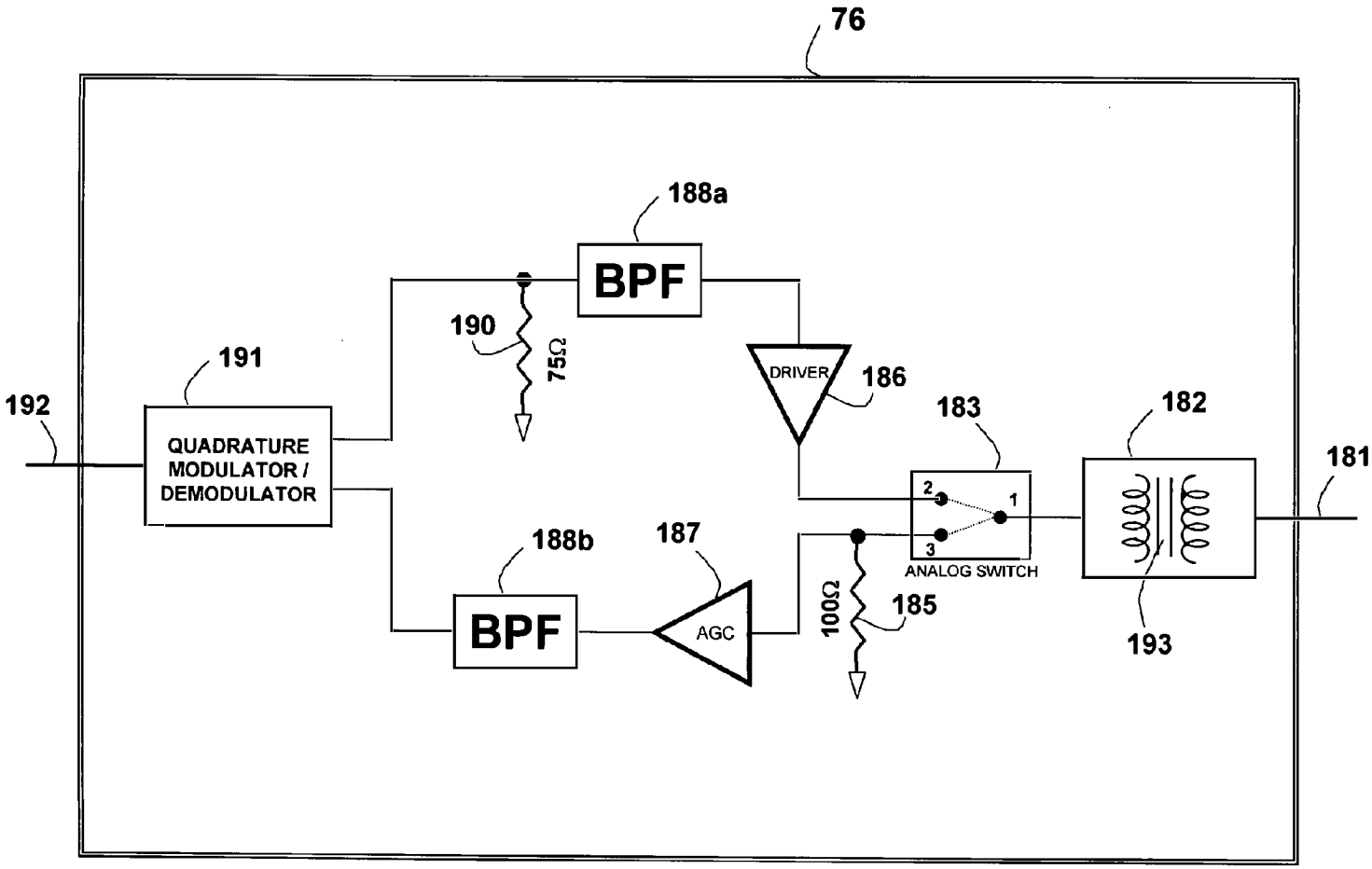

76
188a
BPF
190
75Ω
191
192
QUADRATURE MODULATOR / DEMODULATOR
DRIVER
186
183
182
181
2
1
3
ANALOG SWITCH
188b
187
BPF
AGC
100Ω
185
193

Figure 6a

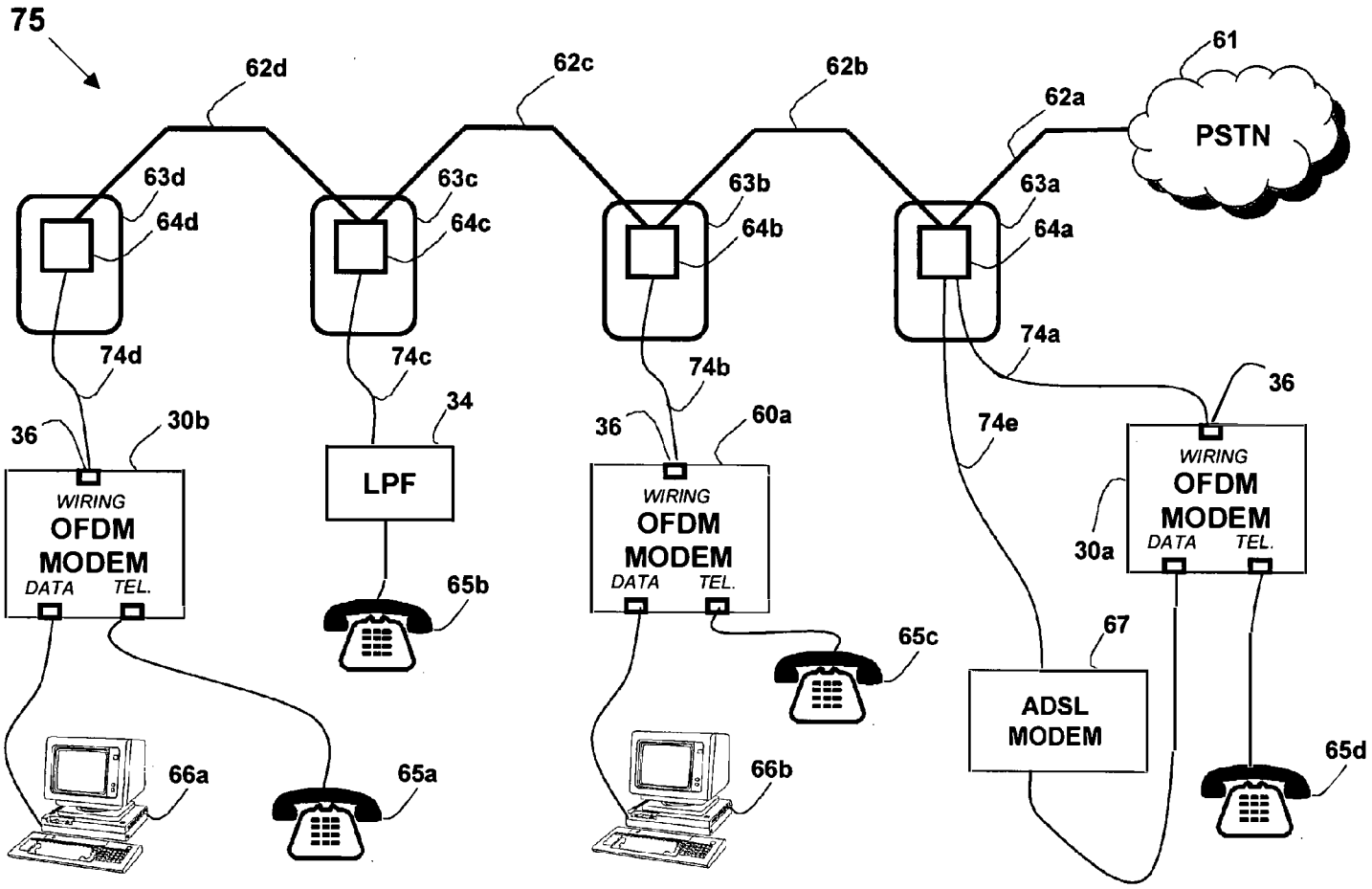

75
62d
62c
62b
62a
61
PSTN
63d
64d
63c
64c
63b
64b
63a
64a
74d
74c
74b
74a
36
30b
34
60a
74e
WIRING
OFDM
MODEM
DATA
TEL.
LPF
65b
65c
30a
67
ADSL
MODEM
65d
66a
65a
66b

Figure 6b

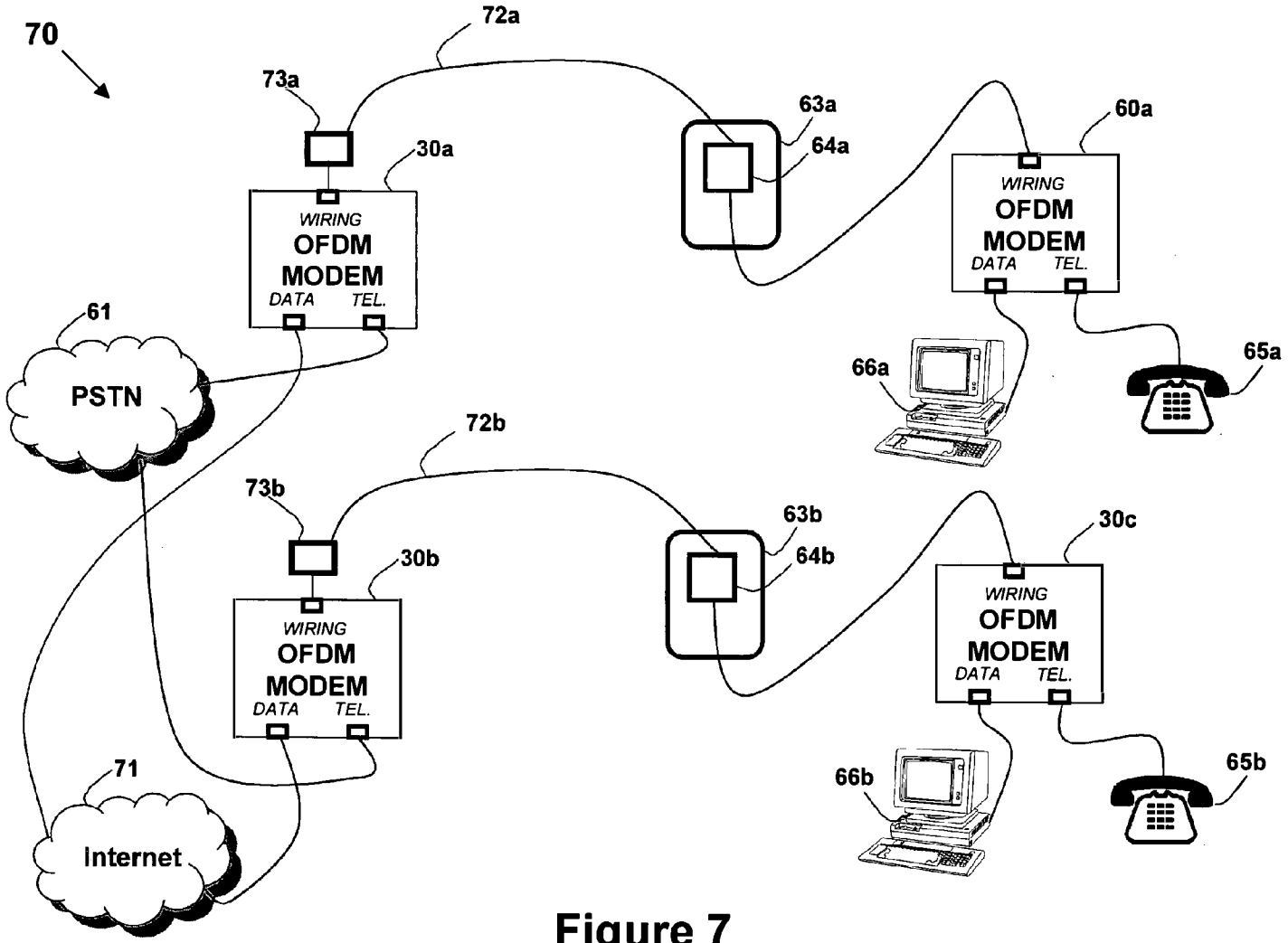

70
72a
73a
30a
63a
64a
60a
WIRING
OFDM
MODEM
DATA TEL.
61
PSTN
66a
65a
72b
73b
63b
64b
30b
30c
71
Internet
66b
65b

Figure 7

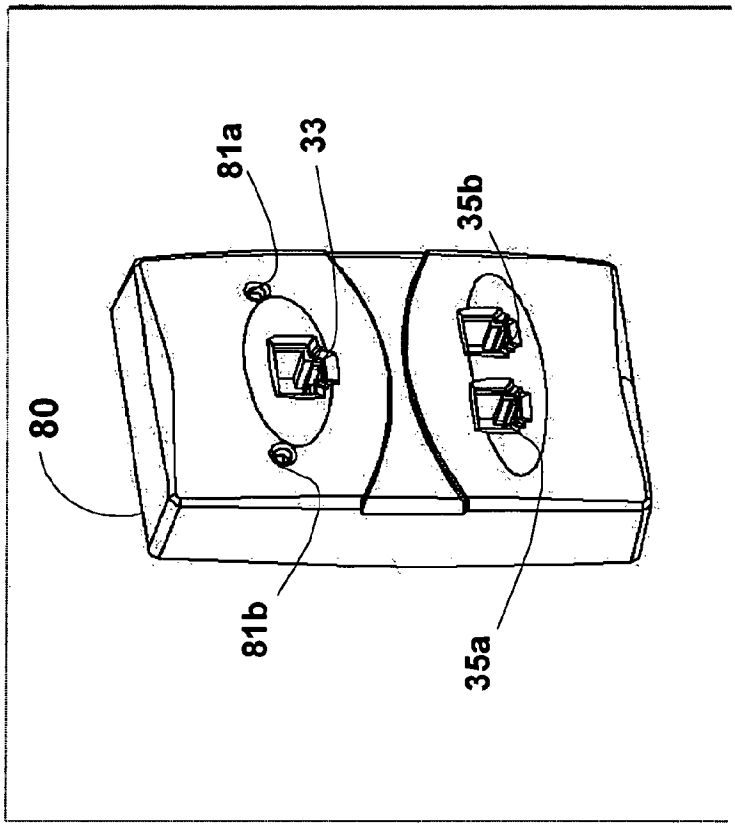


Figure 8

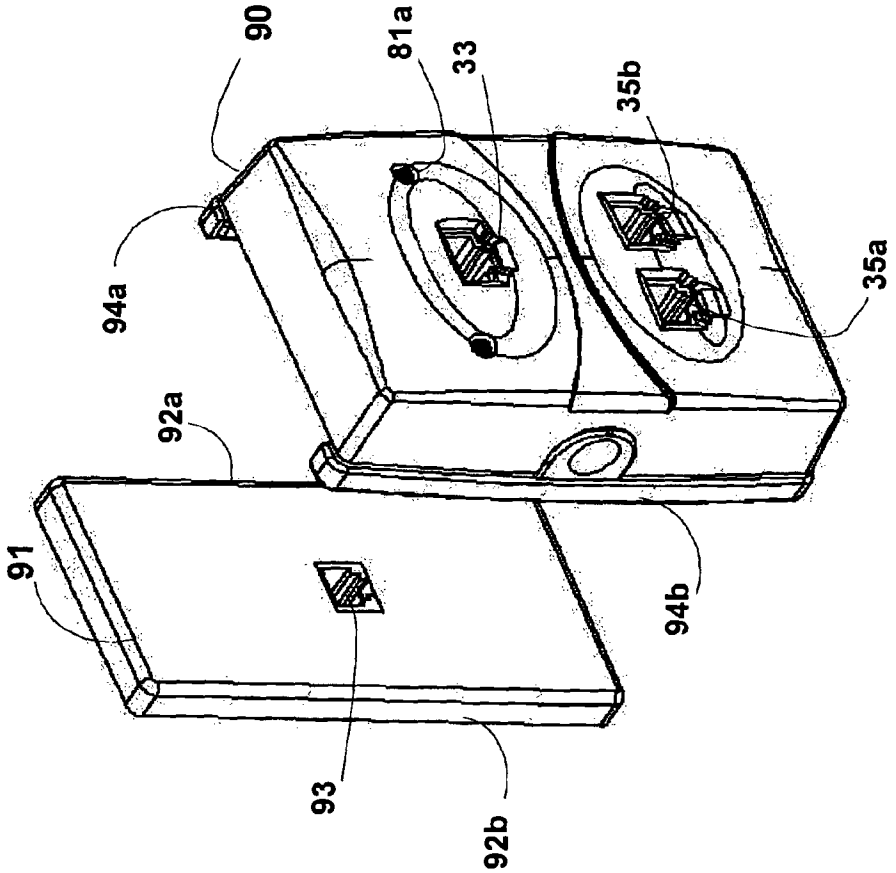
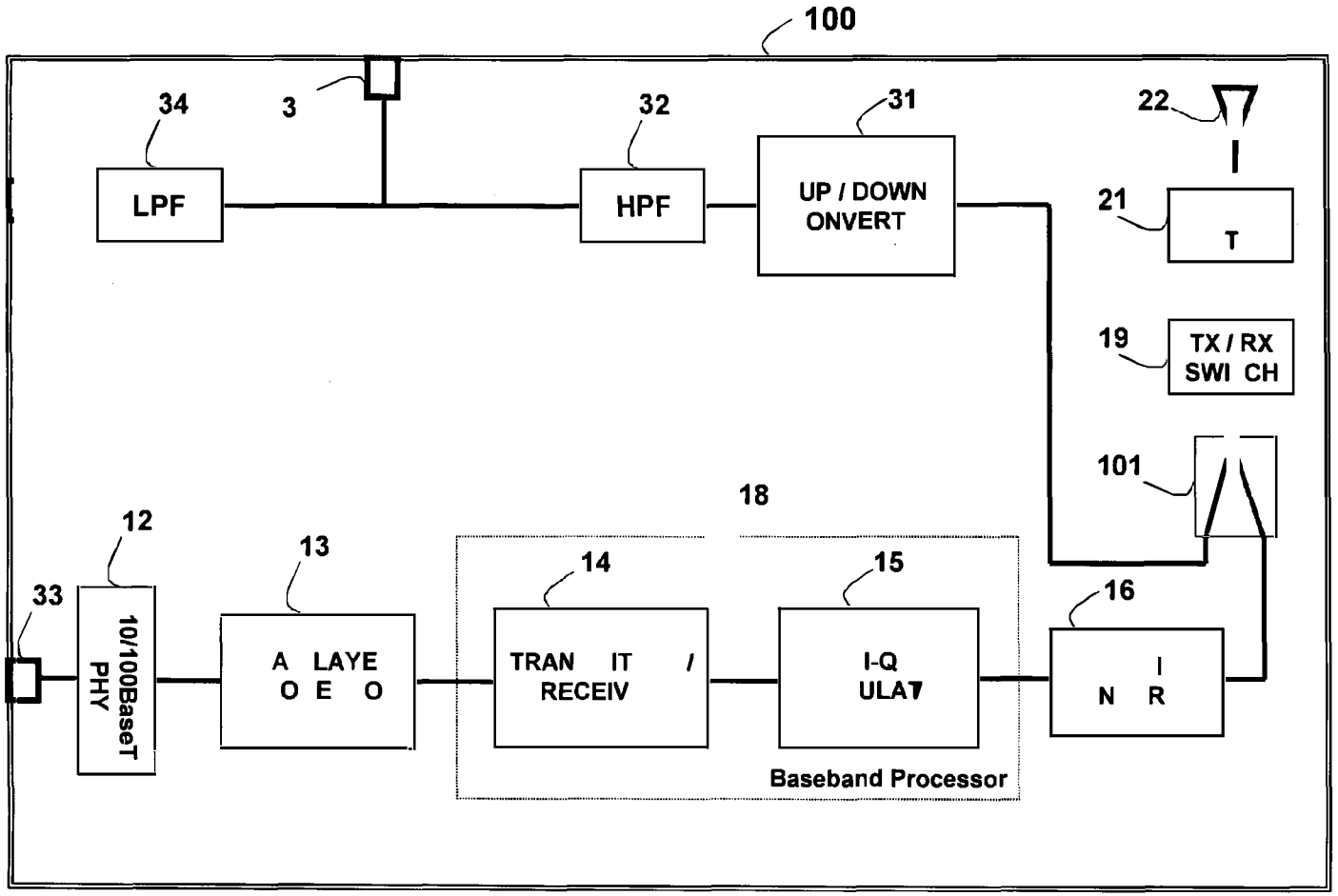


Figure 9


100
34
3
32
31
22
LPF
HPF
UP / DOWN
ONVERT
21
T
19
TX / RX
SWI CH
101
18
12
13
14
15
16
33
10/100BaseT
PHY
A LAYE
O E O
TRAN IT /
RECEIV
I-Q
ULAT
I
N R
Baseband Processor

Fi re 10

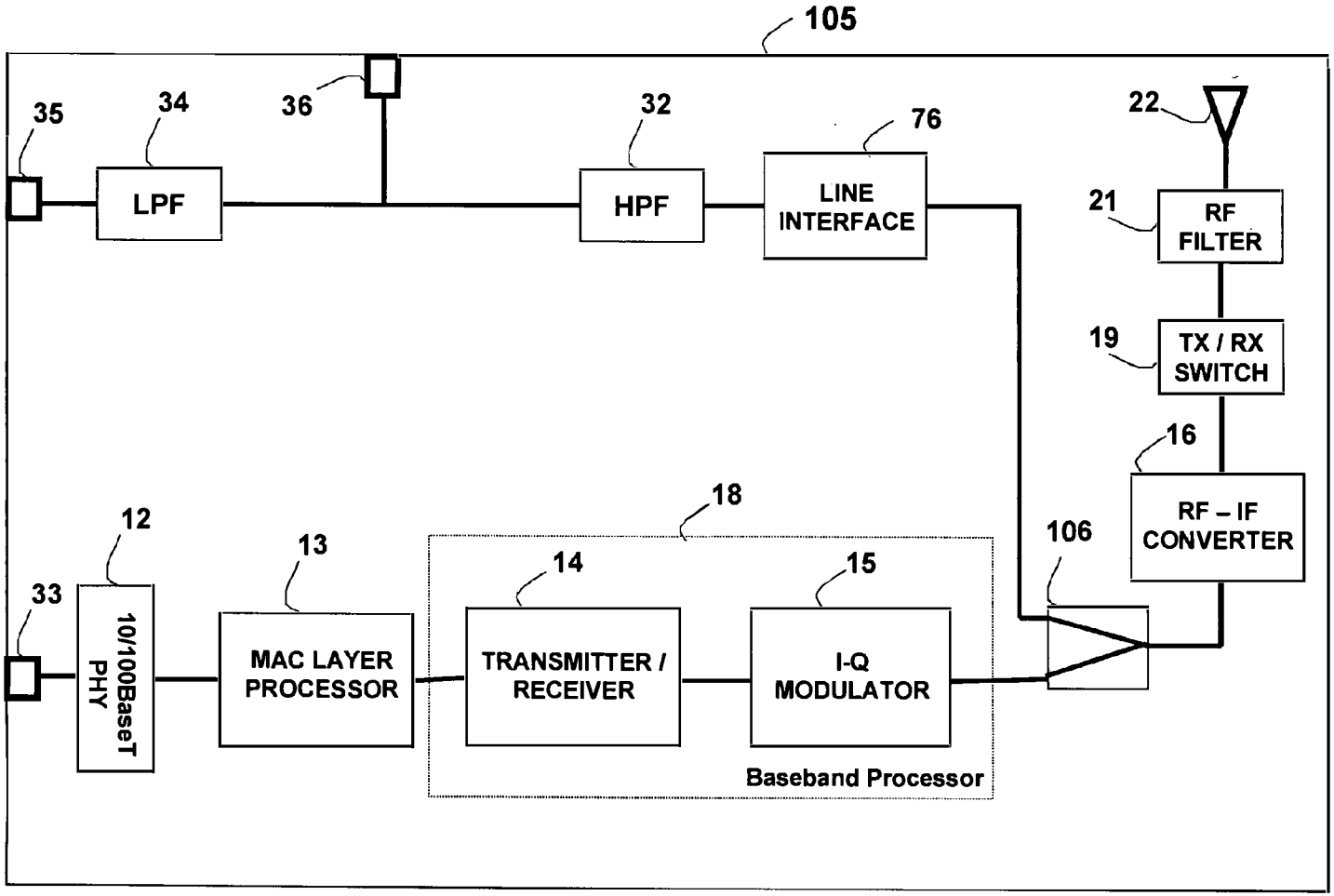

105
35
34
36
32
76
22
LPF
HPF
LINE INTERFACE
21
RF FILTER
19
TX / RX SWITCH
16
RF – IF CONVERTER
18
12
13
14
15
106
33
10/100BaseT PHY
MAC LAYER PROCESSOR
TRANSMITTER / RECEIVER
I-Q MODULATOR
Baseband Processor

Figure 10a

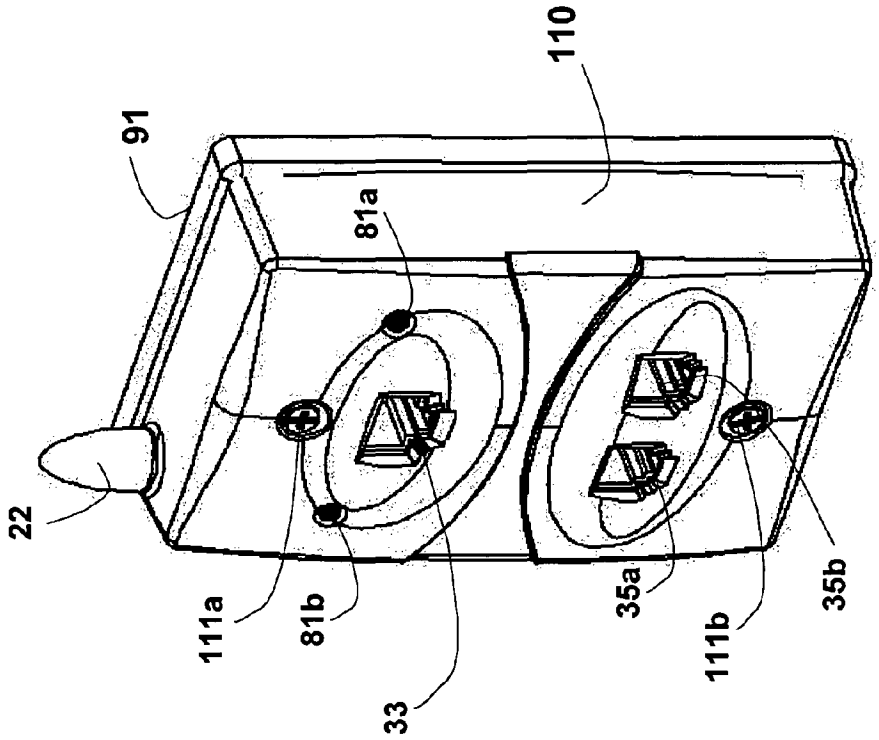


Figure 11

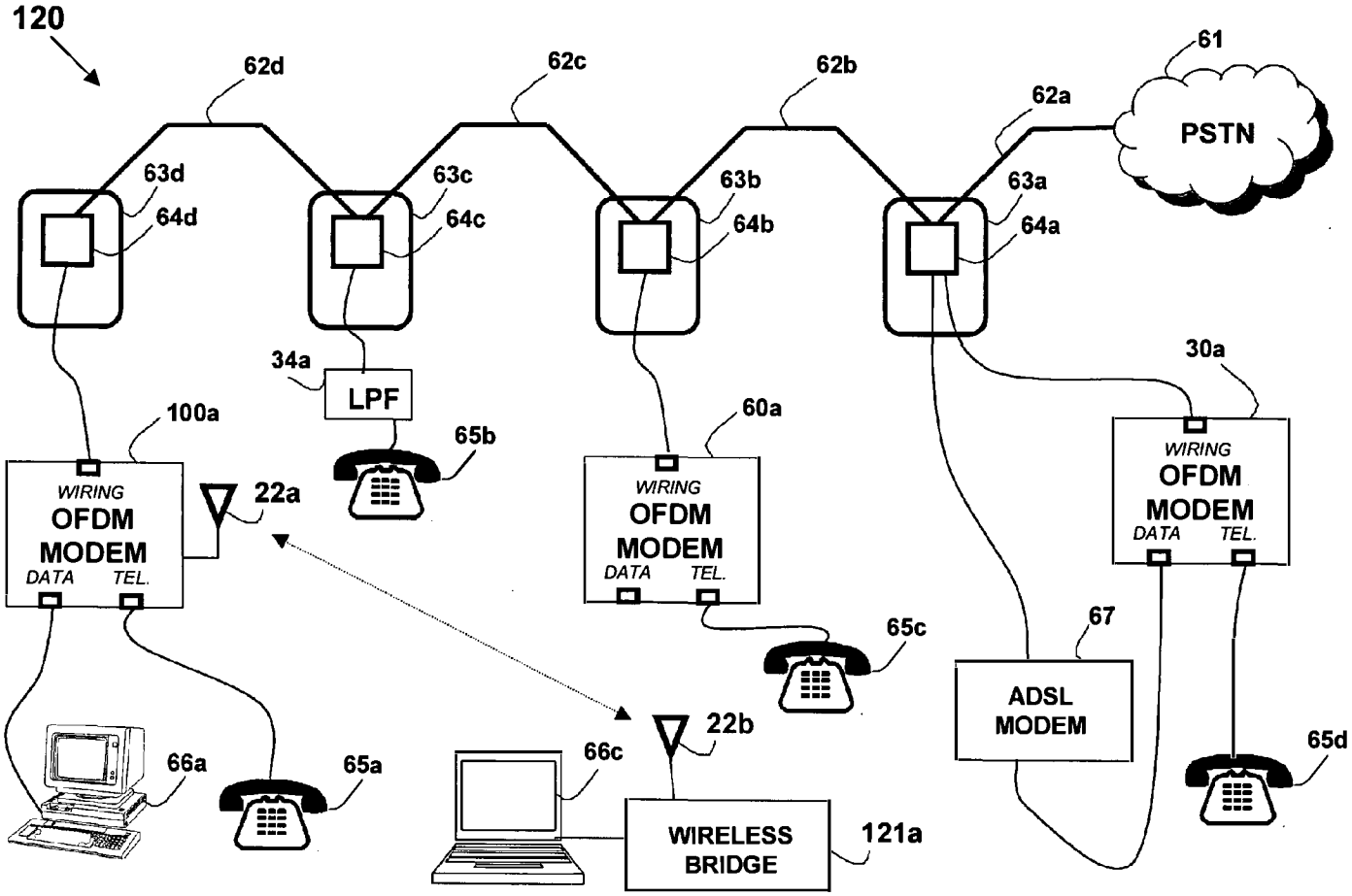
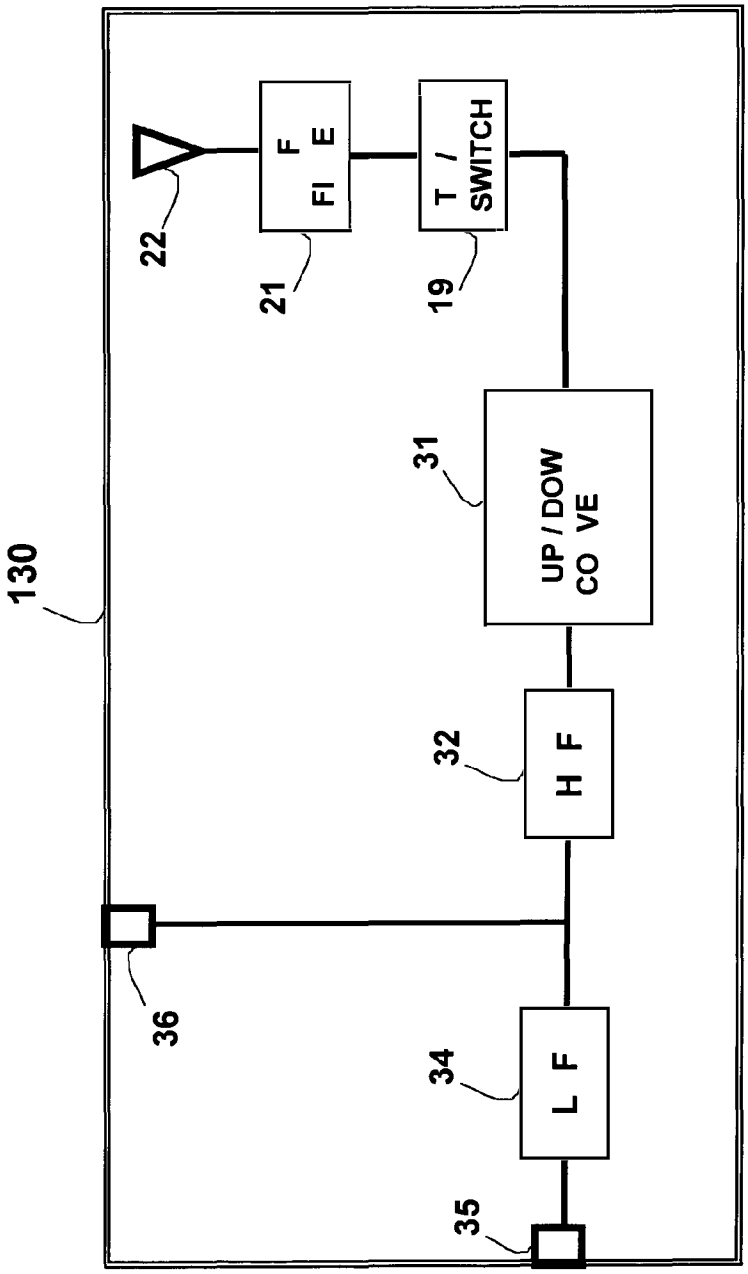

120
62d
62c
62b
62a
61
PSTN
63d
64d
63c
64c
63b
64b
63a
64a
34a
LPF
65b
30a
100a
60a
WIRING
OFDM
MODEM
DATA
TEL.
22a
WIRING
OFDM
MODEM
DATA
TEL.
WIRING
OFDM
MODEM
DATA
TEL.
65c
67
ADSL
MODEM
22b
66a
65a
66c
65d
WIRELESS
BRIDGE
121a

Figure 12



igure 13

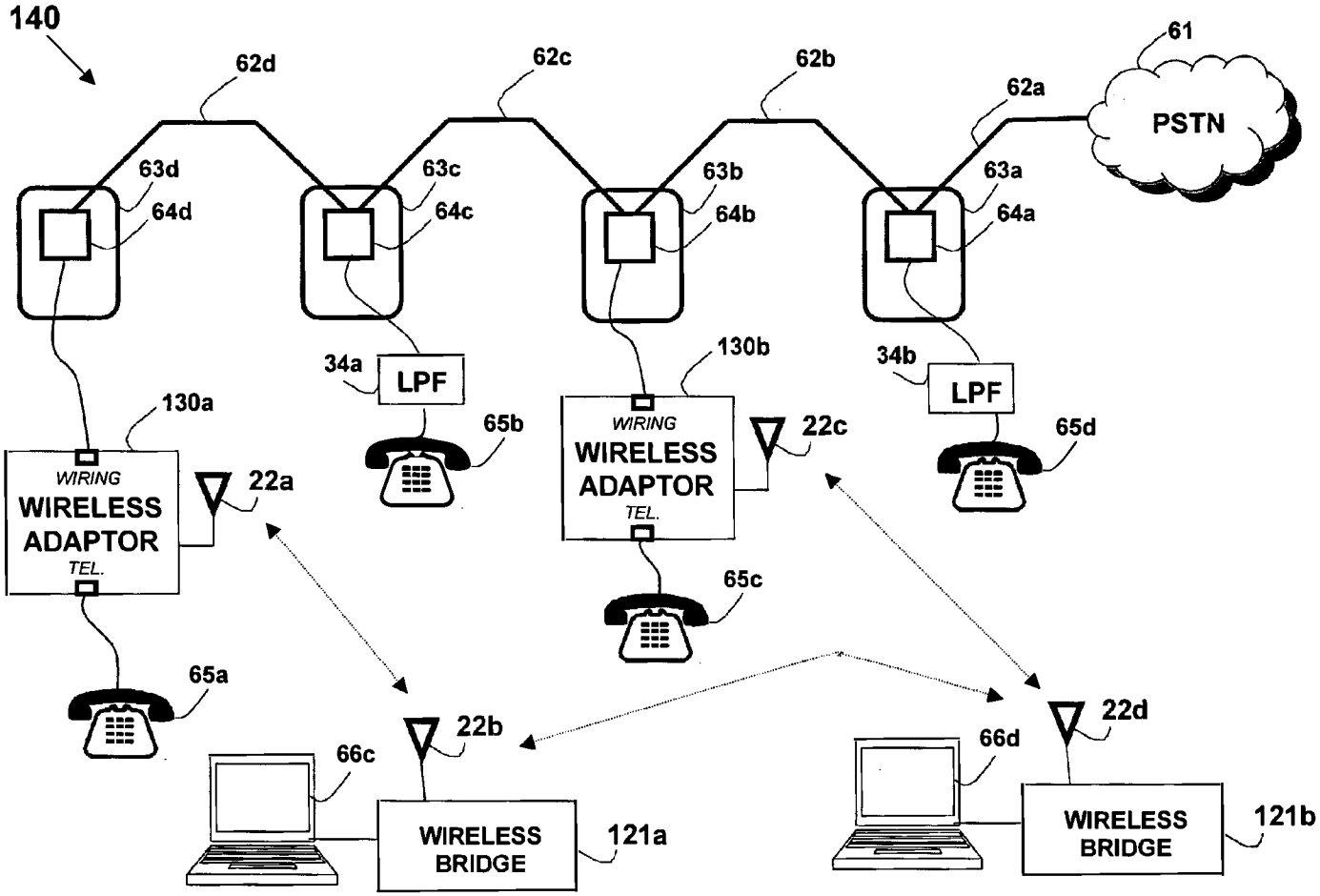

140
62d
62c
62b
62a
61
PSTN
63d
64d
63c
64c
63b
64b
63a
64a
34a
LPF
65b
130b
34b
LPF
65d
130a
WIRING
WIRELESS
ADAPTOR
TEL.
22a
WIRING
WIRELESS
ADAPTOR
TEL.
22c
65c
65a
22b
66c
22d
66d
WIRELESS
BRIDGE
121a
WIRELESS
BRIDGE
121b

Figure 14

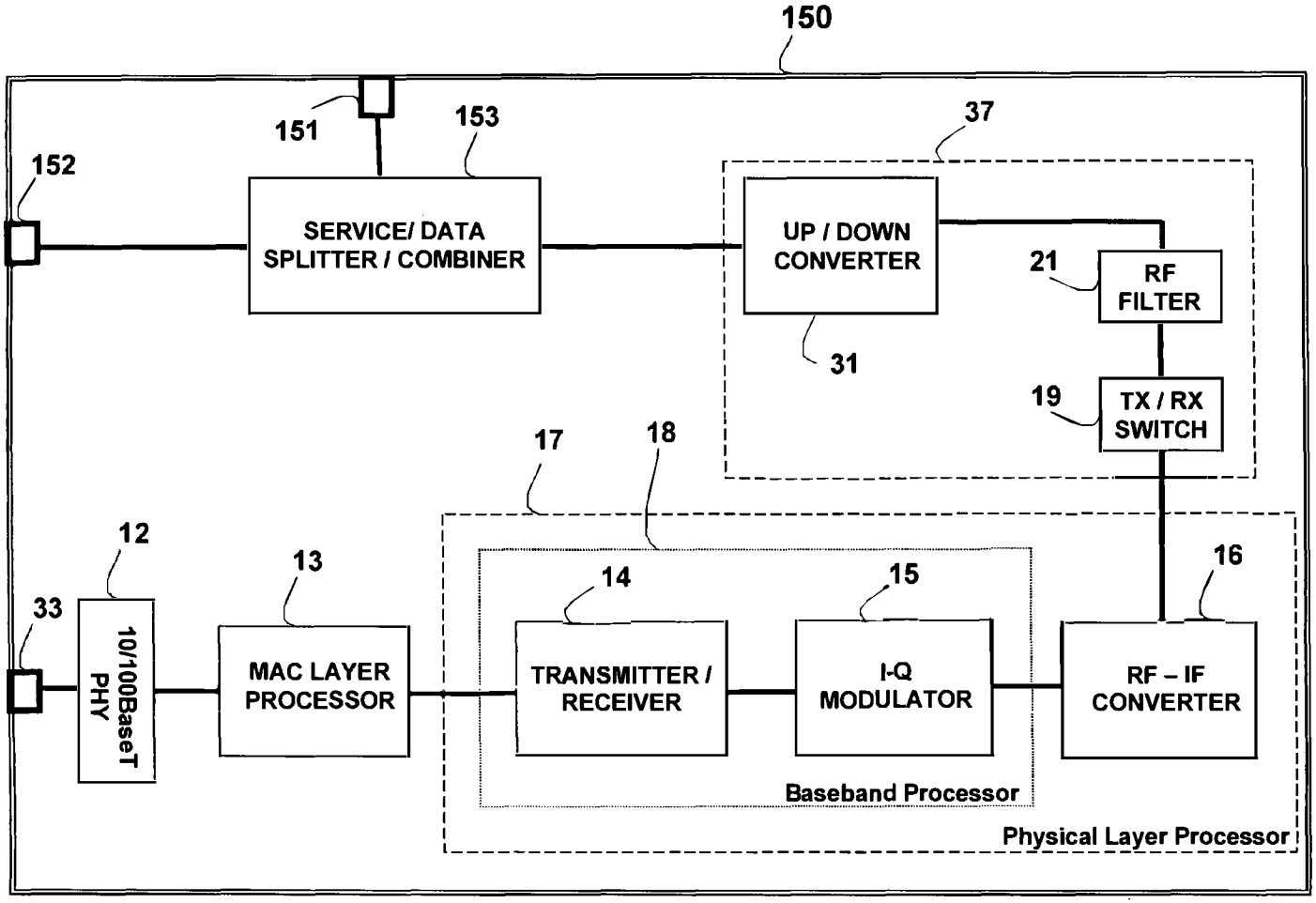

150
151
153
37
152
SERVICE/ DATA SPLITTER / COMBINER
UP / DOWN CONVERTER
21
RF FILTER
31
19
TX / RX SWITCH
17
18
12
13
14
15
16
33
10/100BaseT PHY
MAC LAYER PROCESSOR
TRANSMITTER / RECEIVER
I-Q MODULATOR
RF – IF CONVERTER
Baseband Processor
Physical Layer Processor

Figure 15

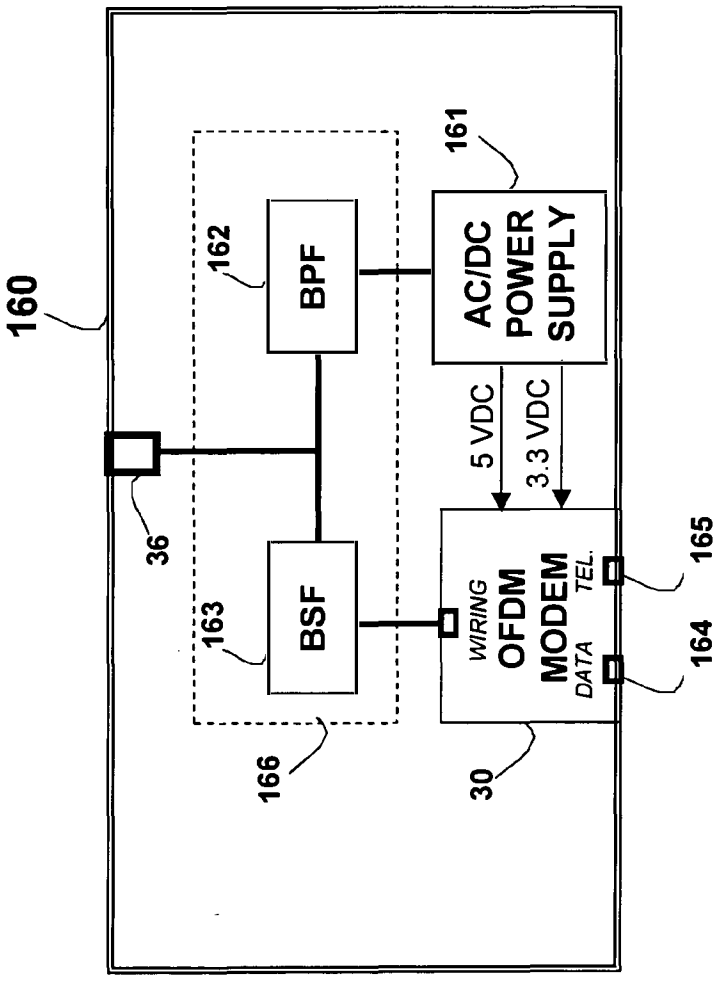

160
162
BPF
161
AC/DC POWER SUPPLY
5 VDC
3.3 VDC
36
163
BSF
WIRING
OFDM MODEM
TEL.
DATA
165
164
166
30

Figure 16

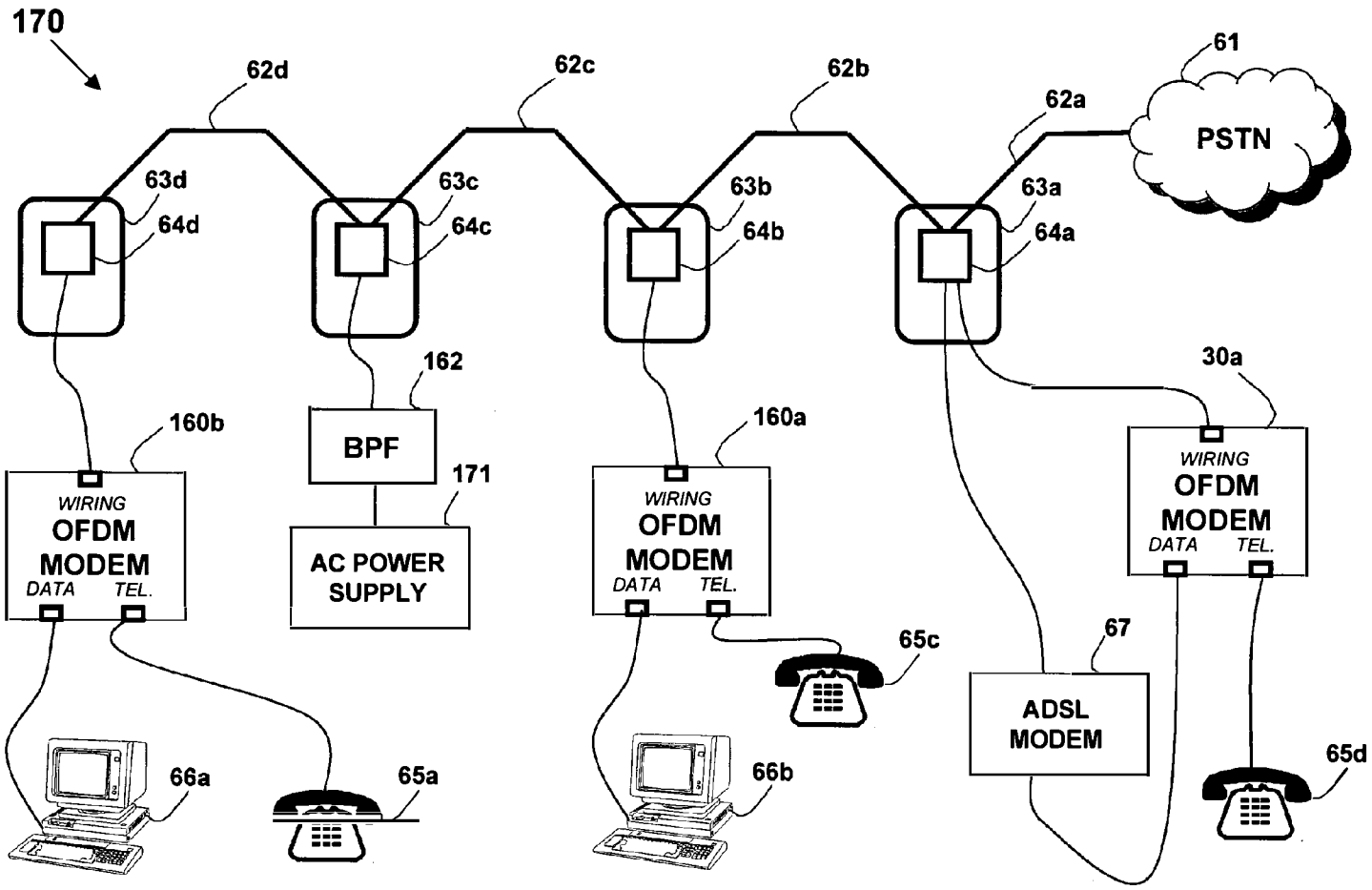

170
62d
62c
62b
62a
61
PSTN
63d
64d
63c
64c
63b
64b
63a
64a
162
BPF
171
AC POWER SUPPLY
160b
WIRING
OFDM
MODEM
DATA
TEL.
160a
30a
65c
67
ADSL MODEM
65d
66a
65a
66b

Figure 17

SYSTEM AND METHOD FOR CARRYING A WIRELESS BASED SIGNAL OVER WIRING

FIELD OF THE INVENTION

[0001] The present invention relates to the field of wired communication, and, more specifically, to using wireless oriented signals over a wired medium.

BACKGROUND OF THE INVENTION

[0002] Wired Home Networking.

[0003] Most existing offices and some of the newly built buildings facilitate a data network structure based on dedicated wiring. However, implementing such a network in existing buildings typically requires installation of new wiring infrastructure. Such installation of new wiring may be impractical, expensive and problematic. As a result, many technologies (referred to as "no new wires" technologies) have been proposed in order to facilitate a LAN in a building without adding new wiring. Some of these techniques use existing utility wiring installed primarily for other purposes such as telephone, electricity, cable television (CATV), and so forth. Such an approach offers the advantage of being able to install such systems and networks without the additional and often substantial cost of installing separate wiring within the building.

[0004] The technical aspect for allowing the wiring to carry both the service (such as telephony, electricity and CATV) and the data communication signal commonly involves using FDM technique (Frequency Division Multiplexing). In such configuration, the service signal and the data communication signals are carried across the respective utility wiring each using a distinct frequency spectrum band. The concept of FDM is known in the art, and provides means of splitting the bandwidth carried by a medium such as wiring. In the case of a telephone wiring carrying both telephony and data communication signals, the frequency spectrum is split into a low-frequency band capable of carrying an analog telephony signal and a high-frequency band capable of carrying data communication or other signals.

[0005] A network in a house based on using powerline-based home network is also known in the art. The medium for networking is the in-house power lines, which is used for carrying both the mains power and the data communication signals. A PLC (Power Line Carrier) modem converts a data communication signal (such as Ethernet IEEE802.3) to a signal which can be carried over the power lines, without affecting and being affected by the power signal available over those wires. A consortium named HomePlug Powerline Alliance, Inc. of San Ramon, Calif. USA is active in standardizing powerline technologies. A powerline communication system is described in U.S. Pat. No. 6,243,571 to Bullock et al., which also provides a comprehensive list of prior art publications referring to powerline technology and application. An example of such PLC modem housed as a snap-on module is HomePlug1.0 based Ethernet-to-Powerline Bridge model DHP-100 from D-Link® Systems, Inc. of Irvine, Calif., USA. Outlets with built in PLC modems for use with combined data and power using powerlines are described in U.S. Patent Application 2003/0062990 to Schaeffer et al. entitled 'Powerline bridge apparatus'. Such power outlets are available as part of PlugLAN™ by Asoka USA Corporation of San Carlos, Calif. USA.

[0006] Similarly, carrying data over existing in home CATV coaxial cabling is also known in the art, for example in U.S. Patent application 2002/0166124 to Gurantz et al. An example of home networking over CATV coaxial cables using outlets is described in U.S. Patent application 2002/0194383 to Cohen et al. Such outlets are available as part of HomeRAN™ system from TMT Ltd. of Jerusalem, Israel.

[0007] Telephony Definitions and Background

[0008] The term "telephony" herein denotes in general any kind of telephone service, including analog and digital service, such as Integrated Services Digital Network (ISDN).

[0009] Analog telephony, popularly known as "Plain Old Telephone Service" ("POTS") has been in existence for over 100 years, and is well-designed and well-engineered for the transmission and switching of voice signals in the 300-3400 Hz portion (or "voice band" or "telephone band") of the audio spectrum. The familiar POTS network supports real-time, low-latency, high-reliability, moderate-fidelity voice telephony, and is capable of establishing a session between two end-points, each using an analog telephone set.

[0010] The terms "telephone", "telephone set", and "telephone device" herein denote any apparatus, without limitation, which can connect to a Public Switch Telephone Network ("PSTN"), including apparatus for both analog and digital telephony, non-limiting examples of which are analog telephones, digital telephones, facsimile ("fax") machines, automatic telephone answering machines, voice (a.k.a. dial-up) modems, and data modems.

[0011] The terms "data unit", "computer" and "personal computer" ("PC") are used herein interchangeably to include workstations, Personal Digital Assistants (PDA) and other data terminal equipment (DTE) with interfaces for connection to a local area network, as well as any other functional unit of a data station that serves as a data source or a data sink (or both).

[0012] In-home telephone service usually employs two or four wires, to which telephone sets are connected via telephone outlets.

[0013] Home Networking Existing In-House Wiring.

[0014] Similarly to the powerlines and CATV cabling described above, it is often desirable to use existing telephone wiring simultaneously for both telephony and data networking. In this way, establishing a new local area network in a home or other building is simplified, because there is no need to install additional wiring. Using FDM technique to carry video over active residential telephone wiring is disclosed by U.S. Pat. No. 5,010,399 to Goodman et al. and U.S. Pat. No. 5,621,455 to Rogers et al.

[0015] Existing products for carrying data digitally over residential telephone wiring concurrently with active telephone service by using FDM commonly uses a technology known as HomePNA (Home Phoneline Networking Alliance) whose phonelines interface has been standardized as ITU-T (ITU Telecommunication Standardization Sector) recommendation G.989.1. The HomePNA technology is described in U.S. Pat. No. 6,069,899 to Foley, U.S. Pat. No.

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5,896,443 to Dichter, U.S. Patent application 2002/0019966 to Yagil et al., U.S. Patent application 2003/0139151 to Lifshitz et al. and others. The available bandwidth over the wiring is split into a low-frequency band capable of carrying an analog telephony signal (POTS), and a high-frequency band is allocated for carrying data communication signals. In such FDM based configuration, telephony is not affected, while a data communication capability is provided over existing telephone wiring within a home.

[0016] Prior art technologies for using the in-place telephone wiring for data networking are based on single carrier modulation techniques, such as AM (Amplitude Modulation), FM (Frequency Modulation) and PM (Phase Modulation), as well as bit encoding techniques such as QAM (Quadrature Amplitude Modulation) and QPSK (Quadrature Phase Shift Keying) and CCK (Complementary Code Keying). Spread spectrum technologies, to include both DSSS (Direct Sequence Spread Spectrum) and FHSS (Frequency Hopping Spread Spectrum) are known in the art. Spread spectrum commonly employs Multi-Carrier Modulation (MCM) such as OFDM (Orthogonal Frequency Division Multiplexing). OFDM and other spread spectrum are commonly used in wireless communication systems, and in particular in WLAN networks. As explained in the document entitled "IEEE 802.11g Offers Higher Data Rates and Longer Range" to Jim Zyren et al. by Intersil which is incorporated herein by reference, multi-carrier modulation (such as OFDM) is employed in such wireless systems in order to overcome the signal impairment due to multipath. Since OFDM as well as other spread spectrum technologies are considered to be complex and expensive (requiring Digital Signal Processors—DSP), and since telephone wiring is considered a better communication medium wherein multipath is less considered as a major impairment than it is in wireless networks, OFDM technique (and any other spread spectrum or any multi-carrier modulation), which is considered to be powerful and high performance, has not been suggested as a dominant modulation for wired communication in general and over telephone wiring in particular.

[0017] There is thus a widely recognized need for, and it would be highly advantageous to have a method and system for using spread spectrum modem technologies such as OFDM for wired applications, such as over utility wiring, and in particular over telephone wiring.

[0018] Wireless Home Networking.

[0019] A popular approach to home networking (as well as office and enterprise environments) is communication via radio frequency (RF) distribution system that transports RF signals throughout a building to and from data devices. Commonly referred to as Wireless Local Area Network (WLAN), such communication makes use of the Industrial, Scientific and Medical (ISM) frequency spectrum, which is unregulated and license free. In the US, three of the bands within the ISM spectrum are the A band, 902-928 MHz; the B band, 2.4-2.484 GHz (a.k.a. 2.4 GHz); and the C band, 5.725-5.875 GHz (a.k.a. 5 GHz). Overlapping and/or similar bands are used in different regions such as Europe and Japan.

[0020] In order to allow interoperability between equipments manufactured by different vendors, few WLAN standards have evolved, as part of the Institute of Electrical and Electronic Engineers (IEEE) 802.11 standard group, branded as WiFi by the Wi-Fi Alliance of Austin, Tex., USA. IEEE 802.11b describes a communication using the 2.4 GHz frequency band and supporting communication rate of 11 Mb/s, IEEE 802.11a uses the 5 GHz frequency band to carry 54 MB/s and IEEE 802.11g uses the 2.4 GHz band to support 54 Mb/s. This is described in an Intel White Paper entitled "54 Mbps IEEE 802.11 Wireless LAN at 2.4 GHz", and a chip-set is described in an Agere Systems White Paper entitled "802.11 Wireless Chip Set Technology White Paper", both of these documents being incorporated herein by reference.

[0021] A node/client with a WLAN interface is commonly referred to as STA (Wireless Station/Wireless client). The STA functionality may be embedded as part of the data unit, or alternatively may be a dedicated unit, referred to as bridge, coupled to the data unit. While STAs may communicate without any additional hardware (ad-hoc mode), such network usually involves Wireless Access Point (a.k.a. WAP or AP) as a mediation device. The WAP implements the Basic Stations Set (BSS) and/or ad-hoc mode based on Independent BSS (IBSS). STA, client, bridge and WAP will be collectively referred to herein as WLAN unit.

[0022] Bandwidth allocation for IEEE802.11g wireless in the USA is shown as graph **20** in **FIG. 2**, along the frequency axis **27**. In order to allow multiple communication sessions to take place simultaneously, eleven overlapping channels are defined spaced 5 MHz apart, spanning from 2412 MHz as the center frequency for channel number 1 (shown as **23**), via channel 2 centered at 2417 MHz (shown as **24**) and 2457 MHz as the center frequency for channel number 10 (shown as **25**), up to channel 11 centered at 2462 MHz (shown as **26**). Each channel bandwidth is 22 MHz, symmetrically (±11 MHz) located around the center frequency.

[0023] WLAN unit block diagram **10** is shown in **FIG. 1**. For the sake of simplicity, only IEEE802.11g will be described from now on. In general, the wireless physical layer signal is handled in two stages. In the transmission path, first the baseband signal (IF) is generated based on the data to be transmitted, using 256 QAM (Quadrature Amplitude Modulation) based OFDM (Orthogonal Frequency Division Multiplexing) modulation technique, resulting in a 22 MHz (single channel wide) frequency band signal. The signal is then up converted to the 2.4 GHz (RF) and placed in the center frequency of the required channel, and wirelessly transmitted via the antenna. Similarly, the receiving path comprises a received channel in the RF spectrum, down converted to the baseband (IF) from which the data is then extracted.

[0024] The WLAN unit **10** connects to the wired medium via port **11**, supporting an IEEE802.3 10/100BaseT (Ethernet) interface. The physical layer of this interface is handled by a 10/100BaseT PHY function block **12**, converting the incoming Manchester or MLT3 modulated signal (according to the 10BaseT or 100BaseTX coding, respectively) into a serial digital stream. Similarly, a WLAN outgoing digital data stream is modulated to the respective coded signal and transmitted via the port **11**, implementing full duplex communication. The internal digital stream may be of proprietary nature of any standard such as MII (Media Independent Interface). Such MII to Ethernet PHY **12** (a.k.a. Ethernet physical layer or Ethernet transceiver) can be

implemented based on LAN83C180 10/100 Fast Ethernet PHY Transceiver available from SMSC—Standard Microsystems Corporation of Hauppauge, N.Y. U.S.A. While this function can be implemented by using a single dedicated component, in many embodiments this function is integrated into single component including other functions, such as handling higher layers. The PHY block **12** also comprises the isolation magnetics, balancing, surge protection and connector (commonly RJ-45) required for proper and standard interface via port **11**.

[**0025**] For the sake of simplicity, in the foregoing and subsequent description only Ethernet 10/100BaseT interface will be described. However, it will be appreciated that any wired interface, being proprietary or standard, packet or synchronous, serial or parallel may be equally used, such as IEEE1394, USB, PCI, PCMCIA or IEEE1284. Furthermore, multiple such interfaces (being of the same type or mixed) may also be used.

[**0026**] In the case wherein the WLAN unit is integrated and enclosed within another unit (such as data unit, e.g. computer) and does not support a dedicated and direct wired interface, the function of block **12** may be omitted.

[**0027**] MAC (Media Access Control) and higher layers are handled in function block **13**, comprising two sub blocks, designated as 10/100 BaseT MAC block **13***a* and IEEE802.11g MAC block **13***b* (typically, the same MAC device is used for all IEEE802.11 variants, such as a/b/g). The MAC block **13***a* handles the MAC layer according to IEEE802.3 MAC associated with the wired port **11**. Such a function block **13***a* may be implemented using LAN91C111 10/100 Non-PCI Ethernet Single Chip MAC+PHY available from SMSC-—Standard Microsystems Corporation of Hauppauge, N.Y. U.S.A, which includes both the MAC **13***a* and the PHY **12** functionalities. Reference is made to the manufacturer's data sheet: SMSC—Standard Microsystems Corporation, LAN91C111 10/100 Non-PCI Ethernet Single Chip MAC+PHY, Datasheet Rev. 15 (O_2-20-04), which is incorporated herein by reference. Similarly, the MAC block **13***b* handles the MAC layer according to IEEE802.11g MAC associated with the wireless port **22**. Such MAC **13***b* is designed to support multiple data rates, encryption algorithms and is commonly based on an embedded processor and various memories. Such a functional block **13***b* may be implemented using WaveLAN™ WL60040 Multimode Wireless LAN media Access Controller (MAC) from Agere Systems of Allentown, Pa. U.S.A., whose a product brief is incorporated herein by reference, which is part of a full chip-set as described in WaveLAN™ 802.11a/b/g Chip Set document from Agere Systems of Allentown, Pa. U.S.A., which is incorporated herein by reference. Reference is made to the manufacturer's data sheet Agere Systems, WaveLAN™ WL60040 Multimode Wireless LAN Media Access Controller (MAC), Product Brief August 2003 PB03-164WLAN, which is incorporated herein by reference. All the bridging required in order to connect the wired IEEE802.3 MAC handled by block **13***a* to the wireless IEEE802.11g MAC handled by block **13***b* is also included in functional block **13**, allowing for integrated and proper operation.

[**0028**] The data stream generated by the IEEE802.11 g MAC **13***b* is converted to an OFDM-based baseband signal (and vice versa) by the baseband processor **18**. In common applications, the baseband processor **18** (a.k.a. wireless modem and IF transceiver) is implemented by a transmitter/receiver **14** digitally processing the data stream, and an analog unit (I-Q modulator) **15** generating the actual signal. The communication channel in wireless environments imposes various impairments such as attenuation, fading, multi-path, interferences among others, and the transmitter may process the data stream according to the following functions:

[**0029**] a. Packet framing, wherein the data from the MAC **13** is adapted and organized as packets, wherein header, CRC, preamble, control information and end-of-frame delimiter are added.

[**0030**] b. Scrambler.

[**0031**] c. Convolution encoder (such as Viterbi encoder) to allow better robustness against channel impairments such as impulse and burst noise.

[**0032**] d. Puncturer to reduce the required data rate.

[**0033**] e. Interleaver performing permutations on the packet blocks (e.g. bytes) in order to better immune against error bursts by spreading the information.

[**0034**] f. IFFT modulator to produce separate QAM (quadrature Amplitude Modulation) constellation sub-carriers.

[**0035**] Using digital to analog conversion, the processed digital from the transmitter **14** is used to generate the OFDM baseband signal in the modulator **15**. The received OFDM baseband signal from functional block **16** is digitized by the modulator **15**, processed by the receiver **14**, transferred to MAC **13** and PHY **12** to be conveyed via port **11**. Some implementations of WLAN chipsets provide the actual baseband signal, while others provides orthogonal analog I/Q modem signals which need to be further processed to provide the actual real analog form IF (Intermediate Frequency) OFDM baseband signal. In such a case, as known in the art, a Local Oscillator (LO) determining the IF frequency is used to generate a sine wave which is multiplied by the I signal, added to the Q signal multiplied by 90 degrees shifted LO signal, to produce the real analog IF baseband signal. Such function can be implemented based on Maxim MAX2450 3V, Ultra-Low-Power Quadrature Modulator/Demodulator from Maxim Integrated Products of Sunnyvale, Calif. U.S.A, a data sheet of which is incorporated herein by reference. The baseband processor block **18** may be implemented based on WaveLAN™ WL64040 Multimode Wireless LAN Baseband from Agere Systems of Allentown, Pa. U.S.A., whose product brief is incorporated herein by reference. SA5250 Multi-Protocol Baseband from Philips Semiconductors including both baseband processor **18** and MAC **13***b* functionalities may be alternatively used.

[**0036**] The RF-IF Converter functional block **16** shifts the IF OFDM baseband signal from the IF band to the ISM RF band. For example, an OFDM baseband signal symmetrically centered around 10 MHz and required to use channel 2 centered at 2417 MHz, is required to be frequency shifted by 2417-10=2407 MHz. Such frequency conversion may use many methods known in the art. A direct modulation transmitter/receiver may be used, such as WaveLAN™ WL54040 Dual-Band Wireless LAN Transceiver from Agere Systems of Allentown, Pa. U.S.A., for directly con-

verting the orthogonal I-Q analog signal to the 2.4 GHz RF band. A product brief is incorporated herein by reference. Alternatively, superheterodyne (dual conversion, for example) architecture may be used, as described for SA5251 Multiband RF Transceiver from Philips Semiconductors. The converter **16** and the baseband processor **18** constitute the wireless path physical layer processor **17**.

[0037] A T/R switch **19** is used to connect the antenna **22** to the transmitter path and disconnect the receiver path (to avoid receiver saturation) only upon a control signal signaling transmission state of the WLAN unit **10**. PIN Diode switch based design is commonly used, such as PIN Diode switch SWX-05 from MCE-KDI Integrated Products of Whippany, N.J. U.S.A., whose data sheet is incorporated herein by reference. The antenna **22** is coupled via a RF filter **21** in order to ensure transmitting limited to the defined band mask (removing unwanted residual signals), and to filter out noise and out of band signal in the receiving mode. Such RF filter **21** may use SAW (Surface Acoustic wave) technology, such as 2441.8 MHz SAW Filter from SAWTEK (A TriQuint company) of Orlando, Fla. U.S.A., whose data sheet is incorporated herein by reference.

[0038] Actual implementation of the WLAN unit **10** may also involve amplifiers, attenuators, limiters, AGC (Automatic Gain Control) and similar circuits involved with signal level functions. For example, a Low Noise Amplifier (LNA), such as MAX2644 2.4 GHz SiGe, High IP3 Low-Noise Amplifier is commonly connected in the receive path near the antenna **22**. Similarly, a Power Amplifier (PA) is used in the transmit path, such as MAX2247 Power Amplifier for IEEE802.11g WLAN. Both the LNA and the PA are available from Maxim Integrated Products of Sunnyvale, Calif. U.S.A. For the sake of simplicity, such functions are omitted in **FIG. 1** as well as in the rest of this document. Similarly, wherever either a transmitting or a receiving path is described in this document, it should be understood that the opposite path also exists for configuring the reciprocal path.

[0039] Outlets

[0040] The term "outlet" herein denotes an electromechanical device, which facilitates easy, rapid connection and disconnection of external devices to and from wiring installed within a building. An outlet commonly has a fixed connection to the wiring, and permits the easy connection of external devices as desired, commonly by means of an integrated connector in a faceplate. The outlet is normally mechanically attached to, or mounted in, a wall or similar surface. Non-limiting examples of common outlets include: telephone outlets for connecting telephones and related devices; CATV outlets for connecting television sets, VCR's, and the like; outlets used as part of LAN wiring (a.k.a. structured wiring) and electrical outlets for connecting power to electrical appliances. The term "wall" herein denotes any interior or exterior surface of a building, including, but not limited to, ceilings and floors, in addition to vertical walls.

[0041] Wireless Coverage.

[0042] Most existing wireless technologies such as IEEE802.11x (e.g. IEEE802.11a/g/b), BlueTooth™, UWB (Ultra WideBand) and others are limited to tens of meters in free line of sight environment. In common building environments, wherein walls and other obstacles are present, the range may be dramatically reduced. As such, in most cases a single wireless unit (such as an access point) cannot efficiently cover the whole premises. In order to improve the coverage, multiple access points (or any other WLAN units) are commonly used, distributed throughout the premises.

[0043] In order to allow the access points to interconnect in order to form a single communication cluster in which all the WLAN units can communicate with each other and/or with wired data units, a wired backbone is commonly used, to which the access points are connected. Such a network combining wired and wireless segments is disclosed for example in U.S. Pat. No. 6,330,244 to Swartz et al. Such a configuration is popular today in offices, businesses, enterprises, industrial facilities and other premises having a dedicated wiring network structure, commonly based on Category **5** cabling (a.k.a. structured wiring). The access points interface the existing wiring based on local area network (LAN), commonly by a standard data interface such as Ethernet based 10/100BaseT.

[0044] However, installing a dedicated network wiring infrastructure in existing houses is not practical as explained above. The prior art discloses using existing AC power wiring also as the wired backbone for interconnecting WLAN units. Examples of such prior art includes U.S. Pat. No. 6,535,110 to Arora et al., U.S. Pat. No. 6,492,897 to Mowery, Jr., U.S. Patent application 2003/0224728 to Heinonen et al., U.S. Pat. No. 6,653,932 to Beamish et al. Using powerlines as a backbone for connecting WLAN units involves several drawbacks. The type of wiring, noise and the general hostile environment results in a poor and unreliable communication medium, providing low data rates and requiring complex and expensive modems. In addition, the connection of a WLAN unit to the powerline requires both wireless and powerline modems for handling the physical layer over the two media involved, as well as a complex MAC (Media Access control) to bridge and handle the two distinct protocols involved. As such, this solution is complex, expensive and offers low reliability due to the amount of hardware required.

[0045] There is thus a widely recognized need for, and it would be highly advantageous to have a method and system for using wireless modem technologies and components in a wired applications. Furthermore, it would be highly advantageous to have a method and system for cost effectively enlarging the coverage of a wireless network by carrying a wireless signal over a wired medium without converting to a dedicated wired modem signal.

SUMMARY OF THE INVENTION

[0046] It is therefore an object of the invention to provide a method and system for using standard existing wireless components for wired communication.

[0047] According to the invention, a standard wireless baseband signal that is conducted by existing wireless components (widely used for wireless transmission), is coupled and carried by a wiring, as a substitute for a dedicated wiring modem. As such, a network (such as local area network) can be configured over the wiring, either in bus topology, point-to-point or any other arbitrary network topology. The invention is based on a WLAN unit design, comprising a wired data port and a wireless port (e.g.

antenna) and enabling a data unit connected to the wired data port (either proprietary or standard) to wirelessly communicate with other data unit.

[0048] In one aspect of the present invention, a device is based on a WLAN data design. However, only the baseband signal is used, so that the baseband to RF portion (hereinafter 'RF portion') of the WLAN unit may be obviated. The baseband signal may be coupled to the wiring via isolation, analog switching, driver and receiver, filtering and impedance matching functionalities, allowing for networking over the wiring with one or more similar devices coupled thereto.

[0049] In another aspect of the present invention, the RF portion of the WLAN unit is also used. In this case, an up/down converter is connected to the RF port (instead of connecting antenna thereto). The converter shifts the center frequency down to a band usable over the wiring.

[0050] In another aspect of the present invention, the full functionality of the WLAN unit is retained, including both the antenna and the RF portion. A wiring port coupled either directly to the baseband signal or to the RF signal via an up/down converter is added. In this case, a three ports sharing device is formed, having a wiring port, wireless (antenna) port and data unit port. Data units connected to a network comprising such multiple devices may be interconnected by the wired medium (via the wiring) or via the air using the RF signals propagating through the air.

[0051] In another aspect of the present invention, the device comprises only the RF portion of a WLAN unit (including antenna). The antenna RF signal is frequency shifted by an up/down converter to a frequency band usable by the wiring (e.g. baseband signal). A similar device or a device according to any of the above embodiments connected to the wiring may couple to the signal, and use it for coupling to a data unit either directly or wirelessly.

[0052] Any single pair wiring may be used as a medium for the baseband signal. In another aspect of the present invention, the wiring is utility wiring in a building, such as telephone, CATV or AC power wiring. In the case wherein the utility wiring also carries an active service signal (e.g. telephone, CATV or AC power signal respectively), FDM technique is used, wherein the service signal and the baseband signal are carried in distinct frequency bands. In another aspect of the present invention, the device further provides a service connector allowing a service unit to be connected thereto. In any case of wiring carrying active service signal, various filters are employed in order to isolate the service signal from the baseband signal, to avoid any interference between the two signals.

[0053] In another aspect of the present invention, the device may be comprised in a data unit. Alternatively, the device may be enclosed as a stand-alone dedicated unit. In another aspect of the present invention, the device is comprised within a service outlet. Alternatively, the device may be enclosed as outlet add-on module.

[0054] The device may be locally powered by a dedicated connection to a local power source (e.g. AC power, directly or via AC/DC converter). Alternatively, the device is power fed from a power signal carried over the wiring. In the latter case, a circuitry isolating the power signal carried over the wiring is employed. In another aspect of the present invention, the device is powered by a data unit connected thereto.

[0055] In another aspect of the present invention, spread spectrum (either DSSS or FHSS) techniques such as employing a multi-carrier modulation (e.g. OFDM, DMT or CDMA) modem, which due to its complexity is mainly used for wireless applications, may be used over a wired medium such as utility wiring in a building (e.g. telephone wiring).

[0056] It is understood that other embodiments of the present invention will become readily apparent to those skilled in the art from the following detailed description, wherein are shown and described only embodiments of the invention by way of illustration. As will be realized, the invention is capable of other and different embodiments and its several details are capable of modification in various other respects, all without departing from the scope of the present invention as defined by the claims. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0057] The invention is herein described, by way of non-limiting example only, with reference to the accompanying drawings, wherein:

[0058] **FIG. 1** shows schematically a general functional block diagram of a prior art WLAN unit.

[0059] **FIG. 2** shows schematically the frequency spectrum allocation of IEEE802.11g standard.

[0060] **FIG. 3** shows schematically a general functional block diagram of an exemplary OFDM modem according to the invention.

[0061] **FIG. 4** shows schematically the frequency spectrum allocation over the telephone wiring according to the invention.

[0062] **FIG. 5** shows schematically a general functional block diagram of an exemplary up/down converter according to the invention.

[0063] **FIG. 6** shows schematically a general functional block diagram of an exemplary OFDM modem according to the invention.

[0064] **FIG. 6*a*** shows schematically a general functional block diagram of an exemplary line interface according to the invention.

[0065] **FIG. 6*b*** shows schematically a general functional block diagram of an exemplary network according to the invention.

[0066] **FIG. 7** shows schematically a general functional block diagram of an exemplary network according to the invention.

[0067] **FIG. 8** shows schematically a view of an exemplary telephone outlet according to the invention.

[0068] **FIG. 9** shows schematically a view of an exemplary telephone module according to the invention.

[0069] **FIG. 10** shows schematically a general functional block diagram of an exemplary OFDM modem according to the invention.

[0070] **FIG. 10*a*** shows schematically a general functional block diagram of an exemplary OFDM modem according to the invention.

[0071] **FIG. 11** shows schematically a view of an exemplary telephone module according to the invention.

[0072] **FIG. 12** shows schematically a general functional block diagram of an exemplary network according to the invention.

[0073] **FIG. 13** shows schematically a general functional block diagram of an exemplary OFDM modem according to the invention.

[0074] **FIG. 14** shows schematically a general functional block diagram of an exemplary network according to the invention.

[0075] **FIG. 15** shows schematically a general functional block diagram of an exemplary OFDM modem according to the invention.

[0076] **FIG. 16** shows schematically a general functional block diagram of an exemplary OFDM modem according to the invention.

[0077] **FIG. 17** shows schematically a general functional block diagram of an exemplary network according to the invention.

DESCRIPTION OF EXEMPLARY EMBODIMENTS OF THE INVENTION

[0078] The principles and operation of a network according to the present invention may be understood with reference to the drawings and the accompanying description wherein similar components appearing in different figures are denoted by identical reference numerals. The drawings and descriptions are conceptual only. In actual practice, a single component can implement one or more functions; alternatively, each function can be implemented by a plurality of components and circuits. In the drawings and descriptions, identical reference numerals indicate those components that are common to different embodiments or configurations.

[0079] A wireless based OFDM modem **30** adapted for operating over telephone wiring according to one or more embodiments of the present invention is described in **FIG. 3**. OFDM modem **30** is primarily based on the design and components shown as WLAN unit **10** in **FIG. 1**. In contrast to WLAN unit **10**, the RF signal is not coupled to antenna **22**, but rather connect to an up/down converter **31**. The converter **31** shifts the ISM band baseband signal to a band usable over telephone wiring in home/office or any other building. Owing to FCC regulation in North America regarding radiated electromagnetic emission, the usable frequency band is considered to extend up to 30 MHz. Hence, a spectrum allocation for a baseband signal occupying 22 MHz may be between 8 MHz and 30 MHz (centered around 19 MHz), as shown in curve **43** being part of graph **40** in **FIG. 4**, illustrating the various power levels allocation along the frequency axis **44**. Such allocation allows for ADSL signal **42** using the 100 KHz (or 25 KHz) to 1.1 MHz and the POTS signal curve **41**. ADSL is an acronym for Asymmetric Digital Subscriber Line uses standard phone lines to deliver high-speed data communications both upstream and downstream, using a part of a phone line's bandwidth not used for voice so as to allow simultaneous voice and data communication.

[0080] As a non-limiting example, in the case wherein the WLAN unit **30** is using channel 10 (shown as curve **25** in **FIG. 2**) centered around 2457 MHz, the converter is required to shift the frequency up or down by 2457–19= 2438 MHz resulting in the frequency allocation shown in graph **40**.

[0081] In order to avoid interference to and from the other signals (POTS **41** and ADSL **42**) carried over the same telephone pair, a High Pass Filter (HPF) **32** is connected between the converter **31** and the telephone wiring connector **36**. The telephone wiring connector **36** in commonly a telephone standard RJ-11 plug used in North America, allowing for coupling the OFDM modem **30** to the telephone pair. The HPF **32** may use passive components implementing a Butterworth filter scheme. In some cases, a telephone unit is required to share the same telephone wiring connector **35**. In such a case, a Low Pass Filter (LPF) **34** is used to isolate the POTS frequency band, allowing a telephone set to couple to the telephone connector **35** via a telephone jack (e.g. RJ-11 jack). Any common filter used to isolate POTS and ADSL signals (a.k.a. micro-filter) may be used as LPF **34**, comprising discrete capacitors and inductors). Such configuration of connecting modem and telephone via a set of LPF and HPF units is known in the art and commonly used also in HomePNA environment.

[0082] OFDM and other spread spectrum modulation techniques are known to be powerful, robust and high-performance. Yet, their implementation complexity and associated costs have militated against their use in communication systems. Even the first WLAN technologies introduced used single-carrier technologies, such as IEEE802.11b using CCK. As such, the OFDM modem **30** shown in **FIG. 3** may be used as a superior substitute to the prior art HomePNAbased phonelines communication. Since the powerful OFDM technology is used, the modem performance is expected to exceed any available or future HomePNA technology using single carrier modulation (such as QAM) as known in the prior-art. Furthermore, since the modem utilizes existing off-the-shelf wireless oriented components such as the wireless MAC **13***b*, the baseband processor **18** and the RF-IF converter **16**, the required effort to develop a dedicated modem is obviated. Furthermore, the rapid proliferation of the WLAN solutions to the residential, office, enterprise and industrial applications, a trend expected to even grow in the future, indicates a high volume of WLAN components, resulting in easy availability, low price and ensured interoperability.

[0083] Up/Down converter **31** used for shifting the frequency as described above is well known in the art. Such converters are known to use mixing and filtering techniques, and may use single or multiple stages (Superheterodyne scheme) as well as Direct Conversion (DC) architecture. A non-limiting example for Up/Down Converter function block **37**, shown in **FIG. 3** to include the functions of the converter unit **31**, the RF filter **21** and TX/RX Switch **19**, is shown as block **50** in **FIG. 5**. Such a block **50** shifts the frequency of the RF signal coupled to port **51** to a low frequency (IF) signal in port **68**. RF Signal received in port **51** is shifted down by a down channel based on mixer **57***a* and Band Pass Filter (BPF) **58***a* and is outputted at port **68**. Similarly, an IF signal received in port **68** is shifted to the RF band by the up channel comprising mixer **57***b* and BPF **58***b*, and as RF signal outputted via port **51**. The RF port **51** is

coupled to the HPF **32** of the OFDM modem **30** and the IF port **68** is coupled to the RF-IF converter **16** of the OFDM modem **30**.

[0084] While transmitting to the telephone pair via connector **36**, a RF signal received in port **51** (from the RF-IF converter **16**) is first filtered by the BPF **52** to remove any unwanted signals residing outside the frequency band of the RF channel (e.g. the ISM RF channel band). Since the converter **50** allows conversion in only one direction at a time, either up or down, ganged switches **56***a* and **56***b* are used, having a center pole marked as (1) and two throw states marked as (2) and (3). When converting from RF to IF, both switches **56***a* and **56***b* are in the (2) state, hence the down channel is operative. Such a switch may be based on PIN diode as explained above regarding switch **19**. The RF signal from the RF port **51** couples to mixer **57***a* via BPF **52** and switch **56***a*. The mixer **57***a* multiplies the local oscillator **54** sine wave signal provided to its LO port via a splitter **55** by the RF signal coupled to its RF port (using its non linear characteristics), yielding in its IF port a signal having two main components, one around the sum of the frequencies and one around their difference. The frequencies' sum signal is then filtered out by the BPF **58***a*, and fed to the IF port **68** via the switch **56***b*. A driver **59** may also be included in order to allow proper driving of the load connected to port **68**. In a similar way, when receiving from the telephone pair, an IF signal from port **68** (originated in the telephone pair, and coupled via connector **36** and HPF **32**), is routed via the switch **56***b* (now in state (3)) to the IF port of mixer **57***b*, via BPF **58***b*. A signal is also fed from the local oscillator **54** via splitter **55** to the LO port of the mixer **57***b*, which outputs an RF signal to port **51** via the switch **56***a* (now in state (3)) and BPF **52**. A level detector (or comparator) **53** is used to monitor the level of the revived RF signal, and accordingly operate the switches **56***a* and **56***b* via control channels **69***b* and **69***a* respectively.

[0085] The converter **50** has been described above as having dedicated up and down channels. However, since only one channel is used at a time and the two channels are not used simultaneously, a single channel (mixer) may also be used, wherein an appropriate switching mechanism is employed.

[0086] A level detector **53** may be designed based on LM311 Voltage Comparator available from National Semiconductors headquartered in Santa-Clara, Calif. U.S.A. The local oscillator **54** may be based on quartz crystal oscillator, wherein the frequency is multiplied using Phase Locked Loop (PLL) circuits, and may comprise T83027 PLL Clock Generator IC with VCXO available from TLSI Incorporated of Huntington, N.Y. U.S.A., whose data sheet is incorporated herein by reference. A mixer **57** may be designed based on MAX9993 High Linearity 1700 MHz Down-Conversion Mixer with LO Buffer/Switch available from Maxim Integrated Products of Sunnyvale, Calif. U.S.A, whose data sheet is incorporated herein by reference. It should be noted that other techniques and methods to implement the converter block **50** functionality are known in the art and may be equally used. Typically, converter block **50** may connect to the telephone wiring using line interface functionalities such as isolation, impedance matching, driving/receiving and filtering, as will be described below for line interface **76** shown in **FIG. 6**.

[0087] The OFDM modem **30** inherently employs double frequency conversions: from IF to RF by converter **16** and back to low frequency by converter **31**. This redundancy may be obviated by directly extracting the baseband signal without going through the RF stage, as shown in OFDM modem functional block diagram **60** illustrated in **FIG. 6**, which may be used in one or more embodiments of the present invention.

[0088] Similar to modem **30**, modem **60** is based on WLAN unit **10** described in **FIG. 1**. However, the OFDM baseband signal generated by the broadband processor **18** is not frequency shifted to RF, but rather handled directly in the IF spectrum. In one non-limiting example, the baseband processor **18** provides an orthogonal analog I/Q signal pair. In this case, a line interface **76** using a Quadrature Modulator/Demodulator **191** shown in **FIG. 6***a* converts the signals directly to a baseband analog signal centered around 19 MHz (for example by using 19 MHz local oscillator) in the example of spectrum allocation according to graph **40**. In another example, an analog signal centered around another frequency is output by the WLAN components comprising baseband processor **18**, and in such a case a simple and single frequency conversion may be used in order to center the signal around 19 MHz.

[0089] A functional block diagram of the line interface **76** is shown in **FIG. 6***a*. The line interface **76** couples to the I-Q modulator **15** in the baseband processor **18** via port **192**. The I-Q signals are converted into a single real signal centered around the 19 MHz frequency (shifted from zero) by the Quadrature Modulator/Demodulator **191**, which may be based on Maxim MAX2450 3V, Ultra-Low-Power Quadrature Modulator/De-modulator from Maxim Integrated Products of Sunnyvale, Calif. U.S.A, whose data sheet which is incorporated herein by reference. The Modulator/Demodulator output impedance is 75 ohms terminated by a resistor **190** (if required), and fed to a driver **186** via BPF **188***a*, passing only the required band (e.g. band **43** in graph **40**). An analog switch **183** routes the transmitted signal to the telephone wiring (via port **36** and HPF **32**) via an isolation unit **182** and through port **181**. The isolation unit **182** is typically based on a signal transformer **193**, and serves to reduce common-mode noises so as to provide a balanced signal, as well as meeting the required safety and ESD requirements imposed by the UL in the U.S.A. and CE in Europe.

[0090] Similarly, a signal received from the telephone wiring is isolated by the isolation unit **182**, and routed via the analog switch **183** to an AGC **187**. A 100 Ohm resistor **185** serves as a termination, matching the telephone wiring characteristic impedance to avoid reflection. After being filtered by a BPF **188***b*, the signal is I-Q modulated by the modulator **191** and coupled to the baseband processor **18**.

[0091] A sample network **75** over a telephone line using OFDM modems is shown in **FIG. 6***b*. A telephone wiring infrastructure as commonly exists in residences in North America is described, based on single telephone pair **62** accessed via outlets **63**. A daisy-chain configuration is shown, wherein wiring segment **62***d* connects outlets **63***d* and **63***c*, wiring segment **62***c* connects outlets **63***b* and **63***c* and wiring segment **62***b* connects outlets **63***a* and **63***b*. Wiring segment **62***a* connects the 'first' outlet **63***a* to the PSTN (Public Switched Telephone Network) **61** via a junc-

tion box (not shown) and the external wiring part known as 'local loop' or 'subscriber loop'. In each outlet, a standard telephone RJ-11 jack is connected to the wiring **62**, allowing telephone units to be connected thereto, using RJ-11 plug. Outlets **63***a*, **63***b*, **63***c* and **63***d* respectively comprise jacks **64***a*, **64***b*, **64***c* and **64***d*. Other wiring topologies such as 'star' (a.k.a. 'HomeRun', 'structured wiring'), tree and mixed topologies are also available, and are also suitable.

[0092] OFDM Modems **30** and **60** may be connected to and networked over the telephone wiring **62** by connecting to the respective RJ-11 telephone connector **64** in outlet **63**, and via cable **74** to the OFDM modem connector **36**, marked as 'wiring' connection. A network may include only OFDM modems **30** as shown functionally in **FIG. 3**, or only OFDM modems **60** as shown functionally in **FIG. 6** or any combination thereof. The network **75** is shown to include an OFDM modem **30***b* connected by a cable **74***d* to outlet **63***d*, an OFDM modem **60***a* connected by a cable **74***b* to outlet **63***b* and OFDM modem **30***a* connected by a cable **74***a* to outlet **63***a*. In each case, connection to the outlets is via the respective connectors **64***d*, **64***b* and **64***a*. Computer **66***a* is shown connected to the OFDM modem **30***b* via its 'data' port (representing port **33** in **FIG. 3**), and computer **66***b* is connected to OFDM modem **60***a* via its 'data' port (representing port **33** in **FIG. 6**). The computers **66** represent any data units, preferably connected via a standard wired data interface. The modems **30***a* and **60***a* allow a half duplex communication between the computers **66***a* and **66***b* over the telephone wiring. Similarly, additional OFDM modem **30***a* may also support an additional data unit through its 'data' port.

[0093] Simultaneously with the data network formed over the telephone line, the standard telephone service is also provided. Telephone set **65***a* is connected to the wiring **62** (so as to connect to the PSTN **61**) via the 'TEL.' Port (port **35** in **FIG. 3**). Similarly, telephone sets **65***c* and **65***d* connect to the PSTN **61** (via the respective outlets **63** and wiring **62**) by connecting to OFDM modems **60***a* and **30***a*, respectively. Telephone set **65***b* is directly connected to outlet **63***c* (via cable **74***c* and plug/jack **64***c*). In such a case, the usage of LPF **34** (a.k.a. micro-filter) is recommended in order to avoid interference to and from the other signals using the same telephone wiring as a medium.

[0094] In order to enable the computers **66***a* and **66***b* to connect to an external network (such as the Internet), a device connected to the external network (either broadband or narrowband) is commonly employed, non-limiting examples including a DOCSIS based cable modem, an ADSL modem, wireless (such as WiMax) and others. Such a device should be connected to the 'data' port of any OFDM modem, hence allowing sharing the external connection to data units connected throughout the building. In one example, an ADSL modem **67** is used. The ADSL modem is shown to connect to the telephone outlet **63***a* via cable **74***e* for coupling to the ADSL signal **42** (depicted in **FIG. 4**), and providing a standard data interface (e.g. USB, 10/100BaseT). This data interface in turn connects to the OFDM modem **30***a* 'data' port, thus allowing computers **66***a* and **66***b* to share the ADSL connection via the formed network. The OFDM modem **30***a* is likewise connected to the telephone outlet **63***a* via a cable **74***a* (together with cable **74***e*).

[0095] While network **75** has been described with regard to 'bus' topology wherein all the modems are connected to the same medium (telephone wiring **62**), it is known that better communication performance (e.g. data-rate) may be achieved in point-to-point structure, wherein two modems are connected at the ends of a wiring segment. Such configuration may exist in newly installed infrastructures (e.g. structured wiring in a newly constructed building) or in MDU (Multiple Dwelling Unit), MTU (Multiple Tenant Unit) and MHU (Multiple Hospitality Unit). In all the above, the wiring segments are in 'star' topology, wherein each wiring segment connects a remote site (e.g. apartment) to a center (e.g. basement).

[0096] An application of OFDM modems to such topology is shown as a non-limiting example as network **70** in **FIG. 7**. The infrastructure of network **70** is described as comprising two wiring segments (each comprising a single pair) **72***a* and **72***b*, respectively connected between connection points **73***a* and **73***b* (e.g. in junction box) and respective outlets **63***a* and **63***b*, allowing telephone connection via the respective connectors **64***a* and **64***b*. In order to allow both telephone and data signals over the same wire pair, OFDM modems (either modem **30** or modem **60** types) are connected to each wiring end. OFDM modem **60***a* connects to wiring segment **72***a* via outlet **63***a*, communicating over the wiring segment **72***a* with OFDM modem **30***a* connected to the other end of the wiring segment **72***a* via connection point **73***a*. Telephone signals are carried over the lower band, allowing telephone set **65***a* to connect to PSTN **61**, simultaneously with the OFDM signal carried over a distinct band and connecting the computer **66***a* (representing any data unit) to the Internet **71** (via any connection such as ADSL DOCSIS cable modem or wireless). Similarly, OFDM modem **30***c* connects to wiring segment **72***b* via outlet **63***b*, communicating over this pair with OFDM modem **30***b* connected to the other end via connection point **73***b*. Telephone signals are carried over the lower band, allowing telephone set **65***b* to connect to PSTN **61**, simultaneously with the OFDM signal carried over a distinct band and connecting the computer **66***b* (representing any data unit) to the Internet **71** (via any connection such as ADSL DOCSIS cable modem or wireless).

[0097] Outlet Enclosed Modem.

[0098] Outlets in general (to include LAN structured wiring, electrical power outlets, telephone outlets, and cable television outlets) have traditionally evolved as passive devices being part of the wiring system house infrastructure and solely serving the purpose of providing access to the in-wall wiring. However, there is a trend towards embedding active circuitry in the outlet in order to use them as part of the home/office network, and typically to provide a standard data communication interface. In most cases, the circuits added serve the purpose of adding data interface connectivity to the outlet, added to its basic passive connectivity function.

[0099] An outlet supporting both telephony and data interfaces for use with telephone wiring is disclosed in U.S. Pat. No. 6,549,616 entitled 'Telephone outlet for implementing a local area network over telephone lines and a local area network using such outlets' to Binder. Such outlets are available as part of NetHome™ system from SercoNet Inc. of Southborough, Mass. U.S.A.

[0100] Another telephone outlet is described in U.S. Pat. No. 6,216,160 to Dichter, entitled 'Automatically configurable computer network'. An example of home networking over CATV coaxial cables using outlets is described in U.S. Patent Application 2002/0194383 to Cohen et al. entitled: 'Cableran Networking over Coaxial Cables' to Cohen et al. Such outlets are available as part of HomeRAN™ system from TMT Ltd. of Jerusalem, Israel. Outlets for use in conjunction with wiring carrying telephony, data and entertainment signals are disclosed in U.S. Patent Application 2003/0099228 to Alcock entitled 'Local area and multimedia network using radio frequency and coaxial cable'. Outlets for use with combined data and power using powerlines are described in U.S. Patent Application 2003/0062990 to Schaeffer et al. entitled 'Powerline bridge apparatus'. Such power outlets are available as part of PlugLAN™ by Asoka USA Corporation of San Carlos, Calif. USA.

[0101] While the active outlets have been described above with regard to networks formed over wiring used for basic services (e.g. telephone, CATV and power), it will be appreciated that the invention can be equally applied to outlets used in networks using dedicated wiring. In such a case, the outlet circuitry is used to provide additional interfaces to an outlet, beyond the basic service of single data connectivity interface. As a non-limiting example, it may be used to provide multiple data interfaces wherein the wiring supports single such data connection. An example of such outlet is the Network Jack™ product family manufactured by 3Com™ of Santa-Clara, Calif., U.S.A. In addition, such outlets are described in U.S. Pat. No. 6,108,331 to Thompson entitled 'Single Medium Wiring Scheme for Multiple Signal Distribution in Building and Access Port Therefor' as well as U.S. Patent Application 2003/0112965 Published Jun. 19, 2003 to McNamara et al. entitled 'Active Wall Outlet'.

[0102] While the outlets described above use active circuitry for splitting the data and service signals, passive implementations are also available. An example of such passive outlet is disclosed in WO 02/25920 to Binder entitled 'Telephone communication system and method over local area network wiring'. Such outlets are available as part of the etherSPLIT™ system from QLynk Communication Inc. of College Station, Tex. USA.

[0103] As known in the art, from the data communication (high frequency band) point of view, the cables **74** connected to the outlets **63** in system **75** are known as 'taps'. Cable **74***c*, terminated in the LPF **34** is considered an 'open tap' or 'bridged tap'. The same goes for cable **74***e*, terminating the ADSL band, but open for higher frequencies. Cable **74***b* (as a non-limiting example) is considered a 'terminated tap', since appropriate termination is expected to be part of the OFDM modem **60***a*. Taps in general and non-terminated taps in particular, are considered a major impairment in any wired communication system. Reflections are generated at the tap points and at the ends of open taps, resulting in a 'notch' pattern in the appropriate frequency. Such characteristics render part of the spectrum non-usable. As such, taps results in lower communication performance, and it is therefore desirable to eliminate taps as much as practical.

[0104] Wireless system in general, and WLAN systems in particular are associated with mobile and handheld devices such as PDA (Personal Digital Assistant), cellular phone, remote-controller and laptop computers. Being mobile and man-carried, the space and weight of the wireless components is critical. As such, a lot of resources are allocated to integration and miniaturization efforts in order to make the wireless components as small as possible. Vendors are increasingly focusing on integrating more and more functions into a minimum set of chips and peripherals. Hence, the small dimension featured by the wireless components makes them well suitable to be housed within small enclosures such as outlets.

[0105] In one or more embodiments of the present invention, the OFDM modem (partially or completely) is integrated into a telephone outlet. In addition to providing all the advantages described in the aforementioned prior art, such configuration eliminates the tap related impairments, thus improving the communication performance. As a non-limiting example, in the case the OFDM modem functionality is integrated into outlet **63***d*, the cable **74***d* is effectively zero in length, hence effectively eliminating the tap existence.

[0106] A pictorial view of such outlet integrating OFDM modem functionality is shown as outlet **80** in **FIG. 8**. The telephone wiring connector **36** is in the back of the outlet (facing the wall), for connecting to the wiring in the common way of connecting wiring to a telephone outlet. The outlet **80** front (facing the room) comprises connector **33**, shown as RJ-45 for 10/100BaseT interface. A telephone connector **35***a* is shown as standard telephone connector RJ-11 jack. A second connector **35***b* may also be used for allowing connection to multiple telephone sets. The outlet **80** also comprises indicators **81***a* and **81***b* (LEDs) that may be used to indicate proper operation such as power availability, communication status (such as LINK signal in Ethernet systems), communication performance and others.

[0107] The above-described outlet **80** is a complete and self-contained device. As such, it can be easily installed in new houses instead of regular passive simple outlets. However, such solutions are not appropriate in the case of retrofitting existing wiring systems. In most cases, any such modification will require dismantling the existing outlets and installing the new ones having the improved features. Such activity is cumbersome, expensive and will often require professional skill. Furthermore, owing to safety aspects involved while handling hazardous voltages (such as in the powerlines and telephone lines), local regulations may require only certified personnel to handle the wiring, making it expensive and militating against a do-it-yourself approach.

[0108] Furthermore, as technology and circumstances change in time, a need to upgrade, modify or change the outlet functionalities, features and characteristics may arise. For example, the data interface may need to be upgraded to interconnect with new standards. In another example, the circuitry may need to be upgraded to support higher bandwidth. Similarly, management and Quality of Service (QoS) functionalities may need to be either introduced or upgraded. In yet another example, additional functionalities and interfaces may need to be added. Using complete self-contained outlets as a substitute to the existing ones also introduces the disadvantages described above.

[0109] One approach to adding functionality to existing outlets is by using a plug-in module. Such plug-in modules for use with powerline communication are described in U.S. Patent Application 2002/0039388 to Smart et al. entitled

'High data-rate powerline network system and method', U.S. Patent Application 2002/0060617 to Walbeck et al. entitled 'Modular power line network adaptor' and also in U.S. Patent Application 2003/0062990 to Schaeffer, JR et al. entitled 'Powerline bridge apparatus'. Such a module using Homeplug™ technology are available from multiple sources such as part of PlugLink™ products by Asoka USA Corporation of San Carlos, Calif., USA. However, such plug-in modules are known only with regards to power outlets, and are not available for telephone or CATV outlets.

[0110] A plug-in module according to one or more embodiments of the present invention is shown as module **90** in **FIG. 9**. The module **90** is based on the outlet **80** described above. However, in contrast to being an outlet, the module **90** has an RJ-11 plug that plugs in the RJ-11 jack **93** of the telephone outlet **91**, the latter thus not requiring replacement or modification. In order to allow mechanical securing of the connection, the module **90** comprises two sliding sides **94***a* and **94***b*, which are latched and pressed against the outlet **91** surfaces **92***a* and **92***b* respectively. In this way, the module **90** is both electrically connected to the wiring and mechanically attached to outlet **91**, while not requiring any specific skills or tools. The POTS service is fully retained through the telephone connectors **35***a* and **35***b*.

[0111] Wireless Port.

[0112] Both OFDM modems **30** and **60** described above offer two wired ports, namely the data unit port **33** and the telephone wiring port **36**, and function to convert signals between those ports. Adding a wireless port will enable the OFDM modems also to network with data units over a non-wired medium.

[0113] Such an OFDM modem **100** comprising an antenna **22** as a wireless port is shown in **FIG. 10**. Generally, such a modem **100** can be considered as a combination of a WLAN unit **10** and OFDM modem **30** respectively as described above in relation to **FIGS. 1 and 3**. Modem **100** is shown to include the full WLAN unit **10** functions, and as such may function as WLAN unit **10**. However, the RF signal is coupled in between the RF-IF converter **16** and TX/RX Switch **19** by a sharing device **101**. The RF signal is thus also coupled to the telephone wiring connector **36** via the Up/Down Converter **31** and the HPF **32**, similar to the description above relating to OFDM modem **30**. Similarly, a telephone set may be coupled via connector **35** and LPF **34**.

[0114] The sharing device **101** is a three ports device and functions to share the three RF signals, such that an RF signal received in any one of the ports is replicated and shared by the other two ports. One RF signal relates to the wireless radio communication via the antenna **22**, a second signal relates to the telephone wiring carried signal via connector **36** and the third RF signal is associated with the data port **33**.

[0115] In such a configuration, the OFDM modem **100** communicates via three ports: Wireless port via antenna **22**, wired data unit port via connector **33** and wired telephone wiring connector **36**. A data packet (such as Ethernet packet) received from the data unit connected via port **33** will be converted to an OFDM RF signal at the RF-IF Converter **16** port, and then fed via sharing device **101** to both the telephone wiring after being down converted to a baseband signal by the Up/Down Converter **31** and through HPF **32** (as described above for modem **30**), and in parallel (via sharing device **101**) to the antenna **22** to be transmitted over the air. Similarly, an OFDM RF signal received in the antenna **22** is fed via the sharing device **101** to both the telephone wiring port **36** in analog baseband form and data unit port **33** as digital packets. Baseband signals received via the telephone wiring port will be converted to RF and then transmitted to the air by the antenna **22** in parallel to being down frequency converted and encoded into a packet in digital form in port **33**. In some cases, an RF signal may be received from both the antenna **22** and the telephone wiring (via port **36**). Since wireless systems are able to handle the through-air multi-path phenomenon, the signal received via the telephone wiring channel should be appreciated as another signal path, hence being handled by the baseband processor **18**.

[0116] The three ports modem **100** is shown to share the three RF signals by sharing device **101**. In one or more embodiments of the present invention, the sharing function is performed in the baseband (or IF) frequency spectrum. Such a modem **105** is shown in **FIG. 10***a*. Similar to modem **100**, three ports are supported, two wired and one wireless. However, in contrast to modem **100**, the sharing device **106** shares three baseband signals: an antenna **22** coupled signal, via the RF-IF Converter **16**, telephone wiring signal via line interface **76** and data unit related signal via the baseband processor **18**. One advantage of such configuration is the use of a single Up/Down Converter **16**, rather than the two converters (**16** and **31**) used in modem **100** configuration.

[0117] Similar to the above discussion relating to OFDM modems **30** and **60**, wireless-port equipped modems **100** and **105** may be equally enclosed within a telephone outlet or snap-on module. Such a snap-on module **110** attached to a telephone outlet **91** is shown in **FIG. 11**. Module **110** is similar to module **90** shown in **FIG. 9**, but in contrast attaches to the outlet using screws **111***a* and **111***b* rather than by snap-fit connection. It should be noted that other mechanical attachment means could be equally employed. In addition to the wired ports shown for module **90**, an antenna **22** is shown, serving as additional over-the-air wireless port.

[0118] A network **120** utilizing a wireless port equipped OFDM modem **100** is shown in **FIG. 12**. OFDM modem **105** may be equally employed. The network **120** is based on network **75** shown in **FIG. 6***b*, wherein OFDM modem **100***a* substitutes OFDM modem **30***b*, hence introducing a wireless port **22***a* to the network. Computer **66***a* and telephone unit **65***a* connect to the OFDM modem **100***a* in a similar manner as before. The additional port **22***a* allows for a laptop computer **66***c* to be connected to the wireless bridge **121***a* comprising an antenna **22***b*. Similarly, the wireless client functionality **121***a* may be built in the computer **66***c*. A wireless link according to standard IEEE802.11g is established between the bridge **121***a* and the modem **100***a*, hence enabling the computer **66***c* to network with the other data units connected to the telephone wiring **62**, as well as to computer **66***a*.

[0119] While a single modem **100** or **105** is part of network **120**, it should be appreciated that multiple such modems may be used, each covering a different area in the premises, hence enlarging the actual wireless coverage.

Furthermore, such network **120** offers the user the flexibility of adding data units either through wiring (by connecting to the data ports of the OFDM modems) or wirelessly (via the wireless port).

[0120] In some cases, only wireless ports may be required, thus tethered data unit connection may be obviated. According to one or more embodiments of the present inventions a wireless adaptor **130** supporting only wireless port is shown in **FIG. 13**. The data unit port **33** associated functions described for modem **100** in **FIG. 10** (such as baseband processor **18**, MAC layer processor **13** and PHY **12**) are omitted. The receiving path comprises the antenna **22**, RF Filter **21** and TX/RX Switch **19**. The received RF signal is then frequency down shifted by Up/Down converter **31**, and fed to the telephone wiring via connector **36** and HPF **32**. Similarly, any OFDM signal carried by the telephone wiring is received and up converted to RF, and then feeds the antenna **22**. A telephone set may be connected to the telephone wiring via connector **35** and LPF **34**.

[0121] A network **140** employing the wireless adaptor **130** is shown in **FIG. 14**. Wireless adaptors **130***a* and **13***b* are respectively connected to outlets **63***d* and **63***b*, and respectively employ antennas **22***a* and **22***c*. Computer **66***c* is wirelessly coupled to the telephone wiring **62** via the wireless bridge **121***a* and antenna **22***b*, communicating with adaptor **130***a* via its antenna **22***a*. Similarly, computer **66***d* is wirelessly coupled to the telephone wiring **62** via the wireless bridge **121***b* and antenna **22***d*, communicating with adaptor **130***b* via its antenna **22***c*. In this configuration, the computers **66***c* and **66***d* communicate over the telephone wiring **62** via the respective adaptors **130**. In such a system, the telephone wiring **62** and the adaptors **130** serve as a repeater, thus allowing communication between units, which cannot directly wirelessly communicate. The lower frequency band of the wiring is used simultaneously to carry telephone signals between the PSTN **61** and the telephones **65***a*, **65***b*, **65***c* and **65***d*. Telephone sets **65***a* and **65***c* respectively connect via adaptors **130***a* and **130***b*. Telephone sets **65***b* and **65***d* connect to the wiring **62** via LPFs **34***a* and **34***b*, respectively.

[0122] Antennas **22***b* and **22***d* may be sufficiently close to enable direct wireless communication between bridges **121***a* and **121***b*. In such case, in addition to the path (or multiple paths) formed through the air, a telephone wiring path is added. As a non-limiting example, bridge **22***d* may receive signals transmitted by bridge **121***a* via the air. In addition, the transmitted signal is received by adaptor **130***a* (via antenna **22***a*), and converted to baseband and carried over the telephone wiring segments **62***d* and **62***c*. The signal is then extracted by adaptor **130***b*, up frequency shifted and transmitted through the air via antenna **22***c* to the bridge **121***b*, hence forming an additional path. Since most wireless technologies and IEEE802.11g in particular are well equipped to handle multi-path, this phenomenon is not expected to degrade the communication performance.

[0123] While the invention has been described with regard to 'bus' topology telephone wiring, it will be appreciated that wireless-port equipped modems and adaptors may equally be used in point to point topology, 'star' topology or any combination thereof.

[0124] While the invention has been described with regard to a single specific channel frequency shifted to a specific band for use over the telephone wiring, it will be appreciated that the invention equally applies to any channel that can be used (as shown in graph **20**) and may be located at any usable frequency band over the telephone wiring (not limited to the example shown as curve **43** of graph **40**). Furthermore, several products are currently available using multiple channels in order to improve data rate performance, as well as using other techniques to improve throughput such as compression. Such techniques are sometimes known as 'Turbo-G', 'Dynamic Turbo', 'Super G' and other brands. Such a solution may be equally employed in one or more embodiments of the invention, using larger baseband signal bandwidth. Exemplary techniques to improve effective data rate are described in Atheros Communication White Paper entitled "Super G Maximizing Wireless Performance", which is incorporated herein by reference.

[0125] While the invention has been described with regard to modems and adaptors supporting telephone port **35**, it will be appreciated that the invention equally applies to the case wherein the telephone wiring is not carrying a telephone (POTS) signal. In such a case, telephone connector **35**, LPF **34** may be omitted, and HPF **32** may be omitted and bypassed. Furthermore, such configuration may apply to any type of wiring dedicated for carrying the baseband signal, not limited to telephone wiring of any kind.

[0126] In one or more embodiments according to the present invention, other utility wiring (not limited to telephone oriented wiring) is used, carrying a service signal. For example, powerlines may be used to carry both the AC power signal and the OFDM signal according to one or more embodiments according to the present invention. In such a case, the HPF **32** should be substituted with HPF filtering out the low frequency band (i.e. 60 Hz in North America and 50 Hz in Europe) carrying the AC signal and its associated noises. Similarly, in the case wherein the modem is required also to provide AC power connection, the telephone connector **35** should be substituted with a two or three prongs power jack suitable for connecting powered appliances, and the telephone-oriented LPF **34** should be substituted by a LPF passing the 50/60 Hz AC signal. Furthermore, similar to the above discussion about housing the modem within a telephone outlet and telephone outlet snap-on module, the powerline OFDM modem may be equally enclosed within an AC power outlet and snap-on module respectively, with the warranted modifications.

[0127] In one or more embodiments according to the present invention, the OFDM baseband signal is carried over CATV cabling, carrying a CATV service signal. In one or more embodiments, the baseband signal may be employed over a band not used for carrying CATV signals (e.g. over 750 MHz in some implementations). The CATV analog video channels are usually carried each occupying a 6 MHz wide band. In such a case, an allocation of four adjacent channels will result in a total bandwidth of 6*4=24 MHz, which may contain the 22 MHz wide OFDM baseband signal. In such case, the Up/Down Converter **31** used should shift the band to the allocated bandwidth, for example by tuning the local oscillator **54** frequency to the required value. Similarly, The HPF **32** should be substituted with a BPF passing the allocated 24 MHz, and the LPF **34** should be substituted with a BSP (Band Stop Filter) blocking the

OFDM signal and passing the CATV channels, to be coupled to via RF connector (BNC or F-Type) substituting for the telephone connector **35**.

[0128] A non-limiting example of generalizing OFDM modem **30** to be used with any type of utility wiring is shown as modem **150** in **FIG. 15**. Connector **151** is connectable to appropriate utility wiring, and represents a dedicated specific applicable connector, such as telephone connector **36** (e.g. RJ-11 plug) in the case where the utility wiring is telephone wiring, or an RF connector in the case of CATV cabling and AC power plug in the case of powerlines. Similarly, a service connector **152** represents the appropriate service signal connector such as telephone connector **35**, RF connector and AC power jack when used with telephone, CATV and AC power wiring, respectively. Service/Data Splitter/Combiner **153** functions to pass the service signal to the service connector **152**, to couple the OFDM baseband signal to the Up/Down Converter block **37** and to avoid interference between both signals. In the case of telephony, the functionality of the Splitter/Combiner **153** is provided by the LPF **34** and HPF **32**. Similarly, LPF and HPF are used in powerline applications, for coupling/stopping the AC power signal. For use over CATV wiring, BPF (Band Pass Filter) and BSP (Band Stop Filter) are used as described above.

[0129] Powering.

[0130] In most of the embodiments according to the present invention, the OFDM modems (or wireless adaptor) include active components (such as Up/Down converter **31**), and as such need to be powered. Three non-limiting powering schemes are described hereinafter including local feeding, power over wiring and via the interface module. The powering schemes apply to the modem/adaptor being a stand-alone enclosure, housed within an outlet, enclosed within a snap-on outlet module or as part of a data unit.

[0131] Local Feeding.

[0132] In this implementation the module is connected to an external power source for feeding its active components. A common small AC/DC converter may be connected to the modem/adaptor via a dedicated power connection.

[0133] A power adaptor may be used in the modem/adaptor, for adapting the external power to the internal needs. Such an adaptor may include voltage conversion (such as DC to DC converter) in order to adapt to specific voltages required, protection circuits (such as fuse or current limiting), regulation and noise filtration, as well as other functionality as known in the art.

[0134] Power Over Wiring.

[0135] In one or more embodiments according to the present invention, the OFDM modem (or the wireless adaptor) is fed by power carried over the wiring to which the module is connected. The power may be carried over separated conductors. In this case, the same wiring connector (such as **36** or **151**) may be used to connect to the power carrying conductors using separated pins. Alternatively, an additional power dedicated connector may be used.

[0136] In one or more preferred embodiments, the power is carried simultaneously over the wiring carrying the data network signals and/or the basic service signal. The implementation of such a mechanism is trivial when the basic service is AC power. In such a case the power is extracted from the AC power signal carried, commonly via AC/DC converter and LPF filter.

[0137] Similarly, a recent technique known as Power over Ethernet (PoE) (a.k.a. Power over LAN) and standardized under IEEE802.3af, also explained in U.S. Pat. No. 6,473,609 to Lehr et al. titled: "Structure Cabling System", describes a method to carry power over LAN wiring, using the phantom mechanism. Such technology, as well as others, may be used to provide power to any of the modems/adaptors described above, in the case where appropriate cabling (such as CAT. 5) is used as the wired medium. As a non-limiting example, in the case of using a different spectrum for the power signal, a filter should be used. In the case of phantom type of feeding, two transformers are required as known in the art.

[0138] Recent techniques developed allow for carrying simultaneously power and basic service (and data) over the same wiring infrastructure. U.S. patent publication 2002/0003873 to Rabenko et al. titled: "System and method for providing power over a home phone line network" teaches carrying AC power over telephone wiring carrying both telephony and data, by using a part of the spectrum not used by the other signals. Such a technique may be used for powering a modem or adaptor according to the current invention. As a non-limiting example, AC power using a sine wave power signal of 50 KHz may be used. As shown in graph **40**, a 50 KHz signal is in a non-allocated frequency band, and hence may be used for power distribution with minimum or no interference to the other signals carried over the same telephone wire pair.

[0139] In most prior-art systems involving carrying a power over a non-power dedicated wiring (e.g. powerlines), the amount of power that can be carried is limited either due to safety regulations and limitations, ensuring minimum interference with the other signals carried over the same wires or due to the power dissipation in the wires. For example, power carried over telephone lines may not exceed 60 VDC due to safety limitations, and power carried over coaxial wiring (e.g. CATV) may degrade its signal carrying characteristics.

[0140] Wireless system in general, and WLAN systems in particular are associated with mobile and handheld devices such as PDA (Personal Digital Assistant), cellular phone, remote-controller and laptop computers. Being battery operated, the power consumption of the wireless components is critical. As such, a lot of resources are allocated to make the wireless components consume very low power, and the power consumption of any wireless components is considered as one of its main features. This approach is described for example in Texas Instruments White Paper entitled "Low Power Advantage of 802.11a/g vs. 802.11b" which is incorporated herein by reference. Hence, the low power feature of the wireless components makes them well suitable to be used in any power over wiring scheme, and also in any non-local feeding scenarios.

[0141] An additional advantage of carrying power over the same wires carrying the OFDM signal relates to the superior characteristics of the OFDM signal. Known single carrier modulations use the whole spectrum for the whole data rates (single 'bin' approach), and as such are greatly susceptible to both white noise and single frequency noise. In contrast,

OFDM uses multiple 'bins', each carrying part of the data, and hence is less impaired by either white or narrowband noise. Power supplies are known to be noisy, and in particular at specific frequencies, such as harmonies of the PWM frequency (in the case of PWM based supply). Furthermore, the wires connecting the wired medium to the power supply and to the loads also serve as antennas and receive noise from the environment. Since the OFDM is much more robust, the effects described are less severe, allowing better performance, and obviating the need for complex and expensive filters.

[0142] Furthermore, since the networks described above are used to serve wireless clients (STAs) which are battery operated and thus are operative even in the case of power outage, carrying power over the wiring allows for continuing network operation in such a case. The power is typically sourced from a central back-up power source (e.g. UPS—Uninterruptible Power Supply), and allows continuous operation of the network even in the case of power outage via the wiring medium.

[0143] A non-limiting example of an OFDM modem **160** capable of being power fed via the telephone wiring is shown in **FIG. 16**. OFDM modem **160** includes modem **30** (shown functionally in **FIG. 3**) and added power extraction and feeding functionalities. OFDM modem **160** connects to the telephone wiring via telephone connector **36**, in a way similar to modem **30**. A BPF **162**, optimized to pass only the 50 KHz power signal, extracts the power signal and feeds AC/DC Power Supply **161**, which converts to various DC levels usually required by the OFDM modem **30**, such as 5 and 3.3 VDC. The non-power related signals (telephony, ADSL and OFDM baseband) are passed through BSF (Band Stop Filter) **163** (which may implement 50 KHz notch filter, for example) and to the wiring port of OFDM modem **30**. The data and telephone ports of the OFDM modem **30** shown as **33** and **35** in **FIG. 3** are represented as modem **160** data port **164** and telephone port **165**, respectively. Hence, OFDM modem **160** implements all OFDM modem **30** functions, added to the capability of being powered by a power signal carried over the telephone wiring.

[0144] The BPF **162** and BSF **163** constitute the power/signal splitter/combiner **166**. In the case wherein the power is carried in any other way, this function block **166** should be accordingly modified to split/combine the power and other signals carried over the wiring.

[0145] A network **170** employing AC power over telephone wiring is shown in **FIG. 17**, based on network **75** described above with reference to **FIG. 6***b*. OFDM modems **30***b* and **60***a* of network **75** are respectively substituted with telephone wiring AC powered modems **160***b* and **160***a*, including the same functionalities added to the capability of being powered via the telephone lines. The 50 KHz power signal is fed into the wiring via the 50 KHz AC power supply **171**, coupled to the telephone wiring **62** via connector **64***c* of outlet **63***c*, through a BPF **162** to avoid interference with the other signals carried over the same wiring **62**. OFDM modem **30***a* is used connected to outlet **63***a*, hence using local powering.

[0146] Powering Via Connected Appliance.

[0147] As explained above, several data interface standards also carry power over the interface. As a non-limiting example, in the case where the module is connected to USB host unit, the USB interface may feed the module. The same applies when the data port **33** is an Ethernet port implementing PoE technology as described above.

[0148] While the invention has been described with regard to a single power source, it will be appreciated that the invention equally applies to the case wherein multiple power sources are used either for redundancy or load sharing.

[0149] General.

[0150] While the invention has been described with regard to the configuration wherein OFDM signal is carried over telephone wiring (or any other utility or dedicated wiring LAN), it will be appreciated that the invention equally applies to any other spread spectrum signaling (using either DSSS or FHSS). As a non-limiting example, any multi-carrier modulation technique may be used such as DMT (Discrete MultiTone) and CDMA (Code Division Multiple Access). The term 'OFDM modem' used herein is to be considered as an example only, and not as limited to solely using OFDM based signal.

[0151] While the invention has been exampled above with regard to using standard IEEE 802.11g technology, signals and components, it will be appreciated that the invention equally applies to any other wireless based technology, using either single or multi carrier signals for implementing either spread spectrum or narrowband, using either unlicensed bands (such as ISM) or licensed spectrum. Such technology may be part of the IEEE 802.11 (such as IEEE 802.11b or IEEE 802.11a), ETSI HiperLAN/2 or any technology used for WLAN, home networking or PAN (Personal Area Network). One non-limiting example is using IEEE 802.11b based on CCK (Complementary Code Keying). Other non-limiting examples are BlueTooth™, ZigBee, UWB and HomeRF™. Furthermore, WAN (Wide Area Network) and other wireless technologies may be equally used, such as cellular technologies (e.g. GSM, GPRS, 2.5G, 3G, UMTS, DCS, PCS and CDMA) and Local Loop oriented technologies (WLL—Wireless Local Loop) such as WiMax, WCDMA and other Fixed Wireless technologies, including microwave based. Similarly, satellite based technologies and components may be equally used. While the technologies mentioned above are all standards-based, proprietary and non-standards technologies may be equally used according to present invention. Furthermore, the invention may equally apply to using technologies and components used in non-radio based through-the-air wireless systems such light (e.g. infrared) or audio (e.g. ultrasonic) based communication systems.

[0152] While the invention has been described with regard to the configuration wherein a single wireless oriented signal is carried over the wiring medium (such as utility or dedicated wiring LAN), it will be appreciated that the invention equally applies to the case wherein multiple such signal are carried using FDM. For example, additional IEEE802.1 g signal may be added to graph **40**, occupying the frequency band of 32-54 Mb/s, hence not overlapping the signals shown. Furthermore, different such signals may be combined, and thus not limited to the same wireless oriented signal.

[0153] While the invention has been described with regard to networks using the same wireless technology (such as

IEEE802.11g) by all modems connected to the wired medium, it will be appreciated that the invention equally applies to other embodiments wherein different but interoperable signals are employed.

[0154] While the invention has been described with regard to embodiments using a complete wireless solution based on existing components, including wireless MAC **13***b*, baseband processor **18** and converter **16**, it will be appreciated that the invention equally applies to other embodiments wherein one or more of theses components are used. As a non-limiting example, the MAC **13***b* may be substituted with a wired-dedicated MAC, still employing all physical layer components. Similarly, other physical layer components may be used, still using the powerful wireless MAC **13***b*. Furthermore, while the wireless signal, either as baseband, IF or RF form, has been described as only being frequency shifted, additional processing may also apply to the standard wireless signals and components, such as amplitude/level handling such as amplification and attenuation and frequency handling such as filtering. Such processing may be warranted in order to better adapt to the wired medium, improve reliability or reduce costs.

[0155] While the invention has been described with regard to wireless signals and systems carrying digital data, it will be appreciated that the invention equally applies to other embodiments wherein the wireless signals (and system) are used to carry analog signals. One non-limiting example involves cordless telephony. Cordless telephones are known to carry telephone (and control) signals over the air using ISM bands. Applying the invention allows for carrying the signals over any wired medium in general and over a utility wiring in particular. In the case of carrying the signals over telephone wiring, the above advantages are apparent, such as enlarging the coverage. Furthermore, such configuration may allow carrying multiple telephone signals over a single telephone pair.

[0156] Those of skill in the art will understand that the various illustrative logical blocks, modules and circuits described in connection with the embodiments disclosed herein may be implemented in any number of ways including electronic hardware, computer software, or combinations of both. The various illustrative components, blocks, modules and circuits have been described generally in terms of their functionality. Whether the functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans recognize the interchangeability of hardware and software under these circumstances, and how best to implement the described functionality for each particular application.

[0157] Although exemplary embodiments of the present invention have been described, this should not be construed to limit the scope of the appended claims. Those skilled in the art will understand that modifications may be made to the described embodiments. Moreover, to those skilled in the various arts, the invention itself herein will suggest solutions to other tasks and adaptations for other applications. It is therefore desired that the present embodiments be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than the foregoing description to indicate the scope of the invention.

PUBLIC NOTICE REGARDING THE SCOPE OF THE INVENTION AND CLAIMS

[0158] While the invention has been described in terms of preferred embodiments and generally associated methods, the inventor contemplates that alterations and permutations of the preferred embodiments and methods will become apparent to those skilled in the art upon a reading of the specification and a study of the drawings.

[0159] Accordingly, neither the above description of preferred exemplary embodiments nor the abstract defines or constrains the invention. Rather, the issued claims variously define the invention. Each variation of the invention is limited only by the recited limitations of its respective claim, and equivalents thereof, without limitation by other terms not present in the claim. In addition, aspects of the invention are particularly pointed out in the claims using terminology that the inventor regards as having its broadest reasonable interpretation; more specific interpretations of 35 U.S.C. section. 112 (6) are only intended in those instances where the term "means" is actually recited. The words "comprising,""including," and "having" are intended as open-ended terminology, with the same meaning as if the phrase "at least" were appended after each instance thereof.

1. A device for configuring a network over a telephone wire pair in a building, the telephone wire pair concurrently carrying an analog telephone signal in an analog telephone frequency band, and the network carrying a spread-spectrum digital data signal in a digital data frequency band separate from, and higher than, the analog telephone frequency band, said device comprising:

a first telephone connector connectable to the telephone wire pair;

a high pass filter coupled to said first telephone connector for passing only signals in the digital data frequency band;

a multi-carrier modem coupled to said high pass filter, said modem being constructed to conduct a first OFDM modulated digital data signal in the digital data frequency band over said telephone wire pair for conducting bi-directional packet-based digital data communication;

a data connector connectable to a data unit; and

a transceiver coupled between said data connector and said modem, said transceiver being constructed for bi-directional packet-based digital data communication with said data unit.

2. The device according to claim 1, said device being constructed for coupling the analog telephone signal to an analog telephone unit, and said device further comprising:

a second telephone connector connectable to the analog telephone unit; and

a low pass filter coupled between said first and second telephone connectors and for passing only the analog telephone signal.

3. The device according to claim 1 wherein the first digital data signal is wireless-based signal.

4. The device according to claim 1 wherein said modem comprises at least one of: a wireless baseband processor; a wireless I/Q modulator; and a wireless RF-IF converter.

5. The device according to claim 1, wherein said modem comprises:

a wireless modem constructed to receive and transmit signals in a radio frequency band; and

an up/down converter coupled to said wireless modem and constructed to convert from the radio frequency band to the digital data frequency band.

6. The device according to claim 5, wherein said up/down converter is heterodyne-based.

7. The device according to claim 1, further comprising a single enclosure housing said first telephone connector, said modem, said data connector and said transceiver, wherein said enclosure is attachable to a wall, or is integrated in a telephone outlet, or is mechanically and electrically attachable to and detachable from a telephone outlet.

8. The device according to claim 1. wherein the telephone wire pair concurrently carries a power signal, and said device is connected to the telephone wire pair to be powered by the power signal.

9. A network for enabling communication between first and second digital data units over telephone wiring in a building using spread-spectrum based digital data signals, the network comprising:

a telephone wire pair at least in part in a wall within the building, said wire pair being connected for carrying an analog telephone signal in an analog telephone signal frequency band frequency multiplexed with an OFDM modulated packet-based digital data signal carried bi-directionally in a digital data signal frequency band distinct from, and higher than, the analog telephone signal frequency band;

a first single enclosure;

a first device housed within said first single enclosure and connected to said telephone wire pair, said first device being connectable to the first data unit and being constructed to couple the digital data signal to the first data unit;

a second single enclosure; and

a second device housed within said second single enclosure and connected to said telephone wire pair, said second device being connectable for bidirectional packet-based communication with the second data unit and being constructed to couple the digital data signal to the second data unit.

10. The network according to claim 9 further constructed for analog telephony, wherein at least on of said first and second devices is connectable to an analog telephone device and constructed to couple the analog telephone signal to the analog telephone device.

11. The network according to claim 9 wherein the digital data signal is a frequency up/down converted wireless signal.

12. The network according to claim 9 wherein at least one of said first and second enclosures is attachable to a wall, or is integrated in a telephone outlet, or is mechanically and electrically attachable to and detachable from a telephone outlet.

13. The network according to claim 9 wherein the telephone wire pair concurrently carries a power signal, and at least part of at least one of said devices is constructed to be powered by the power signal.

14. A device for transferring a digital data signal between a wireless medium and a wired medium, the wired medium being a telephone wire pair in a building, the telephone wire pair concurrently carrying an analog telephone signal in an analog telephone frequency band frequency multiplexed with the digital data signal carried in a wired digital data signal frequency band distinct from, and higher than, the analog telephone signal frequency band, the digital data signal being carried in the wireless medium in a wireless radio frequency band, said device comprising:

a first telephone connector connectable to the telephone wire pair;

a high pass filter coupled to said first telephone connector for passing only signals in the wired digital data frequency band in the wired medium;

an antenna connected for radiating and receiving signals in the wireless radio frequency band in the wireless medium; and

an up/down converter coupled between said antenna and said high pass filter and constructed to transfer the digital data signal from the radio frequency band to the wired digital data frequency band,

wherein the digital data signal is communicated bi-directionally as a packet-based data signal.

15. The device according to claim 14, further constructed for coupling the analog telephone signal to an analog telephone unit, said device further comprising:

a second telephone connector connectable to the analog telephone unit; and

a low pass filter coupled between said first and second telephone connectors for passing only the analog telephone signal.

16. The device according to claim 14, wherein the digital data signal is spread-spectrum multi-carrier modulated in the wireless medium.

17. The device according to claim 16, wherein the digital data signal is modulated with one of: OFDM; DMT; and CDMA in the wireless medium.

18. The device according to claim 14, further comprising a single enclosure housing said first telephone connector and said up/down converter.

19. The device according to claim 18 wherein said enclosure is attachable to a wall, or is integrated in a telephone outlet, or is mechanically and electrically attachable to and detachable from a telephone outlet.

20. The device according to claim 14 wherein the telephone wire pair concurrently carries a power signal, and said device is further constructed to be powered by the power signal.

21. The device according to claim 14 wherein the radio frequency band is a license free band that is one of 900 MHz, 2.4 GHz and 5.8 GHz, and the digital data signal is IEEE802.11 standard based.

22. A network for communication between first and second wireless digital data units over pre-existing telephone wiring in a building, said network comprising:

a telephone wire pair at least in part in a wall within the building, said wire pair being connected for concurrently carrying an analog telephone signal in an analog telephone signal frequency band frequency and a digi-