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(54) **METHODS AND SYSTEMS FOR UTILIZING BACKSCATTERING TECHNIQUES IN WIRELESS APPLICATIONS**

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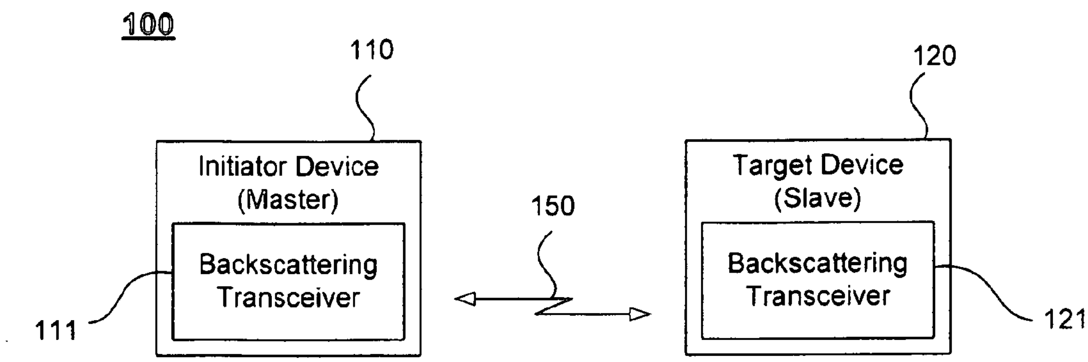
(57) **ABSTRACT**

Embodiments of the present invention include methods and systems for utilizing backscattering techniques in wireless applications. In one embodiment, the present invention includes a method of wirelessly controlling a device comprising, in a first electronic device, generating a first command, modulating the first command, and transmitting the modulated first command over a first communication channel using an RF signal. In a second electronic device, the RF signal is received over the first communication channel, and the modulated first command is demodulated and executed. In one embodiment, the second electronic device absorbs and uses at least some power from the RF signal transmitted by the first electronic device. In one embodiments, data generated by the second device may be transmitted back to the first electronic device using backscattering.



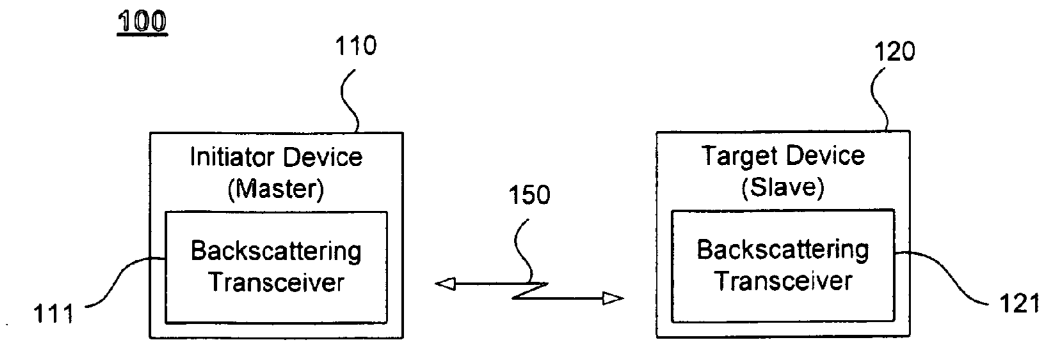

100
110
120
Initiator Device
(Master)
Backscattering
Transceiver
150
Target Device
(Slave)
Backscattering
Transceiver
111
121

Fig. 1

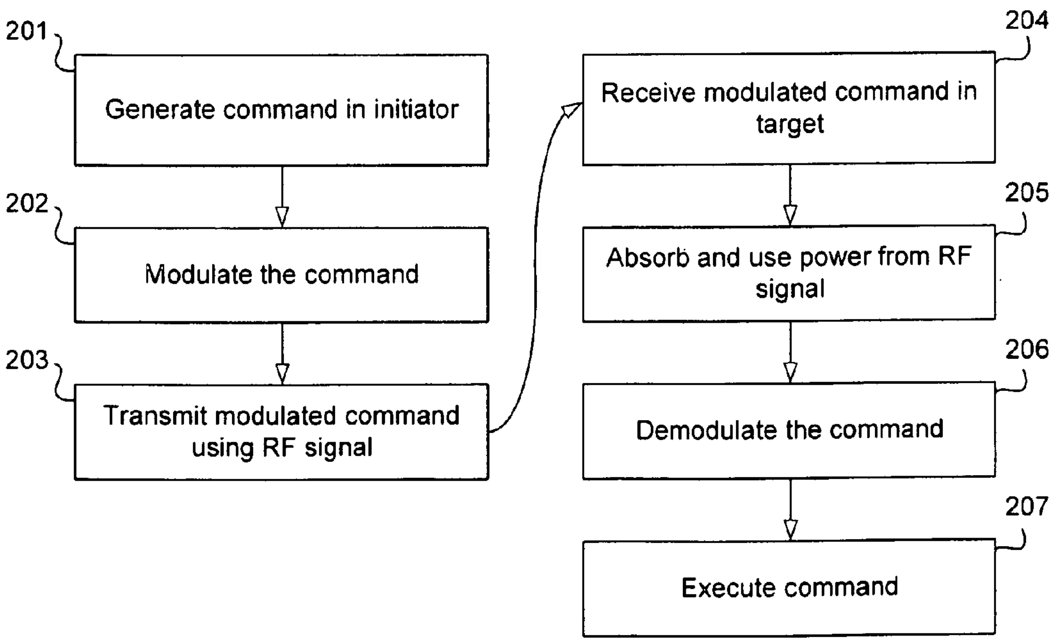

201
Generate command in initiator
202
Modulate the command
203
Transmit modulated command
using RF signal
204
Receive modulated command in
target
205
Absorb and use power from RF
signal
206
Demodulate the command
207
Execute command

Fig. 2

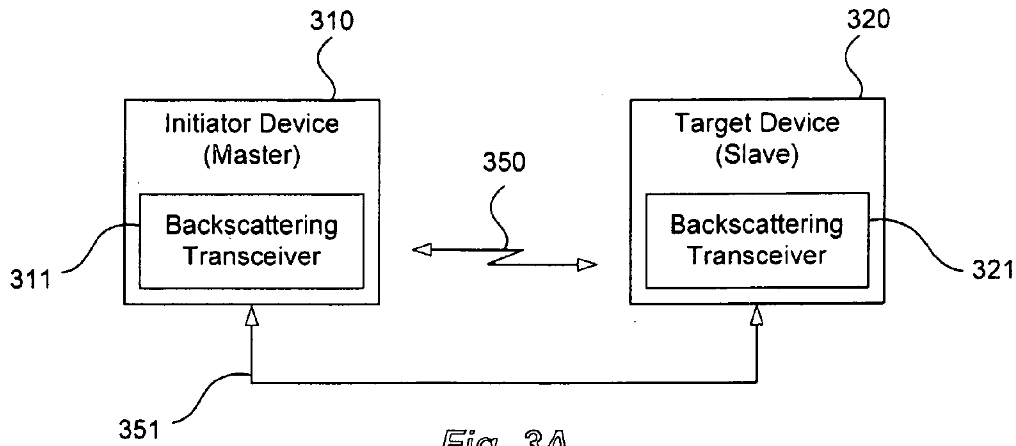


Fig. 3A

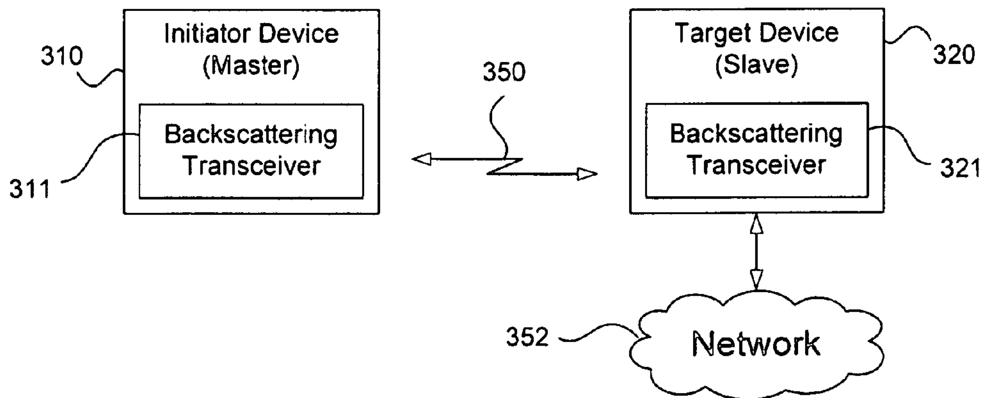


Fig. 3B

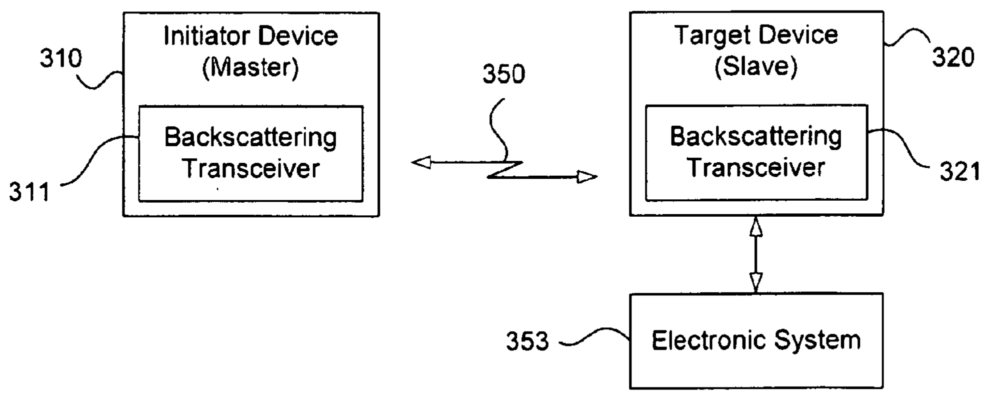


Fig. 3C

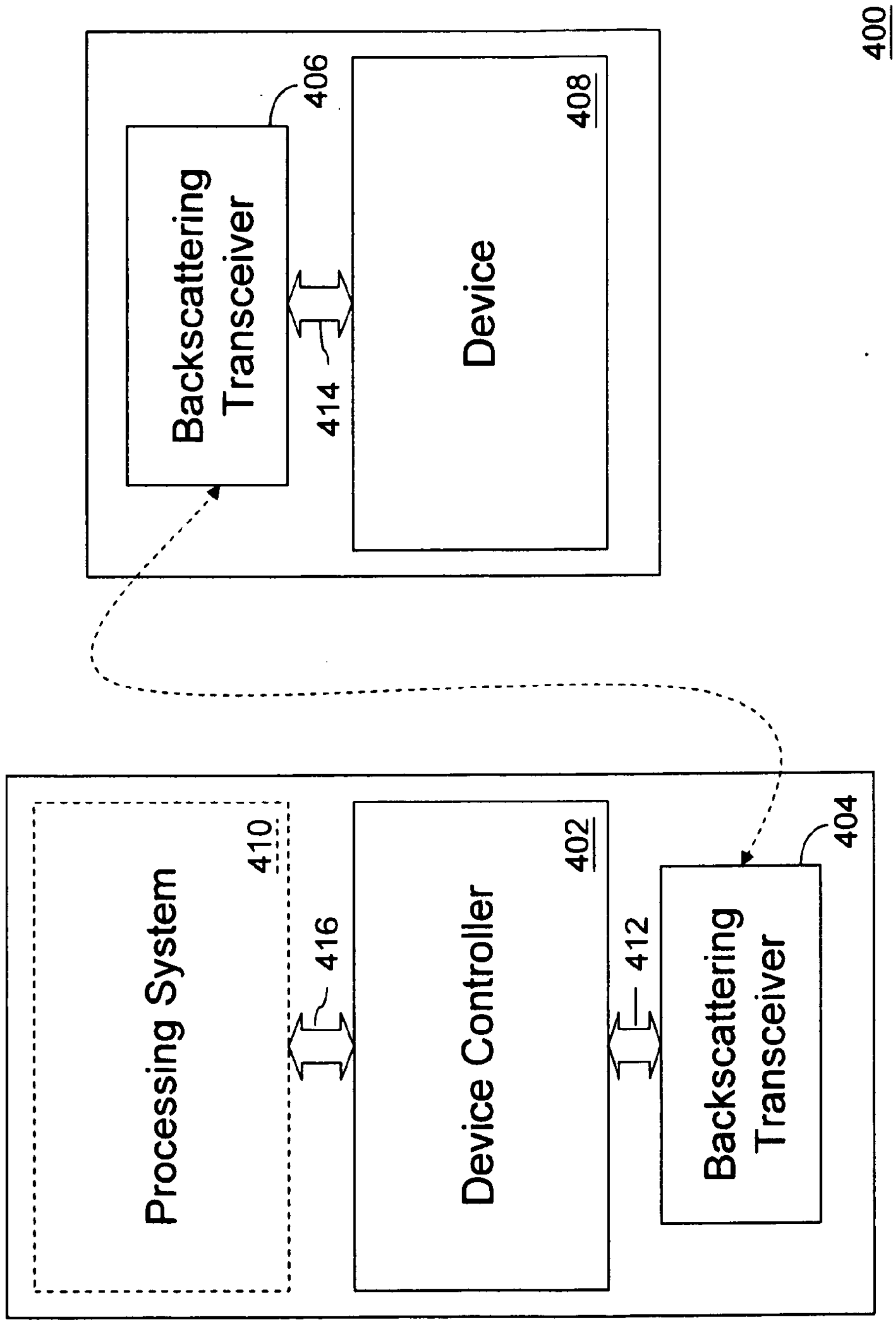

Backscattering Transceiver
406
414
Device
408
400
Processing System
410
416
Device Controller
402
412
Backscattering Transceiver
404

FIG. 4

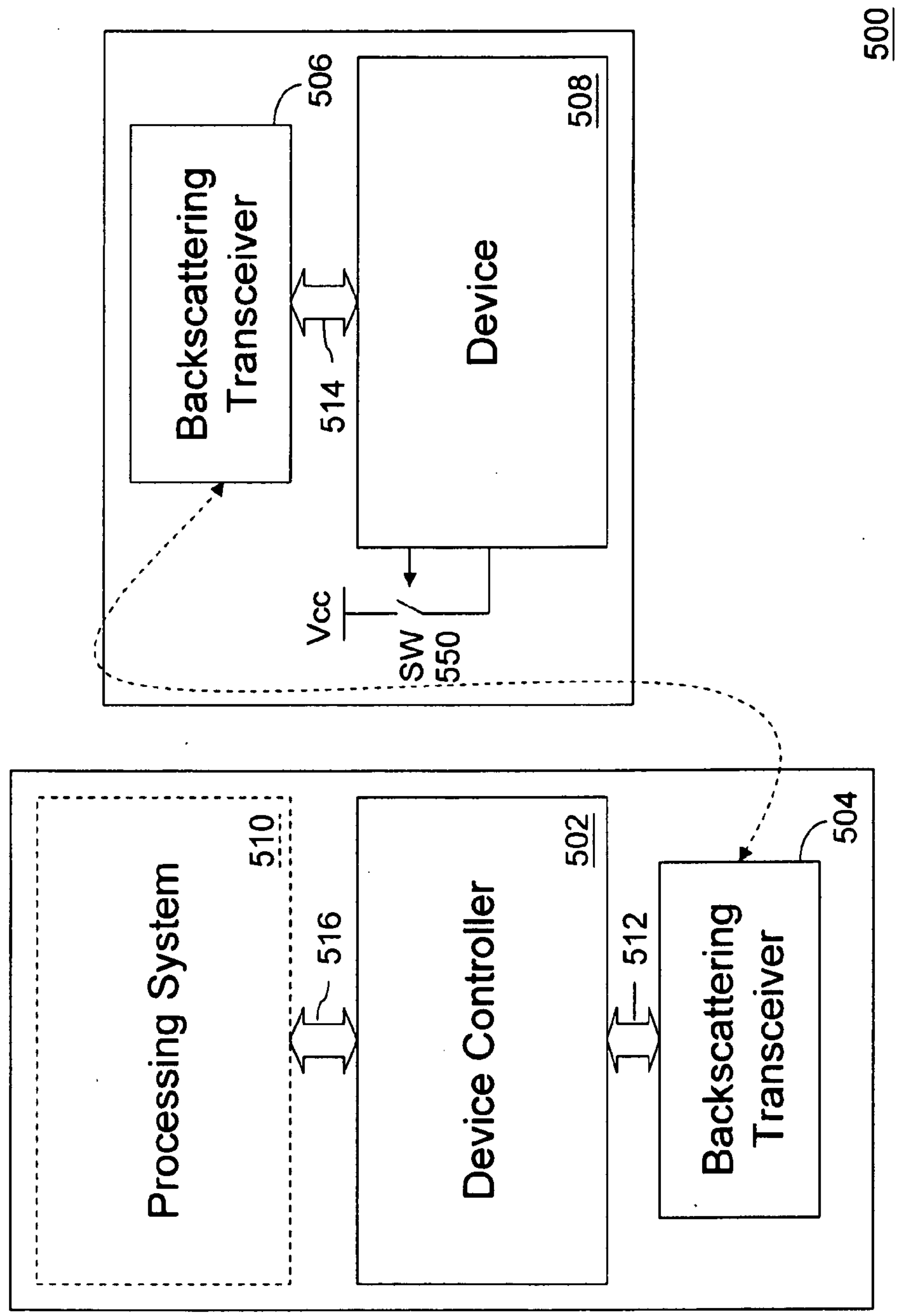

Backscattering Transceiver
506
514
Device
508
Vcc
SW
550
Processing System
510
516
Device Controller
502
512
Backscattering Transceiver
504
500

FIG. 5

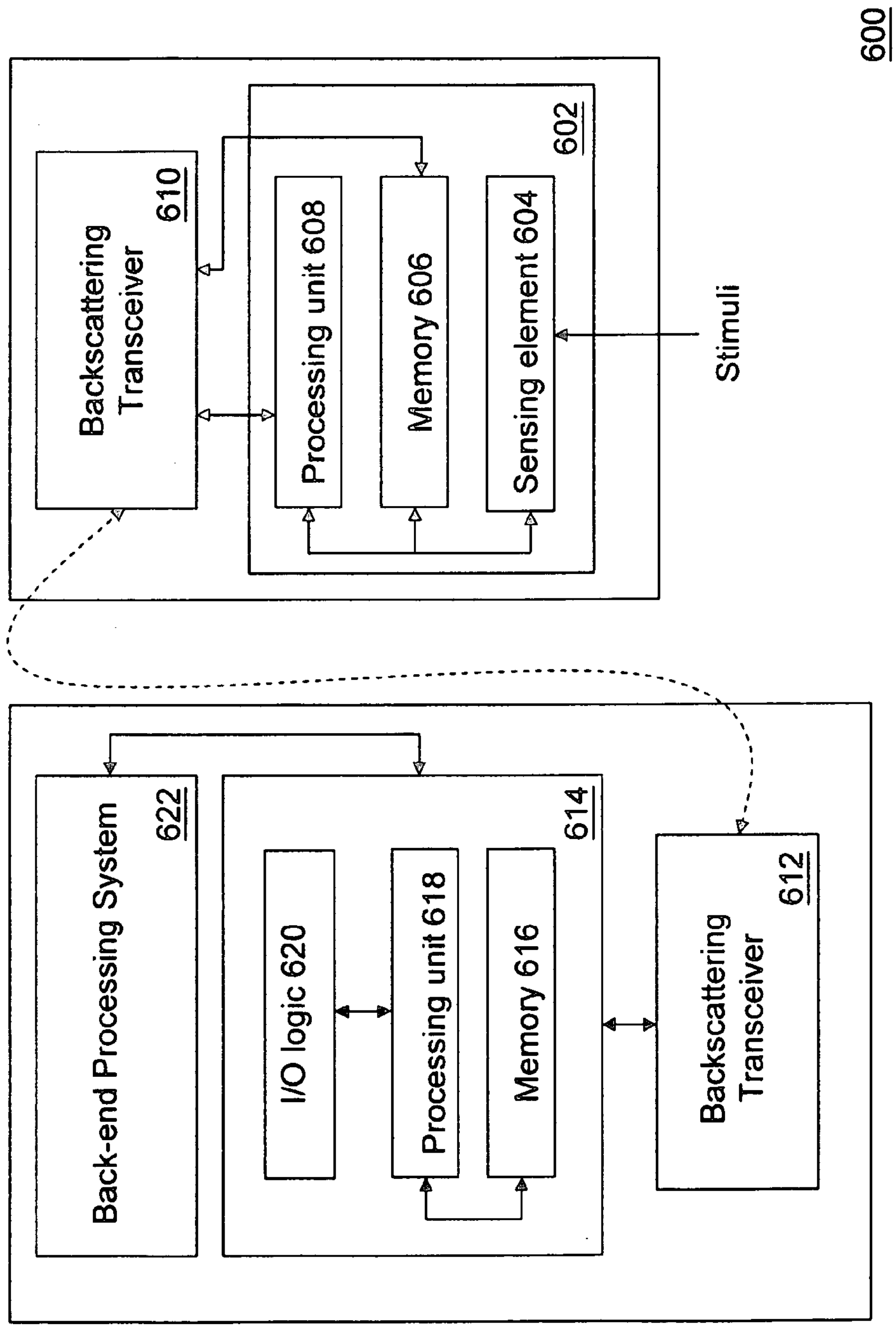

600
Backscattering Transceiver
610
Processing unit 608
Memory 606
Sensing element 604
602
Stimuli
Back-end Processing System
622
I/O logic 620
Processing unit 618
Memory 616
614
Backscattering Transceiver
612

FIG. 6

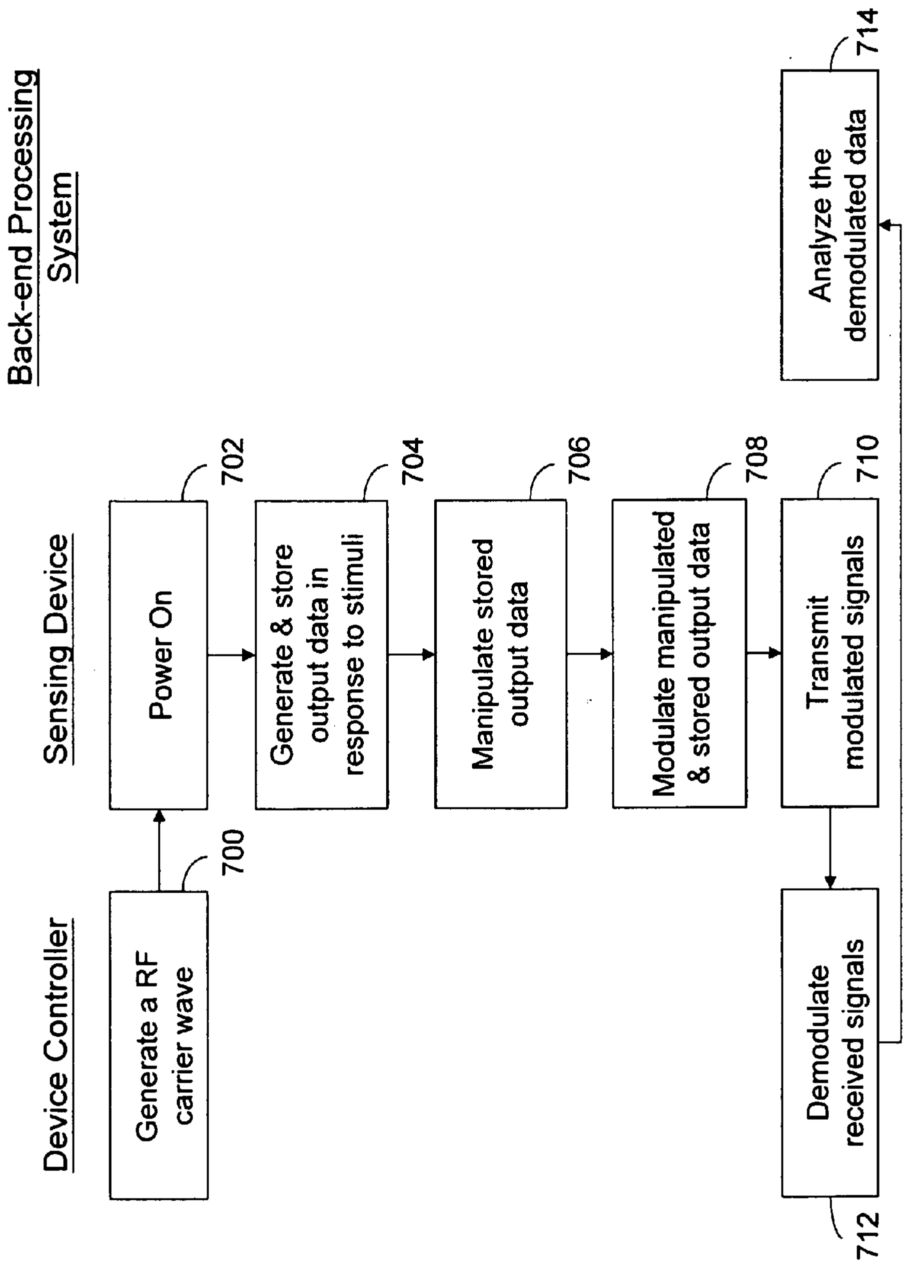

Device Controller
Sensing Device
Back-end Processing System
Generate a RF carrier wave
700
Power On
702
Generate & store output data in response to stimuli
704
Manipulate stored output data
706
Modulate manipulated & stored output data
708
Transmit modulated signals
710
Demodulate received signals
712
Analyze the demodulated data
714

FIG. 7

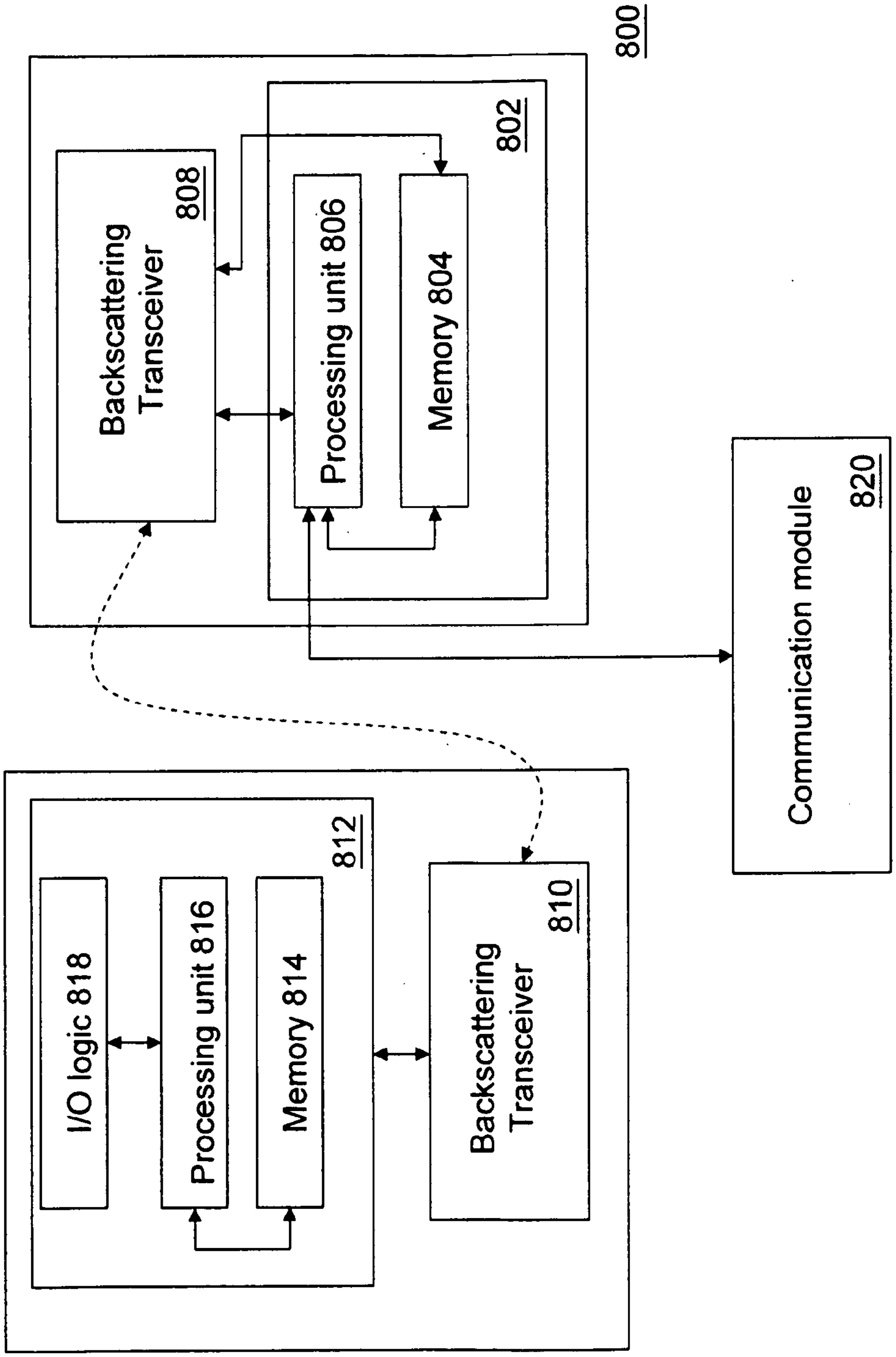

800
802
Backscattering Transceiver
808
Processing unit 806
Memory 804
Communication module
820
812
I/O logic 818
Processing unit 816
Memory 814
Backscattering Transceiver
810

FIG. 8

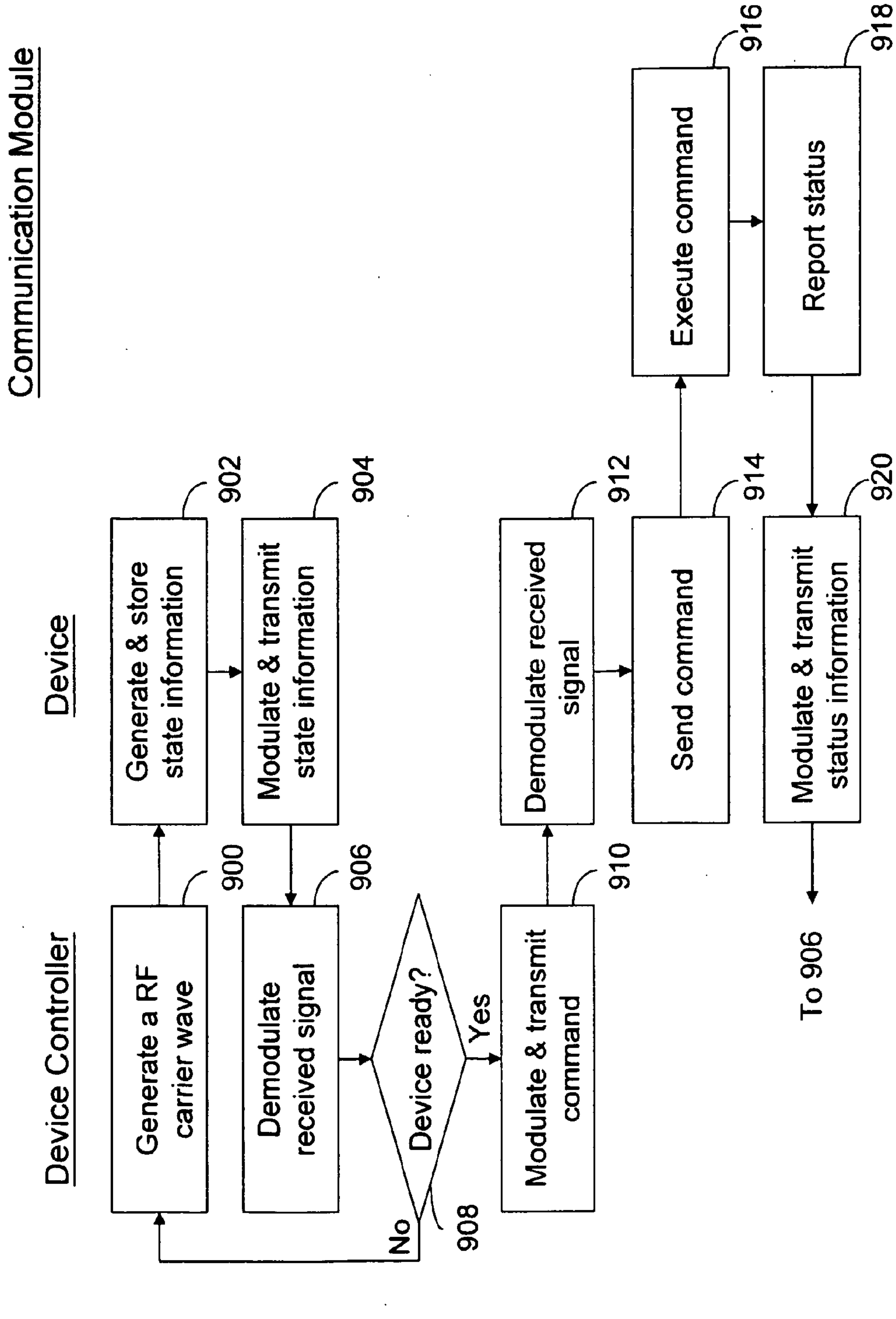

Device Controller
Device
Communication Module
Generate a RF carrier wave
900
Generate & store state information
902
Modulate & transmit state information
904
Demodulate received signal
906
Device ready?
908
No
Yes
Modulate & transmit command
910
Demodulate received signal
912
Send command
914
Execute command
916
Report status
918
Modulate & transmit status information
920
To 906

FIG. 9

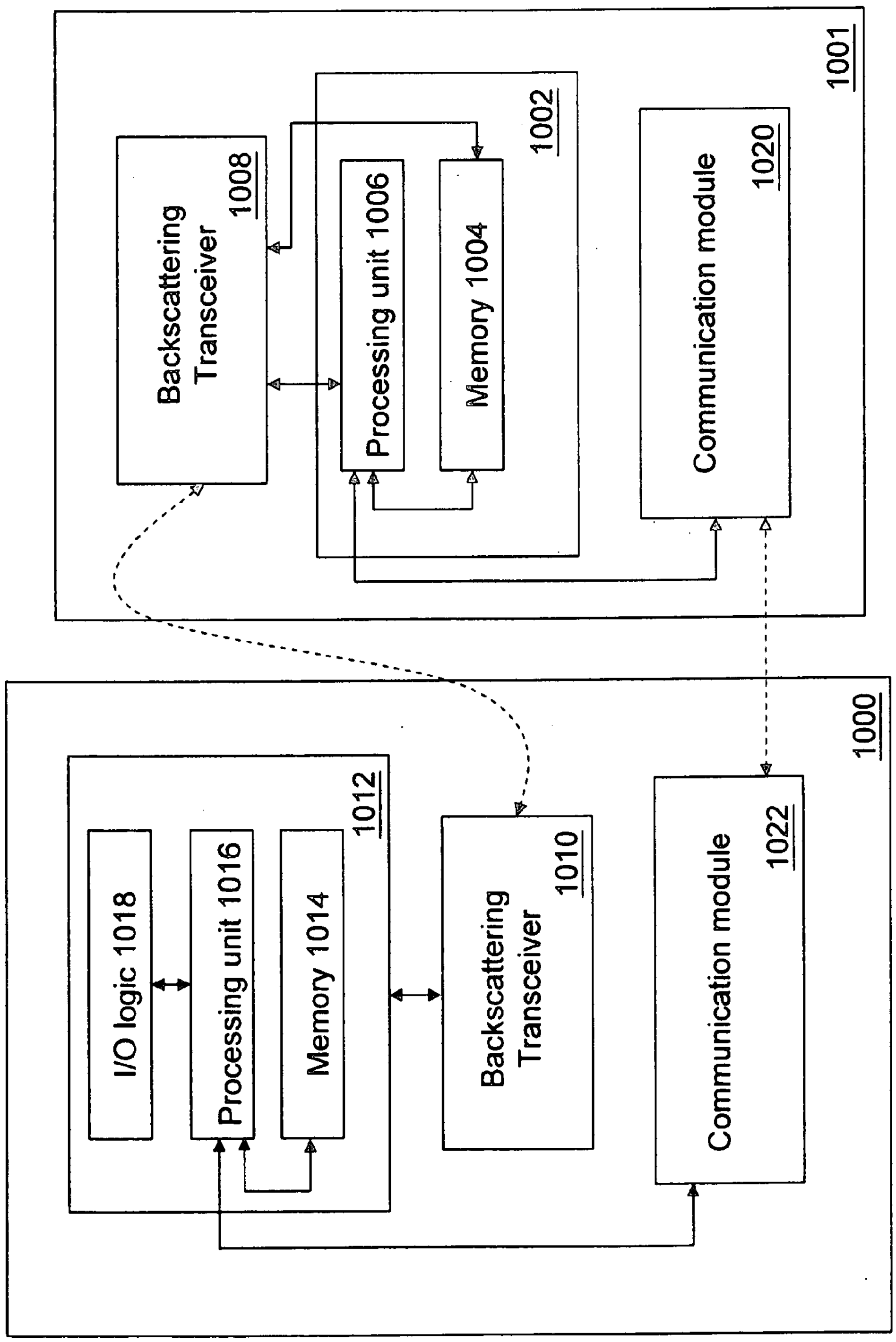

1001
1002
Backscattering Transceiver
1008
Processing unit 1006
Memory 1004
Communication module
1020
1000
1012
I/O logic 1018
Processing unit 1016
Memory 1014
Backscattering Transceiver
1010
Communication module
1022

FIG. 10

METHODS AND SYSTEMS FOR UTILIZING BACKSCATTERING TECHNIQUES IN WIRELESS APPLICATIONS

BACKGROUND

[0001] This patent document generally relates to backscattering communications, especially methods and systems for utilizing backscattering techniques in wireless applications.

[0002] Unless otherwise indicated herein, the approaches described in this section are not necessarily all prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

[0003] Radio Frequency Identification ("RFID") systems typically use radio frequency and backscattering techniques to identify, and track people, animals, and assets. An RFID system contains at least two components, a reader (also known as an "initiator" or an "interrogator") and an RFID tag (target). A reader typically has its own internal power source and generates a RF carrier wave, typically a sine wave, to transmit energy to the RFID tag and retrieve information from it. A passive RFID tag does not have an internal power source and is energized when it receives the RF carrier wave from the reader. An active RFID tag, on the other hand, has an internal power source.

[0004] An RFID tag typically contains identification information, which is backscattered to the reader. "Backscattering" techniques in an RFID system generally refer to the techniques that use backscattered RF profiles to communicate information. For example, when a reader transmits information to a tag, the reader modulates data with a carrier wave and transmits the modulated signal. The tag receives and demodulates the data. A tag may communicate information with a reader by modulating the impedance of an antenna so that a carrier wave generated by the reader backscatters with a profile of the modulated tag data. The reader may then detect the backscattered signal from the tag and demodulate the data from the tag. Some examples of well-known RFID systems include book security systems in libraries and animal identification systems. In the library example, the security gates of a library serve as the reader of this RFID system. Each book in the library has an RFID tag, and each book is associated with the identification information of the tag. Accordingly, any time a book with an RFID tag passes by the security gates, the identification information of the tag backscatters to the security gates, and information associated with the tag is checked against the database of the library to ensure the book has been properly checked out.

[0005] In the exemplary systems discussed above, the tags function only to store identification information (e.g., a tag ID), and backscattering techniques are used solely to communicate the identification information of the tags to the reader. Various methods and systems to further utilize backscattering techniques in wireless application are disclosed herein.

SUMMARY

[0006] Embodiments of the present invention include methods and systems for utilizing backscattering techniques in wireless applications. In one embodiment, the present invention includes a method of wirelessly controlling a device comprising, in a first electronic device, generating a first command, modulating the first command, and transmitting the modulated first command over a first communication channel using an RF signal. In a second electronic device, the RF signal is received over the first communication channel, and the modulated first command is demodulated and executed, wherein the second electronic device absorbs and uses at least some power from the RF signal transmitted by the first electronic device.

[0007] In one embodiment, the first command is an activation command, and the second electronic device includes a power control element, and upon execution of the first command, the power control element is activated and the second electronic device transitions from a first power state to a second power state.

[0008] In one embodiment, the second electronic device is powered off in the first power state and the second electronic device is powered on in the second power state.

[0009] In one embodiment, when the power control element is activated, the second electronic device is coupled to a power source.

[0010] In one embodiment, the power source is a battery.

[0011] In one embodiment, the power source is an AC power source.

[0012] In one embodiment, the second electronic device includes a passive backscattering circuit.

[0013] In one embodiment, the second electronic device includes an active backscattering circuit.

[0014] In one embodiment, the second electronic device includes a nonvolatile memory for storing information when the second electronic device is powered off

[0015] In one embodiment, the second electronic device is a sensor.

[0016] In one embodiment, the second electronic device is coupled to a sensor network, and the first command selectively activates one or more sensors in the network.

[0017] In one embodiment, the second electronic device is coupled to a network, and the first command activates the network.

[0018] In one embodiment, the second electronic device is coupled to a network, and the first command controls the network.

[0019] In one embodiment, the second electronic device is coupled to a network, and the second electronic device sends network information to the first electronic device using backscattering.

[0020] In one embodiment, the second electronic device is coupled to a network, and the second electronic device sends network data to the first electronic device using backscattering.

[0021] In one embodiment, the second electronic device is coupled to an electronic system, and the first command activates the electronic system.

[0022] In one embodiment, the method further comprises enabling a second communication channel in response to executing the first command.

[0023] In one embodiment, the second communication channel is between said first and second devices.

[0024] In one embodiment, the first electronic device is a wireless access point, the second electronic device is a wireless device, and the communication channel is a Bluetooth, Zigbee, Wi-Fi, Infrared, or Ultra-Wideband wireless channel.

[0025] In one embodiment, the method further comprises sending data from the first electronic device to the second electronic device over the first communication channel.

[0026] In one embodiment, the data includes configuration parameters for the second electronic device.

[0027] In one embodiment, the data includes software updates.

[0028] In one embodiment, the first command is generated automatically by a processing system.

[0029] In one embodiment, the first command is generated in response to a user input.

[0030] In one embodiment, the first electronic device is a wireless access point and the second electronic device is a mobile device.

[0031] In one embodiment, the first electronic device and the second electronic device are mobile devices.

[0032] In another embodiment, the present invention includes a method for a wireless application comprising generating output data in response to physical stimuli received by a sensing element of a first device, modulating the output data with a first RF carrier wave to generate a first modulated signal, wherein the RF carrier wave is generated by a second device and received by the first device, receiving the first modulated signal in the second device, and demodulating the first modulated signal in the second device to produce the output data.

[0033] In one embodiment, the method further comprises, before generating said first modulated signal, manipulating said output data in the first device.

[0034] In one embodiment, the first device is a passive device, and the first device is powered by energy from the RF carrier wave.

[0035] In one embodiment, the first device is an active device, and the first device uses energy from the RF carrier wave to activate a power control element for coupling a power source to the first device.

[0036] In one embodiment, the method further comprises filtering the output data in the first device.

[0037] In one embodiment, the method further comprises receiving information in the first device from the second device.

[0038] In one embodiment, the first device receives a command from the second device, and the command selectively activates particular sensors in a sensor network.

[0039] In one embodiment, the first device receives an activation command from the second device that turns on the first device.

[0040] In one embodiment, the first device receives configuration parameters from the second device.

[0041] In one embodiment, the first device receives an algorithm for processing the output data from the second device.

[0042] In one embodiment, the first device receives calibration parameters from the second device for calibrating the sensing element.

[0043] In one embodiment, the method further comprises analyzing the output data in a processing system.

[0044] In one embodiment, the method further comprises passing the output data of the first device to a processing system coupled to the second device for analysis.

[0045] In one embodiment, the method further comprises storing the output data in a database coupled to the processing system.

[0046] In one embodiment, the method further comprises storing the output data in a database.

[0047] In one embodiment, the method further comprises generating a report.

[0048] In another embodiment, the present invention includes a wireless communication method comprising modulating a command generated by a first device with a first RF carrier wave to generate a first modulated signal, transmitting the first modulated signal, receiving the first modulated signal in a second device, demodulating the first modulated signal from the first device to retrieve the command, executing the command on the second device, modulating data generated by the second device with an RF carrier wave to generate a second modulated signal, wherein the RF carrier wave is generated by the first device and received by the second device, receiving the second modulated signal in the first device, and demodulating the second modulated signal to retrieve the data generated by the second device. In one embodiment, the second device is a sensor. In one embodiment, the data is state information about the second device. In one embodiment, the method further comprises enabling a data communication channel in response to executing the command, wherein said data communication channel is between the first and second devices. In one embodiment, the method further comprises activating the second device in response to executing the command. In one embodiment, the method further comprises activating an electronic system in response to executing the command. In one embodiment, the method further comprises selectively activating one or more sensors in a sensor network in response to executing the command. In one embodiment, the method further comprises controlling the second device using the command.

[0049] The following detailed description and accompanying drawings provide a better understanding of the nature and advantages of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050] FIG. **1** illustrates one embodiment of a backscattering system.

[0051] FIG. **2** illustrates wirelessly controlling a device using a backscattering system.

[0052] FIGS. **3**A-C are example backscattering systems according to embodiments of the present invention.

[0053] FIG. **4** illustrates one embodiment of a backscattering system.

[0054] FIG. **5** illustrates one embodiment of a backscattering system.

[0055] FIG. **6** illustrates one embodiment of a backscattering system that supports a wireless sensor application.

[0056] FIG. **7** is a flow chart of one process that one embodiment of a backscattering system follows to support a wireless sensor application.

[0057] FIG. **8** illustrates one embodiment of a backscattering system that supports a wireless remote access or control application.

[0058] FIG. **9** is a flow chart of one process that one embodiment of a backscattering system follows to support a wireless remote access application.

[0059] FIG. **10** illustrates another embodiment of a backscattering system that supports a wireless remote access application between two mobile devices.

DETAILED DESCRIPTION

[0060] Described herein are methods and systems for utilizing backscattering techniques in wireless applications. In the following description, for purposes of explanation, numerous examples and specific details are set forth in order to provide a thorough understanding of the present invention. It will be evident, however, to one skilled in the art that the present invention as defined by the claims may include some or all of the features in these examples alone or in combination with other features described below, and may further include and equivalents of the features and concepts described herein.

[0061] The general theories behind "amplitude modulation and demodulation," "radio frequency communication" ("RF communication"), and "data encoding and decoding" are well known in the art and will not be elaborated in detail. However, throughout this disclosure, "reader" is used interchangeably with "initiator," "interrogator," or "master." Similarly, a "tag" refers to both active and passive "targets" or "slaves." "Memory" is used interchangeably with "memory module." A mobile device broadly refers to, without limitation, a cellular phone, a smart phone, a personal digital assistant ("PDA"), a wireless email system (e.g., a BlackBerry handheld device), a notebook computer, portable electronic music device (e.g., an MP3 player), a memory stick, or any device that can be easily moved around by a person. Additionally, the controllers and processors described below may include, without limitation, microcontrollers, microprocessors, programmable logic devices, digital state machines, or equivalent elements for processing data and performing one or more of the described functions.

System Overview

[0062] An overview of a system that utilizes backscattering techniques in wireless applications is now provided. FIG. **1** is block diagram of one embodiment of a backscattering system. Backscattering system **100** includes a first electronic device **110**, including a backscattering transceiver **111**, and a second electronic device **120**, also including a backscattering transceiver **121**. Backscattering transceivers **111** and **121** enable devices **110** and **120** to communicate over a backscattering channel **150**. Embodiments of the invention may include electronic devices used in a variety of applications including mobile devices, sensors, televisions, stereos, automobile systems, remote controls, or security systems. One or both of the devices may be components of larger electronic systems, for example.

[0063] In some applications, one of the backscattering transceivers acts as an initiator and the other backscattering transceiver acts as a passive or active target. In other applications, the backscattering transceivers may operate in multiple modes (i.e., acting as both an initiator during one period of time and a target during another period of time). A "backscattering transceiver" generally refers to a circuit that is capable of receiving or transmitting, or both, data using backscattering techniques. Example backscattering circuits and techniques that may be used in the present invention are disclosed in "RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identification," by Klaus Finkenzeller, John Wiley & Sons; 2 edition, May 23, 2003, (ISBN: 0470844027). More specifically, "backscattering" broadly refers to the process of transmitting data using an RF carrier wave between an initiator (e.g., the reader) and a target (e.g., a tag) wherein the target may communicate with the initiator using RF reflections from the target (e.g., from the target's antenna). In some implementations, the target may absorb and use at least some power (energy) from the RF signal transmitted by the initiator. Transmission from the target to the initiator is typically accomplished by modulating the impedance of the target's antenna so that the radar signature of the target changes over time in a controlled manner. An RF signal from the initiator is backscattered from the target to the initiator, and the initiator senses the changes in the backscattered signal caused by the modulated impedance of the antenna. Accordingly, data encoded in the modulated antenna may be passed back to the initiator. In a passive target, the energy from the initiator's transmitted signal may be absorbed and used to power the modulation and potentially other functionality as described herein. Accordingly, a backscattering system will typically include an initiator backscattering circuit **111** and a target backscattering circuit **121**.

[0064] Some modulation methods used in a backscattering scheme include, without limitation, frequency shift keying ("FSK"), phase shift keying ("PSK"), amplitude shift keying ("ASK"), or combinations thereof. In one FSK modulation implementation, a '0' and a '1' are transmitted using two frequencies, which are both derived from the frequency of an RF carrier wave. In one PSK modulation scheme, a '0' and a '1' are transmitted using one frequency, which is also derived from the frequency of an RF carrier wave, but with two different phases of the RF carrier wave.

[0065] Other embodiments of backscattering transceivers **111** and **121** may further include data encoders and decoders. In particular, data bit-streams can be encoded before transmission and can be decoded after demodulation. Some examples of the encoding and decoding mechanisms are, without limitation, Return to Zero ("RZ"), Non-Return to Zero ("NRZ") Direct, Differential Biphase, Biphase-L (or Manchester), Biphase-M, or Delay Modulation (Miller Code).

[0066] In one embodiment, device **110** may be an initiator (or master) device that is used to control the state, functionality, or operation of the target (or slave) device **120** over a backscattering channel. Example applications of the present invention may include sending one or more commands to the target device over a backscattering channel. In some embodiments described below, device **120** may be completely powered down, and device **110** may send an activation command (or activating signal) to device **120** that turns the device on or off (i.e., turns the power to device **120** on or off). For example, device **120** may be completely powered off. Device **120** may include a passive backscattering circuit for receiving a carrier wave from device **110**. Device **110** may absorb and use the energy (power) from the carrier wave to activate (turn on) other circuits or systems. In some embodiments, one of devices **110** or **120** may include only a backscattering transmitter, and the other device may include only a backscattering receiver. Such an embodiment may be useful if, for example, device **110** is only being used to send an activation command to device **120**, for example. In other embodiments, other commands may be issued to device **120** over a backscattering channel to execute particular operations. Data may also be sent from device **110** to device **120** over the backscattering channel as described in examples below. In some embodiments, device **120** may transmit data to device **110** over the backscattering channel in response to operations carried out on device **120**.

[0067] In typical master-slave systems, the slave must periodically turn itself on for a short amount of time to determine whether the master wants to initiate a communication cycle. In one embodiment, the present invention includes a low power mechanism for starting a communication channel that does not require continuous power. A master device may use a backscattering channel to send commands to the slave device, which may include an activation command. Example master-slave (initiator-target) systems may include master devices such as cell phones, PDAs, iPods or equivalent devices and headsets, earpieces, or other remote devices as the slave. The slave device may receive a command from the master to control a "switch," for example, to turn the slave ON and OFF. As mentioned above, in one embodiment, the slave device can be completely shut down, and the master device can wake up the slave device using the backscattering channel. For example, a Bluetooth master may initiate and control communications and actions of slave devices. Slave devices may turn on and then execute commands issued by the master device. Example applications include light switches, sensors, or an access point and wireless network connection in a laptop (e.g., wireless features may turn on when a laptop is in the area of an access point after receiving signal from access point or vice versa if desirable). Other examples include a television remote control (Master) and television (Slave) or a toy remote control and a toy.

[0068] FIG. **2** illustrates wirelessly controlling a device using a backscattering system. For example, at **201** a command may be generated in the initiator device. At **202**, the command is modulated. At **203**, the modulated command is transmitted using an RF signal. At **204**, the modulated command is received over the backscattering channel in a target device. At **205**, at least some of the power from the RF signal is absorbed and used to power the target. For example, if the target is a passive device, power from the RF signal may be the only source of power available to power the target electronics. Alternatively, if the target is an active device, the target may have a local power source and may only absorb and use energy from the received RF signal to power a portion of the target's electronics to active a switch turning on the power, for example. At **206**, the command is demodulated. At **207**, the command is executed.

[0069] In one embodiment, the initiator device sends a power up command to the target device over a backscattering communication channel. After the target device is powered up, or after the target device powers up one or more other devices or systems connected to the target device, it may send a response back to the initiator device signaling that the power up command has been executed or that the system is powered on (i.e., a "ready" signal). In other embodiments describe in more detail below, the target device may send data generated in the target device back to the initiator device for further processing.

[0070] FIGS. **3**A-B are examples of backscattering systems. Referring to FIG. **3**A, an initiator device **310** includes a backscattering transceiver **311**, and a target device **320** includes a backscattering transceiver **321**. Thus, backscattering transceivers **311** and **321** allow devices **310** and **320** to communicate across backscattering channel **350**. In this example, devices **310** and **320** are also coupled together over a second communication channel **351**. Communication channel **351** may be based on a wired or wireless connection, for example, such as a Bluetooth, Ethernet, Zigbee, Wi-Fi, Infrared, Ultra-wideband ("UWB"), or an IEEE 802 network. In this example, one or both of the target device **320** and communication channel **351** may be initially inactive. Initiator device **310** may send an activation command over backscattering channel **350**. In response to the activation command, target device **320** may turn on. Alternatively, or additionally, the activation command may activate communication channel **351**.

[0071] For example, an initiator device may be part of a cell phone, and the target may be a wireless earpiece. The earpiece may initially be powered completely off to save maximum battery power. The cell phone may include a backscattering circuit that transmits an activation command to the earpiece if a user initiates a phone call or if an incoming call is detected. In response to receiving the activation command from the cell phone over the backscattering channel, the earpiece may turn on and activate a Bluetooth communication channel between the earpiece and the cell phone. Of course this is just one example application of one of the many techniques described herein that illustrates the power that may be saved by the target device because, using one embodiment of the invention, the target device may be completely powered down until the activation signal is received over the backscattering channel. In other embodiments, the initiator device may be a stationary wireless access point including a backscattering circuit that transmits a backscattering signal in a localized area. In this application a target may be a laptop computer or a mobile device (e.g., a PDA) equipped with backscattering circuits, which may receive the backscattering signal from the reader and automatically activate and/or configure a wireless communication channel with the access point.

[0072] FIG. **3**B is another example of a backscattering system according to one embodiment of the present invention. In this example, device **310** sends commands to device **320** over backscattering channel **350**, and device **320** executes the commands to control a network **352**. Device **320** may also send network information to device **310**. Example networks may include sensor networks, local area wired networks, local area wireless networks, or home entertainment networks. In one embodiment, a network may be initially turned off, and an initiator device **310** may send an activation command to target device **320** to turn the network on. Examples include automatically activated sensor networks wherein arrays of sensing elements may be selectively activated using backscattering channels. Data from the networks may be transmitted back to the initiator device for further processing and/or storage using the backscattering channel. Individual target devices may be activated controlled, and/or configured using commands and data received directly from the initiator device. Alternatively, one target device may be used to send and receive information over the backscattering channel for the network. FIG. **3**C is another example of a backscattering system according to one embodiment of the present invention. In this example, commands from an initiator device **310** are transmitted across backscattering channel **350** to target device **320** to activate, control, and/or configure an electronic system **353**. Information may be transmitted from device **320** to device **310**, and device **310** may include, or be coupled to, a processor to process the information.

Example Backscattering System

[0073] FIG. **4** is another example of a backscattering system according to one embodiment of the present invention. Backscattering system **400** includes device controller **402**, which is coupled to backscattering transceiver **404** via interface **412**. Backscattering system **400** further includes device **408**, which is coupled to backscattering transceiver **406** via interface **414**. Alternatively, backscattering transceivers **404** and **406** can be parts of (e.g., integrated on the same board or chip with) device controller **402** and device **408**, respectively.

[0074] Optionally, device controller **402** is further coupled with processing system **410** via communication link **416**. Communication link **416** supports techniques other than the backscattering techniques. Some examples of the techniques employed by communication link **416** include, without limitation, various versions of the Ethernet related technologies, various versions of the wireless fidelity ("Wi-Fi") related technologies, various cellular technologies, and various internal or external bus technologies (e.g., IEEE 1394, Universal Serial Bus, and serial or parallel data transfer).

[0075] In one application, device controller **402** may be used for controlling device **408**. "Control" here refers to, without limitation, activating and de-activating, monitoring, or directing device **408**. In one embodiment, device **408** is controlled or managed by device controller **402**.

[0076] Interfaces **412** and **414** can be, without limitation, memory mapped input/output ("I/O") interface or I/O mapped interface. In memory mapped I/O interface, the I/O devices are addressed at certain reserved address ranges on the memory bus and can be accessed by memory transfer instructions. On the other hand, in an I/O mapped interface, specialized instructions are used to access the I/O devices. Thus, if memory mapped I/O interface is adopted, then one embodiment of device controller **402** or device **408** can respectively access backscattering transceivers **404** or **406** using the memory transfer instructions of their embedded processing units. If I/O mapped interface is adopted, then one embodiment of device controller **402** or device **408** instead respectively accesses transceiver **404** or **406** using specialized I/O instructions.

[0077] Processing system **410** may be used for analyzing, managing, or converting the data that device controller **402** receives via backscattering transceiver **404**. Subsequent paragraphs will provide some examples of processing system **410**.

Example Backscattering System Supporting a Wireless Activation Application

[0078] FIG. **5** is a block diagram of one embodiment of a backscattering system that supports a wireless activation application. In one embodiment, a backscattering channel is used to remotely activate a remote device or subsystems of the remote device (e.g., network connections), or both. For example, backscattering system **500** may comprise a first electronic device including device electronics **508**, backscattering transceiver **506**, and at least one power control element, such as switch ("SW") **550**, that couples a power supply ("Vcc") to the device electronics. A second electronic device may include a device controller **502**, backscattering transceiver **504**, and optional processing system **510**. Initially, device electronics **508** and backscattering transceiver **506** may be powered down. Accordingly, switch **550** is open so that Vcc is disconnected from the electronics. It is to be understood that while switch **550** is illustrated here as a single switch, in an actual implementation switch **550** may be implemented using multiple circuit elements for turning the power on and off. Furthermore, the power source may be a battery or an AC source of power coupled to the electronics (e.g., through one or more AC to DC converters and/or DC to DC converters). Device controller **502** may generate an activation command to turn on the power to device **508**. Activation command generation may be a result of a direct input into device controller **502**. For example, device controller **502** may be coupled to a cellular RF front end, and may generate an activation command upon detecting an incoming transmission. As another example, device controller **502** may be coupled to an input device, and may generate an activation command upon detecting a user input. For another example, device controller **502** may be embedded in a hand held remote control and used to turn on a television set using a backscattering channel when a user activates one or more inputs (e.g., pressing buttons) on the remote. As yet another example, device controller **502** may generate an activation command in response to instructions from processing system **510**, which may be responsive to user inputs or system instructions.

[0079] An activation command may be modulated with a carrier wave and transmitted from backscattering transceiver **504** to backscattering transceiver **506**. In one embodiment, backscattering transceiver **506** may be a passive circuit that uses the energy from the transmission to receive the modulated command, demodulate the command, and execute the command. In another embodiment, when the activation command is executed, a local power source such as Vcc (e.g., in an active target) may be coupled to some or all of the circuit elements. In one embodiment, the activation command may include control information that is used to determine which components of device **508** are to be activated. As mentioned above, components of device **508** may include device electronics or a communication channel or network between device **508** and other devices. Additionally, while the above example describes turning the power on and off, it is to be understood that the present disclosure includes using the device controller **502** to control device **508** to move between any two power consumption states (e.g., from a deep sleep mode where the majority of circuit elements are powered off to a partial or fully active mode where more or all circuit elements are activated).

Example Backscattering System Supporting a Wireless Sensor Application

[0080] FIG. **6** is a block diagram of one embodiment of a backscattering system that supports a wireless sensor application. In one embodiment, a backscattering channel is used to remotely control, monitor, configure, and/or activate a remote device, such as a sensor or actuator, for example. For example, backscattering system **600** may include sensing device **602**, backscattering transceivers **610** and **612**, device controller **614**, and back-end processing system **622**. One embodiment of sensing device **602** further includes sensing element **604**, memory **606**, and processing unit **608**. One embodiment of device controller **614** includes memory **616**, processing unit **618**, and I/O logic **620**.

[0081] FIG. **7** is a flow chart of one example process that one embodiment of backscattering system **600** may follow to support an example wireless sensor application. Suppose sensing device **602** is a passive target in one embodiment of backscattering system **600**. At **700**, device controller **614** signals transceiver **612** to start generating a RF carrier wave including an activating signal, which may be triggered by **110** logic **620**. For example, I/O logic **620** may receive instructions from a manual input (e.g., the press of a button on a handheld device) or a software automated system for generating an activating signal to turn on remote devices. If backscattering transceiver **610** is within the range of the RF carrier wave, it will detect the carrier wave. In a passive system, the energy from the carrier wave may be used to power up either transceiver **610** or sensor device **602**, or both, at **702**. In an active system, the carrier wave may be received by backscattering transceiver **610**, and the activating signal may be used to control a switch to "power on" the system, or control the system to move from a sleep state to an ON state (e.g., by executing an initiation cycle). Accordingly, as mentioned above, in some applications devices may be turned from an

OFF state (or power saving sleep state) to an active ON state using a backscattering channel. In one embodiment, the activation command selectively activates particular sensors in a sensor network. In this sensor example, after sensing device **602** is activated, physical stimuli may be received by sensing element **604** in sensing device **602**. Sensing element **604** generates output data in response to the physical stimuli and stores the data in memory **606** at **704**. The physical stimuli to a sensor can be, without limitation, temperature, light, sound, pressure, color, and motion, for example, or any other sensed input.

[0082] At **706**, processing unit **608** may manipulate the stored output data from sensing element **604**. For example, processing unit **608** may operate a state machine for manipulating the data. In one implementation, memory **606** contains a set of instructions, which when executed by processing unit **608**, invokes the state machine. For example, in one application, processing unit **608** may filter the stored output data of the sensing element **604**. For example, if sensing element **604** generates and stores output data from both light and sound stimuli, then processing unit **608** may pass only the stored output data in response to light, but not in response to sound, to backscattering transceiver **610**. In another state machine, processing unit **608** filters the stored output data based on a pre-determined threshold. For example, if the stored output data are generated in response to sound stimuli, then processing unit **608** may pass only the stored output data that exceed a pre-determined decibel threshold. In yet anther state machine, processing unit **608** may pass (1) information relating to sensing device **602** (e.g., the location or the identification information of the device), which may be stored in memory **606** at the time of the installation of sensing device **602**, and (2) the stored output data that result from the stimuli to backscattering transceiver **610**.

[0083] At **708**, backscattering transceiver **610** modulates the manipulated and stored output data. In one implementation, backscattering transceiver **610** may also encode the data before modulating them. After modulation, at **710**, backscattering transceiver **610** transmits the modulated signals by reflecting back some or all of the RF signal from backscattering transceiver **612**, for example, by modulating the impedance of an antenna on transceiver **610**. One embodiment of backscattering transceiver **612** demodulates the modulated signals at **712** by detecting the change in the amplitude of a reflected carrier wave. At **714**, back-end processing system **622** may analyze the demodulated data and perform one or more actions based on the results of the analyses. Furthermore, back-end processing system **622** may automatically store the data in a database or generate a report on the data.

[0084] In alternative embodiments of backscattering system **600**, sensing device **602** can be an active target having an internal power source or a passive target without internal power. Either system can be used to remotely power up a device. If a passive target is used, the energy from the RF signal is used to initiate a power on sequence for the device. In one embodiment, device **602** is completely passive, and all data acquisition functions, processing, and communications are executed using energy from the received RF signal. In this embodiment, memory **606** may include a nonvolatile memory (e.g., using tunneling or hot electron devices) so that information may be stored and retained on the device when no power is available. If an active target is used, the RF signal triggers activation of the device using local power as described above.

[0085] In one embodiment, device controller **614** may send other types of commands or information to sensing device **602** over a backscattering channel. For example, after device **602** is turned on, it may receive additional data from controller **614**. Accordingly, transceiver **612** may send commands or other information from controller **614** to transceiver **610** and device **602**. Backscattering transceiver **610** receives the additional data, and processing unit **608** may process the received information and/or carry out one or more received commands. For example, device controller **614** may issue a command to reconfigure parameters of sensing device **602** or send software updates to the sensing device. Configuration parameters or software may include calibration parameters, algorithms (e.g., filtering or sensor data processing), or other executable code updates, for example.

Example Backscattering System Supporting a Wireless Remote Access or Control Application

[0086] FIG. **8** is a block diagram of one embodiment of a backscattering system that supports a wireless remote access or control application. For example, one embodiment of backscattering system **800** may support power up, initialization, and/or control of communication networks using a backscattering channel. Backscattering system **800** includes a first device **812** and a second device **802**. Device **802** is coupled to wireless communication module **820**. In one embodiment, device controller **812** may initiate and power up a communication module **820** by issuing commands to device **802** over a backscattering channel. Communication module may activate an entire communication network, for example. For example, one embodiment of communication module **820** may support various wireless standards described above such as the different versions of the 802.11 standards.

[0087] FIG. **9** is a flow chart of one process that one embodiment of backscattering system **800** may follow to support a wireless remote access or control application. Suppose device **802** is an active target in one embodiment of backscattering system **800**. At **900**, device controller **812** begins generating a RF carrier wave including an activating signal triggered by I/O logic **818**. I/O logic may receive instructions from a manual system (e.g., the press of a button on a handheld device) or software automated system for generating an activating signal to turn on the network, for example. Backscattering transceiver **810** modulates and transmits the activating signal over the backscattering channel to device **802**. Device **802** receives the activating signal, and processing unit **806** of device **802** performs a startup sequence of the network at **902**, which may include conducting an internal check, initialization, and storing the current state information of device **802** in memory **804**. At **904**, backscattering transceiver **808** modulates and transmits the stored state information over the backscattering channel to device controller **812**.

[0088] Backscattering transceiver **810** receives the modulated signal and demodulates the received signal at **906** to retrieve the state information. At **908**, processing unit **816** of device controller **812** verifies whether the retrieved state information indicates that device **802** is ready to receive commands. If device **802** is ready and a state machine operated by processing unit **816** indicates a command is to be sent to communication module **820**, then processing unit **816** of device controller **812** retrieves the command from memory **814** and passes it to backscattering transceiver **810**. Backscattering transceiver **810** modulates and transmits the command at **910**. Some examples of the commands include, without limitation, turning on and turning off communication module **820**.

[0089] At **912**, backscattering transceiver **808** receives the modulated signal and demodulates the received signal to retrieve the command. Then processing unit **806** of device **802** causes the command to be sent to communication module **820** at **914**. Communication module **820** executes the command at **916** and then reports the status of the execution at **918** to device **802**. Backscattering transceiver **808** modulates the status information of communication module **820** with the RF carrier wave from backscattering transceiver **810** and transmits the modulated signal at **920**. Then the aforementioned process repeats if device controller **812** has additional commands for communication module **820**.

[0090] Alternatively, one embodiment of backscattering system **800** issues commands to devices other than communication module **820**. Using the same process as set forth in FIG. **9** and as discussed above, the commands issued can be, without limitation, to turn on and off a device, such as a light switch, adjust the thermostat of an air conditioning system or a refrigerator, or to adjust the volume of a stereo system, to name just a few examples.

[0091] FIG. **10** is a block diagram of another embodiment of a backscattering system that supports a wireless remote access application between two systems **1000** and **1001**. In this embodiment, system **1000** contains backscattering transceiver **1010** and device controller **1012** as discussed above. In addition, system **1000** also includes communication module **1022**, which supports communication techniques other than the backscattering techniques. System **1001** contains backscattering transceiver **1008**, device **1002**, and communication module **1020** as discussed above. For example, system **1000** may be an access point that initiates and powers up a wireless device **1001** to establish a wireless communication channel so that the wireless device can access a network through the access point. For example, an access point **1000** may initiate a power up by sending a power up command between backscattering transceivers **1010** and **1008**. The received signal may be used to power up device **1002** so that a processing unit **1006** issues power up and other commands to a communication module **1020** to set up the wireless channel.

[0092] Alternatively, systems **1000** and **1001** may be mobile devices, and backscattering system supports wireless remote access between two mobile devices. For illustration purposes, suppose communication modules **1022** and **1020** both support the same Wi-Fi standards and can communicate with one another. Also, suppose the power of communication module **1020** of mobile device **1001** is currently off due a period of inactivity. Suppose further User U of mobile device **1000** wishes to access certain data stored on mobile device **1001**. According to the flow chart of FIG. **9**, the following activities may occur:

[0093] (1) User U enables device controller **1012** by pressing a designated button on mobile device **1000** as U is physically near by mobile device **1001**. The press of the button signals I/O logic **1018**, which then causes processing unit **1016** to operate a state machine by executing certain instructions stored in memory **1014**. Here, processing unit **1016** causes backscattering transceiver **1010** to generate a RF carrier wave including an activation command to activate device **1002** and/or module **1020**;

[0094] (2) Device **1002** in mobile device **1001** indicates whether it is ready to receive commands by backscattering its current state information using the carrier wave generated by backscattering transceiver **1010** in mobile device **1000**. When the state information indicates that device **1002** is ready, processing unit **1016** operates a state machine, which determines if any command, such as to turn on communication module **1020**, is to be sent to device **1002**. If the command is to be sent, backscattering transceiver **1010** modulates the command with a RF carrier wave that it generates and transmits the modulated signal.

[0095] (3) After communication module **1020** is turned on, and communication channel between **1020** and **1022** is established, mobile device **1000** can retrieve data stored in mobile device **1001** via a Wi-Fi communication channel established between communication modules **1022** and **1020**. Moreover, after the data transfer is completed, one embodiment of processing unit **1016** may cause backscattering transceiver **1010** to modulate and transmit a command of turning off communication module **1020**.

[0096] The above description illustrates various embodiments of the present invention along with examples of how aspects of the present invention may be implemented. The above examples, embodiments, and drawings should not be deemed to be the only embodiments, and are presented to illustrate the flexibility and advantages of the present invention as defined by the following claims. Based on the above disclosure and the following claims, other arrangements, embodiments, implementations, and equivalents will be evident to those skilled in the art and may be employed without departing from the spirit and scope of the invention as defined by the claims.

1-50. (canceled)

51. A method of controlling a plurality of remote devices connected to a network, the plurality of remote devices comprising a first remote device comprising a backscattering transceiver, the method comprising:

at the first remote device, receiving a command from a master device over a backscattering communication channel;

sending the command from the first remote device to one or more of said plurality of remote devices over the network;

receiving information at the first remote device from one or more of said plurality of remote devices; and

transmitting the received information from the first device to the master device over the backscattering communication channel.

52. The method of claim **51**, wherein the command is an activation command that selectively powers up particular remote devices of said plurality of remote devices.

53. The method of claim **51**, wherein the information from one or more of said plurality of devices includes state information requested by the master device.

54. The method of claim **51**, wherein the command includes configuration data for selectively configuring particular remote devices of said plurality of remote devices.

55. The method of claim **51**, wherein the plurality of remote devices comprises an electronic system, wherein each remote device is a component of the electronic system and is independently controlled through commands from the master device.

56. The method of claim **51**, wherein communications within the network is through a communication channel that is one of a Bluetooth, Zigbee, Wi-Fi, Infrared, and Ultra-Wideband wireless channel.

57. A method of controlling a first device by a second device, the first and second devices each comprising a backscattering transceiver, the method comprising:

detecting an incoming transmission at the second device from a third device through a cellular radio frequency channel;

generating a modulated command at the second device in response to detecting said incoming transmission from the third device; and

transmitting the modulated command to the first device through a backscattering channel.

58. The method of claim **57**, wherein the third device is a software automated system.

59. The method of claim **57**, wherein the second device is a back end processing system, wherein the third device is a cellular radio frequency front end device.

60. The method of claim **57**, wherein the modulated command is for configuring the first device,

61. The method of claim **57**, wherein the first device includes a power control element, wherein upon the execution of the command the power control element is activated and the first device transitions from a first power state to a second power state.

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