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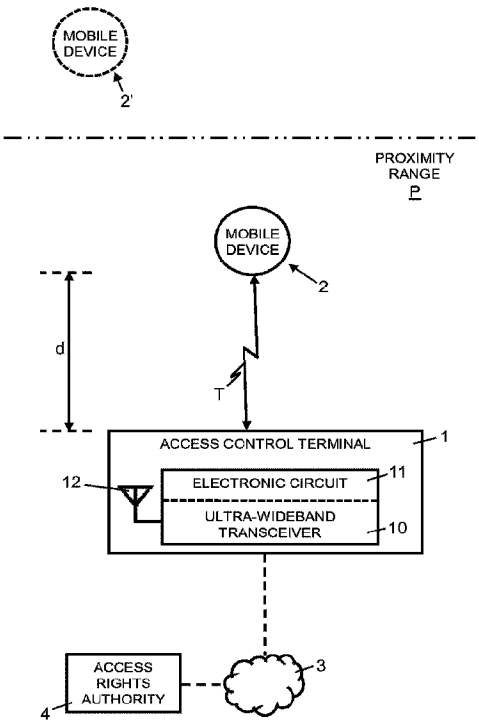

(57) Abrégé/Abstract:
An access control terminal (1), comprising an electronic circuit (11) and an ultra-wide-band transceiver (10) connected to the electronic circuit (11) wherein the electronic circuit (11) exchanges messages with a mobile device (2) to determine a distance (d) of the mobile device (2) from the access control terminal (1), and to transmit to the mobile device (2) one or more update messages configured to update access rights data in the mobile device (2), if the mobile device (2) is within the pre-determined proximity range (P).

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(54) **Title:** UWB ACCESS RIGHTS UPDATE

(57) **Abstract:** An access control terminal (1), comprising an electronic circuit (11) and an ultra-wide-band transceiver (10) connected to the electronic circuit (11) wherein the electronic circuit (11) exchanges messages with a mobile device (2) to determine a distance (d) of the mobile device (2) from the access control terminal (1), and to transmit to the mobile device (2) one or more update messages configured to update access rights data in the mobile device (2), if the mobile device (2) is within the pre-determined proximity range (P).

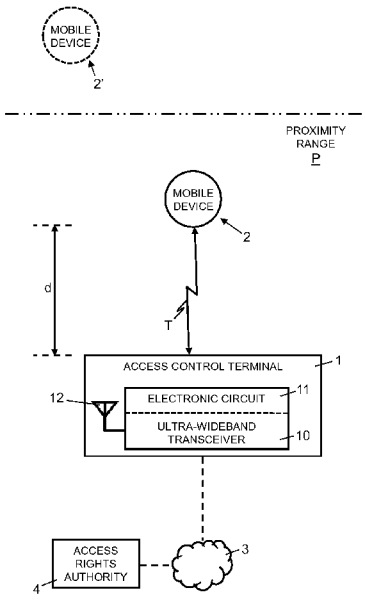


Fig. 1

WO 2020/083750 A1

UWB ACCESS RIGHTS UPDATE

TECHNICAL FIELD

The present disclosure relates to an access control terminal. Specifically, the present disclosure relates to an access control terminal, comprising an electronic circuit and an ultra-wideband (UWB) transceiver, a method of updating access rights, and a computer program product for updating access rights.

BACKGROUND

Keyless entry systems have become widely used in applications ranging from vehicle entry systems and vehicle access control, to building and room access control. For very close-range applications, a radio-frequency identification (RFID) transponder (or tag) is often used, which has mostly replaced earlier magnetic stripe cards. For applications which do not require a very close range, other wireless technologies such as Bluetooth and ultra-wideband radio have emerged.

The network topologies of access control systems typically comprise a central access rights server to which each access control terminal is connected. An access control device held by a user is brought close to an access control terminal for wireless exchange of credentials. These credentials are then transmitted from the access control terminal to the server, which performs a look-up in a database of access rights. If access is granted, the server sends a signal to the access control terminal, which allows the user access through an electronically controlled doorway. The disadvantage of this topology is that it requires each access control terminal to be permanently connected to the server, which is associated with considerable cost in wiring and presents a single point of failure. More modern access control systems have relegated access control decisions to the access control terminals themselves. If these access control terminals are not connected to the server, however, the issue then arises of how and when to update the database of access rights in each access control terminal.

Date Reçue/Date Received 2022-07-25

Other access rights systems invert the situation by storing a database or table of the user's access rights in the access control devices themselves. At an access control point, the access control terminals and the access control devices exchange data containing an identifier of the access control terminal and the user's access rights at that access control point. Access control devices must be cheap and small, and therefore a disadvantage of these systems is that they typically have only a limited memory, and therefore for a large access control system comprising a large number of access control points, the user's access rights table cannot be stored in the access control device in its entirety. Similarly, updating access rights becomes cumbersome as every affected party must have its access control device updated with new access rights.

BRIEF SUMMARY

The present disclosure describes an access control terminal and a method of updating access rights, which do not have at least some of the disadvantages of the prior art.

In one embodiment, an access control terminal comprises an electronic circuit and an ultra-wideband transceiver connected to the electronic circuit. The electronic circuit is configured to transmit, via the ultra-wideband transceiver, to a mobile device a request message and to receive, via the ultra-wideband transceiver, from the mobile device a response message. The electronic circuit is further configured to determine a distance of the mobile device from the access control terminal, using the response message, and to determine, using the distance, if the mobile device is within a pre-determined proximity range, and to transmit to the mobile device one or more update messages configured to update access rights data in the mobile device, if the mobile device is within the pre-determined proximity range.

In an embodiment, the electronic circuit is configured to determine the distance using a time difference between transmitting the request message and receiving the response message.

Date Reçue/Date Received 2022-07-25

In an embodiment, the electronic circuit is configured to include in the access rights data access control point rights, which grant a user of the mobile device access at certain access control points, and/or access control point times, which grant the user of the mobile device access at certain access control points at certain times and/or for certain periods of time.

In an embodiment the electronic circuit is configured to transmit to the mobile device one or more update messages using the ultra-wideband transceiver, a Bluetooth transceiver, a WLAN transceiver, and/or a mobile cellular transceiver.

In an embodiment the electronic circuit is further configured to determine and store a plurality of distances of the mobile device from the access control terminal, to determine, using the plurality of distances, a predicted path of the mobile device, and to transmit, via the ultra-wideband transceiver, the one or more update messages configured to update the access rights data in the mobile device, if the predicted path of the mobile device is within the proximity range for a predetermined update period.

In addition to an access control terminal, there is also provided a method of updating access rights between an access control terminal and a mobile device, the access control terminal comprising an electronic circuit and an ultra-wideband transceiver connected to the electronic circuit. The method comprises transmitting, by the electronic circuit via the ultra-wideband transceiver, a request message to the mobile device. The method further comprises receiving, by the electronic circuit via the ultra-wideband transceiver, a response message from the mobile device. The method further comprises determining, in the electronic circuit, using the response message, a distance of the mobile device from the access control terminal. The method further comprises determining, in the electronic circuit, using the distance, if the mobile device is within a pre-determined proximity range, and trans-

Date Reçue/Date Received 2022-07-25

mitting, from the electronic circuit to the mobile device one or more update messages configured to update access rights data in the mobile device, if the mobile device is within the pre-determined proximity range.

In an embodiment, the method comprises determining, in the electronic circuit, the distance using a time difference between transmitting the request message and receiving the response message.

In an embodiment, the method comprises including, by the electronic circuit, in the access rights data access control point rights, which grant a user of the mobile device access at certain access control points, and/or access control point times, which grant the user of the mobile device access at certain access control points at certain times and/or for certain periods of time.

In an embodiment, the method further comprises the electronic circuit transmitting, to the mobile device, one or more update messages via the ultra-wideband transceiver, a Bluetooth transceiver, a WLAN transceiver, and/or mobile cellular transceiver.

In an embodiment, the method further comprises determining and storing, in the electronic circuit, a plurality of distances of the mobile device from the access control terminal. The method further comprises determining, using the plurality of distances, a predicted path of the mobile device. The method further comprises transmitting, via the ultra-wideband transceiver, the one or more update messages configured to update the access rights data in the mobile device, if the predicted path of the mobile device is within the proximity range for a predetermined update period.

In addition to an access control terminal and a method of updating access rights, there is also provided a computer program product comprising a non-transitory computer readable medium having stored thereon computer code configured to control a processor of an access control terminal, comprising an ultra-wideband transceiver, to transmit, via the ultra-wideband transceiver, a request message to

Date Reçue/Date Received 2022-07-25

a mobile device and receive, via the ultra-wideband transceiver a response message from the mobile device. The computer code is further configured to control the processor to determine, using the response message, a distance of the mobile device from the access control terminal, and determine, using the distance, if the mobile device is within a pre-determined proximity range. The computer code is further configured to control the processor to transmit to the mobile device one or more update messages configured to update access rights data in the mobile device, if the mobile device is within the pre-determined proximity range.

In an embodiment, the computer program is configured to control the processor to determine, in the electronic circuit, the distance using a time difference between transmitting the request message and receiving the response message.

In an embodiment, the computer program is further configured to control the processor to include, by the electronic circuit, in the access rights data access control point rights, which grant a user of the mobile device access at certain access control points, and/or access control point times, which grant the user of the mobile device access at certain access control points at certain times and/or for certain periods of time.

In an embodiment, the computer program is further configured to control the processor to transmit to the mobile device one or more update messages via the ultra-wideband transceiver, a Bluetooth transceiver, a WLAN transceiver, and/or mobile cellular transceiver.

In an embodiment, the computer program is further configured to control the processor to determine and store, in the electronic circuit, a plurality of distances of the mobile device from the access control terminal. The computer program is further configured to control the processor to determine, using the plurality of distances, a predicted path of the mobile device, and to transmit, via the ultra-wide-

Date Reçue/Date Received 2022-07-25

band transceiver, the one or more update messages configured to update the access rights data in the mobile device, if the predicted path of the mobile device is within the proximity range for a predetermined update period.

BRIEF DESCRIPTION OF THE DRAWINGS

The concepts described herein will be explained in more detail, by way of example, with reference to the drawings in which:

Fig. 1 shows a block diagram illustrating schematically a mobile device interacting with an access control terminal;

Fig. 2 shows a block diagram illustrating schematically a mobile device comprising a data store and an ultra-wideband transceiver, interacting with an access control terminal comprising an electronic circuit, an ultra-wideband transceiver, a data store, and a processor;

Fig. 3 shows a flow diagram illustrating an exemplary sequence of steps for updating access rights between an access control terminal and a mobile device and/or transmitting events data from the mobile device to the access control terminal.

DETAILED DESCRIPTION

In Figures **1**, **2**, and **3**, reference numeral **1** refers to an access control terminal, which is an electronic device, mounted on or in a wall near a doorway, gate, or access control location, or incorporated into a door or gate itself. The access control terminal **1** further comprises an electronic circuit **11** connected to an ultra-wideband transceiver **10**. The access control terminal **1** comprises an antenna **12** connected to the ultra-wideband transceiver **10**. In an embodiment, the access control terminal **1** comprises a plurality of antennas **12**, arranged such that a direction of a transmission from the mobile device **2** to the access control terminal **1** may be determined. The plurality of antennas **12** are arranged at a distance from each

Date Reçue/Date Received 2022-07-25

other such that the times of arrival of a transmission from a mobile device **2** to the plurality of antenna **12** are distinguishable from each other.

In Figures **1**, **2**, and **3**, reference numeral **2** refers to a mobile device, which is an electronic communication device, such as a mobile radio telephone (cellular phone), a tablet computer, a laptop computer, a smart watch, or another operable portable/mobile electronic device comprising a battery powered electronic circuit, e.g., a programmed processor and/or an application specific integrated circuit (ASIC).

Reference character d refers to a distance between the mobile device **2** and the access control terminal **1**.

Reference character T refers to an ultra-wideband transmission between the mobile device **2** and the access control terminal **1**, or between the access control terminal **1** and the mobile device **2**.

Reference character P refers to a proximity range, which is a distance from the access control terminal **1**, or an area surrounding, adjacent to, or near the access control terminal **1**. The proximity range P comprises the area of a room or a corridor, for example. In an embodiment, the proximity range P extends to a distance of up to **5** meters, preferably up to **10** meters, more preferably up to **20** meters from the access control terminal **1**.

Reference numeral **2** refers to a mobile device situated inside the proximity range P of the access control terminal **1**. Reference numeral **2'** refers to a mobile device situated outside the proximity range P of the access control terminal **1**.

In an embodiment, the mobile device **2**, **2'**, is carried by a user, and as such can either be stationary or in motion with respect to the access control terminal **1**. The mobile device **2**, **2'** can be carried in the hand of the user but can also be carried in a garment or an accessory of the user, such as in a pocket or in a handbag. Due

Date Reçue/Date Received 2022-07-25

to the properties of ultra-wideband signals, the mobile device **2**, **2'** does not need to be within line-of-sight of the access control terminal **1**.

Reference numeral **3** refers to a network, specifically a wired or wireless network which may comprise a plurality of networks such as a local area network (LAN), a wireless local area network (WLAN), a cellular network such GSM, and the Internet.

Reference numeral **4** refers to an access rights authority, which is a computer system comprising a memory on which access rights data is stored. The computer system implementing the access rights authority **4** may be a virtual cloud-based system, or a physical computer or server computer.

In the following paragraphs, described with reference to Figure **2** are additional modules and components of the mobile device **2** and the access control terminal **1**.

The mobile device **2** comprises an ultra-wideband transceiver **20** configured for communication via an antenna **22** with the electronic circuit **11** of the access control terminal **1**, via the antenna **12** and the ultra-wideband transceiver **10**. The mobile device **2** comprises a data store **21**, specifically a memory module such as flash memory, EEPROM, or other non-volatile memory. The data store **21** has stored thereon access rights data **211**, which comprises access control point rights **212** and access right times **213**. Access rights **212** are associated with a user. The user is also associated with the mobile device **2**. If the user switches to using a different mobile device **2**, an authentication process takes place in which the association between the user and the different mobile device **2** is verified. If the association is affirmatively verified, the access rights **212** in the mobile device **2** are set in accordance with the user's access rights. Access control point rights **212** grant the user of the mobile device **2** access at certain access control points of an access control system. For example, the user may be granted access at a particular set of access control points, but not others. Such access control points may be doorways

Date Reçue/Date Received 2022-07-25

or gates. Access control point times **213** grant the user of the mobile device **2** access at certain access control points at certain times and/or for certain periods of time. For example, access control point times **213** may grant the user access during normal business hours or may grant the user access for a limited period of time, such as one hour or one day. Access control point times **213** may grant the user access for only a limited number of times, such as once, or for only a limited number of times in a given time period, such as once per day.

In an embodiment, the data store **21** further comprises events data **214**, which the mobile device **2** received from access control points. The events data **214** comprises information regarding the status of specific access control points and access log files of specific access control points. The status of the specific access control point indicates a battery level of the specific access control point, error messages describing error or warning events of the specific access control points, or further diagnostic information such as hardware identifiers and software identifiers. Access log files indicate which user's devices underwent access control at the specific access control point. Specifically, the events data **214** includes an identifier associated with a specific access control point, a timestamp representing the time an event occurred, and/or an event type.

The access control terminal **1** comprises a processor **14**, specifically a microprocessor or Application-Specific Integrated Circuit (ASIC), further comprises a communications module (not shown) for communicating with the network **3**. The access control terminal **1** further comprises a data store **13**, specifically non-volatile memory such as flash or EEPROM memory. The data store **13** comprises update messages **131**, which are data files or data packages for updating access rights data **211** in the mobile device **2** associated with the user.

In the following paragraphs, described with reference to Figure **3** are the steps, functions, and operations performed by the access control terminal **1** or its processor **14** or the electronic circuit **11**, respectively, and the mobile device **2**, for exchanging updating access rights in the mobile device **2**.

Date Reçue/Date Received 2022-07-25

In Step S**1**, the access control terminal **1** or its processor **14** or electronic circuit **11**, respectively, generates a request message. In an embodiment, the request message comprises an identifier of the access control terminal **1** and a nonce, which is an arbitrary number used once.

In transmission T**1**, the request message is transmitted from the access control terminal **1** to the mobile device **2**. The mobile device **2** receives the request message via the antenna **22** and the ultra-wideband transceiver **20** of the mobile device **2**.

In step S**2**, the mobile device **2** generates a response message using the received request message. The response message comprises a mobile device identifier of the mobile device **2** and the nonce.

In transmission T**2**, the response message is transmitted by the ultra-wideband transceiver **20** of the mobile device **2** and received by the ultra-wideband transceiver **10** of the access control terminal **1**.

In step S**3**, the electronic circuit **11** of the access control terminal **1** determines the distance d between the mobile device **2** and the access control terminal **1**, if the nonce of the response message matches the nonce of the request message. In other embodiments, security protocols other than exchanging a nonce may be used to securely identify the mobile device **2** and determine the distance d in such a way as to secure against man-in-the-middle or side-channel attacks.

The distance d is determined by using a round trip time-of-flight calculation, using a time difference between sending the request message and receiving the response message. A processing time, indicating the time delay in the mobile device **2** of receiving the request message and transmitting the response message, is also used in determining the distance d. In an embodiment, the access control terminal

Date Reçue/Date Received 2022-07-25

1 comprises a plurality of antennas **12** and determining the distance d further comprises determining the direction of the transmission by trilateration or by other geometric calculations, using the plurality of distances from the mobile device **2** to each of the antennas **12**.

In step S**4**, the distance d is used to determine whether the mobile device **2** is within the proximity range P. If the mobile device **2** is not within the proximity range P, the access control terminal **1** reverts to step S**1** and generates a new request message. In an embodiment, in transmitting a plurality of request messages and receiving a plurality of response messages, the access control terminal **1** determines a plurality of locations of the mobile device **2** which are associated with a specific time and determines a path of the mobile device **2**. By extrapolating the path, the access control terminal **1** predicts a future location of the mobile device **2** for determining whether the mobile device **2** will remain within the proximity range P for a given time.

In step S**5**, if the mobile device **2** is within the proximity range P or its predicted location is within the proximity range P, the processor **14** of the access control terminal **1** generates one or more update messages **131** for the respective mobile device **2** which is associated with the user. The update messages **131** comprise access rights data, which comprises access control point rights and access right times of the user of the mobile device **2**. The update messages **131** are configured to update the access rights data **211** in the data store **21** of the mobile device **2**. The update messages **131** are generated using the mobile phone identifier of the mobile device **2** received in the response message. The update messages **131** are generated by the processor **14** using access rights data received from an access rights authority **4** via the network **3**. Depending on the data size of the received access rights data and the size of the data payload of an ultra-wideband transmission, the access rights data is partitioned into one or more update messages **131** by the processor **14**. In an embodiment, the access rights authority **4** generates the update messages **131** and transmits them to access control terminal **1**, which stores them in the data store **13**. In the one or more transmissions T**3** the update

Date Reçue/Date Received 2022-07-25

messages **131** are transmitted from the access control terminal **1** by the electronic circuit **11** and the ultra-wideband transceiver **10** to the mobile device **2** via the ultra-wideband transceiver **20** of the mobile device **2**.

As the access rights data may be partitioned into a plurality of update messages **131**, the access control terminal **1** determines in step S**4**, as described above, whether mobile device **2** or its predicted location, respectively, is inside the proximity range P before the access control terminal **1** begins transmitting the update messages **131**. As the transmission and reception range of the ultra-wideband transmissions T**3** is larger than the proximity range P, it is ensured that the update messages **131** are successfully received by the mobile device **2**, even if the user of the mobile device **2** is not stationary during the transmitting of the update messages **131**. The access control terminal **1** is configured to continue transmitting the update messages **131** even if the user of the mobile device **2** leaves the proximity range P during the transmitting of the update messages **131**. This ensures a seamless update process as the user can be in motion while the access control terminal **1** transmits update messages **131**.

The user does not have to handle or interact with the mobile device **2** for the mobile device **2** to receive the update messages **131**. The user, carrying the mobile device **2**, is only required to enter the proximity range P. In particular, the user does not have to present the mobile device **2** to the access rights terminal **1** for the mobile device **2** to receive the update messages **131**. This makes receiving the update messages **131** user-friendly and efficient.

In step S**6**, the mobile device **2** updates the access rights data **211** using the received update messages **131**. The received update messages comprise access rights data **211**.

In an embodiment, in step S**7**, the mobile device **2** generates one more events data messages. The events data messages comprise events data **214** received from one or more access control points and stored in the data store **21**.

Date Reçue/Date Received 2022-07-25

In (optional) transmission T**4**, the mobile device **2** transmits the one or more events data messages which are received by the access control terminal **1**. The access control terminal **1** forwards the events data **214** to the access rights authority **4** via the network **3**. The mobile device **2** either transmits events data **214** to the access control terminal **1** while receiving the update messages **131** from the access control terminal **1** or transmits events data **214** to the access control terminal **1** independently from receiving the update messages **131**. The events data **214** can also be transmitted from the mobile device **2** without receiving update messages **131**.

The transmission of events data **214** from access control points to the access rights authority **4** via the data store **21** of the mobile device **2**, the access control terminal **1** and the network **3**, enables a system administrator to receive information including the status and access log files of access control points, without the access control points being directly connected to the network **3**.

In step S**8**, after updating access rights data **211**, the mobile device **2** generates a confirmation message comprising the mobile phone identifier of the mobile device **2** of the user. In transmission T**5**, the confirmation message is transmitted from the mobile device **2** and received by the access control terminal **1**.

Date Reçue/Date Received 2022-07-25

EMBODIMENTS IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An access control terminal, comprising:

an electronic circuit; and

an ultra-wideband transceiver connected to the electronic circuit;

wherein the electronic circuit is configured to transmit (T**1**), via the ultra-wideband transceiver, to a mobile device a request message, to receive (T**2**), via the ultra-wideband transceiver, from the mobile device a response message, to determine (S**3**) a distance (d) of the mobile device from the access control terminal, using the response message, to determine, using the distance (d), if the mobile device is within a pre-determined proximity range (P), and to transmit (T**3**) to the mobile device one or more update messages configured to update (S**6**) access rights data in the mobile device, if the mobile device is within the pre-determined proximity range (P).

2. The access control terminal of claim **1**, wherein the electronic circuit is configured to determine (S**3**) the distance (d) using a time difference between transmitting (T**1**) the request message and receiving (T**2**) the response message.

3. The access control terminal of claim **1** or **2**, wherein the electronic circuit is configured to include in the access rights data at least one of:

access control point rights, which grant a user of the mobile device access at certain access control points; and

access control point times, which grant the user of the mobile device access at certain access control points at at least one of:

certain times; and

Date Reçue/Date Received 2022-07-25

certain periods of time.

4. The access control terminal of any one of claims **1** to **3**, wherein the electronic circuit is configured to transmit (T**3**) to the mobile device one or more update messages using at least one of:

the ultra-wideband transceiver;

a Bluetooth transceiver;

a WLAN transceiver; and

a mobile cellular transceiver.

5. The access control terminal of any one of claims **1** to **4**, wherein the electronic circuit is further configured to:

determine (S**3**) and store a plurality of distances (d) of the mobile device from the access control terminal

to determine, using the plurality of distances (d), a predicted path of the mobile device; and

transmit (T**3**), via the ultra-wideband transceiver, the one or more update messages configured to update the access rights data in the mobile device, if the predicted path of the mobile device is within the proximity range (P) for a predetermined update period.

6. A method of updating access rights between an access control terminal and a mobile device, the access control terminal comprising an electronic circuit and an ultra-wideband transceiver connected to the electronic circuit, wherein the method comprises:

transmitting (T**1**), by the electronic circuit via the ultra-wideband transceiver, a request message to the mobile device;

receiving (T**3**), by the electronic circuit via the ultra-wideband transceiver, a response message from the mobile device;

Date Reçue/Date Received 2022-07-25

determining (S**3**), in the electronic circuit, using the response message, a distance (d) of the mobile device from the access control terminal;

determining (S**4**), in the electronic circuit, using the distance (d), if the mobile device is within a pre-determined proximity range (P); and

transmitting (T**3**), from the electronic circuit to the mobile device one or more update messages configured to update access rights data in the mobile device, if the mobile device is within the pre-determined proximity range (P).

7. The method of claim **6**, wherein the method comprises determining (S**3**), in the electronic circuit, the distance (d) using a time difference between transmitting (T**1**) the request message and receiving (T**2**) the response message.

8. The method of claim **6** or **7**, wherein the method comprises:

including, by the electronic circuit, in the access rights data at least one of:

access control point rights, which grant a user of the mobile device access at certain access control points, and

access control point times, which grant the user of the mobile device access at certain access control points at at least one of:

certain times; and

for certain periods of time.

9. The method of any one of claims **6** to **8**, wherein the method further comprises the electronic circuit transmitting (T**3**), to the mobile device, one or more update messages via at least one of:

the ultra-wideband transceiver;

a Bluetooth transceiver;

a WLAN transceiver; and

Date Reçue/Date Received 2022-07-25

a mobile cellular transceiver.

10. The method of any one of claims **6** to **9**, wherein the method further comprises:

determining and storing, in the electronic circuit, a plurality of distances (d) of the mobile device from the access control terminal;

determining, using the plurality of distances (d), a predicted path of the mobile device; and

transmitting (T**3**), via the ultra-wideband transceiver, the one or more update messages configured to update the access rights data in the mobile device, if the predicted path of the mobile device is within the proximity range (P) for a predetermined update period.

11. A computer program product comprising a non-transitory computer readable medium having stored thereon computer code configured to control a processor of an access control terminal comprising an ultra-wideband transceiver, such that the processor performs the steps of:

transmitting (T**1**), via the ultra-wideband transceiver, a request message to a mobile device;

receiving (T2), via the ultra-wideband transceiver, a response message from the mobile device;

determining (S3), using the response message, a distance (d) of the mobile device from the access control terminal;

determining (S4), using the distance (d), if the mobile device is within a pre-determined proximity range (P); and

transmitting (T3) to the mobile device one or more update messages configured to update access rights data in the mobile device, if the mobile device is within the pre-determined proximity range (P).

Date Reçue/Date Received 2022-07-25

12. The computer program product of claim **11**, wherein the computer code is configured to control the processor to perform the step of determining (S**3**), in the electronic circuit, the distance (d) using a time difference between transmitting (T**1**) the request message and receiving (T**2**) the response message.

13. The computer program product of claim **11** or **12**, wherein the computer code is further configured to control the processor to perform the steps of:

including, by the electronic circuit, in the access rights data at least one of:

access control point rights, which grant a user of the mobile device access at certain access control points; and

access control point times, which grant the user of the mobile device access at certain access control points at at least one of:

certain times; and

for certain periods of time.

14. The computer program product of any one of claims **11** to **13**, wherein the computer code is further configured to control the processor to perform the step of transmitting (T**3**) to the mobile device one or more update messages via at least one of:

the ultra-wideband transceiver;

a Bluetooth transceiver;

a WLAN transceiver; and

a mobile cellular transceiver.

15. The computer program product of any one of claims **11** to **14**, wherein the computer code is further configured to control the processor to perform the steps of:

Date Reçue/Date Received 2022-07-25

determining and storing, in the electronic circuit, a plurality of distances (d) of the mobile device from the access control terminal;

determining, using the plurality of distances (d), a predicted path of the mobile device; and

transmitting (T3), via the ultra-wideband transceiver, the one or more update messages configured to update the access rights data in the mobile device, if the predicted path of the mobile device is within the proximity range (P) for a predetermined update period.

Date Reçue/Date Received 2022-07-25

1/3

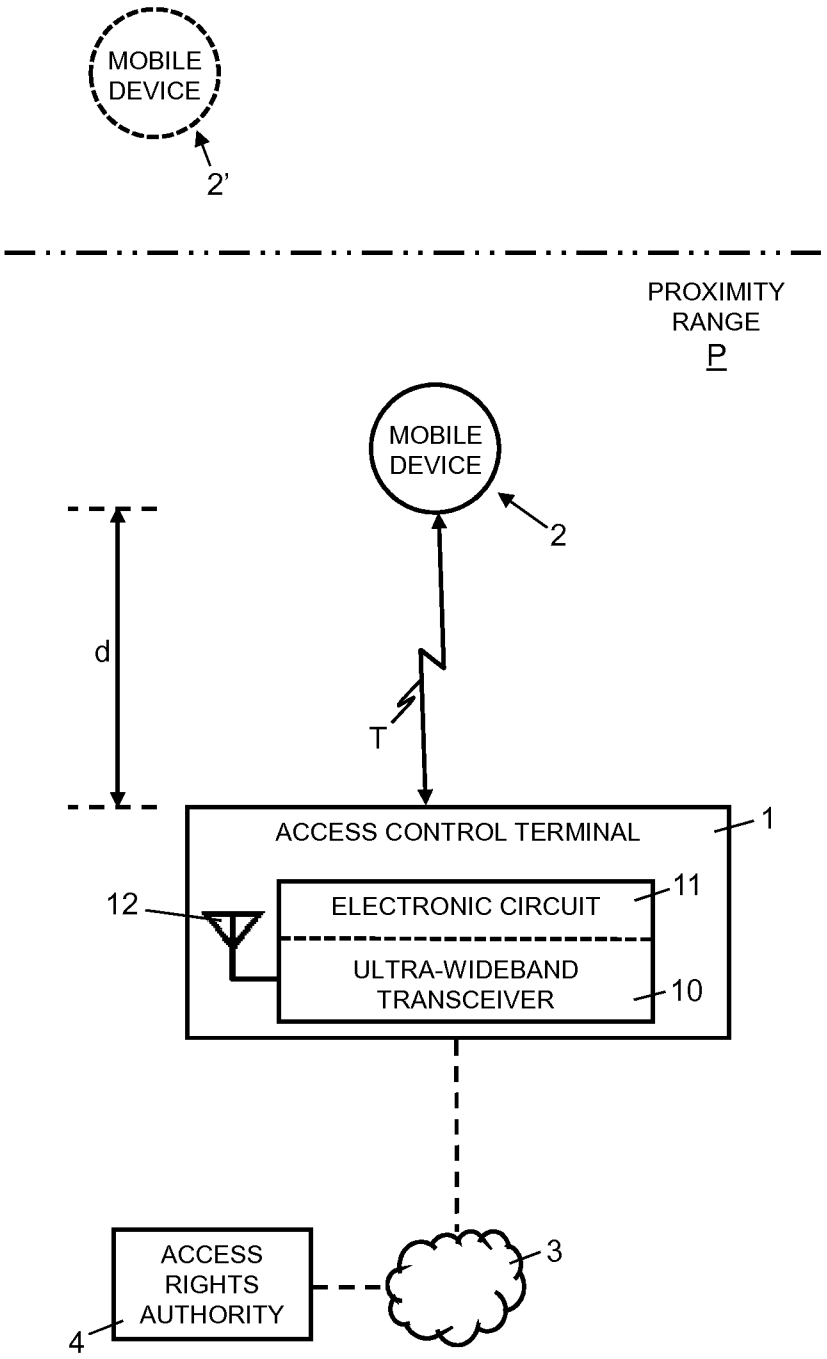

MOBILE DEVICE
2'
PROXIMITY RANGE
P
MOBILE DEVICE
2
d
T
ACCESS CONTROL TERMINAL
1
12
ELECTRONIC CIRCUIT
11
ULTRA-WIDEBAND TRANSCEIVER
10
ACCESS RIGHTS AUTHORITY
4
3

Fig. 1

2/3

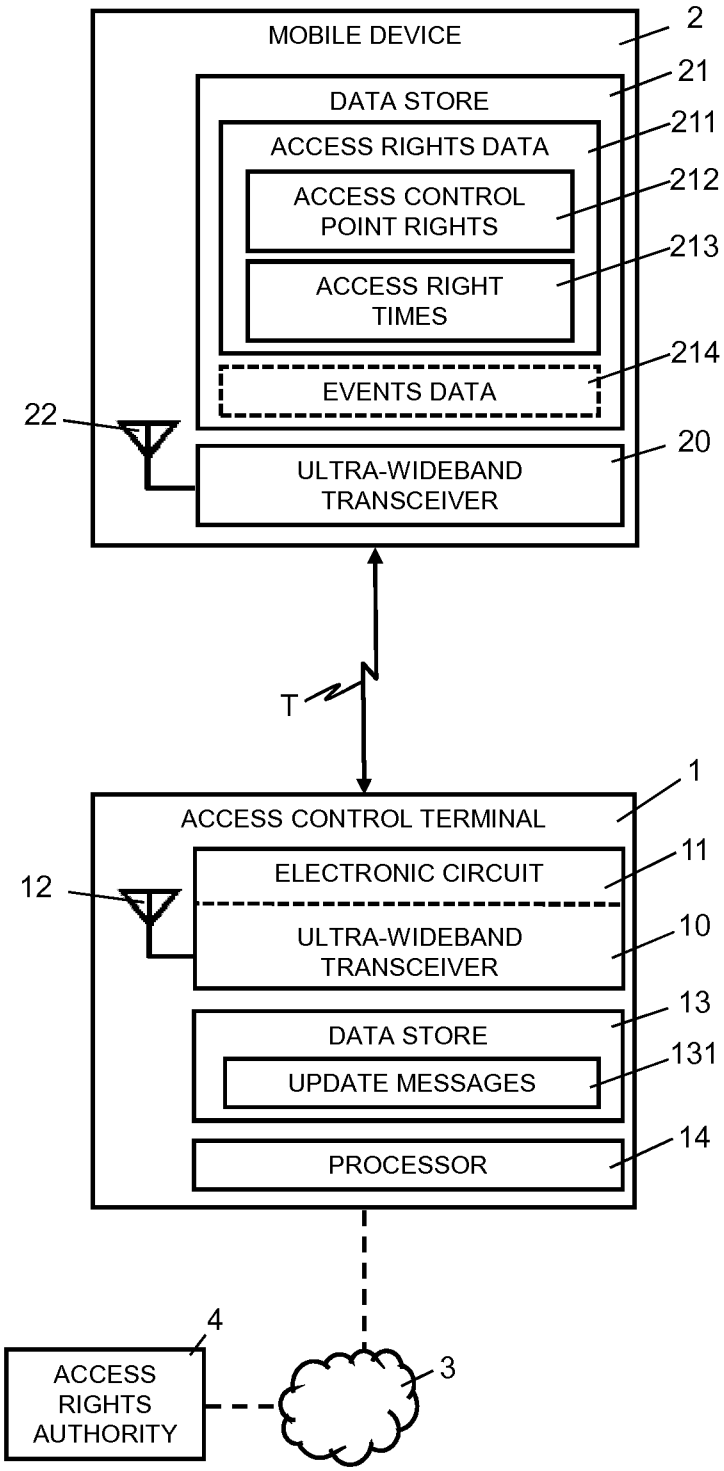

MOBILE DEVICE
2
DATA STORE
21
ACCESS RIGHTS DATA
211
ACCESS CONTROL POINT RIGHTS
212
ACCESS RIGHT TIMES
213
EVENTS DATA
214
22
ULTRA-WIDEBAND TRANSCEIVER
20
T
ACCESS CONTROL TERMINAL
1
ELECTRONIC CIRCUIT
11
12
ULTRA-WIDEBAND TRANSCEIVER
10
DATA STORE
13
UPDATE MESSAGES
131
PROCESSOR
14
4
ACCESS RIGHTS AUTHORITY
3

Fig. 2

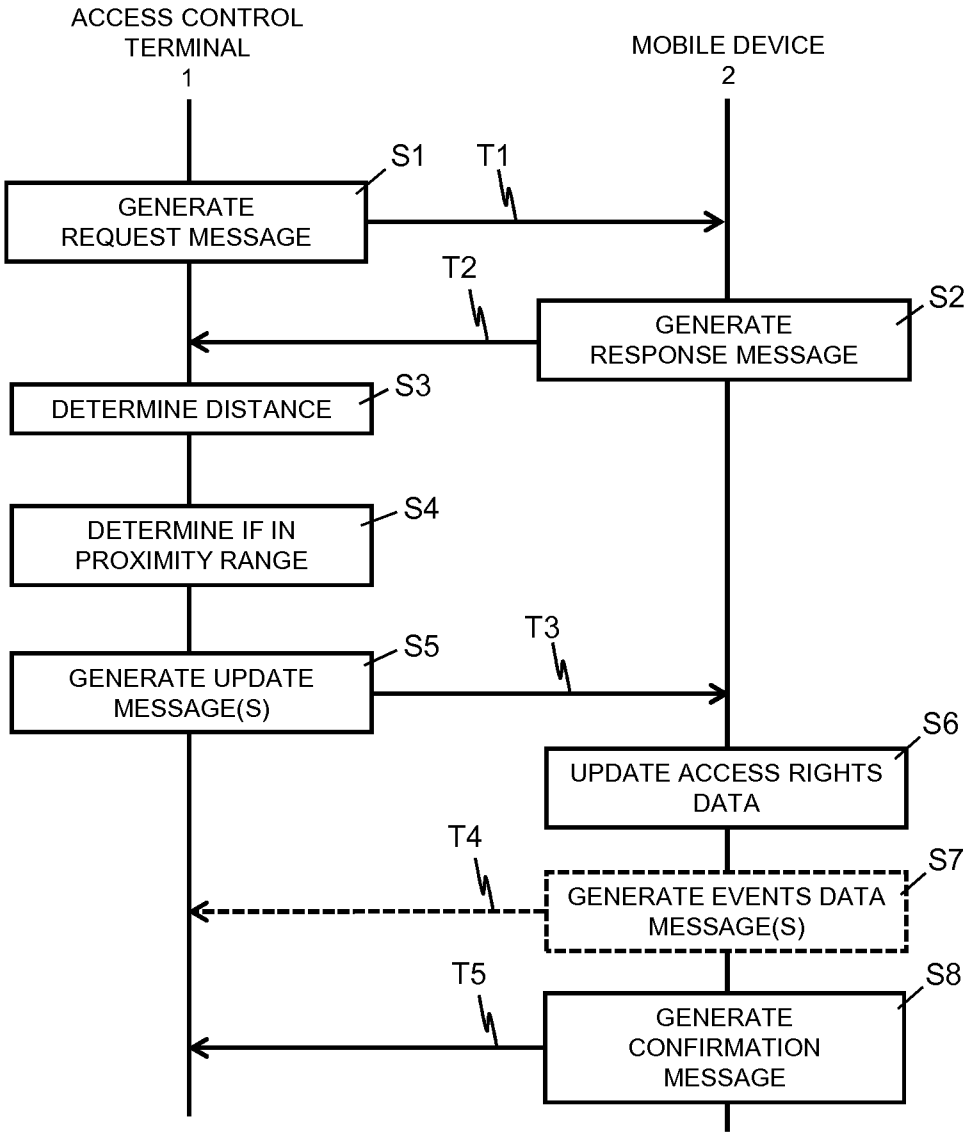
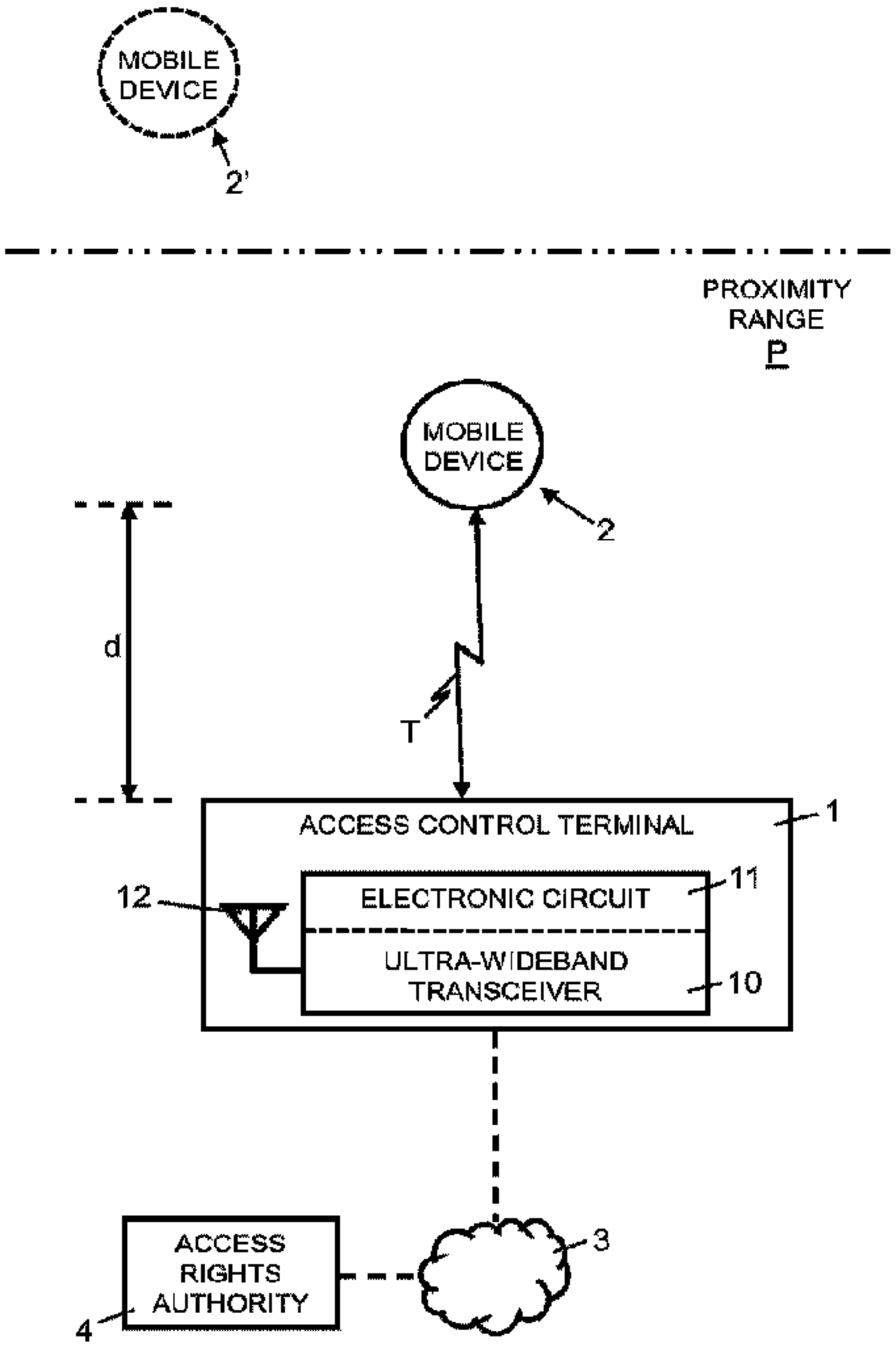

ACCESS CONTROL TERMINAL 1
MOBILE DEVICE 2
S1
T1
GENERATE REQUEST MESSAGE
T2
S2
GENERATE RESPONSE MESSAGE
S3
DETERMINE DISTANCE
S4
DETERMINE IF IN PROXIMITY RANGE
T3
S5
GENERATE UPDATE MESSAGE(S)
S6
UPDATE ACCESS RIGHTS DATA
T4
S7
GENERATE EVENTS DATA MESSAGE(S)
T5
S8
GENERATE CONFIRMATION MESSAGE

Fig. 3


MOBILE DEVICE
2'
PROXIMITY RANGE P
MOBILE DEVICE
2
d
T
ACCESS CONTROL TERMINAL
1
12
ELECTRONIC CIRCUIT
11
ULTRA-WIDEBAND TRANSCEIVER
10
ACCESS RIGHTS AUTHORITY
4
3