

(19)



(11)

EP 3 541 150 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.09.2019 Bulletin 2019/38

(51) Int Cl.:
H05B 37/02 (2006.01)

(21) Application number: **18162216.8**

(22) Date of filing: **16.03.2018**

(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**
 Designated Extension States:
BA ME
 Designated Validation States:
KH MA MD TN

(71) Applicant: **Helvar Oy Ab**
02150 Espoo (FI)

(72) Inventor: **AHOLA, Jukka**
02150 Espoo (FI)

(74) Representative: **Berggren Oy, Helsinki & Oulu**
P.O. Box 16
Eteläinen Rautatiekatu 10A
00101 Helsinki (FI)

(54) **LUMINAIRE DETECTION**

(57) According to an example embodiment, a method for establishing a wireless connection between a mobile device and a desired one of a plurality of luminaires is provided, the method comprising repeatedly transmitting, from each of the plurality of luminaires, respective first device discovery messages, wherein a device discovery message includes a device identifier of the respective luminaire; receiving, in the mobile device from the plurality of luminaires, respective at least one first device discovery message; receiving, via a user interface of the mobile device, a selection of a first luminaire of the plurality of luminaires; transmitting, from the mobile device, at least one second device discovery message that includes a device identifier of the first luminaire and a first command; initiating, in the first luminaire, provision of a selection indication in response to receiving at least one second device discovery message including the device identifier assigned therefor and the first command; and receiving, in the mobile device one of a selection of a second luminaire of the plurality of luminaires or a confirmation of selection of the first luminaire: transmitting, in response to receiving a selection of the second luminaire, at least one further second device discovery message that includes a device identifier of the second selected luminaire and the first command, and establishing, in response to receiving a confirmation of selection of the first luminaire, a wireless connection with the first luminaire for exchange of information between the mobile device and the first luminaire.

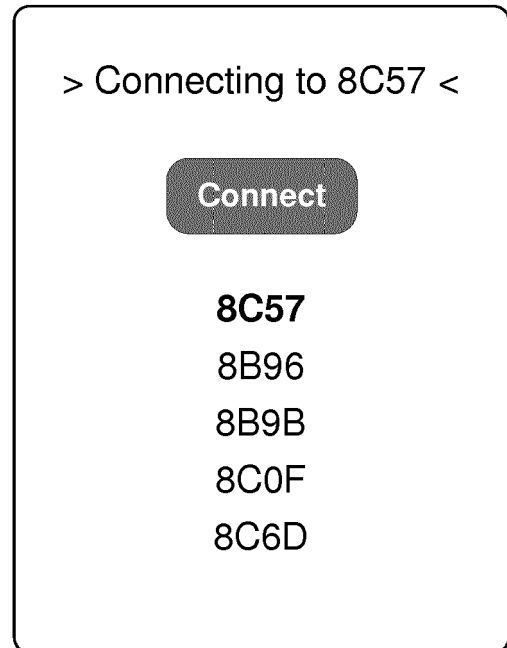


Figure 3A

EP 3 541 150 A1

Description

TECHNICAL FIELD

[0001] The example and non-limiting embodiments of the present invention relate to wirelessly connecting a mobile device to a desired one of a plurality of luminaires for exchanging information that enables monitoring and/or adjusting operational parameters of the desired luminaire via the mobile device.

BACKGROUND

[0002] Many modern luminaires enable monitoring and/or adjustment of at least some of their operational parameters e.g. during installation, during maintenance and/or even during their normal operation. Monitoring and/or adjustment may be carried out via a control unit provided in the luminaire and these operational parameters may include settings related aspects such as light intensity level, dimming behavior, response to sensor signals (such as light sensors and/or presence sensors), color temperature, etc.

[0003] Access to the adjustable parameters of a luminaire may be provided by a mobile device such as a mobile phone that communicates with a control unit of the luminaire over a wireless channel using a suitable short-range wireless technology such as Bluetooth (BT). Such solution may be referred to as remote monitoring and/or adjustment and it involves both the luminaire and the mobile device being provided with suitable transceiver means and control software that enable establishing a wireless connection between the luminaire and the mobile device and making use of the wireless connection to transfer information between the two devices.

[0004] In a practical scenario many spaces are provided with a high number of luminaires, which may impose some challenges in remote monitoring and/or adjustment of luminaire parameters over the wireless link. In particular, in a scenario where a plurality of luminaires are simultaneously within a communication range of the mobile device, establishing the wireless connection with the desired one of the plurality of luminaires is typically not a straightforward task.

[0005] A known solution in this regard involves using the wireless communication means in the mobile device to search for luminaires equipped with respective wireless communication means in its vicinity and establishing a wireless connection with one of the detected luminaires. After having established the wireless connection, the connected luminaire provides an indication in this regard, e.g. by blinking the lights, which in turn enables the user of the mobile device to identify the connected luminaire in his/her vicinity. In case the connected luminaire is the desired one, the user uses the established wireless connection to read and/or adjust parameters of the connected luminaire, whereas in case the connected luminaire is not the desired one, the user disconnects the

luminaire and proceeds into establishing a wireless connection with another one of the detected luminaires. This procedure is repeated in a trial-and-error manner until the desired one of the luminaires has been encountered.

5 **[0006]** The approach outlined above enables finding the desired one among a plurality of luminaires installed in locations that difficult or to reach for visual inspection and/or without need to inspect e.g. identification labels affixed to luminaires. Moreover, this approach also quite
10 apparently enables a fast access to the operating parameters of a single luminaire in a space. On the other hand, in a scenario where there is a plurality of luminaires installed in the space, the above-outlined approach may involve a significant delay in identifying the desired one
15 of the plurality of luminaires using a trial-and-error procedure.

SUMMARY

20 **[0007]** It is an object of the present invention to provide a technique that enables faster identification of a desired one of a plurality of luminaires for remote monitoring and/or adjustment over a wireless connection between a mobile device and the desired luminaire also in a scenario where there is a high number of luminaires within
25 a communication range from the mobile device.

[0008] According to an example embodiment, a method for establishing a wireless connection between a mobile device and a desired one of a plurality of luminaires is provided, the method comprising repeatedly transmitting, from each of the plurality of luminaires, respective
30 first device discovery messages, wherein a device discovery message includes a device identifier of the respective luminaire; receiving, in the mobile device from the plurality of luminaires, respective at least one first
35 device discovery message; receiving, via a user interface of the mobile device, a selection of a first luminaire of the plurality of luminaires; transmitting, from the mobile device, at least one second device discovery message that
40 includes a device identifier of the first luminaire and a first command; initiating, in the first luminaire, provision of a selection indication in response to receiving at least one second device discovery message including the device identifier assigned therefor and the first command;
45 and receiving, in the mobile device one of a selection of a second luminaire of the plurality of luminaires or a confirmation of selection of the first luminaire: transmitting, in response to receiving a selection of the second luminaire, at least one further second device discovery
50 message that includes a device identifier of the second selected luminaire and the first command, and establishing, in response to receiving a confirmation of selection of the first luminaire, a wireless connection with the first luminaire for exchange of information between the mobile
55 device and the first luminaire.

[0009] According to another example embodiment, a lighting system comprising a mobile device and a plurality of luminaires is provided, the lighting system comprising

means for repeatedly transmitting, from each of the plurality of luminaires (110), respective first device discovery messages, wherein a device discovery message includes a device identifier of the respective luminaire; means for receiving, in the mobile device (130) from the plurality of luminaires (110), respective at least one first device discovery message; means for receiving, via a user interface of the mobile device, a selection of a first luminaire of the plurality of luminaires; means for transmitting, from the mobile device, at least one second device discovery message that includes a device identifier of the first luminaire and a first command; means for initiating, in the first luminaire, provision of a selection indication in response to receiving at least one second device discovery message including the device identifier assigned therefor and the first command; means for receiving, in the mobile device one of a selection of a second luminaire of the plurality of luminaires or a confirmation of selection of the first luminaire; means for transmitting, from the mobile device, in response to receiving a selection of the second luminaire, at least one further second device discovery message that includes a device identifier of the second selected luminaire and the first command; and means for establishing, by the mobile device, in response to receiving a confirmation of selection of the first luminaire, a wireless connection with the first luminaire for exchange of information between the mobile device and the first luminaire.

BRIEF DESCRIPTION OF FIGURES

[0010] The embodiments of the invention are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings, where

Figure 1 illustrates a block diagram of some components of a lighting arrangement according to an example;

Figure 2A illustrates a flow chart depicting a method according to an example;

Figure 2B illustrates a flow chart depicting a method according to an example;

Figure 3A illustrates an aspect of a user interface according to an example;

Figure 3B illustrates an aspect of a user interface according to an example;

Figure 3C illustrates an aspect of a user interface according to an example; and

Figure 3D illustrates an aspect of a user interface according to an example;

DESCRIPTION OF SOME EMBODIMENTS

[0011] Figure 1 illustrates a block diagram of some components of a lighting arrangement 100 according to an example. In this regard, Figure 1 depicts luminaires 110-1, 110-2 and 110-N and a mobile device 130. The example of Figure 1 suggests N luminaires, whereas in general the lighting arrangement 100 involves two or more luminaires 110. In the following, an individual luminaire of the one or more luminaires 110 may be referred to as a luminaire 110-n, whereas the two or more luminaires 110 may be collectively referred to as a plurality of luminaires 110 or just as luminaires 110.

[0012] Each luminaire 110-n comprises respective one or more light sources for providing the light output from the luminaire 110-n (i.e. illumination) and a respective control means for managing provision of the operating power to the one or more light sources, for controlling provision of the light output from the luminaire 110-n and for otherwise controlling operation of the luminaire 110-n. The control means may operate on basis of one or more operating parameters that define respective aspects of luminaire operation, which operating parameters are typically set to respective desired values e.g. upon manufacturing the luminaire 110-n or upon installing the luminaire 110-n in its operating environment. The control means may constitute or it may comprise a driver device for operating the one or more light sources of the luminaire 110-n. The light sources and the driver devices are customary components of luminaires known in the art and their operation for control of lighting is well known. Therefore, these aspects of the luminaires 110 are not described herein in detail apart from the aspects of the control means that relate to enabling fast identification of a desired one of the luminaires 110.

[0013] The control means of a luminaire 110-n may comprise or it may be coupled to a wireless communication means 111-n that enables wireless communication with the mobile device 130 using suitable short-range wireless communication technology. The control means of the luminaire 110-n is arranged to control operation of the wireless communication means 111-n to transfer information to and from the mobile device 130. The mobile device 130 includes a wireless communication means 131 that enables wireless communication with the one or more luminaires 110 using the same short-range wireless communication technology. A control means in the mobile device 130 is arranged to control operation of the wireless communication means 131 to transfer information to and from the one or more luminaires 110. Examples of some components of the respective control means in the luminaire 110-n and in the mobile device 130 are provided later in this disclosure.

[0014] According to an example, the wireless communication means 111-n and the wireless communication means 131 are arranged to employ Bluetooth Low Energy (BLE) protocol to enable the short-range wireless communication with each other. While the BLE protocol

serves as a non-limiting example of an applicable short-range wireless communication protocol, it is used in the following as an example in this regard for clarity and brevity of description.

[0015] The luminaires 110 may be provided as independent luminaires that operate autonomously without external control (apart from supply of operating power) and they are typically not connected to each other or to an external control entity e.g. via a lighting control network. In such a scenario, a luminaire 110-n may be provided with one or more light sensors and/or one or more proximity sensors that are arranged to provide respective sensor signals to the control means of the luminaire 110-n, which control means is arranged to adjust the light output from the luminaire 110-n in dependence of the received sensor signal(s) in accordance with (respective values of) the one or more operating parameters of the luminaire 110-n. For such an independent luminaire, the wireless communication means 111-n may be the only way to access the operating parameters of the luminaire 110-n.

[0016] In an example, the luminaire 110-n is provided as a self-learning (or self-adapting) luminaire that is able to autonomously adjust at least one of its operating parameters in the course of its operation e.g. via observed movement patterns in the space the luminaire 110-n is installed. Moreover, such a self-learning luminaire may employ the wireless communication means 111-n to connect to one or more other luminaires in its vicinity (e.g. by forming a mesh network with the one or more other luminaires) e.g. to transmit sensor data to one or more other luminaires and/or to receive corresponding sensor data from the one or more other luminaires, where the sensor data may comprise e.g. sensor signal(s) and/or information extracted therefrom at the respective luminaire. The control means 111-n of the self-learning luminaire may employ the received sensor data as further input for adjusting its operating parameter(s).

[0017] The control means in the luminaires 110 and in control means in the mobile device 130 are arranged to carry out a procedure for establishing a wireless connection between the mobile device and a desired one of the plurality of luminaires 110 in the framework of the lighting arrangement 100. In this regard, such connection establishment procedure considers the luminaires 110 that are within the operating range of the wireless communication means 131 of the mobile device 130. Such an arrangement of luminaires 110 may include, for example, a plurality of luminaires 110 installed in a single space (e.g. a single room) or a plurality of luminaires 110 installed in two or more separate spaces (e.g. two or more rooms that are adjacent or otherwise close to each other).

[0018] In the following, operation of components of the lighting arrangement 100 for providing the procedure for wirelessly connecting the mobile device 130 to a desired one of the plurality of luminaires 110 is described via a number of non-limiting examples. The description in this regard is provided with references to methods 200a and

200b that are illustrated by respective flowcharts depicted in Figures 2A and 2B. The method 200a may be carried out in the user device 130 and the method 200b may be carried out in each of the luminaires 110.

[0019] The method 200b proceeds from the luminaires 110 using the respective wireless communication means 111-n to repeatedly transmit first device discovery messages, as indicated in block 222. The method 200a commences from the mobile device 130 receiving, via the wireless communication means 131, respective at least one first device discovery message from the plurality of luminaires 110, as indicated in block 202.

[0020] The repeated transmission of the first discovery messages may be provided by arranging a luminaire 110-n to continually transmit the first device discovery messages according to a predefined pattern, e.g. at regular or substantially regular predefined intervals. The luminaire 110-m may be arranged to autonomously transmit the first device discovery messages without an explicit command in this regard, e.g. such that the first device discovery messages are transmitted according to the predefined pattern when the luminaire 110-n is in receipt of operating power.

[0021] The first device discovery messages transmitted from a luminaire 110-n carry at least a device identifier assigned for the luminaire 110-n. The device identifier serves to uniquely identify the luminaire 110-n in the framework of the lighting arrangement 100. In an example, the device identifier comprises a (permanent) address assigned for the luminaire 110-n. In other examples, the device identifier may comprise, for example, a name assigned for the luminaire 110-n or a serial number assigned for the luminaire 110-n. The first device discovery messages may comprise a header part and a payload part, and the device identifier may be carried in the header part of the first device discovery message, in the payload part of the first device discovery message, or both in the header part and the payload part of the first device discovery message.

[0022] The first device discovery messages from the luminaire 110-n may include further identifiers assigned for the luminaire 110-n, such as one or more of a device type identifier, a service identifier, a vendor identifier. The further identifier(s), if included in a device discovery message, are carried in the payload part of the first device discovery message. One or more such further identifiers may enable the mobile device 130 that receives the first device discovery messages to classify or 'filter' the discovered devices. As an example in this regard, a certain predefined value of a device type identifier may be applied to indicate that the source of the first device discovery message is a luminaire (and not e.g. another mobile device).

[0023] The first device discovery messages transmitted from the luminaire 110-n serve as an indication that the luminaire 110-n is connectable by other devices, in other words they indicate that the luminaire 110-n accepts connection requests from other devices. In this re-

gard, the header part of the first device discovery messages may include an indication regarding the connectable status of the luminaire 110-n.

[0024] As an example of the first device discovery messages transmitted from the luminaire 110-n by the wireless communication means 111-n, the first device discovery messages may comprise BLE advertising messages. In this regard, the BLE advertising messages may be provided e.g. as ADV_IND protocol data units (PDUs), where the AdvA field or the AdvData field of the payload is employed to carry at least the device identifier assigned to the luminaire 110-n.

[0025] The operations described with references to blocks 222 and 202 that involve the mobile device 130 receiving respective first device discovery messages from the plurality of luminaires 110 and thereby obtaining respective device identifiers result in the mobile device 130 detecting the plurality of luminaires that are within the operating range of the wireless communication means 131 of the mobile device 130.

[0026] From block 202 the method 200a proceeds into receiving a selection of one of the detected luminaires 110, as indicated block 204. The selection may be received, for example, via a user interface of the mobile device 130, in response to a user selecting one of the luminaires 110 from a list of device identifiers displayed to him/her via the user interface of the mobile device 130. The selection aspect will be described via more detailed examples later in this disclosure. In the following, the selected luminaire is referred to as a first selected luminaire 110-k.

[0027] Receiving the selection of one of the detected luminaires 110 results in the method 200a proceeding into the mobile device 130 using the wireless communication means 131 to transmit at least one second device discovery message that comprises at least the device identifier assigned to the first selected luminaire 110-k and a first command, as indicated in block 206, thereby addressing the first command to the first selected luminaire 110-k. The method 200b proceeds into the first selected luminaire 110-k receiving, by the wireless communication means 110-k, at least one second device discovery message that comprises the device identifier assigned for the first selected luminaire 110-k and the first command, as indicated in block 224.

[0028] The second device discovery messages transmitted from the mobile device 130 may comprise a header part and a payload part, and the device identifier of the first selected luminaire 110-k and the first command are carried in the payload part. The header part, the payload part or both the header part and payload part of the second device discovery messages may further carry a device identifier assigned for the user device 130, which device identifier may uniquely identify the user device 130 in the framework of the lighting arrangement 100. In an example, the device identifier assigned for the user device 130 comprises a (permanent) address assigned for the user device 130. In other examples, the device

identifier assigned for the user device 130 may comprise, for example, a name assigned for the user device 130 or a serial number assigned for the user device 130.

[0029] The second device discovery messages transmitted from the user device 130 serve to convey the device identifier of the first selected luminaire 110-k and the first command, while they may at the same time serve as an indication that the user device 130 is not connectable by other devices. In other words, the second device discovery messages may indicate that the user device 130 is non-connectable and hence it does not respond to connection requests from other devices. In this regard, the header part of the second device discovery messages may include an indication regarding the non-connectable status of the user device 130.

[0030] As an example of the second device discovery messages transmitted from the user device 130 by the wireless communication means 131, the second device discovery messages may comprise BLE advertising messages. In this regard, the BLE advertising messages may be provided e.g. as ADV_NONCONN_IND PDUs, where the AdvData field of the payload is employed to carry at least the device identifier assigned to the first selected luminaire 110-k and the first command.

[0031] The first command may comprise a first predefined bit pattern that, when received by a luminaire 110-n identified in the second device discovery message, triggers the luminaire 110-n to initiate provision of a selection indication. Hence, the first selected luminaire 110-k initiates provision of a selection indication in response to receiving the at least one second device discovery message that comprises the device identifier assigned for the first selected luminaire 110-k and the first command, as indicated in block 226. The selection indication serves a prompt to the user of the mobile device 130 for identification of the first selected luminaire 110-k in his/her physical environment. The predefined indication is preferably a visual indication. In an example, the selection indication involves changing the light output of the first selected luminaire 110-k in a predefined manner, e.g. by providing the light at a predefined intensity level or changing the light intensity level according to a predefined pattern (e.g. to cause blinking of the light output).

[0032] Also other luminaires 110 may receive the second device discovery message(s) transmitted from the user device 130. However, only the first selected luminaire 110-k whose device identifier is included in the second device discovery message(s) reacts by initiating provision of the selection indication. In an example, the first selected luminaire 110-k discontinues provision of the selection in response to receiving a third device discovery message that comprises the device identifier assigned for the first selected luminaire 110-k and a second command (described later in this disclosure). In another example, the first selected luminaire 110-k discontinues provision of the selection indication in response to receiving a third device discovery message that comprises a device identifier that is not assigned for the first selected

luminaire 110-k (but is assigned, for example, to another one of the luminaires 110) and the first command. In a further example, the first selected luminaire 110-k terminates provision of the selection indication after a predefined period of time.

[0033] Referring back to the method 200a, the selection of one of the detected luminaires 110 in the mobile device 130 further results in the mobile device 130 initiating connection establishment with the selected luminaire 110-k, as indicated in block 208. The initiation of connection establishment may involve, for example, the user device 130 using the wireless communication means 131 to respond to the first device discovery messages received from the first selected luminaire 110-k by transmitting one or more device discovery response messages and/or connection request messages addressed to the first selected luminaire 110-k. In parallel, in the course of the method 200b, the first selected luminaire 110-k initiates the connection establishment with the mobile device 130 in response to the device discovery response messages and/or connection request messages received from the user device, as indicated in block 228.

[0034] The user of the mobile device 130 observes his/her environment and verifies whether the first selected luminaire 110-k that is currently providing the selection indication (e.g. via changing its light output in the predefined manner, such as by blinking the lights) is the desired one. This action by the user does not form a part of the method 200a but rather serves as an event that may lead to the user operating the user device 130 to control the method 200a to proceed into one of the following:

- The method 200a may involve receiving a selection of a second one of the detected luminaires 110, as indicated in block 210a. The selection of the second one of the detected luminaires 110 may be received via the user interface of the mobile device 130. In the following, the luminaire selected via operations of block 210a is referred to as a second selected luminaire 110-m. The method 200a may proceed into operations of block 210a in response to the user determining that the first selected luminaire 110-k is not the desired one and, consequently, entering selection of the second selected luminaire 110-m via the user interface of the mobile device 130.
- The method 200a may involve receiving a confirmation of selection of the first selected luminaire 110-k, as indicated in block 210b. The confirmation may be received via the user interface of the mobile device 130. The method 200a may proceed into operations of block 210b in response to the user determining that the first selected luminaire 110-k is the desired one and, consequently, entering confirmation of selection of the first selected luminaire 110-k via the user interface of the mobile device 130.

[0035] Referring now to the method 200b, the process may proceed from block 228 either to the first selected

luminaire 110-k detecting the mobile device 130 having selected another one of the luminaires 110, as indicated in block 230, or the process may proceed into the first selected luminaire 110-k completing the connection establishment with the mobile device 130 to enable transfer of data therebetween.

[0036] In case of receiving a selection of another one of the detected luminaires 110 (block 210a), the method 200a proceeds into terminating the connection to the first selected luminaire 110-k, as indicated in block 212. In case the connection establishment is not yet completed, the operation of block 212 involves terminating the connection establishment with the first selected luminaire 110-k. Moreover, the mobile device 130 may also proceed into using the wireless communication means 131 to transmit at least one third device discovery message that comprises at least the device identifier assigned to the first selected luminaire 110-k and the second command, as indicated in block 214. The second command may comprise a second predefined bit pattern that, when received by a luminaire 110-n identified in the second device discovery message, triggers the luminaire 110-n to terminate or discontinue provision of the selection indication. From block 214, the operation of the method 200a returns to block 206 for transmission of at least one further second device discovery message that now comprises at least the device identifier assigned to the second selected luminaire 110-m and the first command.

[0037] In the first selected luminaire 110-k, detection of the mobile device 130 having selected another one of the luminaires 110 (block 230) results in the first selected luminaire 110-k terminating the provision of the selection indication, as indicated in block 232. Moreover, the first selected luminaire 110-k may terminate the connection to the mobile device 130, as indicated in block 234, if the connection has been already established and it is not yet terminated by the mobile device 130 (cf. block 212).

[0038] As an example of the third device discovery messages transmitted from the user device 130 by the wireless communication means 131, the third device discovery messages may comprise BLE advertising messages. In this regard, the BLE advertising messages may be provided e.g. as ADV_NONCONN_IND PDUs, where the AdvData field of the payload is employed to carry at least the device identifier assigned to the first selected luminaire 110-k and the second command.

[0039] In a variation of operation of the methods 200a and 200b, transmission of the at least one third device discovery message that comprises at least the device identifier assigned to the first selected luminaire 110-k and the second command (cf. block 214) may be omitted and the method 200a may directly proceed into transmission of the at least one further second device discovery message that comprises at least the device identifier assigned to the second selected luminaire 110-m and the first command (block 206). In such a variation, the first selected luminaire 110-k may consider termination of the connection or termination of the connection estab-

ishment by the mobile device 130 (cf. block 212) as an indication of the mobile device 130 having selected another one of the luminaires 110 (cf. block 230), which results in termination of provision of the selection indication (cf. block 232). Alternatively, since also the first selected luminaire 110-k typically receives the further second device discovery message(s) addressing the first command to the second selected luminaire 110-m, it may consider the first command addressed to the second selected luminaire 110-m as an indication of the mobile device 130 having selected another one of the luminaires 110 (cf. block 230), which results in termination of provision of the selection indication (cf. block 232).

[0040] In case of receiving a confirmation of selection of the first selected luminaire (block 210b), if the connection establishment with the first selected luminaire 110-k is not yet completed, the method 200a proceeds into completing the connection establishment with the first selected luminaire 110-k, as indicated in block 216. Furthermore, the mobile device 130 also proceeds into exchanging information with the first selected luminaire 110-k via the established connection. The exchange of information may involve, for example, reading values of operating parameters from the first selected luminaire 110-k and/or adjusting values of operating parameters in the first selected luminaire 110-k. When the exchange of information with the first selected luminaire 110-k is completed, the mobile device 130 may terminate the connection to the first selected luminaire 110-k.

[0041] In the method 200b, the first selected luminaire 110-k completes the connection establishment with the mobile device 130 (if not yet completed), as indicated in block 236, and proceeds into exchanging information with the mobile device 130, as indicated in block 238. In an example, the first selected luminaire 110-m terminates provision of the selection indication in response to the mobile device 130 terminating the connection thereto. In another example, the mobile device 130 may further transmit at least one third device discovery message that comprises at least the device identifier assigned to the first selected luminaire 110-k and the second command, reception of which results in the first selected luminaire 110-k terminating provision of the selection indication.

[0042] In an exemplifying variation of the method 200a and 200b, the initiation of the connection establishment between the mobile device 130 and the first selected luminaire 110-k described with references to blocks 208 and 228 is omitted and the wireless connection between the mobile device 130 and the first selected luminaire 110-k is initiated and carried out after having received the confirmation of selection of the first selected luminaire 110-k (cf. block 210b), for example in context of operations pertaining to blocks 216 and 236 of the methods 200a and 200b, respectively. While this variation may introduce an additional delay in the user device 130 establishing the wireless connection with the desired one of the luminaires 110, especially in a scenario where multiple luminaires are tried before encountering the desired

one, it has the benefit of conserving operating power by avoiding connection establishment operations before having confirmed the selection of the desired one of the luminaires 110.

[0043] Referring back to block 204 in the method 200a, the mobile device 130 may arrange the device identifiers received from the detected luminaires 110 into a list of device identifiers and display the list of device identifiers for the user via the user interface of the mobile device 130. The user interface may further provide the user with a possibility to select, on basis of the list displayed to him/her, a desired one of the detected luminaires 110. Consequently, the user-selection results in the mobile device 130 receiving the selection of one of the detected luminaires in accordance with block 204.

[0044] In an example, the device identifiers are arranged in the list in a decreasing order of received signal strength indication (RSSI) computed therefor. In this regard, the mobile device 130 may compute a RSSI value for a luminaire 110-n on basis of respective radio signal carrying one or more first device discovery messages received from the luminaire 110-n. Hence, the RSSI for the luminaire 110-n may be computed, for example, as the average RSSI of the piece of radio signal carrying a single first device discovery message originating from the luminaire 110-n or as the average RSSI of the respective pieces of radio signal that carry two or more device discovery messages originating from the luminaire 110-n. Since luminaires 110 that have their wireless communication means 111 closest to the mobile device 110 are likely to yield the highest RSSI values, such ordering of the device identifiers in the list typically places the luminaires 110 that are closest to the mobile device among the first ones on the list. Consequently, the user may be able to make use of the ordering of the luminaires 110 in the list as a hint towards promptly finding the desired one of the luminaires 110.

[0045] Figure 3A schematically illustrates an example of the user interface (UI) that enables the user selecting a luminaire among the detected luminaires 110. The list of device identifiers is shown as the bottom part of the UI, comprising respective device identifiers of five detected luminaires 110 ("8C57", "8B96", "8B9B", "8C0F", "8C6D"). The device identifier in the top of the list ("8C57") is shown in bold text, indicating that the user has provisionally selected this luminaire 110 from the list. The top part of the UI shows a status indication ("> Connecting to 8C57 <") that serves as an indication that the user has also entered selection of the first selected luminaire 110-k via operating the button in the middle part of the UI (with the label "Connect") and that the mobile device has initiated the operations described in blocks 206 and 208, i. e. transmitted the at least one device discovery message that includes the device identifier of the first selected luminaire 110-k (in this example "8C57") and the first command and initiated connection establishment with the first selected luminaire 110-k.

[0046] Figure 3B schematically illustrates an example

of the user interface (UI) that reflects a later stage in a procedure according to the method 200a, where the user has operated the button in the middle of the UI (with the label "Select") to confirm selection of the first selected luminaire 110-k and the connection between the mobile device 130 and the first selected luminaire 110-k has been established (cf. block 236). Consequently, the procedure according to the method 200a may continue to exchange of information between the two connected devices in accordance with block 238.

[0047] Figures 3C and 3D schematically illustrate further examples of the UI aspect in the mobile device 130. In the example of Figure 3C the procedure according to the method 200a has proceeded to the user provisionally selecting the second device identifier in the list ("8B96") that is shown in bold text, with the top part of the UI showing a status indication ("> Connecting to 8B96 <") that serves as an indication that the user has also entered selection of the second selected luminaire 110-m via operating the "Connect" button in the middle part of the UI and that the mobile device 130 has re-initiated the operations described in blocks 206 and 208, i.e. has transmitted the at least one second device discovery message that includes the device identifier of the second selected luminaire 110-m (in this example "8B96") and the first command, and initiated connection establishment with the second selected luminaire 110-m. In the example of Figure 3D the procedure according to the method 200a has proceeded to the user having confirmed selection of the second selected luminaire 110-m, and the connection between the mobile device 130 and the second selected luminaire 110-m has been established (cf. block 236).

[0048] The approach described in the foregoing with a number examples that refer to one or more components of a lighting arrangement 100 and/or to the methods 200a and/or 200b enable using the mobile device 130 for fast identification of a desired one of the luminaires 110 to enable exchange of information between the mobile device and the desired one of the luminaires 110 also in a scenario where there is a relatively high number of luminaires in relatively small space. Moreover, the approach described in this disclosure also enables fast and convenient mapping of positions of the luminaires 110 on a floorplan or other presentation of the space(s) in which the luminaires 110 are installed via the device identifiers received in the first device discovery messages transmitting from each of the plurality of luminaires 110.

[0049] The control means in the mobile device 130 may be provided, for example, by a processor and a program code stored in a memory, where the program code is arranged to cause the mobile device 130 to implement operations described in the foregoing by various examples that refer to the method 200a when the program code executed by the processor. The mobile device 130 may comprise, for example, a general purpose mobile device such as a mobile phone, a tablet computer, a laptop computer, etc. arranged to carry out the operations described via examples provided in the foregoing. In another ex-

ample, the mobile device 130 may comprise a special-purpose device that serves as a 'remote controller' for monitoring and/or adjusting operating parameters of the luminaires 110.

[0050] The control means in the luminaire 110-n may be provided, for example, by a processor and a program code stored in a memory, where the program code is arranged to cause the luminaire 110-n to implement operations described in the foregoing by various examples that refer to the method 200b when the program code executed by the processor. As an example, such control means may be provided as part of the driver device of the luminaire 110-n.

[0051] In the present disclosure, although functions have been described with reference to certain features, those functions may be performable by other features whether described or not. Although features have been described with reference to certain embodiments, those features may also be present in other embodiments whether described or not.

Claims

1. A method for establishing a wireless connection between a mobile device (130) and a desired one of a plurality of luminaires (110), the method comprising repeatedly transmitting, from each of the plurality of luminaires (110), respective first device discovery messages, wherein a device discovery message includes a device identifier of the respective luminaire (110-n); receiving, in the mobile device (130) from the plurality of luminaires (110), respective at least one first device discovery message; receiving, via a user interface of the mobile device (130), a selection of a first luminaire (110-k) of the plurality of luminaires (110); transmitting, from the mobile device (130), at least one second device discovery message that includes a device identifier of the first luminaire (110-k) and a first command; initiating, in the first luminaire (110-k), provision of a selection indication in response to receiving at least one second device discovery message including the device identifier assigned therefor and the first command; and receiving, via the user interface of the mobile device (130) one of a selection of a second luminaire (110-m) of the plurality of luminaires (110) or a confirmation of selection of the first luminaire (110-k):

transmitting, in response to receiving a selection of the second luminaire (110-m), at least one further second device discovery message that includes a device identifier of the second selected luminaire (110-m) and the first command, and establishing, in response to receiving a confir-

- mation of selection of the first luminaire (110-k), a wireless connection with the first luminaire (110-k) for exchange of information between the mobile device (130) and the first luminaire (110-k).
2. A method according to claim 1, further comprising initiating, by the mobile device (130), establishment of a wireless connection with the first luminaire (110-k) in response to receiving the selection of a first luminaire (110-k); and terminating, by the mobile device (130), the establishment of a wireless connection with the first luminaire (110-k) in response to receiving a selection of the second luminaire (110-m).
 3. A method according to claim 1, further comprising initiating, by the mobile device (130), establishment of a wireless connection with the first luminaire (110-k) in response to receiving a confirmation of selection of the first luminaire (110-k).
 4. A method according to any of claims 1 to 3, further comprising terminating, in the first luminaire (110-k), provision of the selection indication in response to receiving at least one further second device discovery message including the device identifier not assigned therefor and the first command.
 5. A method according to any of claims 1 to 3, further comprising transmitting, from the mobile device (130) in response to receiving a selection of the second luminaire (110-m), at least one third device discovery message that includes the device identifier of the first luminaire (110-k) and a second command; and terminating, in the first luminaire (110-k), provision of the selection indication in response to receiving at least one third device discovery message including the device identifier assigned therefor and the second command.
 6. A method according to any of claims 1 to 5, further comprising, exchanging, in response to receiving a confirmation of selection of the first luminaire (110-k), information between the mobile device (130) and the first luminaire (110-k) via the established wireless connection.
 7. A method according to any of claims 1 to 6, wherein receiving a selection of a first luminaire (110-k) and receiving a selection of a second luminaire comprises computing, in the mobile device (130), for each of the plurality of luminaires (110), a respective received signal strength indicator (RSSI) on basis of radio signals that carry at least one first device discovery message received from the respective luminaire (110-n); displaying, via the user interface of the mobile device (130), a list of device identifiers arranged in a descending order of RSSIs computed for the respective luminaires (110); and receiving the selection of the first luminaire (110-k) or the second luminaire (110-m) via the user interface of the mobile device (130).
 8. A method according to any of claims 1 to 7, wherein the selection indication comprises changing the light output from the first luminaire (110-k) in a predefined manner.
 9. A method according to any of claims 1 to 8, wherein said first device discovery messages comprise device discovery messages that indicate connectable status of the luminaire (110-n) transmitting said message; said second device discovery messages and further second device discovery messages comprise respective device discovery messages that indicate non-connectable status of the mobile device (130).
 10. A method according to any of claims 1 to 9, wherein said device discovery messages comprise Bluetooth Low Energy (BLE) advertising messages, wherein said first device discovery messages comprise BLE ADV_IND protocol data units (PDU); and said second device discovery messages and further second device discovery messages comprise BLE ADV_NONCONN_IND PDUs.
 11. A method according to any of claims 1 to 10, wherein said device discovery messages comprise a header part and a payload part, and wherein the device identification and the first and/or second command is included in the payload part.
 12. A system comprising a mobile device (130) and a plurality of luminaires (110), the system comprising means for repeatedly transmitting, from each of the plurality of luminaires (110), respective first device discovery messages, wherein a device discovery message includes a device identifier of the respective luminaire (110-n); means for receiving, in the mobile device (130) from the plurality of luminaires (110), respective at least one first device discovery message; means for receiving, via a user interface of the mobile device (130), a selection of a first luminaire (110-k) of the plurality of luminaires (110); means for transmitting, from the mobile device (130), at least one second device discovery message that includes a device identifier of the first luminaire (110-k) and a first command;

means for initiating, in the first luminaire (110-k), provision of a selection indication in response to receiving at least one second device discovery message including the device identifier assigned therefor and the first command; 5

means for receiving, via the user interface of the mobile device (130) one of a selection of a second luminaire (110-m) of the plurality of luminaires (110) or a confirmation of selection of the first luminaire (110-k); 10

means for transmitting, from the mobile device (130), in response to receiving a selection of the second luminaire (110-m), at least one further second device discovery message that includes a device identifier of the second selected luminaire (110-m) and the first command; and 15

means for establishing, by the mobile device (130), in response to receiving a confirmation of selection of the first luminaire (110-k), a wireless connection with the first luminaire (110-k) for exchange of information between the mobile device (130) and the first luminaire (110-k). 20

13. A system according to claim 12, further comprising means for initiating, by the mobile device (130), establishment of a wireless connection with the first luminaire (110-k) in response to receiving the selection of a first luminaire (110-k); and 25

means for terminating, by the mobile device (130), the establishment of a wireless connection with the first luminaire (110-k) in response to receiving a selection of the second luminaire (110-m). 30

14. A system according to claim 12, further comprising means for initiating, by the mobile device (130), establishment of a wireless connection with the first luminaire (110-k) in response to receiving a confirmation of selection of the first luminaire (110-k). 35

15. A system according to any of claims 12 to 14, wherein said device discovery messages comprise Bluetooth Low Energy (BLE) advertising messages, wherein said first device discovery messages comprise BLE ADV_IND protocol data units (PDU); and 40
said second device discovery messages and further second device discovery messages comprise BLE ADV_NONCONN_IND PDUs. 45

50

55

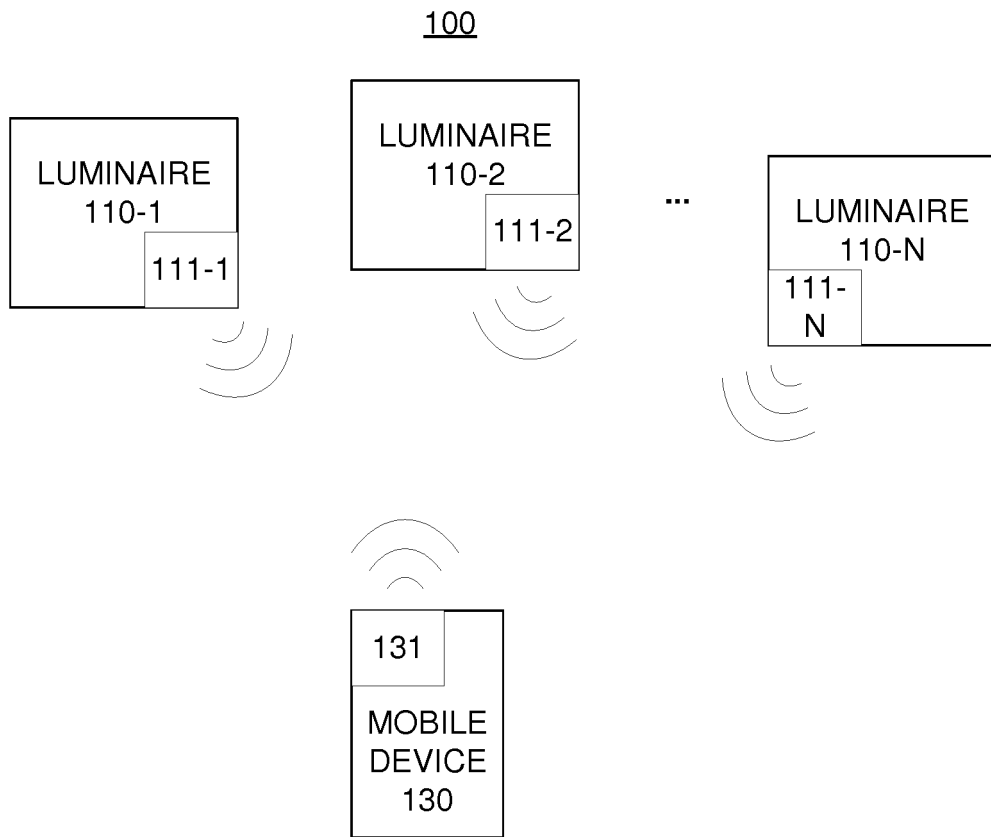


Figure 1

200a

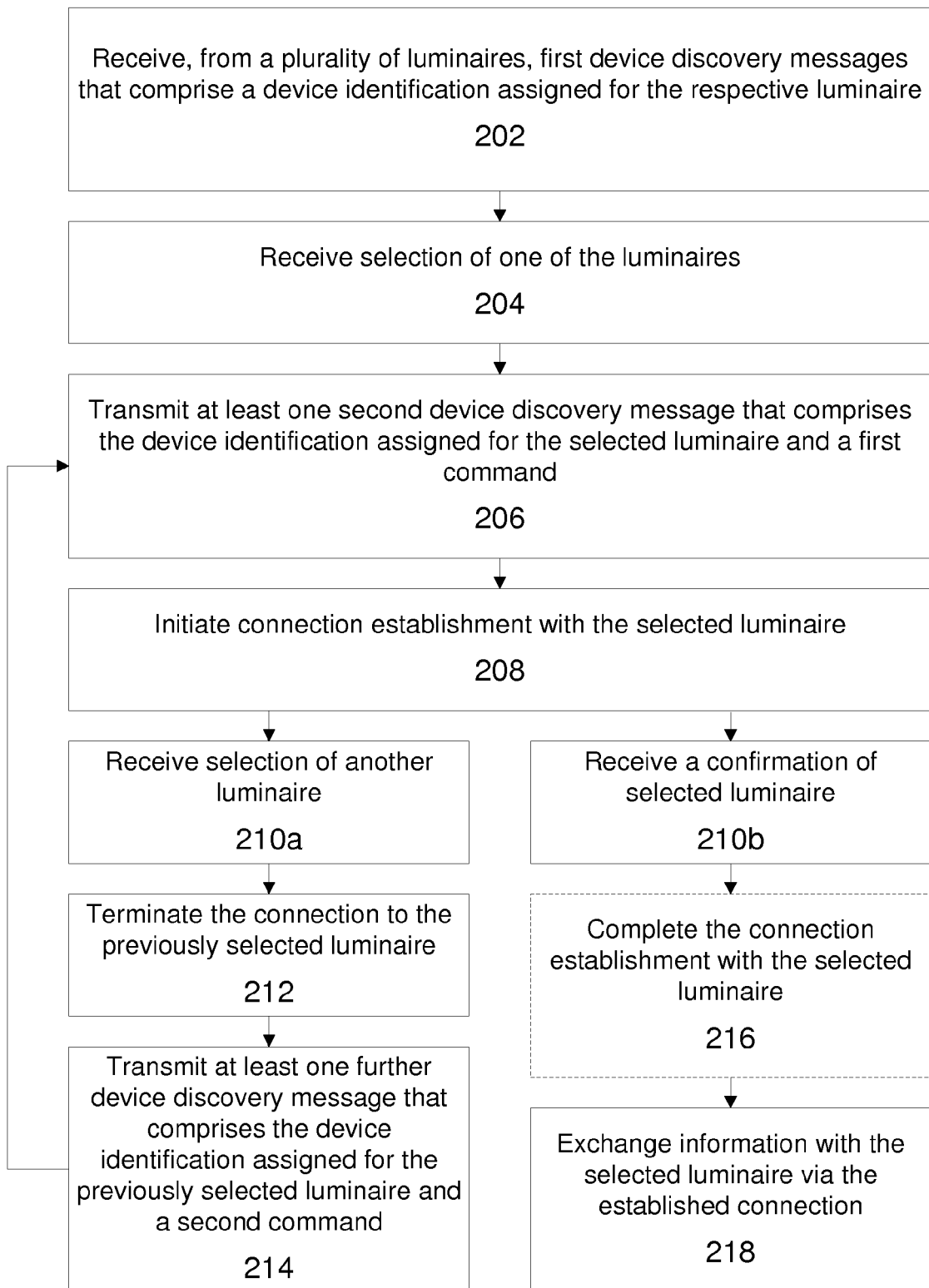


Figure 2A

200b

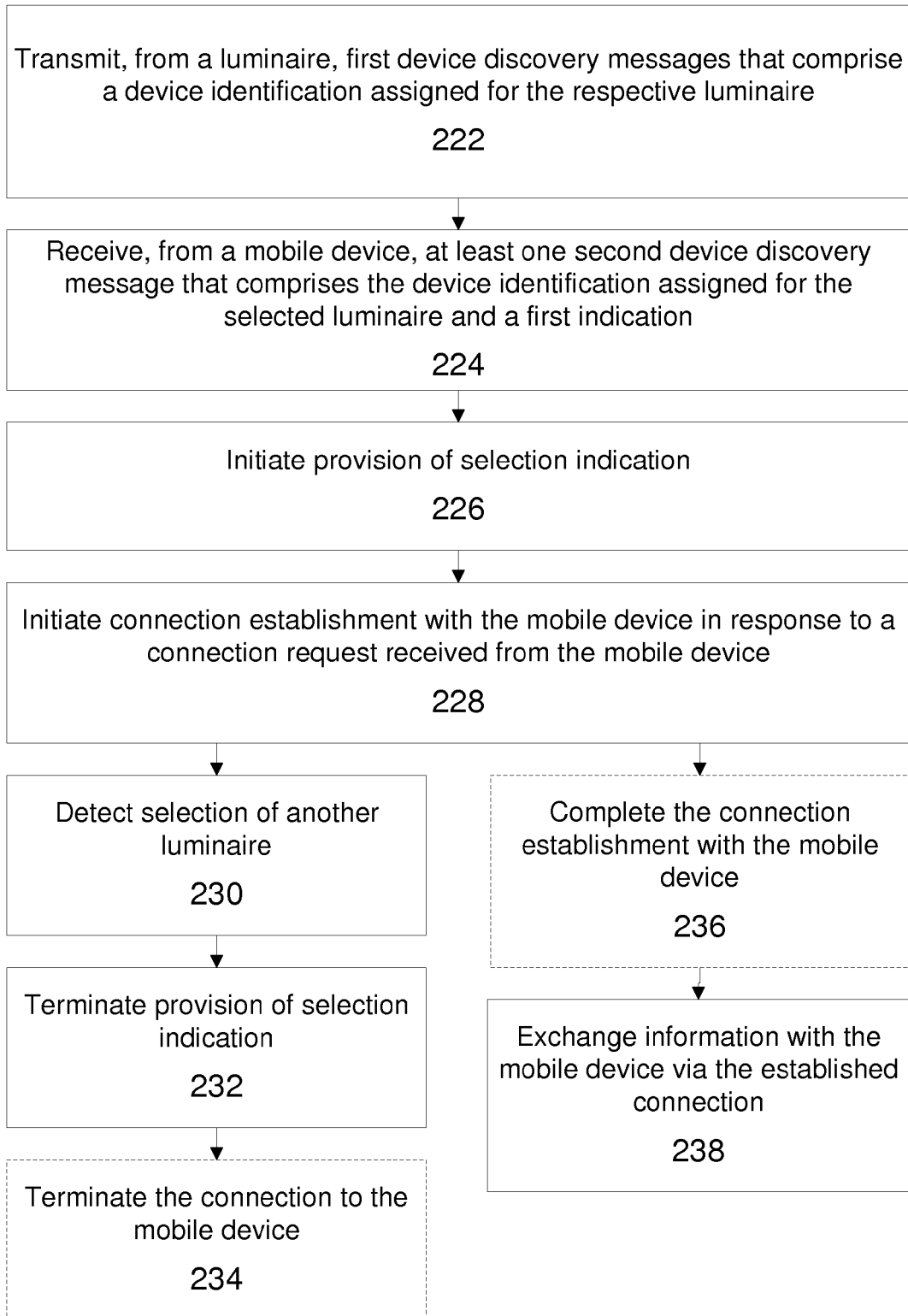


Figure 2B

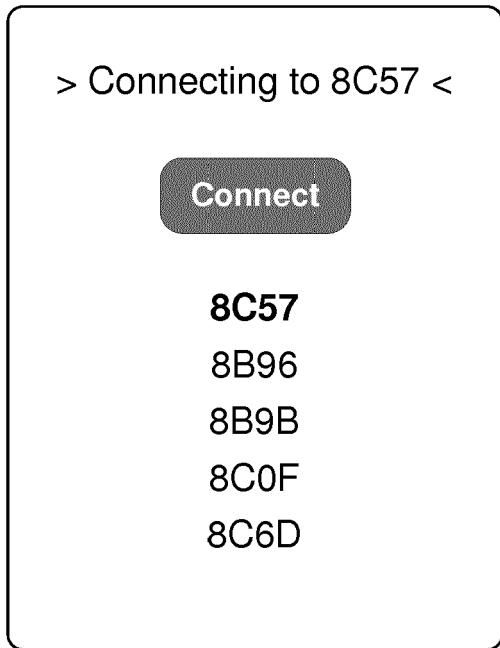


Figure 3A

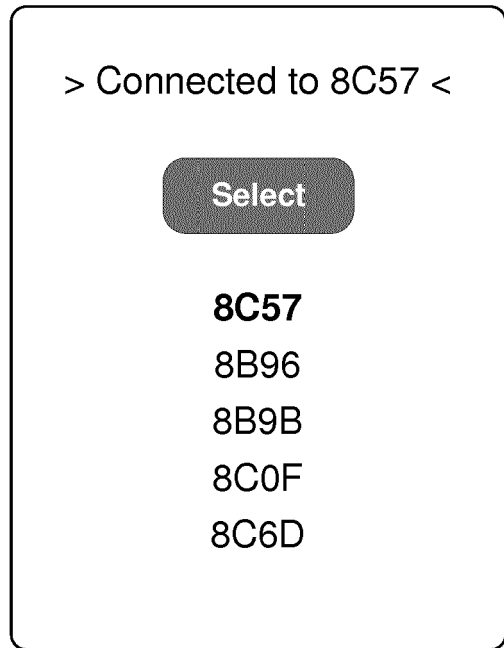


Figure 3B

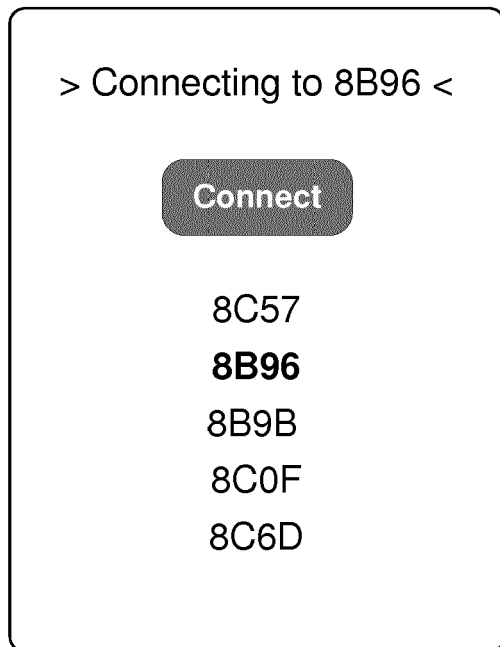


Figure 3C

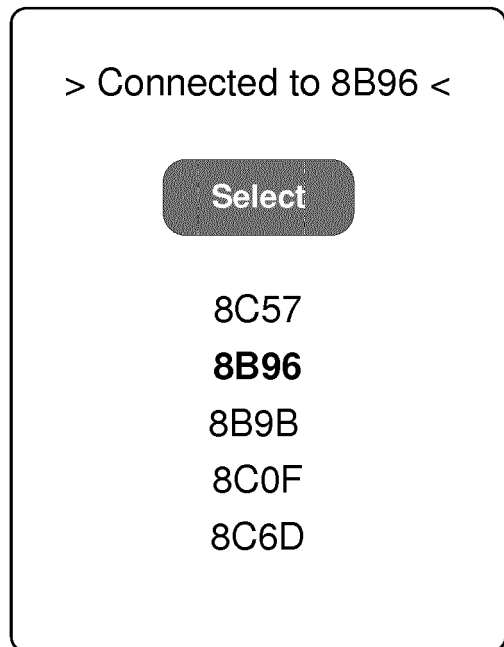


Figure 3D



EUROPEAN SEARCH REPORT

Application Number
EP 18 16 2216

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2017/123390 A1 (BARCO KYLE THOMAS [US] ET AL) 4 May 2017 (2017-05-04) * paragraph [0169] - paragraph [0184]; figures fig. 8A-8I *	1-8, 12-14	INV. H05B37/02
X	US 2016/278006 A1 (LEE MINSOO [KR] ET AL) 22 September 2016 (2016-09-22) * paragraph [0117] - paragraph [020182]; figures 2-7 *	1,9-12, 15	
X	US 2011/140864 A1 (BUCCI GEORGE [US]) 16 June 2011 (2011-06-16) * paragraph [0219] - paragraph [0226]; figure 9 *	1,12	
			TECHNICAL FIELDS SEARCHED (IPC)
			H05B H04W H04L
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 September 2018	Examiner Beaugrand, Francois
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04/C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 18 16 2216

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

10-09-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2017123390 A1	04-05-2017	CA 3003146 A1	04-05-2017
		CN 108476575 A	31-08-2018
		EP 3369291 A2	05-09-2018
		US 2017123390 A1	04-05-2017
		WO 2017075542 A2	04-05-2017

US 2016278006 A1	22-09-2016	US 2016278006 A1	22-09-2016
		WO 2015068988 A1	14-05-2015

US 2011140864 A1	16-06-2011	CA 2725242 A1	16-06-2011
		US 2011140864 A1	16-06-2011
		US 2014043147 A1	13-02-2014
		US 2014256263 A1	11-09-2014
		US 2016037325 A1	04-02-2016
