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Radio frequency protocol for a security / automation system

Abstract

Example implementations include a method, apparatus, and computer-readable medium comprising receiving, by a multi-capability device from a control panel, a message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device; transmitting, responsive to the message querying a single capability of the multi-capability device, a second message from the multi-capability device to the control panel, wherein the second message includes a packet configured according to the packet format to include a state or data value for the single capability of the device; and transmitting, responsive to the message querying at least two capabilities of the multi-capability device, a third message from the multi-capability device to the control panel, wherein the third message includes a packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the device.

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Background/Summary

FIELD
(1) The present disclosure relates generally to security/automation systems and methods.
SUMMARY

(2) The following presents a simplified summary of one or more aspects in order to provide a basic understanding of such aspects. This summary is not an extensive overview of all contemplated aspects, and is intended to neither identify key or critical elements of all aspects nor delineate the scope of any or all aspects. Its sole purpose is to present some concepts of one or more aspects in a simplified form as a prelude to the more detailed description that is presented later.

(3) An example implementation includes a method of communications comprising receiving, by a multi-capability device from a control panel, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device. The method further includes transmitting, responsive to the first message querying a single capability of the multi-capability device, a second message from the multi-capability device to the control panel, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device. The method further includes transmitting, responsive to the first message querying at least two capabilities of the multi-capability device, a third message from the multi-capability device to the control panel, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(4) Another example implementation includes an apparatus for communications comprising a memory and a processor communicatively coupled with the memory. The processor is configured to receive, by a multi-capability device from a control panel, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device. The processor is further configured to transmit, responsive to the first message querying a single capability of the multi-capability device, a second message from the multi-capability device to the control panel, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device. The processor is further configured to transmit, responsive to the first message querying at least two capabilities of the multi-capability device, a third message from the multi-capability device to the control panel, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(5) Another example implementation includes an apparatus for communications comprising means for receiving, by a multi-capability device from a control panel, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device. The apparatus further comprises means for transmitting, responsive to the first message querying a single capability of the multi-capability device, a second message from the multi-capability device to the control panel, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device. The apparatus further comprises means for transmitting, responsive to the first message querying at least two capabilities of the multi-capability device, a third message from the multi-capability device to the control panel, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(6) Another example implementation includes a computer-readable medium storing instructions for communications executable by a processor that, when executed, cause the processor to receive, by a multi-capability device from a control panel, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device. The instructions, when executed, further cause the processor to transmit, responsive to the first message querying a single capability of the multi-capability device, a second message from the multi-capability device to the control panel, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability

of the multi-capability device. The instructions, when executed, further cause the processor to transmit, responsive to the first message querying at least two capabilities of the multi-capability device, a third message from the multi-capability device to the control panel, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(7) A further example implementation includes a method of communications comprising transmitting, from a control panel to a multi-capability device, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device. The method further includes receiving, responsive to the first message querying a single capability of the multi-capability device, a second message by the control panel from the multi-capability device, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device. The method further includes receiving, responsive to the first message querying at least two capabilities of the multi-capability device, a third message by the control panel from the multi-capability device, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(8) Another example implementation includes an apparatus for communications comprising a memory and a processor communicatively coupled with the memory. The processor is configured to transmit, from a control panel to a multi-capability device, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device. The processor is further configured to receive, responsive to the first message querying a single capability of the multi-capability device, a second message by the control panel from the multi-capability device, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device. The processor is further configured to receive, responsive to the first message querying at least two capabilities of the multi-capability device, a third message by the control panel from the multi-capability device, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(9) Another example implementation includes an apparatus for communications comprising means for transmitting, from a control panel to a multi-capability device, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device. The apparatus further comprises means for receiving, responsive to the first message querying a single capability of the multi-capability device, a second message by the control panel from the multi-capability device, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device. The apparatus further comprises means for receiving, responsive to the first message querying at least two capabilities of the multi-capability device, a third message by the control panel from the multi-capability device, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(10) Another example implementation includes a computer-readable medium storing instructions for communications executable by a processor that, when executed, cause the processor to transmit, from a control panel to a multi-capability device, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device. The instructions, when executed, further cause the processor to receive, responsive to the first message querying a single capability of the multi-capability device, a second message by the control panel from the multi-capability device, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability

of the multi-capability device. The instructions, when executed, further cause the processor to receive, responsive to the first message querying at least two capabilities of the multi-capability device, a third message by the control panel from the multi-capability device, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(11) To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative features of the one or more aspects. These features are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed, and this description is intended to include all such aspects and their equivalents.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The disclosed aspects will hereinafter be described in conjunction with the appended drawings, provided to illustrate and not to limit the disclosed aspects, wherein like designations denote like elements, and in which:

(2) FIG. **1** is a schematic diagram of an example security/automation system including a control panel and one or more sensors/devices that each implement a radio-frequency (RF) protocol and radio, according to some aspects;

(3) FIG. **2** is an example message sequence diagram for enrollment of a sensor/device in FIG. **1**, according to some aspects;

(4) FIG. **3** is a block diagram of an example computing device which may implement all or a portion of any component in FIG. **1**, according to some aspects;

(5) FIG. **4** is a block diagram of example components of a computing device which may implement all or a portion of a control panel or a sensor/device in FIG. **1** configured for RF communication, according to some aspects;

(6) FIG. **5** is a flow diagram of a first example method for RF communication by a sensor/device in FIG. **1**, according to some aspects;

(7) FIG. **6** is a flow diagram of a second example method for RF communication by a sensor/device in FIG. **1**, according to some aspects;

(8) FIG. **7** is a flow diagram of a third example method for RF communication by a sensor/device in FIG. **1**, according to some aspects;

(9) FIG. **8** is a flow diagram of a fourth example method for RF communication by a control panel in FIG. **1**, according to some aspects;

(10) FIG. **9** is a flow diagram of a fifth example method for RF communication by a control panel in FIG. **1**, according to some aspects; and

(11) FIG. **10** is a flow diagram of a sixth example method for RF communication by a control panel in FIG. **1**, according to some aspects.

DETAILED DESCRIPTION

(12) The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known components may be shown in block diagram form in order to avoid obscuring such concepts.

(13) Some present aspects provide a radio-frequency (RF) protocol and radio for a

security/automation system. In one non-limiting aspect, for example, one or more sensors/devices in a premises security/automation system may implement an RF protocol and radio that provide flexible, encrypted, 2-way communication and improved range, while maintaining the price point and battery life of legacy sensors/devices.

(14) For example, some legacy sensors/devices transmit at 319 MHz, 345 MHZ, and 433 MHz, and use one-way unencrypted communication with simple RF modulation (varying the carrier frequency waveform with a modulating waveform; carrier frequency is the frequency of the carrier waveform, which is modulated with an information-carrying waveform to transmit a message). Accordingly, these legacy sensors/devices use frequencies that have long wavelengths, thus requiring either large/long antennas or inefficient antennas. In some cases, for example, a small legacy sensor with inefficient antennas require a lot of wasted power in the RF transmitter, leading to lower battery life.

(15) Because legacy sensors/devices use one-way communication, there is no guarantee that a message transmitted by a sensor/device is received by the control panel, and over-the-air firmware updates are also not possible. In some cases, redundant transmissions are required to mitigate RF collision, leading to lower battery life.

(16) Further, the protocols implemented in legacy sensors/devices are limited, and legacy sensors/devices can only communicate limited states, such as, for example, door open/closed, temperature above/below a threshold, etc., but cannot communicate values, such as actual temperature, etc. For example, since a legacy temperature sensor cannot send the actual temperature and can only indicate if the temperature is above or below a threshold, the legacy temperature sensor may not be useful for controlling a heat, ventilation, and air conditioning (HVAC) system for example.

(17) Moreover, federal communication commission (FCC) rules limit the transmit power of the sensors/devices to very low levels which limits link budget/range. On the other hand, the modulation technique implemented in legacy sensors/devices (e.g., on-off keying (OOK)) requires high signal to noise ratio (SNR) and transmitting each message multiple times for successful decoding at the receiver, which also limits the link budget/range. Since legacy sensors/devices have limited range and no flexibility, the installs often require using repeaters at additional cost, or using PowerG sensors/devices that provide better range by using high transmit power and frequency hopping (transmitting radio signals by switching the carrier frequency among several distinct frequency channels occupying a spectral band) but are significantly more expensive and have shorter battery life because the receiver of the sensor/device has high transmit power and has to be always on to listen to a coordinator for frequency hopping. Also, since PowerG uses high transmit power and requires a receiver that is always on for frequency hopping coordination, sensors/devices that implement PowerG have more power usage and may require a relatively larger battery.

(18) In contrast, the present aspects provide an RF protocol and radio for automation/security system sensors/devices, where the RF protocol and radio support 2-way communication with a retry mechanism for reliable communication between sensors/devices and an automation/security control panel. In some aspects, the RF communication is encrypted (e.g., implementing advanced encryption standard-128 (AES-128) encryption), is operable to report both states and values, and is configured to support multi-capability sensors/devices. A multi-capability sensor/device is a sensor/device that is operable to provide more than one capability, such as more than one measurements (e.g., door/window displacement, temperature, smoke, etc.) or measurement types (e.g., temperature state and temperature value). In an aspect, the present RF protocol and radio allow for a control panel to enroll/register, configure, and communicate with a multi-capability sensor/device as a single endpoint. That is, using the present RF protocol and radio, the control panel registers the multi-capability sensor/device as one sensor/device (as opposed to multiple separately/registered sensors/devices), and all queried and/or reported state/value capability

information may be included in one packet for communication between the control panel and the multi-capability device. As such, the present RF protocol and radio allow for less over-the-air traffic. The present RF protocol also allows for sensor/device settings to be configurable over-the-air, and for firmware updates of the sensors/devices to be implemented over-the-air.

(19) Some aspects further provide low-power radio hardware for implementing the present RF protocol. In an aspect, the radio hardware may communicate at frequencies such as 915 MHZ/868 MHz, thus allowing for small, efficient antennas (e.g., compact ceramic antennas). In some aspects, for improved receiver sensitivity (the weakest signal power that a receiver can identify and process), the radio hardware implements an RF modulation such as offset quadrature phase shift keying (OQPSK), Gaussian frequency shift keying (GFSK, a modulation scheme in which pulses are shaped by a Gaussian filter before modulation), or 2-level GFSK (2GFSK, a modulation scheme in which information is transmitted through two distinct frequency changes, and pulses are shaped by a Gaussian filter before modulation), and/or direct sequence spread spectrum (DSSS, a modulation scheme in which the transmitted signal bandwidth is increased by a spreading factor (power in Hz is reduced by spreading factor) to decrease signal interference). In contrast to the modulation schemes used in legacy sensors/devices, such as OOK modulation that uses the two key parameters of amplitude and timing for modulation, the modulation schemes used in the present aspects use at least the four parameters of amplitude, phase, frequency, and timing. Accordingly, in comparison with the modulation schemes used in legacy sensors/devices, the modulation schemes used in the present aspects require lower SNR and therefore provide improved link budget/range. Further, by using the present modulation schemes, the receiver of a sensor/device may not need to be always on, and therefore the sensor/device may require a smaller battery size as compared to, for example, sensors/devices that implement frequency hopping accordingly to PowerG.

(20) In one non-limiting aspect, for example, the radio may include a Silicon Labs Flex Gecko chipset. In one non-limiting aspect, for example, the chipset may have daughter card modularity when implemented on a security/automation system control panel.

(21) Turning now to the figures, example aspects are depicted with reference to one or more components described herein, where components in dashed lines may be optional.

(22) Referring to FIG. **1**, a security/automation system **150** may include various sensors/devices **102**, **104** (e.g., sensors, cameras, etc., installed throughout a premises) that communicate packets **114**, **116** with a control panel **106** according to an RF protocol **100**. Specifically, for example, a first sensor/device **102** may include a first sensor/device radio **108** operable according to the RF protocol **100** (which may be included in the firmware of the first sensor/device **102**) to communicate with the control panel **106** that also includes a control panel radio **112** operable according to the RF protocol **100**. Similarly, a second sensor/device **104** may also include a second sensor/device radio **110** operable according to the RF protocol **100** to communicate with the control panel **106**. Further details of the sensors/devices **102**, **104** and the control panel **106** are described with reference to various aspects below.

(23) In an aspect, for example, the sensors/devices **102**, **104** and the control panel **106** may implement two-way communication for reliable transport where every packet received by the control panel **106** or by a sensor/device **102**, **104** (except for acknowledgment (ACK) packet types themselves) is acknowledged (ACKed), and packet transmission is retried if an ACK is not received within a timeout period.

(24) In some aspects, the RF protocol **100** may define and support various packet types, such as a "Data" packet type, an "ACK" packet type, an "ACK+Data" packet type, etc. For example, in an aspect, in addition to using ACK packet types for acknowledging a packet, an "ACK+Data" packet type may be used for more conversational exchanges such as queries and their responses in order to reduce the number of packets that need to be sent. In some aspects, the "ACK" packet type and the "ACK+Data" packet type may both be used in the enrollment process (e.g., see below).

(25) In an aspect, the RF protocol **100** may defines a packet format **101** in which each packet

includes a preamble, a header, a payload, and/or a cyclic redundancy check (CRC). In an aspect, the header of the packet indicates a packet type (e.g., as described above) and a payload type (e.g., as described below). In some aspects, the payload includes a packet identifier (ID) and payload data. The packet ID is used to identify packets so that the receiver can disregard duplicate packets that have been retransmitted and already successfully received. The payload data includes payload type for unique message identification. In some aspects, the packet ID is encrypted with the payload data in order to vary the payload and protect against man-in-the-middle attacks.

(26) The payload type may be an indicator of any one of a number of protocol-specific messages, such as but not limited to: an enrollment request message, an enrollment device data message, a Diffie-Hellman message, a capabilities and settings request or reporting or enable/disable or update message (either specific one or all capabilities/settings), received signal strength indication and/or transmit power request and reporting messages, a request or reporting of attached device information, a firmware update message, an ACK message, a timeout confirmation message (e.g., from the control panel **106** when waiting to receive information or enrollment responses), a firmware update message, and/or an unenrollment request or response message. In one non-limiting aspect, attached device information may include data such as Electronic Serial Number (ESN), device type, firmware version (major and minor), etc. In an aspect, attached device information encompasses all of the payload data in the "Enrollment Request" packet. In an aspect, an unenrollment request or response message is configured to unenroll a multi-capability device that has been previously enrolled with the control panel **106**.

(27) Further, when a packet is an "ACK+Data" packet type, two Packet IDs are listed in the payload. For instance, one packet ID may be the ID of the packet it is included in, and the other packet ID is the ID of the packet being ACKed which was received previously.

(28) In some aspects, the RF protocol **100** may define a format where the packet type also indicates whether or not another packet is to be expected, e.g., whether or not to stay awake.

(29) In some aspects, if an ACK is not received for a packet, packet transmission is retried for a certain number of times, where the certain number of times may be specific to and configurable for each sensor/device. In some aspects, if a basic retry does not succeed, a subsequent retry may be attempted with increased transmit power. In some aspects, if a packet is received, the sensor/device may decrease the transmit power in order to find the minimum transmit power that supports a communication link that allows the control panel to continue to successfully receive packets from the sensor/device. As a result, transmitting at such a minimum transmit power saves battery power and increases battery lifetime. In an aspect, for example, the control panel may determine the signal strength from each sensor/device and instruct the sensor/device to increase or decrease the transmit power based on the signal strength detected at the control panel. Accordingly, the control panel may cause robust performance across different sensors/devices in an installation.

(30) Some aspects may further implement Clear Channel Assessment (CCA) to avoid RF collisions. CCA implements a "listen-before-talk" mechanism where before attempting to transmit a packet, a sensor/device checks the channel to determine whether the channel is busy. If the channel is busy, there is a random back off period before the sensor/device attempts to transmit again. This decreases the chance that two sensors/devices will transmit at the same time.

(31) In some aspects, using the present RF protocol and radio, a sensor/device may report states as well as values. In one non-limiting aspect, for example, a sensor/device may provide a temperature state report (e.g., may report that temperature is above a threshold), a temperature value report (e.g., may report that temperature is 38.7° C.), a battery state report (e.g., may report low battery), a battery value report (e.g., may report that the battery voltage is 2853 mV), etc.

(32) In some aspects, the present RF protocol and radio may be implemented in a multi-capability sensor/device, such as a sensor/device that includes a door/window displacement sensor and a temperature sensor (e.g., reporting a door/window state as well as a temperature value), a smoke/carbon monoxide (CO)/heat detector (e.g., reporting smoke state, CO state, heat state, CO

ppm value, and temperature value), etc. In an aspect, the multi-capability sensor/device may indicate its multiple capabilities (send a description of its capabilities) to the control panel during sensor/device enrollment, so that the control panel knows what data to expect from the sensor/device and what data may be queried from the sensor/device. In an aspect, for example, the control panel may enable/disable one or more capabilities of the multi-capability sensor/device. In an aspect, for example, the control panel may save battery life of the sensor/device by disabling one or more capabilities. In another aspect, for example, the control panel may query individual capabilities or may query a list of capabilities of the multi-capability sensor/device. Such query functionality is applicable, for example but not limited to, automation devices where the control panel requires high responsiveness from a sensor/device.

(33) In some aspects, the RF protocol **100** allows for secure encrypted communication. For example, but not limited hereto, the communication between the sensor/device and the control panel may be AES-encrypted, where the encryption key is derived from a Diffie-Hellman key exchange (e.g., FIG. **2** below). Specifically, the control panel and the sensor/device have individual secret keys that are not shared publicly. The control panel and the sensor/device each use their respective secret key and a common public to obtain a respective public key for a public exchange where the receiver does not know the private key used to obtain the public key. Each receiver then uses the received public key and its own private key to obtain a same secret key. Because the common secret is derived by operations that are not reversible, the control panel and the sensor/device may separately derive a common secret key without sharing any information that could be used by an adversary to determine the secret key. In some aspects, the hardware platform in the sensor/device includes a hardware acceleration engine that allows for implementing the above for robust security.

(34) In an aspect, using an enrollment process, a new sensor/device may be paired with the control panel. During the enrollment process, the new sensor/device and the control panel exchange the required information in order to be able to address each other and have the encryption keys to encrypt and decrypt messages for encrypted communication. In an aspect, the control panel issues a separate key for each sensor/device that is enrolled with the control panel. The control panel stores all of the keys for the enrolled sensors/device, and each sensor/device stores its own key. In an aspect, the key information stored on the control panel may be backed up in a server on a network (e.g., the cloud), and if the control panel is replaced with a new control panel, the keys may be downloaded and restored to the new control panel from the cloud. Accordingly, the new control panel has access to all the encryption keys, and therefore the sensors/devices do not need to be re-enrolled with the new control panel. This is advantageous, for example, in large installation with many sensors/devices, since an installer would not need to walk through the installation and open each sensor/device for re-enrollment.

(35) Referring to FIG. **2**, in an aspect, for example, an installer **200** may interact with a host **202** (e.g., a control panel a security/automation system of a premises) to enroll a new sensor/device **204** that is added to an installation. At **206** the installer selects the enrollment mode on the host **202**, for example, via a user interface of the host **202**. In response, the host **202** enters the enrollment mode at **208**. Then, at **210** the installer **200** performs a trip/tamper/power cycle on the device **204**. In response, at **212** the device **204** looks for a short ID. If it is determined that the device **204** has not been assigned a short ID, at **214** the device **204** sends an enrollment request to the host **202** and begins a timed enrollment process at **216**. In an aspect, the enrollment request may indicate one or more of a default system token, an electronic serial number (ESN), device type, firmware version, etc. In some aspects, the device type may indicate the device as being a type such as, but not limited to, a security type of device (e.g., video, glass break, tilt, shock, image, motion, door/window contact, fob), a life safety type of device (e.g., smoke, heat, panic, carbon monoxide, flood), and/or a lifestyle type device (e.g., smart socket, dimmer, light, doorbell, outlet).

(36) Upon receiving the enrollment request, at **218** the host **202** sends an ACK to the device **204**,

and at **220** the host **202** searches for device information in an enrollment table. If a matching device is not found in the enrollment table, at **222** the host **202** displays (e.g., via a user interface of the host **202**) the ESN of the device **204** for the installer **200** to confirm. At **224** the installer **200** confirms the device ESN (e.g., via a user interface of the host **202**). Then, the host **202** and the device **204** perform a key exchange, such as a Diffie-Hellman key exchange, to derive a common key for encrypted communication that is only understood by the host **202** and the device **204**.

(37) Specifically, at **226** the host **202** sends a Diffie-Hellman public to the device **204**. The Diffie-Hellman public includes a public (prime) base "g" and a public (prime) modulus "p." At **238** the device **204** uses its private key "a" to perform the Diffie-Hellman calculation "g{circumflex over (   )}a mod p" that provides a device public key "A," and sends the device public key "A" with an ACK to the host **202** at **232**. In response, the host **202** who at **232** has also used its private key "b" to perform the Diffie-Hellman calculation "g{circumflex over (   )}b mod p" that provides a host public key "B," sends the host public key "B" along with an ACK to the device **204** at **234**. At **236** the host **202** again uses its private key "b" to perform the Diffie-Hellman calculation "B{circumflex over (   )}a mod p" that provides the common secret key "s," and the host **202** stores the common secret "s" at **238**. Further, at **240** the device **204** uses its private key "a" to perform the Diffie-Hellman calculation "A{circumflex over (   )}b mod p" that provides the same common secret key "s" as calculated by the host **202**. At **242** the device **204** stores the common secret "s," and at **244** the device **204** sends an ACK to the host **202**, which concludes the key exchange.

(38) Accordingly, unlike other protocols where one key is used for an entire network, the present aspects provide an enrollment process to establish an encryption key that is unique between each sensor/device and the control panel. In one non-limiting aspect, for example, the packets communicated between the control panel and a sensor/device are AES-128 encrypted according to Diffie-Hellman encryption.

(39) In some aspects, a sensor/device may indicate a unique device ID and one or more capabilities of the sensor/device to the control panel, and the control panel may set which capabilities of the sensor/device are active or disabled. In an aspect, each capability of the sensor/device has its own configurable settings, and the control panel may program those settings on the sensor/device.

(40) In some aspects, the RF protocol defines programmable settings. For example, for each capability of a multi-capability sensor/device, the RF protocol may provide unique programmable settings that are programmable by the control panel, and the control panel may also query the values of such settings from the sensor/device. For instance, the RF protocol may define a packet format having a packet type that indicates the packet is a capabilities and settings request packet or a capabilities and settings reporting packet, wherein a payload is formatted to indicate the number of capability types and the associated settings. In an aspect, for example, the RF protocol may provide unique programmable settings for temperature threshold (e.g., for indicating when a temperature is out of acceptable bounds), noise level threshold (e.g., a party/crowd detector), voltage for low battery warning (or different levels of warnings such as low battery, replace battery soon, urgent—replace battery), etc. In an alternative or additional aspect, the RF protocol may also provide unique programmable settings for number of retries, length of supervisory interval, and transmit power, and such settings are programmable by the control panel. In another alternative or additional aspect, the RF protocol may also provide unique programmable settings for configurable wake/sleep behavior of a sensor/device. Such settings may allow for various configurable wake/sleep behavior options, and different sensors/devices may have different sleep behavior which is configurable. For example, the settings may allow for configuring a device/sensor into an always-listening device (for AC powered sensors/devices such as home automation devices that do not have battery life constraints and therefore can always be on and listening), a semi-sleeping device (to conserve power while also being responsive to queries/command, optionally with a configurable wake-up period), a full-sleepy device (to conserve maximum power by only waking

up when there is a packet to transmit (e.g., a status/supervisory/heartbeat message) and wait for a short period of time after transmitting to listen to the panel (e.g., to receive an ACK or a query for more information), and programming the supervisory interval of these sensors/devices impacts sensor/device responsiveness (e.g., 200 seconds)), a schedule wake up device (e.g., an NB-IoT device that periodically wakes up for a short duration according to a configured schedule) etc.

(41) In one non-limiting aspect, for example, a sensor/device may be programmed into a semi-sleeping mode such that the radio of the sensor/device wakes up in response to a specific event such as receiving a specific packet (e.g., a low level packet such as an OOK packet that the sensor can easily recognize in a low power state), and after the sensor is awake, the control panel may communicate with the sensor using regular packets. In an alternative non-limiting aspect, for example, a sensor/device may be programmed into a preamble sense mode such that the sensor/device is in a low energy state and senses the preamble of a packet before waking up to receive the packet.

(42) In some aspects, some devices such as smoke detectors may be subject to certifications that prevent from configuring the sensor/device into a deep sleep. For these sensors/devices, some aspects define a more awake sleep state that does not invalidate the required certifications.

(43) As described, the present aspects allow for flexible, encrypted, 2-way communication and improved range, while maintaining the price point and battery life of legacy sensors/devices. For example, in one non-limiting example implementation, a door/window displacement sensor according to the present aspects may be implemented at a same/similar cost as a legacy sensor/device, and a size of 1.83″×0.87″×0.4″, with an estimated link budget/range of 1150 ft, one 130 mAh CR1632 battery providing an estimated battery life of 6-7 years, a radio transmit power of −10 dBm, a sensor antenna gain of −4 dBi, and a receiver sensitivity of −110 dBm.

(44) In one non-limiting example implementation, a sensor/device configured with the RF protocol and radio according to the present aspects may send and receive packets, participate in an enrollment process (e.g., as described above using a simplified Diffie-Hellman key exchange), and perform address filtering and packet ID filtering. The sensor/device may implement a media access control (MAC) protocol such as carrier-sense multiple access with collision avoidance (CSMA/CA), and may be configured to send ACK packets as well as ACK plus data packets. For packets that are not successfully communicated, the sensor/device may perform packet transmission retries. The sensor/device may store configuration registers, capabilities, and settings in a nonvolatile memory of the sensor/device. The sensor/device may read from and write to the nonvolatile memory from the firmware of the sensor/device. For example, the sensor/device may include a third generation non-volatile memory (NVM3), implement custom tokens, and write default values to the tokens and the NVM3 using a command line tool such as Simplicity Commander. In one non-limiting aspect, the sensor/device may enter EM4 wakeup mode, and use the CRYOTIMER to wake up. The sensor/device may use a general purpose input output (GPIO) for polling. In one non-limiting implementation, for example, such a sensor/device may include Reed switch functionality to implement a door/window displacement detector.

(45) FIG. **3** illustrates an example block diagram providing details of computing components in a computing device **300** that may implement all or a portion of one or more components in a control panel, a sensor/device, or any other component described above. The computing device **300** includes a processor **302** which may be configured to execute or implement software, hardware, and/or firmware modules that perform any functionality described above with reference to one or more components in a control panel, a sensor/device, or any other component described above. For example, the processor **302** may be configured to execute an RF communication component **312** to provide RF communication functionality, as described herein with reference to various aspects.

(46) The processor **302** may be a micro-controller and/or may include a single or multiple set of processors or multi-core processors. Moreover, the processor **302** may be implemented as an integrated processing system and/or a distributed processing system. The computing device **300**

may further include a memory **304**, such as for storing local versions of applications being executed by the processor **302**, related instructions, parameters, etc. The memory **304** may include a type of memory usable by a computer, such as random access memory (RAM), read only memory (ROM), tapes, flash drives, magnetic discs, optical discs, volatile memory, non-volatile memory, and any combination thereof. Additionally, the processor **302** and the memory **304** may include and execute an operating system executing on the processor **302**, one or more applications, display drivers, etc., and/or other components of the computing device **300**.

(47) Further, the computing device **300** may include a communications component **306** that provides for establishing and maintaining communications with one or more other devices, parties, entities, etc., utilizing hardware, software, and services. The communications component **306** may carry communications between components on the computing device **300**, as well as between the computing device **300** and external devices, such as devices located across a communications network and/or devices serially or locally connected to the computing device **300**. For example, the communications component **306** may include one or more buses, and may further include transmit chain components and receive chain components associated with a wireless or wired transmitter and receiver, respectively, operable for interfacing with external devices.

(48) Additionally, the computing device **300** may include a data store **308**, which can be any suitable combination of hardware and/or software, that provides for mass storage of information, databases, and programs. For example, the data store **308** may be or may include a data repository for applications and/or related parameters not currently being executed by the processor **302**. In addition, the data store **308** may be a data repository for an operating system, application, display driver, etc., executing on the processor **302**, and/or one or more other components of the computing device **300**.

(49) The computing device **300** may also include a user interface component **310** operable to receive inputs from a user of the computing device **300** and further operable to generate outputs for presentation to the user (e.g., via a display interface to a display device). The user interface component **310** may include one or more input devices, including but not limited to a keyboard, a number pad, a mouse, a touch-sensitive display, a navigation key, a function key, a microphone, a voice recognition component, or any other mechanism capable of receiving an input from a user, or any combination thereof. Further, the user interface component **310** may include one or more output devices, including but not limited to a display interface, a speaker, a haptic feedback mechanism, a printer, any other mechanism capable of presenting an output to a user, or any combination thereof.

(50) Referring to FIGS. **4-10**, in operation for RF communication functionality, computing device **400** may implement at least a portion of one or more components in FIGS. **1-3** above, such as all or at least a portion of the first sensor/device **102**, the second sensor/device **104**, or the control panel **106** in FIG. **1**, and may perform method **500** or method **600** such as via execution of RF communication component **312** by processor **402** and/or memory **404**. Specifically, computing device **400** may be configured to perform method **500** for performing an aspect of RF communication functionality by a sensor/device, as described herein. Further, computing device **400** may be configured to perform method **600** for performing an aspect of RF communication functionality by a control panel, as described herein. It should be noted that computing device **400**, processor **402**, and memory **404** may be the same or similar to computing device **300**, processor **302**, and memory **304** as described above with respect to FIG. **3**.

(51) The below description of method **500** begins with optional blocks **502**, **504**, **506**, and **508**, which may be optionally performed prior to block **510**.

(52) Referring to FIG. **5**, in one optional implementation, at block **502**, the method **500** may include transmitting an enrollment request according to a protocol from a multi-capability device to a control panel. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may

comprise means for transmitting an enrollment request according to a protocol from a multi-capability device to a control panel.

(53) For example, in an aspect, the transmitting at block **502** may include the first sensor/device **102** executing the transmitting component **408** to transmit an enrollment request according to the RF protocol **100** to the control panel **106**, for example, as described herein with reference to block **214** in FIG. **2**. In an aspect, the first sensor/device **102** is a multi-capability sensor/device, which is a sensor/device that is operable to provide more than one capability, such as more than one measurement (e.g., door/window displacement, temperature, smoke, etc.) and/or more than one measurement type (e.g., temperature state and temperature value). In an aspect, using an enrollment process, a new sensor/device may be paired with the control panel. During the enrollment process, the new sensor/device and the control panel exchange the required information in order to be able to address each other and have the encryption keys to encrypt and decrypt messages for encrypted communication.

(54) In one optional implementation, at block **504**, the method **500** may include performing, in response to the enrollment request, a key exchange according to the protocol by the multi-capability device with the control panel. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or exchanging component **414** may be configured to or may comprise means for performing, in response to the enrollment request, a key exchange according to the protocol by the multi-capability device with the control panel.

(55) For example, in one non-limiting aspect, the exchanging at block **504** may include the first sensor/device **102** executing the exchanging component **414** to perform, in response to the enrollment request, a Diffie-Hellman key exchange according to the RF protocol **100** with the control panel **106**, for example, as described above with reference to blocks **226**, **230**, and **234** in FIG. **2**.

(56) In one optional implementation, at block **506**, the method **500** may include generating, in response to the key exchange, an encryption key that is unique to the multi-capability device as compared to one or more other devices configured to communicate with the control panel according to the protocol. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or generating component **416** may be configured to or may comprise means for generating, in response to the key exchange, an encryption key that is unique to the multi-capability device as compared to one or more other devices configured to communicate with the control panel according to the protocol.

(57) For example, in an aspect, the generating at block **506** may include the first sensor/device **102** executing the generating component **416** to generate, in response to the key exchange, an encryption key that is unique to the first sensor/device **102** as compared to the second sensor/device **104** that is also configured to communicate with the control panel according to the RF protocol **100**, for example, as described above with reference to a Diffie-Hellman key exchange at blocks **228** and **240** in FIG. **2**. For example, the first sensor/device **102** and the control panel **106** may perform a key exchange according to FIG. **2**. During the key exchange, the first sensor/device **102** and the control panel **106** may use the first sensor private key **118** that is only known to the first sensor/device **102** and the first panel private key **122** that is only known to the control panel **106** to separately derive the first encryption key **120** for encrypted communication of the first packet **114** between the first sensor/device **102** and the control panel **106**. The first encryption key **120** is unique to the first sensor/device **102** as compared to other devices that communicate with the control panel **106**, such as the second sensor/device **104**. In fact, the second sensor/device **104** and the control panel **106** may also perform a key exchange according to FIG. **2**. During the key exchange, the second sensor/device **104** and the control panel **106** may use the second sensor private key **124** that is only known to the second sensor/device **104** and the second panel private key **131** that is only known to the control panel **106** to separately derive the second encryption key

128 for encrypted communication of the second packet **116** between the second sensor/device **104** and the control panel **106**. The second encryption key **128** is unique to the second sensor/device **104** as compared to other devices that communicate with the control panel **106**, such as the first sensor/device **102**.

(58) In one optional implementation, at block **508**, the method **500** may include storing the encryption key at the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or storing component **418** may be configured to or may comprise means for storing the encryption key at the multi-capability device.

(59) For example, in an aspect, the storing at block **508** may include the first sensor/device **102** executing the storing component **418** to store the first encryption key **120**, e.g., at the memory **404** of the first sensor/device **102**, for example, as described above with reference to block **242** in FIG. **2**.

(60) Continuing to FIG. **6**, at block **510**, the method **500** includes receiving, by a multi-capability device from a control panel, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or receiving component **406** may be configured to or may comprise means for receiving, by a multi-capability device from a control panel, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device.

(61) For example, in an aspect, the receiving at block **510** may include the first sensor/device **102** executing the receiving component **406** to receive, from the control panel **106**, a message including a packet that is configured according to the RF protocol **100** that defines a packet format **101** configurable to indicate each/every queried capability of the first sensor/device **102**. In one optional implementation, for example, the control panel **106** may specify one or more capabilities for the multi-capability device to respond with the corresponding capability data values/states. For example, the control panel **106** may specify the capability type (e.g., a value corresponding to a specific capability) that the control panel **106** is querying the multi-capability device for. In an alternative optional implementation, for example, the control panel **106** may send a message where no capabilities are specified, but the payload type of the message indicates that the control panel **106** is querying all of the capabilities of the multi-capability device.

(62) In one optional implementation, at block **512**, the method **500** may include transmitting, responsive to the first message querying a single capability of the multi-capability device, a second message from the multi-capability device to the control panel, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device.

(63) For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for transmitting, responsive to the first message querying a single capability of the multi-capability device, a second message from the multi-capability device to the control panel, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device.

(64) For example, in an aspect, the transmitting at block **512** may include the first sensor/device **102** executing the transmitting component **408** to transmit, responsive to receiving a query message querying a single capability of the first sensor/device **102**, a response message to the control panel **106**, wherein the response message includes a packet configured according to the packet format **101** to include a state or data value for the queried capability of the first sensor/device **102**. For example, in an aspect, if the first sensor/device **102** receives a packet from the control panel **106** that is configured according to the packet format **101** to include a capability query **129** for only one

of the multiple capabilities of the first sensor/device **102**, then the first sensor/device **102** responds to the control panel **106** by sending a packet configured according to the packet format **101** to include a first capability state/data value **130** for the queried capability of the first sensor/device **102** (e.g., a temperature state such as "temperature above threshold," or a temperature value such as "70 degrees"). In one optional implementation, for example, the control panel **106** may specify a single capability for the multi-capability device to respond with the corresponding capability data value/state. For example, the control panel **106** may specify a single capability type (e.g., a value corresponding to a specific capability) that the control panel **106** is querying the multi-capability device for.

(65) In one optional implementation, at block **514**, the method **500** may include transmitting, responsive to the first message querying at least two capabilities of the multi-capability device, a third message from the multi-capability device to the control panel, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for transmitting, responsive to the first message querying at least two capabilities of the multi-capability device, a third message from the multi-capability device to the control panel, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(66) For example, in an aspect, the transmitting at block **514** may include the first sensor/device **102** executing the transmitting component **408** to transmit, responsive to receiving a query message querying at least two capabilities of the first sensor/device **102**, a response message to the control panel **106**, wherein the response message includes a packet configured according to the packet format **101** to include one state or data value for each one of the queried capabilities of the first sensor/device **102**. For example, in an aspect, if the first sensor/device **102** receives a packet from the control panel **106** that is configured according to the packet format **101** to include a capability query **129** that queries a first as well as a second capability of the first sensor/device **102**, then the first sensor/device **102** responds to the control panel **106** by sending a packet configured according to the packet format **101** to include a first capability state/data value **130** for the first queried capability of the first sensor/device **102** (e.g., a temperature state such as "temperature above threshold") as well as a second capability state/data value **132** for the second queried capability of the first sensor/device **102** (e.g., a temperature value such as "70 degrees"). In one optional implementation, for example, the control panel **106** may specify multiple capabilities for the multi-capability device to respond with the corresponding capability data values/states. For example, the control panel **106** may specify multiple capability types (e.g., multiple values corresponding to respective capabilities) that the control panel **106** is querying the multi-capability device for. In an alternative optional implementation, for example, the control panel **106** may send a message where no capabilities are specified, but the payload type of the message indicates that the control panel **106** is querying all of the capabilities of the multi-capability device.

(67) In one optional implementation, at block **516**, the method **500** may include determining whether a transmitted one of the second message or the third message is received by the control panel based on whether the multi-capability device has received an acknowledgment for the transmitted one of the second message or the third message from the control panel. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or determining component **410** may be configured to or may comprise means for determining whether a transmitted one of the second message or the third message is received by the control panel based on whether the multi-capability device has received an acknowledgment for the transmitted one of the second message or the third message from the control panel.

(68) For example, in an aspect, the determining at block **516** may include the first sensor/device

102 executing the determining component **410** to determine whether a message transmitted by the first sensor/device **102** is received by the control panel **106**, based on whether the first sensor/device **102** has received an acknowledgment for the transmitted message from the control panel **106**. For example, in an aspect, the packet format **101** allows for the control panel **106** to configure and transmit a packet that includes an ACK **134** for each packet received from the first sensor/device **102**, and the first sensor/device **102** may look for such ACK **134** from the control panel **106** after transmitting each packet to the control panel **106**.

(69) In one optional implementation, at block **518**, the method **500** may include retransmitting the transmitted one of the second message or the third message responsive to an absence of the acknowledgment from the control panel. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for retransmitting the transmitted one of the second message or the third message responsive to an absence of the acknowledgment from the control panel.

(70) For example, in an aspect, the re-transmitting at block **518** may include the first sensor/device **102** executing the transmitting component **408** to retransmit a previously transmitted packet when an ACK **134** is not received from the control panel **106** for the previously transmitted packet.

(71) In one optional implementation, each message communicated between the first sensor/device **102** and the control panel **106** is encrypted using the first encryption key **120** that is unique to the first sensor/device **102** as compared to one or more other devices configured to communicate with the control panel **106** according to the RF protocol **100**, such as the second sensor/device **104**. Similarly, each message communicated between the second sensor/device **104** and the control panel **106** is encrypted using the second encryption key **128** that is unique to the second sensor/device **104** as compared to one or more other devices configured to communicate with the control panel **106** according to the RF protocol **100**, such as the first sensor/device **102**.

(72) Continuing to FIG. **7**, in one optional implementation, at block **520**, the method **500** may include receiving a fourth message according to the protocol by the multi-capability device from the control panel, wherein the fourth message includes an over-the-air firmware update. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or receiving component **406** may be configured to or may comprise means for receiving a fourth message according to the protocol by the multi-capability device from the control panel, wherein the fourth message includes an over-the-air firmware update.

(73) For example, in an aspect, the receiving at block **520** may include the first sensor/device **102** executing the receiving component **406** to receive a message according to the RF protocol **100** from the control panel **106**, wherein the message includes a packet configured according to the packet format **101** to include an over-the-air firmware update **140** for the first sensor/device **102**.

(74) In one optional implementation, at block **522**, the method **500** may include updating a firmware of the multi-capability device according to the over-the-air firmware update. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or updating component **412** may be configured to or may comprise means for updating a firmware of the multi-capability device according to the over-the-air firmware update.

(75) For example, in an aspect, the updating at block **522** may include the first sensor/device **102** executing the updating component **412** to update a firmware of the first sensor/device **102** according to the over-the-air firmware update **140** received from the control panel **106** in a packet configured according to the packet format **101**.

(76) In one optional implementation, at block **524**, the method **500** may include receiving a fourth message according to the protocol by the multi-capability device from the control panel, wherein the fourth message includes a query for a transmit power of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or receiving component **406** may be configured to or may comprise means for

receiving a fourth message according to the protocol by the multi-capability device from the control panel, wherein the fourth message includes a query for a transmit power of the multi-capability device.

(77) For example, in an aspect, the receiving at block **524** may include the first sensor/device **102** executing the receiving component **406** to receive a message according to the RF protocol **100** from the control panel **106**, wherein the message includes a packet configured according to the packet format **101** to include a power query **135** to query a current transmit power of the first sensor/device **102**. In one optional implementation, for example, a multi-capability device (e.g., the first sensor/device **102**) may keep track of the minimum, maximum, average, and most recent packet received signal strength indicator (RSSI) values. In these implementations, one or more of these values may be queried/requested by the control panel **106**, and the control panel **106** may also request to reset one or more of these values (e.g., reset the running average).

(78) In one optional implementation, at block **526**, the method **500** may include transmitting, responsive to the fourth message, a fifth message from the multi-capability device to the control panel, wherein the fifth message includes a third packet configured according to the packet format to include a power value of a current transmit power of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for transmitting, responsive to the fourth message, a fifth message from the multi-capability device to the control panel, wherein the fifth message includes a third packet configured according to the packet format to include a power value of a current transmit power of the multi-capability device.

(79) For example, in an aspect, the transmitting at block **526** may include the first sensor/device **102** executing the transmitting component **408** to transmit a message to the control panel **106** responsive to a query from the control panel **106** for a current transmit power of the first sensor/device **102**, where the message includes a packet configured according to the packet format **101** to include a power value **142** of a current transmit power of the first sensor/device **102**.

(80) In one optional implementation, at block **528**, the method **500** may include receiving a sixth message according to the protocol by the multi-capability device from the control panel, wherein the sixth message is configured to change the transmit power of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or receiving component **406** may be configured to or may comprise means for receiving a sixth message according to the protocol by the multi-capability device from the control panel, wherein the sixth message is configured to change the transmit power of the multi-capability device.

(81) For example, in an aspect, the receiving at block **528** may include the first sensor/device **102** executing the receiving component **406** to receive a message according to the RF protocol **100** from the control panel **106**, wherein the message includes a packet configured according to the packet format **101** to include a transmit power update **144** to update/change a transmit power of the first sensor/device **102**.

(82) In one optional implementation, at block **530**, the method **500** may include updating the transmit power of the multi-capability device according to the sixth message. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or updating component **412** may be configured to or may comprise means for updating the transmit power of the multi-capability device according to the sixth message.

(83) For example, in an aspect, the updating at block **530** may include the first sensor/device **102** executing the updating component **412** to update the transmit power of the first sensor/device **102** according to the transmit power update **144** received from the control panel **106** in a packet configured according to the packet format **101**.

(84) In one optional implementation, at block **532**, the method **500** may include receiving a fourth message according to the protocol by the multi-capability device from the control panel, wherein

the fourth message is configured to change a setting of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or receiving component **406** may be configured to or may comprise means for receiving a fourth message according to the protocol by the multi-capability device from the control panel, wherein the fourth message is configured to change a setting of the multi-capability device.

(85) For example, in an aspect, the receiving at block **532** may include the first sensor/device **102** executing the receiving component **406** to receive a message according to the RF protocol **100** from the control panel **106**, wherein the message is configured according to the packet format **101** to include a setting such as a capability setting **136** (e.g., to enable or disable a capability) or a wake/sleep setting **138** (e.g., to change a wake/sleep behavior/pattern) of the first sensor/device **102**. In one optional implementation, for example, one or more setting changes may be specified in a message from the control panel **106** to a multi-capability device (e.g., the first sensor/device **102**). In one optional implementation, for example, the control panel **106** may query a multi-capability device for the device's current setting values. In one optional implementation, for example, the control panel **106** may query a specific list of settings of a multi-capability device. In an alternative optional implementation, for example, a payload type of a message from the control panel **106** to a multi-capability device may indicate that all the settings of the multi-capability device are being queried.

(86) In one optional implementation, at block **534**, the method **500** may include updating the setting of the multi-capability device according to the fourth message. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or updating component **412** may be configured to or may comprise means for updating the setting of the multi-capability device according to the fourth message.

(87) For example, in an aspect, the updating at block **534** may include the first sensor/device **102** executing the updating component **412** to update a setting of the first sensor/device **102** according to a capability setting **136** (e.g., to enable or disable a capability) or a wake/sleep setting **138** (e.g., to change a wake/sleep behavior/pattern) received from the control panel **106** in a packet configured according to the packet format **101**.

(88) In one optional implementation, the packet format **101** may define a packet payload for a packet, wherein the packet payload includes a packet identifier and payload data.

(89) In one optional implementation, the packet identifier is encrypted with the payload data of the packet.

(90) The below description of method **600** begins with optional blocks **602**, **604**, **606**, and **608**, which may be optionally performed prior to block **610**.

(91) Referring to FIG. **8**, in one optional implementation, at block **602**, the method **600** may include receiving an enrollment request according to a protocol from a multi-capability device by a control panel. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or receiving component **406** may be configured to or may comprise means for receiving an enrollment request according to a protocol from a multi-capability device by a control panel.

(92) For example, in an aspect, the receiving at block **602** may include the control panel **106** executing the receiving component **406** to receive an enrollment request according to the RF protocol **100** from the first sensor/device **102**, for example, as described herein with reference to block **214** in FIG. **2**. In an aspect, the first sensor/device **102** is a multi-capability sensor/device, which is a sensor/device that is operable to provide more than one capability, such as more than one measurement (e.g., door/window displacement, temperature, smoke, etc.) and/or more than one measurement type (e.g., temperature state and temperature value). In an aspect, using an enrollment process, a new sensor/device may be paired with the control panel. During the enrollment process, the new sensor/device and the control panel exchange the required information in order to be able to address each other and have the encryption keys to encrypt and decrypt messages for encrypted

communication.

(93) In one optional implementation, at block **604**, the method **600** may include performing, in response to the enrollment request, a key exchange according to the protocol by the control panel with the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or exchanging component **414** may be configured to or may comprise means for performing, in response to the enrollment request, a key exchange according to the protocol by the control panel with the multi-capability device.

(94) For example, in one non-limiting aspect, the exchanging at block **504** may include the control panel **106** executing the exchanging component **414** to perform, in response to the enrollment request, a Diffie-Hellman key exchange according to the RF protocol **100** with the first sensor/device **102**, for example, as described above with reference to blocks **226**, **230**, and **234** in FIG. **2**.

(95) In one optional implementation, at block **606**, the method **600** may include generating, in response to the key exchange, an encryption key that is unique to the multi-capability device as compared to one or more other devices configured to communicate with the control panel according to the protocol. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or generating component **416** may be configured to or may comprise means for generating, in response to the key exchange, an encryption key that is unique to the multi-capability device as compared to one or more other devices configured to communicate with the control panel according to the protocol.

(96) For example, in an aspect, the generating at block **606** may include the control panel **106** executing the generating component **416** to generate, in response to the key exchange, an encryption key that is unique to the first sensor/device **102** as compared to the second sensor/device **104** that is also configured to communicate with the control panel **106** according to the RF protocol **100**, for example, as described above with reference to a Diffie-Hellman key exchange at blocks **232** and **236** in FIG. **2**. For example, the first sensor/device **102** and the control panel **106** may perform a key exchange according to FIG. **2**. During the key exchange, the first sensor/device **102** and the control panel **106** may use the first sensor private key **118** that is only known to the first sensor/device **102** and the first panel private key **122** that is only known to the control panel **106** to separately derive the first encryption key **120** for encrypted communication of the first packet **114** between the first sensor/device **102** and the control panel **106**. The first encryption key **120** is unique to the first sensor/device **102** as compared to other devices that communicate with the control panel **106**, such as the second sensor/device **104**. In fact, the second sensor/device **104** and the control panel **106** may also perform a key exchange according to FIG. **2**. During the key exchange, the second sensor/device **104** and the control panel **106** may use the second sensor private key **124** that is only known to the second sensor/device **104** and the second panel private key **131** that is only known to the control panel **106** to separately derive the second encryption key **128** for encrypted communication of the second packet **116** between the second sensor/device **104** and the control panel **106**. The second encryption key **128** is unique to the second sensor/device **104** as compared to other devices that communicate with the control panel **106**, such as the first sensor/device **102**.

(97) In one optional implementation, at block **608**, the method **600** may include storing the encryption key at the control panel. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or storing component **418** may be configured to or may comprise means for storing the encryption key at the control panel.

(98) For example, in an aspect, the storing at block **608** may include the control panel **106** executing the storing component **418** to store the first encryption key **120**, e.g., at the memory **404** of the control panel **106**, for example, as described above with reference to block **238** in FIG. **2**.

(99) Continuing to FIG. **9**, at block **610**, the method **600** includes transmitting, from a control panel to a multi-capability device, a first message configured according to a protocol that defines a packet

format configurable to indicate each queried capability of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for transmitting, from a control panel to a multi-capability device, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device.

(100) For example, in an aspect, the transmitting at block **610** may include the control panel **106** executing the transmitting component **408** to transmit, to the first sensor/device **102**, a message including a packet that is configured according to the RF protocol **100** that defines a packet format **101** configurable to indicate each/every queried capability of the first sensor/device **102**. In one optional implementation, for example, the control panel **106** may specify one or more capabilities for the multi-capability device to respond with the corresponding capability data values/states. For example, the control panel **106** may specify the capability type (e.g., a value corresponding to a specific capability) that the control panel **106** is querying the multi-capability device for. In an alternative optional implementation, for example, the control panel **106** may send a message where no capabilities are specified, but the payload type of the message indicates that the control panel **106** is querying all of the capabilities of the multi-capability device.

(101) In one optional implementation, at block **612**, the method **600** may include receiving, responsive to the first message querying a single capability of the multi-capability device, a second message by the control panel from the multi-capability device, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or receiving component **406** may be configured to or may comprise means for receiving, responsive to the first message querying a single capability of the multi-capability device, a second message by the control panel from the multi-capability device, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device.

(102) For example, in an aspect, the receiving at block **612** may include the control panel **106** executing the receiving component **406** to receive, responsive to transmitting a query message querying a single capability of the first sensor/device **102**, a response message from the first sensor/device **102**, wherein the response message includes a packet configured according to the packet format **101** to include a state or data value for the queried capability of the first sensor/device **102**. For example, in an aspect, if the first sensor/device **102** receives a packet from the control panel **106** that is configured according to the packet format **101** to include a capability query **129** for only one of the multiple capabilities of the first sensor/device **102**, then the first sensor/device **102** responds to the control panel **106** by sending a packet configured according to the packet format **101** to include a first capability state/data value **130** for the queried capability of the first sensor/device **102** (e.g., a temperature state such as "temperature above threshold," or a temperature value such as "70 degrees"). In one optional implementation, for example, the control panel **106** may specify a single capability for the multi-capability device to respond with the corresponding capability data value/state. For example, the control panel **106** may specify a single capability type (e.g., a value corresponding to a specific capability) that the control panel **106** is querying the multi-capability device for.

(103) In one optional implementation, at block **614**, the method **600** may include receiving, responsive to the first message querying at least two capabilities of the multi-capability device, a third message by the control panel from the multi-capability device, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**,

and/or receiving component **406** may be configured to or may comprise means for receiving, responsive to the first message querying at least two capabilities of the multi-capability device, a third message by the control panel from the multi-capability device, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(104) For example, in an aspect, the receiving at block **614** may include the control panel **106** executing the receiving component **406** to receive, responsive to transmitting a query message querying at least two capabilities of the first sensor/device **102**, a response message from the first sensor/device **102**, wherein the response message includes a packet configured according to the packet format **101** to include one state or data value for each one of the queried capabilities of the first sensor/device **102**. For example, in an aspect, if the first sensor/device **102** receives a packet from the control panel **106** that is configured according to the packet format **101** to include a capability query **129** that queries a first as well as a second capability of the first sensor/device **102**, then the first sensor/device **102** responds to the control panel **106** by sending a packet configured according to the packet format **101** to include a first capability state/data value **130** for the first queried capability of the first sensor/device **102** (e.g., a temperature state such as "temperature above threshold") as well as a second capability state/data value **132** for the second queried capability of the first sensor/device **102** (e.g., a temperature value such as "70 degrees"). In one optional implementation, for example, the control panel **106** may specify multiple capabilities for the multi-capability device to respond with the corresponding capability data values/states. For example, the control panel **106** may specify multiple capability types (e.g., multiple values corresponding to respective capabilities) that the control panel **106** is querying the multi-capability device for. In an alternative optional implementation, for example, the control panel **106** may send a message where no capabilities are specified, but the payload type of the message indicates that the control panel **106** is querying all of the capabilities of the multi-capability device.

(105) In one optional implementation, at block **616**, the method **600** may include sending an acknowledgment from the control panel to the multi-capability device responsive to a received one of the second message or the third message. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for sending an acknowledgment from the control panel to the multi-capability device responsive to a received one of the second message or the third message.

(106) For example, in an aspect, the sending at block **616** may include the control panel **106** executing the transmitting component **408** to transmit a packet that includes an ACK **134** for each packet received from the first sensor/device **102**.

(107) In one optional implementation, each message communicated between the first sensor/device **102** and the control panel **106** is encrypted using the first encryption key **120** that is unique to the first sensor/device **102** as compared to one or more other devices configured to communicate with the control panel **106** according to the RF protocol **100**, such as the second sensor/device **104**. Similarly, each message communicated between the second sensor/device **104** and the control panel **106** is encrypted using the second encryption key **128** that is unique to the second sensor/device **104** as compared to one or more other devices configured to communicate with the control panel **106** according to the RF protocol **100**, such as the first sensor/device **102**.

(108) Continuing to FIG. **10**, in one optional implementation, at block **618**, the method **600** may include transmitting a fourth message according to the protocol from the control panel to the multi-capability device, wherein the fourth message includes an over-the-air firmware update. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for transmitting a fourth message according to the protocol from the control panel to the multi-capability device, wherein the fourth message includes an over-the-air firmware update.

(109) For example, in an aspect, the transmitting at block **618** may include the control panel **106** executing the transmitting component **408** to transmit a message according to the RF protocol **100** to the first sensor/device **102**, wherein the message includes a packet configured according to the packet format **101** to include an over-the-air firmware update **140** for the first sensor/device **102**.

(110) In one optional implementation, at block **620**, the method **600** may include transmitting a fourth message according to the protocol from the control panel to the multi-capability device, wherein the fourth message includes a query for a transmit power of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for transmitting a fourth message according to the protocol from the control panel to the multi-capability device, wherein the fourth message includes a query for a transmit power of the multi-capability device.

(111) For example, in an aspect, the transmitting at block **620** may include the control panel **106** executing the transmitting component **408** to transmit a message according to the RF protocol **100** to the first sensor/device **102**, wherein the message includes a packet configured according to the packet format **101** to include a power query **135** to query a current transmit power of the first sensor/device **102**. In one optional implementation, for example, a multi-capability device (e.g., the first sensor/device **102**) may keep track of the minimum, maximum, average, and most recent packet received signal strength indicator (RSSI) values. In these implementations, one or more of these values may be queried/requested by the control panel **106**, and the control panel **106** may also request to reset one or more of these values (e.g., reset the running average).

(112) In one optional implementation, at block **622**, the method **600** may include receiving, responsive to the fourth message, a fifth message by the control panel **106** from the multi-capability device, wherein the fifth message includes a third packet configured according to the packet format to include a power value of a current transmit power of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or receiving component **406** may be configured to or may comprise means for receiving, responsive to the fourth message, a fifth message by the control panel from the multi-capability device, wherein the fifth message includes a third packet configured according to the packet format to include a power value of a current transmit power of the multi-capability device.

(113) For example, in an aspect, the receiving at block **622** may include the control panel **106** executing the receiving component **406** to receive a message from the first sensor/device **102** responsive to a query for a current transmit power of the first sensor/device **102**, where the message includes a packet configured according to the packet format **101** to include a power value **142** of a current transmit power of the first sensor/device **102**.

(114) In one optional implementation, at block **624**, the method **600** may include transmitting a sixth message according to the protocol by the control panel to the multi-capability device, wherein the sixth message is configured to change the transmit power of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for transmitting a sixth message according to the protocol by the control panel to the multi-capability device, wherein the sixth message is configured to change the transmit power of the multi-capability device.

(115) For example, in an aspect, the transmitting at block **624** may include the control panel **106** executing the transmitting component **408** to transmit a message according to the RF protocol **100** to the first sensor/device **102**, wherein the message includes a packet configured according to the packet format **101** to include a transmit power update **144** to update/change a transmit power of the first sensor/device **102**.

(116) In one optional implementation, at block **626**, the method **600** may include transmitting a fourth message according to the protocol by the control panel to the multi-capability device,

wherein the fourth message is configured to change a setting of the multi-capability device. For example, in an aspect, computing device **400**, processor **402**, memory **404**, RF communication component **312**, and/or transmitting component **408** may be configured to or may comprise means for transmitting a fourth message according to the protocol by the control panel to the multi-capability device, wherein the fourth message is configured to change a setting of the multi-capability device.

(117) For example, in an aspect, the transmitting at block **626** may include the control panel **106** executing the transmitting component **408** to transmit a message according to the RF protocol **100** to the first sensor/device **102**, wherein the message is configured according to the packet format **101** to include a setting such as a capability setting **136** (e.g., to enable or disable a capability) or a wake/sleep setting **138** (e.g., to change a wake/sleep behavior/pattern) of the first sensor/device **102**. In one optional implementation, for example, one or more setting changes may be specified in a message from the control panel **106** to a multi-capability device (e.g., the first sensor/device **102**). In one optional implementation, for example, the control panel **106** may query a multi-capability device for the device's current setting values. In one optional implementation, for example, the control panel **106** may query a specific list of settings of a multi-capability device. In an alternative optional implementation, for example, a payload type of a message from the control panel **106** to a multi-capability device may indicate that all the settings of the multi-capability device are being queried

(118) Some further example aspects are provided below.

(119) 1. A method comprising: receiving, receiving, by a multi-capability device from a control panel, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device; transmitting, responsive to the first message querying a single capability of the multi-capability device, a second message from the multi-capability device to the control panel, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device; and transmitting, responsive to the first message querying at least two capabilities of the multi-capability device, a third message from the multi-capability device to the control panel, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(120) 2. The method of clause 1, further comprising: determining whether a transmitted one of the second message or the third message is received by the control panel based on whether the multi-capability device has received an acknowledgment for the transmitted one of the second message or the third message from the control panel; and retransmitting the transmitted one of the second message or the third message responsive to an absence of the acknowledgment from the control panel.

(121) 3. The method of any of the above clauses, wherein the first message and the transmitted one of the second message or the third message are encrypted using an encryption key that is unique to the multi-capability device as compared to one or more other devices configured to communicate with the control panel according to the protocol.

(122) 4. The method of any of the above clauses, further comprising: receiving a fourth message according to the protocol by the multi-capability device from the control panel, wherein the fourth message includes an over-the-air firmware update; and updating a firmware of the multi-capability device according to the over-the-air firmware update.

(123) 5. The method of any of the above clauses, further comprising: receiving a fourth message according to the protocol by the multi-capability device from the control panel, wherein the fourth message includes a query for a transmit power of the multi-capability device; and transmitting, responsive to the fourth message, a fifth message from the multi-capability device to the control panel, wherein the fifth message includes a third packet configured according to the packet format

to include a power value of a current transmit power of the multi-capability device.

(124) 6. The method of any of the above clauses, further comprising: receiving a sixth message according to the protocol by the multi-capability device from the control panel, wherein the sixth message is configured to change the transmit power of the multi-capability device; and updating the transmit power of the multi-capability device according to the sixth message.

(125) 7. The method of any of the above clauses, wherein, prior to receiving the first message, the method further comprises: transmitting an enrollment request according to the protocol from the multi-capability device to the control panel; performing, in response to the enrollment request, a key exchange according to the protocol by the multi-capability device with the control panel; generating, in response to the key exchange, an encryption key that is unique to the multi-capability device as compared to one or more other devices configured to communicate with the control panel according to the protocol; and storing the encryption key at the multi-capability device.

(126) 8. The method of any of the above clauses, further comprising: receiving a fourth message according to the protocol by the multi-capability device from the control panel, wherein the fourth message is configured to change a setting of the multi-capability device; and updating the setting of the multi-capability device according to the fourth message.

(127) 9. The method of any of the above clauses, wherein the setting comprises a wake/sleep behavior of the multi-capability device.

(128) 10. The method of any of the above clauses, wherein the setting comprises enabling or disabling a capability of the multi-capability device by the control panel.

(129) 11. The method of any of the above clauses, wherein the packet format defines a packet payload for a packet, wherein the packet payload includes a packet identifier and payload data.

(130) 12. The method of any of the above clauses, wherein the packet identifier is encrypted with the payload data of the packet.

(131) 13. A method comprising: transmitting, from a control panel to a multi-capability device, a first message configured according to a protocol that defines a packet format configurable to indicate each queried capability of the multi-capability device; receiving, responsive to the first message querying a single capability of the multi-capability device, a second message by the control panel from the multi-capability device, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single capability of the multi-capability device; and receiving, responsive to the first message querying at least two capabilities of the multi-capability device, a third message by the control panel from the multi-capability device, wherein the third message includes a second packet configured according to the packet format to include one state or data value for each one of the at least two capabilities of the multi-capability device.

(132) 14. The method of clause 13, further comprising: sending an acknowledgement from the control panel to the multi-capability device responsive to a received one of the second message or the third message.

(133) 15. The method of clause 13 or 14, wherein the first message and the received one of the second message or the third message are encrypted using an encryption key that is unique to the multi-capability device as compared to one or more other devices configured to communicate with the control panel according to the protocol.

(134) 16. The method of any of clauses 13-15, further comprising: transmitting a fourth message according to the protocol from the control panel to the multi-capability device, wherein the fourth message includes an over-the-air firmware update.

(135) 17. The method of any of clauses 13-16, further comprising: transmitting a fourth message according to the protocol from the control panel to the multi-capability device, wherein the fourth message includes a query for a transmit power of the multi-capability device; and receiving, responsive to the fourth message, a fifth message by the control panel from the multi-capability device, wherein the fifth message includes a third packet configured according to the packet format

to include a power value of a current transmit power of the multi-capability device.

(136) 18. The method of any of clauses 13-17, further comprising: transmitting a sixth message according to the protocol from the control panel to the multi-capability device, wherein the sixth message is configured to change the transmit power of the multi-capability device.

(137) 19. The method of any of clauses 13-18, wherein, prior to transmitting the first message, the method further comprises: receiving an enrollment request according to the protocol from the multi-capability device by the control panel; performing, in response to the enrollment request, a key exchange according to the protocol by the control panel with the multi-capability device; generating, in response to the key exchange, an encryption key that is unique to the multi-capability device as compared to one or more other devices configured to communicate with the control panel according to the protocol; and storing the encryption key at the control panel.

(138) 20. The method of any of clauses 13-19, further comprising: transmitting a fourth message according to the protocol from the control panel to the multi-capability device, wherein the fourth message is configured to change a setting of the multi-capability device, wherein the setting comprises a wake/sleep behavior of the multi-capability device or enabling or disabling a capability of the multi-capability device.

(139) 21. The method of any of the above clauses, wherein the packet format defines a packet payload for a packet, wherein the packet payload includes a packet identifier and payload data.

(140) 22. The method of any of the above clauses, wherein the packet identifier is encrypted with the payload data of the packet.

(141) An apparatus comprising: a memory; and a processor communicatively coupled with the memory and configured to perform the method of any of the above clauses.

(142) A non-transitory computer-readable medium storing instructions executable by a processor that, when executed, cause the processor to perform the method of any of the above clauses.

(143) An apparatus comprising means for performing the method of any of the above clauses.

(144) The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." The word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any aspect described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other aspects. Unless specifically stated otherwise, the term "some" refers to one or more. Combinations such as "at least one of A, B, or C," "one or more of A, B, or C," "at least one of A, B, and C," "one or more of A, B, and C," and "A, B, C, or any combination thereof" include any combination of A, B, and/or C, and may include multiples of A, multiples of B, or multiples of C. Specifically, combinations such as "at least one of A, B, or C," "one or more of A, B, or C," "at least one of A, B, and C," "one or more of A, B, and C," and "A, B, C, or any combination thereof" may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. The words "module," "mechanism," "element," "device," and the like may not be a substitute for the word "means." As such, no claim element is to be construed as a means plus function unless the element is expressly recited using the phrase "means for."

Claims

1. A method comprising: receiving, by a multi-sensor device comprising two or more sensors, from a control panel, a first message configured according to a protocol that defines a packet format configurable to query one or more sensors of the multi-sensor device, wherein the protocol defines at least three packet types for responding to the first message, including a "Data" packet type for sending data queried by the first message, an "ACK" packet type for acknowledging the first message, and an "ACK+Data" packet type for sending the data queried by the first message and also acknowledging the first message that queried the data; determining, by the multi-sensor device, based on the first message, whether the control panel is querying all or only some of the two or more sensors of the multi-sensor device; transmitting, responsive to the first message querying a single sensor of the multi-sensor device, a second message from the multi-sensor device to the control panel, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single sensor of the multi-sensor device; and transmitting, responsive to the first message querying at least two sensors of the multi-sensor device, a third message from the multi-sensor device to the control panel, wherein the third message includes a second packet configured according to the packet format to include a header and a payload, the header indicating that a packet type of the second packet is the "ACK+Data" packet type configured to acknowledge the first message and also provide the data queried by the first message, the payload including one state or data value for each one of the at least two sensors of the multi-sensor device.
2. The method of claim 1, further comprising: determining whether a transmitted one of the second message or the third message is received by the control panel based on whether the multi-sensor device has received an acknowledgment for the transmitted one of the second message or the third message from the control panel; and retransmitting the transmitted one of the second message or the third message responsive to an absence of the acknowledgment from the control panel.
3. The method of claim 1, wherein the first message and a transmitted one of the second message or the third message are encrypted using an encryption key that is unique to the multi-sensor device as compared to one or more other devices configured to communicate with the control panel according to the protocol.
4. The method of claim 1, further comprising: receiving a fourth message according to the protocol by the multi-sensor device from the control panel, wherein the fourth message includes an over-the-air firmware update; and updating a firmware of the multi-sensor device according to the over-the-air firmware update.
5. The method of claim 1, further comprising: receiving a fourth message according to the protocol by the multi-sensor device from the control panel, wherein the fourth message includes a query for a transmit power of the multi-sensor device; and transmitting, responsive to the fourth message, a fifth message from the multi-sensor device to the control panel, wherein the fifth message includes a third packet configured according to the packet format to include a second header and a second payload, the second payload including a power value of a current transmit power of the multi-sensor device.
6. The method of claim 5, further comprising: receiving a sixth message according to the protocol by the multi-sensor device from the control panel, wherein the sixth message is configured to change the transmit power of the multi-sensor device; and updating the transmit power of the multi-sensor device according to the sixth message.
7. The method of claim 1, wherein, prior to receiving the first message, the method further comprises: transmitting an enrollment request according to the protocol from the multi-sensor device to the control panel; performing, in response to the enrollment request, a key exchange according to the protocol by the multi-sensor device with the control panel; generating, in response

to the key exchange, an encryption key that is unique to the multi-sensor device as compared to one or more other devices configured to communicate with the control panel according to the protocol; and storing the encryption key at the multi-sensor device.

8. The method of claim 1, further comprising: receiving a fourth message according to the protocol by the multi-sensor device from the control panel, wherein the fourth message is configured to change a setting of the multi-sensor device; and updating the setting of the multi-sensor device according to the fourth message.

9. The method of claim 8, wherein the setting comprises a wake/sleep behavior of the multi-sensor device.

10. The method of claim 8, wherein the setting comprises enabling or disabling a sensor of the multi-sensor device by the control panel.

11. The method of claim 1, wherein the packet format defines a packet payload for a packet, wherein the packet payload includes a packet identifier and payload data.

12. The method of claim 11, wherein the packet identifier is encrypted with the payload data of the packet.

13. The method of claim 1, wherein when no sensors of the multi-sensor device are specified in the first message, a payload type of the first message indicates that the control panel is querying all sensors of the multi-sensor device.

14. The method of claim 13, wherein the first message includes a second header and a second payload, wherein the second header of the first message indicates the payload type of the first message.

15. A method comprising: transmitting, from a control panel to a multi-sensor device comprising two or more sensors, a first message configured according to a protocol that defines a packet format configurable to query one or more sensors of the multi-sensor device, wherein the protocol defines at least three packet types for responding to the first message, including a "Data" packet type for sending data queried by the first message, an "ACK" packet type for acknowledging the first message, and an "ACK+Data" packet type for sending the data queried by the first message and also acknowledging the first message that queried the data, wherein the first message is configured to cause the multi-sensor device to determine, based on the first message, whether the control panel is querying all or only some of the two or more sensors of the multi-sensor device; receiving, responsive to the first message querying a single sensor of the multi-sensor device, a second message by the control panel from the multi-sensor device, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single sensor of the multi-sensor device; and receiving, responsive to the first message querying at least two sensors of the multi-sensor device, a third message by the control panel from the multi-sensor device, wherein the third message includes a second packet configured according to the packet format to include a header and a payload, the header indicating that a packet type of the second packet is the "ACK+Data" packet type configured to acknowledge the first message and also provide the data queried by the first message, the payload including one state or data value for each one of the at least two sensors of the multi-sensor device.

16. The method of claim 15, further comprising: sending an acknowledgement from the control panel to the multi-sensor device responsive to a received one of the second message or the third message.

17. The method of claim 15, wherein the first message and a received one of the second message or the third message are encrypted using an encryption key that is unique to the multi-sensor device as compared to one or more other devices configured to communicate with the control panel according to the protocol.

18. The method of claim 15, further comprising: transmitting a fourth message according to the protocol from the control panel to the multi-sensor device, wherein the fourth message includes an over-the-air firmware update.

19. The method of claim 15, further comprising: transmitting a fourth message according to the protocol from the control panel to the multi-sensor device, wherein the fourth message includes a query for a transmit power of the multi-sensor device; and receiving, responsive to the fourth message, a fifth message by the control panel from the multi-sensor device, wherein the fifth message includes a third packet configured according to the packet format to include a second header and a second payload, the second payload including a power value of a current transmit power of the multi-sensor device.

20. The method of claim 19, further comprising: transmitting a sixth message according to the protocol from the control panel to the multi-sensor device, wherein the sixth message is configured to change the transmit power of the multi-sensor device.

21. The method of claim 15, wherein, prior to transmitting the first message, the method further comprises: receiving an enrollment request according to the protocol from the multi-sensor device by the control panel; performing, in response to the enrollment request, a key exchange according to the protocol by the control panel with the multi-sensor device; generating, in response to the key exchange, an encryption key that is unique to the multi-sensor device as compared to one or more other devices configured to communicate with the control panel according to the protocol; and storing the encryption key at the control panel.

22. The method of claim 15, further comprising: transmitting a fourth message according to the protocol from the control panel to the multi-sensor device, wherein the fourth message is configured to change a setting of the multi-sensor device, wherein the setting comprises a wake/sleep behavior of the multi-sensor device or enabling or disabling a capability of the multi-sensor device.

23. An apparatus comprising: a memory; and a processor communicatively coupled with the memory and configured to: receive, by a multi-sensor device comprising two or more sensors, from a control panel, a first message configured according to a protocol that defines a packet format configurable to query one or more sensors of the multi-sensor device, wherein the protocol defines at least three packet types for responding to the first message, including a "Data" packet type for sending data queried by the first message, an "ACK" packet type for acknowledging the first message, and an "ACK+Data" packet type for sending the data queried by the first message and also acknowledging the first message that queried the data; determine, by the multi-sensor device, based on the first message, whether the control panel is querying all or only some of the two or more sensors of the multi-sensor device; transmit, responsive to the first message querying a single sensor of the multi-sensor device, a second message from the multi-sensor device to the control panel, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single sensor of the multi-sensor device; and transmit, responsive to the first message querying at least two sensors of the multi-sensor device, a third message from the multi-sensor device to the control panel, wherein the third message includes a second packet configured according to the packet format to include a header and a payload, the header indicating that a packet type of the second packet is the "ACK+Data" packet type configured to acknowledge the first message and also provide the data queried by the first message, the payload including one state or data value for each one of the at least two sensors of the multi-sensor device.

24. An apparatus comprising: a memory; and a processor communicatively coupled with the memory and configured to: transmit, from a control panel to a multi-sensor device comprising two or more sensors, a first message configured according to a protocol that defines a packet format configurable to query one or more sensors of the multi-sensor device, wherein the protocol defines at least three packet types for responding to the first message, including a "Data" packet type for sending data queried by the first message, an "ACK" packet type for acknowledging the first message, and an "ACK+Data" packet type for sending the data queried by the first message and also acknowledging the first message that queried the data, wherein the first message is configured

to cause the multi-sensor device to determine, based on the first message, whether the control panel is querying all or only some of the two or more sensors of the multi-sensor device; receive, responsive to the first message querying a single sensor of the multi-sensor device, a second message by the control panel from the multi-sensor device, wherein the second message includes a first packet configured according to the packet format to include a state or data value for the single sensor of the multi-sensor device; and receive, responsive to the first message querying at least two sensors of the multi-sensor device, a third message by the control panel from the multi-sensor device, wherein the third message includes a second packet configured according to the packet format to include a header and a payload, the header indicating that a packet type of the second packet is the "ACK+Data" packet type configured to acknowledge the first message and also provide the data queried by the first message, the payload including one state or data value for each one of the at least two sensors of the multi-sensor device.