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(54) Title: KEY READER THAT ENABLES COMMUNICATION

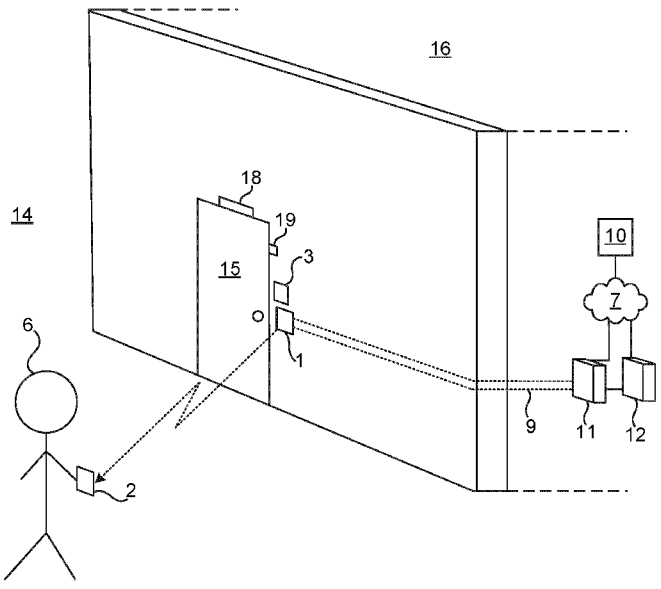

Fig. 1

(57) Abstract: It is provided a key reader comprising: a key interface for communicating with an electronic key; a wire-based power interface for receiving power over a wire pair; wherein the wire-based power interface is configured to also be used for bi-directional communication by modulating and demodulating the communication over the wire pair used for receiving power; and a wireless interface for providing a short-range wireless communication channel with one or more external devices.

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KEY READER THAT ENABLES COMMUNICATION

TECHNICAL FIELD

[0001] The present disclosure relates to the field of key readers used in gaining physical access and in particular to a key reader also configured to enable communication for external devices.

BACKGROUND

[0002] Locks and keys are evolving from the traditional pure mechanical locks. These days, electronic locks are becoming increasingly common. For electronic locks, no mechanical key profile is needed for authentication of a user. The electronic locks can e.g. be opened using an electronic key stored on a special carrier (fob, card, etc.) or in a smartphone. The electronic key and electronic lock can e.g. communicate over a wireless interface. Such electronic locks provide a number of benefits, including improved flexibility in management of access rights, audit trails, key management, etc.

[0003] More and more separate electronic devices are provided in the field of electronic access control. For instance, the functionality for electronic access control can be split among two separate devices: a key reader which reads the electronic key, and an electronic lock which is controllable to be in an unlocked or locked state. Moreover, additional devices can be added to assist in the access control, such as open/closed sensors, door openers, etc.

[0004] The devices for access control typically need communication abilities, e.g. to a control room or remote server. This can be provided with Wi-Fi, but coverage is often patchy and the cost of ensuring reliable Wi-Fi coverage in all necessary spaces can be very high, particularly in commercial buildings with large amounts of concrete and steel. Moreover, Wi-Fi requires is power hungry for devices. In many cases, Wi-Fi networks are used as part of a corporate IT (Information Technology) infrastructure and it gets complicated with responsibilities the Wi-Fi network is also used by devices used in electronic access control . Furthermore, the use of Wi-Fi often requires distribution of passwords and/or encryption keys. Such distribution can be a security risk and requires cumbersome configuration for any device which is to use the Wi-Fi network.

[0005] New 5G cellular networks are being deployed, but also these require a significant amount of power in the user devices and 5G use is costly.

SUMMARY

[0006] One object is to improve communication ability for low-power auxiliary devices provided for or in conjunction with access control.

[0007] According to a first aspect, it is provided a key reader comprising: a key interface for communicating with an electronic key; a wire-based power interface for receiving power over a wire pair; wherein the wire-based power interface is configured to also be used for bi-directional communication by modulating and demodulating the communication over the wire pair used for receiving power; and a wireless interface for providing a short-range wireless communication channel with one or more external devices.

[0008] The wire-based power interface may be configured for the key reader to receive direct current, DC, power.

[0009] The bi-directional communication may be based on orthogonal frequency-division multiplex, OFDM.

[0010] The key reader may further comprise: a wire-based key data interface is configured to communicate key data received over the key interface to an access controller.

[0011] The wireless interface can comply with a mesh-based communication protocol.

[0012] The wireless interface can comply with a point-to-point-based communication protocol.

[0013] The key reader may be configured to receiver firmware upgrades using the bi-directional communication via the wire-based power interface.

[0014] The key reader may further comprise a battery that is configured to be the only power source for the key reader.

[0015] According to a second aspect, it is provided a method performed in a key reader. The method comprises the steps of: communicating with an electronic key over a key interface of the key reader; receiving power over a wire pair using a wire-based power interface; performing bi-directional communication over the wire-based power interface by modulating and demodulating the communication over the wire pair used for receiving power; and providing a short-range wireless communication channel for one or more external devices over a wireless interface.

[0016] The method may further comprise the step of: routing data between the one or more external devices and the bi-directional communication over the wire-based power interface.

[0017] According to a third aspect, it is provided a computer program comprising computer program code which, when executed on a key reader causes the key reader to: communicate with an electronic key over a key interface of the key reader; receive power over a wire pair using a wire-based power interface; perform bi-directional communication over the wire-based power interface by modulating and demodulating the communication over the wire pair used for receiving power; and provide a short-range wireless connection for one or more external devices over a wireless interface.

[0018] According to a fourth aspect, it is provided a computer program product comprising a computer program according to the third aspect and a computer readable means on which the computer program is stored.

[0019] Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the element, apparatus, component, means, step, etc." are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless explicitly stated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Aspects and embodiments are now described, by way of example, with reference to the accompanying drawings, in which:

[0021] Fig 1 shows an environment in which embodiments presented herein can be applied;

[0022] Fig 2 is a schematic diagram illustrating components of the key reader of Fig 1;

[0023] Fig 3 is a flow chart illustrating embodiments of methods performed by the key reader of Fig 1; and

[0024] Fig 4 shows one example of a computer program product 90 comprising computer readable means.

DETAILED DESCRIPTION

[0025] The aspects of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments of the invention are shown. These aspects may, however, be embodied in many different forms and should not be construed as limiting; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and to fully convey the scope of all aspects of invention to those skilled in the art. Like numbers refer to like elements throughout the description.

[0026] Fig 1 is a schematic diagram showing an environment in which embodiments presented herein can be applied. Access to a physical space 16 is restricted by a physical barrier 15 which is selectively unlockable. The physical barrier 15 stands between the restricted physical space 16 and an accessible physical space 14. Note that the accessible physical space 14 can be a restricted physical space in itself, but in relation to this physical barrier 15, the accessible physical space 14 is accessible. The barrier 15 can be a door, gate, hatch, cabinet door, drawer, window, etc. In order to control access to the physical space 16, by selectively unlocking the barrier 15, an electronic lock 3 and a key reader 1 is provided.

[0027] A user 6 carries an electronic key 2 which can communicate with the key reader 1 using any suitable technology, e.g. using RFID (Radio Frequency Identification), BLE (Bluetooth Low Energy), Bluetooth, or using a galvanic (e.g. galvanic smartcard) or magnetic (e.g. card swiping) connection.

[0028] The key reader 1 communicates key data (derived from the communication with the key 2) to an access controller 12. The access controller 12 determines whether to grant or deny access for the key 2 as known in the art per se. If access is granted, the access controller 12 transmits an unlock command to the electronic lock 3. In this way, the electronic lock 3 is controllable to be in a locked state or in an unlocked state based on the key 2 communicating with the key reader 1.

[0029] When the electronic lock 3 is in an unlocked state, the barrier 15 can be opened and when the electronic lock 3 is in a locked state, the barrier 15 cannot be opened. In this way, access to a restricted physical space 16 is controlled based on cooperation between the key 3, the key reader 1, the access controller 12 and the electronic lock 3.

[0030] The key reader 1 is powered over a wired power connection 9, e.g. by receiving DC (Direct Current) power of a suitable voltage. Alternative, the wired power connection 9 can be based on AC (Alternating Current), e.g. conventional 120V/230V mains power. The wired power connection is made up of a wire pair, e.g. two copper wires.

[0031] The key reader 1 further comprises a wireless interface for providing a short-range wireless communication channel for use by one or more external devices, e.g. the electronic lock 3, a door opener 18 and/or a sensor 19 for detecting open/closed status of the barrier 15. More external devices can be provided by the barrier 15, which can communicate over the wireless communication channel with the key reader 1. The short-range wireless communication channel can be of low power to allow the external devices to be battery powered. For instance, the short-range wireless communication channel can be based on mesh technology and can e.g. ZigBee, Thread, Z-Wave or any of the IEEE 802.15.5 specifications. Alternatively or additionally, the short range-wireless communication channel ca be based on a point-to-point-based protocol, providing a

wireless star topology, e.g. based on BLE, IEEE 802.15.4, IEEE 802.11 or LoRa (Long Range) when configured to be work in a short range mode.

[0032] According to embodiments presented herein, the wire pair of the wired power connection 9 is also used for providing bi-directional communication with a bridge device 11. In this way, the key reader 1 communicates uplink with the bridge device 11 over the wired power connection 9. The communication over the wire pair can be based on OFDM (orthogonal frequency-division multiplex) modulation, e.g. G.hn, specified in i.a. ITU-T G.9960/G.9961. Uplink is here to be construed as communication towards more central network elements (e.g. from the key reader 1 to the bridge device 11) and downlink is to be construed as the reverse of uplink. The modulation of the communication, e.g. using OFDM, allows the communication to be carried over the wire pair used for power transfer, i.e. the communication is transferred over the same pair of wires that transfer the power by overlaying communication on the same connection that is used for power transfer. In other words, the key reader supports bi-directional communication by modulating uplink communication and demodulating downlink communication over the wire pair used for receiving power.

[0033] In this way, the key reader 1 functions as a router between the wireless interface and the communication over the wired power connection 9. The key reader 1 is thus configured to route uplink communication from the one or more external devices 3, 18, 25 to the bridge device 11 and to route downlink communication from the bridge device 11 to the one or more external devices 3, 18, 19. The key reader 1 can also be a terminal device for receiving and transmitting data for itself. The wired power connection 9 is a simple wire pair and is easy to install or may be installed already for power supply purposes. In other words, there is no need to install CAT (Category) 5/6 cables to support this type of installation.

[0034] In uplink communication over the wired power connection, the key reader 1 receives uplink data internally or from one of the external devices 3, 18, 19. The uplink data is overlaid the power transfer on the wired power connection 9. The communication of data on the wired power connection 9 is not dependent on the direction of power transfer. The bridge device 11 extracts the overlaid uplink data on the wired power connection 9 from the key reader 1. The extracted uplink data is then

routed via a communication network 7 to a network device 10 (e.g. a server) or to the access controller 12. The communication network 7 can be based on any one or more suitable communication technologies, e.g. Ethernet, optical fibre connection, Wi-Fi, cellular network connection, etc. The communication network 7 can form part of the Internet and/or a local area network (LAN).

[0035] In downlink communication, the bridge device 11 receives downlink data destined for the key reader 1 or one of the external devices 3, 18, 19. The downlink data is overlaid the power transfer on the wired power connection 9. Again, the communication of data on the wired power connection 9 is not dependent on the direction of power transfer. The key reader 1 extracts the overlaid downlink data on the wired power connection 9 from the bridge device 11. The extracted downlink data is provided internally to the key reader 1 itself, or is routed further via the wireless interface to one or more of the external devices 3, 18, 19.

[0036] Optionally, the key reader 1 also communicates with the access controller 12 over a separate wired connection 9 for key data. This can be a legacy connection e.g. based on unidirectional Wiegand communication or a serial RS485 communication of key data from the key reader 1 to the access controller 12. The separate wired connection 9 for key data between the key reader 1 and the access controller 12 can be a connection via the bridge device 11 (as shown) or a direct connection between the key reader 1 and the access controller 12.

[0037] The access controller can be provided in a secure location, e.g. within the protected physical space 16, optionally within a separately locked space (not shown), such as a control room or server room.

[0038] The key reader 1 thus provides connectivity to the external devices 3, 18, 19. Since the key reader 1 is provided by the barrier 15 and the external devices 3, 18, 19 are provided for (or in conjunction with) access control, the distance between the key reader 1 and the external devices 3, 18, 19 is small. Moreover, very few or no interfering objects are provided between the key reader 1 and the external devices 3, 18, 19. In this way, the communication link between the key reader 1 and the external devices 3, 18, 19 is both reliable and uses less power (due to minimal fading and limited range requirements).

[0039] The installation of the key reader 1 with the communication and routing ability is straightforward and requires no wireless configuration from the technician. Moreover, adding the bridge, is a straight-forward task, since the bridge can be installed in a location where a connection to the communication network 7 is available, e.g. in the control room or server room. Moreover, such a key reader 1 can easily be retrofitted to an existing installation by simply replacing the old key reader 1 with one according to embodiments presented herein.

[0040] It is to be noted that, while only one key reader 1 is shown in Fig 1, several key readers can be connected to a single bridge device 11 (and single access controller 12).

[0041] Fig 2 is a schematic diagram illustrating components of the key reader 1 of Fig 1. A processor 60 is provided using any combination of one or more of a suitable central processing unit (CPU), multiprocessor, microcontroller, digital signal processor (DSP), etc., capable of executing software instructions 67 stored in a memory 64, which can thus be a computer program product. The processor 60 could alternatively be implemented using an application specific integrated circuit (ASIC), field programmable gate array (FPGA), etc. The processor 60 can be configured to execute the embodiments of methods described with reference to Fig 3 below.

[0042] The memory 64 can be any combination of random-access memory (RAM) and/or read-only memory (ROM). The memory 64 also comprises persistent storage, which, for example, can be any single one or combination of magnetic memory, optical memory, solid-state memory.

[0043] A data memory 66 is also provided for reading and/or storing data during execution of software instructions in the processor 60. The data memory 66 can be any combination of RAM and/or ROM.

[0044] The key reader 1 further comprises I/O interfaces 62 for communicating with external and/or internal entities.

[0045] A key interface 20 is provided for communicating with an electronic key 2. As mentioned above, the key interface 20 can be based on a wireless, galvanic and/or a magnetic connection with the key 2.

[0046] A wire-based power interface 21 is provided for receiving power. The wire-based power interface 21 is configured to also be used for bi-directional communication as described above.

[0047] A wireless interface 22 is provided for providing short-range wireless connection with one or more external devices 3, 18, 19, e.g. based on mesh network technology.

[0048] Optionally, a wire-based key data interface 23 is provided. The wire-based key data interface 23 is then configured to communicate key data received over the key interface 20 to an access controller 12, e.g. based on unidirectional Wiegand communication or RS485 communication.

[0049] Other components of the key reader 1 are omitted in order not to obscure the concepts presented herein.

[0050] Fig 3 is a flow chart illustrating embodiments of methods performed by the key reader of Fig 1 for enables communication for external devices. The method also enables communication with an electronic key 2 for controlling access to a physical space 16. The method being performed in a key reader 1.

[0051] It is to be noted that while the steps are here illustrated in sequence, one or more (or even all) steps can be performed in parallel by the key reader 1.

[0052] In a *communicate over key interface* step 40, the key reader 1 communicates with an electronic key 2 over a key interface 20 of the key reader 1.

[0053] In a *receive power* step 42, the key reader 1 receives power over a wire-based power interface 21. It is to be noted that power is received continuously when the key reader is powered, i.e. also when this method is now performed.

[0054] In a *perform bi-directional communication* step 44, the key reader 1 performs bi-directional communication over the wire-based power interface 21. The bi-directional communication is thus superimposed over the power delivery on the wire-based power interface 21.

[0055] In a *provide short-range wireless communication* step 46, the key reader 1 provides a short-range wireless communication channel for one or more external devices 3, 18, 19 over a wireless interface 22.

[0056] In an optional *route data* step 48, the key reader 1 routes data between the one or more external devices 3, 18, 19 and the bi-directional communication over the wire-based power interface 21 connected to the bridge device 11.

[0057] Fig 4 shows one example of a computer program product 90 comprising computer readable means. On this computer readable means, a computer program 91 can be stored, which computer program can cause a processor to execute a method according to embodiments described herein. In this example, the computer program product is in the form of a removable solid-state memory, e.g. a Universal Serial Bus (USB) drive. As explained above, the computer program product could also be embodied in a memory of a device, such as the computer program product 64 of Fig 2. While the computer program 91 is here schematically shown as a section of the removable solid-state memory, the computer program can be stored in any way which is suitable for the computer program product, such as another type of removable solid-state memory, or an optical disc, such as a CD (compact disc), a DVD (digital versatile disc) or a Blu-Ray disc.

[0058] Some embodiment will now be presented, enumerated with roman numerals.

[0059] i. A key reader comprising:

a key interface for communicating with an electronic key;

a wire-based power interface for receiving power;

wherein the wire-based power interface is configured to also be used for bi-directional communication; and

a wireless interface for providing a short-range wireless communication channel with one or more external devices.

[0060] ii. The key reader according to embodiment i, wherein the wire-based power interface is configured for the key reader to receive direct current, DC, power.

[0061] iii. The key reader according to embodiment i or ii, wherein the bi-directional communication is based on orthogonal frequency-division multiplex, OFDM.

[0062] iv. The key reader according to any one of the preceding embodiments, further comprising:

a wire-based key data interface is configured to communicate key data received over the key interface to an access controller.

[0063] v. The key reader according to any one of the preceding embodiments, wherein the wireless interface complies with a mesh-based communication protocol.

[0064] vi. The key reader according to any one of embodiments i to iv, wherein the wireless interface complies with a point-to-point-based communication protocol.

[0065] vii. The key reader according to any one of the preceding embodiments, wherein the wire-based power interface complies with a power over Ethernet protocol.

[0066] viii. The key reader according to any one of the preceding embodiments, wherein the key reader is configured to receiver firmware upgrades using the bi-directional communication via the wire-based power interface.

[0067] ix. The key reader according to any one of the preceding embodiments, further comprising a battery that is configured to be the only power source for the key reader.

[0068] x. A method performed in a key reader, the method comprising the steps of:

communicating with an electronic key over a key interface of the key reader;

receiving power over a wire-based power interface;

performing bi-directional communication over the wire-based power interface; and

providing a short-range wireless communication channel for one or more external devices over a wireless interface.

[0069] xi. The method according to embodiment x, further comprising the step of:

routing data between the one or more external devices and the bi-directional communication over the wire-based power interface.

[0070] xii. A computer program comprising computer program code which, when executed on a key reader causes the key reader to:

communicate with an electronic key over a key interface of the key reader;

receive power over a wire-based power interface;

perform bi-directional communication over the wire-based power interface; and

provide a short-range wireless connection for one or more external devices over a wireless interface.

[0071] xiii. A computer program product comprising a computer program according to embodiment xii and a computer readable means on which the computer program is stored.

[0072] The aspects of the present disclosure have mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the invention, as defined by the appended patent claims. Thus, while various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

CLAIMS

1. A key reader (1) comprising:

a key interface (20) for communicating with an electronic key (2);

a wire-based power interface (21) for receiving power over a wire pair;

wherein the wire-based power interface (21) is configured to also be used for bi-directional communication by modulating and demodulating the communication over the wire pair used for receiving power; and

a wireless interface (22) for providing a short-range wireless communication channel with one or more external devices (3, 18, 19).

2. The key reader (1) according to claim 1, wherein the wire-based power interface (21) is configured for the key reader (1) to receive direct current, DC, power.

3. The key reader (1) according to claim 1 or 2, wherein the bi-directional communication is based on orthogonal frequency-division multiplex, OFDM.

4. The key reader (1) according to any one of the preceding claims, further comprising:

a wire-based key data interface (23) is configured to communicate key data received over the key interface (20) to an access controller (12).

5. The key reader (1) according to any one of the preceding claims, wherein the wireless interface (22) complies with a mesh-based communication protocol.

6. The key reader (1) according to any one of claims 1 to 4, wherein the wireless interface complies with a point-to-point-based communication protocol.

7. The key reader (1) according to any one of the preceding claims, wherein the key reader (1) is configured to receiver firmware upgrades using the bi-directional communication via the wire-based power interface.

8. The key reader (1) according to any one of the preceding claims, further comprising a battery (24) that is configured to be the only power source for the key reader (1).

9. A method performed in a key reader (1), the method comprising the steps of:

communicating (40) with an electronic key (2) over a key interface (20) of the key

reader (1);

receiving (42) power over a wire pair using a wire-based power interface (21);

performing (44) bi-directional communication over the wire-based power interface (21) by modulating and demodulating the communication over the wire pair used for receiving power; and

providing (46) a short-range wireless communication channel for one or more external devices (3, 18, 19) over a wireless interface (22).

10. The method according to claim 9, further comprising the step of:

routing (48) data between the one or more external devices (3, 18, 19) and the bi-directional communication over the wire-based power interface (21).

11. A computer program (67, 91) comprising computer program code which, when executed on a key reader (1) causes the key reader (1) to:

communicate with an electronic key (2) over a key interface (20) of the key reader (1);

receive power over a wire pair using a wire-based power interface (21);

perform bi-directional communication over the wire-based power interface (21) by modulating and demodulating the communication over the wire pair used for receiving power; and

provide a short-range wireless connection for one or more external devices (3, 18, 19) over a wireless interface (22).

12. A computer program product (64, 90) comprising a computer program according to claim 11 and a computer readable means on which the computer program is stored.

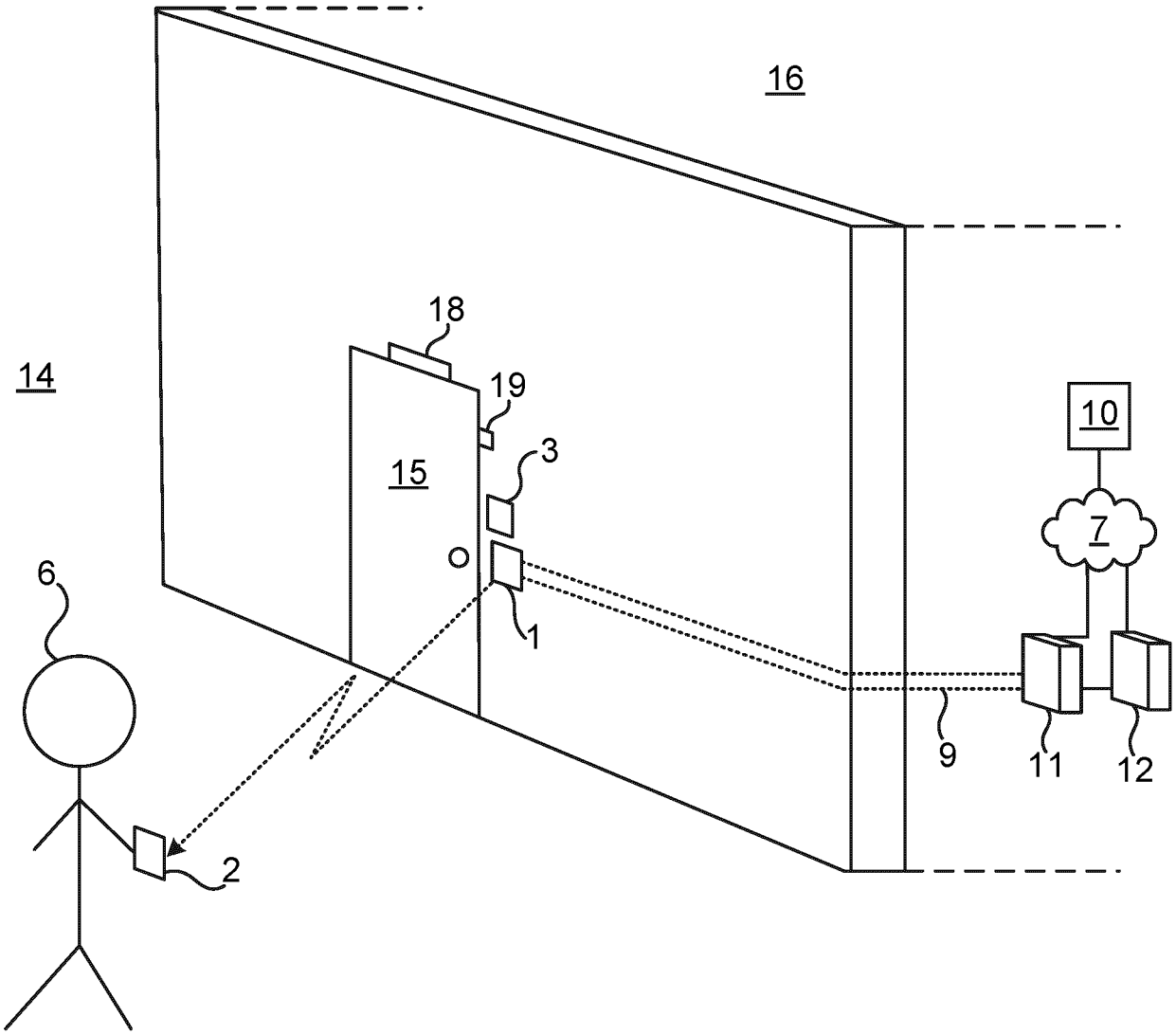

Fig. 1

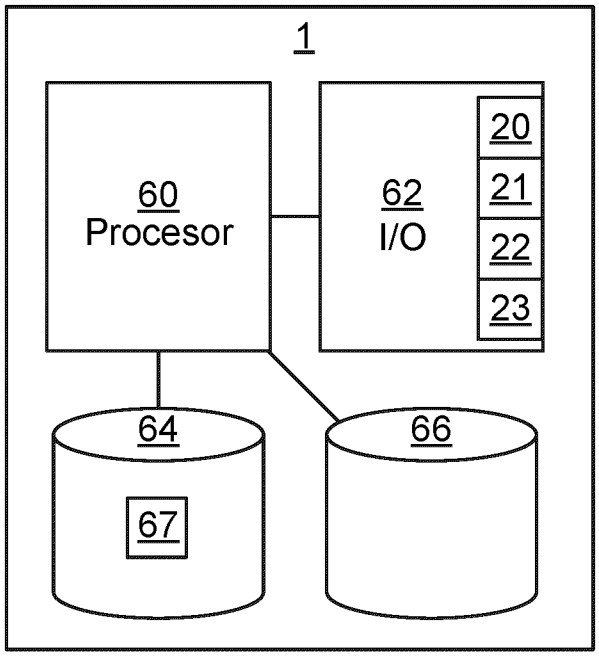

Fig. 2

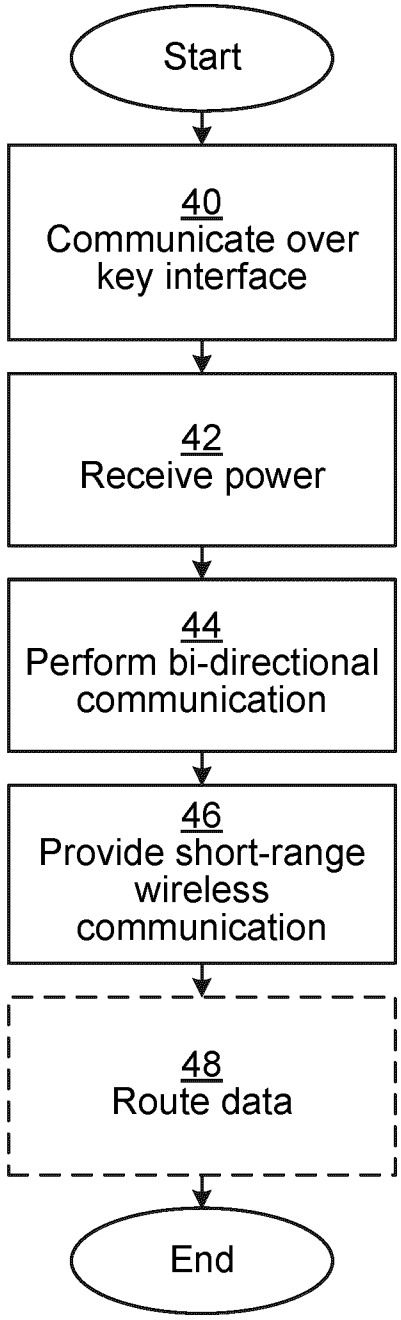

Fig. 3

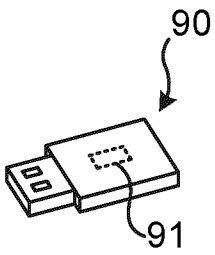

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/056355

A. CLASSIFICATION OF SUBJECT MATTER
INV. G07C9/00
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G07C

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2019/188934 A1 (CALVERT RICHARD [US] ET AL) 20 June 2019 (2019-06-20) abstract; figures 1, 2 paragraph [0021] paragraph [0025] - paragraph [0048] paragraph [0058] paragraph [0095] -----	1-12
X A	US 2019/096148 A1 (HOPKINS BENJAMIN [US] ET AL) 28 March 2019 (2019-03-28) abstract; figures 1, 2 paragraph [0003] paragraph [0007] - paragraph [0009] paragraph [0012] paragraph [0017] - paragraph [0022] paragraph [0036] - paragraph [0048] ----- -/--	1,2,5-7, 9,11,12 3,4,8,10

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
26 May 2021	04/06/2021

Name and mailing address of the ISA/	Authorized officer
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X	US 2016/019736 A1 (RADICELLA MICHAEL [US] ET AL) 21 January 2016 (2016-01-21)	1,2,5-7, 9,11,12
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2021/056355

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