(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 107 072 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
11.01.2023 Bulletin 2023/02

(21) Application number: **15172113.1**

(22) Date of filing: **15.06.2015**

(51) International Patent Classification (IPC):
G07C 9/00 *(2020.01)*

(52) Cooperative Patent Classification (CPC):
G07C 9/00309; G07C 9/00571; G07C 2209/63

(54) **LOCATING AN ELECTRONIC KEY**

LOKALISIERUNG EINES ELEKTRONISCHEN SCHLÜSSELS

LOCALISATION D'UNE CLÉ ÉLECTRONIQUE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(43) Date of publication of application:
21.12.2016 Bulletin 2016/51

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(56) References cited:
EP-A2- 1 564 691
CN-A- 102 685 256
US-A1- 2006 028 339
US-B1- 8 402 134
WO-A1-2007/128011
US-A1- 2005 122 216
US-A1- 2010 033 342

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Description

TECHNICAL FIELD

[0001] The invention relates to a method, a locating device, a computer program and a computer program product for locating an electronic key, e.g. when the key has been reported lost.

BACKGROUND

[0002] Locks and keys are evolving from the traditional pure mechanical locks. These days, there are wireless interfaces for electronic locks, e.g. by interacting with an electronic key. In some installations, to save power and complexity, the electronic locks are offline without communication ability with a central access control system.

[0003] One issue is when an electronic key is lost. With locks being offline, these can not be used to locate any lost electronic keys. Moreover, when the electronic key lacks ability to directly communicate with a central server, this further complicates any ability to locate a lost electronic key.

[0004] WO 2007/128011 A1 discloses a locking system, where a key features a radio signal receiver which is designed to deactivate the locking function of the key and/or to emit a position indication signal upon receiving an instruction signal from a corresponding radio signal transmitter.

[0005] US 2006/028339 A1 discloses a portable device search system for an electronic key system formed by a portable device and handy equipment such as a cellular phone, PDA and the like, which is separate from the portable device.

[0006] EP 1564 691 A2 discloses A control system for improving the security level of a security device. A portable device is provided with a communication function and has a portable device ID code. A security controller includes a memory for recording a controller ID code.

[0007] US 2005/122216 A1 discloses a device that promotes finding the device when lost. The device includes means for engaging a lock and means for receiving an activation signal from a remote transmitter. When the activation signal is received, the device also includes means for emitting an output signal that promotes finding the device when lost.

[0008] CN 102 685 256 A discloses a system, a method and a computer program product for locating a lost or stolen electronic device.

[0009] US 2010/033342 A discloses a method for finding a vehicle key fob by a telematics unit of a vehicle upon a request from a call center. At least one function of the key is deactivated by the telematics device before the key is found, and the key is reactivated once it is found.

SUMMARY

[0010] It is an object to provide a way to locate an electronic key which lacks ability to directly communicate with a central server.

[0011] According to a first aspect, it is presented a method for locating an electronic key for access to a physical space according to appended claim 1

[0012] According to a second aspect, it is presented a locating device for locating an electronic key for access to a physical space according to appended claim 5. According to a third aspect, it is presented a computer program for locating an electronic key for access to a physical space according to appended claim 9 According to a fourth aspect, it is presented 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. 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

[0013] The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Fig 1 is a schematic diagram showing an environment in which embodiments presented herein can be applied;

Fig 2 is a schematic diagram illustrating a situation where a lost electronic key is located using a locating device;

Fig 3 is a sequence diagram illustrating communication for locating an electronic key;

Fig 4 is a flow chart illustrating a method for locating an electronic key, performed in the locating device of Figs 2 and 3;

Fig 5 is a schematic diagram illustrating some components of a locating device according to Figs 2 and 3;

Fig 6 is a schematic diagram illustrating a locating device provided as part of a mobile phone; and

Fig 7 shows one example of a computer program product comprising computer readable means.

DETAILED DESCRIPTION

[0014] The invention will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments of the invention are

shown.

[0015] Like numbers refer to like elements throughout the description.

[0016] 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, window, drawer, etc. In order to unlock the barrier 15, an access control device 13 is provided. The access control device 13 is connected to a physical lock device 12, which is controllable by the access control device 13 to be set in an unlocked state or locked state. In this embodiment, the access control device 13 is mounted close to the physical lock device 12. The barrier 15 is provided in a surrounding fixed structure, such as a wall or fence.

[0017] The access control device 13 is able to receive and send signals from/to an electronic key 2 over a communication channel 3 which may be a short range wireless interface or a conductive (i.e. galvanic/electric) connection. The electronic key 2 is any suitable device portable by a user and which can be used for authentication over the communication channel 3. The electronic key 2 is typically carried or worn by the user and may be implemented asa physical key, a key fob, wearable device, etc. The short range wireless interface is a radio frequency wireless interface and could e.g. be using Bluetooth, Bluetooth Low Energy (BLE), ZigBee, any of the IEEE 802. 11 standards, any of the IEEE 802.15 standards, wireless USB, etc. Using the communication channel 3, the authenticity of the electronic key 2 can be checked, e.g. using a challenge and response scheme, after which the access control device 13 grants or denies access.

[0018] When access is granted, the access control device 13 sends an unlock signal to the lock device 12, whereby the lock device 12 is set in an unlocked state. In this embodiment, this can e.g. imply a signal over a wire-based communication interface, e.g. using Universal Serial Bus (USB), Ethernet, a serial connection (e.g. RS-485 or RS-232) or even a simple electric connection (e.g. to the lock device 12), or alternatively signal over a wireless communication interface. When the lock device 12 is in an unlocked state, the barrier 15 can be opened and when the lock device 12 is in a locked state, the barrier 15 cannot be opened. In this way, access to a closed space 16 is controlled by the access control device 13. It is to be noted that the access control device 13 and/or the lock device 12 can be mounted in the fixed structure 16 by the physical barrier 15 (as shown) or in the physical barrier 15 itself (not shown). Optionally, the lock device 12 and access control device 13 are combined in one unit. In one embodiment, the lock device (optionally combined with the access control device) is in the form of a padlock or any other suitable implementation.

[0019] The access control device 13 can be implemented as an offline device, without the ability to directly communicate with a central server of an access control system. In this way, the access control device 13 is easier to implement and uses less power. This allows the access control device 13 to be powered for a long time using a battery or by the electronic key. Optionally, energy harvesting of mechanical user actions and/or environmental power (solar power, wind, etc.) can be utilised to prolong the life span of the battery or event to allow the battery to be omitted.

[0020] Fig 2 is a schematic diagram illustrating a situation where an electronic key is located using a locating device. A central server 10 of the access control system is responsible for managing keys and locks. The central server 10 can be accessed by an operator to thereby perform management tasks in the access control system.

[0021] There is a first locating device 1a and a second locating device 1b. Each one of the first and second locating devices are described in more detail below, and can e.g. be implemented as part of a mobile phone or as a dedicated locating device. The locating devices 1a-b can communicate with an electronic key for locating purposes, as explained below, and optionally also for other purposes.

[0022] In this example, a user has lost an electronic key 2' or has had the electronic key 2' stolen. The electronic key 2' then needs to be located to prevent an attacker from gaining access to closed physical spaces, otherwise accessible using the lost electronic key 2'. The central server 10 is made aware of the lost electronic key 2', e.g. by an operator indicating that the electronic key 2' is lost. The central server 10 then sends a location query to all relevant locating devices 1a-b as explained more below.

[0023] The second locating device 1b is within range 7 to communicate over a short range radio interface 5 with the lost electronic key 2'. This allows the second locating device 1b to communicate with the lost electronic key 2'. In this way, the second locating device 1b can discover the electronic key 2'. The range 7 depends on the type of short range radio which can be used and radio conditions in the vicinity of the electronic key 2'. When communication channel 3 of Fig 1 is wireless, the short range radio interface 5 may be the same as the communication channel 3. However, when the communication channel 3 of Fig 1 is based on a conductive connection, the short range radio interface 5 is not the same as the communication channel 3. The short range radio interface 5 may optionally be used for other purposes, e.g. other maintenance purposes for the electronic key 2'.

[0024] It is to be noted that the first locating device 1a is outside the range 7 of the lost electronic key 2', whereby it is unable to discover and locate the lost electronic key 2'.

[0025] Fig 3 is a sequence diagram illustrating com-

munication for locating an electronic key, e.g. in the environment shown in Fig 2. The sequence is performed to locate of an electronic key. Hereinafter, the electronic key to be located is referred to as a lost electronic key. However, there may be other reasons for locating the electronic key, e.g. the electronic key being stolen or that an employee has ended employment and whose electronic key needs to be located.

[0026] Once the central server 10 is made aware of the lost key, the central server 10 sends a location query 20 to all relevant locating devices 1. This can e.g. be all possible locating devices or only locating devices in a specific area, e.g. within a specific range from a last known location of the lost electronic key 2'. The locating query 20 comprises an identifier of the lost electronic key 2'.

[0027] A locating device 1 detects the presence 21 of the lost electronic key 2' (e.g. as shown for the second locating device 1b of Fig 2). The locating device 1 detects that the identity of the electronic key 2' matches the identity of the location query 20. It is to be noted that when an electronic key is detected which does not have an identity matching any location query, the locating device 1 does not need to proceed further in the sequence diagram.

[0028] Once the match is confirmed between the lost electronic key 2' and the location query 20, the locating device 1 transmits a location response 22 to the central server 10 indicating that lost electronic key 2' has been located. The location response 22 comprises an indicator of a position of the locating device and a distance indicator indicating a distance between the locating device 1 and the lost electronic key 2'.

[0029] This allows the central server 10 to decide on any further action. For instance, the central server 10 may decide that the lost electronic key 2' is to be invalidated to prevent an attacker from illegitimately using the lost electronic key 2' to gain access to otherwise access controlled physical spaces.

[0030] The subsequent part of the sequence diagram relates to such optional invalidation. The central server 10 transmits a central invalidation command 30 to the locating device. Once the central invalidation command 30 has been received, the locating device 1 transmits a local invalidation command 32 to the lost electronic key 2'. Optionally, the content of the central invalidation command 30 and the local invalidation command 32 is the same. For instance, both can contain an invalidation package which can be encrypted and/or signed for the lost electronic key 2'. This allows the lost electronic key 2' to validate authenticity of the local invalidation command. In such a case, the locating device 1 routes the invalidation package to the lost key 2' and does not (or cannot) examine the contents of the invalidation package. Upon receipt of the local invalidation command 32, the lost electronic key 2' makes itself invalid. Optionally, the electronic key 2' verifies the integrity of the invalidation command (as explained below) prior to performing its invalidation procedure. Optionally, the electronic key 2' sends a local confirmation message 33 to the locating device 1. The locating device 1 can then send a central confirmation message 34 to the central server 10.

[0031] In this way, the central server 10 can locate and optionally initiate an invalidation using all relevant locating devices and can optionally be informed of when the invalidation has been successful. Using this method, the lost electronic key 2' can be located and optionally invalidated even though it has no direct communication link with the central server 10.

[0032] Fig 4 is a flow chart illustrating a method for locating an electronic key for access to a physical space. The method is performed in the locating device of Figs 2 and 3. The method corresponds to the actions of the locating device 1 in Fig 3.

[0033] In a *receive location query* step 40, a location query is received from the central server. The location query comprises an identifier of an electronic key which is to be located. The location query can e.g. be received over a wide area network, such as the Internet.

[0034] In a *discover presence* step 42, a presence of the electronic key to be located is discovered over short range radio. This can e.g. be performed by discovering the presence of the electronic key using BLE. Any other short range radio technology is equally applicable.

[0035] In an *obtain distance indicator* step 43, a distance indicator is obtained. The distance indicator indicates a distance between the locating device and the electronic key. The distance can be estimated using any suitable method. For instance, the distance can be estimated by measuring received signal strength and comparing this to transmission power. More specifically, an indicator of the transmission power which is used can be transmitted as part of the message. The receiver can then compare the received signal strength with the power used to transmit it and can thus estimate the distance based on the attenuation of the signal. Alternatively, two-way ranging can be used, measuring the time it takes to transmit a signal and receive its response, which gives a distance indication when divided by two multiplied by the speed of light.

[0036] In a *transmit location response* step 44, a location response is transmitted to the central server indicating that the electronic key has been located.

[0037] The location response comprises an indicator of a position (e.g. in form of a longitude and a latitude) of the locating device, e.g. obtained using GPS (Global Positioning System) or any other suitable location technology. Also, when the *obtain distance indicator* step 43 is performed, the location response comprises an estimated distance (e.g. in metres) to the electronic key from the position of the locating device. The position and estimated distance simplifies the retrieval of the electronic key to be able to reprogram and reuse the lost electronic key.

[0038] In a *receive central invalidation command* step 46, a central invalidation command is received from the

central server. The central invalidation command comprises a way to identify the electronic key to be invalidated, e.g. by an explicit identifier of an electronic key or by a reference to a session comprising the location query. The central invalidation command can e.g. be received over a wide area network, such as the Internet.

[0039] Furthermore, the central invalidation command can comprise a main command and an integrity indicator. The integrity can e.g. be derived using the main command and a private electronic key, e.g. using a cryptographic hash function such as SHA-2 (Secure Hash Algorithm 2) or MD-5 (Message Digest algorithm 5).

[0040] In a *transmit local invalidation command* step 48, a local invalidation command is transmitted to the electronic key to be invalidated. The main command and the integrity indicator of the central invalidation command can form part of the local invalidation command. This allows the electronic key to verify the source of the invalidation, i.e. from the central server. In this way, third parties are prevented from invalidating keys.

[0041] In a *receive local confirmation message* step 50, a local confirmation message is received from the electronic key to be invalidated. The local confirmation message indicates a successful invalidation.

[0042] In a *transmit central confirmation message* step 52, a central confirmation message is transmitted to the central server. The central confirmation message indicates a successful invalidation.

[0043] Fig 5 is a schematic diagram showing some components of the locating device of Figs 2 and 3. 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), application specific integrated circuit etc., capable of executing software instructions 66 stored in a memory 64, which can thus be a computer program product. The processor 60 can be configured to execute the method described with reference to Fig 4 above.

[0044] The memory 64 can be any combination of read and write memory (RAM) and 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 or even remotely mounted memory.

[0045] 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 read and write memory (RAM) and read only memory (ROM).

[0046] The locating device 1 further comprises an I/O interface 67 for communicating with other external entities. Optionally, the I/O interface 67 also includes a user interface.

[0047] Other components of the locating device 1 are omitted in order not to obscure the concepts presented herein.

[0048] Fig 6 is a schematic diagram illustrating a locating device 1 provided as part of a mobile phone 4. In such a case, components of the mobile phone 4 can be utilised also by the locating device 1.

[0049] In another embodiment, the locating device 1 is a device dedicated to the purpose of locating electronic keys. In such a case, the dedicated locating device 1 can be placed in a location where there is a large chance of discovering a lost electronic key. For instance, the dedicated locating device can be placed by the entrance of a building or by a public transport gateway (e.g. underground turnstiles). The dedicated locating device 1 does not need to be portable and can thus be connected to a power socket and wireless and/or wire based communication links for communication with the central server. In this way, the dedicated locating device 1 can be continuously active.

[0050] Fig 7 shows one example of a computer program product 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 an optical disc, such as a CD (compact disc) or a DVD (digital versatile disc) or a Blu-Ray disc. 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 5. While the computer program 91 is here schematically shown as a track on the depicted optical disk, the computer program can be stored in any way which is suitable for the computer program product, such as a removable solid state memory, e.g. a Universal Serial Bus (USB) drive.

[0051] The invention has 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.

Claims

1. A method for locating an electronic key (2') for access to a physical space (16), the method being performed in a locating device (1, 1a, 1b) and comprising the steps of:

   receiving (40) a location query (20) from a central server (10), the location query (20) comprising an identifier of an electronic key (2');
   discovering (42) a presence of the electronic key (2') over short range radio;
   obtaining (43) a distance indicator, indicating a distance between the locating device (1, 1a, 1b) and the electronic key (2'); and
   transmitting (44) a location response (22) to the central server indicating that the electronic key (2') has been located, wherein the location response (22) comprises an indicator of a position

of the locating device (1, 1a, 1b), and wherein the location response (22) comprises the distance indicator;
wherein the method further comprises, after the step of transmitting (44) a location response, the steps of:

receiving (46) a central invalidation command (30) from the central server (10); and
transmitting (48) a local invalidation command (32) to the electronic key.

2. The method according to claim 1, wherein the step of obtaining (43) a distance indicator comprises using a received signal strength indicator.

3. The method according to any one of the preceding claims, wherein the step of discovering (42) comprises discovering the presence of the electronic key (2') using Bluetooth low energy, BLE.

4. The method according to any one of the preceding claims, further comprising the steps of:

receiving (50) a local confirmation message (33) from the electronic key (2') to be invalidated, the local confirmation message (33) indicating a successful invalidation; and
transmitting (52) a central confirmation message (34) to the central server, the central confirmation message (34) indicating a successful invalidation.

5. A locating device (1, 1a, 1b) for locating an electronic key (2') for access to a physical space (16), the locating device (1, 1a, 1b) comprising:

a processor (60); and
a memory (64) storing instructions (66) that, when executed by the processor, cause the locating device (1, 1a, 1b) to:

receive a location query (20) from a central server (10), the location query (20) comprising an identifier of an electronic key (2');
discover a presence of the electronic key (2') over short range radio;
obtain a distance indicator, indicating a distance between the locating device (1, 1a, 1b) and the electronic key (2'); and
transmit a location response (22) to the central server indicating that the electronic key (2') has been located, wherein the location response (22) comprises an indicator of a position of the locating device (1, 1a, 1b) and wherein the location response (22) comprises the distance indicator;
wherein the instructions further comprise instructions, to be executed after the instructions to transmit a location response, to:

receive a central invalidation command (30) from the central server (10); and
transmit a local invalidation command (32) to the electronic key.

6. The locating device (1, 1a, 1b) according to claim 5, wherein the instructions to obtain a distance indicator comprise instructions (66) that, when executed by the processor, cause the locating device (1, 1a, 1b) to use a received signal strength indicator.

7. The locating device (1, 1a, 1b) according to any one of claims 5 to 6, wherein the locating device forms part of a mobile phone.

8. The locating device (1, 1a, 1b) according to any one of claims 5 to 7, wherein the locating device is a device dedicated to the purpose of locating electronic keys.

9. A computer program (90) for locating an electronic key (2') for access to a physical space (16), the computer program comprising computer program code which, when run on a locating device (1, 1a, 1b), causes the locating device (1, 1a, 1b) to:

receive a location query (20) from a central server (10), the location query (20) comprising an identifier of an electronic key (2');
discover a presence of the electronic key (2') over short range radio;
obtain a distance indicator, indicating a distance between the locating device (1, 1a, 1b) and the electronic key (2'); and
transmit a location response (22) to the central server indicating that the electronic key (2') has been located, wherein the location response (22) comprises an indicator of a position of the locating device (1, 1a, 1b) and wherein the location response (22) comprises the distance indicator;
wherein the computer program code further comprise computer program code, to be executed after the computer program code to transmit a location response, to:

receive a central invalidation command (30) from the central server (10); and
transmit a local invalidation command (32) to the electronic key.

10. A computer program product (91) comprising a computer program according to claim 9 and a computer readable means on which the computer program is

stored.

Patentansprüche

1. Verfahren zur Lokalisierung eines elektronischen Schlüssels (2') für den Zugang zu einem physischen Raum (16), wobei das Verfahren in einer Lokalisierungsvorrichtung (1, 1a, 1b) durchgeführt wird und die Schritte umfasst:

   Empfangen (40) einer Positionsabfrage (20) von einem zentralen Server (10), wobei die Positionsabfrage (20) eine Kennung eines elektronischen Schlüssels (2') umfasst;
   Erkennen (42) eines Vorhandenseins des elektronischen Schlüssels (2') über Kurzstreckenfunk;
   Erhalten (43) eines Entfernungsindikators, der eine Entfernung zwischen der Lokalisierungsvorrichtung (1, la, 1b) und dem elektronischen Schlüssel (2') anzeigt; und
   Senden (44) einer Positionsantwort (22) an den zentralen Server, die anzeigt, dass der elektronische Schlüssel (2') lokalisiert wurde, wobei die Positionsantwort (22) einen Indikator einer Position der Lokalisierungsvorrichtung (1, 1a, 1b) umfasst, und wobei die Positionsantwort (22) den Entfernungsindikator umfasst;
   wobei das Verfahren ferner nach dem Schritt des Sendens (44) einer Positionsantwort die Schritte umfasst:

      Empfangen (46) eines zentralen Entwertungsbefehls (30) von dem zentralen Server (10); und
      Senden (48) eines lokalen Entwertungsbefehls (32) an den elektronischen Schlüssel.

2. Verfahren nach Anspruch 1, wobei der Schritt des Erhaltens (43) eines Entfernungsindikators die Verwendung eines Empfangssignalstärkeindikators umfasst.

3. Verfahren nach einem der vorhergehenden Ansprüche, wobei der Schritt des Erkennens (42) ein Erkennen des Vorhandenseins des elektronischen Schlüssels (2') unter Verwendung von Bluetooth Low Energy, BLE, umfasst.

4. Verfahren nach einem der vorhergehenden Ansprüche, ferner umfassend die Schritte:

   Empfangen (50) einer lokalen Bestätigungsnachricht (33) von dem zu entwertenden elektronischen Schlüssel (2'), wobei die lokale Bestätigungsnachricht (33) eine erfolgreiche Entwertung anzeigt; und
   Senden (52) einer zentralen Bestätigungsnachricht (34) an den zentralen Server, wobei die zentrale Bestätigungsnachricht (34) eine erfolgreiche Entwertung anzeigt.

5. Lokalisierungsvorrichtung (1, 1a, 1b) zur Lokalisierung eines elektronischen Schlüssels (2') für den Zugang zu einem physischen Raum (16), wobei die Lokalisierungsvorrichtung (1, 1a, 1b) umfasst:

   einen Prozessor (60); und
   einen Speicher (64), der Anweisungen (66) speichert, die, wenn sie von dem Prozessor ausgeführt werden, die Lokalisierungsvorrichtung (1, 1a, 1b) veranlassen zum:

      Empfangen einer Positionsabfrage (20) von einem zentralen Server (10), wobei die Positionsabfrage (20) eine Kennung eines elektronischen Schlüssels (2') umfasst;
      Erkennen eines Vorhandenseins des elektronischen Schlüssels (2') über Kurzstreckenfunk;
      Erhalten eines Entfernungsindikators, der eine Entfernung zwischen der Lokalisierungsvorrichtung (1, 1a, 1b) und dem elektronischen Schlüssel (2') anzeigt; und
      Senden einer Positionsantwort (22) an den zentralen Server, die anzeigt, dass der elektronische Schlüssel (2') lokalisiert wurde, wobei die Positionsantwort (22) einen Indikator einer Position der Lokalisierungsvorrichtung (1, 1a, 1b) umfasst, und wobei die Positionsantwort (22) den Entfernungsindikator umfasst;

   wobei die Anweisungen ferner Anweisungen umfassen, die nach den Anweisungen zum Senden einer Positionsantwort auszuführen sind, zum:

      Empfangen eines zentralen Entwertungsbefehls (30) von dem zentralen Server (10); und
      Senden eines lokalen Entwertungsbefehls (32) an den elektronischen Schlüssel.

6. Lokalisierungsvorrichtung (1, 1a, 1b) nach Anspruch 5, wobei die Anweisungen zum Erhalten eines Entfernungsindikators Anweisungen (66) umfassen, die, wenn sie durch den Prozessor ausgeführt werden, die Lokalisierungsvorrichtung (1, 1a, 1b) veranlassen, eine Empfangssignalstärkeanzeige zu verwenden.

7. Lokalisierungsvorrichtung (1, 1a, 1b) nach einem der Ansprüche 5 bis 6, wobei das Lokalisierungsvorrichtung Teil eines Mobiltelefons ist.

8. Lokalisierungsvorrichtung (1, 1a, 1b) nach einem der Ansprüche 5 bis 7, wobei die Lokalisierungsvorrichtung eine Vorrichtung ist, die für den Zweck des Lokalisierens von elektronischen Schlüsseln dediziert ist.

9. Computerprogramm (9o) zur Lokalisierung eines elektronischen Schlüssels (2') für den Zugang zu einem physischen Raum (16), wobei das Computerprogramm einen Computerprogrammcode umfasst, der, wenn er auf einer Lokalisierungsvorrichtung (1, 1a, 1b) ausgeführt wird, die Lokalisierungsvorrichtung (1, la, 1b) veranlasst zum:

Empfangen einer Positionsabfrage (20) von einem zentralen Server (10), wobei die Positionsabfrage (20) eine Kennung eines elektronischen Schlüssels (2') umfasst;
Erkennen eines Vorhandenseins des elektronischen Schlüssels (2') über Kurzstreckenfunk;
Erhalten eines Entfernungsindikators, der eine Entfernung zwischen der Lokalisierungsvorrichtung (1, la, 1b) und dem elektronischen Schlüssel (2') anzeigt; und
Senden einer Positionsantwort (22) an den zentralen Server, die anzeigt, dass der elektronische Schlüssel (2') lokalisiert wurde, wobei die Positionsantwort (22) einen Indikator einer Position der Lokalisierungsvorrichtung (1, la, 1b) umfasst und wobei die Positionsantwort (22) den Entfernungsindikator umfasst;
wobei der Computerprogrammcode ferner Computerprogrammcode umfasst, der nach dem Computerprogrammcode, eine Positionsantwort zu senden, auszuführen ist, zum:

Empfangen eines zentralen Entwertungsbefehls (30) von dem zentralen Server (10); und
Senden eines lokalen Entwertungsbefehls (32) an den elektronischen Schlüssel.

10. Computerprogrammprodukt (91), umfassend ein Computerprogramm nach Anspruch 9 und ein computerlesbares Mittel, auf dem das Computerprogramm gespeichert ist.

Revendications

1. Procédé de localisation d'une clé électronique (2') en vue d'un accès à un espace physique (16), le procédé étant réalisé dans un dispositif (1, la, 1b) de localisation et comportant les étapes consistant à :

recevoir (40) une interrogation (20) de localisation en provenance d'un serveur central (10), l'interrogation (20) de localisation comportant un identifiant d'une clé électronique (2') ;
découvrir (42) une présence de la clé électronique (2') par radio à courte portée ;
obtenir (43) un indicateur de distance, indiquant une distance entre le dispositif (1, la, 1b) de localisation et la clé électronique (2') ; et
transmettre (44) au serveur central une réponse (22) de localisation indiquant que la clé électronique (2') a été localisée, la réponse (22) de localisation comportant un indicateur d'une position du dispositif (1, 1a, 1b) de localisation, et la réponse (22) de localisation comportant l'indicateur de distance ;
le procédé comportant en outre, après l'étape de transmission (44) d'une réponse de localisation, les étapes consistant à :

recevoir (46) une commande (30) d'invalidation centrale en provenance du serveur central (10) ; et
transmettre (48) une commande (32) d'invalidation locale à la clé électronique.

2. Procédé selon la revendication 1, l'étape d'obtention (43) d'un indicateur de distance comportant l'utilisation d'un indicateur d'intensité du signal reçu.

3. Procédé selon l'une quelconque des revendications précédentes, l'étape de découverte (42) comportant la découverte de la présence de la clé électronique (2') en utilisant le Bluetooth à faible énergie, BLE.

4. Procédé selon l'une quelconque des revendications précédentes, comportant en outre les étapes consistant à :

recevoir (50) un message (33) de confirmation locale en provenance de la clé électronique (2') à invalider, le message (33) de confirmation locale indiquant une invalidation réussie ; et
transmettre (52) un message (34) de confirmation centrale au serveur central, le message (34) de confirmation centrale indiquant une invalidation réussie.

5. Dispositif (1, 1a, 1b) de localisation destiné à localiser une clé électronique (2') en vue d'un accès à un espace physique (16), le dispositif (1, 1a, 1b) de localisation comportant :

un processeur (60) ; et
une mémoire (64) conservant des instructions (66) qui, lorsqu'elles sont exécutées par le processeur, amènent le dispositif (1, 1a, 1b) de localisation à :

recevoir une interrogation (20) de localisation en provenance d'un serveur central

(10), l'interrogation (20) de localisation comportant un identifiant d'une clé électronique (2') ;
découvrir une présence de la clé électronique (2') par radio à courte portée ;
obtenir un indicateur de distance, indiquant une distance entre le dispositif (1, 1a, 1b) de localisation et la clé électronique (2') ; et
transmettre au serveur central une réponse (22) de localisation indiquant que la clé électronique (2') a été localisée, la réponse (22) de localisation comportant un indicateur d'une position du dispositif (1, 1a, 1b) de localisation et la réponse (22) de localisation comportant l'indicateur de distance ;

les instructions comportant en outre des instructions, à exécuter après les instructions servant à transmettre une réponse de localisation, pour :

recevoir une commande (30) d'invalidation centrale en provenance du serveur central (10) ; et
transmettre une commande (32) d'invalidation locale à la clé électronique.

6. Dispositif (1, 1a, 1b) de localisation selon la revendication 5, les instructions servant à obtenir un indicateur de distance comportant des instructions (66) qui, lorsqu'elles sont exécutées par le processeur, amènent le dispositif (1, 1a, 1b) de localisation à utiliser un indicateur d'intensité du signal reçu.

7. Dispositif (1, 1a, 1b) de localisation selon l'une quelconque des revendications 5 à 6, le dispositif de localisation faisant partie d'un téléphone mobile.

8. Dispositif (1, 1a, 1b) de localisation selon l'une quelconque des revendications 5 à 7, le dispositif de localisation étant un dispositif dédié à la fonction de localisation de clés électroniques.

9. Programme informatique (90) destiné à localiser une clé électronique (2') en vue d'un accès à un espace physique (16), le programme informatique comportant du code de programme informatique qui, lorsqu'il est exécuté sur un dispositif (1, 1a, 1b) de localisation, amène le dispositif (1, 1a, 1b) de localisation à :

recevoir une interrogation (20) de localisation en provenance d'un serveur central (10), l'interrogation (20) de localisation comportant un identifiant d'une clé électronique (2') ;
découvrir une présence de la clé électronique (2') par radio à courte portée ;
obtenir un indicateur de distance, indiquant une distance entre le dispositif (1, 1a, 1b) de localisation et la clé électronique (2') ; et
transmettre au serveur central une réponse (22) de localisation indiquant que la clé électronique (2') a été localisée, la réponse (22) de localisation comportant un indicateur d'une position du dispositif (1, 1a, 1b) de localisation et la réponse (22) de localisation comportant l'indicateur de distance ;
le code de programme informatique comportant en outre du code de programme informatique, à exécuter après le code de programme informatique servant à transmettre une réponse de localisation, pour :

recevoir une commande (30) d'invalidation centrale en provenance du serveur central (10) ; et
transmettre une commande (32) d'invalidation locale à la clé électronique.

10. Produit (91) de programme informatique comportant un programme informatique selon la revendication 9 et un moyen lisible par ordinateur sur lequel est stocké le programme informatique.

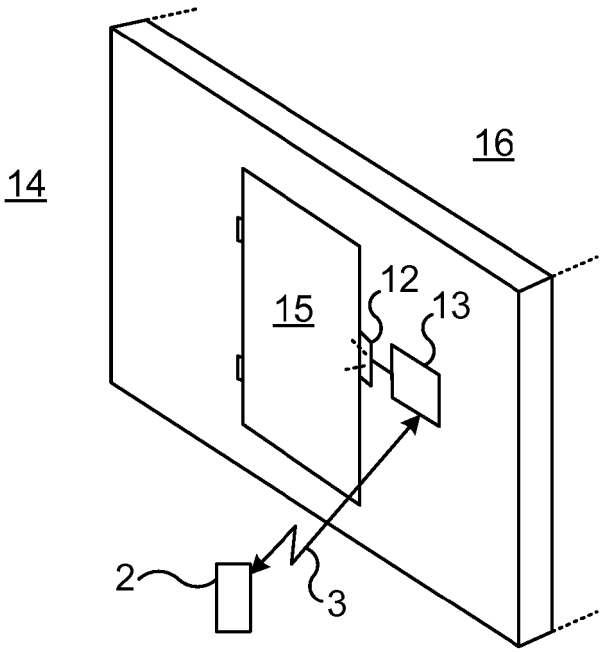

Fig. 1

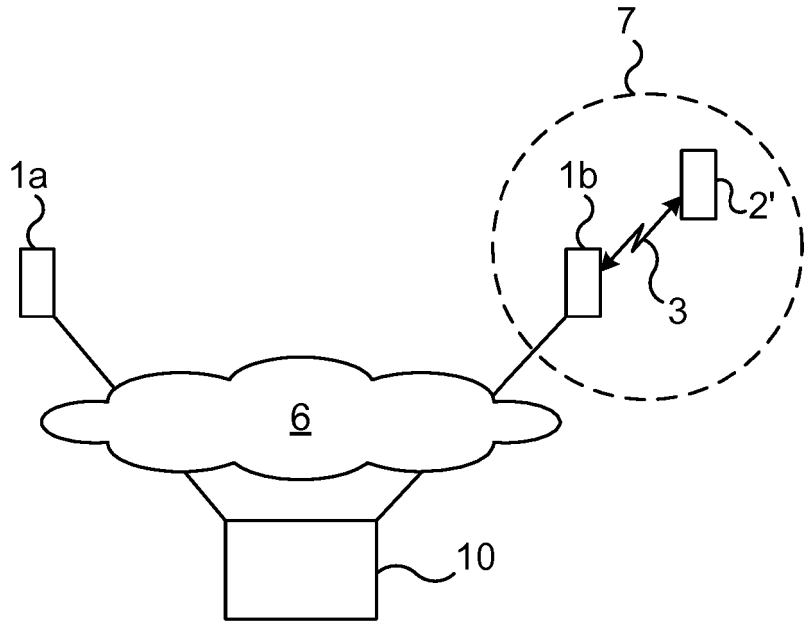

Fig. 2

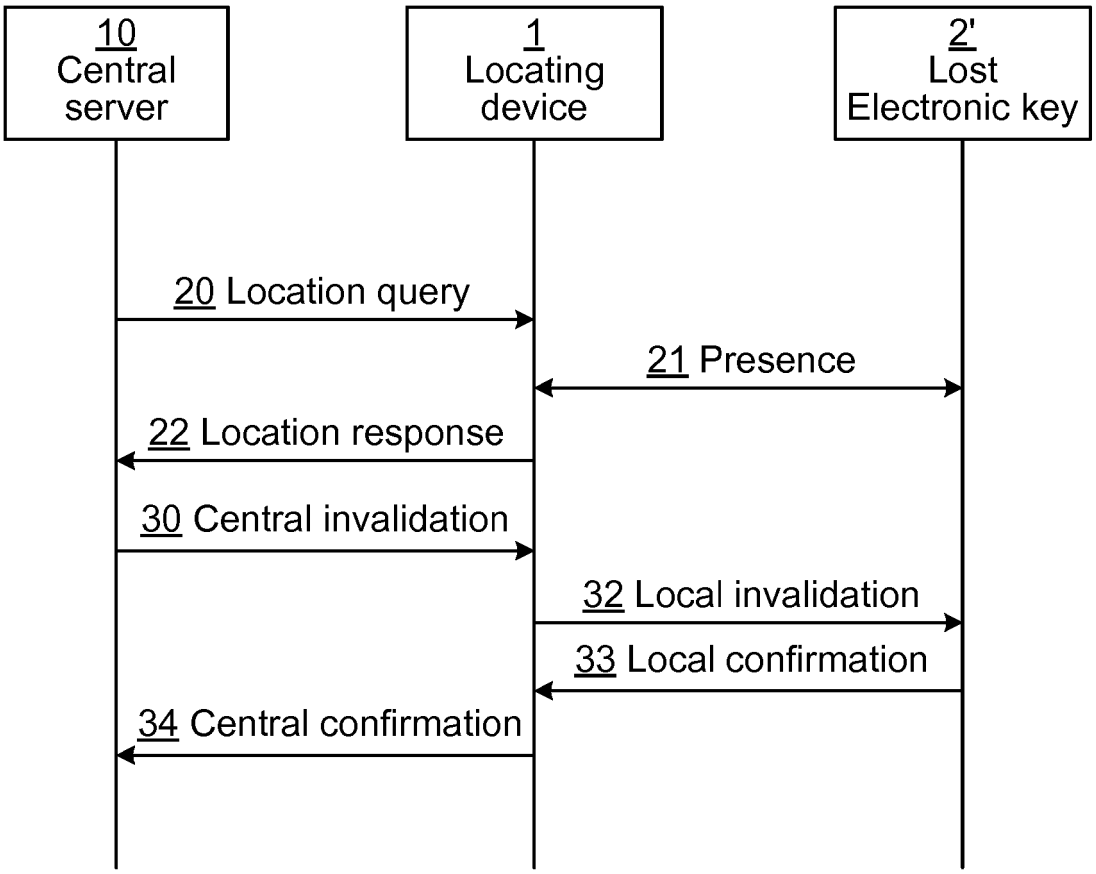
10
Central
server
1
Locating
device
2'
Lost
Electronic key
20 Location query
21 Presence
22 Location response
30 Central invalidation
32 Local invalidation
33 Local confirmation
34 Central confirmation

Fig. 3

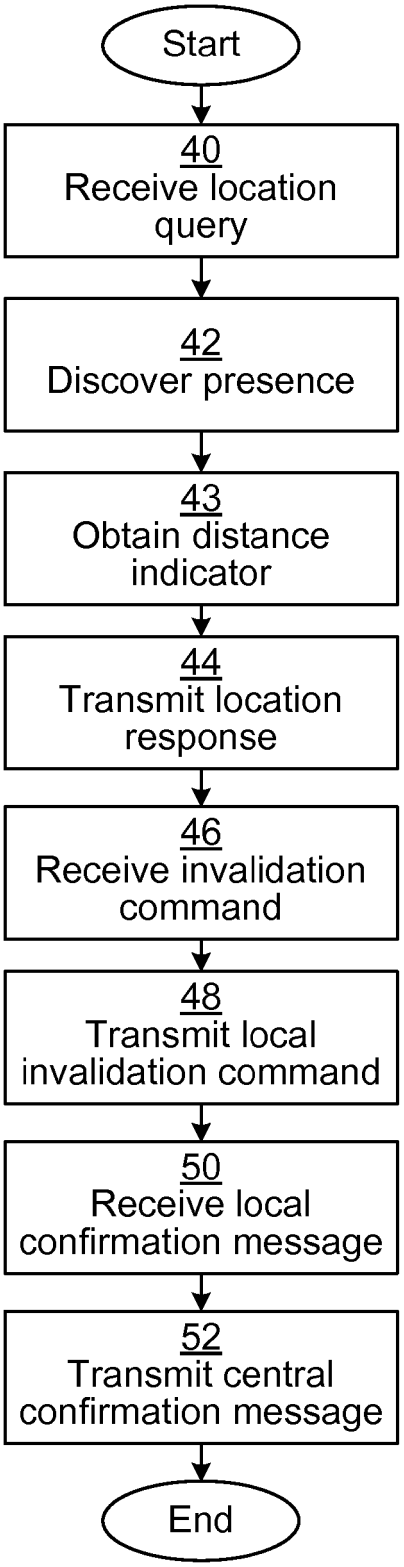

Fig. 4

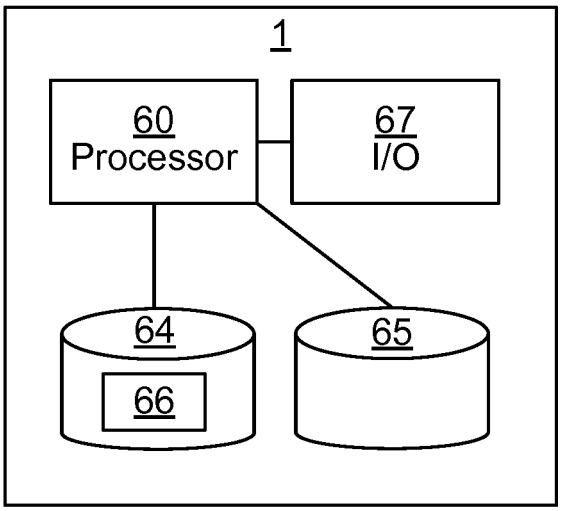

Fig. 5

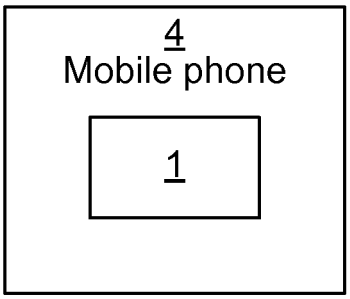

Fig. 6

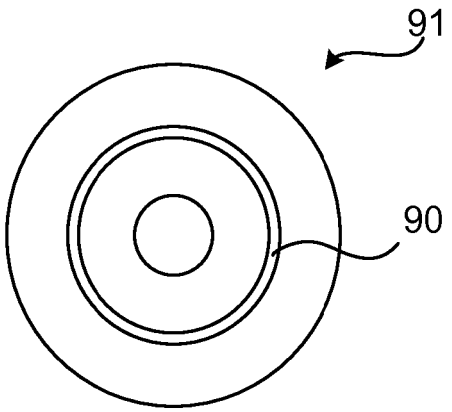

Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2007128011 A1 **[0004]**
- US 2006028339 A1 **[0005]**
- EP 1564691 A2 **[0006]**
- US 2005122216 A1 **[0007]**
- CN 102685256 A **[0008]**
- US 2010033342 A **[0009]**