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(71) Applicant: **Clarion Co., Ltd.**
Tokyo
112-8608 (JP)

(72) Inventor: **Kumagai, Masatoshi**
Tokyo 100-8220 (JP)

(74) Representative: **Matias, Bruno M.**
MERH-IP
Matias Erny Reichl Hoffmann
Paul-Heyse-Strasse 29
80336 München (DE)

(54) Method and apparatus for determining traffic information and system for route calculation

(57) The present invention relates to a method and an apparatus for determining traffic information based on statistical traffic information and real-time traffic information and a system for route calculation based on statistical traffic information and real-time traffic information. According to the present invention, a reliability parameter α_i for said real-time traffic information RTD for a first link i of a traffic network is determined, wherein said reliability parameter α_i indicates a reliability of said real-time traffic information RTD for said first link i, and combined traffic information for said first link i is determined, wherein said combined traffic information for said first link i is determined by combining said statistical traffic information STD for said first link i and said real-time traffic information RTD for said first link i based on the determined reliability parameter α_i.

Fig. 2

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Description

Technical Field of the Invention

[0001] The present invention relates to a method and an apparatus for determining traffic information based on statistical traffic information and real-time traffic information and a system for route calculation based on statistical traffic information and real-time traffic information.

Background of the Invention

[0002] According to the prior art, navigation systems, in particular car navigation systems are known, which are configured to utilize statistical traffic data, sometimes referred to as "STD", for route calculation purposes. Such statistical traffic data can be respectively provided for different links of a traffic network, in particular a road network, wherein a link corresponds to a connection between two intersections of the road network. Statistical traffic data for a particular link is based on statistical observations of traffic in that particular link and may depend on particular patterns that could be observed for that link in the past, wherein such patterns may for example depend on the particular time of the day, e.g. occurrences of congestions in the rush-hour, or also on the type of the day, e.g. whether it is a weekday, a day of the weekend or even a holiday.

[0003] Furthermore, according to the prior art, navigation systems, in particular car navigation systems, are known, which are configured to receive real-time traffic data, sometimes referred to as "RTD", for route calculation purposes. Similar to the above-described statistical traffic data, such real-time traffic data can be respectively provided for different links of a traffic network. However, such real-time traffic data does not depend on statistical observations of traffic behaviour in a particular link but is based on real-time observations of traffic in this particular link. i.e. on the current traffic situation in this particular link. Accordingly, by utilizing real-time traffic data, it becomes possible to receive real-time information of the actual current traffic situation in a particular link based on real-time observations. This may be particularly important in case the actual traffic situation differs from a general pattern indicated by statistical traffic data, for example, in case an accident has occurred in the particular link which has caused a congestion in the particular link, possibly even in links downstream of the link in which the accident has occurred. For providing real-time traffic data, there is for example known the RDS-TMC ("Radio Data System - Traffic Message Channel") system in Europe or the VICS ("Vehicle Information and Communication System") system in Japan. According to the prior art, real-time traffic information is generally used instead of statistical traffic data, i.e. real-time traffic information is preferred over statistical traffic data and used instead, if it is available. If real-time traffic information is not available, statistical traffic data is used.

[0004] From JP 2006-023241, a car navigation system is known which compares statistical traffic data with real-time traffic data and indicates differences in a map which is displayed on a display of a car navigation device so that a user can manually select to avoid certain links in which real-time traffic data indicates a congestion so as to avoid potential congestions. However, the real-time traffic data is always considered accurate.

[0005] However, in route calculation methods utilizing real-time traffic data, there can occur the problem that the available real-time traffic data indicates a traffic situation which does not actually correspond to the actual current traffic situation in the link due to a delay of the real-time traffic data against the actual traffic situation. Such a delay may for example be caused by a time required for data processing, wherein such a required data processing time may for example include the time required for sensing or observing the real-time traffic data, the time required for calculations in connection with the real-time traffic data, and/or also the time required for distributing the real-time traffic data, e.g. the distribution to the respective navigation systems via an information provider. However, even if the time required for data processing and the affiliated delay is known, it cannot be corrected in real-time. In case the delay is known, the knowledge can only be used for off-line delay correction, when the obtained real-time data is used for updating statistical traffic data.

[0006] The above-described problem may generally occur especially in situations where a larger number of links are congested and begin to respectively become free-flow such as for example at the end of rush-hour. In such situations, some links may be actually already in a free-flow state, whereas the corresponding real-time traffic data still indicates that these links are congested because of the above-mentioned delay of the real-time traffic data against the actual traffic situation. In case the real-time traffic data is used for route calculation purposes, it may not be possible to calculate the actual fastest route according to the actual traffic situation because potential links for an optimal fastest route which are actually already in a free-flow state might be omitted in route calculation since the corresponding links are indicated to be still congested according to the real-time traffic data.

[0007] Accordingly, it is an object of the present invention to solve the above-described problems which occur, when real-time traffic data, which has a delay against the actual traffic situation, is used for route calculation purposes according to the prior art. Furthermore, it is an object of the present invention to provide a method, an apparatus and a system for determining traffic information based on statistical traffic information and real-time traffic information according to which the determined traffic information can be reliably utilized for route calculation purposes.

Summary of the Invention

[0008] To solve the above-mentioned problems, a method for determining traffic information based on statistical traffic information and real-time traffic information according to claim 1, an apparatus for determining traffic information based on statistical traffic information and real-time traffic information according to claim 9, and a system for route calculation based on statistical traffic information and real-time traffic information according to claim 15 are proposed according to the present invention. Preferred embodiments of the present invention are described by the dependent claims.

[0009] A method for determining traffic information based on statistical traffic information and real-time traffic information according to the present invention comprises:

- determining a reliability parameter for said real-time traffic information for a first link of a traffic network, wherein the reliability parameter indicates a reliability of the real-time traffic information for the first link, and
- determining combined traffic information for the first link, wherein the combined traffic information for the first link is determined by combining the statistical traffic information for the first link and the real-time traffic information for the first link based on the determined reliability parameter.

[0010] This enables to estimate the reliability of the real-time traffic information based on a determined reliability parameter. Accordingly, efficient route calculation can be enabled based on combined traffic information comprising real-time statistical information and statistical traffic information based on an estimate of the reliability of real-time traffic information so that the problems of the prior art can be avoided, in particular relating to a delay of real-time traffic information.

[0011] According to an aspect of the present invention, the method preferably further comprises determining a discrepancy parameter, when it is determined that the real-time traffic information for the first link and the statistical traffic information for the first link indicate a different traffic state for the first link, wherein the reliability parameter for the real-time traffic information for the first link is preferably determined based on the determined discrepancy parameter. This enables to estimate the reliability of real-time traffic information based on a determined discrepancy parameter.

[0012] According to an aspect of the present invention, the method preferably further comprises determining a first link state parameter, wherein the first link state parameter preferably indicates, whether a first link of a traffic network is in a free-flow traffic state or a congested traffic state based on statistical traffic information for the first link,

- determining a second link state parameter, wherein the second link state parameter preferably indicates, whether the first link is in a free-flow traffic state or a congested traffic state based on real-time traffic information for the first link, and/or
- comparing the determined first link state parameter and the second determined link state parameter for determining, whether the first link state parameter and the second link state parameter indicate a similar traffic state for the first link or a different traffic state for the first link. This enables to efficiently compare real-time traffic information and statistical traffic information based on a traffic state parameter having two possible results, e.g. C for congested or F fro free-flow.

[0013] According to an aspect of the invention, the discrepancy parameter is preferably determined, when it is determined that the first link state parameter and the second link state parameter indicate a different traffic state for the first link, wherein the discrepancy parameter preferably indicates a duration of the discrepancy (difference of indicated traffic states) between the first link state parameter and the second link state parameter.

[0014] According to an aspect of the present invention, the statistical traffic information preferably indicates an average link travel time and/or an average link travel velocity based on statistical traffic data, and the real-time traffic information preferably indicates an average link travel time and/or an average link travel velocity based on real-time traffic data.

[0015] According to an aspect of the present invention, the first link state parameter is preferably determined by determining, whether the average link travel time or the average link travel velocity indicated by the statistical traffic information is above or below a threshold value for the first link, and wherein the second link state parameter is preferably determined by determining, whether the average link travel time or the average link travel velocity indicated by the real-time traffic information is above or below the threshold value for the first link. This enables a simple efficient determination of the traffic state based on a threshold value.

[0016] According to an aspect of the present invention, the discrepancy parameter is preferably determined as the time difference between a current time and a time stamp which preferably indicates a specific time at which the first link state parameter switches from indicating the congested traffic state to indicating the free-flow traffic state for the first link. This enables a simple efficient determination of the discrepancy parameter.

[0017] According to an aspect of the present invention, the discrepancy parameter is preferably determined to be zero, preferably set to zero, if the first link state parameter and the second link state parameter indicate the similar traffic state for the first link, and/or if the second link state parameter indicates a free-flow traffic state for the first link.

[0018] According to an aspect of the present invention, the steps of determining a first link state parameter based on statistical traffic information, determining a second link state parameter based on real-time traffic information, and/or determining a discrepancy parameter are preferably carried out for a plurality of links of a traffic network so that a discrepancy parameter is preferably determined for each of the plurality of links, wherein the step of determining the reliability parameter of the real-time traffic information for the first link is preferably based on the discrepancy parameters respectively determined for each of the plurality of links. This enables to determine a reliability parameter for one link based on information and/or data about a plurality of links for further increasing the reliability of the reliability estimate.

[0019] According to an aspect of the present invention, the step of determining combined traffic information for the first link, a weighted combination of the statistical traffic information for the first link and the real-time traffic information for the first link is preferably determined, wherein a weighting factor for the weighted combination of traffic information is preferably based on the determined reliability parameter so that the weighted combination of traffic information preferably reflects the statistical traffic information for the first link, when the determined reliability parameter indicates a low reliability for the real-time traffic information for the first link, and the weighted combination of traffic information preferably reflects the real-time traffic information for the first link, when the determined reliability parameter indicates a high reliability for the real-time traffic information for the first link. This enables to efficiently reflect the determined reliability of the real-time traffic information in combined traffic information where the ratio of real-time and statistical traffic information in the combined traffic information is efficiently and reliably obtained by a weighted combination based on the determined reliability parameter.

[0020] According to an aspect of the present invention, the combined traffic information is preferably determined so that it preferably reflects the weighted combination of traffic information for the first link, when the number of links of the plurality of links for which the real-time traffic information indicates a congested traffic state is large compared to the number of the plurality of links, and so that the combined traffic information preferably reflects the real-time traffic information for the first link, when the number of links of the plurality of links for which the real-time traffic information indicates a congested traffic state is small compared to the number of the plurality of links. This enables to efficiently and reliably obtain combined traffic information based on the traffic situation in a plurality of links.

[0021] According to an aspect of the present invention, the statistical traffic information for the first link is preferably used for route calculation purposes, if the statistical traffic information indicates a smaller average link travel velocity for the first link than the combined traffic information for the first link, or if the statistical traffic information indicates a larger average link travel time than the combined traffic information for the first link. This further improves the reliability of the determination method so as to avoid potential congestions in a road network in route calculations.

[0022] In the following, an apparatus for determining traffic information based on statistical traffic information and real-time traffic information according to the present invention according to the present invention and preferred aspects thereof are described. The apparatus is configured to perform at least one of the above-described methods according to the invention possibly in combination with any of the preferred aspects thereof.

[0023] An apparatus for determining traffic information based on statistical traffic information and real-time traffic information according to the present invention is configured to carry out a method according to at least one of the above-described aspects of the present invention and comprises:

- a reliability parameter determination means for determining a reliability parameter of the real-time traffic information for the first link, wherein the reliability parameter indicates a reliability of the real-time traffic information for the first link, and/or
- a combined traffic information determination means for determining combined traffic information for the first link, wherein the combined traffic information for the first link is determined by combining the statistical traffic information for the first link and the real-time traffic information for the first link based on the determined reliability parameter.

[0024] According to an aspect of the present invention, the apparatus preferably further comprises a discrepancy determination means for determining a discrepancy parameter, when it is determined that the statistical traffic information for the first link and the real-time traffic information for the first link indicate a different traffic state for the first link, wherein the reliability parameter determination means is preferably configured to determine the reliability parameter of the real-time traffic information for the first link based on the determined discrepancy parameter.

[0025] According to an aspect of the present invention, the apparatus preferably further comprises:

- a statistical traffic information determination means for determining a first link state parameter, wherein the first link state parameter preferably indicates, whether a first link of a traffic network is in a free-flow traffic state or a congested traffic state based on statistical traffic information for the first link,

- a real-time traffic information determination means for determining a second link state parameter, wherein the second link state parameter preferably indicates, whether the first link is in a free-flow traffic state or a congested traffic state based on real-time traffic information for the first link, and/or
- a traffic state comparison means for comparing the first link state parameter and the second link state parameter for determining, whether the first link state parameter and the second link state parameter indicate a similar traffic state for the first link or a different traffic state for the first link.

[0026] According to an aspect of the present invention, the discrepancy determination means is preferably configured to determine the discrepancy parameter, when it is determined that the first link state parameter and the second link state parameter indicate a different traffic state for the first link, wherein the discrepancy parameter preferably indicates a duration of the discrepancy between the first link state parameter and the second link state parameter.

[0027] According to an aspect of the present invention, the apparatus preferably further comprises a state memory means for storing a time stamp which preferably indicates a specific time at which the first link state parameter switches from indicating the congested traffic state to indicating the free-flow traffic state for the first link.

[0028] According to an aspect of the present invention, the combined traffic information determination means is preferably configured to determine a weighted combination of the statistical traffic information for the first link and the real-time traffic information for the first link, wherein a weighting factor for the weighted combination of traffic information is preferably based on the reliability parameter determined by the reliability parameter determination means so that the weighted combination of traffic information preferably reflects the statistical traffic information for the first link, when the determined reliability parameter indicates a low reliability for the real-time traffic information for the first link, and the weighted combination of traffic information preferably reflects the real-time traffic information for the first link, when the determined reliability parameter indicates a high reliability for the real-time traffic information for the first link.

[0029] According to an aspect of the present invention, the combined traffic information determination means is preferably configured to determine the combined traffic information so that it preferably reflects the weighted combination of traffic information for the first link, when the number of links of the plurality of links for which the real-time traffic information indicates a congested traffic state is large compared to the number of the plurality of links, and so that the combined traffic information preferably reflects the real-time traffic information for the first link, when the number of links of the plurality of links for which the real-time traffic information indicates a congested traffic state is small compared to the number of the plurality of links.

[0030] According to an aspect of the present invention, the apparatus preferably further comprises:

- a receiving means for receiving real-time traffic information from an traffic information provider, and/or
- a storage means for storing statistical traffic information.

[0031] According to the present invention, the apparatus preferably further comprises a traffic information output means for outputting the combined traffic information determined by the combined traffic determination means or statistical traffic information to a route calculation means for route calculation purposes.

[0032] A system for route calculation based on statistical traffic information and real-time traffic information according to the present invention is configured to carry out at least one of the methods according to the above-described aspects of the present invention and comprises:

- an apparatus for determining traffic information for route calculation based on statistical traffic information and received real-time traffic information according to at least one of the above-mentioned aspects of the present invention, and
- a route calculation means for calculating a route from a starting location to a selected destination location in a traffic network comprising a plurality of links based on traffic information provided by the apparatus for determining traffic information for route calculation.

[0033] Aspects and features of the above-described method, apparatus and system may be exchanged or combined in any way, partly or as a whole. In particular, the method and the means of the apparatus may be realized by hardware, software, or a combination thereof. The above-described aspects and features and advantages thereof will become more apparent from the following detailed description of preferred embodiments, which will be described with reference to the accompanying figures.

Brief Description of the Figures

[0034]

Fig. 1 shows an example of traffic state determination as used in a method for determining traffic information according to an embodiment of the present invention.

Fig. 2 shows a flow chart of a method for determining traffic information according to an embodiment of the present invention.

Fig. 3 shows an example of a probability distribution of the discrepancy parameter in a method for determining traffic information according to an embodiment of the present invention.

Fig. 4 shows a flow chart of a method for determining traffic information according to a further embodiment of the present invention.

Fig. 5 shows a flow chart of a method for determining traffic information according to a further embodiment of the present invention.

Fig. 6 schematically illustrates a data merging structure according to the method for determining traffic information according to the flow chart of Fig. 5.

Fig. 7 shows a flow chart of a method for determining traffic information according to a further embodiment of the present invention.

Fig. 8 schematically illustrates a data merging structure according to a method for determining traffic information according to a further embodiment of the present invention.

Fig. 9 shows a flow chart of a method for determining traffic information according to a further embodiment of the present invention.

Fig. 10A shows an example of a time sequence of output of traffic state determination as used in a method for determining traffic information according to an embodiment of the present invention and Fig. 10B shows a corresponding example for stored content in a memory means.

Fig. 11 shows a schematic drawing of a system for route calculation according to an embodiment of the present invention.

Detailed Description of the Figures and Preferred Embodiments of the Present invention

[0035] Preferred embodiments of the present invention will be described below with reference to the figures. It is to be noted that the present invention is not limited to the following described embodiments thereof and, in particular, the below described features and aspects of the embodiments may be modified, exchanged or combined, partly or as a whole, to form further embodiments of the present invention. The order of method steps is mainly described as particular example orders and other orders of the steps may be used, e.g. steps S1 and S2 discussed below can be generally performed in any order or even simultaneously.

[0036] In the following description of embodiments, it is generally assumed as an example that the traffic information comprises data indicating an average link travel velocity (or average link travel speed) in a link or a plurality of links. The average link travel velocity indicated by the real-time traffic information is based on real-time observations in the particular link and the average link travel velocity indicated by the statistical traffic information is based on statistical data about the traffic situation in the particular link depending for example on the type of day (e.g. weekday, weekend, or holiday) and the time of day (e.g. rush hour). Based on the average link travel velocity, it can be determined if the particular link is in a free-flow state (the traffic in the particular link can flow freely) or in a congested state (the particular link is congested and traffic flow is restricted due to the congestion) by comparing the average link travel velocity with a threshold value. If the average link travel velocity in the particular link indicated by the real-time traffic information or the statistical traffic information is above the threshold value (larger than the threshold value or larger or equal than the threshold value), it can be determined that the particular link is in the free-flow state since the average link travel velocity is relatively large (above the threshold). If the average link travel velocity of the particular link indicated by the real-time traffic information or the statistical traffic information is, however, below the threshold value (smaller or equal than the threshold value or smaller than the threshold value), it can be determined that the particular link is in the congested state since the average link travel velocity is relatively small (below the threshold).

[0037] Fig. 1 shows an example of traffic state determination as used in a method for determining traffic information according to an embodiment of the present invention. For a particular link, the real-time traffic information and the statistical traffic information indicates an average link travel velocity for the particular link of a traffic network such as a road link, wherein the average link travel velocity changes as a function of time. The threshold value is illustrated by the horizontal line and the traffic state in the particular link is repeatedly determined, where F indicates the detection of the free-flow state, when the average link travel velocity is above the threshold value, and C indicates the detection of the congested state, when the average link travel velocity is below the threshold value. The threshold value can be predetermined based on the type of link, i.e. on the type of road e.g. based on the number of lanes, the official speed limit or the like. Further, it can be the same for each link, different for different types of links based on the type of link as described above, or even individually defined for each link based on individual characteristics of the link.

[0038] However, the present invention is not limited to embodiments, where the real-time traffic information and/or the statistical traffic information indicate an average link travel velocity. For example, the real-time traffic information and/or the statistical traffic information can also indicate an average link travel time (directly connected to the average link travel velocity by the length of the particular link), where the traffic state can be determined by comparing the average link travel time with a threshold value. Then, based on the average link travel time, it can be determined if the particular link is in a free-flow state (the traffic in the particular link can flow freely) or in a congested state (the particular link is congested and traffic flow is restricted due to the congestion) by comparing the average link travel time with the threshold value. If the average link travel time in the particular link indicated by the real-time traffic information or the statistical traffic information is below the threshold value (smaller than the threshold value or smaller or equal than the threshold value), it can be determined that the particular link is in the free-flow state since the average link travel time is relatively small (below the threshold). If the average link travel time in the particular link indicated by the real-time traffic information or the statistical traffic information is, however, above the threshold value (larger or equal than the threshold value or larger than the threshold value), it can be determined that the particular link is in the congested state since the average link travel time is relatively large (above the threshold).

[0039] The real-time traffic information and/or the statistical traffic information can also already indicate non-numerical data, e.g. already indicate whether the particular link is in a free-flow traffic state or in a congested traffic state (e.g. also as binary data, e.g. "0" for congested and "1" for free-flow or vice versa). Moreover, real-time and/or statistical traffic data can also indicate a congestion length in the particular link (e.g. 250m congestion length), a congestion length ratio (e.g. 25% of link length congested), a volume of traffic flow (e.g. vehicles per unit time) which also allow a determination of a congested and a free-flow traffic state of the particular link, possibly also based on a comparison with a corresponding threshold value. It is further possible to combine the above-mentioned indicators for a traffic state of the particular link to decide (determine), whether the particular link is free-flow or congested.

[0040] For each of the below described methods for determining traffic information according to embodiments of the present invention, a first link state parameter Si and a second link state parameter R_i are determined for a particular link. The first link state parameter Si is determined based on statistical traffic information for the link i and the second link state parameter R_i is determined based on real-time traffic information for the link i as described above with reference to Fig. 1. Namely, it is determined, whether the statistical traffic information for the link i indicates that link i is in the congested traffic state (S_i = "C") or that link i is in the free-flow traffic state (S_i = "F"), and whether the real-time traffic information for the link i indicates that link i is in the congested traffic state (R_i = "C") or that link i is in the free-flow traffic state (R_i = "F").

[0041] This is for example illustrated in Fig. 2 which shows a flow chart of a method for determining traffic information according to an embodiment of the present invention. The method illustrated in Fig. 2 comprises the step S1 of determining the first link state parameter S_i and the step S2 of determining the second link state parameter R_i. Furthermore, the determined first link state parameter S_i and second link state parameter Rare compared in the step S5 of comparing the first link state parameter S_i and second link state parameter R_i in order to determine, whether the determined first link state parameter S_i and second link state parameter R_i indicate the same or the different traffic state for the traffic state of link i, and, subsequently, a discrepancy parameter ΔT_i is determined based on this comparison (e.g. in step S6 of determining the discrepancy parameter ΔT_i in the method as illustrated with the flow chart of Fig. 2). Here, the discrepancy parameter ΔT_i is determined based on the duration of the discrepancy between the first link state parameter S_i and the second link state parameter R_i.

[0042] In the described embodiments, the discrepancy parameter ΔT_i is determined to be zero (or be set to zero) if the same traffic state is indicated by the first link state parameter S_i and second link state parameter R_i. Furthermore, the discrepancy parameter ΔT_i is determined so as to corresponds to the duration of the discrepancy between the first link state parameter S_i and the second link state parameter R_i in the case that the first link state parameter S_i indicates the free-flow traffic state for the link i (S_i = "F") and the second link state parameter R_i still indicates the congested traffic state for the link i (R_i = "C").

[0043] Namely, the discrepancy parameter ΔT_i for the link i at a current time Tc is determined according to the following equation 1:

$$\Delta T_i = \begin{cases} 0 & \text{for} \begin{cases} R_i = \text{"}C\text{"}\,\text{AND}\,S_i = \text{"}C\text{"} \\ R_i = \text{"}F\text{"}\,\text{AND}\,S_i = \text{"}F\text{"} \\ R_i = \text{"}F\text{"}\,\text{AND}\,S_i = \text{"}C\text{"} \end{cases} \\ T_C - T_{S,i} & \text{for} \quad R_i = \text{"}C\text{"}\,\text{AND}\,S_i = \text{"}F\text{"} \end{cases} \qquad (1)$$

[0044] Here, $T_{S,i}$ indicates the time at which the traffic state indicated by the statistical traffic information for the link i switched from the congested traffic state to the free-flow traffic state (and/or the time at which the traffic state indicated by the statistical traffic information for the link i is determined to have switched from the congested traffic state to the free-flow traffic state), while the real-time traffic information still indicates a congested traffic state for the link i. This situation can for example occur at the end of rush hour on a weekday, when the statistical data indicates that congestions of the rush hour should have resolved to a free-flow traffic state according to statistical estimations, whereas the real-time traffic information indicates that the rush hour congestion still exists in the link i.

[0045] According to the invention, a reliability parameter α_i for the real-time traffic information can determined for indicating the reliability of the real-time traffic information for the link i, and combined traffic information for the first link i can be determined based on this determined reliability parameter α_i. For example, in the method for determining traffic information as illustrated with reference to the flow chart of Fig. 2, a step S7 of determining the reliability parameter α_i is carried out.

[0046] According to the invention, the combined traffic information for the link i is, then, determined by combining the statistical traffic information for the link i and the real-time traffic information for the link i based on the determined reliability parameter α_i, i.e. based on the determined reliability of the particular real-time traffic information. Consequently, according to the invention, traffic information can be obtained (determined) based on the real-time and the statistical traffic data depending on an estimation of the reliability of the real-time traffic information. Moreover, combined traffic information can be determined based on a merging of real-time traffic data and statistical traffic data based on the reliability estimate.

[0047] Here, the reliability of the real-time traffic information for the link i is determined depending on the discrepancy parameter ΔT_i for the link i, i.e. the duration of the period during which the real-time traffic information still indicates a congested link i, although the statistical traffic information already indicates already a free-flow link i, e.g. at the end of rush hour. The invention uses the idea that the statistical traffic information is a statistical representative (possibly indicating the average time of the resolution of congestions) and that the statistical traffic information can be used as an indicator (probability indicator) for indicating if the real-time traffic information is reliable (for providing a probability indicator of the reliability of the real-time traffic information).

[0048] This is for example illustrated in Fig. 3 which shows an example of a probability distribution of the discrepancy parameter ΔT_i for the link i. $T_{S,i}$ indicates the time at which the traffic state for the link i switches from the congested traffic state to the free-flow traffic state according to the statistical traffic information since this time provides the highest probability for the time (of day) the traffic state in the link switches from the congested traffic state into the free-flow traffic state. In other words, based on the observed patterns and observations of the traffic state in the link i of the past, $T_{S,i}$ indicates the average time of congestion resolution e.g. at the end of rush hour. Hence, the larger the discrepancy parameter ΔT_i is determined, the larger is the deviation of the current time from the most probable time for congestion resolution, i.e. $T_{S,i}$. For instance, if the congestion on a particular day ends at a time t_1. the end of the congestion occurs only a little later than usual, i.e. only a little later than the expected time $T_{S,i}$ indicated by the statistical traffic data and within an expected variation. However, if the congestion on a particular day ends at a time t_2, the end of the congestion occurs far later than usually expected based on the statistical traffic data and this can be used to determine the reliability of the real-time traffic information, if the real-time traffic information still indicates at time t_2 that link i is still in the congested traffic state.

[0049] Accordingly, based on a probability distribution as shown in Fig. 3, when a congestion in link i is indicated by the real-time traffic information but the statistical traffic information indicates already the free-flow state for link i, it may be estimated that the probability of the existence of an actual congestion in link i is low (possibly in relation to discrepancy parameters of other links such as neighbour links of link i), if the discrepancy parameter ΔT_i is large, and it may be estimated that the existence of an actual congestion is high, if the discrepancy parameter ΔT_i is small (possibly in relation to discrepancy parameters of other links such as neighbour links of link i).

[0050] For example, the reliability parameter α_i for link i can be determined according to the following Equation (2) based on determined discrepancy parameters ΔT_1, ΔT_2,..., ΔT_j,..., ΔI_N determined for the links 1, 2, ... , j, ..., N of the road network:

$$\alpha_i = 1 - \frac{\Delta T_i}{\max(\Delta T_1, \Delta T_2, ..., \Delta T_N)} \qquad (2)$$

[0051] According to this definition, the reliability parameter α_i is a normalized value, i.e. it is a value between zero and one. The links 1 to N are for example all links 1 to N of a particular road network, all links 1 to N of a road network within the limits of a city, state or region or within the limits of another geographically defined area, or all links 1 to N of a road network within a predetermined area or distance in the road network surrounding the link i, or the like. Furthermore, according to the definition of Equation (2), the reliability parameter α_i is closer to one in case the real-time traffic information can be estimated to be reliable and the reliability parameter α_i is closer to zero in case the real-time traffic information can be estimated to be less reliable. Moreover, the reliability can be continuously represented by values between zero and one, where a larger value indicates a higher reliability.

[0052] According to Equation (2), in the described embodiments, the reliability parameter α_i indicating the reliability of the real-time traffic information for a link i is determined based on information about other links as well, e.g. based on discrepancy parameters ΔT_1, ΔT_2, ..., ΔT_j, ... , ΔT_N which are determined for the other links. However, the present invention is not limited to this particular determination of the reliability parameter α_i according to Equation (2) above. Generally, a reliability parameter determination may be based on a function $\alpha_i(\Delta T_i)$ having a co-domain between 0 and 1 and which is monotonically decreasing, equals 1 for $\Delta T_i = 0$ and which approximates 0 for increasing ΔT_i. Such a function may further depend on information from other links as well such as for example a function multi-parameter function $\alpha_i(\Delta T_1, \Delta T_2, ... , \Delta T_i, ..., \Delta T_j, ... , \Delta T_N)$, e.g. as in Equation (2), or depend only on statistical information relating to link i.

[0053] According to the method as illustrated with reference to the flow chart of Fig. 2, combined traffic information is determined based on the determined reliability parameter i.e. taking into account the reliability of the real-time traffic information for the particular link, in that a weighted combination of the average link travel velocity indicated by the real-time traffic information and the average link travel velocity indicated by the statistical traffic information is determined for the link i based on the determined reliability parameter α_i according to the following Equation (3) (relating to step S8 of determining the weighted combination $V_{M,i}$):

$$V_{M,i} = \alpha_i V_{R,i} + (1-\alpha_i) V_{S,i} \qquad \textbf{(3)}$$

[0054] Here, α_i is the determined reliability parameter indicating the reliability of the real-time traffic information for link i, $V_{R,i}$ is the average link travel velocity in the link i as indicated by the real-time traffic information and $V_{S,i}$ is the average link travel velocity in the link i as indicated by the statistical traffic information. The determined reliability parameter α_i is used as a weighting factor. By using such a weighted combination for combining the real-time traffic information and the statistical traffic information based on the determined reliability parameter α_i, a weighted value $V_{M,i}$ for a link travel velocity is determined which can be used as a (weighted) link travel velocity value for route calculation purposes instead of $V_{R,i}$ or $V_{S,i}$. Accordingly, combined traffic information is determined in the method of Fig. 2 in step S8 of determining the weighted combination $V_{M,i}$ and in step S12 of outputting the combined traffic information $V_{M,i}$, the weighted average link travel velocity value can be determined for the link i based on the real-time traffic information and the statistical traffic information, combined in dependence of the determined reliability parameter α_i of the real-time traffic information for the link i. In step S12, the combined traffic information can be output for route calculation purposes.

[0055] According to Equation (3), the weighted average link travel velocity value $V_{M,i}$ is close to the average link travel velocity $V_{R,i}$ indicated by the real-time traffic information for link i, when the determined reliability parameter α_i is close to one (high reliability of the real-time traffic information estimated), and the weighted average link travel velocity value $V_{M,i}$ is close to the average link travel velocity $V_{S,i}$ indicated by the statistical traffic information for link i, when the determined reliability parameter α_i is close to zero (low reliability of the real-time traffic information estimated). The weighted average link travel velocity value $V_{M,i}$ can even be identical to the average link travel velocity $V_{S,i}$ indicated by the statistical traffic information for link i for $\alpha_i = 0$ and the weighted average link travel velocity value $V_{M,i}$ can also be identical to the average link travel velocity $V_{R,i}$ indicated by the real-time traffic information for link i for $\alpha_i = 1$. Accordingly, the determined reliability of the real-time traffic information is reflected in the combined traffic information.

[0056] Fig. 4 shows a flow chart of a method for determining traffic information according to a further embodiment of the present invention. In this embodiment, the steps S1 of determining the first link state parameter S_i, S2 of determining the second link state parameter R_i, S5 of comparing the link state parameters S_i and R_i, S6 of determining the discrepancy parameter ΔT_i, S7 of determining the reliability parameter α_i, and S8 of determining the weighted combination $V_{M,i}$ are performed as described above with reference to Fig. 2. According to the embodiment of Fig. 4, a further weighted combination $V_{N,i}$ is determined in an additional step S9, whereas in the step S12 of outputting the combined traffic information, the second weighted combination $V_{N,i}$ is used as the combined traffic information that can be used for route calculation purposes.

[0057] Here, the weighted combination $V_{N,i}$ is intended to take into account the situation of the road network or at least of the traffic situation in the vicinity of the link i in that the traffic situation (or traffic state) of other links of the road network or at least of the links in the vicinity of the link I are considered. The idea to improve further the method of Fig. 2 is to add further conditions and influences for the determination of the combined traffic information. For instance, when it is indicated by the real-time traffic data that the entire road network or at least a large part thereof is congested (a plurality of links are indicated to be congested by the respective real-time traffic information), the real-time traffic information should be preferably used for route calculation if the determined reliability parameter α_i is large for most of the congested links (for a high number of links which are indicated to be in the congested traffic state) since the probability that the congestion actually exists in these links is relatively high. However, when it is indicated by the real-time traffic data that the entire road network or at least a large part thereof is congested (a plurality of links are indicated to be congested by the respective real-time traffic information), and a few of the links which are indicated to be congested by the real-time traffic data have a relatively small determined reliability parameter α_i, the statistical real time traffic information for these links should be preferably used for the route calculation rather than the real-time traffic information since the probability of a congestion in these links may be lower. On the other hand, when almost the entire road network is in the free-flow traffic state (the plurality of links is in the free-flow traffic state) and only a limited part of links is indicated to be congested by the real-time traffic information, it may be preferable to use the real-time traffic information independent of the determined reliability in order to avoid any potential congestion which is not reflected in the statistical traffic information (or the probability distribution based on the statistical traffic information) such as for example congestions due to accidents or the like. It can further be preferable to rather use statistical traffic information for a link i in the case that the real-time traffic information indicates a congested traffic state whereas the real-time traffic information indicates free-flow since the statistical traffic information can indicate a potential congestion (e.g. which may not yet indicated by the real-time traffic information due to a delay or which may even form in the near future).

[0058] This can be for example achieved in the method as shown in Fig. 4 by determining the further second weighted combination $V_{N,i}$ in step S9 according to Equation (4):

$$V_{N,i} = \frac{N_C \; V_{M,i} + N_F \; V_{R,i}}{N} \qquad (4)$$

[0059] Here, N denotes a total number of links of the entire road network or at least part of the entire road network, e.g. within the limits of a geographical region such as a city, a state or the like or within a defined range surrounding the link i. Further, Nc denotes the number of links which are indicated to be in a congested traffic state by their corresponding real-time traffic information and N_F denotes the number of links which are indicated to be in a free-flow traffic state by their corresponding real-time traffic information such that:

$$N = N_C + N_F \qquad (5)$$

[0060] According to the definition of Equation (4), the second weighted combination $V_{N,i}$ is close to the weighted combination $V_{M,i}$ if the number of congested links is relatively large and the second weighted combination $V_{N,i}$ is close to the average link travel velocity as indicated by the real-time traffic information for link I if the number of congested links is relatively small. Accordingly, the second weighted combination $V_{N,i}$ reflects the real-time traffic information $V_{R,i}$ rather than the weighted combination $V_{M,i}$ when almost the entire road network (the plurality of the N links) is indicated to be in a free-flow state in order to avoid any potential congestions. According to this embodiment, the second weighted combination $V_{N,i}$ is used as the determined combined traffic information for link i for route calculation purposes. N_F/N or also Nc/N can be regarded as a weighting factor in Equation (4).

[0061] In a yet further modified embodiment of a method for determining combined traffic information as illustrated with reference to the flow chart of Fig. 5, the second weighted combination $V_{N,i}$ is further compared with the statistical traffic information for link i by calculating the following Equation (6) and using the output as combined traffic information for route calculation purposes:

$$V_{P,i} = \min\left(V_{N,i}, V_{S,i}\right) \qquad (6)$$

[0062] Accordingly, the method as illustrated in the flow chart of Fig. 5 comprises the steps S1 of determining the first link state parameter S_i, S2 of determining the second link state parameter R_i, S5 of comparing the link state parameters S_i and R_i, S6 of determining the discrepancy parameter ΔT_i, S7 of determining the reliability parameter α_i, S8 of determining the weighted combination $V_{M,i}$, and S9 of determining the weighted combination $V_{N,i}$ as described above with reference to the Figs. 2 and 4.

[0063] Furthermore, in step S10, it is determined whether the second weighted combination $V_{N,i}$ is larger or equal (or only larger) to the average link travel velocity $V_{S,i}$ indicated by the statistical traffic information or not. In the affirmative, the average link travel velocity $V_{S,i}$ is used and can be outputted for route calculation purposes (S13). However, if it is determined that the second weighted combination $V_{N,i}$ is not larger and not equal (or only not larger) to the average link travel velocity $V_{S,i}$, the second weighted combination $V_{N,i}$ is used as combined traffic information and can be outputted for route calculation purposes (S12). In other words, the calculated parameter $V_{P,i}$ as defined in Equation (6) is used as combined traffic information and can be outputted for route calculation purposes. According to this embodiment, combined traffic information $V_{P,i}$ reflects any potential congestion which may be indicated by statistical traffic information $V_{S,i}$ or the second weighted combination $V_{N,i}$. It is to be noted that Equation (6) has to be modified in case the parameter of the average link travel time is used instead of the average link travel velocity (max instead of min).

[0064] Fig. 6 schematically illustrates the structure of the merging of traffic data according to the above-described method for determining traffic information according to the embodiment as illustrated with reference to the flow chart of Fig. 5 (according to a data fusion/merging strategy of the embodiment as described with reference to Fig. 5).

[0065] It is to be noted that the above-mentioned parameter $V_{N,i}$ (determined as a second weighted combination after determination a first weighted combination) can also be directly determined without calculating $V_{M,i}$ (i.e. as a first weighted combination) according to the following Equation (7):

$$V_{N,i}=\left[1-\frac{N_C}{N}\frac{\Delta T_i}{\max(\Delta T_1,\Delta T_2,...,\Delta T_N)}\right]V_{R,i}+\left(\frac{N_C}{N}\frac{\Delta T_i}{\max(\Delta T_1,\Delta T_2,...,\Delta T_N)}\right)V_{S,i} \tag{7}$$

[0066] Of course, Equation (7) can be written as:

$$V_{N,i}=(1-\beta_i)\,V_{R,i}+\beta_i\,V_{S,i} \tag{8}$$

by defining a weighting factor β_i as follows:

$$\beta_i=\frac{N_C}{N}\frac{\Delta T_i}{\max(\Delta T_1,\Delta T_2,...,\Delta T_N)} \tag{9}$$

[0067] Accordingly, the method as illustrated with reference to the flow chart of Fig. 7 comprises the steps S1 of determining the first link state parameter S_i, S2 of determining the second link state parameter R_i, S5 of comparing the link state parameters S_i and R_i, S6 of determining the discrepancy parameter ΔT_i, S7 of determining the reliability parameter $1-\beta_i$, and S9 of (directly) determining the weighted combination $V_{N,i}$ according to Equation (7). Here, also α_i does not have to be determined since $1-\beta_i$ may be regarded to function as a reliability parameter.

[0068] Of course, this step S9 in Fig. 7 can also be followed by a determination of $V_{P,i}$ as described above. This is exemplary illustrated in Fig. 8, which schematically illustrates a data merging structure according to which the weighted combination $V_{N,i}$ is directly determined according to Equation (7).

[0069] Fig. 9 shows a flow chart of a method for determining traffic information according to a further embodiment of the present invention. In the above-described methods for determining combined traffic information according to various embodiments of the present invention, a reliability parameter has been determined based on information about other links (the discrepancy parameters ΔT_j) so that at least the steps S1 of determining the first link state parameter S_i, S2 of determining the second link state parameter R_i, S5 of comparing the link state parameters S_i and R_i, S6 of determining the discrepancy parameter ΔT_i should be generally repeated for different links so as to be able to calculate (determine) the reliability parameter for a link i based on the determined discrepancy parameters of a plurality of links. The method as illustrated with reference to the flow chart of Fig. 9 relates to a preferred embodiment of a method in which these steps are repeated for plural links in that two loops are realized which are repeated for plural links, i.e. the steps in each one of the loops are carried out for a link i and then repeated again for the next link i +1.

[0070] According to the method of Fig. 9, the first loop comprises the steps S1 of determining the first link state parameter S_i, S2 of determining the second link state parameter R_i, S5 of comparing the link state parameters S_i and R_i, S6 of determining the discrepancy parameter ΔT_i. However, after determining the first and second link state parameters S_i and R_i in steps S1 and S2, it is determined if the condition is fulfilled that the determined first link state parameter S_i indicates a free-flow traffic state (F for free-flow) AND the first link state parameter S_i as stored in a state memory means 15 (according to the last determination of the first link state parameter S_i) indicates a congested traffic state (C for congested), which means that the traffic state indicated by the statistical traffic information has just switched from C to F since the last determination of the first link state parameter S_i e.g. after the traffic state switched from C to F.

[0071] Then, if it is determined that the determined first link state parameter S_i and the first link state parameter S_i as stored in the state memory means 15 do indicate the same traffic state (both C or both F) or if it is determined that the determined first link state parameter S_i indicates a congested state and the first link state parameter S_i as stored in the state memory means indicates a free-flow state, the method carries on with a step S4 of updating a state memory in that the determined first and second state parameters S_i and R_i are stored in the state memory means 15 together with the respective time of the determination as for example illustrated in Fig. 10A. On the other hand, if it is determined that the determined first link state parameter S_i indicates a free-flow traffic state (F for free-flow) AND the first link state parameter S_i as stored in the state memory means 15 indicates a congested traffic state (C for congested), the method carries on with a step S3 of updating a stored time stamp $T_{S,i}$ in order to store the current time of the determination as a new (updated) time stamp $T_{S,i}$ of the time at which the statistical traffic information has just switched from C to F (or has been determined to have switched from C to F). This is for example illustrated in Fig. 10B, where different stored time stamps are shown in a table for different links. Then the method carries on with step S4 of updating the state memory.

[0072] Based on the information stored in the state memory means 15, the discrepancy parameter ΔT_i for a link i is determined according to Equation (1), where the discrepancy parameter ΔT_i can be set to zero (determined to be zero) according to equation 1, if the condition S_i = F AND R_i = C is not fulfilled, and where the discrepancy parameter ΔT_i can be determined as $\Delta T_i = Tc - T_{S,i}$ based on the current time Tc and the time stamp $T_{S,i}$ stored in the state memory means 15, if the condition S_i = F AND R_i = C is fulfilled. Thereafter, the loop continues for the next link i + 1 by repeating the above-described steps for link i + 1 (indicated by i = i + 1, where the loop can continues for link 1 again, as soon as the steps are carried out for the link N).

[0073] As shown in Fig. 9, in a separate (possibly independent) second loop, the steps S7 of determining the reliability parameter and S11 of determining combined traffic information are performed for the different links, where in step S11, the combined traffic information can be determined as $V_{M,i}$, $V_{N,i}$ or $V_{P,i}$ according to the above-described embodiments.

[0074] Fig. 11 shows a schematic drawing of a system for route calculation according to an embodiment of the present invention. The system for route calculation comprises an apparatus 11 for determining combined traffic information according to the above-mentioned methods for determining combined traffic information. The apparatus 11 comprises an interface 20 (e.g. as a part of a receiving means such as a wireless receiving means) for receiving real-time traffic data such as real-time traffic information for one or more links of a road network provided from a real-time traffic data provider 10. Furthermore, the apparatus 11 comprises a further interface 21 for providing traffic information such as real-time traffic information, statistical traffic information and/or the determined combined traffic information to a route calculation means 19 which is configured to calculate a route based on the traffic information for a plurality of links of the road network.

[0075] The apparatus 11 for determining combined traffic information comprises a reliability parameter determination means 17 for determining a reliability parameter α_i and/or 1-β_i indicating the reliability of the real-time traffic information RTD for a link i (and/or for a plurality of links), and a combined traffic information determination means 18 for determining combined traffic information for the link i (and/or for a plurality of links), wherein the combined traffic information determination means 18 is configured to determine combined traffic information such as for example $V_{M,i}$, $V_{N,i}$ or $V_{P,i}$ according to the above-described embodiments for the link i combining statistical traffic information STD for the link i and real-time traffic information RTD for the link i based on the determined reliability parameter α_i and/or 1-β_i. The combined traffic information determination means 18 is further configured to output the combined traffic information for the link i (and/or for a plurality of links) to the route calculation means 19 of the system via the interface 21. The combined traffic information determination means 18 can also output the real-time and/or the statistical traffic information to the route calculation means 19. The route calculation means 19 is configured to determine a fastest route from a start destination to an end destination by selecting the links for a connected chain of links between the start destination and the end destination based on traffic information of a plurality of links of a road network. Such route calculation means are known in the prior art, e.g. as part of car navigation systems, and a detailed description is omitted here.

[0076] Furthermore, the apparatus 11 for determining combined traffic information comprises a statistical traffic information determination means 14 for determining the first link state parameter S_i for the link i (and/or for a plurality of links) which indicates whether the link i is in the free-flow traffic state F or in the congested traffic state C according to the statistical traffic information STD for the link i, a real-time traffic information determination means 13 for determining the second link state parameter R_i for the link i (and/or for a plurality of links) which indicates whether the link i is in the free-flow traffic state F or in the congested traffic state C according to the real-time traffic information RTD for link i, and a discrepancy determination means 16 for determining the discrepancy parameter ΔT_i according to any of the above-described methods. The discrepancy determination means 16 comprises a traffic state comparison means 16A for comparing the first link state parameter S_i and the second link state parameter R_i as determined by the statistical traffic information determination means 14 and the real-time traffic information determination means 13 for the first link for determining whether the first link state parameter S_i and the second link state parameter R_i indicate the similar traffic state for the first link i (i.e. both indicate the congested traffic state or both indicate the free-flow traffic state) or a different traffic state for the link i (i.e. the first or the second link state parameter indicates the free-flow traffic state and the other link state parameter indicates the congested traffic state).

[0077] The apparatus 11 for determining combined traffic information further comprises a storage means 12 in which statistical traffic information STD for the link i (and/or for a plurality of links) is stored, wherein the statistical traffic information STD is provided from the storage means 12 to the statistical traffic information determination means 14 for determining the first link state parameter S_i for the link i (and/or for a plurality of links) based on the statistical traffic data stored in the storage means 12. The storage means 12 can be configured so that the stored statistical traffic data can be updated (manually and/or automatically, e.g. via information provided from the information provider 10).

[0078] Furthermore, the apparatus 11 for determining combined traffic information comprises a state memory means 15 for storing traffic state information such as link state parameters determined by the statistical traffic information determination means 14 and/or the real-time traffic information determination means 13 together with the time of determination such as for example illustrated in Fig. 10A. The state memory means 15 is further configured to store a determined time stamp $T_{S,i}$ for a link i (and/or for a plurality of links) as for example illustrated in Fig. 10B, which time stamp $T_{S,i}$ indicates the time when the traffic state of the link i as indicated by the statistical traffic information switched from the congested traffic state to the free-flow traffic state (from C to F). As described with reference to the above embodiments of methods for determining the combined traffic information, the time stamp $T_{S,i}$ stored in the state memory means 15 for link i can be set to zero in case the statistical traffic information indicates the congested traffic state (while the real-time traffic information indicates the congested or the free-flow traffic state) and/or in case both of the statistical real-time traffic information and real-time traffic information indicate the free-flow traffic state.

[0079] According to the above embodiments, features and aspects of the present invention, a method and an apparatus for determining traffic information based on real-time traffic information and statistical traffic information, and a system for route calculation can be provided for determining and/or using combined traffic information comprising real-time statistical information and statistical traffic information based on an estimate of the reliability of real-time traffic information.

[0080] The above-described examples, aspects and features of the plural embodiments of the present invention may be combined in any way, party or as a whole. In particular, features, components and specific details of the structures of the above-described embodiments and particular examples thereof may be exchanged or combined to form further embodiments optimized for the respective application. As far as those modifications are apparent for an expert skilled in the art they shall be disclosed implicitly by the above description without specifying explicitly every possible combination.

Claims

1. Method for determining traffic information based on statistical traffic information and real-time traffic information, comprising:

- determining a reliability parameter (α_i; 1-β_i) for said real-time traffic information (RTD) for a first link (i) of a traffic network, wherein said reliability parameter (α_i; 1-β_i) indicates a reliability of said real-time traffic information (RTD) for said first link (i), and
- determining combined traffic information for said first link (i), wherein said combined traffic information for said first link (i) is determined by combining said statistical traffic information (STD) for said first link (i) and said real-time traffic information (RTD) for said first link (i) based on the determined reliability parameter (α_i; 1-β_i).

2. Method according to claim 1, **characterized in that** the method further comprises:

- determining a discrepancy parameter (ΔT_i), when it is determined that said real-time traffic information (RTD) for a first link (i) and said statistical traffic information (STD) for said first link (i) indicate a different traffic state for said first link (i),

wherein said reliability parameter (α_i; 1-β_i) for said real-time traffic information (RTD) for said first link (i) is determined based on the determined discrepancy parameter (ΔT_i).

3. Method according to claim 1 or 2, **characterized in that** the method further comprises:

- determining a first link state parameter (Si), wherein said first link state parameter (Si) indicates, whether said first link (i) is in a free-flow traffic state (F_{Si}) or a congested traffic state (C_{Si}) based on statistical traffic information (STD) for said first link (i),
- determining a second link state parameter (R_i), wherein said second link state parameter (R_i) indicates, whether said first link (i) is in a free-flow traffic state (F_{Ri}) or a congested traffic state (C_{Ri}) based on real-time traffic information (RTD) for said first link (i), and
- comparing the determined first link state parameter (Si) and the second determined link state parameter (R_i) for determining, whether the first link state parameter (Si) and the second link state parameter (R_i) indicate a similar traffic state for said first link (i) or a different traffic state for said first link (i).

4. Method according to claim 3, **characterized in that** said discrepancy parameter (ΔT_i) is determined, when it is determined that the first link state parameter (Si) and the second link state parameter (R_i) indicate a different traffic state for said first link (i), wherein the discrepancy parameter (ΔT_i) indicates a duration of the discrepancy between said first link state parameter (Si) and said second link state parameter (R_i).

5. Method according to at least one of claims 1 to 4, **characterized in that** said statistical traffic information (STD) indicates an average link travel time or an average link travel velocity ($V_{S,i}$) based on statistical traffic data, and wherein said real-time traffic information (RTD) indicates an average link travel time or an average link travel velocity ($V_{R,i}$) based on real-time traffic data.

6. Method according to claim 5, **characterized in that** said first link state parameter (Si) is determined by determining, whether said average link travel time or said average link travel velocity ($V_{S,i}$) indicated by said statistical traffic information (STD) is above or below a threshold value for said first link (i), and wherein said second link state parameter (R_i) is determined by determining, whether said average link travel time or said average link travel velocity ($V_{R,i}$) indicated by said real-time traffic information (RTD) is above or below said threshold value for said first link (i).

7. Method according to at least one of claims 2 to 6, **characterized in that** determining a first link state parameter (Si) based on statistical traffic information (STD), determining a second link state parameter (R_i) based on real-time traffic information (RTD), comparing the determined first link state parameter (Si) and the second determined link state parameter (R_i), and/or determining a discrepancy parameter (ΔT_i) are carried out for a plurality of links of a traffic network so that a discrepancy parameter (ΔT_i) is determined for each of the plurality of links, wherein determining the reliability parameter (α_i; 1-β_i) of said real-time traffic information (RTD) for said first link (i) is based on the determined discrepancy parameters of the plurality of links.

8. Method according to at least one of claims 1 to 7, **characterized in that** determining combined traffic information for said first link (i) comprises determining a weighted combination ($V_{M,i}$; $V_{N,i}$) of said statistical traffic information (STD) for said first link (i) and said real-time traffic information (RTD) for said first link (i), wherein a weighting factor for the weighted combination ($V_{M,i}$; $V_{N,i}$) of traffic information is based on the determined reliability parameter (α_i; 1-β_i) so that the weighted combination ($V_{M,i}$; $V_{N,i}$) of traffic information reflects the statistical traffic information (STD) for said first link (i), when the determined reliability parameter (α_i; 1-β_i) indicates a low reliability for said real-time traffic information (STD) for said first link (i), and the weighted combination ($V_{M,i}$; $V_{N,i}$) of traffic information reflects the real-time traffic information (RTD) for said first link (i), when the determined reliability parameter (α_i; 1-β_i) indicates a high reliability for said real-time traffic information (RTD) for said first link (i).

9. Apparatus for determining traffic information based on statistical traffic information and real-time traffic information according to a method according to at least one of claims 1 to 8, comprising:

- a reliability parameter determination means (17) for determining a reliability parameter (α_i; 1-β_i) of said real-time traffic information (RTD) for a first link (i), wherein the reliability parameter (α_i; 1-β_i) indicates a reliability of said real-time traffic information (RTD) for said first link (i), and
- a combined traffic information determination means (18) for determining combined traffic information for said first link (i), wherein the combined traffic information for said first link (i) is determined by combining said statistical traffic information (STD) for said first link (i) and said real-time traffic information (RTD) for said first link (i) based on the determined reliability parameter (α_i; 1-β_i).

10. Apparatus according to claim 9, **characterized in that** it further comprises a discrepancy determination means (16) for determining a discrepancy parameter (ΔT_i), when it is determined that said statistical traffic information (STD) for said first link (i) and said real-time traffic information (RTD) for said first link (i) indicate a different traffic state for said first link (i), wherein said reliability parameter determination means (17) is configured for determining said reliability parameter (α_i; 1-β_i) of said real-time traffic information (RTD) for said first link (i) based on the determined discrepancy parameter (ΔT_i).

11. Apparatus according to claim 8 or 9, **characterized in that** it further comprises:

- a statistical traffic information determination means (14) for determining a first link state parameter (Si), wherein said first link state parameter (Si) indicates, whether a first link (i) of a traffic network is in a free-flow traffic state (F_{Si}) or a congested traffic state (C_{Si}) based on statistical traffic information (STD) for said first link (i),
- a real-time traffic information determination means (13) for determining a second link state parameter (R_i), wherein said second link state parameter (R_i) indicates, whether said first link (i) is in a free-flow traffic state (F_{Ri}) or a congested traffic state (C_{Ri}) based on real-time traffic information (RTD) for said first link (i),
- a traffic state comparison means (16A) for comparing the first link state parameter (Si) and the second link state parameter (R_i) for determining, whether the first link state parameter (Si) and the second link state parameter (R_i) indicate a similar traffic state for said first link (i) or a different traffic state for said first link (i).

12. Apparatus according to claim 11, **characterized in that**
said discrepancy determination means (16) is configured for determining said discrepancy parameter (ΔT_i), when it is determined that the first link state parameter (Si) and the second link state parameter (R_i) indicate a different traffic state for said first link (i), wherein the discrepancy parameter (ΔT_i) indicates a duration of the discrepancy between said first link state parameter (Si) and said second link state parameter (R_i).

13. Apparatus according to at least one of claims 9 to 12, **characterized in that** it further comprises:

- a receiving means (20) for receiving real-time traffic information (RTD) from an traffic information provider (10), and/or
- a storage means (12) for storing statistical traffic information (STD).

14. Apparatus according to at least one of claims 9 to 13, **characterized in that** it further comprises a traffic information output means (21) for outputting the combined traffic information determined by the combined traffic determination means (18), real-time traffic information, and/or statistical traffic information (STD) to a route calculation means (19) for route calculation purposes.

15. System for route calculation based on statistical traffic information and real-time traffic information according to a method according to at least one of claims 1 to 8, comprising:

- an apparatus (11) for determining traffic information for route calculation based on statistical traffic information and received real-time traffic information according to at least one of claims 9 to 14, and
- a route calculation means (19) for calculating a route from a starting location to a selected destination location in a traffic network comprising a plurality of links based on traffic information provided by the apparatus (11) for determining traffic information for route calculation.

Fig. 1

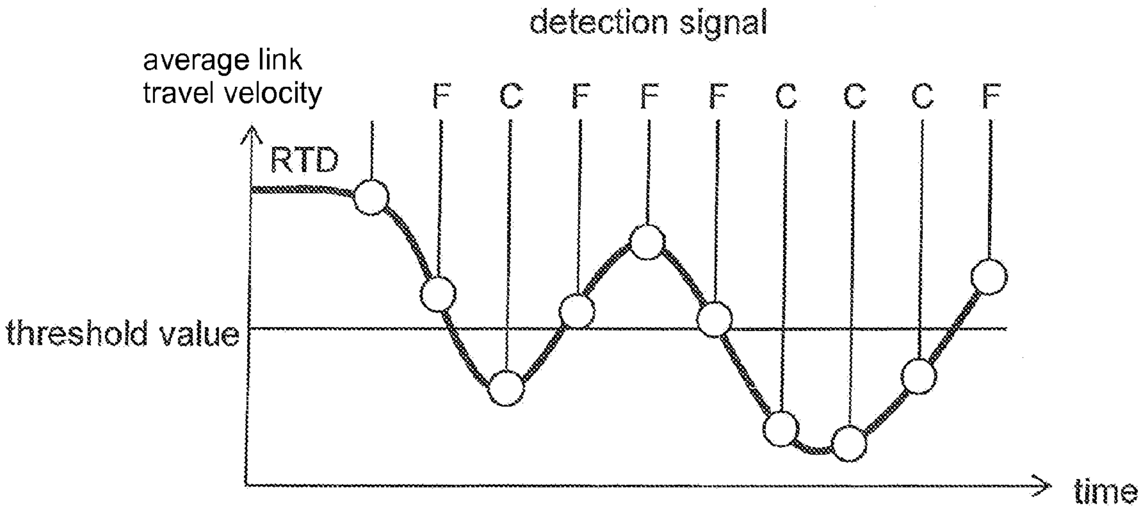

detection signal
average link
travel velocity
F C F F F C C C F
RTD
threshold value
time

Fig. 2

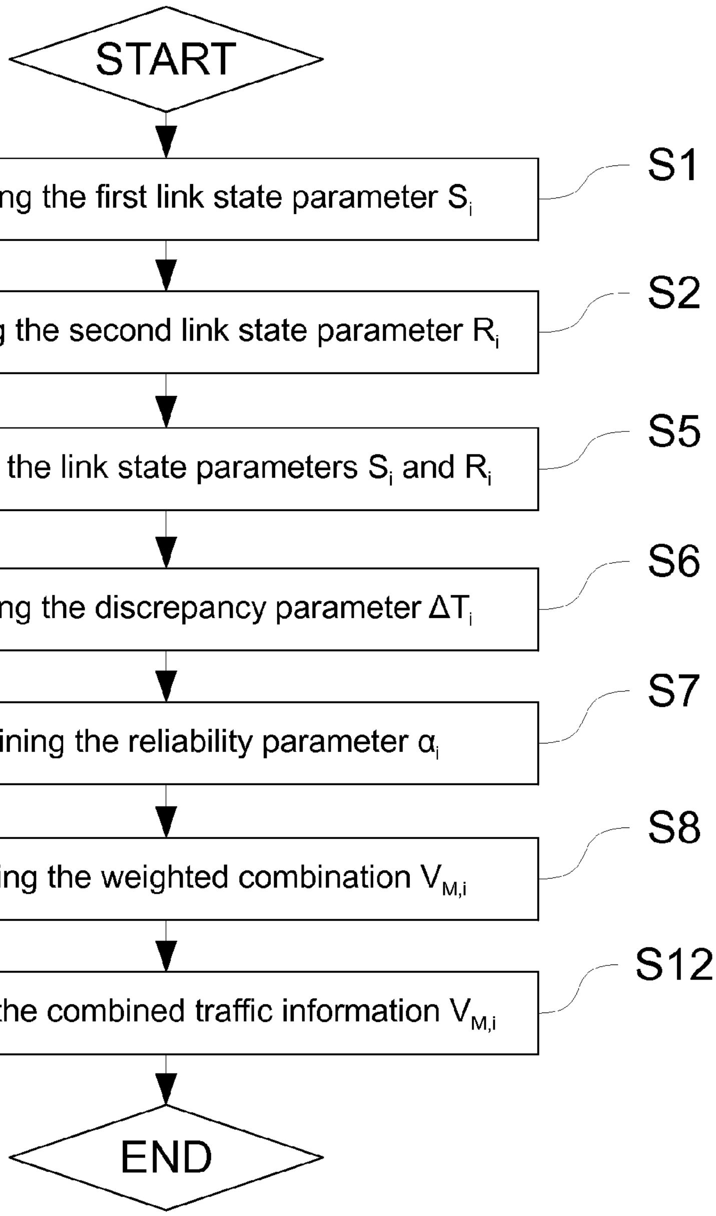

START
Determining the first link state parameter S_i
S1
Determining the second link state parameter R_i
S2
Comparing the link state parameters S_i and R_i
S5
Determining the discrepancy parameter ΔT_i
S6
Determining the reliability parameter α_i
S7
Determining the weighted combination V_M,i
S8
Outputting the combined traffic information V_M,i
S12
END

Fig. 3

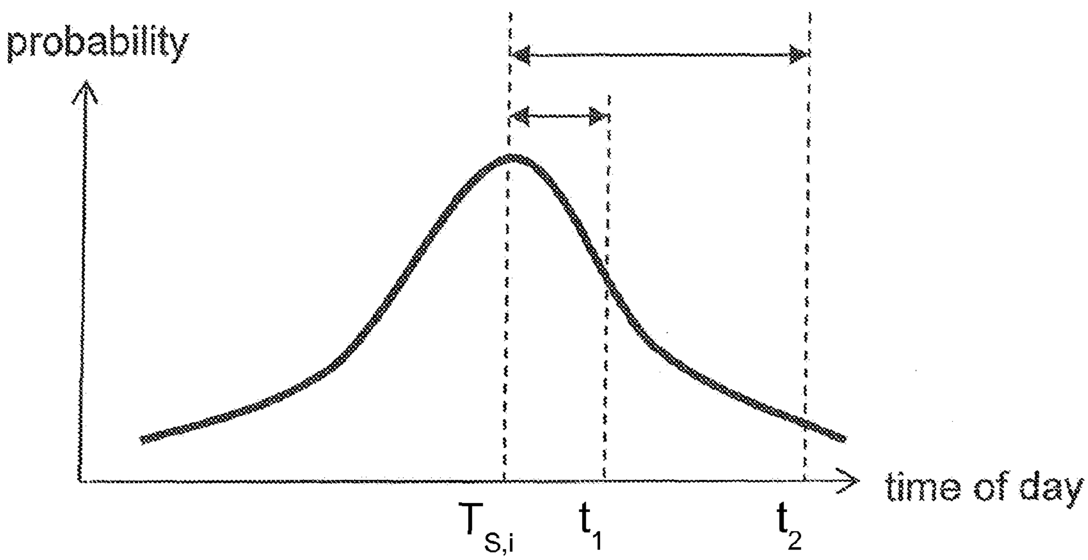


Fig. 4

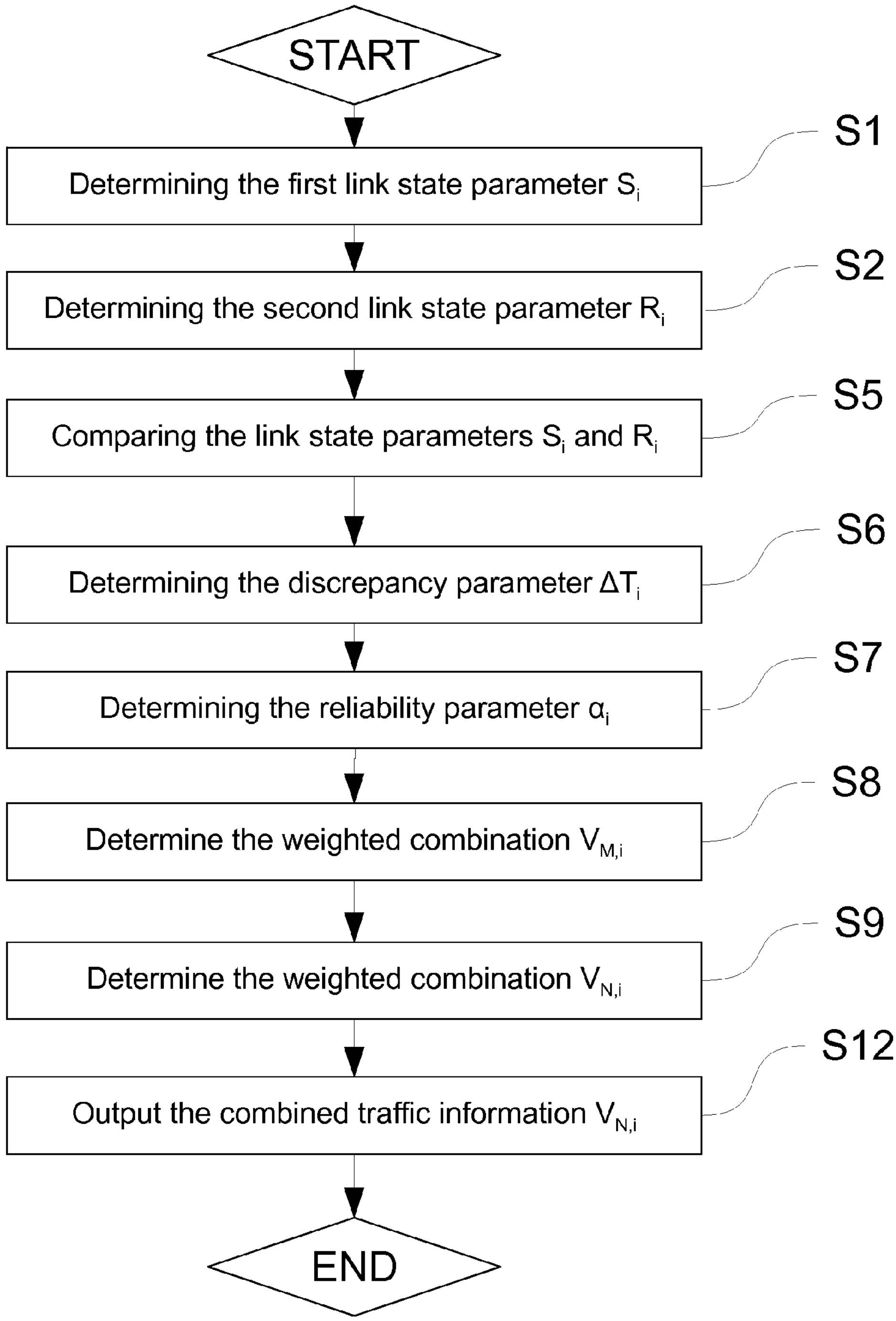

START
S1
Determining the first link state parameter S_i
S2
Determining the second link state parameter R_i
S5
Comparing the link state parameters S_i and R_i
S6
Determining the discrepancy parameter ΔT_i
S7
Determining the reliability parameter α_i
S8
Determine the weighted combination $V_{M,i}$
S9
Determine the weighted combination $V_{N,i}$
S12
Output the combined traffic information $V_{N,i}$
END

Fig. 5

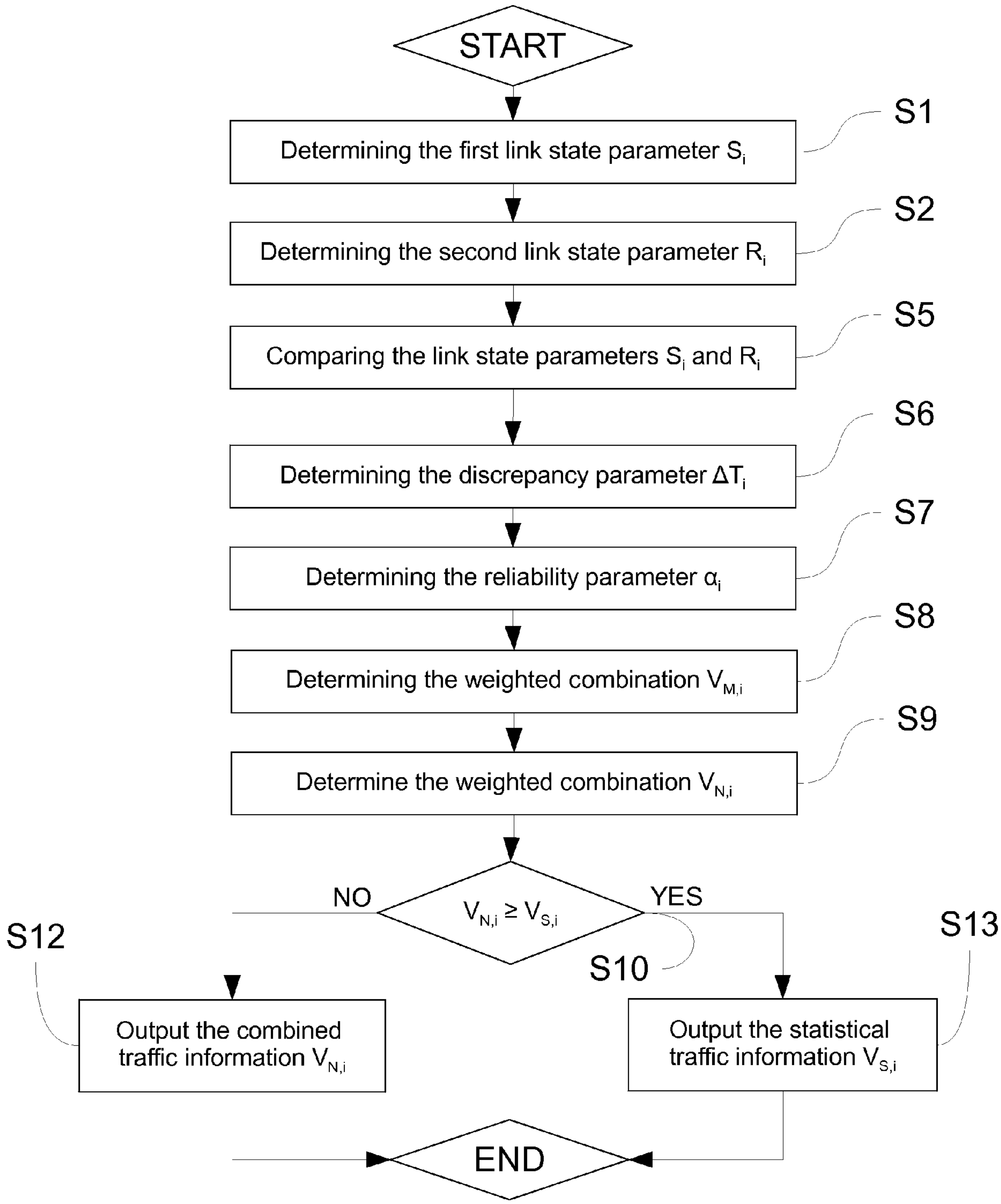

START
S1
Determining the first link state parameter S_i
S2
Determining the second link state parameter R_i
S5
Comparing the link state parameters S_i and R_i
S6
Determining the discrepancy parameter ΔT_i
S7
Determining the reliability parameter α_i
S8
Determining the weighted combination $V_{M,i}$
S9
Determine the weighted combination $V_{N,i}$
NO
$V_{N,i} \geq V_{S,i}$
YES
S10
S12
Output the combined traffic information $V_{N,i}$
S13
Output the statistical traffic information $V_{S,i}$
END

Fig. 6

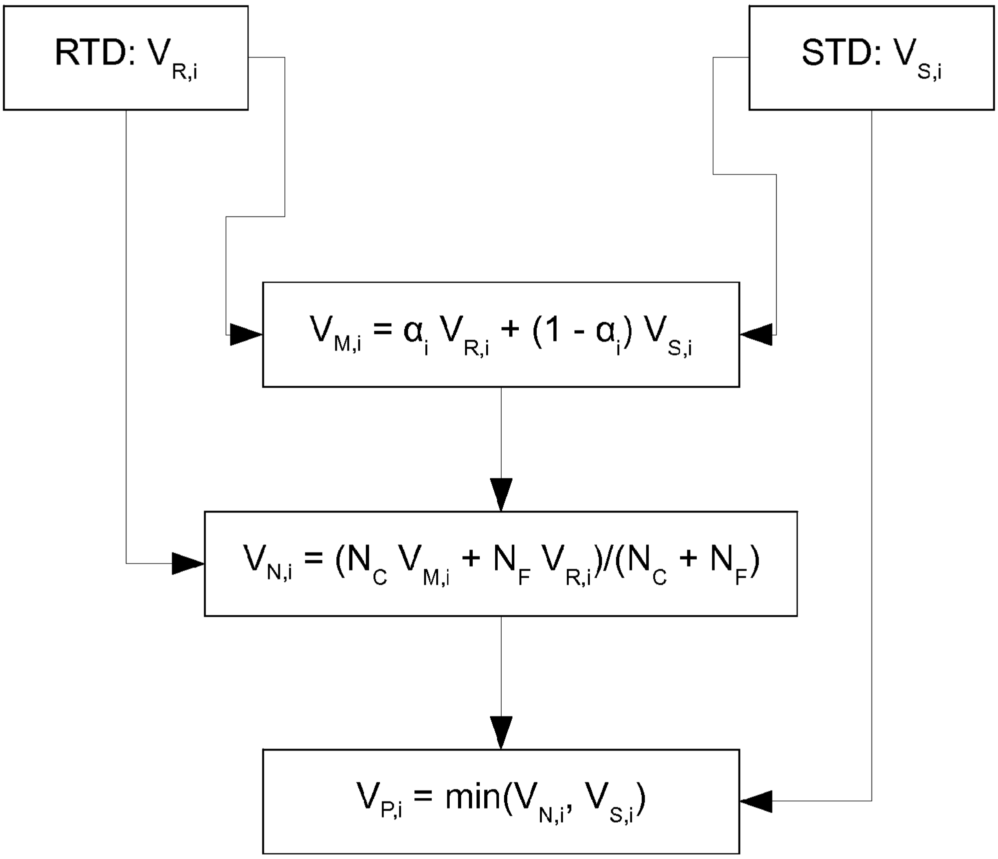

RTD: $V_{R,i}$
STD: $V_{S,i}$
$V_{M,i} = \alpha_i V_{R,i} + (1 - \alpha_i) V_{S,i}$
$V_{N,i} = (N_C V_{M,i} + N_F V_{R,i})/(N_C + N_F)$
$V_{P,i} = \min(V_{N,i}, V_{S,i})$

Fig. 7

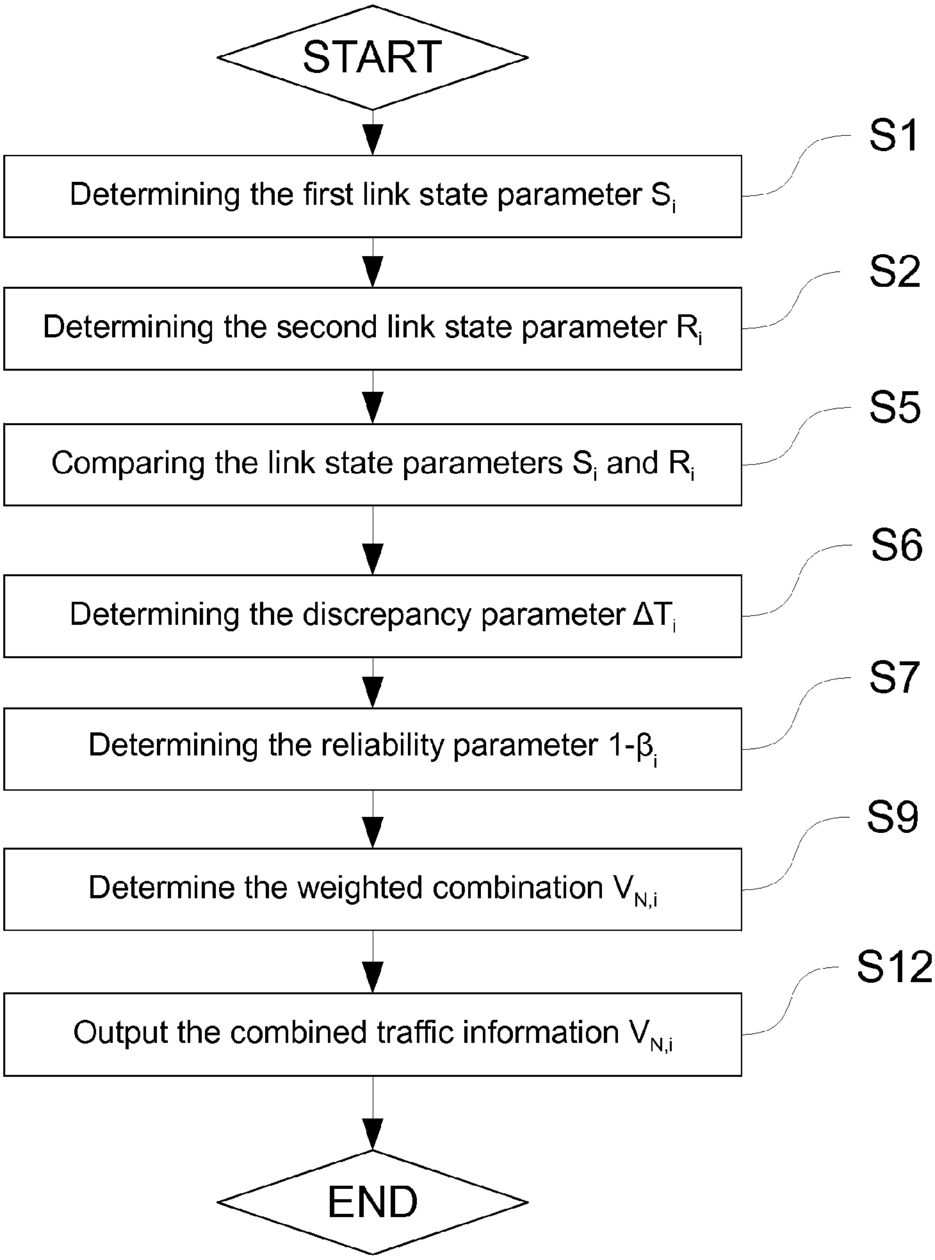

START
Determining the first link state parameter S_i
S1
Determining the second link state parameter R_i
S2
Comparing the link state parameters S_i and R_i
S5
Determining the discrepancy parameter ΔT_i
S6
Determining the reliability parameter $1-\beta_i$
S7
Determine the weighted combination $V_{N,i}$
S9
Output the combined traffic information $V_{N,i}$
S12
END

Fig. 8

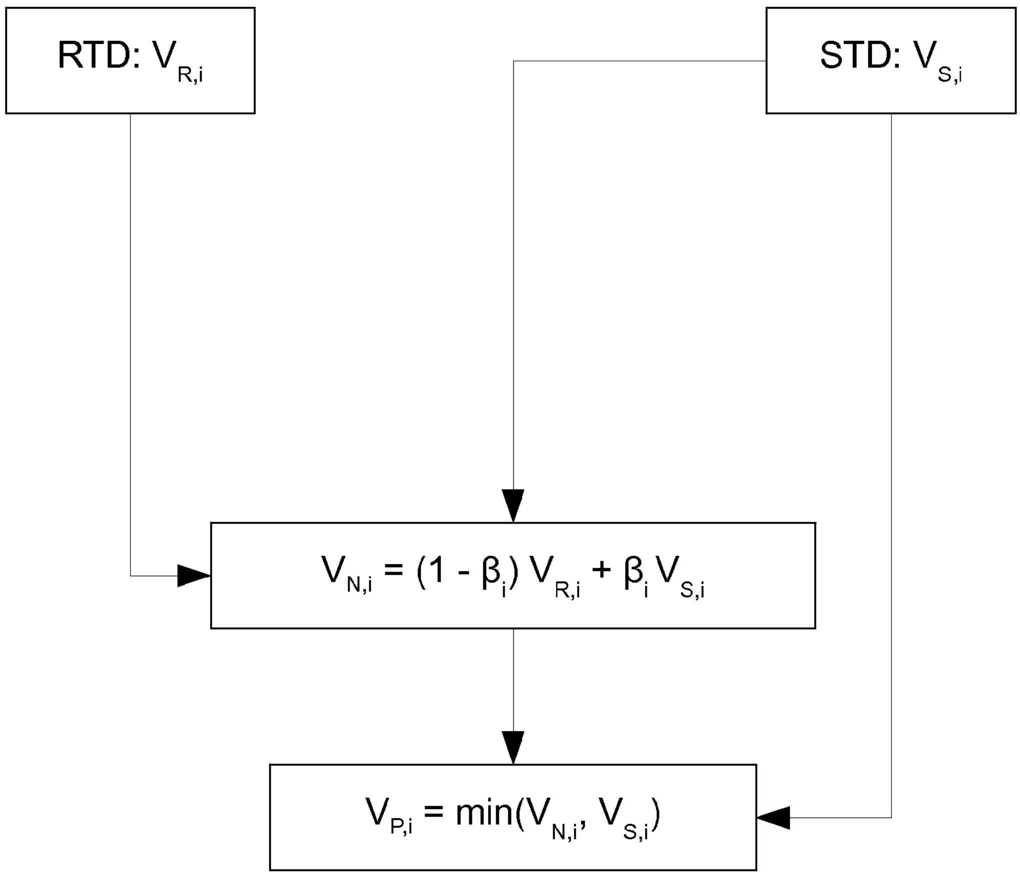


Fig. 9

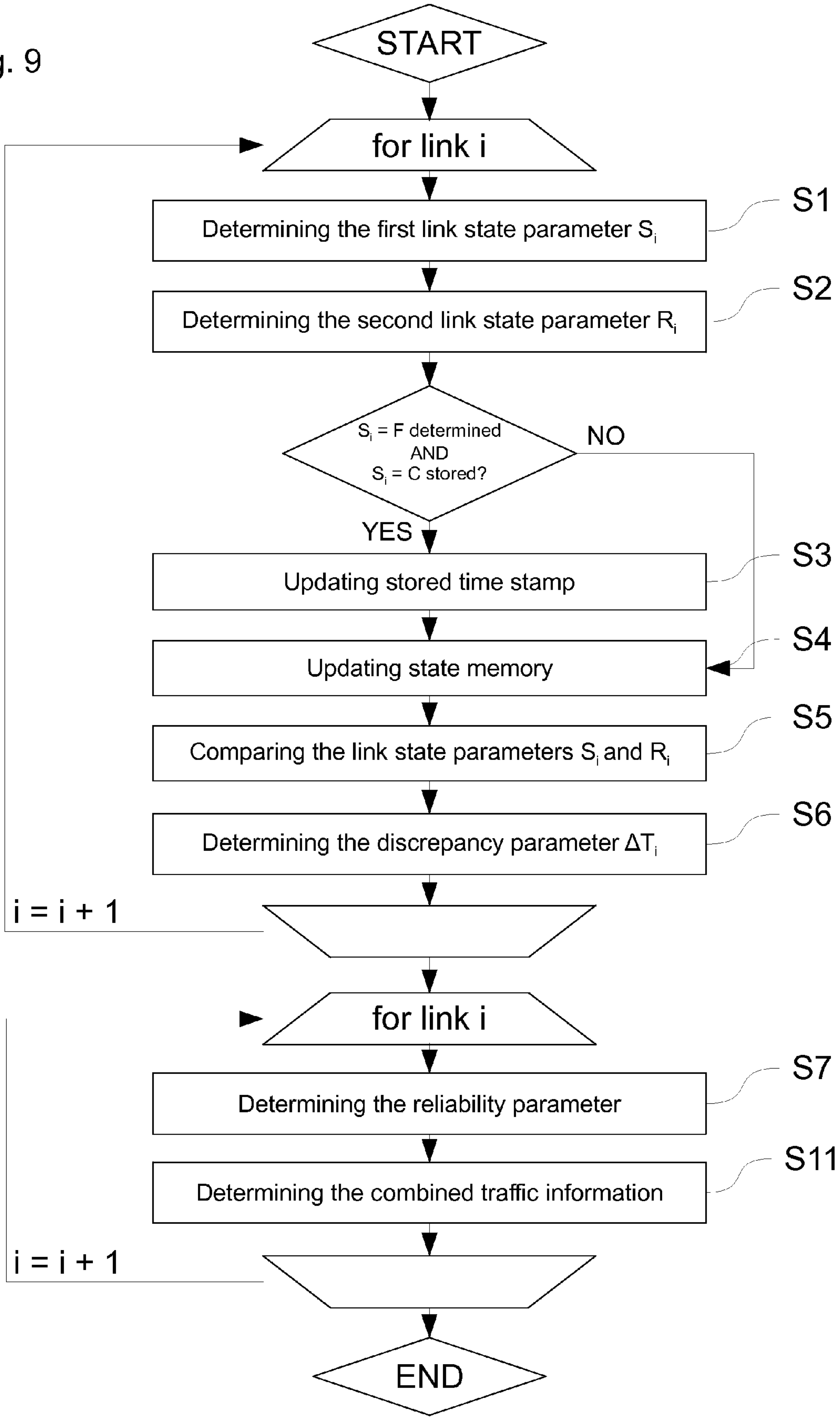

START
for link i
Determining the first link state parameter S_i
S1
Determining the second link state parameter R_i
S2
S_i = F determined
AND
S_i = C stored?
NO
YES
Updating stored time stamp
S3
Updating state memory
S4
Comparing the link state parameters S_i and R_i
S5
Determining the discrepancy parameter ΔT_i
S6
i = i + 1
for link i
Determining the reliability parameter
S7
Determining the combined traffic information
S11
i = i + 1
END

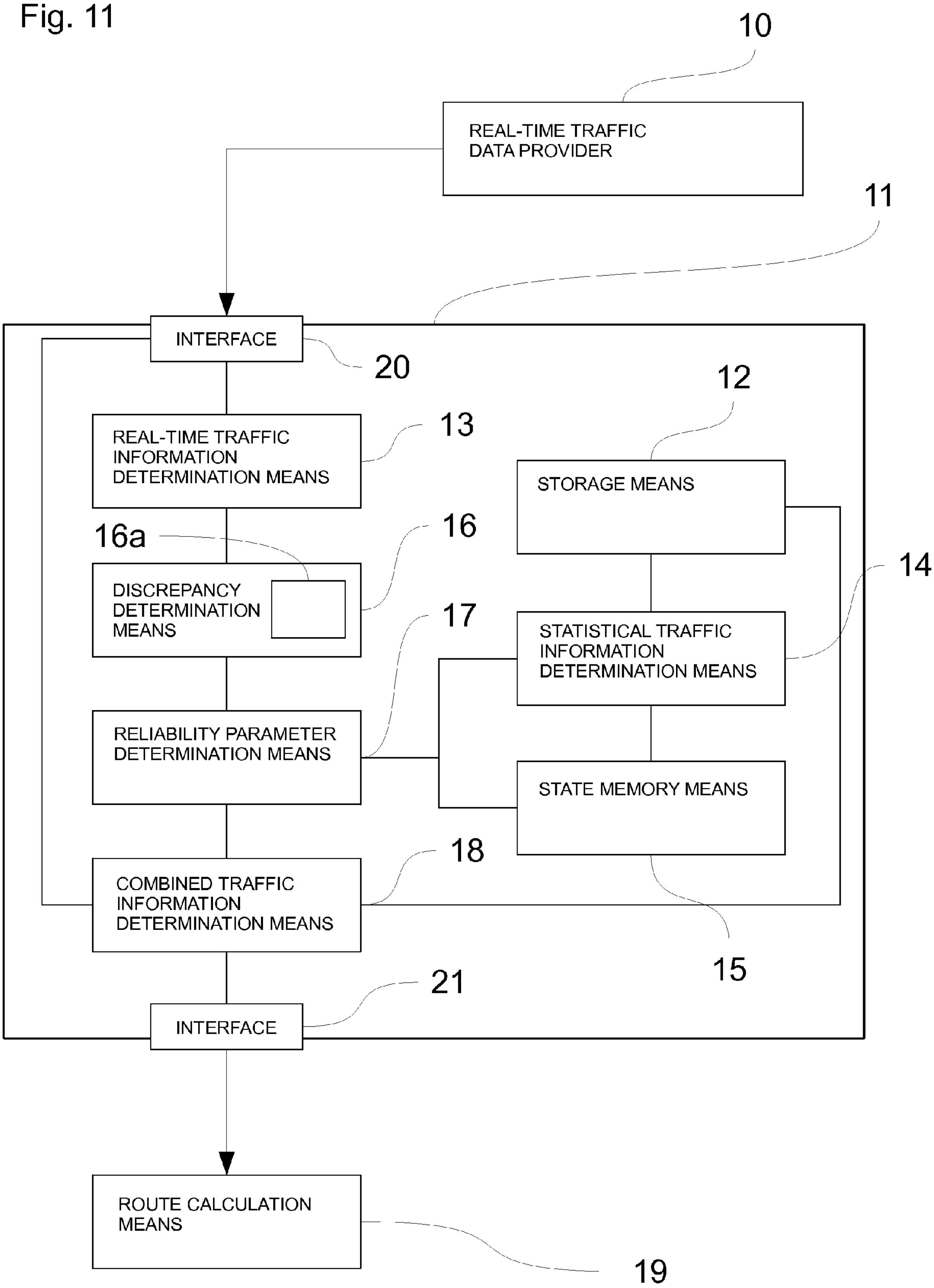
Fig. 10A

time	RTD congestion detector				STD congestion detector			
	link 1	link 2	link 3	...	link 1	link 2	link 3	...
19:10	C	C	C		C	C	C	
19:15	C	C	C		F	C	C	
19:20	F	C	C		F	C	F	
19:25	F	F	F		F	F	F	

Fig. 10B

	STD state memory			
	link 1	link 2	link 3	...
stored signal	F	F	F	
time stamp	19:15	19:25	19:20	

Fig. 11


10
REAL-TIME TRAFFIC DATA PROVIDER
11
INTERFACE
20
12
REAL-TIME TRAFFIC INFORMATION DETERMINATION MEANS
13
STORAGE MEANS
16a
16
DISCREPANCY DETERMINATION MEANS
14
17
STATISTICAL TRAFFIC INFORMATION DETERMINATION MEANS
RELIABILITY PARAMETER DETERMINATION MEANS
STATE MEMORY MEANS
18
COMBINED TRAFFIC INFORMATION DETERMINATION MEANS
15
21
INTERFACE
ROUTE CALCULATION MEANS
19

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EUROPEAN SEARCH REPORT

Application Number
EP 09 16 6514

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/080973 A1 (BESPALOV DMITRIY [US] ET AL) 26 March 2009 (2009-03-26)	1,9	INV. G08G1/01
Y	* paragraph [0002] *	2,10	
A	* paragraph [0011] *	3-8, 10-14	
	* paragraph [0013] *		
	* paragraph [0017]; claims 1-4,11 *		
Y	EP 2 023 308 A (HITACHI LTD [JP]) 11 February 2009 (2009-02-11)	2,10	
A	* abstract *	1,3-9, 11-15	
A	* page 3, line 49 - page 8, line 10; figure 1 *	3-8, 11-15	
X	US 2008/097686 A1 (TAKEUCHI JUNICHI [JP] ET AL) 24 April 2008 (2008-04-24)	1	
Y	* abstract *	2	
A	WO 2005/013063 A (LANDSONAR INC [US]; KANTARJIEV CHRISTOPHER [US]; HUBBARD JONATHAN [US]) 10 February 2005 (2005-02-10)	1-5	
	* paragraph [0046] - paragraph [0047] *		
	* paragraph [0069] - paragraph [0076] *		

TECHNICAL FIELDS SEARCHED (IPC)

G08G

The present search report has been drawn up for all claims

3

Place of search	Date of completion of the search	Examiner
Munich	23 October 2009	Wagner, Ulrich

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23-10-2009

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		US 2009082948 A1	26-03-2009
US 2008097686 A1	24-04-2008	JP 2008123474 A	29-05-2008
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