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(54) Title: PROVIDING AN INDICATOR AT A TARGET LOCATION

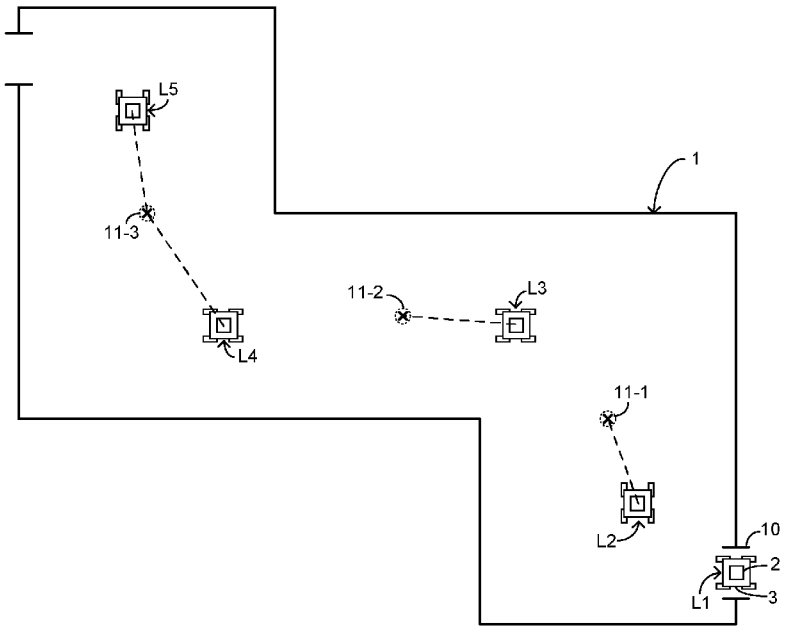


Figure 1A

(57) Abstract: This specification describes a method comprising determining a target location (11-1 to 11-3) within a space (1), determining a current location within the space of a mobile apparatus (2) having target indication mechanism, and based on the current location of the mobile apparatus (2) and the target location (11-1 to 11-3), controlling the target indication mechanism to provide an indicator at the target location (11-1 to 11-3).

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Providing an Indicator at a Target Location

Field

This specification relates generally to provision of an indicator at a target location.

Background

It is often desirable or beneficial for objects or devices forming part of a system or network to be installed at a particular location with a relatively high degree of accuracy. Such objects may include, for example, lighting and control units of a lighting system, sensors of a security system and nodes, beacons or positioning devices of a positioning system.

Currently when installing such objects or devices, installers must refer to a plan and make measurements within the installation space in order to install the objects at the desired location. This is both time consuming and potentially inaccurate.

Summary

In a first aspect, this specification describes a method comprising determining a target location within a space, determining a current location within the space of a mobile apparatus having target indication mechanism, and, based on the current location of the mobile apparatus and the target location, controlling the target indication mechanism to provide an indicator at the target location.

The method may comprise determining an orientation of the mobile apparatus and controlling the target indication mechanism to provide an indicator at the target location based on the determined orientation, the current location and the target location.

The method may comprise receiving signals indicative of movement of the mobile apparatus from at least one sensor associated with the mobile apparatus. The method may comprise determining an orientation of the mobile apparatus based on the received signals and an initial orientation of the mobile apparatus; and controlling the target indication mechanism to provide an indicator at the target location based on the determined orientation, the current location and the target location. The method may comprise determining the current location of the mobile apparatus based on the received signals and an initial location of the mobile apparatus. Alternatively, the current location may be determined using a global navigation satellite system.

The method may comprise detecting a change in current location of the mobile apparatus, and, based on the target location and the changed current location, controlling the target indication mechanism to maintain the indicator at the target location.

The target indication mechanism may comprise an indication projector configured to project a visual indicator to the target location. The target indication mechanism may further comprise an actuator configured to direct the indicator projected by the indication projector to the target location. The indication projector may comprise a light projector.

The method may comprise receiving plan data indicating at least one target location within the space, and determining the target location based on the received plan data. The plan data may include layout information describing a layout of the space.

The target location may be an installation location for an object to be installed. The indicator may be provided at the target location indicates an orientation with which the installable object is to be installed at the location. The object to be installed may be a positioning device of a positioning system for enabling determination of a position of a remote device within the space.

The mobile apparatus may further comprise calibration components for enabling determination of the physical location and/or orientation of an installed positioning device, and the method may further comprise, subsequent to installation of a positioning device, the calibration components causing transmission of signals to, or receipt of signals from, the installed positioning device to enable determination of the physical location and/or orientation of the installed positioning device.

The mobile apparatus may be mounted on wheeled base unit.

In a second aspect, this specification describes apparatus configured to perform any method as described with reference to the first aspect.

In a third aspect, this specification describes apparatus comprising at least one processor, and at least one memory including computer program code which, when executed by the at least one processor, causes the apparatus: to determine a target location within a space; to determine a current location within the space of a mobile apparatus having target indication mechanism; and based on the current location of the mobile apparatus and the

target location, to control the target indication mechanism to provide an indicator at the target location.

The computer program code, when executed by the at least one processor, may cause the apparatus to determine an orientation of the mobile apparatus and to control the target indication mechanism to provide an indicator at the target location based on the determined orientation, the current location and the target location.

The computer program code, when executed by the at least one processor, may cause the apparatus to receive signals indicative of movement of the mobile apparatus from at least one sensor associated with the mobile apparatus.

The computer program code, when executed by the at least one processor, may cause the apparatus to determine an orientation of the mobile apparatus based on the received signals and an initial orientation of the mobile apparatus, and to control the target indication mechanism to provide an indicator at the target location based on the determined orientation, the current location and the target location. The computer program code, when executed by the at least one processor, may cause the apparatus to determine the current location of the mobile apparatus based on the received signals and an initial location of the mobile apparatus. Alternatively, the current location may be determined using a global navigation satellite system.

The computer program code, when executed by the at least one processor, may cause the apparatus to detect a change in current location of the mobile apparatus, and to control the target indication mechanism to maintain the indicator at the target location, based on the target location and the changed current location.

The target indication mechanism may comprise an indication projector configured to project a visual indicator to the target location. The target indication mechanism may further comprise an actuator configured to direct the visual indicator projected by the indication projector to the target location. The indication projector may comprise a light projector.

The computer program code, when executed by the at least one processor, may cause the apparatus to receive plan data indicating at least one target location within the space, and to determine the target location based on the received plan data. The plan data may include layout information describing a layout of the space.

The target location may be an installation location for an object to be installed. The indicator provided at the target location may indicate an orientation with which the installable object is to be installed at the location. The object to be installed may be a positioning device of a positioning system for enabling determination of a position of a remote device within the space. The mobile apparatus may further comprise calibration components for enabling determination of the physical location and/or orientation of an installed positioning device, and the computer program code, when executed by the at least one processor, may cause the calibration components, subsequent to installation of a positioning device, to cause transmission of signals to, or receipt of signals from, the installed positioning device to enable determination of the physical location and/or orientation of the installed positioning device.

The mobile apparatus may be mounted on wheeled base unit.

In a fourth aspect, this specification describes computer-readable code which, when executed by computing apparatus, causes the computing apparatus to perform any method as described with reference to the first aspect.

In a fifth aspect, this specification describes a computer-readable medium having computer-readable code stored thereon, the computer readable code, when executed by a least one processor, cause performance of at least: determining a target location within a space; determining a current location within the space of a mobile apparatus having target indication mechanism; and based on the current location of the mobile apparatus and the target location, controlling the target indication mechanism to provide an indicator at the target location. The computer readable code of the fifth aspect may, when executed by the least one processor, additionally cause the performance of any other operation or any suitable combination of the other operations described with reference to the method of the first aspect.

In a sixth aspect, this specification describes an apparatus comprising means for determining a target location within a space, means for determining a current location within the space of a mobile apparatus having target indication mechanism, and means for controlling the target indication mechanism to provide an indicator at the target location, based on the current location of the mobile apparatus and the target location. The apparatus of the sixth aspect may further comprise means for performing any other

operation or any suitable combination of the other operations described with reference to the method of the first aspect.

Brief Description of the Figures

For a more complete understanding of the methods, apparatuses and computer readable instructions described in this specification, reference is now made to the following description, taken in connection with the accompanying figures in which:

Figures 1A and 1B are simplified schematic illustrations of various operations of an installation facilitation apparatus for facilitating the identification of installation locations within a space;

Figure 2A is a simplified schematic of a mobile base unit carrying the installation facilitation apparatus shown in Figures 1A and 1B;

Figure 2B is a simplified schematic illustrating a bootstrapping operation in respect of the installation facilitation apparatus;

Figure 3 is a simplified schematic showing an example configuration of the installation facilitation apparatus;

Figure 4 is a flow chart illustrating various operations which may be performed by the installation facilitation apparatus described with reference to the previous figures; and

Figure 5 is a flow-type diagram illustrating a method of installation of devices or nodes of a positioning system.

Detailed Description

In the description and drawings, like reference numerals may refer to like elements throughout.

Figures 1A and 1B illustrate operations of an installation facilitation apparatus 2 for indicating installation locations (or target locations) for installable objects within a space 1. More specifically, Figure 1A is a plan view of the space and Figure 1B is a simplified side view of the space. Both of Figures 1A and 1B illustrate the progression of the installation facilitation apparatus 2 from a first location L1 through to a fifth location L5 within the space 1. As the installation facilitation apparatus 2 is designed so as to be movable within the space, it may be referred to "mobile apparatus". The space may, in some examples, be indoors, for instance a floor or area of a shopping centre or hospital.

In general terms, the installation facilitation apparatus 2 is configured to determine at least one target location 11-1 to 11-3 within a space 1. The apparatus 2 is further configured to determine its own current location within the space and, based on its

current location and the determined target location 11-1 to 11-3, to control a target indication mechanism 20 (as shown schematically in Figures 2A and 2B) to provide an indicator at the target location 11-1 to 11-3. The apparatus 2 may be further configured to determine its orientation and to control the target indication mechanism 20 based on its determined orientation in addition to its current location and the target location 11-1 to 11-3.

The apparatus 2 may further be configured to detect a change in its current location and, based on the target location and its changed location, to control the target indication 20 mechanism to maintain the indicator at the target location. The indicator may be maintained at the target location until, for instance, the current location is determined to be closer to another (or second) target location than to the original target location at which point the apparatus 2 may control the target indication mechanism 20 to provide the indicator at the other target location.

The target locations 11-1 to 11-3 within the space 1 may be determined based on plan data (which may be referred to as map data) which indicates the one or more target locations within the space 1. The plan data may further include layout information describing a layout (e.g. a floor plan) of the space 1, with the target locations being defined relative to the layout. In such examples, the apparatus 2 may be configured to determine, based on its current location, a target location 11-1 to 11-3 and the layout information, if there is a direct line of sight between the current location and the target location 11-1 to 11-3. The apparatus 2 may control the target indication mechanism 20 to provide the indicator at the target location 11-1 to 11-3 only if it is determined that there is direct line of sight. If there is not a direct line of sight, the apparatus 2 may be configured to indicate this to the user. In some examples, the target indication mechanism 20 may be configured to provide plural indicators at plural different target locations11-1 to 11-3.

As can be seen in Figures 2A and 2B, the installation facilitation apparatus 2 may be mounted or carried on a mobile base unit 3, which may, for instance, be a wheeled trolley or cart. At least two of the wheels 34 may be in the form of swivel castors to facilitate movement of the installation facilitation apparatus 2.

As shown in Figure 3, the target indication mechanism 20 (which may in some instances be referred to as target indication means) may comprise an indication projector 21 configured to project a visual indicator onto a surface within the space thereby to indicate the target location 11-1 to 11-3. In some specific examples, the indication projector 21 may

be a light projector. In such examples, the target indication mechanism 20 may be referred to as a light projection mechanism. In the example of Figure 3, the target indication mechanism 20 further comprises an actuator 22 which is configured to direct light projected by the light projector 21 towards the target location 11-1 to 11-3 thereby to provide the indicator. The light projector 21 may be, for example but not limited to, a data projector or a laser pointer. The actuator 22 may be configured to change the orientation of the light projector 21 and/or to change the orientation of a system of one or more reflectors (such as mirrors) thereby to direct the projected light to the target location.

The apparatus 2 may further comprise one or more sensors 23 configured to output signals based on which movement of the apparatus 2 can be determined. In particular, based on the signals output by the one or more sensors 23, the apparatus 2 may be able to determine a change in its location and/or orientation. For instance, the one or more sensors 23 may include one or more optical sensors (e.g. laser sensors) configured to detect movement of the apparatus 2 relative to surface across which the apparatus 2 is moving (e.g. the floor). Plural optical sensors are shown in Figure 2A provided on an underside of a base unit 3. In order to detect changes in the location and orientation of the apparatus 2, at least two optical sensors 23 may be required. Alternatively or additionally, the sensors 23 may include an accelerometer or solid state compass configured to enable detection of a change in orientation of the apparatus 2. The apparatus 2 may be configured to determine its current location based on a reference or initial known location and the signals received from the one or more sensors 23 indicating its movement. In other examples, the apparatus may comprise a positioning module 24 (e.g. a GNSS module) for enabling the apparatus 2 to determine its location. The positioning module 24 may include a dedicated antenna 24-1.

Returning now to Figures 1A and 1B, the installation facilitation apparatus 2 is initially positioned at a first location L1. In this example, the first location is within a doorway 10 or entrance into the space 1. The initial location L1 (which may or may not be in a doorway or entrance) may be used as the reference location for determining the subsequent locations of the apparatus 2. The user and/or the apparatus 2 may have some prior knowledge of the reference location and so, prior to utilising the apparatus 2, the user may first position the apparatus 2 at the reference location. Once the apparatus 2 is positioned at the reference location, the user may provide an input for indicating that this is the case. The input may be provided via a portable communications device 4 (see Figure 3) which may communicate an indication of the input to the installation facilitation apparatus 2. Alternatively the input may be provided directly to the installation

facilitation apparatus 2 via in input interface 25 (which may be of any suitable type). The user may additionally orientate the apparatus 2 in a predetermined manner thereby to provide a reference orientation. For example, as illustrated in Figure 2B, the installation facilitation apparatus 2 may be positioned with a particular orientation relative to the doorway. The reference location/orientation may be indicated to the user via the portable communications device 4 or via an output device (not shown) which is physically coupled to the installation facilitation apparatus 2.

After providing the indication that the apparatus 2 is located and oriented as per the reference location/orientation, the user moves the apparatus 2 to a second location L2. The movement of the apparatus 2 is detected, for instance using the one or more sensors 23, and the apparatus 2 calculates its new current location accordingly. Then, based on the current location and a target location, the apparatus 2 controls the target indication mechanism 20 to provide an indicator at the target location (which in this example is a first target location 11-1). In the example of Figure 1A, the indicator is denoted by a cross. As can be seen from Figure 1B, in this example which relates to installation of positioning (or locator) devices of a positioning system, the target location 11-1 is on the ceiling of the space 1. However, the target locations may alternatively or additionally be on a wall or on the floor.

Next, the installation facilitation apparatus 2 is moved to a third location L3. During movement of the apparatus 2, it may repeatedly determine its current location based on the movement detected by the at least one sensor 23. The apparatus 2 may control the target indication mechanism to maintain the indicator at the first target location 11-1. This may occur until the apparatus 2 determines that it has reached a location at which a new target location, in this example a second target location 11-2, is closer to the current location of the apparatus than is the first target location 11-1. Following such a determination, the apparatus 2 may control the target indication mechanism 20 to provide the indicator at the second target location 11-2. This can be seen in Figures 1A and 1B when the installation facilitation apparatus 2 is located at the third location L3.

Next, the apparatus 2 is moved from the third location L3 to a fifth location L5 via a fourth location L4. At some point between the third and fourth locations L3, L4, the apparatus 2 causes the target indication mechanism 20 to switch from providing the indicator at the second target location 11-2 to providing the target indicator at the third location 11-3.

Although not shown in Figures 1A and 1B, the user of the apparatus 2 may use the indicators as a guide for performing installation operations. For instance, the user may install locator or positioning devices of a positioning system at the target locations, or may install brackets or fixings for allowing subsequent attachment of the locator devices, or may simply drill the necessary holes and/or make suitable markings on the surface for allowing later attachment of the locator devices. The locator devices may be of any suitable type, including but not limited to phased antenna array devices of a high accuracy indoor positioning system.

In some implementations, it may be desirable or beneficial to install the object with a particular orientation. This may be the case with positioning systems in which the positioning system requires knowledge of the orientation of the locator devices (e.g. the phased antenna array devices) in order to be able to determine the location of assets/devices etc within the space. When installing such objects, the installation facilitation apparatus may be configured to indicate an orientation with which the object should be installed. This may be provided in any suitable way. For instance, the indicator may include an arrow or some other means for indicating the orientation. In such examples, the light projector 21 may be rotatable relative to the apparatus thereby to alter the indicated orientation as necessary. In other examples, for instance where the light projector 21 is a data projector, the orientation indication may be part of the projected data.

It will thus be understood that the installation facilitation apparatus 2 provides a useful tool by means of which users are able to quickly and accurately identify target locations at which to install objects and devices. Although this specification is mainly directed to use of the apparatus 2 for installing positioning/locator devices within a positioning system, it will be appreciated that the apparatus 2 is widely applicable to many different types of installation. Indeed, it might be used for installing or distributing any type of object where the positions of those objects have previously been defined in a virtual, digital environment.

Returning now to Figure 3, it can be seen that the installation facilitation apparatus 2 comprises a controller 26 which is configured to control the other components of the apparatus 2. The controller 26 is operable to receive signals from various ones of the components (e.g. any of sensors 23, positioning module 24 and input interface 25) and to output signals for controlling operation of other components such as the target indication mechanism 20.

The apparatus 2 may, in some examples, include a user input override mechanism 29 (which may be in any suitable form, for instance but not limited to a physical button or switch) via which a user is able to provide an input for disabling and activating the target indication mechanism 20 or, more specifically, the light projector 20 or any alternative means for providing the indicator. This improves the safety of the apparatus 2 because, in this way, the target indication mechanism 20 can be activated only when it is safe to do so.

The apparatus 2 may further comprise a transceiver 27 and an associated antenna 28. The transceiver and antenna are operable under the control of the controller 26 to transmit and/or receive wireless messages from other communications devices. For instance, the apparatus 2 may retrieve the plan data, which indicates the target locations within the floor plan, from a planning server 5, which may be for instance located in the cloud. Similarly, the apparatus 2 may be configured to receive via the transceiver 27 and the antenna 28 messages such as indications of user inputs from the portable communications device 4. The apparatus 2 may further cause transmission of messages via the transceiver 27 and antenna 28 to the planning server 5, for instance to request receipt of plan data.

As can also be seen from Figure 3, the portable communications device 4 which may be of any suitable type (e.g. a smart phone, a lap top computer or a tablet computer) may be configured to communicate with the planning server 5. For instance, the target locations may be defined by a user using the portable communications device 4 and information defining those target locations may be transmitted for storage at the planning server 5. In some examples, the portable communications device 4 may display the layout or floor plan of the installation space in which the objects are to be installed and the user may provide inputs via the portable communications device 4 to indicate the locations relative to the displayed floor plan. In other examples, the target locations may be defined by a user using a non-portable device such as a desktop computer or in any other manner.

In the example of Figure 3, the installation facilitation apparatus 2 further comprises calibration components 30 for enabling calibration of newly installed positioning devices of the positioning system (which may have been installed at for instance the first, second and third target locations shown in Figures 1A and 1B). Calibration of a positioning device 6 involves the exchange of data between the calibration components 30 and the positioning device 6 thereby to enable the location and orientation of the device to be accurately calculated. The calibration components 30 include a transceiver 31 and an associated antenna 32 which can be controlled to transmit and/or receive data to/from the

positioning device being calibrated. The calibration components 30 may further be operable to communicate with a positioning server 7 of the positioning system either directly or via the positioning devices 6. In this example the calibration components 30 include a calibration controller 33 for controlling the exchange of data between the calibration components 30 and the positioning devices 6 thereby to calibrate the newly installed positioning devices. The calibration of the positioning devices 6 may be performed in any suitable way, for instance as described in WO 2013/179090 A1.

In the example of Figure 3, the calibration components 30 are separate from the rest of the installation facilitation apparatus 2. However, in other examples, the controller 26 may be configured also to cause performance of the necessary calibration operations. Similarly, the first transceiver 27 and antenna 28 may be used to transmit and/or receive any messages necessary for calibration of the positioning devices.

Figure 4 is a flow-chart illustrating various operations which may be performed by the installation facilitation apparatus 2, particularly the controller 26. In other examples, however, some or all of the operations may be performed remotely by a remote device (e.g. the portable communications device 4 or the planning or positioning servers 5, 7) which is in communication with the installation facilitation apparatus 7 in order to transmit and receive the necessary data between the remote device and the apparatus 2).

In operation S4.1, the apparatus 2 receives target location information. This may be in the form of plan data received from the planning server 5 either directly or via the portable communications device 4. The plan data may have been received at the apparatus 2 in response to a request transmitted from one of the apparatus 2 and the communications device 4. In other examples, the plan data may be provided to the apparatus 2 manually by a user.

In operation S4.2, the apparatus 2 enables receipt of an indication that the apparatus 2 is at the reference location (and has the correct orientation). As discussed previously, this may be received via the portable communications device 4 or via an input interface 25 which forms part of the installation facilitation apparatus 2. Although not shown in Figure 3, the apparatus 2 may cause information to be displayed to the user (e.g. via an output device) for indicating the reference location and orientation to which the apparatus should be moved.

In operation S4.3, the installation facilitation apparatus 2 determines the nearest target location. This may be determined based on the reference location and the target location information received in operation S4.1. The apparatus 2 controls the target indication mechanism 20 to provide an indicator at the target location 11-1. This is determined based on the current location of the apparatus 2 (which prior to movement of the apparatus is assumed to be the reference location), the orientation of the apparatus 2 (which initially is assumed to be the reference orientation) and the nearest target location. Provision of the indicator at the target location may comprise switching on the light projector 21 and controlling the actuator 22 to direct light projected by the light projector 21 to the target location.

Next, in operation S4.5, the installation facilitation apparatus 2 determines if movement of the apparatus 2 has been detected. This may be determined based on signals received from the one or more sensors 23 and/or the positioning module 24.

If no movement is detected, the apparatus may proceed to operation S4.6 in which it is determined whether a positioning device 6 has been installed at the target location. This may be determined based a user input received either directly at the apparatus 2 or via the portable communications device 4.

If, in operation S4.5 movement of the apparatus 2 is detected, the apparatus 2 performs operation S4.7. In operation S4.7, the apparatus 2 determines at least one of its current location and orientation, for instance based on the signals received from the sensors and the reference location/orientation.

Once the current location is determined, the apparatus 2, in operation S4.8, determines if the current location is nearer to a new target location than to the original target location determined in S4.3.

If it is determined that the target location which is nearest to the current location of the apparatus is the original target location 11-1, the apparatus 2 returns to operation S4.4 in which the target indication mechanism 20 is controlled to maintain the indicator at the original target location 11-1. This may include controlling the actuator 22 in order to compensate for the movement of the apparatus 2.

If, however, it is determined that a new target location 11-2 is now closer to the current location, the apparatus 2 performs operation S4.9 in which the target indication

mechanism 20 is controlled to provide the indicator at the new target location 11-2. This may include controlling the actuator 22 to direct light projected by the light projector 21 to the new target location 11-2.

After this, the apparatus 2 returns to operation S4.5 in which it is determined if further movement of the apparatus 2 has occurred.

Returning now to operation S4.6, if it is determined that a positioning device has been installed at the target location, the apparatus may proceed to operation S4.10 in which the installed positioning device 6 is calibrated. This may include, for instance, exchanging data with the newly-installed positioning device 6 thereby to allow the location and orientation of the positioning device 6 to be determined. Once determined, the location and orientation information is stored by the positioning server 7 and/or the positioning device 6.

Once calibration has been completed, which may be detected automatically by the calibration components 30 or may be indicated by a user, the apparatus 2 may proceed to operation S4.9. In operation S4.9, the apparatus 2 may cause the target indication mechanism to provide the indicator at a new target location, which may be the target location that is the next closest to the current location.

As will of course be appreciated, the flow chart of Figure 4 is merely an example. As such, various operations illustrated in Figure 4 may be omitted. For instance, in certain implementations, the installation facilitation apparatus 2 may not be required to perform calibration of the objects that have just been installed and so operations S4.6 and S4.10 may be omitted. Similarly, in some examples the target indication mechanism 20 may be configured to simultaneously indicate plural target locations. In such examples, operations S4.3 and S4.8 may be omitted. Also, the determination of S4.6 as to whether a device has been installed may not be performed in response to detection that the apparatus has not moved. Instead, detection of that a device has been installed may operation S4.6 may occur at any time in response to receipt of a particular user indication regardless of the operation currently or previously being performed.

In some examples, the apparatus 2 may perform operations in addition to those shown in Figure 4. For instance, the apparatus 2 may determine if a particular target location is visible from a current location and may control the target indication mechanism to provide the indicator at that target location only if it is determined that the target location

is visible. Such an operation may be performed for instance between operations S4.3 and S4.4 and/or between operations S4.8 and S4.9. In such examples, in the event of a negative determination (i.e. a determination that a particular target location, e.g. the nearest, is not visible from the current location) the apparatus 2 may cause the indicators to be provided at another target location, for instance the next nearest. Alternatively or additionally, the apparatus may provide a suitable indication to the user that a particular target location is near to the target location but is not currently visible. For instance, the light projector may be controlled so as to project an indicator towards a target location in a first colour (e.g. green) if the target location is visible and in a second colour (e.g. red) if the target location is not visible. As will also be appreciated, the order in which some of the operations illustrated in Figure 4 are performed may also be different. For instance, operations S4.5 and S4.7 may be performed prior to operation S4.4.

Of course, the above variations to the process of Figure 4 are examples only and any number of modifications to the flow-chart of Figure 4 may be made so long as the method performed by the installation facilitation apparatus 2 or the system as a whole falls within the scope of the independent claims.

Figure 5 is a flow-type diagram illustrating an overview of a method of installation of one or more positioning devices 6 within a space 1 using the installation facilitation apparatus 2 as described with reference to the previous Figures. Each of the planning server 5, the positioning server 7, the installation facilitation apparatus 2 and the user/installer are denoted by a different vertical line in the figure.

In operation S5.1, the planning server 5 defines the target locations. The target locations which are within a map of a space (or a floor plan) may be defined based on user indications or selections received via the portable communications device 4.

After the locations are defined, in operation S5.2, the plan data including the target location information is transmitted from the planning server 5 to the installation facilitation apparatus 2. Transmission of the location information may be performed in response to a request received from the installation facilitation apparatus 2 or the portable communications device 4. Transmission of the location information may be via the portable communications device 4 or may be transmitted to the installation facilitation apparatus 2 without the involvement of the portable communications device 4.

In operation S5.3, the user positions the installation facilitation apparatus 2 at the reference location with the reference orientation. Once the apparatus 2 is in the reference location with the correct orientation, this is indicated to the installation facilitation apparatus 2 in operation S5.4.

Next, in operation S5.5, the installation facilitation apparatus 2 determines its own location and orientation, for instance as described with reference to Figures 1-4. In operation S5.6, the apparatus 2 causes provision of the indicator at one or more of the target locations. As will be appreciated from the discussion with regard to Figure 4, in some instances, provision of the indicator (operation S5.6) may be performed prior to any determination of the current location (i.e. prior to movement of the apparatus 2). Also, operations S5.5 and S5.6 may be repeated a number of times as the apparatus 2 is moved within the space.

In operation S5.7, the user installs a positioning device 6 at the indicated target location and in operation S5.8 the user indicates that installation of the device is complete (e.g. via the portable communications device 4). This indication is then relayed to the planning server 5, which receives the indication in operation S5.9. In operation S5.10, the planning server 5 causes a message to be transmitted to the positioning server 7 indicating that calibration of the newly installed device can now be performed.

Subsequently, in operation S5.11 the installation facilitation apparatus 2 and the positioning server 7 together perform the necessary calibration operations for calibrating the newly installed positioning device.

Next, once calibration is complete, the positioning server 7, in operation S5.12 may send an indication of this to the planning server 5 which, in operation S5.13 may provide an indication of this to the user via the installation facilitation apparatus 2 or the portable communication device 4. Alternatively, the installation facilitation apparatus 2 may determine when calibration is complete in some other way, for instance automatically. At this point, the method either ends or the user moves the installation facilitation apparatus 2 to a new location and operations S5.5 to S5.14 are repeated until all positioning devices have been installed and calibrated.

In this example, the positioning devices 6 are installed and then calibrated one at a time. This means that installation and calibration of a positioning system may require just a single pass through a particular space. This is generally more efficient and enables the

positioning system to be installed and in operation in less time. In other examples, however, all the devices may be first installed and then, after all devices are installed, may be calibrated.

In the above examples, the indication projector 21 has generally been described as a light projector. However, in alternative examples, the indication projector 21 may be configured to project or propel (for instance using compressed air or spring power) an indicator, in the form of a (possibly brightly-coloured) physical projectile, to the target location, thereby to provide the indicator as a marker. The physical projectile may adhere to the surface at the target location or may leave a suitable visible mark for indicating the target location to the installer. This alternative may have certain benefits. For instance, the indicator provided is more permanent than is an indicator provided by a light projector. As such, all target locations within a space can be indicated in this way and subsequently, after that task is completed, installation of the devices can begin. Also, this alternative indicator cannot be obscured by the installer when attempting installation, as could be the case with an indicator provided by projected light.

Some further details of components and features of the above-described apparatus 2 and alternatives for them will now be described.

The controllers 26, 33 may comprise processing circuitry 261, 331 communicatively coupled with memory 262, 332. The memory 262, 332 has computer readable instructions 262A, 332A stored thereon, which when executed by the processing circuitry 261, 331 causes the processing circuitry 261, 331 to cause performance of various ones of the operations described with reference to Figures 1 to 5.

The processing circuitry 261, 331 of the apparatus 2 described with reference to Figures 1 to 5 may be of any suitable composition and may include one or more processors 261A, 331A of any suitable type or suitable combination of types. For example, the processing circuitry 261, 331 may be a programmable processor that interprets computer program instructions 262A, 332A and processes data. The processing circuitry 261, 331 may include plural programmable processors. Alternatively, the processing circuitry 261, 331 may be, for example, programmable hardware with embedded firmware. The processing circuitry 261, 331 may be termed processing means. The processing circuitry 261, 331 may alternatively or additionally include one or more Application Specific Integrated Circuits (ASICs). In some instances, processing circuitry 261, 331 may be referred to as computing apparatus.

The processing circuitry 261, 331 is coupled to the respective memory (or one or more storage devices) 262, 332 and is operable to read/write data to/from the memory 262, 332. The memory 262, 332 may comprise a single memory unit or a plurality of memory units, upon which the computer readable instructions (or code) 262A, 332A, is stored. For example, the memory 262, 332 may comprise both volatile memory and non-volatile memory. For example, the computer readable instructions 262A, 332A may be stored in the non-volatile memory and may be executed by the processing circuitry 261, 331 using the volatile memory for temporary storage of data or data and instructions. Examples of volatile memory include RAM, DRAM, SDRAM etc. Examples of non-volatile memory include ROM, PROM, EEPROM, flash memory, optical storage, magnetic storage, etc. The memories in general may be referred to as non-transitory computer readable memory media.

The term 'memory', in addition to covering memory comprising both non-volatile memory and volatile memory, may also cover one or more volatile memories only, one or more non-volatile memories only, or one or more volatile memories and one or more non-volatile memories.

The computer readable instructions 262A, 332A may be pre-programmed into the apparatuses 2. Alternatively, the computer readable instructions 262A, 332A may arrive at the apparatus 2 via an electromagnetic carrier signal or may be copied from a physical entity 210 (see Figure 3) such as a computer program product, a memory device or a record medium such as a CD-ROM or DVD. The computer readable instructions 262A, 332A may provide the logic and routines that enables the apparatus 2 to perform the functionality described above.

The combination of computer-readable instructions stored on memory (of any of the types described above) may be referred to as a computer program product.

The one or more transceivers 27, 31 of the apparatus 2 may be configured transmit and/or receive signals using any suitable protocol or combination of protocols. In some examples, such as when the apparatus 2 is used for installing high accuracy positioning devices, the calibration transceiver 31 may be adapted for transmitting and/or receiving signals via Bluetooth, for instance Bluetooth Low Energy (BLE). The installation facilitation transceiver 27 may be configured to transmit and or receive signals using, for

instance but not limited to, a Bluetooth protocol (e.g. BLE), a cellular data protocol, 802.11 wireless local area network protocols (e.g. WiFi), or a ZigBee protocols.

Where applicable, the BLE-capability of the transceivers 27, 31 may be provided by a single integrated circuit. It may alternatively be provided by a set of integrated circuits (i.e. a chipset). The BLE-capability may alternatively be a hardwired, application-specific integrated circuit (ASIC).

As will be appreciated, the apparatus 2 described herein may include various components which have may not been shown in the Figures. The apparatus 2 may comprise further optional SW components which are not described in this specification since they may not be useful in understanding the general operation of the apparatus.

Embodiments of the present invention may be implemented in software, hardware, application logic or a combination of software, hardware and application logic. The software, application logic and/or hardware may reside on memory, or any computer media. In an example embodiment, the application logic, software or an instruction set is maintained on any one of various conventional computer-readable media. In the context of this document, a "memory" or "computer-readable medium" may be any media or means that can contain, store, communicate, propagate or transport the instructions for use by or in connection with an instruction execution system, apparatus, or device, such as a computer.

Reference to, where relevant, "computer-readable storage medium", "computer program product", "tangibly embodied computer program" etc, or a "processor" or "processing circuitry" etc. should be understood to encompass not only computers having differing architectures such as single/multi processor architectures and sequencers/parallel architectures, but also specialised circuits such as field programmable gate arrays FPGA, application specify circuits ASIC, signal processing devices and other devices. References to computer program, instructions, code etc. should be understood to express software for a programmable processor firmware such as the programmable content of a hardware device as instructions for a processor or configured or configuration settings for a fixed function device, gate array, programmable logic device, etc.

As used in this application, the term 'circuitry' refers to all of the following: (a)hardware-only circuit implementations (such as implementations in only analogue and/or digital circuitry) and (b) to combinations of circuits and software (and/or firmware), such as (as

applicable): (i) to a combination of processor(s) or (ii) to portions of processor(s)/software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and (c) to circuits, such as a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation, even if the software or firmware is not physically present.

This definition of 'circuitry' applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term "circuitry" would also cover an implementation of merely a processor (or multiple processors) or portion of a processor and its (or their) accompanying software and/or firmware. The term "circuitry" would also cover, for example and if applicable to the particular claim element, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in server, a cellular network device, or other network device.

Although various aspects of the invention are set out in the independent claims, other aspects of the invention comprise other combinations of features from the described embodiments and/or the dependent claims with the features of the independent claims, and not solely the combinations explicitly set out in the claims.

It is also noted herein that while the above describes various examples, these descriptions should not be viewed in a limiting sense. Rather, there are several variations and modifications which may be made without departing from the scope of the present invention as defined in the appended claims.

Claims

1. A method comprising:

determining a target location within a space;

determining a current location within the space of a mobile apparatus having target indication mechanism; and

based on the current location of the mobile apparatus and the target location, controlling the target indication mechanism to provide an indicator at the target location.

2. The method of claim 1, comprising:

determining an orientation of the mobile apparatus and controlling the target indication mechanism to provide an indicator at the target location based on the determined orientation, the current location and the target location.

3. The method of claim 1, comprising:

receiving signals indicative of movement of the mobile apparatus from at least one sensor associated with the mobile apparatus.

4. The method of claim 3, comprising:

determining an orientation of the mobile apparatus based on the received signals and an initial orientation of the mobile apparatus; and

controlling the target indication mechanism to provide an indicator at the target location based on the determined orientation, the current location and the target location.

5. The method of claim 3 or claim 4, determining the current location of the mobile apparatus based on the received signals and an initial location of the mobile apparatus.

6. The method of any of claims 1 to 4, wherein the current location is determined using a global navigation satellite system.

7. The method of any preceding claim, comprising:

detecting a change in current location of the mobile apparatus; and

based on the target location and the changed current location, controlling the target indication mechanism to maintain the indicator at the target location.

8. The method of any preceding claim, wherein the target indication mechanism comprises an indication projector configured to project a visual indicator to the target location.

9. The method of claim 8, wherein the target indication mechanism comprises an actuator configured to direct the indicator projected by the indication projector to the target location.

10. The method of claim 8 or claim 9, wherein the indication projector comprises a light projector.

11. The method of any of claims 1 to 10, comprising:
receiving plan data indicating at least one target location within the space; and
determining the target location based on the received plan data.

12. The method of claim 11, wherein the plan data includes layout information describing a layout of the space.

13. The method of any preceding claim wherein the target location is an installation location for an object to be installed.

14. The method of claim 13, wherein the indicator provided at the target location indicates an orientation with which the installable object is to be installed at the location.

15. The method of claim 13 or claim 14, wherein the object to be installed is a positioning device of a positioning system for enabling determination of a position of a remote device within the space.

16. The method of claim 15, wherein the mobile apparatus further comprises calibration components for enabling determination of the physical location and/or orientation of an installed positioning device, the method further comprising:
subsequent to installation of a positioning device, the calibration components causing transmission of signals to, or receipt of signals from, the installed positioning device to enable determination of the physical location and/or orientation of the installed positioning device.

17. The method of any preceding claim, wherein the mobile apparatus is mounted on wheeled base unit.

18. Apparatus configured to perform a method according to any of claim 1 to 17.

19. Apparatus comprising:

at least one processor; and

at least one memory including computer program code which, when executed by the at least one processor, causes the apparatus:

to determine a target location within a space;

to determine a current location within the space of a mobile apparatus having target indication mechanism; and

based on the current location of the mobile apparatus and the target location, to control the target indication mechanism to provide an indicator at the target location.

20. The apparatus of claim 19, wherein the computer program code, when executed by the at least one processor, causes the apparatus:

to determine an orientation of the mobile apparatus and to control the target indication mechanism to provide an indicator at the target location based on the determined orientation, the current location and the target location.

21. The apparatus of claim 19, wherein the computer program code, when executed by the at least one processor, causes the apparatus:

to receive signals indicative of movement of the mobile apparatus from at least one sensor associated with the mobile apparatus.

22. The apparatus of claim 21, wherein the computer program code, when executed by the at least one processor, causes the apparatus:

to determine an orientation of the mobile apparatus based on the received signals and an initial orientation of the mobile apparatus; and

to control the target indication mechanism to provide an indicator at the target location based on the determined orientation, the current location and the target location.

23. The apparatus of claim 21 or 22, wherein the computer program code, when executed by the at least one processor, causes the apparatus:

to determine the current location of the mobile apparatus based on the received signals and an initial location of the mobile apparatus.

24. The apparatus of any of claims 19 to 22, wherein the current location is determined using a global navigation satellite system.

25. The apparatus of any of claims 19 to 24, wherein the computer program code, when executed by the at least one processor, causes the apparatus:

to detect a change in current location of the mobile apparatus; and

to control the target indication mechanism to maintain the indicator at the target location based on the target location and the changed current location.

26. The apparatus of any of claims 19 to 25, wherein the target indication mechanism comprises an indication projector configured to project a visual indicator to the target location.

27. The apparatus of claim 26, wherein the target indication mechanism comprises an actuator configured to direct the visual indicator projected by the indication projector to the target location.

28. The apparatus of claim 26 or claim 27, wherein the indication projector comprises a light projector.

29. The apparatus of any of claims 19 to 28, wherein the computer program code, when executed by the at least one processor, causes the apparatus:

to receive plan data indicating at least one target location within the space; and

to determine the target location based on the received plan data.

30. The apparatus of claim 29, wherein the plan data includes layout information describing a layout of the space.

31. The apparatus of any of claims 19 to 30, wherein the target location is an installation location for an object to be installed.

32. The apparatus of claim 31, wherein the indicator provided at the target location indicates an orientation with which the installable object is to be installed at the location.

33. The apparatus of claim 31 or claim 32, wherein the object to be installed is a positioning device of a positioning system for enabling determination of a position of a remote device within the space.

34. The apparatus of claim 33, wherein the mobile apparatus further comprises calibration components for enabling determination of the physical location and/or orientation of an installed positioning device, and wherein the computer program code, when executed by the at least one processor, causes the calibration components:

subsequent to installation of a positioning device, to cause transmission of signals to, or receipt of signals from, the installed positioning device to enable determination of the physical location and/or orientation of the installed positioning device.

35. The apparatus of any of claims 19 to 34, wherein the mobile apparatus is mounted on wheeled base unit.

36. Computer-readable code which, when executed by computing apparatus, causes the computing apparatus to perform a method according to any of claims 1 to 17.

37. A computer-readable medium having computer-readable code stored thereon, the computer readable code, when executed by a least one processor, cause performance of at least:

determining a target location within a space;

determining a current location within the space of a mobile apparatus having target indication mechanism; and

based on the current location of the mobile apparatus and the target location, controlling the target indication mechanism to provide an indicator at the target location.

38. Apparatus comprising:

means for determining a target location within a space;

means for determining a current location within the space of a mobile apparatus having target indication mechanism; and

means for controlling the target indication mechanism to provide an indicator at the target location, based on the current location of the mobile apparatus and the target location.

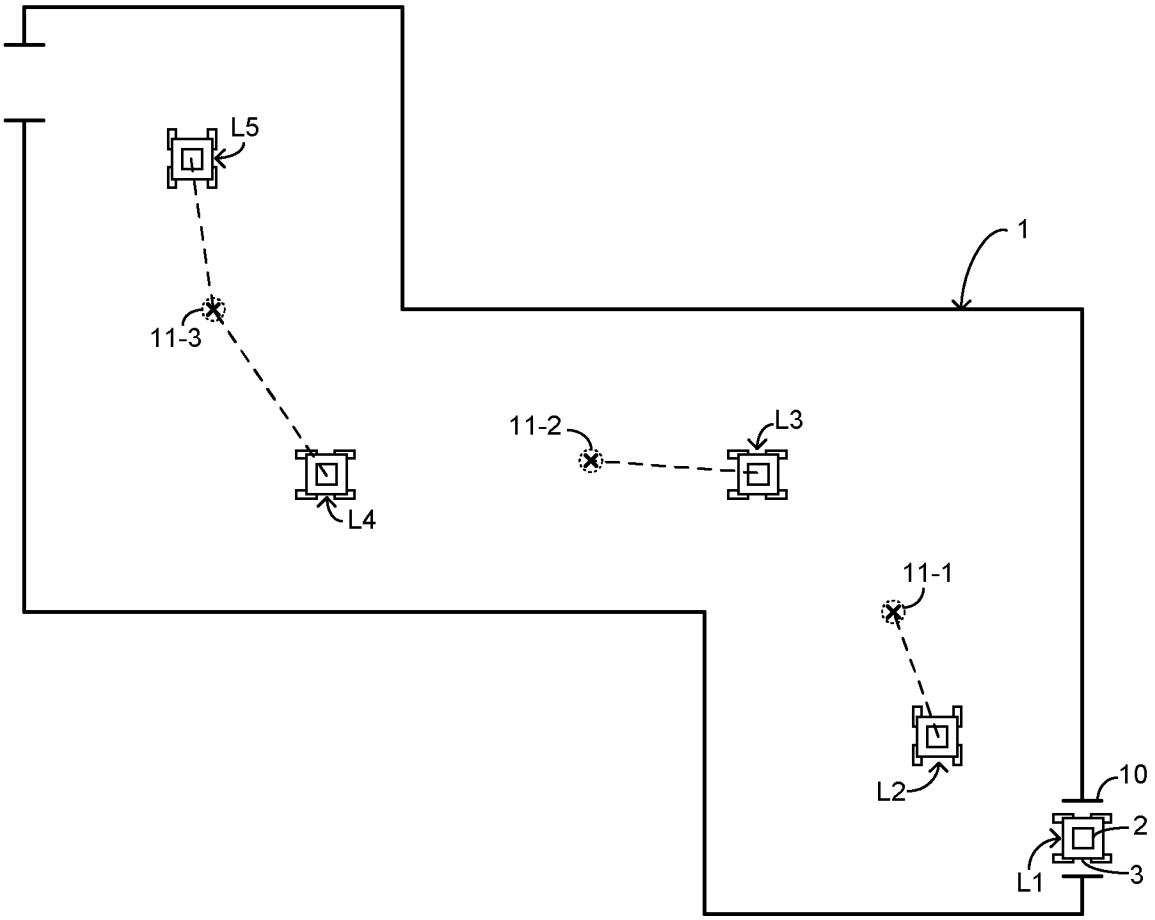


Figure 1A

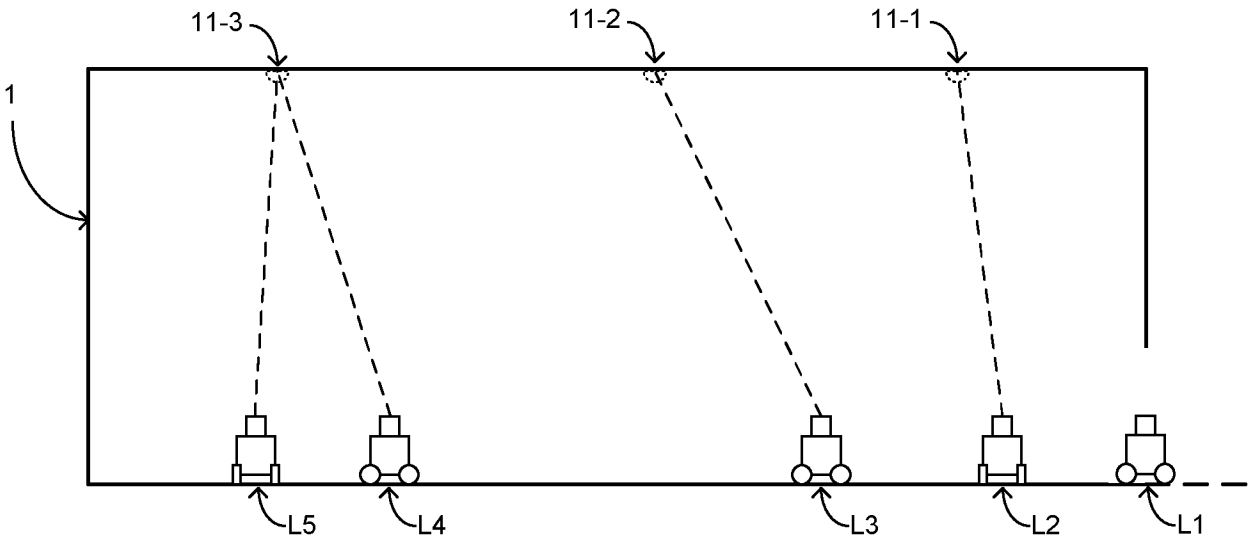


Figure 1B

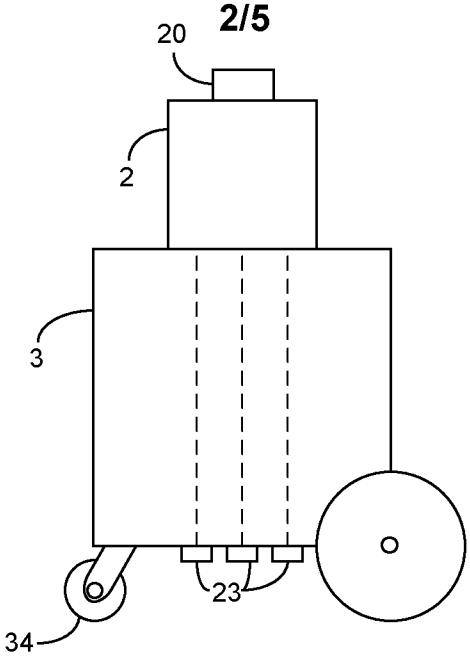


Figure 2A

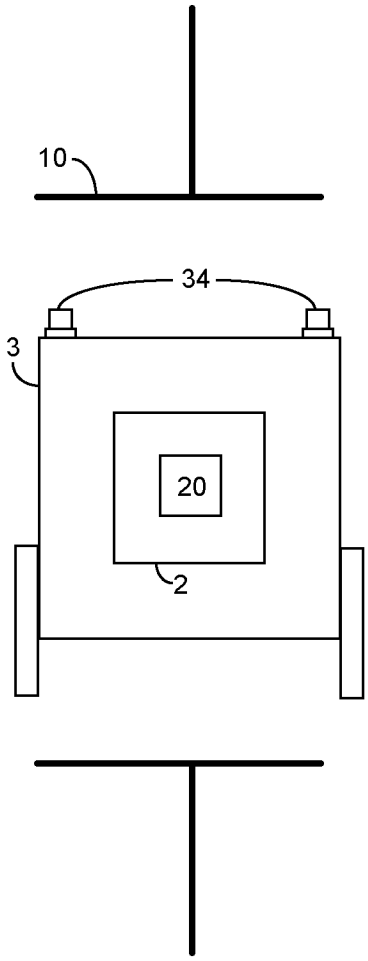


Figure 2B

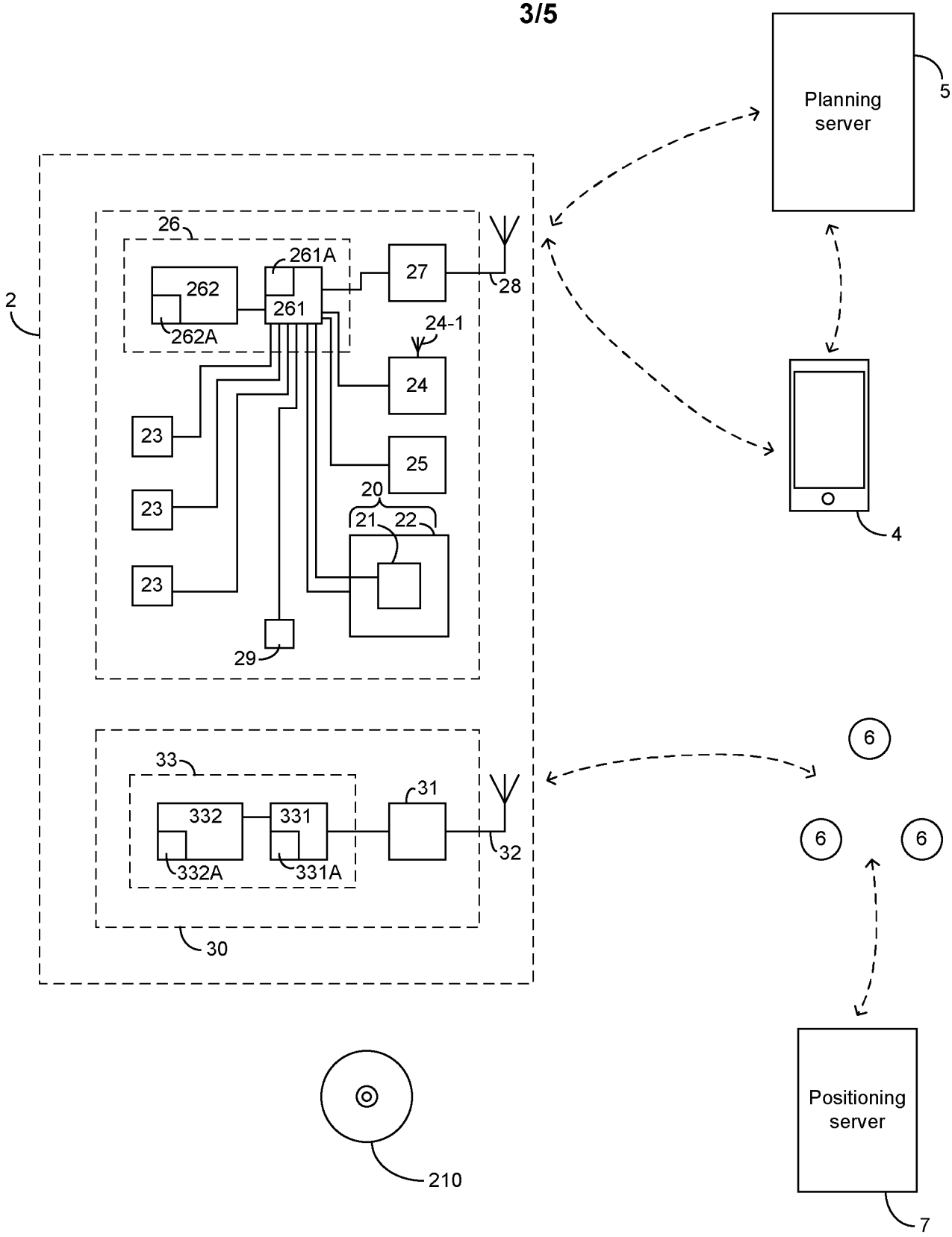

Planning server
5
2
26
261A
262
261
262A
27
28
24-1
24
23
25
23
20
21
22
23
29
4
33
31
332
331
332A
331A
32
30
6
6
6
Positioning server
7
210

Figure 3

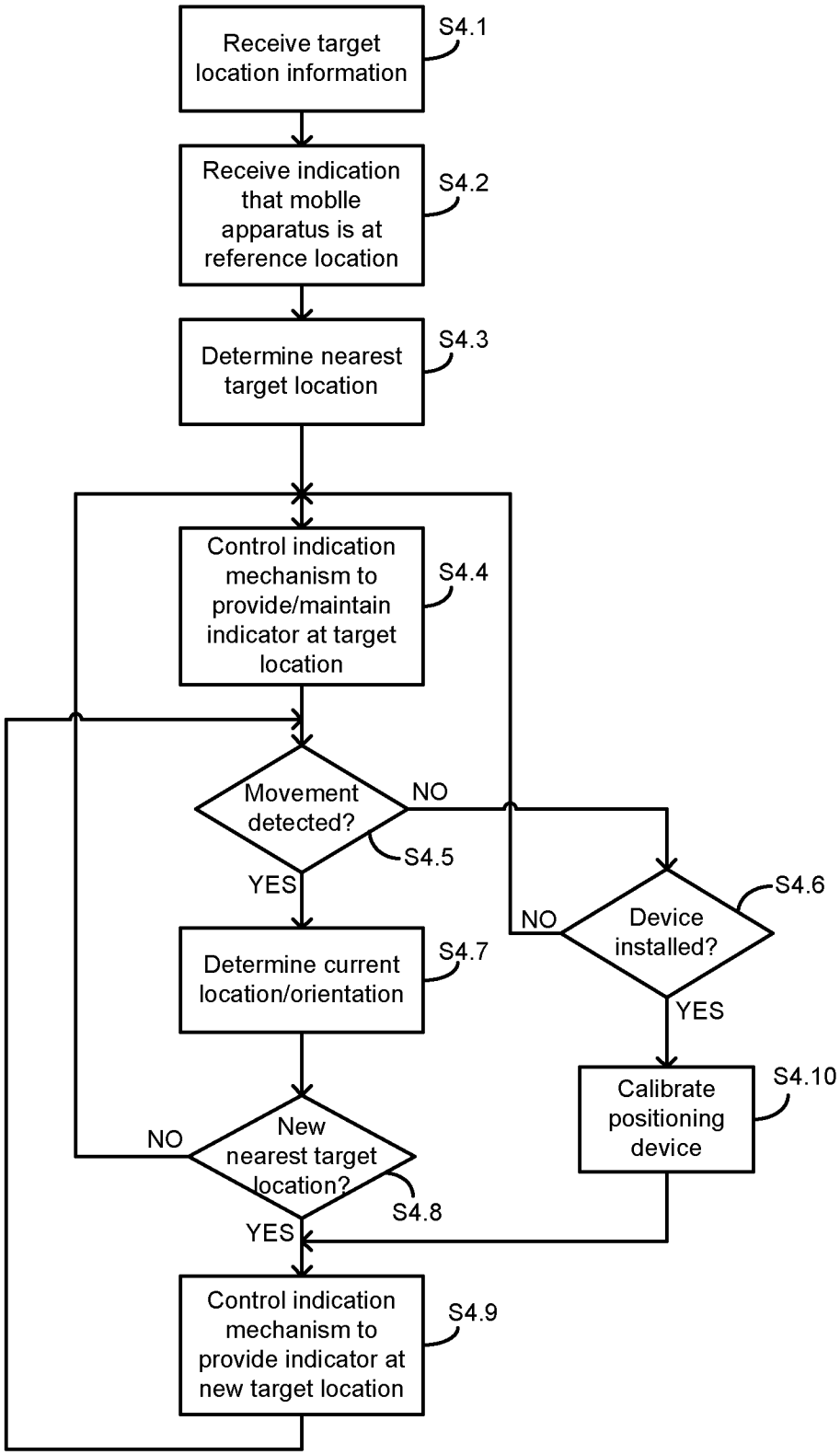

Receive target location information
S4.1
Receive indication that moblle apparatus is at reference location
S4.2
Determine nearest target location
S4.3
Control indication mechanism to provide/maintain indicator at target location
S4.4
Movement detected?
NO
S4.5
YES
Device installed?
S4.6
NO
YES
Determine current location/orientation
S4.7
Calibrate positioning device
S4.10
New nearest target location?
NO
S4.8
YES
Control indication mechanism to provide indicator at new target location
S4.9

Figure 4

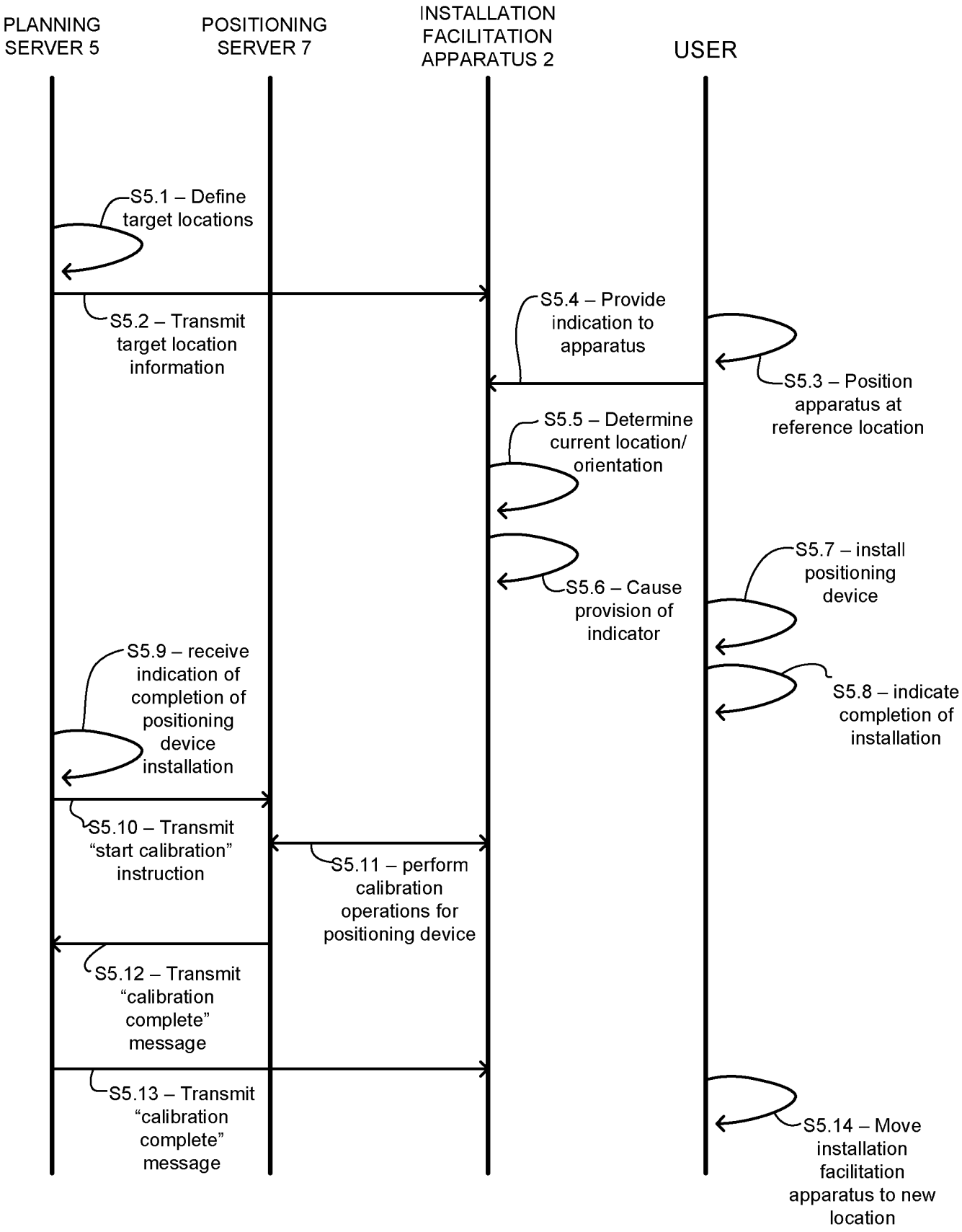

PLANNING SERVER 5
POSITIONING SERVER 7
INSTALLATION FACILITATION APPARATUS 2
USER
S5.1 – Define target locations
S5.2 – Transmit target location information
S5.4 – Provide indication to apparatus
S5.3 – Position apparatus at reference location
S5.5 – Determine current location/ orientation
S5.6 – Cause provision of indicator
S5.7 – install positioning device
S5.8 – indicate completion of installation
S5.9 – receive indication of completion of positioning device installation
S5.10 – Transmit "start calibration" instruction
S5.11 – perform calibration operations for positioning device
S5.12 – Transmit "calibration complete" message
S5.13 – Transmit "calibration complete" message
S5.14 – Move installation facilitation apparatus to new location

Figure 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2015/050501

A. **CLASSIFICATION OF SUBJECT MATTER**

See extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W, G08B, G08C, G02B, G01S, G01C, G01B

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

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base, and, where practicable, search terms used)

EPO-Internal & translations from Thomson Reuters and IPPH/SIPO, WPIAP, INSPEC, XPESP, XPI3E, XPIEE, XPAIP, NPL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2005082262 A1 (RUEB K. D. [CA] et al.) 21 April 2005 (21.04.2005) abstract; paragraphs [0008]–[0012], [0034]–[0039], [0042]–[0043]; claims 1, 17, 21, 23; figures 1–5	1–3, 7–14, 17–21, 25–32, 35–38
X	US 6140957 A (WILSON R. P. [NZ] et al.) 31 October 2000 (31.10.2000) abstract; column 5, lines 1–50; column 7, line 46–column 8, line 26; column 10, line 55–column 11, line 36; figures 5, 10	1–10, 17–28, 35–38
X	US 2013074350 A1 (LE MER E. [FR] et al.) 28 March 2013 (28.03.2013) abstract; paragraphs [0010]–[0011], [0015]–[0037]; figures 1–4	1–2, 8, 10–15, 18–20, 26, 28–33, 36–38

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 November 2015 (18.11.2015)	20 November 2015 (20.11.2015)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2015/050501

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012323534 A1 (KAHLE K. [US] et al.) 20 December 2012 (20.12.2012) abstract; paragraphs [0003]–[0006], [0016]–[0033]; figures 1–4	1–2, 8–13, 15, 18–20, 26–31, 33, 36–38

INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2015/050501

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2015/050501

CLASSIFICATION OF SUBJECT MATTER

IPC
H04W 4/04 (2009.01)
G01C 15/02 (2006.01)
G08B 5/36 (2006.01)
G02B 26/08 (2006.01)
G01S 5/00 (2006.01)