

BUILDING SYSTEM WITH ELEVATOR AND ROUTE PLANNING
FUNCTIONALITY

Description

5 The disclosure generally relates to guiding and transporting users in buildings. More particularly, the disclosure relates to a building system having an elevator operable in consideration of its energy efficiency and user interests, and a method of operating the building system according to these considerations.

10 In a building and as part of a building system, an elevator system may be controlled with an objective to optimize its energy efficiency. Various approaches are known to address the energy consumption of an elevator system. For example, US 9,212,030 B2 discloses an elevator system that obtains energy settings for a user upon the user entering an elevator call. The energy settings determine, for example, movement of an elevator car depending on factors that affect energy consumption, and thus the energy efficiency, of

15 an elevator trip, such as acceleration of the elevator car during a trip, occupancy rate of the car, and settings for car components that consume power, such as car fans, car climate control, and car lighting. According to an approach disclosed in US 9,016,440 B2, the elevator system determines several possible trips for a given destination, displays them together with energy consumption values, allows selection of one of the trips or energy

20 consumption values, and upon selection, operates the elevator car according to the selection.

Although these approaches address the objective of affecting the energy efficiency of an elevator system, for certain buildings these approaches may be too complex, for example,

25 because several possible trips may not be available. Further, while buildings strive to accommodate user interests, it may not be desired that users can choose their own energy settings for an elevator trip. There is, therefore, a need for an alternative approach for optimizing the energy efficiency that is less complex and usable for a broader spectrum of buildings.

30 One aspect of the technology described herein relates to a building system in a building having floors and at least one stairwell connecting the floors. The building system includes at least one elevator having an elevator car and an elevator controller adapted to

cause the elevator car to move between the floors in response to elevator calls entered on call entry floors by elevator users. Further, the building system includes a route planning computer communicatively coupled to the at least one elevator to receive elevator call information, wherein the elevator call information specifies for an entered elevator call a call entry floor and a destination within the building. The route planning computer is adapted to calculate an estimated first energy value of a first elevator trip serving a first elevator call, wherein the first elevator call's call entry floor is used as a first boarding floor and a floor associated with the first elevator call's destination is used as a first destination floor. The route planning computer is further adapted to calculate an estimated second energy value of a second elevator trip serving the first elevator call, wherein for the second elevator trip a second boarding floor is different than the call entry floor and/or a second destination floor is different than the floor associated with the first elevator call's destination. Further, the route planning computer is adapted to generate and transmit, in response to the second energy value being lower than the first energy value, an energy-oriented trip schedule to an elevator call terminal used to enter the first call. The energy-oriented trip schedule includes the second boarding floor and/or the second destination floor, and guidance information for guiding the user from the call input floor to the boarding floor and/or from the destination floor to the floor associated with the first elevator call's destination. The elevator call terminal is adapted to communicate the energy-oriented trip schedule to the user.

Another aspect involves a method of operating such a building system. The method includes receiving elevator call information by the route planning computer, wherein the elevator call information includes for an entered first elevator call a call entry floor and a destination within the building. It further includes calculating an estimated first energy value of a first elevator trip serving the first elevator call. The first elevator call's call entry floor is used as a first boarding floor and a floor corresponding to the elevator call's destination is used as a first destination floor. In addition, the method includes calculating an estimated second energy value of a second elevator trip serving the first elevator call. For the second elevator trip, a second boarding floor is different than the call entry floor and/or a second destination floor is different than the floor associated with the first elevator call's destination. In response to the second energy value being lower than the first energy value, the method includes generating and transmitting an energy-oriented trip schedule to an elevator call terminal used to enter the first elevator call, wherein the

elevator call terminal communicates the energy-oriented trip schedule to the user. The energy-oriented trip schedule includes the second boarding floor and/or the second destination floor, and guidance information for guiding the user from the call entry floor to the boarding floor and/or from the destination floor to the floor corresponding to the first elevator call's destination.

The technology described herein provides for a building system to be more efficient with respect to its consumption of electrical energy and general system performance. In addition, the technology allows a building operator to encourage building users to be more physically active, in particular to use the elevator less and to use instead a stairwell for a portion of a trip. To make it easier for the users, the building system generates and communicates energy-oriented trip schedules upon elevator calls are entered. Although the energy-oriented trip schedule may be considered to be less beneficial for a user because the trip schedule includes a trip portion via the stairwell, overall users' waiting times may be reduced, in particular during times of peak traffic in the building.

An energy-oriented trip schedule may be considered to be more beneficial for the building system, as it helps saving energy and improving the system performance, for example, if empty-car trips or intermediate stops can be avoided or reduced. In case an empty elevator car is in standby mode at one floor above or below the user's call entry floor, an empty-car trip can be avoided if the user is asked to walk up or down to the floor where the elevator car is in standby mode. An intermediate stop can be avoided, for example, if one user is asked to walk to the floor where another user entered an elevator call, as well. In that case, the elevator has to serve only one boarding floor for both users. While the energy-oriented trip schedule can include a trip portion in upward or downward direction, in one embodiment, the upward direction is preferred because it is assumed that the activity level is higher when users walk up the stairs instead in downward direction and because users may proceed faster, safer and more comfortable if all walk in the same direction.

In the building system, the status of the elevator is known. Information regarding the elevator status can include a current traffic situation, a number of elevator calls per unit time, the floors where the elevator calls are entered, which includes knowing where call-entering users are located, and a status of an elevator car, e. g., standby mode and its

destinations or stops when traveling up or down. The route planning computer uses that information to generate an energy-oriented trip schedule when a user enters an elevator call. At that time, information is available about the status of the elevator car(s) and the location (floor) of any other user that entered an elevator call. The route planning
5 computer can then determine if it is, with respect to energy consumption, beneficial to ask the user to use the stairwell to get to the floor where the other user is waiting, or the elevator car is in standby mode. In addition, the skilled person recognizes that in general elevator traffic is reduced when, e. g., one user is asked to walk to the other user's floor.

10 In one embodiment, which may be combined with any of the described embodiments, the building system includes a database stored in a storage system configured for read and write operations by the route planning computer. The database stores data of a building plan, wherein the building plan data specifies at least locations of at least one of elevator halls, residences, establishments, call terminals, stairwells, doors, access gates, escalators,
15 emergency exits or routes, and main building entrances, routes to these locations, and distances between these locations. This allows determining a suitable path to guide the user to the boarding and/or destination. Maintaining this information and data in the database facilitates reading the information and data and updating it, if necessary.

20 In one embodiment, which may be combined with any of the described embodiments, the database stores user profiles. A user's profile specifies transport preferences of the user. The route planning computer is further adapted to determine if the user profile of the user entering the first elevator call specifies as a transport preference the first elevator trip. The first elevator trip is a direct elevator trip between the call entry floor, which is the
25 boarding floor, to the destination, which is the destination floor. In response to determining the user's preference of the first elevator trip, the route planning computer refrains from generating the energy-oriented trip schedule. Instead, the route planning computer generates a standard trip schedule for the first elevator trip and transmits the standard trip schedule to the user. Without a trip portion involving a stairwell, the user is
30 then transported from the call entry floor/boarding floor to the destination floor.

In one embodiment, which may be combined with any of the described embodiments, the energy-oriented trip schedule includes a cancellation option to be selected by the user to reject the energy-oriented trip schedule. The user may reject the energy-oriented trip

schedule for a variety of reasons, e. g., because of a temporary limited mobility (e. g., crutches or a wheelchair) or because of a transport of luggage or other heavy goods. In that case, a rejection signal is received from the elevator call terminal that communicates the energy-oriented trip schedule to the user. The rejection signal indicates the user's
5 selection of the cancellation option to reject the energy-oriented trip schedule. In response, the first elevator trip is scheduled, and a corresponding standard trip schedule is communicated to the user.

In one embodiment, which may be combined with any of the described embodiments, the
10 elevator call terminal is installed on a floor of the building. In addition, or alternatively, a call terminal may be a mobile phone carried by a passenger. The mobile phone may be provided with a software application (app) configured to operate with the technology described herein. Such an app makes it easier for users to orientate themselves and to move within the building; as such, it can help that users accept the energy-oriented trip
15 schedule.

At least some embodiments of the disclosed methods can be implemented using a computer or computer-based device that performs one or more method acts, the computer or computer-based device having read instructions for performing the method acts from
20 one or more computer-readable storage media. The computer-readable storage media can comprise, for example, one or more optical disks, volatile memory components (such as DRAM or SRAM), and/or nonvolatile memory components (such as hard drives, Flash RAM or ROM). The computer-readable storage media do not cover pure transitory signals.

25 In the following, various aspects of the improved technology are explained in more detail by means of exemplary embodiments in connection with the figures. All figures are merely schematic illustrations of methods and terminals or their components according to exemplary embodiments of the improved technology. In particular, distances and size relations are not reproduced to scale in the figures. In the figures, identical elements have
30 identical reference signs. In the drawings:

Fig. 1 shows a schematic side view of an exemplary embodiment of a building system having an elevator;

Fig 2 shows a flow diagram of an exemplary embodiment of a method of operating the building system;

Fig. 3 shows an exemplary embodiment of an elevator call terminal arranged on a call entry floor and displaying a graphical user interface controlled to show guidance information; and

Fig. 4 shows an exemplary embodiment of a mobile communications device used as an elevator call terminal displaying a graphical user interface controlled to show guidance information.

Fig. 1 shows a schematic illustration of an exemplary embodiment of a building system 1 having at least one elevator 2 installed in a building and a route planning computer 20. The route planning computer 20 is communicatively coupled to the at least one elevator 2 to receive elevator call information. The building can be any type of multilevel building (e. g., a residential building, a hotel, an office building, a sports station, or a mixed-use building). Further, the elevator system 1 may be installed on a ship. In the following, components, and functions of the elevator 2 are explained with reference to **Fig. 1** and as far as they may be helpful for an understanding of the technology described herein. The building shown in **Fig. 1** has a plurality of floors L1, L2, L3 and at least one internal or external stairwell 3 (also referred to as stairs) that interconnects the floors L1, L2, L3. The elevator 2 serves these floors L1, L2, L3, i. e., the elevator 2, under control of an elevator controller (EC) 12, transports a user 8 in an elevator car 10 from a boarding floor to a destination floor in response to the user 8 entering an elevator call using an elevator call terminal 4. In the exemplary embodiment shown in **Fig. 1**, the elevator car 10 is movable along a travel path in the building; the travel path extends along a vertical elevator shaft 26, without being limited to such a travel path. Embodiments of the technology disclosed herein are described with reference to the exemplary elevator 2 shown in **Fig. 1**.

In the situation shown in **Fig. 1**, the technology described herein may be advantageously used to improve the operation of the elevator 2 with respect to use of electrical energy and system performance, and at the same time to motivate users 8 to use the elevator 2 less and, instead, to use the stairwell 3 for a portion of a trip for additional physical activity. Summarized and by way of example, the building system 1 according to one exemplary embodiment uses a route planning computer 20 to generate and transmit a trip

schedule to a user 8. Regarding elevator performance and use of electrical energy, this trip schedule is generally more beneficial for the building system 1 and may be considered less beneficial for a user 8 because the trip schedule includes a trip portion via the stairwell 3. This generated trip schedule is herein referred to as an energy-oriented trip
5 schedule. In one embodiment, the trip portion is in upward direction, for example, because it is assumed that the activity level is higher when users 8 walk up the stairs instead in downward direction.

Referring to the illustrated situation, the user 8 is at a call entry floor and enters an
10 elevator call using an elevator call terminal 4 installed at that floor. The route planning computer 20 compares the electrical energy needed for a direct elevator trip between the call entry floor (= boarding floor) to the destination (= destination floor) with the electrical energy needed for an indirect elevator trip in which the boarding floor is
15 different from the call entry floor and/or the destination floor is different from the desired destination. If the indirect elevator trip needs less electrical energy, the route planning computer 20 generates and communicates an energy-oriented trip schedules to the user 8; the energy-oriented trip schedule includes the determined boarding floor and/or the determined destination floor and guidance information for guiding the user 8 from the call
input floor to the boarding floor and/or from the destination floor to the floor
20 corresponding to the desired destination. In such an indirect elevator trip, the user 8 is expected to use the stairwell 3 to bridge the difference between one or more floors. Further details are disclosed elsewhere in this description.

The exemplary elevator system 2 shown in **Fig. 1** includes further a drive machine (M)
25 14, a counterweight 18, a suspension means 16 (one or more steel ropes or flat belts) and a plurality of deflection pulleys 24. The suspension means 16 has two ends, each end being attached to a fixed point 22 in the elevator shaft 26. Between the fixed points 22, the suspension means 16 partially wraps around the deflection pulley 24 on the counterweight 18, a traction sheave of the drive machine 14 and the deflection pulleys 24
30 on the elevator car 10. The elevator system 2 shown is a traction elevator, wherein further details, such as, for example, guide rails for the elevator car 10 and guide rails for the counterweight 18 are not shown in **Fig. 1**. The elevator controller 12 is connected to the drive machine 14 and controls it to move the elevator car 10 in the shaft 26. The function of a traction elevator, the components of which and the tasks of an elevator control 12 are

generally known to the person skilled in the art. The person skilled in the art will recognize that the technology described here is not limited to use in a traction elevator. The person skilled in the art will also recognize that the elevator system 2 can comprise a plurality of elevator cars 10 or multi-deck cars in one or more elevator shafts or can
5 comprise one or more groups of elevators.

In the embodiment of **Fig. 1**, an elevator call terminal 4 is arranged on each floor L1, L2, L3 and is coupled to the route planning computer 20 by means of a communication connection 6. The communication connection 6 may be implemented with wire cables
10 (e. g., by individual lines or a communication bus) and/or without wires (e. g., using known RF technologies such as Wi-Fi/WLAN or ZigBee networks). Each of these operating terminals 4 can have, for example, a terminal identifier (also referred to as a terminal ID) by which an elevator call terminal 4 is identifiable and addressable; in one embodiment, for example, the elevator call terminal 4 transmits an entered elevator call
15 along with its terminal ID to the route planning computer 20 which acknowledges the call to the elevator call terminal 4 identified by the terminal ID. In connection with the technology described herein, the energy-oriented trip schedule including guidance information and information about the elevator 2 allocated to serve the call can be sent to the elevator call terminal 4.

20 The elevator 2 is provided with a destination call control technology. A floor-side elevator call terminal 4 allows a user 8 to enter a destination floor, while a car terminal may allow the user 8, e. g., to signal an emergency and/or to affect the closing of the elevator doors. One example of an elevator system equipped with a destination call
25 control technology is a Schindler 7000 elevator system with the Schindler PORT Technology. The destination call control system is based on a call allocation algorithm whose principle is generally described in Koehler, Jana, et al., An AI-Based Approach to Destination Control in Elevators, AI Magazine, Vol. 23, Nr. 3, 2002, S. 59-78. The allocation algorithm applies the concept of "cost" and uses one or more cost functions to
30 determine an elevator car best suited to serve an elevator call. Embodiments of the technology described herein are in the following described with reference to the destination call control technology.

The floor-side elevator call terminal 4 can be arranged at a desired location on a floor L1,

L2, L3, e. g., on a building wall or freestanding at a desired location. The location can be, e. g., an anteroom in front of one or more elevator (floor) doors or an entrance to an elevator lobby. While the location is relatively freely selectable, there are specifications (e. g. according to a standard (e. g., EN81-70) or applicable laws and regulations) in terms of at what height range the elevator call terminal 4 or a user interface of the elevator call terminal 4 are to be arranged. This is to ensure that the elevator call terminal 4 is located at a height at which the elevator call terminal 4 or the user interface can be reached by potential users and displayed information can be perceived, in particular by users with reduced mobility.

Entry of an elevator call may require a user 8 to present an RFID (radio-frequency identification) or NFC card, a magnetic storage device (e. g., magnetic strip cards); and/or an optical code device, e. g., for identification and/or authentication purposes. These installed terminals 1 are illustrated in **Fig. 1** as floor terminals displaying, e. g., a selection of possible destinations within the building 1. In addition, a portable mobile device, e. g., a mobile (smart) phone, may be configured to execute a dedicated software application (app) and serve as a mobile elevator call terminal, which is illustrated in **Fig. 1** as a mobile communications device such as mobile phone. A mobile phone may be equipped with an RFID/NFC, Bluetooth module to communicate with the elevator system 2. The skilled person will recognize that other radio communication technologies may be used, such as ultra-wideband (UWB) technology, which is known to be used, for example, for collection of sensor data, and detection, precise location and tracking of objects and persons. For ease of reference, a mobile device is herein considered as an elevator call terminal and, hence, reference numeral "4" is used for a mobile phone, as well.

As mentioned above, the user 8 can enter the elevator call at an elevator call terminal 4 installed on a floor L1, L2, L3 or by means of a mobile phone that communicates with the elevator call terminal 4, wherein the elevator call terminal 4 forwards in one embodiment the elevator call to the elevator controller 12. In this case, the user's location results from the location of the elevator call terminal 4; the user 8 is on the same floor L1, L2, L3 as the elevator call terminal 4 and, for example, in its vicinity. The elevator 2 with its elevator call terminals 4, hence, implements a function of determining or detecting a location of the user 8 that enters an elevator call.

In another embodiment, a separate location system 28 may be provided that detects a location of a user 8 entering an elevator call using a mobile phone that cannot communicate with the elevator call terminal 4, e. g., because the elevator call terminal 4 is not equipped with an RF communications module. The detected location of the user 8 is on the call entry floor L1, L2, L3, and corresponding information may be limited to specifying that the user 8 is on the call entry floor L1, L2, L3; in another embodiment, the corresponding information may specify the user's location on the call entry floor L1, L2, L3 in more detail. The corresponding information is in one embodiment included in the elevator call information.

The location system 28 can include a set of RF communications modules (e. g., Bluetooth, WLAN or UWB technology), a set of cameras, or a set of dynamically changing QR code devices, wherein each floor L1, L2, L3 can be provided with an RF communications module, a camera or a QR code device; their locations can be documented in a building plan. The location system 28 can be communicatively coupled, for example, to the elevator controller 12 or the route planning computer 20, as indicated in Fig. 1. It is further contemplated that the location system 28 includes hardware and software to control the RF communications modules, cameras and device to process their recordings. The processing may include detecting the user 8, e. g., in a video recording for tracking purposes (e. g., to determine in which direction a user 8 walks, or which elevator car 10 the user 8 boards, and when), or performing facial recognition for identification and/or authentication purposes (e. g., to determine if the user 8 is authorized to use the transport system 8 and/or to access a certain destination). Tracking, identification and/or authentication may also be applied to determine if a user 8 follows a certain path/travel route, e. g., if the user 8 board the "correct" elevator.

In one embodiment, the functionality of the location system 28 can be implemented at least partially in the route planning computer 20. Using documented floor locations of the RF modules, cameras or QR code devices, the location system 28 determines the location of the user 8 entering an elevator call using a mobile phone. In such a situation, the location system 28 further assists in verifying that the user 8 is in fact within the building when entering the elevator call.

The route planning computer 20 is coupled to receive elevator call information which includes for an entered elevator call the call entry floor L1, L2, L3 and a destination within the building. In one embodiment, the route planning computer 20 may be further coupled to receive location information from the location system 28 if provided in the building. In the embodiment of **Fig. 1**, a computer-readable storage system 30 is shown that stores at least one database. In one embodiment, the storage system 30 can be a part of the route planning computer 20. The storage system 30 is adapted for read and write operations by the route planning computer 20. The database stores data of a building plan or a building model. The stored data may include a directory of residents and available services (e. g., company names, hotels, restaurants, gyms, and other services or points of interest) within the building, including data specifying where they are located (e. g., floor number and office/store/room/apartment number). For each resident or group of residents (e. g., a family or a firm) a passenger profile may be stored in the same or a different database. The user profile can specify any transport requirements, such as solo travel, mobility restrictions (e. g., no stairs, no escalators)

The stored data may further specify the location of the elevator 2 within the building and the respective distances from the residential locations (e. g., room/apartment number), call terminals 4 and available services. The building plan data may further specify, e. g., locations of doors, security/access gates, escalators, emergency exits or routes, main building entrances, routes and lanes to these locations, and distances between these locations. Areas or zones within the building that are not assigned to a residence or service may be identified by one or more sectors or sector numbers. It is contemplated that the stored building data is provided and available to such a level of detail that allows planning a route from a place of departure to a destination location. The building data may be updated, e. g., due to changing occupancies or uses, or to reflect current building situations (e. g., constructions, out-of-service elevator cars or vehicles).

The functionality of the route planning computer 20 may be implemented in the elevator 2, e. g., in connection with its call allocation function. These functionalities execute in one embodiment algorithms, e. g., including one similar to the above-mentioned allocation algorithm of a destination call control system, that use at least one of the elevator call information, the location information, and the building plan data in combination with to determine various route options and the energy values (EV) for these

route options.

For calculating energy values, at least one energy measuring apparatus may be installed in the building system 1. An energy measuring apparatus can be locally placed on a
5 selected energy consumer, e. g., the drive machine 12, to detect its energy consumption. Further, a traffic situation can be detected and used for calculating the energy values. In order to detect the traffic situation, a number of elevator calls per unit of time can be detected, or a number of users 8 who have been transported by the elevator 2 in a unit of time in the building can be determined. It can also be appropriate to take a number of
10 users 8 who have been transported by the elevator 2 from boarding floors to destination floors in a unit of time as a basis as the user flow in the building and, thus, as the traffic situation.

The detected energy consumption and/or the detected traffic situation can be stored in the
15 computer-readable storage system 30, with the result that the stored data can be identified for subsequent use and can be retrieved from the storage system 30. The energy values can then be estimated on the basis of retrieved data. In this case, an energy consumption and/or a traffic situation need only be identified and can then be loaded, which can make renewed detection unnecessary.

20 The route planning computer 20 is adapted to generate the energy-oriented trip schedule on the basis of determined energy values. A direct trip and a resultant energy value, for example, may be taken as a (energy) basis for an elevator call. Further energy values can be determined for trips where the user 8 enters or leaves the elevator car 10 at another
25 floor instead of the call entry floor or destination. In addition, energy values can be determined for traffic situations involving intermediate stops, for instance in order to allow further users 8 to get in or out of the elevator car 10.

30 The algorithms can take special situations or users 8 into account, for example, in consideration of user profiles defined for the users 8. The user profiles can be stored in the database of the storage system 30, or in another storage device of the building system. In a user profile, a user's access rights, and transport preferences can be specified, for example. For instance, the algorithms may exclude an indirect trip and schedule only a direct trip for an elevator call entered by a user 8 whose user profile indicates that it is a

wheelchair user that cannot use the staircase 3 or that it is a VIP user that requires special security in the building and fast elevator service. It is contemplated that user profiles may specify other reasons for excluding indirect trips. It is further contemplated that the algorithms may take the time of day and related traffic situations into account. For
5 example, it can be set that during peak traffic times, unless in case of a special situation or user, direct trips are excluded.

Furthermore, in one embodiment, the route planning computer 20 may apply any number of path computation techniques, for example, in combination with the allocation
10 algorithm. Example techniques can be similar to those used by software programs that plan travel routes and/or driving directions. Such a path computation technique may be used, for example, to determine the shortest and/or fastest way from a user's current location at the call entry floor to the location where the elevator car 10 is to be boarded on the boarding floor when the energy-oriented trip schedule involves the staircase 3. In case
15 the building has more than one staircase 3, the most convenient (e. g., closest) for the user 8 may be selected. With the way being selected, the path computation technique can estimate the time when the user 8 will arrive at the boarding floor; the elevator controller 12 can use this estimated time to make the elevator car 10 available to the user 8 at about this time.

20 With the understanding of the components of the building system 1 described above and their functions, an exemplary method of operating the building system 1 shown in **Fig. 1** is described below in conjunction with **Fig. 2**. In the situation shown in **Fig. 1**, the user 8 is on the floor L1 and uses an elevator call terminal 4 to enter an elevator call that
25 specifies a desired destination within the building. Depending on the building, the user 8 may be required to present some form of credential when entering the elevator call; the credential may be used to verify the passenger's transport and/or access rights. If the elevator call terminal 4 is installed on the floor L1, its location is documented in and available from the building plan. If the elevator call terminal 4 is a mobile phone, it
30 receives according to one embodiment a radio transmission from, e. g., the location system 28 and its fixed radio transmitting device (e. g., a sender, transceiver or beacon using a WLAN or a Bluetooth technology) whose location is documented in the building plan; the mobile phone's location is then set as being in proximity of this radio transmitting device. In another embodiment, the user 8 may manually enter the location

using a graphical user interface provided by a touchscreen of a call terminal 4 (either in its installed terminal configuration or as a mobile phone). An exemplary graphical user interface 32 of a floor-installed elevator call terminal 4 is shown in **Fig. 3**, and an exemplary graphical user interface 36 of a mobile elevator call terminal 4 (mobile phone) is shown in **Fig. 4**.

The user interface 32 of the floor-installed elevator call terminal 4 may be configured to display a selection of possible destinations (e. g., as indicated in **Fig. 1**), e. g., the most recently used destinations or only those the user 8 is authorized to access, from which the user 8 may select a destination. In another embodiment, the user interface may display a keyboard to allow the user 8 to enter the destination. As mentioned above, the user 8 may have to present some form of credential at a recognition device 38 shown in **Fig. 3** to obtain access to a destination.

The method shown in **Fig. 2** begins with a step **S1** and ends with a step **S10**. A person skilled in the art will recognize that the division into these steps is by way of example, and that one or more of these steps may be divided into one or more sub-steps, or that several of the steps may be combined into one step.

At a step **S2**, elevator call information is received. The elevator call information is received by the route planning computer 10 and derived from an elevator call entered by the user 8 using an elevator call terminal 4. The elevator call information specifies a call entry floor (e. g., L2) and the desired destination.

At a step **S3**, an estimated first energy value EV1 is calculated. The route planning computer 10 calculates the first energy value EV1 for a first elevator trip serving the elevator call, wherein the elevator call's call entry floor is used as a first boarding floor and a floor corresponding to the elevator call's destination is used as a first destination floor. Using the first boarding floor, the first destination floor and the building plan data, the route planning computer 20 uses the algorithms, as mentioned above, to determine several transportation cost values for direct trips and to select the one that has the lowest transportation cost value as the first energy value EV1. The algorithm uses in one embodiment waiting time, travel time, elevator availability and energy use as parameters.

At a step **S4**, an estimated second energy value EV2 is calculated. The route planning computer 10 calculates the second energy value EV2 for a second elevator trip serving the first elevator call, wherein for the second elevator trip a second boarding floor is different than the call entry floor and/or a second destination floor is different than the floor associated with the first elevator call's destination. Unlike in the step **S3**, this calculation assumes that the user 8 will have to use the stairwell 3 to board the elevator car 10, to finally reach the destination floor, or both. Using the second boarding floor, the second destination floor and the building plan data, the route planning computer 20 uses the algorithms, as mentioned above, to determine several transportation cost values for indirect trips and to select the one with the lowest energy use as the second energy value EV2.

At a step **S5**, the calculated first and second energy values EV1, EV2 are compared. If the second energy value EV1 is lower than the second energy value EV2, the method proceeds along the YES branch to a step **S6**, other along the NO branch to a step **S7**.

At the step **S6**, in response to the second energy value EV2 being lower than the first energy value EV1, an energy-oriented trip schedule is generated. The energy-oriented trip schedule includes the second boarding floor and/or the second destination floor, and guidance information for guiding the user 8 from the call entry floor to the boarding floor and/or from the destination floor to the floor corresponding to the first elevator call's destination. The energy-oriented trip schedule can include an identification of the elevator car 10 assigned to serve the user's elevator call and any additional information believed to assist the user 8, e. g., how much time it takes to reach the assigned elevator car 10 at the boarding floor or the desired destination after exiting the assigned elevator car 10. It is contemplated that the energy-oriented trip schedule allows for sufficient time for the user 8 to transition from the call entry floor to the boarding floor. These considerations facilitate the user's orientation within the building, e. g., after using the stairwell 3 and arriving at the boarding floor, and further in case more than one elevator car 10 serves this boarding floor. In another embodiment, the identification of the elevator car 10 can be communicated to the user 8 once the user 8 is at the boarding floor.

At the step **S7**, in response to the second energy value EV2 not being lower than the first energy value EV1, a trip schedule is generated, as well. For that trip schedule, the call

entry floor is the boarding floor and the floor corresponding to the elevator call's destination is the destination floor. As this results in a conventional elevator trip, the trip schedule generated at the step **S7** is herein referred to as standard trip schedule.

5 At a step **S8**, the trip schedule is communicated to the user 8. In particular, the energy-oriented trip schedule generated in the step **S6** is communicated to the user 8 because the user 8 is expected to use the staircase 3 when boarding and/or exiting the elevator car 10. The energy-oriented trip schedule may cover the whole trip or only a certain trip section (e. g. floor-by-floor). The elevator call terminal 4 controls the graphical user interface 32
10 shown in **Fig. 3** and/or the mobile phone's graphical user interface 36 shown in **Fig. 4** to display the trip schedule to the user 8. The graphical user interface 32 according to the embodiment shown in **Fig. 3** includes, for example, a symbol for stairs and an arrow that points upwards from floor L1 to floor L2 to instruct the user 8 to use the stairwell 3. In another embodiment, additional information may be displayed, e. g., a route to the closest
15 staircase 3 and/or other guidance information depending on particularities of the building.

In one embodiment, the graphical user interface 32 shown in **Fig. 3** displays a button 34 that allows the user 8 to cancel or confirm a call. The graphical user interface 36 according to the embodiment shown in **Fig. 4** displays corresponding information
20 including a button 40 to cancel or confirm a call. The buttons 34, 40 provide for a cancellation option to be selected by the user 8 to reject the energy-oriented trip schedule. The user 8 may reject the energy-oriented trip schedule for a variety of reasons, e. g., because of a temporary limited mobility (e. g., using crutches or a wheelchair) or because of a transport of luggage or other heavy goods. In that case, a rejection signal is received
25 from the elevator call terminal 4 that communicates the energy-oriented trip schedule to the user. The rejection signal indicates the user's selection of the cancellation option to reject the energy-oriented trip schedule. In response, the first elevator trip is scheduled, and a corresponding standard trip schedule is communicated to the user 8.

30 Communicating the standard trip schedule generated in the step **S7**, however, can be optional, as indicated in **Fig. 2** through a dashed line between the steps **S7** and **S8**, because the user 8 does not have to use the staircase 3. After the step **S7** and in case it is communicated, the communication can be limited to an acknowledgement of the user's elevator call and/or an identification of the elevator car 10 assigned to serve elevator call.

Depending on the elevator 2, the communication may indicate (e. g., in seconds) when the assigned elevator car 10 is estimated to arrive at the boarding floor.

5 At a step **S9**, the trip schedule according to one of the steps **S6** and **S7** is executed. The trip planning computer 20 controls the elevator controller 12 according to the respective trip schedule. For example, in the embodiment shown in **Fig. 3**, the elevator controller 12 sends the elevator car 10 to the floor L2 instead of to the call entry floor L1, and then to the destination floor determined. At the step **S10**, the method ends.

10 The execution of the trip schedule can be monitored, e. g., using the location system 28. For example, the building system 1 may be equipped to track the user 8 in real time and, hence, can compare a current location or trajectory of the user 8 with the route the user 8 should take according to the trip schedule. For example, the building system 1 may recognize that the user 8 boards or is about to board an elevator car 10 not allocated for
15 the trip, or recognize that the user 8 exits the elevator car 10 at the wrong floor. In case the building system 1 determines a deviation that negatively affects servicing the elevator call, the route planning computer 10 may initiate a mitigating measure (e. g., re-allocate the elevator car 10) and/or a notification for the user 8, e. g., by sending a (push) message to the user's mobile phone. The message could advise the user 8 that the trip schedule has
20 been modified and include an updated trip schedule.

It is contemplated that a mobile phone is one example of a portable electronic device that can be used in conjunction with the technology described herein. In this particular embodiment, the mobile phone 4 comprises a touch screen, but other embodiments can
25 use a variety of input devices and output devices. The touch screen displays a graphical user interface 60 with an input area for receiving a destination of a trip. The touch screen also displays an input area for indicating a desired arrival time at the destination. The user 8 can use a button to submit the trip information and reserve the trip. Additional information can also be provided by the user 8 through the elevator call terminal 4. For
30 example, the user 8 can indicate a preferred mode of transportation, how many other people will be traveling with the user 8, how much luggage the user 8 will bring and/or information about any reminders the user 8 wishes to receive prior to departure.

Claims

1. A building system (1) in a building having floors (L1, L2, L3) and at least one stairwell (3) connecting the floors (L1, L2, L3), comprising:
- at least one elevator (2) having an elevator car (10) and an elevator controller (12)
- 5 adapted to cause the elevator car (10) to move between the floors (L1, L2, L3) in response to elevator calls entered on call entry floors (L1, L2, L3) by elevator users (8); and
- a route planning computer (20) communicatively coupled to the at least one elevator (2) to receive elevator call information, wherein the elevator call information
- 10 specifies for an entered elevator call a call entry floor (L1, L2, L3) and a destination within the building, and wherein the route planning computer (20) is adapted:
- to calculate an estimated first energy value (EV1) of a first elevator trip serving a first elevator call, wherein the first elevator call's call entry floor is used as a first boarding floor and a floor associated with the first elevator call's destination is
 - 15 used as a first destination floor;
 - to calculate an estimated second energy value (EV2) of a second elevator trip serving the first elevator call, wherein for the second elevator trip a second boarding floor is different than the call entry floor and/or a second destination floor is different than the floor associated with the first elevator call's destination;
 - 20 and
 - in response to the second energy value (EV2) being lower than the first energy value (EV1), to generate and transmit an energy-oriented trip schedule to an elevator call terminal (4) used to enter the first call, wherein the energy-oriented trip schedule includes the second boarding floor and/or the second destination
 - 25 floor, and guidance information for guiding the user from the call input floor to the boarding floor and/or from the destination floor to the floor associated with the first elevator call's destination, wherein the elevator call terminal (4) is adapted to communicate the energy-oriented trip schedule to the user (8).
- 30 2. The building system (1) of claim 1, further comprising a database stored in a storage system (30) configured for read and write operations by the route planning computer (20), wherein the database stores data of a building plan, the building plan data specifying at least locations of at least one of elevator halls, residences, establishments, elevator call terminals (4), doors, access gates, escalators, emergency exits or routes,

stairwells (3), main building entrances, routes to these locations, and distances between these locations.

3. The building system (1) of claim 2, wherein the database stores user profiles,
5 wherein a user's profile specifies transport preferences of the user (8), wherein the route planning computer (20) is further adapted to determine if the user profile of the user (8) entering the first elevator call specifies as a transport preference the first elevator trip, and in response to determining the preference of the first elevator trip, refraining from generating the energy-oriented trip schedule, generating a standard trip schedule for the
10 first elevator trip and transmitting the standard trip schedule to the user (8).

4. The building system (1) of any preceding claim, further comprising a location system (28) coupled to the route planning computer (20) and adapted to detect a location of a user (8) entering an elevator call, wherein the detected location is included in the
15 elevator call information for use in the calculation of at least one of the first and second energy values (EV1, EV2).

5. The building system (1) of any preceding claim, wherein the elevator call terminal (4) is installed on a floor (L1, L2, L3) and/or wherein the elevator call terminal (4) is a
20 mobile communications device carried by the user (8), wherein the elevator call terminal (4) includes a graphical user interface (32, 36) to communicate at least the energy-oriented trip schedule via a visual notification and/or an audible notification to the user (8).

6. The building system (1) of any preceding claim, wherein the energy-oriented trip schedule includes a cancellation option (34, 40) to be selected by the user (8) to reject the energy-oriented trip schedule, wherein the route planning computer (20) is adapted to receive a rejection signal from the elevator call terminal (4) communicating the energy-oriented trip schedule to the user (8), wherein the rejection signal indicates the user's
25 selection of the cancellation option (34, 40), and generating a standard trip schedule according to the first elevator trip and transmitting the standard trip schedule to the user (8).
30

7. The building system (1) of any preceding claim, wherein the route planning

computer (20) is further adapted to determine a status of the elevator car (10), in particular whether it is in a standby mode at a floor above or below the user's call entry floor, and/or to determine if a second elevator call is entered at a different call entry floor (L1, L2, L3), wherein the energy-oriented trip schedule includes the floor above or below the user's call entry floor and/or the different call entry floor (L1, L2, L3) as the second departure floor, wherein the guidance information instructs the user (8) to use the stairwell (3) to get to the second departure floor.

8. A method of operating a building system (1) having at least one elevator (2) and a route planning computer (20) communicatively coupled to the at least one elevator (2) to receive elevator call information, wherein the at least one elevator (2) has an elevator car (10) and an elevator controller (12) adapted to cause the elevator car (10) to move between floors (L1, L2, L3) of a building (2) in response to elevator calls entered on call entry floors (L1, L2, L3) by elevator users (8), the method comprising:

- receiving elevator call information by the route planning computer (20), wherein the elevator call information includes for an entered first elevator call a call entry floor (L1, L2, L3) and a destination within the building;
- calculating an estimated first energy value of a first elevator trip serving the first elevator call, wherein the elevator call's call entry floor is used as a first boarding floor and a floor corresponding to the elevator call's destination is used as a first destination floor,
- calculating an estimated second energy value of a second elevator trip serving the first elevator call, wherein for the second elevator trip a second boarding floor is different than the call entry floor and/or a second destination floor is different than the floor associated with the first elevator call's destination; and
- in response to the second energy value being lower than the first energy value, generating and transmitting an energy-oriented trip schedule to an elevator call terminal (4) used to enter the first elevator call, wherein the energy-oriented trip schedule includes the second boarding floor and/or the second destination floor, and guidance information for guiding the user (8) from the call entry floor to the boarding floor and/or from the destination floor to the floor corresponding to the first elevator call's destination, wherein the elevator call terminal (4) is adapted to communicate the energy-oriented trip schedule to the user (8).

9. The method of claim 8, further comprising reading data of a building plan from a database stored in a storage system (30), wherein the database stores data of a building plan, the building data specifying at least locations of at least one of elevator halls, residences, establishments, call terminals (4), doors, access gates, escalators, emergency
5 exits or routes, stairwells (3), main building entrances, routes and lanes to these locations, and distances between these locations, and using read building plan data for calculating the trip schedule.

10. The method of claim 9, wherein the database stores user profiles, wherein a user's
10 profile specifies transport preferences of the user (8), the method further comprising determining if the user profile of the user (8) entering the first elevator call specifies as a transport preference the first elevator trip, and in response to determining the preference of the first elevator trip, refraining from generating the energy-oriented trip schedule, generating a standard trip schedule according to the first elevator trip and transmitting the
15 standard trip schedule to the user (8).

11. The method of one of claims 8 – 10, further comprising detecting, using a location system (28) coupled to the route planning computer (20), a location of the user (8) entering the first elevator call, including the detected location d in the elevator call
20 information for use in the calculation of at least one of the first and second energy values (EV1, EV2).

12. The method of one of claims 8 – 11, further comprising receiving a rejection signal from the elevator call terminal (4) communicating the energy-oriented trip schedule to the
25 user (8), wherein the rejection signal indicates the user's selection of a cancellation option (34, 40) included in the energy-oriented trip schedule to reject the energy-oriented trip schedule, and generating a standard trip schedule according to the first elevator trip and transmitting the standard trip schedule to the user (8).

30 13. The method of one of claims 7 – 12 further comprising monitoring a movement of the user (8) to determine if the user (8) moves according to the energy-oriented trip schedule using a location system (28) coupled to the route planning computer (20) and generating and communicating a notification to the user (8) in case a deviation.

14. The method of claim 13, further comprising initiating at least one mitigating measure in response to deviation, wherein the at least one mitigating measure includes generating a further notification for being communicated to the user (8).