METHOD AND ARRANGEMENT FOR TRACKING MOBILE TERMINALS

A method and arrangement in a traffic server (200) for tracking a plurality of mobile terminals (202) served by a mobile communication network. Geographic locations of cell switching points (CSP; s) where handover takes place are determined and stored (2:1, 2:2) when a positioning capable mobile terminal (202) travels along a selected known route (100) during a set-up phase. Cell transition events are then obtained (2:3) for the mobile terminals whenever handover takes place during a run-time phase. The cell transition events include at least an identity of an entered cell and an associated timestamp. Cell switching points corresponding to the obtained cell transition events are identified, and tracking information reflecting the traffic of the mobile terminals, is derived (2:4) based on the obtained cell transition events and corresponding cell switching points.
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TECHNICAL FIELD

The present invention relates generally to a method and arrangement for tracking movements of a plurality of mobile terminals, which can be used for detecting mobile users and making traffic estimations for road systems.

BACKGROUND

It is a well-known problem that traffic congestion frequently occurs in various road systems in cities and other areas with dense traffic. Different solutions for tracking presence and movements of vehicles in such areas have been devised to enable traffic estimations and forecasts. Traffic information can be obtained by means of various traffic sensors and detection functions. For example, a traffic situation may be reported by humans on a voluntary basis, or observations can be made from a helicopter or from any spot with a good view of the traffic.

Various automatic traffic detecting devices can also be used for measuring the traffic. Thus, vehicle detectors may be applied at suitable locations along a road which are designed to register passing vehicles in order to measure the current traffic density. Traffic registration data from plural vehicle detectors is typically collected in a central server which may also be configured to calculate various parameters reflecting the current traffic situation in a useful manner. Vehicle detectors may be implemented as pressure or vibration sensors embedded in the road structure, camera pods or photo-cells mounted alongside the road, etc.
Moreover, mobile networks can be helpful by providing information on the whereabouts of their subscribers to a traffic surveillance centre or the like. Thus, many vehicle drivers bring their mobile terminals which the mobile networks can detect by means of different positioning functions. In general, mobile networks are often required to provide and certify the location of their subscribers in order to support emergency services and other location dependent services. Positioning functions are therefore typically employed in the mobile networks for locating terminals, including identifying the current cell or deriving a more accurate position from signal strength and/or time alignment measurements on signals from different base station sites, the latter method being known as "triangulation".

Traffic information obtained by any of the above methods can then be presented to the public in different ways, such as broadcasted radio reporting, radio alerts advising of traffic related incidents and using techniques known as RDS (Radio Data System) and TMC (Traffic Message Channel), Web-based information services, or messaging to user terminals using SMS (Short Message Service), MMS (Multimedia Messaging Service) or WAP (Wireless Application Protocol).

However, the solutions above can be associated with various problems. Relying on observations by humans is naturally dependent on the commitment of the persons involved and is also often lacking in coverage. On the other hand, usage of automatic traffic detecting devices requires installation and maintenance of costly infrastructure including robust and weather-proof equipment distributed alongside the roads such as cameras or other sensors, as
well as functionality for collecting registrations or measurements from the distributed detecting devices. Cameras are particularly weather-sensitive and may provide poor image quality as well as a limited view, especially during dark hours, and many cameras are needed to obtain adequate coverage. Such infrastructure installations also require a formal permission and can therefore in reality only be employed by public authorities. Relying on information from a mobile network may also be unsatisfactory in that a cell identity is not very accurate and it may be difficult to derive useful knowledge of the traffic conditions from the positioning data available.

Hence, it is desirable to obtain data and information related to vehicle traffic from which useful estimations, conclusions and forecasts can be made regarding the traffic conditions. More generally, an effortless yet reliable and accurate mechanism is needed for tracking movements of a plurality of mobile terminals.

SUMMARY

It is an object of the present invention to address at least some of the problems outlined above, and to provide a solution for tracking movements of a plurality of mobile terminals. These objects and others may be obtained by providing a method and apparatus according to the attached independent claims.

According to one aspect, a method is provided in a traffic server for tracking a plurality of mobile terminals served by a mobile communication network. In the method, geographic locations of cell switching points (CSP:s) where handover takes place between successive cells of the network are determined and stored when a positioning capable mobile
terminal travels along at least one selected known route. This activity can be seen as a set-up phase of the procedure. Cell transition events are then obtained when handover takes place for mobile terminals present in the network, each cell transition event including at least an identity of an entered cell and an associated timestamp.

This activity can be seen as a run-time phase of the procedure. Cell switching points corresponding to the obtained cell transition events are further identified, and tracking information reflecting the traffic of the mobile terminals is derived based on the obtained cell transition events and corresponding cell switching points.

In one embodiment, the geographic locations of cell switching points can be obtained from the positioning capable terminal which is equipped with a satellite based positioning tool and reports the identity of a new entered cell and an associated position at each handover when moving along the route. Information on each handover may be stored in the positioning capable terminal, to be reported jointly to the traffic server.

In another embodiment, the cell switching points are linked to the route travelled by the positioning capable terminal. A travelled route can then be identified from a sequence of cell transition events obtained for a mobile terminal, based on the linking of cell switching points to the route.

In further embodiments, the cell transition events can be obtained as handover reports, either from the mobile terminals or from the mobile network serving the mobile terminals. Each handover report may include an entered new cell and an associated timestamp for the handover. Deriving tracking information may include computing a current speed,
direction and/or position of the mobile terminals, based on the cell switching point locations and associated timestamps of the obtained cell transition events. The locations of cell switching points may be obtained for a plurality of selected routes forming a road system.

According to another aspect, an arrangement is provided in a traffic server for tracking a plurality of mobile terminals connected to a mobile communication network. In the arrangement, a locating unit is adapted to determine and store geographic locations of cell switching points where handover takes place between successive cells of the network when a positioning capable mobile terminal travels along at least one selected known route. An event obtaining unit is adapted to obtain cell transition events for the mobile terminals when handover takes place, each cell transition event including at least an identity of an entered cell and an associated timestamp. A logic unit is adapted to derive tracking information reflecting the traffic of the mobile terminals, based on the obtained cell transition events and corresponding cell switching points.

Further possible features and benefits of the invention will become apparent from the detailed description below.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the invention will now be described in more detail and with reference to the accompanying drawings, in which:

- Fig. 1 is a schematic view of a route having radio coverage in a cell pattern of a mobile network, for which various embodiments can be implemented.
- Fig. 2 is a schematic view illustrating a procedure and arrangement for tracking mobile terminals using a traffic server, according to one exemplary embodiment.
- Fig. 3 is a flow chart illustrating a procedure for enabling tracking of mobile terminals, executed by a tracking server, according to another exemplary embodiment.
- Fig. 4 illustrates some exemplary tables with various data that can be used to estimate live traffic in a road system by detecting movements of terminal users, e.g. according to the described embodiments.
- Fig. 5 is a flow chart illustrating a procedure for tracking mobile terminals to generate traffic information, executed by a traffic server and using the tables of Fig. 4, according to another embodiment.
- Fig. 6 is a block diagram illustrating a traffic server in more detail, according to further embodiments.

DETAILED DESCRIPTION

Briefly described, a mechanism and procedure are provided which can be basically seen as divided into a set-up phase and a run-time phase. It is assumed that one or more routes of interest have been selected for study, which may include a road with dense vehicle traffic or any other path along which a multitude of mobile terminal users typically travels. It is thus of interest to obtain information on the movements of these mobile terminal users along the route(s) and possibly to derive further knowledge therefrom, e.g., by making traffic estimations or any analysis of such movements in general.

In the set-up phase, it is identified which cells of a mobile network that provide radio coverage for a selected route. Then, a positioning capable mobile terminal
equipped with a satellite based navigation system such as GPS (Global Positioning System) or Galileo, is utilised to accurately determine the geographical locations where the terminal switches connection with the network from one cell to another when travelling the route, i.e. the positions for normal handover events. These positions will be referred to as "Cell Switching Points (CSP)" in this description. In practice, the set-up phase above can be executed as a "capture phase" when the positioning capable terminal reports the identity of a new entered cell and an associated position at each handover, and an "organize phase" when the CSP information is stored and linked with road information, which will be described in more detail further below with reference to practical examples.

It has actually been found in practical tests that handover between two cells can be expected to take place at basically the same spot for any mobile terminal travelling a predefined route such as a road. Thus, a CSP determined by means of the positioning capable terminal according to the above can be regarded as a reliable and accurate spot for handover.

In the run-time phase, cell transition events are registered for a plurality of mobile terminals travelling along the one or more selected routes, i.e. it is registered when each mobile terminal makes a handover from one cell to another assuming that each handover takes place at a CSP. Registering a cell transition event or handover for a travelling terminal includes identifying the CSP location for the handover and an associated timestamp.

A sequence of passed CSP:s and associated timestamps will then be generated for each travelling terminal, and from this information the travelled route can
firstly be identified, e.g. using road linking information stored with the CSP:s in the set-up (organize) phase. Then, the speed and position of the travelling terminal can also be computed, since the geographical position of each CSP is known from the set-up phase which also provides the mutual distances between successive CSP:s along the route. In practice, the run-time phase above can be executed as a "sense phase" when the handovers are detected and the corresponding CSP:s are identified, and a "synthezise phase\" when traffic information is derived from the registered cell transition events, such as computing the speed and position of travelling mobile terminals.

In this way, the movements of plural mobile terminals can be automatically tracked along the route and also for other selected routes in a similar manner, and the traffic of terminal users can then be estimated and even traffic forecasts are possible, e.g. for a system of vehicle roads, without requiring any dedicated sensors or extra traffic detecting equipment or personnel whatsoever.

An example of how this can be done will now be described with reference to Fig. 1 illustrating a selected route 100 running from a start point "A" to an end point "B", and to Fig. 2 illustrating a procedure for tracking a plurality of mobile terminals on the route 100 by means of a traffic server 200. The route 100 in Fig. 1 may be a vehicle road typically having dense traffic, although the invention is not limited to such roads but can be applied for any route along which mobile terminal users travel, e.g. also including walkers, cyclists, etc.

The route 100 has radio coverage by cells in a mobile communication network, each cell being served by a base station, not shown, and the route from A to B is
covered by a sequence of successive cells A-F as shown in Fig. 1. Another route 100' in the opposite direction may also be selected for study, i.e. from a start point B to an end point A which is covered by a reversed sequence of cells F-A.

In the aforementioned set-up or capture phase of the procedure, a positioning capable mobile terminal 202, equipped with a GPS receiver or other accurate positioning tool, is used to accurately determine CSP:s along the route 100, i.e. the spots where handover takes place. This is done by simply travelling the route with the GPS equipped terminal 202 in hand, which also has a specific registering software adapted to register a GPS-determined position at each handover from one cell to another, and also an associated identity of each entered cell.

Thus, the positioning capable terminal 202 is connected to cell-A when starting the journey, and the first handover from cell-A to cell-B takes place at a spot CSPl which is registered by terminal 202 by determining the current position immediately when the handover is detected. In this example, the registering software in terminal 202 registers the handover spot by reporting the identity of the new entered cell and the associated GPS position to the traffic server 200, as shown in a first step 2:1. A first CSPl is then defined for the detected handover spot, including the reported GPS position and entered cell identity, which are stored in a CSP register at server 200 in a further step 2:2.

This process is thus repeated whenever a handover takes place between successive cells during the journey from A to B. The stored CSP:s may also be linked to the travelled route in a suitable manner at the traffic server 200, such
that the route can be identified for any successive travelling mobile terminals for which handovers are registered in the run-time phase. However, if this solution is used for estimating or just monitoring traffic along a single route only, the linking of CSP:s to route is naturally not necessary and can be omitted.

In this way, a CSP is defined for each reported handover spot when the GSP equipped terminal 202 travels the route 100 from A to B, such that a sequence of CSP:s linked to the route 100 is defined in the traffic server 200, in Fig. 1 indicated as CSP1, CSP2, CSP3,... and so forth. Alternatively, the handover events may be registered by saving this information at each handover in a local memory of terminal 202, which can then be reported or otherwise transferred jointly to the traffic server 200 after completion of the journey.

In the same manner, a sequence of CSP:s can be defined and registered for the opposite direction, i.e. the route 100' from B to A, which will result in different locations for the handover spots or CSP:s, in the figure indicated as CSP'1, CSP'2, CSP'3,... and so forth. This set-up procedure can also be executed for any other selected routes of interest, e.g. in a road system, resulting in a sequence of CSP:s for each route. While GPS is used in the above example, the skilled person will understand that any other type of positioning tool may be employed by the positioning capable terminal 202.

The set-up phase is now completed and the sequence of cells along the selected route (25) and the positions of associated CSP:s are known in the traffic server 200. This information can be organised in suitable register tables for use during the run-time phase, e.g. including a CSP
register, a cell register and a route register, which will be described in more detail by means of an example later below.

In the run-time (sense) phase of the procedure, cell transition events, i.e. handovers, are registered for a plurality of mobile terminals 204 travelling along any of the selected routes, as shown by a step 2:3. As mentioned above, it is assumed that each handover from one cell to another takes place at a CSP, at least roughly, which can be identified for each handover event. Registering a cell transition event or handover for a travelling terminal can be made in different ways.

One possible way is that the terminals themselves are equipped with a handover reporting software adapted to detect each handover and to send a handover report to the traffic server 200, including the identity of the entered new cell and an associated timestamp for the handover. The traffic server 200 can then identify the CSP of each handover from the reported cell identity, thereby knowing the position of the terminal at each given timestamp.

Another possible way is that the mobile network sends a handover report to the server 300 whenever a handover is detected for a mobile terminal. The latter alternative does not require any handover reporting software in the mobile terminal, while the former alternative is not dependent on the mobile network.

When a succession of such cell transition events has been obtained or sensed for a mobile terminal, providing a sequence of passed cells, CSP:s and associated timestamps, the server 200 can identify the route, if necessary, and also compute the speed and position of the mobile terminal.
based on the known CSP positions and the reported timestamps, as shown in a step 2:4.

Information on cell transition events for multiple mobile terminals 204 can generally be used to derive or "synthesize" various useful information on movements of the terminals 204, in the run-time (synthesise) phase, e.g. for estimating live traffic assuming that the mobile terminals are used in vehicles travelling along the route. A final step 2:5 illustrates schematically that a useful result from such analysis and computing can be outputted from the traffic server 200, e.g. to be displayed on a screen or reported to a traffic surveillance facility or the like. The skilled person will understand that various interesting and/or useful information on the live traffic can be derived from the registered cell transition events, which is however outside the scope of the described embodiments.

A procedure for enabling tracking of mobile terminals will now be described with reference to a flowchart shown in Fig. 3. The procedure can basically be executed by a traffic server or the like, e.g. server 200 in the example above. Again, it is assumed that one or more known routes of interest have been selected for study. In a first step 300, locations of cell switching points (CSP:s) where handover takes place are determined and stored in the traffic server, when a positioning capable mobile terminal travels along a selected route of interest. As described for step 2:1 above, this can be done by means of a GPS equipped mobile terminal or other positioning capable terminal.

In a next step 302, the determined CSP locations may be linked with the travelled selected route, e.g. in a suitable storage means at the traffic server. Steps 300 and 302 are basically part of the above-mentioned set-up phase
and can be repeated for plural different selected routes of interest, e.g. in a road system, as indicated by the dashed arrow. In this way, a database can be formed with CSP locations and associated routes, to be used in the run-time phase according to the following steps. From this information, detected cell transition events of mobile terminals moving in the network can be associated with specific routes at a later stage, i.e. the routes travelled by the terminals can be identified. As described above, in some cases it may not be necessary to link the CSP:s to the route depending on the implementation, and step 302 can therefore be considered optional.

In a further step 304, being part of the run-time phase, cell transition events are generally obtained for a plurality of mobile terminals, including at least an identity of each new entered cell at handover and an associated timestamp, resulting in a travelled cell sequence for each terminal. Knowing the selected route(s) and the sequence of cells covering each route, the traffic server can in this step also identify the cell switching points and their locations where each handover has taken place from the obtained cell transition events. As indicated above, these events may be obtained as reports from the terminals themselves or from the mobile network serving the terminals.

Next, the route travelled by each terminal may be identified in a further step 306, if necessary, which can thus be identified from the sequence of cell transition events obtained in step 302 for each terminal. On the other hand, in some cases the route may be obvious and does not require identification, e.g. if only a single road is monitored. Step 306 can thus be considered optional as well depending on the implementation.
In a final shown step 308, tracking information regarding movements of the mobile terminals is generally derived based on information in the obtained cell transition events. The term "tracking information" is used here to represent any information or data reflecting the movements of the mobile terminals, e.g. speed, direction and current position, which can be computed by knowing where and when handovers have taken place for each terminal.

As mentioned above, the geographical positions of known CSP:s and associated cells along selected routes as well as data related to cell transition events can be organised in various register tables at the traffic server. In particular, register tables with CSP/cell data and current traffic data may be generated from the obtained cell transition events during the run-time phase. Some exemplary tables with data that can generally be used to track mobile terminals according to the above description, will now be presented with reference to Fig. 4. The register tables of Fig. 4 may be implemented in a database residing in the traffic server or elsewhere accessible to the traffic server. It should be noted that Fig. 4 illustrates one possible way of organising such register tables, although the invention is not limited to this example.

In Fig. 4, a positioning capable mobile terminal 202 provides locations of CSP:s, in the figure marked as "HO (Handover) locations", to a CSP register 400. For reported CSP locations during the set-up phase, CSP register 400 contains columns holding information on a CSP identity ("CSP-ID") generated by the server, a cell identity for the exit cell ("From Cell-ID") and a cell identity for the enter cell ("To Cell-ID"), respectively, and a geographical
position ("Position") for each registered CSP location, e.g. specified as longitude and latitude values.

A sensor event register 402 holds information regarding cell transition events received from mobile terminals, comprising a terminal identity ("Terminal-ID") which may be the terminal's telephone number or a suitable alias, a cell identity ("Cell-ID") associated with each cell transition events, and a timestamp for the event ("Timestamp"). These columns can be populated when cell transition events are obtained for various mobile terminals during the run-time phase. The Cell-ID in register 402 associated with a cell transition event refers to the enter cell and can be used together with the previous cell to identify which CSP in register 400 where the handover has taken place, as indicated by the dashed arrows.

A route register 404 stores information on routes selected for monitoring with respect to traffic, such as roads with dense traffic often subjected to traffic congestions. The route register 404 comprises columns with a route identity ("Route-ID") generated by the server, one or more start CSP:s ("Start-CSP (s)") where handover takes place at the beginning of the route, and one or more end CSP:s ("End-CSP (s)") where handover takes place at the end of the route. For example, CSP1 in Fig. 1 may be appointed as start CSP and CSP5 may be appointed as end CSP for the route 100.

The route register 404 further comprises a column for one or more identification CSP:s ("Ident-CSP (s)") which have been selected from somewhere between the start CSP(s) and the end CSP(s) of a route, e.g. CSP3 and CSP4 in Fig. 1. The identification CSP:s are used for exclusively identifying the route from a chain of cell transition events obtained for a particular terminal. The identification CSP:s
should thus be unique for each route to enable unambiguous identification of the route. Appointing the start, end and identification CSP:s for a route is made as configuring actions in the set-up phase. The route register 404 actually provides the linking of CSP:s to routes mentioned above, such that if a chain of CSP:s has been detected for a terminal, the route can be identified from the register entry containing matching identity CSP:s in route register 404.

The route register 404 also comprises a column for various measured distances between either of the CSP:s above, which can be used in the run-time phase for computing speed, distance and position of a particular terminal. For example, the following four CSP related distances may be recorded in register 404 for a route with two start CSP:s and two end CSP:s defined: 1) the distance between a first start CSP and a first end CSP, 2) the distance between a second start CSP and a second end CSP, 3) the distance between the first start CSP and the second end CSP, and 4) the distance between the second start CSP and the first end CSP. In this way, redundancy is created such that if for some reason a particular cell transition event is not obtained for a terminal, e.g. at the second start CSP, its movement can be computed anyway from distances between CSP:s of other cell transition events that has in fact been obtained. The skilled person will understand that any distances between any CSP:s can be recorded and used for computing terminal movements in the manner described here.

The route register 404 in this example also comprises a column for an aggregated speed ("Agg-speed") of plural terminals for which cell transition events have been registered in the sensor event register 402. Finally, a
tracking register 406 holds computed tracking information on the terminals registered in the route register 404. The tracking register 406 comprises columns for terminal identities ("Terminal-ID"), route identities ("Route-ID") that have been identified for the terminals from obtained cell transition events, speeds computed for the terminals and associated timestamps. The columns in the tracking register 406 can thus be populated by data obtained from the CSP register 400, the sensor event register 402 and the route register 404, as indicated by the dashed arrows.

Another exemplary and slightly different procedure for tracking mobile terminals, as executed by a tracking server, e.g. using register tables as exemplified in Fig. 4, will now be described with reference to a flow chart illustrated in Fig. 5. In this example, a plurality of routes, e.g. vehicle roads, have been selected for observation in order to make traffic estimations. In a first step 500, locations of cell switching points are determined and stored in the traffic server as linked to corresponding selected routes, again by means of a positioning capable mobile terminal travelling along the selected routes. This step effectively constitutes the set-up phase and corresponds basically to steps 300 and 302 in Fig. 3 as when repeated for different routes.

In a next step 502, a succession of cell transition events is obtained for a mobile terminal in the run-time phase, i.e. as the actual tracking process (i.e. sensing phase) has begun. As described above, a cell transition event comprises at least the identity of an entered cell and a time stamp. It can also include the identity of the cell which the terminal is handed over from, although this information can be deduced from the sequence
of cells. A sequence of CSP:s is then identified from the entered cell identities in the obtained cell transition events, in a further step 504.

It is then checked in a next step 506 if a route can be found that matches the identified CSP sequence, by comparing the identified CSP sequence with the cell switching points linked to different routes in step 500. If not, it may be concluded that the terminal has not followed any of the selected routes and is therefore not interesting in terms of traffic, and the process may return to step 502 for evaluating another mobile terminal, denoted "next terminal" in the figure. On the other hand, if a matching route is found in step 506, the terminal is considered interesting and various tracking parameters can be determined for the terminal in a next step 508, based on the CSP locations and associated timestamps of the obtained cell transition events. The tracking parameters may comprise computing the terminal's current speed, direction and/or position.

Steps 502-508 thus completes the detection and evaluation of the terminal, and the process may return to step 502 for detecting or evaluating a next terminal in the same manner. In general, steps 502-508 may be repeated for a multitude of mobile terminals until the overall terminal traffic can be estimated in a suitable manner, based on the computed current speed, direction and position of the terminals, in a final step 510. The details of estimating the overall traffic from the obtained information on individual terminals is however outside the scope of the described embodiments.

A traffic server with functional units adapted to execute any of the above-described procedures, will now be
described in more detail with reference to Fig. 6. The traffic server 600 is thus used for tracking movements of mobile terminals served by a mobile communication network, and comprises a CSP locating unit 600a adapted to determine geographic locations of CSP:s where handover takes place using a positioning capable mobile terminal travelling along at least one selected known route, in the manner described above. CSP locating unit 600a is also adapted to store the CSP locations in a suitable register 600b which may reside in the server 600 as shown, or may alternatively be implemented elsewhere but accessible to the server 600.

The traffic server 600 further comprises an event obtaining unit 600c adapted to obtain cell transition events (i.e. HO events) for said plurality of mobile terminals when handover takes place. The cell transition events may be received directly from the terminals themselves or from the serving network, as described above. Each cell transition event includes at least an identity of an entered cell and an associated timestamp, which is also stored in the register 600b.

The traffic server 600 also comprises a logic unit 600d adapted to identify cell switching points that correspond to the obtained cell transition events, and to derive tracking information reflecting the traffic of the mobile terminals, based on the obtained cell transition events and corresponding cell switching points.

The CSP locating unit 600a may be further adapted to link the cell switching points to the route travelled by the positioning capable terminal. The logic unit 600d may then be able to identify a travelled route from a sequence of cell transition events obtained for a mobile terminal, based on said linking of cell switching points to the route.
The event obtaining unit 600c may be further adapted to obtain the cell transition events as handover reports, either from the mobile terminals being adapted to detect each handover and to send a handover report to the traffic server, or from the mobile network serving the mobile terminals. Each handover report may include an entered new cell and an associated timestamp for the handover.

The logic unit 600d may be further adapted to derive tracking information by computing a current speed, direction and/or position of a plurality of detected mobile terminals, based on the CSP locations and associated timestamps of the obtained cell transition events.

By using the above-described solution, live traffic in a road system or the like can be estimated and analyzed in a highly automated manner and in real-time. Advantage is taken from the existing handover function in the mobile network without relying on any service agreement with the network or similar, and from the GPS technology or similar which can easily be included or attached to the positioning capable mobile terminal. Moreover, no specific infrastructure along the routes is necessary to install and maintain for this solution.

While the invention has been described with reference to specific exemplary embodiments, the description is in general only intended to illustrate the inventive concept and should not be taken as limiting the scope of the invention. Further, the invention is not limited to any particular traffic surveillance service and may be used for providing tracking information for any type of service requiring such information. The present invention is defined by the appended claims.
CLAIMS

1. A method in a traffic server (200) of tracking a plurality of mobile terminals (202) served by a mobile communication network, comprising the following steps:
   - determining and storing geographic locations of cell switching points (CSP: s) where handover takes place between successive cells of the network when a positioning capable mobile terminal (202) travels along at least one selected known route (100),
   - obtaining cell transition events for said plurality of mobile terminals when handover takes place, each cell transition event including at least an identity of an entered cell and an associated timestamp,
   - identifying cell switching points corresponding to the obtained cell transition events, and
   - deriving tracking information reflecting the traffic of the mobile terminals, based on the obtained cell transition events and corresponding cell switching points.

2. A method according to claim 1, wherein the geographic locations of cell switching points are obtained from the positioning capable terminal being equipped with a satellite based positioning tool and reporting the identity of a new entered cell and an associated position at each handover when moving along the route.

3. A method according to claim 2, wherein information on each handover is stored in the positioning capable terminal, and is then reported jointly to the traffic server.
4. A method according to any of claims 1-3, wherein the cell switching points are linked to the route travelled by the positioning capable terminal.

5. A method according to claim 4, wherein a travelled route is identified from a sequence of cell transition events obtained for a mobile terminal, based on said linking of cell switching points to the route.

6. A method according to any of claims 1-5, wherein the cell transition events are obtained as handover reports from the mobile terminals being adapted to detect each handover and to send a handover report to the traffic server.

7. A method according to any of claims 1-5, wherein said cell transition events are obtained as handover reports from the mobile network serving the mobile terminals.

8. A method according to claim 6 or 7, wherein each handover report includes an entered new cell and an associated timestamp for the handover.

9. A method according to any of claims 1-8, wherein deriving tracking information includes computing a current speed, direction and/or position of the mobile terminals, based on the cell switching point locations and associated timestamps of the obtained cell transition events.

10. A method according to any of claims 1-9, wherein the locations of cell switching points are obtained for a plurality of selected routes forming a road system.
11. An arrangement in a traffic server (600) for tracking a plurality of mobile terminals connected to a mobile communication network, comprising:
- a locating unit (600a) adapted to determine and store geographic locations of cell switching points (CSP: s) where handover takes place between successive cells of the network when a positioning capable mobile terminal (202) travels along at least one selected known route (100),
- an event obtaining unit (600b) adapted to obtain cell transition events for said plurality of mobile terminals when handover takes place, each cell transition event including at least an identity of an entered cell and an associated timestamp, and
- a logic unit (600d) adapted to derive tracking information reflecting the traffic of the mobile terminals, based on the obtained cell transition events and corresponding cell switching points.

12. An arrangement according to claim 11, wherein the locating unit is further adapted to link the cell switching points to the route travelled by the positioning capable terminal.

13. An arrangement according to claim 12, wherein the logic unit is further adapted to identify a travelled route from a sequence of cell transition events obtained for a mobile terminal, based on said linking of cell switching points to the route.

14. An arrangement according to any of claims 11-13, wherein the event obtaining unit is further adapted to obtain the cell transition events as handover reports from the mobile
terminals being adapted to detect each handover and to send a handover report to the traffic server.

15. An arrangement according to any of claims 11-14, wherein the event obtaining unit is further adapted to obtain said cell transition events as handover reports from the mobile network serving the mobile terminals.

16. An arrangement according to claim 14 or 15, wherein each handover report includes an entered new cell and an associated timestamp for the handover.

17. An arrangement according to any of claims 11-16, wherein the logic unit is further adapted to derive tracking information by computing a current speed, direction and/or position of the mobile terminals, based on the cell switching point locations and associated timestamps of the obtained cell transition events.
**Fig. 1**

Diagram showing CSPs and cells (A to B)

**Fig. 2**

Flowchart:

1. **2:1** HO location reports (GPS/cell)
2. **2:2** Store CSP locations
3. **2:3** Identify routes and compute speed and position
4. **2:4** Transition events (CSP)
5. **2:5** Output result

**Fig. 3**

Flowchart:

1. Determine CSP locations along selected route
2. Link CSP locations with route
3. Obtain cell transition events and travelled cell sequence for terminals
4. Identify travelled routes
5. Derive tracking information based on cell transitions
200: CSP Register

<table>
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<tr>
<th>CSP-ID</th>
<th>FromCell-ID</th>
<th>ToCell-ID</th>
<th>Position</th>
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202 HO locations (cell/GPS)

402: Sensor Event Register

<table>
<thead>
<tr>
<th>Terminal-ID</th>
<th>Cell-ID</th>
<th>Timestamp</th>
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204 HO events

404: Route Register

<table>
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<tr>
<th>Route-ID</th>
<th>Start-CSP(s)</th>
<th>End-CSP(s)</th>
<th>Ident-CSP(s)</th>
<th>Distance</th>
<th>Agg-speed</th>
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406: Tracking Register

<table>
<thead>
<tr>
<th>Terminal-ID</th>
<th>Route-ID</th>
<th>Computed speed</th>
<th>Timestamp</th>
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Fig. 4
500 Determine and store locations of cell switching points as linked to corresponding routes

502 Obtain cell transition events for terminal

504 Identify CSP sequence

506 Matching route?

508 Compute speed, direction and current position based on CSP locations and timestamps

510 Estimate traffic based on current speed, direction and position of terminals

Fig. 5

Fig. 6

Traffic Server

CSP:s

Event Obtaining Unit

Logic Unit

Register

Output

CSP Locating Unit

HO events

600a

600c

600d

600b
**INTERNATIONAL SEARCH REPORT**

**International application No**
PCT/SE2009/050111

**A. CLASSIFICATION OF SUBJECT MATTER**

INV.: H04W64/00

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

G08G H04W

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

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

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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Further documents are listed in the continuation of Box C.

See patent family annex.

**Date of the actual completion of the international search**
23 October 2009

**Date of mailing of the international search report**
30/10/2009

Name and mailing address of the ISA:
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax. (+31-70) 340-3016

Authorized officer
Hegeman, Hans
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### INTERNATIONAL SEARCH REPORT

**Information on patent family members**

**International application No**

PCT/SE2009/050111

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Form PCT/ISA/210 (patent family annex) (April 2005)