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(54) **VEHICLE MONITORING SYSTEM**

(57) The present invention relates to a control server for monitoring an electronic guided transport system comprising one or more vehicles. The control server comprises a mobile movement identification unit configured to receive a physical identification tag (PT) comprising a physical identification code (PID) and a time stamp of receiving the PID from a beacon of one or more beacons comprising vehicle beacons installed at vehicles of the one or more vehicles and local beacons installed at local

destinations, a logical information database storing logical identification codes (LID) of logical identification tags (LT) comprising LIDs of the one or more vehicles and time stamps scheduled for one or more local destinations of a travelling route of each of the one or more vehicles, and an assignment unit configured to iteratively assign all PIDs received from the mobile devices to LIDs stored in the logical database, until every PID is assigned to a LID.

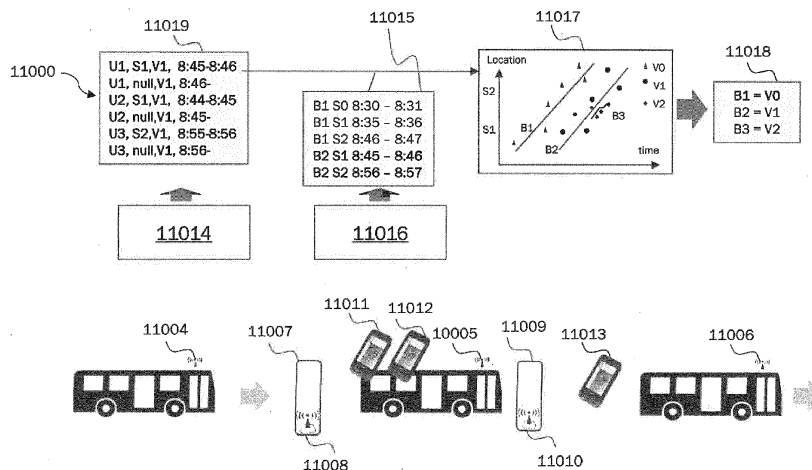


Fig. 11

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Description

[0001] The present disclosure relates to a control server, a control system, a control method and a computer program, preferably, for monitoring an electronic guided transport system comprising one or more vehicles.

Background

[0002] Electronic guided transport systems, such as electronic guided buses, for example, are controlled based on electronic track information provided by beacons in the buses and at local destinations, such as bus stops, for example.

[0003] US 2015/0294566 A1 describes a method for trip management provided for an electronic guided bus that follows an electronic track.

[0004] Further, electronic ticketing systems are known that provide a user's mobile device with ticket information for using an electronic guided transport system.

[0005] Since electronic ticketing systems and electronic transport systems are independent from each other, an operator operating a fleet of electronic guided buses cannot combine the information provided by an electronic ticketing system and an electronic guided transport system. Thus, the operator is not able to monitor a number of people using a particular bus, for example. Accordingly, situations occur, where overcrowded or empty buses are provided.

Problem and Solution

[0006] It is an object of the herein described disclosure to provide a solution to the problem of monitoring an electronic guided transport system and to thereby improve the control thereof.

[0007] The following aspects are in particular provided: According to a first aspect, there is provided a control server for monitoring an electronic guided transport comprising one or more vehicles. The control server comprises a mobile movement identification unit configured to receive a physical identification tag (PT) comprising a physical identification code (PID) and a time stamp of receiving the PID from a beacon of one or more beacons comprising vehicle beacons installed at vehicles of the one or more vehicles and local beacons installed at local destinations, a logical information database storing logical identification codes (LID) of logical identification tags (LT) comprising LIDs of the one or more vehicles and time stamps scheduled for one or more local destinations of a travelling route of each of the one or more vehicles, and an assignment unit configured to iteratively assign all PIDs received from the mobile devices to LIDs stored in the logical database, until every PID is assigned to a LID.

[0008] In the context of the present disclosure, a PT may be a dataset comprising one or more codes and one or more time stamps. In particular, a PT may be a table

comprising at least one PID and associated time stamps.

[0009] In the context of the present disclosure, a PID may be unique code provided by a beacon, such as a vehicle identification number or any other unique identification feature that is non-editable.

[0010] In the context of the present disclosure, a mobile device may be an electronic user device, such as a phone, a laptop or any other electronic mobile unit for exchanging information with a server over a communication network. A server may be a remote computer or a plurality of computers. The computers may be distributed over a network, such as in a cloud-computing scenario.

[0011] In the context of the present disclosure, a beacon may be an electronic device that is configured to transmit information by a radio signal unidirectional to another electronic device in a predetermined range. In particular, a beacon may be based on WIFI, RFID or NFC or any other wireless data transmission technology. The local beacon may especially be a stationary beacon that is installed at points of interest, such a station of a public transportation system. The beacons installed on a vehicle are "mobile beacons" because they move corresponding to the movement of the vehicle. The mobile device of a user using a vehicle, such as a bus, a train, or the like, will receive frequently emitted signals from the beacons which are in the range of the signal transmission of a beacon. Every time the mobile device receives a beacon signal, which includes the unique code of said beacon, a time stamp is added to a data package which is then sent to the server/remote computer(s).

[0012] In the context of the present disclosure, a LT may be a dataset comprising one or more logical codes and one or more scheduled time stamps. In particular, a LT may be a table comprising at least one LID and associated scheduled time stamps.

[0013] In the context of the present disclosure, a LID may be unique code provided by an operator, for example, such as predetermined randomized number of digits and/or letters which may be assigned to a beacon or a vehicle and it may change/be changed.

[0014] The control server described herein is preferably based on the principle that information provided by an electronic guided transport system is combined with information from mobile electronic devices of users using the electronic guided transport system and with logical information provided by an operator of the electronic guided transport system, for example.

[0015] The combination of information provided by an electronic guided transport system, information from users using the electronic guided transport system and logical information is achieved by assigning PIDs received from mobile devices of the users to LIDs stored in the logical database. Based on the assigned information, additional systems, such as control units for controlling a number of vehicles used in electronic guided transport systems or planning units for planning additional or alternative routes can be operated. Further, an operator,

such as a technician, can be provided with combined information that allows the operator to monitor all the information provided by an electronic guided transport system, information from users using the electronic guided transport system, and logical information at a glance.

[0016] For combining the information provided by an electronic guided transport system, information from mobile devices of users using the electronic guided transport system and logical information, an iterative approach is used by the control server disclosed herein. This iterative approach may be based on a number of correlation patterns that each associates every PID to a LID and an evaluation of the correlation patterns, such that a best matching correlation pattern can be found.

[0017] Based on the best matching correlation pattern or another pattern, a dataset can be provided that provides valid data for the users that are using a vehicle. Thus, an occupancy rate of a particular vehicle or of the route of a public transportation vehicle can be determined.

[0018] According to a preferred example, the control server further comprises a determination unit configured to determine a location of a PT from a beacon in a vehicle (BV) in case the PT from the BV is received with the same time stamp from the same mobile device as a PT from a beacon installed at a local destination (BL), and the control server further comprises a correction unit configured to generate a correction term for assigning a particular PID to a particular LID that is proportional to a difference between a time stamp of the PT from the BV received with the same time stamp from the same mobile device as a PT from the BL and a time stamp of a LT for the location of the BL.

[0019] In case a PT from a beacon in a vehicle received with the same time stamp and from the same mobile device as a PT from a beacon installed at a local destination, the likelihood that the vehicle is at the local destination and the user of the mobile device is inside the vehicle are very high.

[0020] However, in case a PT from a beacon in a vehicle received with another time stamp from the same mobile device as a PT from a beacon installed at a local destination, the likelihood that the vehicle is at the local destination and the user of the mobile device is inside the vehicle are very low. Thus, by using a correction that takes into account a difference in time between information sent from user including a PT from vehicle and a PT from a local destination, the changing likelihoods for the user being inside the vehicle are mathematically modeled. Accordingly, an iterative approach that takes into account the correction term is even more precise in associating vehicle information with user information that an iterative approach without a correction term.

[0021] According to another preferred example, the assignment unit is further configured to iteratively assign all PIDs received from the mobile devices to LIDs stored in the logical database, by: extracting all possible combinations between the PIDs and the LIDs, creating an ID

correlation pattern based on the possible combinations, evaluating a score of a particular ID correlation pattern, comparing the score of the particular ID correlation pattern with the score of another ID correlation pattern, and confirming the ID correlation pattern with the best score.

[0022] Based on an iterative algorithm that extracts all possible combinations between the PIDs and the LIDs and creates an ID correlation pattern based on the possible combinations, an evaluation score can be calculated for every ID correlation pattern that enables the ID correlation pattern to be evaluated, i.e., compared with each other.

[0023] According to another preferred example, the assignment unit is configured to evaluate the score of a particular ID correlation pattern based on the correction terms of the ID correlation pattern.

[0024] The evaluation score may be calculated based on differences between times of PIDs transmitted by an electronic device from particular local destinations and scheduled times for the local destinations in LIDs associated to the PIDs by the particular correlation pattern to be evaluated. Thus, the evaluation score reflects a relation between a movement pattern of a user i.e., a user's electronic device and a predetermined route of a vehicle.

In case the evaluation score is low, for example, the relation may be high and vice versa. Thus, the differences between times of PIDs transmitted by an electronic device from particular local destinations and scheduled times for the local destinations in LIDs associated to the PIDs by the particular correlation pattern to be evaluated may be treated as a penalty term.

[0025] According to another preferred example, the assignment unit is further configured to create an ID correlation pattern by using a decision tree that matches all PIDs to particular LIDs.

[0026] By using a decision tree, every PID can be associated to a particular LID, thereby forming a correlation pattern. Such an association can be evaluated by using an evaluation for a complete decision tree and/or for every branch of a decision tree.

[0027] Thus, according to a preferred example, the assignment unit is configured to generate a correction term for every branch of a decision tree.

[0028] According to another preferred example, the control server comprises an ID correlation table that stores all information of an ID correlation pattern having the best evaluation score.

[0029] By using an ID correlation table, the information that are associated to another can be easily updated in case an ID correlation pattern is determined that has the best evaluation score, or an evaluation score that is better than an evaluation score of a current ID correlation pattern.

[0030] According to another preferred example, the assignment unit is configured to correct the time stamps of at least one LT for a particular location based on historical data measured at a vehicle in the past.

[0031] By using historical data measured at a vehicle

in the past, time deviations between measured data determined by a user's mobile device and scheduled data provided by an operator based on external influences, such as traffic problems due to changes in infrastructure, can be excluded from the association procedure. Thus, a very precise matching of information provided by an electronic guided transport system, information from users using the electronic guided transport system and logical information is achieved.

[0032] According to a second aspect, there is provided a control method for monitoring an electronic guided transport system comprising one or more vehicles. The control method comprises a first transmission step, wherein a unique PID of a beacon is transmitted to mobile devices in a range of the beacon by one or more vehicle beacons installed at vehicles and local beacons installed at local destinations, a second transmission step, wherein mobile devices that received a PID from a beacon, transmit a PT comprising the PID and a time stamp of receiving the PID to a server, and an assignment step, wherein all PIDs received from the mobile devices are assigned to a LID of an LT comprising a LID of a vehicle and a time stamp scheduled for a local destination of a travelling route of the vehicle, until every PID is assigned to a LID, by the server.

[0033] In particular, the control method disclosed herein can be used to operate the control server as disclosed herein.

[0034] According to a third aspect, Control system for monitoring an electronic guided transport system comprising one or more vehicles, wherein the control system comprises one or more beacons, one or more mobile devices, an embodiment of the control server disclosed herein. The one or more beacons comprise vehicle beacons installed at vehicles of the one or more vehicles and local beacons installed at local destinations, wherein each beacon of the one or more beacons is configured to transmit a unique PID to mobile devices in a range of the beacon, wherein each mobile device of the one or more mobile devices is configured to transmit a PT comprising the PID received from a particular beacon and a time stamp of receiving the PID, to the server, wherein the control server comprises a logical information database storing LIDs of LTs of the one or more vehicles and time stamps scheduled for one or more local destinations of a travelling route of each of the one or more vehicles, and wherein the control server comprises an assignment unit configured to iteratively assign all PIDs received from the mobile devices to LIDs stored in the logical database, until every PID is assigned to a LID.

[0035] According to a preferred example, each mobile device of the one or more mobile devices is configured to add a device identification code (DID) to a PT for transmission to the control server.

[0036] By using a DID, all information provided by particular mobile device can be associated to the particular mobile device and/or to a user profile. Thus, the mobile device, i.e., the user can be tracked and route information

about a route of the user can be taken into account for finding a correlation pattern.

[0037] According to a fourth aspect, there is provided a computer program product having computer program logic arranged to put into effect an embodiment of the control method for monitoring one or more vehicles disclosed herein, when being executed by a computer system.

10 Brief Description of Drawings

[0038]

- Fig. 1 shows an embodiment of the control system described herein with an embodiment of the server described herein,
- Fig. 2 shows an example of a physical identification tag,
- Fig. 3 shows another example of a physical identification tag,
- Fig. 4 shows an example of a logical identification tag,
- Fig. 5 shows an example of historical data,
- Fig. 6 shows a graphical representation of combined information from the physical identification tag according to Fig. 2 and the logical identification tag according to Fig. 4,
- Fig. 7 shows a flow chart of an embodiment of the control method disclosed herein,
- Fig. 8 shows an example of possible combinations between the physical identification tag according to Fig. 2 and the logical identification tag according to Fig. 4,
- Fig. 9 shows an example of a decision tree of a correlation pattern between the physical identification tag according to Fig. 2 and the logical identification tag according to Fig. 4,
- Fig. 10 shows an example of a correlation table based on the decision tree according to Fig. 9, and
- Fig. 11 shows an overview of an embodiment of the method disclosed herein.

Detailed Description of Exemplary Embodiments

[0039] In the following, preferred aspects and examples will be described in more detail with reference to the accompanying figures. Same or similar features in different drawings and examples are referred to by similar reference numerals. It is to be understood that the detailed description below relating to various preferred aspects and preferred examples are not to be meant as limiting the scope of the present disclosure.

[0040] In Fig. 1, a control system 1000 is shown. The control system 1000 comprises a control server 1100 that has, for example, five types of tables stored in its database. However, the number of tables may be higher or lower. Fig. 1 shows that it comprises a location information table 1101, a vehicle movement table 1102, a sched-

ule data table 1103, a historical data table 1104 and an ID correlation table 1105. Further, the server 1100 comprises a mobility movement identification unit 1111 for receiving physical identification tags (PT) comprising a physical identification code (PID) and a time stamp of receiving the PID from a beacon of one or more beacons comprising vehicle beacons installed at vehicles of the one or more vehicles and local beacons installed at local/stationary destinations, and an assignment unit 1112 for assigning PIDs received by the mobility movement identification unit 1111 to LIDs in the schedule data table 1103.

[0041] The ID assignment unit 1112 may provide a certificate to external resources, such as a traffic planning system confirming that a particular PID and an assigned LID have the same meaning. Thus, in case the external resource does not have historical data for an LID, time data for the assigned PID can be used instead.

[0042] Further, an optional determination unit and a correction unit may be added to the server 1100 which are not shown by an additional box in Fig. 1 and which are described further below.

[0043] Further, a vehicle 1200 is shown, in which a beacon 1210 is installed. It is noted that the provision of one or more beacons 1210 per vehicle shall be entailed by this disclosure, especially in case the vehicle 1200 should have different parts, cars or the like, e.g., such as in case of a train. The vehicle 1200 may be a train with a plurality of cars or a bus, preferably it is a vehicle of a public transportation system. The beacon 1210 is configured to transmit a physical identification code (PID) to mobile devices 1300 and 1310 in the transmission range of the beacon 1210. Specifically, the beacon(s) 1210 emit their PID constantly or periodically and a mobile device 1300/1310 of a user which is within the range of the signal of the beacon can receive the beacons signal including the PID.

[0044] For reception of the PID, each of the mobile devices 1300 and 1310 comprises a beacon signal detection unit 1301, 1311 and a location info tracking system 1302, 1312 which both are preferably software units or mixed software/hardware units. The beacon signal detection unit 1301, 1311 is configured to detect the presence of a signal from a beacon 1210 and to process said signal in the mobile electronic device 1300, 1310. The processing, in particular, includes associating a time stamp to the PID at the time of receiving the beacons' signal and the location info tracking system (or unit) 1302, 1312 may determine the location where the beacon signal has been received. The location may include geographic coordinates and the system/unit 1302, 1312 may be a GPS module, a Galileo module or the like which is usually present in a today's mobile electronic device 1300/1310, such as a smartphone.

[0045] For the example of Fig. 1, it is assumed that the vehicle 1200 is used by two users (U1, U2) and both of the two users has one mobile device 1300/1310. The mobile devices 1300 and 1310 are configured to transmit

the processed signals detected by their respective signal detection units 1301, 1311 as the physical identification tag (PT). Said tag being data having a predefined format, such as shown in Figure 2, according to a preferred example. However, other possible data formats are usable, too. For example, the Figure 2 shows that the tag includes a plurality of lines in a table and each line includes the data associated to one event of receiving a beacon signal. This may be different, for example, the tag may include only one line, i.e., only data relating to a single beacon signal reception event. In another example, the number of events which are transmitted may be higher or lower than shown in Figure 2. Generally, if more than one event is transmitted via a tag (PT), the number of transmission actions of the mobile device may be reduced, saving energy of the mobile device. On the other hand, transmitting each reception event, may enable that the transmission is closer, timewise, to the reception event. Preferably, the physical identification tag (PT) comprises the PID of the vehicle 1200 which is indicated by P1, P2, etc. in Fig. 2 (and V1, V2, etc. in Fig. 11), information of a time stamp, i.e., the receiving time of the beacon signal, at which the signal detection units 1301, 1311 received the signal from the beacon 1210, and a device identification code (DID) to the server 1100. The device identification code (DID) is related to a user of the mobile device 1300/1310 and in Fig. 2 each user has a DID, such as U1, U2, etc. as an example for rendering the general principle clear.

[0046] The server 1100 stores the PT information at the vehicle movement table 1102 and assigns the data provided by the PT to data stored in the schedule data table 1103.

[0047] In order to identify the identification tag (LT) with the LID of the vehicle 1200 out of the data stored in the schedule data table 1103, a preferred iterative assignment approach is carried out by the server 1100, preferably by the assignment unit 1112. During the preferred iterative assignment approach, the server 1100 evaluates a number of correlation patterns that each match the PIDs to the LIDs stored in the vehicle movement table 1102. The best evaluated correlation pattern is stored in the ID correlation table 1105 for further processing by an external system, such as a traffic planning system, for example. The matching may be carried out in different preferred ways, e.g., each of the PIDs and the LIDs are directly compared and matched to each other. And, even more preferably, the PIDs and the LIDs may be assigned to travelling routes of the vehicles 1200 first, and, subsequently, these routes are compared to each other. It is noted that also in the latter option, the matching matches all PIDs and all LIDs with each other, however, in a kind of group-wise action, wherein the groups are the routes which are compared. The latter approach hence allows to reduce the number of iteration steps in the matching process and this is saving computational burden.

[0048] A preferred option of the assignment procedure

of routes carried out by the assignment unit 1112 will become clearer in connection with the following description of the tables which are stored in the database of the server 1100. The database being indicated schematically by the cylindrical space within the server 1100 in Fig. 1.

[0049] However, before explaining the preferred assignment procedure, it is noted that the determination unit and the correction unit may be included in the server 1100 and they provide the following preferred functionality: The control server 1100 may further comprise a determination unit (not shown) which is configured to determine a location of a PT from a beacon in a vehicle (BV) in case the PT from the BV is received with the same time stamp from the same mobile device as a PT from a beacon installed at a local/stationary destination (BL), and the control server further comprises a correction unit configured to generate a correction term for assigning a particular PID to a particular LID that is proportional to a difference between a time stamp of the PT from the BV received with the same time stamp from the same mobile device as a PT from the BL and a time stamp of a LT for the location of the BL. In case a PT from a beacon in a vehicle received with the same time stamp and from the same mobile device as a PT from a beacon installed at a local destination, the likelihood that the vehicle is at the local destination and the user of the mobile device is inside the vehicle are very high. However, in case a PT from a beacon in a vehicle received with another time stamp from the same mobile device as a PT from a beacon installed at a local destination, the likelihood that the vehicle is at the local destination and the user of the mobile device is inside the vehicle are very low. Thus, by using a correction that takes into account a difference in time between information sent from user including a PT from vehicle and a PT from a local destination, the changing likelihoods for the user being inside the vehicle are mathematically modeled. Accordingly, an iterative approach that takes into account the correction term is even more precise in associating vehicle information with user information than an iterative approach without a correction term. In other words, the provision of a determination unit and a correction unit enables the reconstruction of a driving route of a vehicle 1200 with higher accuracy because the location information provided by the location info tracking system 1302/1312 of each mobile device of a user 1300/1310 can be directly mapped to the closest station, stop or the like of the vehicle 1200/the route of the vehicle 1200. However, if these units are not provided, the location information 2002 added to the PT are not related to a specific station/destination or stop of the vehicle 1200 and they may include geographic coordinates which are located in between of two stations/destinations, e.g., during the travelling of the vehicle 1200 when the user of the mobile device 1300/1310 is aboard said vehicle 1200. In both cases, however, it is possible to use the location information 2002 combined with the time stamps 2003 to reconstruct a travelling route of the vehicle 1200.

[0050] As mentioned above, the Figures relating to the exemplary content of the tables/data provided to the server 1100 and/or stored in the tables of the server 1100, provide further understanding of the assignment/matching procedure.

[0051] In Fig. 2, a physical identification tag (PT) 2000 is shown which, preferably, has the same data structure like the location information table 1101 of the server 1100 so that Fig. 2 is also an example for the content of said table. The number of entries may be much larger than shown in Fig. 2 when the data of many users and vehicles 1200 is monitored over a period of time, such as days, weeks or the like.

[0052] The PT 2000 comprises DIDs 2001, location/destination IDs 2002 of locations or local destinations, such as a bus stop or train station, for example. It is noted that the term "destination" shall be construed to entail all possible locations in general, i.e., each stop of a public transportation system may be a destination. With regard to the PT, the location ID 2002 is added by the location info tracking system 1302, 1312 of a mobile device and it is preferably a set of geographical coordinates, such as latitude and longitude. In case of Fig. 2 showing the table content of the location information table 1101 of the server 1100, the location ID 2002 may also be the destination ID 2002. The difference relates to whether a determination unit and correction unit, as explained above, are provided in the server 1100 which map the geographical coordinates of the PT to a destination, i.e., a stop, station or the like, and whose coordinates or an ID thereof would be stored in the table 1101. If the determination unit and correction unit should not be provided, the table 1101 will include the geographical coordinates as location/destination IDs 2002 as transmitted by the mobile device 1300/1310, i.e., without further post processing in view of mapping them to specific stations and the like of the transportation system.

[0053] Further, the PT includes time stamps 2003 for each of the DIDs at the particular local destinations 2002 and PIDs 2004 transmitted by the particular electronic devices associated with the DIDs.

[0054] The set of information included in the PT and the table 1101, respectively, (as noted above the table 1101 collects and accumulates the PT information over time in the server 1100), enable to generate a movement pattern of different vehicles 1200 based on their different PIDs 2004 which are indicated by P1, P2, etc. in the Fig. 2 (V1, V2, etc. in Fig. 11). In other words, the table depicted by Fig. 2 shows that six different users U1 to U6 travelled with four different vehicles 1200 (indicated by P1 to P4) along different locations/stations, indicated by L1 to L5 in between 08:03:00 AM and 09:15:00 AM. The server 1100 or one of the computing units and preferably the assignment unit 1112 can use this information for, firstly, rearranging the information, such as to arrive at the table as shown by Fig. 3.

[0055] In Fig. 3, another PT 3000 and/or, as explained in connection with Fig. 2, the content of the vehicle move-

ment table 1102 is shown that is generated based on the PT 2000 according to Fig. 2. Specifically, data in table 1192 comprises the PIDs 2004 transmitted by the particular electronic mobile devices 1300/1310 associated with the DIDs, the destination IDs 2002 and the time stamps 2003. Thus, the data, PT 3000, is anonymized by cancelling the DIDs 2001 and it is furthermore sorted by the PIDs 2004. The first point is beneficial in view of ensuring privacy protection for single users. The latter point enables to determine routes of vehicles 1200 which can be matched with scheduled routes of a transportation table. For example, Fig. 3 shows that the vehicle with the PID P1 has travelled from location/destination L1 to L5 from 08:03 AM to 08:23 AM. Therefore, the PID P1 can also be considered as a travelling route of said vehicle having the PID P1. The same holds for the data shown in connection with P2, P3 and P4. It is now evident that comparing PIDs and LIDs may be entail comparing single locations/destinations with each other or, as preferred, this can beneficially also entail comparing whole routes of a vehicle 1200 with each other. It is furthermore noted that the present example is explained based on a small number of users so that a route may not be reconstructed fully, e.g., in case the user does use the vehicle 1200 only for a limited number of stops/destinations. However, in reality, the system will collect PTs from many users so that, due to the vast number of data, a full route can be reconstructed or at least extrapolated for each vehicle 1200.

[0056] As explained before, the server 1100 and especially its assignment unit 1112 are configured to compare and match the LIDs and the PIDs. The LIDs are found in scheduled (pre-set) travelling plans of vehicles 1200 of a transportation system. For example, in a public transportation system, the routes and times of each vehicle 1200 of said public transportation system are pre-planned and the schedule is publicly available. Fig. 4 shows now a very brief example of such a scheduled travelling plan or time schedule. The server 1100 may receive said data of the schedule data table 1103 of Fig. 4 from an external system such as traffic management system or a cloud service providing the information as open data.

[0057] Specifically, in Fig. 4 a time schedule 4000 is shown wherein said data give an example for the content of the schedule data table 1103 of the server 1100. The time schedule 4000 comprises logical identification codes (LIDs) 4001 of a plurality of vehicles 1200 (here four as an example), which are indicated as S1, S2, S3 and S4 (B1, B2, etc. in Fig. 11), destination IDs 4002 and scheduled/planned times 4003 for the arriving of a particular vehicle 1200 at a particular destination. In other words, Fig. 4 shows a time table of a transportation system and, the destination IDs 4002 of this table 1103 only belong to stations, stops, and the like of the transportation system.

[0058] With the data 4000 as shown Fig. 4 and the data 3000 as shown by Fig. 3, the assignment unit 1112 can

perform a comparison and matching of the PIDs and LIDs to find the most likely corresponding ones. As explained before, preferably and as evident from the data shown in Fig. 3 and 4 which associate LIDs and PIDs of a vehicle 1200 to all related location IDs of said vehicle 1200, whole routes or at least parts of routes of a vehicle 1200 are compared and matched with each other. When the matching has been finalized, the server 1100 can return the result which indicates which data set received from the users/their mobile devices 1300/1310 belongs to which vehicle 1200 in a planned schedule/time table. The users remain anonymous protecting their privacy. The matched data/the result further allows, e.g., to identify overcrowded vehicles 1200 or the like and thus allows to improve the service to the users of the transportation system in a tailored fashion.

[0059] Before discussing Fig. 6 which shows a graphical representation of an example for the matching, another preferred modification is explained in connection with Fig. 5.

[0060] In Fig. 5, a dataset 5000 is shown comprising the logical identification codes (LIDs) 4001, the destination IDs 4002 and measured times 5003 at which the particular vehicles have arrived at the particular destinations in the past. The server 1100 receives said data from an external system such as traffic management system or a cloud service providing information as open data. Blank symbols in "Time" 5003 shows that the server 1100 didn't receive historical data, e.g., because of a limitation of the external system or the service hasn't run yet, or the like. The "real" travelling data recorded and provided to the server 1100 may be stored in an additional table, the historical data table 1104. The above explained server 1100 and its processing do not require the real-recorded historical data of the vehicles 1200 for putting the present disclosure into practice. However, it allows to further improve the accuracy thereof, because the data 4000 of Fig. 4 can be modified by the historical data 5000 of Fig. 5, so that an error factor for the matching can be deleted. For example, Fig. 5 shows that the vehicle with LID S1 was at the destination L3 15 seconds later than planned.

[0061] Now, in Fig. 6, a graph 6000 is shown which depicts the routes of the different vehicles 1200 graphically. The data on the x-axis indicate the time and the y-axis shows locations with the destinations L1 to L5 specifically indicated. Planned (or modified based on data 5000 of Fig. 5) movement patterns of vehicles 1200 according to LIDs S1 to S4 are represented by continuous/unbroken lines, whereas measured movement patterns of vehicles 1200 according to PIDs P1 to P4 are represented by dashed lines. The latter data is the data as shown by Fig. 3, e.g., and, thus, is the data received from mobile devices 1300/1310 of users travelling with the vehicles 1200.

[0062] In this example, with regard to the general principle of the matching, since LID "S1" and PID "P1" extend over the same locations and a time delay between "S1"

and "P1" is very small, the likelihood for "P1" being a PID of "S1" are very high. In other words, the likelihood that PID "P1" and LID "S1" match each other, are very high and the server 1100/assignment unit 1112 will conclude that the vehicle 1200 with the LID S1 in the travel plan belongs to the user-based data of the PID P1.

[0063] In contrast, a LID "S4" and a PID "P4" extend over different locations and a time delay between "S4" and "P4" is quite high. Thus, the likelihood for "P4" being a PID of "S4" are relatively small. In other words, the likelihood that "P4" and "S4" match each other, are considered to be small by the assignment unit 1112.

[0064] In order to reflect the likelihood of particular PIDs matching particular LIDs, a correction term can be calculated based on a time delay between particular PIDs and particular LIDs, as further described with respect to Fig. 9. Further, as explained before, the server 1100/assignment unit 1112 iterate all possible combinations of LID/PID pairs until the best possible solution is found. This will be explained in more detail in the following.

[0065] In Fig. 7, a flow chart 7000 of an embodiment of a method for monitoring an electronic guided transport system comprising one or more vehicles is shown.

[0066] After starting a corresponding system in step 7001, by acquiring data from one or more databases of the system, such as server 1100 according to Fig. 1, for example, all possible combinations between PIDs and LIDs stored in the tables of the database(s) are extracted in step 7002. For example, the data as shown by Figs. 3 and 4 may be extracted for a comparison. It is noted that this can be done in (more or less, i.e., considering latency and the like) real time when the vehicles 1200 operate because the tables/database of the server 1100 continuously receive PTs from the mobile devices 1300/1310. Otherwise, the process/method can also be performed at discrete times, e.g., every end of a service day or the like.

[0067] In step 7003, an ID correlation pattern is generated based on the possible combinations extracted in step 7002. The ID correlation pattern is generated based on the principles of the PID/LID matching as described above and as carried out by the assignment unit 1112.

[0068] In step 7004 a step of checking is performed whether an ID correlation pattern has been created for every possible combination of LIDs/PIDs, and, subsequently, the result is confirmed as a temporary solution in step 7008 and the process ends at step 7009. Alternatively, in case at least one ID correlation is lacking, i.e. in case that not all LIDs are matched with PIDs (or vice versa), an evaluation score is calculated for each ID correlation pattern in step 7005.

[0069] In step 7006, the evaluation score calculated in step 7004 is compared to an old evaluation score stored in a memory of the system/server 1100 (not shown). In case the evaluation score calculated in step 7004 is better, i.e., lower than the old/previous evaluation value, for example, the process ends at step 7007 by keeping the evaluation score calculated in step 7004 as a temporary

best solution. In case the evaluation score calculated in step 7004 is worse, i.e., higher than the old evaluation value, for example, the process continues with step 7003 again.

[0070] In Fig. 8, a table 8000 of possible combinations between PIDs and LIDs is shown using the LID and PID names of Fig. 6. Table 8000 is a possible correlation pattern extracted by the ID assignment unit 1112 as shown in Fig. 1, for example. The correlation pattern shown in Fig. 8 is based on the assumption that: "if a running area of a vehicle is inside the range of a mobility service, i.e., a route planned for an LID, the vehicle is a possible candidate for being assigned to the LID". For example, "P1" is a possible candidate for being assigned to "S1" because "P1" and "S1" move across the same locations, as shown in Fig. 6, for example. On the other hand, "P1" cannot be a possible candidate for being assigned to "S3" or "S4", since "P1" moves across other locations than "S3" or "S4", i.e., the movement pattern of "P1" is wider than the movement pattern of "S3" and "S4". In other words, one part of generating the correlation pattern may include, preferably, and preferably as a first step, to match LIDs and PIDs based on the destinations or routes covered and to find possibly excluded correlations, such as explained above in view of P1 and S3 or S4. If the step of excluding possible correlations is performed (and preferably first), the number of iterations can be reduced so that the computational burden can be decreased. Then, Fig. 9 shows a preferred general principle for finding a correlation pattern which may start with a first matching of one LID and one PID which are not excluded by the above considerations.

[0071] In Fig. 9, a preferred method 9000 for finding a correlation pattern based on a decision tree is shown. Thus, all PIDs (P1, P2, P3, P4) are assigned to particular LIDs (S1, S2, S3, S4). All branches of the decision tree are rated with an evaluation term that is antiproportional to a sum of time delay between PIDs and LIDs in the particular branch. Thus, small time delays between the combination of (S1, P1), (S2, P2), (S3, P4) and (S4, P3) result in a high evaluation score, whereas large time delays between the combinations of (S1, P1), (P4, S2), (P3, S3) and (P2, S4) result in a small evaluation score. In case a branch does not have a solution because there are not PID data to be assigned to LID data, the evaluation score has the value "0". In other words, Fig. 9 shows a very preferred way (or part thereof) of enabling the process (or part thereof) which is performed by the assignment unit 1112 with regard to "iteratively assign all PIDs received from the mobile devices to LIDs stored in the logical database, until every PID is assigned to a LID", especially in combination with the iteration as shown by Fig. 7 and the loop which is included therein related to finding the correlation pattern with the best evaluation score.

[0072] In Fig. 10, the result of the method for monitoring an electronic guided transport system comprising one or more vehicles as shown in Fig. 7 is shown as an ID cor-

relation table 1105 according to Fig. 1. Since the combination of (S1, P1), (S2, P2), (S3, P4) and (S4, P3) resulted in the highest evaluation term, as shown in Fig. 9, this result is stored in the ID correlation table 1105. Thus, ID correlation table 1105 may be transmitted to external resources as a certificate confirming that a particular PID and an assigned LID have the same meaning. Thus, in case the external resource does not have historical data for an LID, time data for the assigned PID can be used instead.

[0073] In Fig. 11, an overview of a control method 11000 for monitoring an electronic guided transport system is shown.

[0074] Each of a plurality of buses 11001, 11002, and 11003 has a beacon 11004, 11005, and 11006 on board. Further a first location 11007 is provided with a beacon 11008 and a second location 11009 is provided with another beacon 11010.

[0075] All beacons are sending a unique PID to mobile devices 11011, 11012, and 11013 in their range.

[0076] As the mobile devices 11011, 11012, and 11013 are part of a mobile ticketing system 11014, the mobile devices 11011, 11012, and 11013 sent their unique device identification codes (DID) together with the PID received from a particular beacon 11004, 11005, 11006, 11008, and/or 11010 in a report/PT 11019 (corresponding to, e.g., Fig. 3 whereas in Fig. 11 S1, S2, etc. relates to locations, such as L1, L2, etc. in Fig. 3) to a server, such as the server 1100 according to Fig. 1.

[0077] The server 1100 assigns the PIDs transmitted by the mobile devices 11011, 11012, and 11013 to LIDs provided in a timetable 11015 (e.g., as shown by Fig. 4) by a traffic control system 11016, as indicated by graph 11017 (which is corresponding to Fig. 6). The assignment results in an ID correlation table 11018 (like in Fig. 10, however, with B and V for P and S as abbreviations for the PID/LID) that assigns a particular PID to a particular LID. Thus, the ID correlation table 11018 confirms a matching of particular PIDs to a particular LIDs, such that the traffic control system 11016 may use time information provided for PIDs in case no time information for the corresponding LIDs is available, for planning a number of buses to be operated, for example.

[0078] As will be appreciated by one of skill in the art, the present disclosure, as described hereinabove and the accompanying figures, may be embodied as a method (e.g., a computer-implemented process or any other process), apparatus (including a device, machine, system, computer program product, and/or any other apparatus), or a combination of the foregoing. Aspects/Examples of the present disclosure may be a software entirely (including firmware, resident software, micro-code, etc.), or a combination of software and hardware aspects that may be referred to as a "system". Furthermore, the present disclosure may take the form of a computer program product on a computer-readable medium having computer-executable program code embodied in the medium.

[0079] It should be noted that arrows may be used in drawings to represent communication, transfer, or other activity involving two or more entities. Double-ended arrows generally indicate that activity may occur in both directions (e.g., a command/request in one direction with a corresponding reply back in the other direction, or peer-to-peer communications initiated by either entity), although in some situations, activity may not necessarily occur in both directions.

[0080] Single-ended arrows generally indicate activity exclusively or predominantly in one direction, although it should be noted that, in certain situations, such directional activity actually may involve activities in both directions (e.g., a message from a sender to a receiver and an acknowledgement back from the receiver to the sender, or establishment of a connection prior to a transfer and termination of the connection following the transfer). Thus, the type of arrow used in a particular drawing to represent a particular activity is exemplary and should not be seen as limiting.

[0081] The present disclosure may be described with reference to flowchart illustrations and/or block diagrams of methods and apparatuses, and with reference to a number of sample views of a graphical user interface generated by the methods and/or apparatuses. It will be understood that each block of the flowchart illustrations and/or block diagrams, and/or combinations of blocks in the flowchart illustrations and/or block diagrams, as well as the graphical user interface, can be implemented by computer-executable program code.

[0082] The computer-executable program code may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a particular machine, such that the program code, which executes via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts/outputs specified in the flowchart, block diagram block or blocks, figures, and/or written description.

[0083] The computer-executable program code may also be stored in a computer-readable memory that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the program code stored in the computer readable memory produce an article of manufacture including instruction means which implement the function/act/output specified in the flowchart, block diagram block(s), figures, and/or written description.

[0084] The computer-executable program code may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the program code which executes on the computer or other programmable apparatus provides steps for implementing the functions/acts/outputs specified in the flowchart, block diagram block(s),

figures, and/or written description. Alternatively, computer program implemented steps or acts may be combined with operator or human implemented steps or acts in order to carry out an embodiment of the disclosure.

[0085] It should be noted that terms such as "server" and "processor" may be used herein to describe devices that may be used in certain aspects of the present disclosure and should not be construed to limit the present disclosure to any particular device type unless the context otherwise requires. Thus, a device may include, without limitation, a bridge, router, bridge-router (brouter), switch, node, server, computer, appliance, or other type of device. Such devices typically include one or more network interfaces for communicating over a communication network and a processor (e.g., a microprocessor with memory and other peripherals and/or application-specific hardware) configured accordingly to perform device functions.

[0086] Communication networks generally may include public and/or private networks; may include local-area, wide-area, metropolitan-area, storage, and/or other types of networks; and may employ communication technologies including, but in no way limited to, analog technologies, digital technologies, optical technologies, wireless technologies (e.g., Bluetooth), networking technologies, and internetworking technologies.

[0087] It should also be noted that devices may use communication protocols and messages (e.g., messages created, transmitted, received, stored, and/or processed by the device), and such messages may be conveyed by a communication network or medium.

[0088] Unless the context otherwise requires, the present disclosure should not be construed as being limited to any particular communication message type, communication message format, or communication protocol. Thus, a communication message generally may include, without limitation, a frame, packet, datagram, user datagram, cell, or other type of communication message.

[0089] Unless the context requires otherwise, references to specific communication protocols are exemplary, and it should be understood that alternatives may, as appropriate, employ variations of such communication protocols (e.g., modifications or extensions of the protocol that may be made from time-to-time) or other protocols either known or developed in the future.

[0090] It should also be noted that logic flows may be described herein to demonstrate various aspects of the disclosure, and should not be construed to limit the present disclosure to any particular logic flow or logic implementation. The described logic may be partitioned into different logic blocks (e.g., programs, modules, functions, or subroutines) without changing the overall results or otherwise departing from the true scope of the disclosure.

[0091] Often, logic elements may be added, modified, omitted, performed in a different order, or implemented using different logic constructs (e.g., logic gates, looping primitives, conditional logic, and other logic constructs)

without changing the overall results or otherwise departing from the scope of the disclosure.

[0092] The present disclosure may be embodied in many different forms, including, but in no way limited to, a graphical processing unit as well as computer program logic for use with a processor (e.g., a microprocessor, microcontroller, digital signal processor, or general purpose computer), programmable logic for use with a programmable logic device (e.g., a Field Programmable Gate Array (FPGA) or other PLD), discrete components, integrated circuitry (e.g., an Application Specific Integrated Circuit (ASIC)), or any other means including any combination thereof. Computer program logic implementing some or all of the described functionality is typically implemented as a set of computer program instructions that is converted into a computer executable form, stored as such in a computer readable medium, and executed by a microprocessor under the control of an operating system. Hardware-based logic implementing some or all of the described functionality may be implemented using one or more appropriately configured FPGAs.

[0093] Computer program logic implementing all or part of the functionality previously described herein may be embodied in various forms, including, but in no way limited to, a source code form, a computer executable form, and various intermediate forms (e.g., forms generated by an assembler, compiler, linker, or locator).

[0094] Source code may include a series of computer program instructions implemented in any of various programming languages (e.g., an object code, an assembly language, or a high-level language such as Fortran, python, C, C++, JAVA, JavaScript or HTML) for use with various operating systems or operating environments. The source code may define and use various data structures and communication messages. The source code may be in a computer executable form (e.g., via an interpreter), or the source code may be converted (e.g., via a translator, assembler, or compiler) into a computer executable form.

[0095] Computer-executable program code for carrying out operations of embodiments of the present disclosure may be written in an object oriented, scripted or unscripted programming language such as Java, Perl, Smalltalk, C++, or the like. However, the computer program code for carrying out operations of aspects of the present disclosure may also be written in conventional procedural programming languages, such as the "C" programming language or similar programming languages.

[0096] Computer program logic implementing all or part of the functionality previously described herein may be executed at different times on a single processor (e.g., concurrently) or may be executed at the same or different times on multiple processors and may run under a single operating system process/thread or under different operating system processes/threads.

[0097] Thus, the term "computer process" refers generally to the execution of a set of computer program instructions regardless of whether different computer proc-

esses are executed on the same or different processors and regardless of whether different computer processes run under the same operating system process/thread or different operating system processes/threads.

[0098] The computer program may be fixed in any form (e.g., source code form, computer executable form, or an intermediate form) either permanently or transitorily in a tangible storage medium, such as a semiconductor memory device (e.g., a RAM, ROM, PROM, EEPROM, or Flash-Programmable RAM), a magnetic memory device (e.g., a diskette or fixed disk), an optical memory device (e.g., a CD-ROM), a PC card (e.g., PCMCIA card), or other memory device.

[0099] The computer program may be fixed in any form in a signal that is transmittable to a computer using any of various communication technologies, including, but in no way limited to, analog technologies, digital technologies, optical technologies, wireless technologies (e.g., Bluetooth), networking technologies, and internetworking technologies.

[0100] The computer program may be distributed in any form as a removable storage medium with accompanying printed or electronic documentation (e.g., shrink wrapped software), preloaded with a computer system (e.g., on system ROM or fixed disk), or distributed from a server or electronic bulletin board over the communication system (e.g., the Internet or World Wide Web).

[0101] Hardware logic (including programmable logic for use with a programmable logic device) implementing all or part of the functionality previously described herein may be designed using traditional manual methods, or may be designed, captured, simulated, or documented electronically using various tools, such as Computer Aided Design (CAD), a hardware description language (e.g., VHDL or AHDL), or a PLD programming language (e.g., PALASM, ABEL, or CUPL).

[0102] Any suitable computer readable medium may be utilized. The computer readable medium may be, for example but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, device, or medium.

[0103] More specific examples of the computer readable medium include, but are not limited to, an electrical connection having one or more wires or other tangible storage medium such as a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), a compact disc read-only memory (CD-ROM), or other optical or magnetic storage device.

[0104] Programmable logic may be fixed either permanently or transitorily in a tangible storage medium, such as a semiconductor memory device (e.g., a RAM, ROM, PROM, EEPROM, or Flash-Programmable RAM), a magnetic memory device (e.g., a diskette or fixed disk), an optical memory device (e.g., a CD-ROM), or other memory device.

[0105] The programmable logic may be fixed in a signal

that is transmittable to a computer using any of various communication technologies, including, but in no way limited to, analog technologies, digital technologies, optical technologies, wireless technologies (e.g., Bluetooth), networking technologies, and internetworking technologies.

[0106] The programmable logic may be distributed as a removable storage medium with accompanying printed or electronic documentation (e.g., shrink wrapped software), preloaded with a computer system (e.g., on system ROM or fixed disk), or distributed from a server or electronic bulletin board over the communication system (e.g., the Internet or World Wide Web). Of course, some embodiments of the disclosure may be implemented as a combination of both software (e.g., a computer program product) and hardware. Still other aspects of the present disclosure are implemented as entirely hardware, or entirely software.

[0107] While certain exemplary aspects have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and are not restrictive on the broad disclosure, and that the aspects of the present disclosure are not limited to the specific constructions and arrangements shown and described, since various other changes, combinations, omissions, modifications and substitutions, in addition to those set forth in the above paragraphs, are possible.

[0108] Those skilled in the art will appreciate that various adaptations, modifications, and/or combination of the just described aspects and examples can be configured. Therefore, it is to be understood that, within the scope of the appended claims, the disclosure may be practiced other than as specifically described herein. For example, unless expressly stated otherwise, the steps of processes described herein may be performed in orders different from those described herein and one or more steps may be combined, split, or performed simultaneously. Those skilled in the art will also appreciate, in view of this disclosure, that different aspects or examples of the disclosure described herein may be combined to form other aspects or examples of the disclosure.

45 Claims

1. A control server for monitoring an electronic guided transport system comprising one or more vehicles, wherein the control server (1100) comprises:

a mobile movement identification unit (1111) configured to receive a physical identification tag (PT) comprising a physical identification code (PID) and a time stamp of receiving the PID from a beacon of one or more beacons comprising vehicle beacons installed at vehicles of the one or more vehicles and local beacons installed at local destinations,

- a database storing logical identification codes (LID) of logical identification tags (LT) comprising LIDs of the one or more vehicles and times scheduled for one or more local destinations of a travelling route of each of the one or more vehicles, and
 an assignment unit (1112) configured to iteratively assign all PIDs received from the mobile devices to LIDs stored in the logical database, until every PID is assigned to a LID.
2. Control server according to claim 1,
- wherein the control server (1100) further comprises a determination unit configured to determine a location of a PT from a beacon in a vehicle (BV) in case the PT from the BV is received with the same time stamp from the same mobile device as a PT from a beacon installed at a local destination (BL), and
 wherein the control server (1100) further comprises a correction unit configured to generate a correction term for assigning a particular PID to a particular LID that is proportional to a difference between a time stamp of the PT from the BV received with the same time stamp from the same mobile device as a PT from the BL and a time stamp of a LT for the location of the BL.
3. Control server according to claim 1 or 2, wherein the assignment unit (1112) is further configured to iteratively assign the PIDs received from the mobile devices to the LIDs, by:
- extracting possible combinations between the PIDs and the LIDs,
 - creating an ID correlation pattern based on the possible combinations,
 - evaluating a score of a particular ID correlation pattern,
 - comparing the score of the particular ID correlation pattern with the evaluation score of another ID correlation pattern,
 - confirming the ID correlation pattern with the best evaluation score.
4. Control server according to claims 2 and 3, wherein the assignment unit (1112) is configured to evaluate the score of a particular ID correlation pattern based on the correction terms of the ID correlation pattern.
5. Control server according to claim 4, wherein the assignment unit (1112) is further configured to create an ID correlation pattern by using a decision tree that matches all PIDs to particular LIDs.
6. Control server according to claim 5,
- wherein the assignment unit (1112) is configured to generate a correction term for every branch of a decision tree.
7. Control server according to any of the preceding claims, wherein the control server (1100) comprises an ID correlation table that stores all information of an ID correlation pattern having the best evaluation score.
8. Control server according to any of the preceding claims, wherein the assignment unit (1112) is configured to correct the time stamps of at least one LT for a particular location based on historical data measured at a vehicle in the past.
9. A control method for monitoring an electronic guided transport system comprising one or more vehicles, wherein the control method comprises:
- a first transmission step, wherein a unique physical identification code (PID) of a beacon is transmitted to mobile devices in a range of the beacon by one or more vehicle beacons installed at vehicles and local beacons installed at local destinations,
 - a second transmission step, wherein mobile devices that received a PID from a beacon, transmit a physical identification tag (PT) comprising the PID and a time stamp of receiving the PID to a server,
 - an assignment step, wherein all PIDs received from the mobile devices are assigned to given logical identification codes (LID) of logical identification tags (LT) comprising a LID of a vehicle and a time stamp scheduled for a local destination of a travelling route of the vehicle, until every PID is assigned to a LID, by the server.
10. A computer program product having computer program logic arranged to put into effect the control method for monitoring one or more vehicles according to claim 9, when being executed by a computer system.
11. A control system for monitoring an electronic guided transport system comprising one or more vehicles,
- wherein the control system comprises:
- one or more beacons,
 - one or more mobile devices,
 - control server (1100) according to one of claims 1 to 8,
- wherein the one or more beacons comprise vehicle beacons installed at vehicles of the one or

more vehicles and local beacons installed at local destinations,
 wherein each beacon of the one or more beacons is configured to transmit a unique physical identification code (PID) to mobile devices in a range of the beacon, 5
 wherein each mobile device of the one or more mobile devices is configured to transmit a physical identification tag (PT) comprising the PID received from a particular beacon and a time stamp of receiving the PID, to the server, 10
 wherein the control server comprises a logical information database storing logical identification codes (LID) of logical identification tags (LT) of the one or more vehicles and time stamps scheduled for one or more local destinations of a travelling route of each of the one or more vehicles, and 15
 wherein the control server comprises an assignment unit configured to iteratively assign all PIDs received from the mobile devices to LIDs, until every PID is assigned to a LID. 20

12. Control system according to any of the preceding claims, 25
 wherein each mobile device (1300, 1310) of the one or more mobile devices is configured to add a device identification code (DID) to a PT for transmission to the control server (1100). 30

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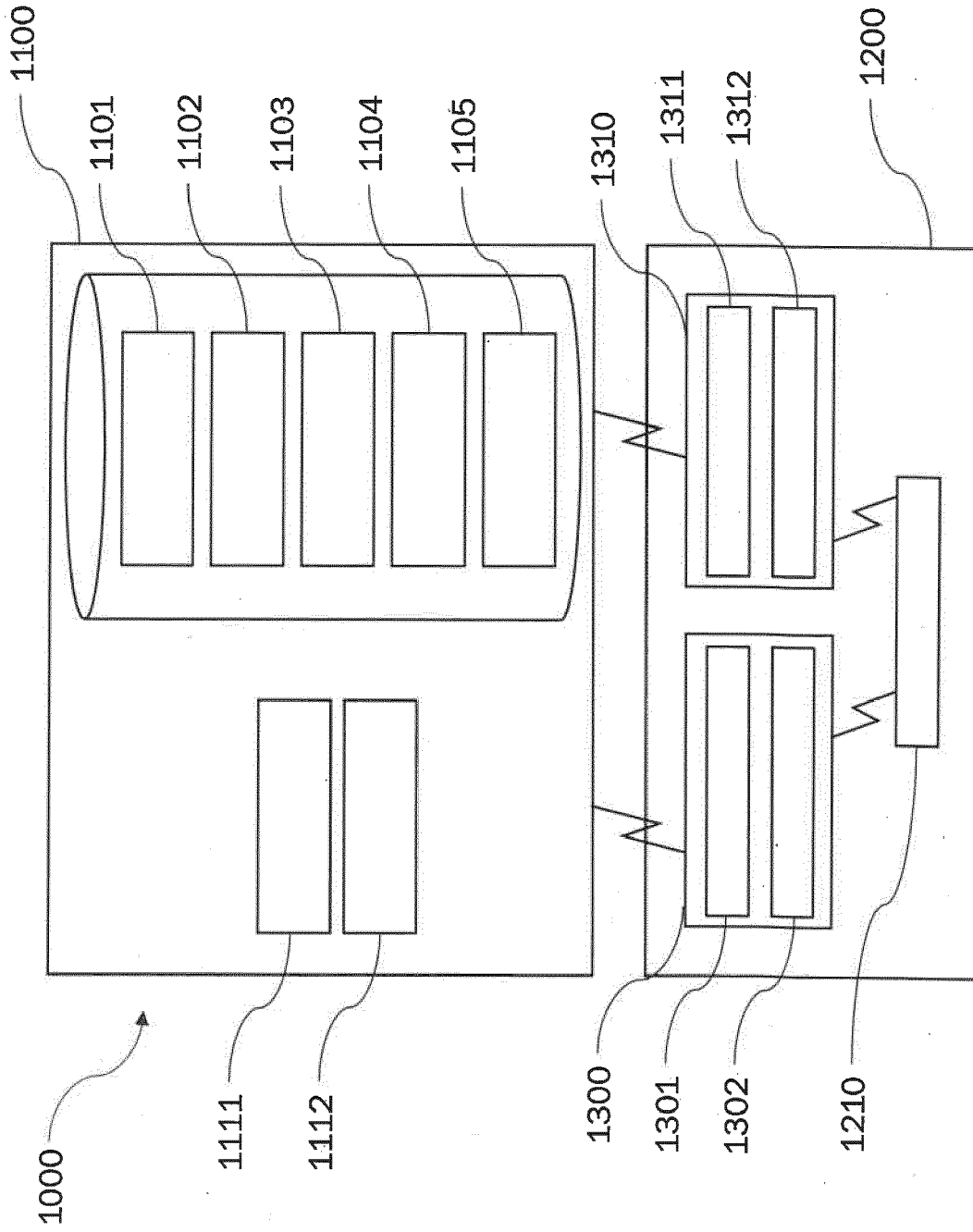


Fig. 1

2000

	2001	2002	2003	2004
U1	L1		8:03:00	P1
U1	L5		8:23:00	P1
U2	L2		8:08:00	P1
U2	L3		8:13:00	P1
U3	L3		8:13:30	P1
U3	L4		8:18:00	P1
U4	L2		8:35:00	P2
U4	L4		8:45:00	P2
U5	L2		9:00:00	P3
U5	L4		9:10:00	P3
U6	L1		9:05:00	P4
U6	L3		9:15:00	P4

Fig. 2

3000

2004	2002	2003
P1	L1	8:03:00
	L2	8:08:00
	L3	8:13:15
	L4	8:18:00
	L5	8:23:00
P2	L2	8:35:00
	L4	8:45:00
P3	L2	9:05:00
	L4	9:15:00
P4	L1	9:05:00
	L3	9:10:00

Fig. 3

4000

	L1		8:00:00
	L2		8:05:00
S1	L3		8:10:00
	L4		8:15:00
	L5		8:20:00
	L1		8:20:00
	L2		8:25:00
S2	L3		8:30:00
	L4		8:35:00
	L5		8:40:00
	L1		8:40:00
	L2		8:45:00
S3	L3		8:50:00
	L4		8:55:00
	L2		8:55:00
	L3		9:00:00
S4	L4		9:05:00
	L5		9:10:00

4001 4002 4003

Fig. 4

5000

4001	S1	4002	L1	5003	8:00:00
			L2	8:05:00	
			L3	8:10:15	
			L4	8:15:15	
			L5	8:20:30	
S2	L1	-			
	L2	-			
	L3	-			
	L4	-			
	L5	-			
S3	L1	-			
	L2	-			
	L3	-			
	L4	-			
	L5	-			
S4	L1	-			
	L2	-			
	L3	-			
	L4	-			
	L5	-			

Fig. 5

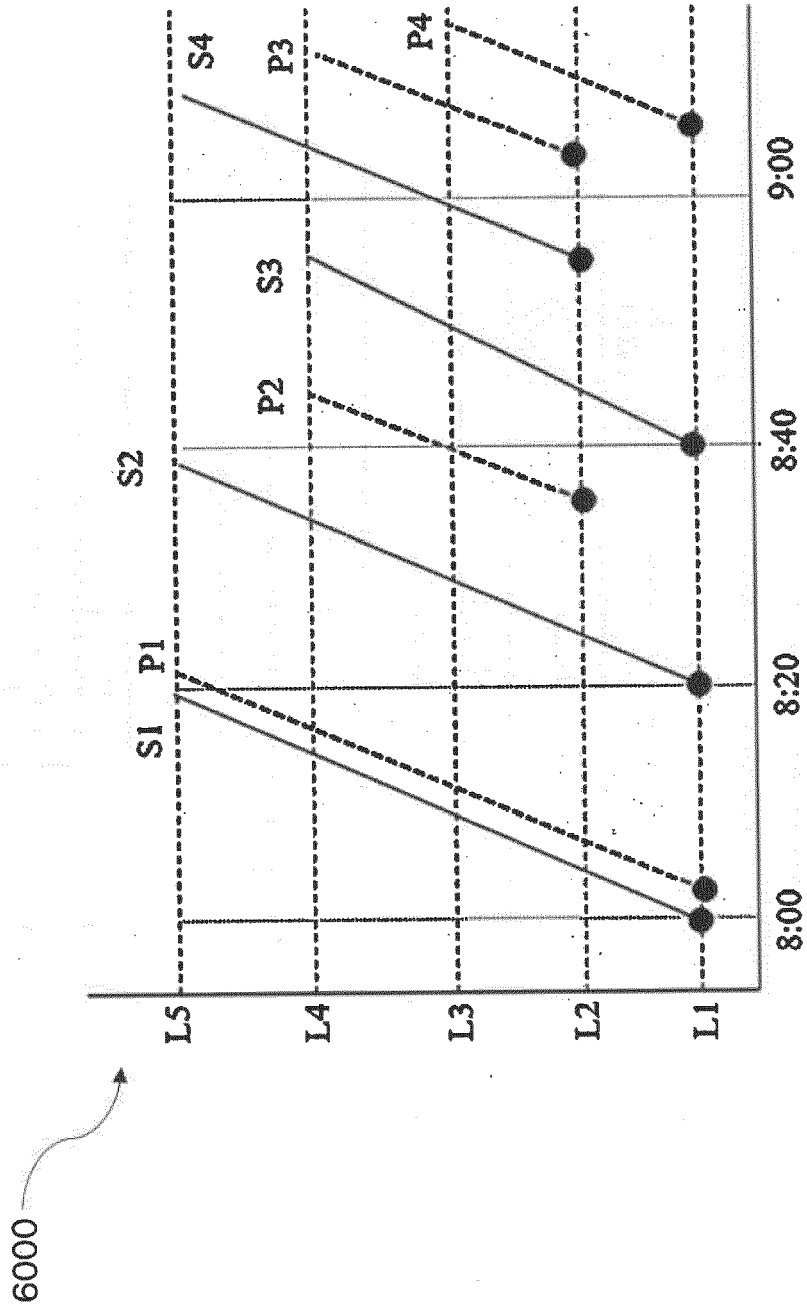


Fig. 6

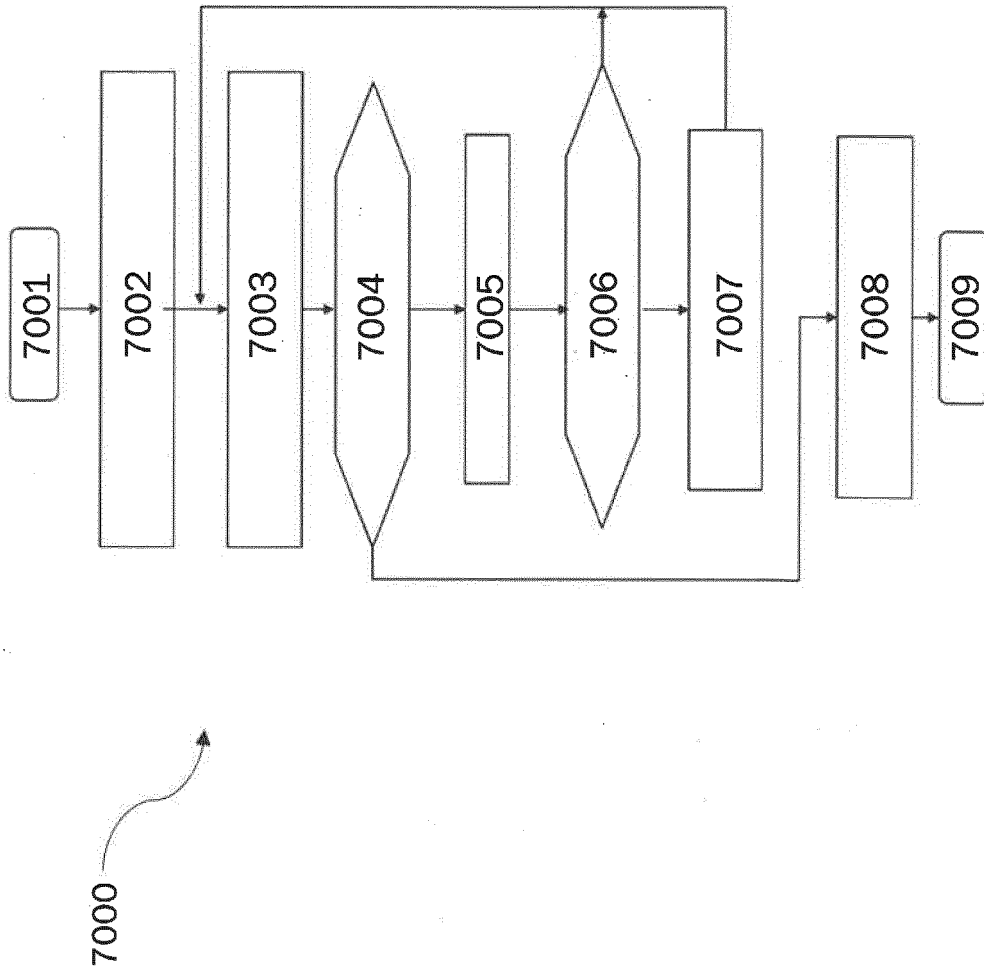
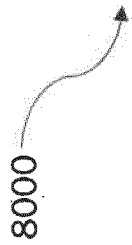


Fig. 7

8000



	P1	P2	P3	P4
S1	1	1	1	1
S2	1	1	1	1
S3	0	1	1	1
S4	0	1	1	0

Fig. 8

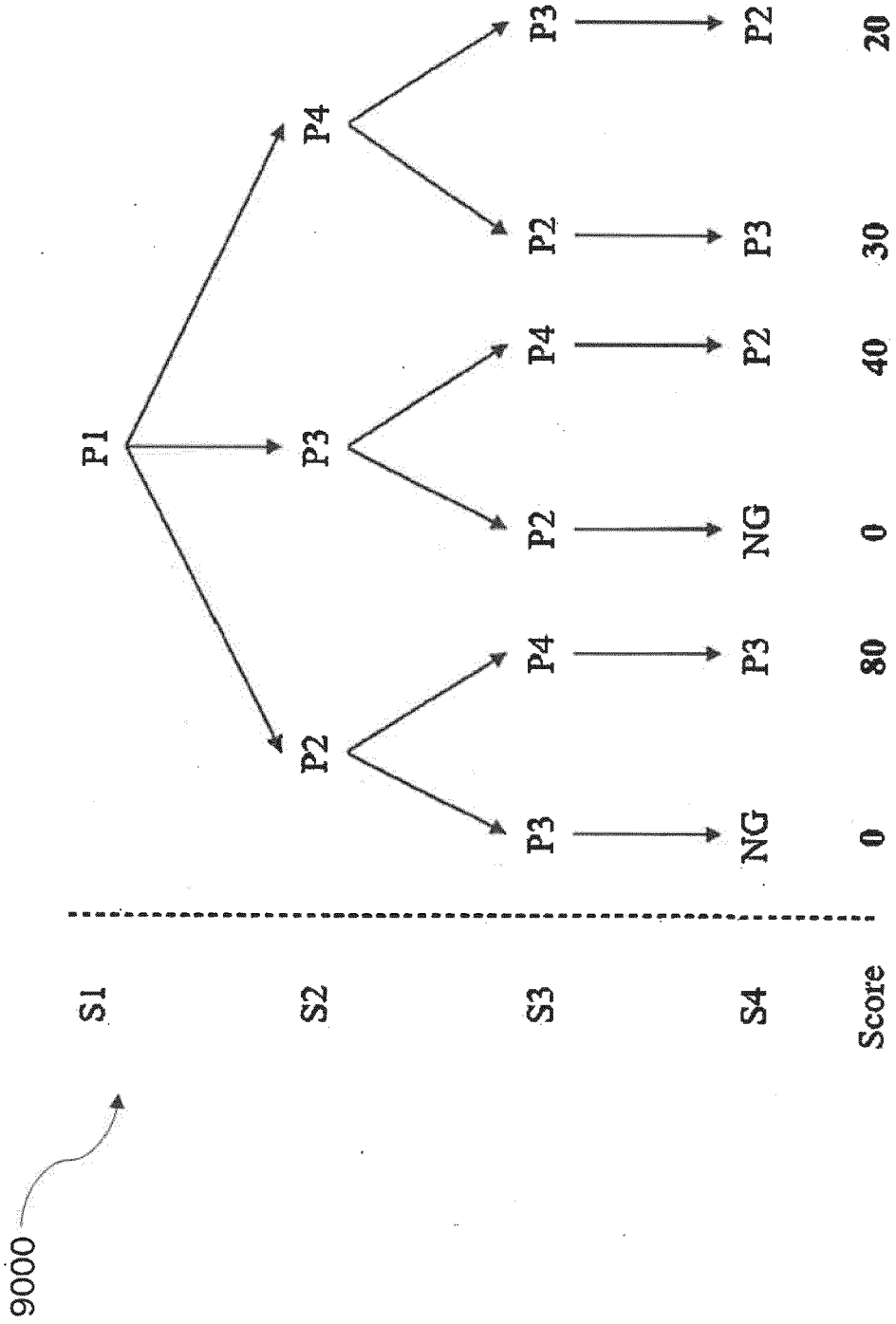


Fig. 9

S1	P1
S2	P2
S3	P4
S4	P3

1105 

Fig. 10

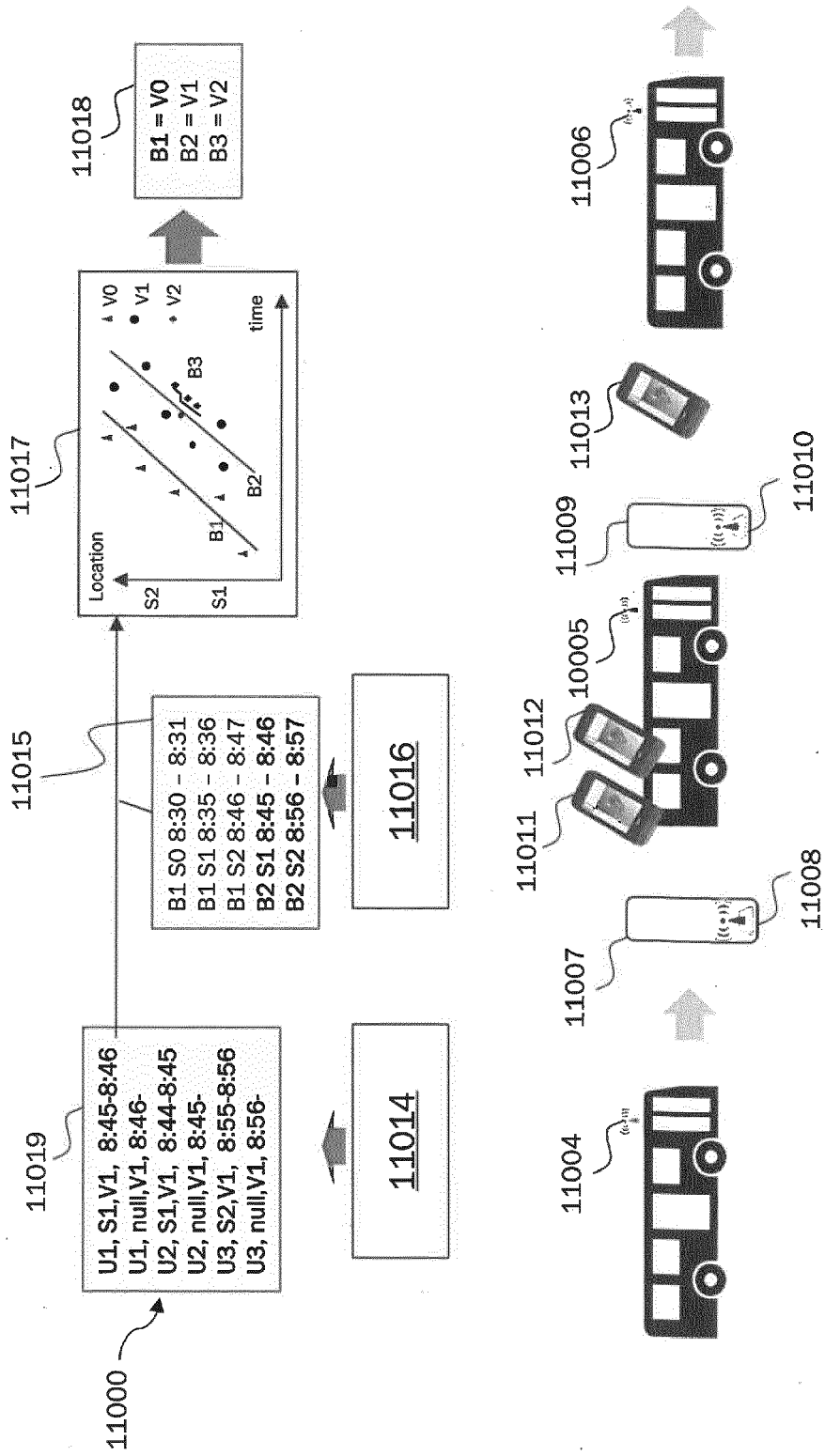


Fig. 11



EUROPEAN SEARCH REPORT

Application Number

EP 21 18 9754

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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