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Remarks:

Amended claims in accordance with Rule 86 (2) EPC.

(54) **Method and system for estimating the arrival time of a public transport means at predetermined points of its path**

(57) Described herein are a method and a system for estimating the arrival time (ETA_i) of a vehicle (2) in a given point of its path, in which the arrival time (ETA_i) is determined on the basis of the time taken by the vehicle (2) to cover the distance between the current position of the vehicle and the point of passage and in which the time taken by the vehicle (2) to cover said distance is calculated on the basis of a historical mean time of coverage of said distance and of a time taken by at least one preceding vehicle to cover it.

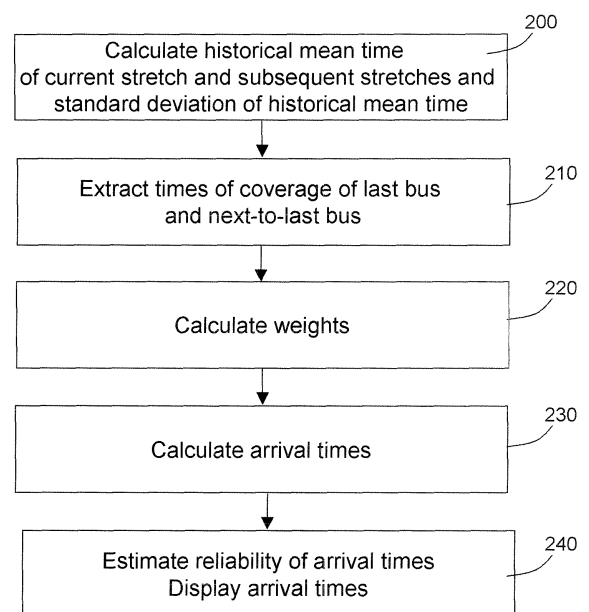


Fig.4

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Description

[0001] The present invention relates to a method and a system for estimating the arrival time of a public transport mean at predetermined points of its path, for example the stops.

[0002] As is known, the arrival time of public transport means, such as buses, trams, surface and underground trains, etc., at the stops to enable passengers to get off and on frequently differ even considerably from arrival times indicated in the programmed timetables affixed to the stops themselves, generally on account of delays due to the traffic conditions and/or to roadworks in progress along the path of the public transport means themselves.

[0003] The delay of the public transport means at the stops inevitably causes a prolongation of the waiting times of the users at the stops themselves, with consequent inconvenience for said users. Said inconvenience is considerably accentuated in the case where the users waiting at a stop are not provided with information regarding the expected times of arrival of the subsequent public transport mean.

[0004] In order to deal with this problem, above all in large towns, the public-transport companies have for some time equipped some stops with displays, on which the expected arrival times of the subsequent public transport means are displayed.

[0005] More recently, public-transport companies or other specialized service companies offer a pay information service that gives the expected arrival times of the subsequent public transport means via SMS messages.

[0006] The information provided to the users regarding the expected arrival times of the subsequent public transport means frequently prove rather imprecise or at times even altogether unreliable on account of the variable conditions of the traffic or other unforeseeable events, such as demonstrations, accidents, etc., so that the need is felt to find more precise and reliable methods of estimating the arrival times of the subsequent public transport means at the stops and, more in general, in characteristic points of their path.

[0007] Consequently, the aim of the present invention is to provide a method and a system for estimating the arrival time of a public transport mean at predetermined points of its path. According to the present invention, a method and a system for estimating the arrival time of a public transport mean at predetermined points of its path are provided, as defined in Claim 1.

[0008] For a better understanding of the present invention, a preferred embodiment thereof, provided purely by way of nonlimiting example, is now described with reference to the annexed plate of drawings, wherein:

- Figure 1 shows a line of a public-transport network equipped with a system for estimating the arrival time of a public transport mean at predetermined points of its path, according to the invention;
- Figure 2 shows a block diagram of the system for estimating the arrival time of a public transport mean at predetermined points of its path according to the invention; and
- Figures 3-7 show flowcharts regarding the method for estimating the arrival time of a public transport mean at predetermined points of its path according to the invention.

[0009] Designated as a whole by 1 in Figure 1 is a line of public transport, along which public transport means 2 travel, only one of which is shown in Figure 1 in the form of a bus, said line forming part of a public-transport network equipped with a system 3 for estimating the arrival time of a public transport mean at predetermined points of its path, such as, for example, stops, designated by the numbers 4 to 8, traffic lights, designated by the numbers 9 to 11, roundabouts, just one of which is shown in Figure 1 and designated by the number 12, etc.

[0010] In particular, the path of the buses 2 between the two terminals can be divided into a plurality of stretches, designated in Figure 1 by the letters A, B, C, D, and E, in which the stretch A is comprised between the stops 4 and 5, the stretch B is comprised between the stops 5 and the traffic light 9, the stretch C is comprised between the traffic light 9 and the stop 6, the stretch D is comprised between the stops 6 and 7, and the stretch E is comprised between the stops 7 and 8. To these, other characteristic points could be added, for example, in a position corresponding to the entrance to and/or exit from the roundabout 12, and more in general in all those points of the path of the bus 2 that can in some way influence the arrival times of the bus 2 in the subsequent characteristic points.

[0011] With reference to Figures 1 and 2, the system 3 for estimating the arrival times comprises:

- a plurality of mobile location units 13, each set on board a respective bus 2 to be monitored;
- a plurality of fixed display units 14, each set in a position corresponding to a respective stop 4-8 for providing users with information regarding the arrival times of the subsequent buses 2;
- a plurality of portable display units (not illustrated in the figures), for example cellphones, for providing users with information regarding the arrival times of the subsequent buses 2; and
- a remote operating centre 15 in communication with the mobile location units 13, the portable units, and the fixed display units 14 for monitoring the position of the buses 2, estimating the arrival times in characteristic points of their path, and sending said information to the fixed display units 14, as described in greater detail hereinafter with

reference to the flowcharts shown in Figures 3-7.

[0012] In particular, each mobile location unit 13 comprises:

- a satellite location device **16** designed to determine the position of the bus 2;
- a transceiver unit 17 designed to receive and transmit radio signals from and to the operating centre 15; and
- a processing unit 18 connected to the satellite location device **16** and to the transceiver unit 17 and designed to manage the operativeness thereof.

[0013] In detail, the satellite location device **16** co-operates in use, in a way in itself known and hence not described in detail, with a satellite location system (GPS - Global Positioning System) formed by a plurality of satellites arranged in orbit around the Earth, distributed on six different orbital planes, and designed to produce radio signals that, once received by the satellite location device **16**, enable the latter to determine the absolute position of the bus 2 on the surface of the Earth through a calculation of geometrical triangulation based upon the bus's distance from at least four satellites.

[0014] The processing unit 18 is provided with an internal memory (not illustrated), in which a set of data are stored regarding the bus 2 and its operativeness, which can be entered manually by the driver, such as, for example, a code identifying the bus 2, its operating state (in service, out of service, breakdown, re-entry into the depot, etc.).

[0015] In use, the transceiver unit 17 transmits to the operating centre 15 the position of the bus 2 and the data stored in the memory of the processing unit 18, and receives information transmitted by the operating centre 15 and addressed to the driver, such as, for example, the existence and the amount of a delay with respect to the table of running times programmed for the bus, information on the presence of heavy traffic or traffic jams, etc.

[0016] The operating centre 15 comprises:

- a transceiver unit 19 designed to receive the position of the buses 2 and the data stored in the memories of the processing unit 18 transmitted by the transceiver units 17, to transmit to the latter information for the drivers, and to transmit to the fixed display units 14 and to the portable display units the estimated times of passage of the buses 2 at the respective stops 4-8; and
- a processing unit 20 connected to the transceiver unit 19 and designed to estimate the arrival times of the buses 2 in characteristic points of their path, amongst which the stops 4-8 and to transmit them to the fixed display units 14 through the transceiver unit 19 itself.

[0017] In particular, the processing unit 20 is provided with an internal memory (not illustrated), in which a data base is stored containing information regarding the public-transport network, such as for example:

- a code identifying each line of the public-transport network;
- a code identifying each bus 2 of the public-transport network;
- a code identifying each trip made by the each bus 2;
- a code identifying each characteristic point of each path taken by each bus 2;
- a code identifying each driver;
- a table containing, for each path of each bus 2 between the respective terminals, the total length of the path, and the length of the individual stretches of the path; and
- a historical file formed by the effective times of passage of the buses 2 at the characteristic points of their paths previously sent to the operating centre 15 by the buses 2 themselves, and by the times of coverage of each stretch of the paths of the buses 2 calculated by the processing unit 20 on the basis of the effective times of passage of the buses 2 at the characteristic points of their paths sent to the operating centre 15 by the buses 2 themselves, as well as the conditions in which these times have been calculated, such as the period of the week (working days or holidays), the day of the week, the period of the year (season, school period, etc.), the time range (peak, evening, etc.), the timetable, etc.; and
- algorithms for processing the information contained in the data base.

[0018] Finally, each fixed display unit 14 comprises:

- a receiving unit 21, designed to receive arrival times of the buses 2 estimated by the processing unit 20 and transmitted by the transceiver unit 19;
- a display 22 for displaying arrival times of the buses 2; and
- a processing unit 23 connected to the receiving unit 21 and to the display 22 for managing the display of arrival times of the buses 2 on the display 23 itself.

[0019] Illustrated in Figure 3 is a rough flowchart of the operations executed by the operating centre 15 for estimating arrival times of the buses 2 in the characteristic points of their paths. In particular, the ensuing description will be made with reference to the estimate of the arrival time of a bus 2 at the stops 4-8, taking into account arrival times in all the characteristic points of the path of the bus 2.

[0020] In particular, according to what is shown in Figure 3, each bus 2 continuously sends to the operating centre 15 radio signals containing the current data and time, its identifier code, its geographical position detected by the satellite location device 16, and its operating state, so that when the operating centre 15 receives a new radio signal coming from a bus 2 (block 100), it verifies the operating state of the bus 2 in such a way as to establish whether it is necessary to make or not the estimate of arrival times (block 110). In fact, the operating centre 15 makes the estimate of the arrival times only for those buses 2 that are in service, whilst it does not take into consideration those buses that, for any reason (breakdown, return into the depot, etc.), are out of service.

[0021] In the case where the bus 2 is in service and prepares to begin a new trip starting from the terminal 4 (Figure 1), it is then necessary to make the estimate of its times of passage in the characteristic points of its path, so that the operating centre 15 identifies first of all the bus 2 from which the communication arrives, verifying that its identifier code corresponds to the one is stored in the data base of the operating centre 15, as well as the line on which the bus 2 is providing the service and the current stretch of the path of the bus 2 (i.e., the one in which the bus 2 is located), on the basis of the position transmitted thereby (block 120), after which it starts the procedure for estimating the arrival times of the bus 2 in the characteristic points of its path for the purpose of updating the ones currently displayed on the displays of the subsequent stops 5-8 (block 130), as described in detail hereinafter with reference to the flowchart of Figure 4.

[0022] According to what is shown in Figure 4, the operating centre 15 calculates the historical mean times $T_{M,i}$ of coverage of the current stretch (in the example shown in Figure 1, the stretch

A) and of the subsequent stretches (in the example shown in Figure 1, the stretches B, C, D and E) of the path of the bus 2 (block 200). In particular, to make said calculation the operating centre 15 extracts first of all from its historical file the effective times of coverage of all the stretches of the path of the bus 2 that have been calculated in conditions similar to the current ones, i.e., that have been calculated in the same period of the week, in the same period of the year, on the same day of the week, in the same time range, at the same time, etc., and then verifies whether the amount of data extracted from the historical file is comprised in a pre-set interval, i.e., whether it is sufficient to make a reliable estimate but at the same time not too large to consider days that are too remote and thus nullify the effects of the periodic variations.

[0023] In the case where the amount of data extracted from the historical file is comprised in the aforesaid pre-set interval, then the operating centre 15 calculates, for each of the stretches of the path of the bus 2, identified in what follows with the subscript i, the historical mean time $T_{M,i}$ of coverage of the stretch of path as arithmetic mean of the times of coverage of the stretches of path extracted from the historical file, as well as the standard deviation $D_{std,i}$.

[0024] In the case, instead, where the amount of data extracted from the historical file falls outside the aforesaid pre-set interval, then the operating centre 15 sets the historical mean time $T_{M,i}$ and the standard deviation $D_{std,i}$ equal to a pre-set value.

[0025] Next, the operating centre 15 extracts from the historical file the times $T_{LAST,i}$ and $T_{LAST-1,i}$ previously calculated, taken by the two preceding buses that have run the service along the same line 1 to cover the same stretches of path (block 210).

[0026] At this point, for each stretch of the path of the bus 2, the operating centre 15 calculates three weights $P_{1,i}$, $P_{2,i}$ and $P_{3,i}$ on the basis of the times $T_{LAST,i}$ and $T_{LAST-1,i}$ of coverage of said stretch of path taken by the two preceding buses (block 220), in the way described in what follows with reference to the flowchart of Figure 5.

[0027] Next, the operating centre 15 calculates the time ETA_i of passage of the bus 2 in each of the characteristic points of its path subsequent to its current position (block 230), in the way described in what follows with reference to the flowchart of Figure 6.

[0028] Finally, the operating centre 15 makes an evaluation of the reliability of the estimate of the arrival times and, on the basis of this, sees to updating the arrival times displayed on the displays 22 of the display units 14 present at the stops (block 240), in the way described in what follows with reference to the flowchart of Figure 7.

[0029] As regards the calculation of the weights $P_{1,i}$, $P_{2,i}$ and $P_{3,i}$, according to what is illustrated in Figure 5, the operating centre 15 calculates first of all a reference time T_{Hi} (block 300) according to the following formula:

$$T_{H,i} = T_{M,i} + 2 \cdot D_{std,i}$$

and then makes the verifications indicated in the flowchart of Figure 5, assigning to the three weights $P_{1,i}$, $P_{2,i}$ and $P_{3,i}$

values indicated in the flowchart of Figure 5 on the basis of the results of the verifications.

[0030] In particular, assigned to the three weights $P_{1,i}$, $P_{2,i}$ and $P_{3,i}$ are the values:

$$\bullet P_{1,i} = 0.3 \quad P_{2,i} = 0.3 \quad P_{3,i} = 0.4$$

if the times $T_{LAST,i}$ and $T_{LAST-1,i}$ taken by the two preceding buses that have run the service along the same line 1 to cover the same stretches of path are shorter than the reference time $T_{H,i}$ (block 320);

$$\bullet P_{1,i} = 0.475 \quad P_{2,i} = 0.05 \quad P_{3,i} = 0.475$$

if the time $T_{LAST,i}$ is shorter than the reference time $T_{H,i}$ and the time $T_{LAST-1,i}$ is longer than the reference time $T_{H,i}$ (block 340);

$$\bullet P_{1,i} = 0.4 \quad P_{2,i} = 0.2 \quad P_{3,i} = 0.4$$

if the time $T_{LAST,i}$ is longer than the reference time $T_{H,i}$ and the time $T_{LAST-1,i}$ is shorter than the reference time $T_{H,i}$ (block 360); and

$$\bullet P_{1,i} = 0.45 \quad P_{2,i} = 0.45 \quad P_{3,i} = 0.1$$

in all the other cases (block 370).

[0031] As regards, instead, the calculation of the time ETA_i of passage of the bus 2 in each of the characteristic points of its path subsequent to its current position, according to what is shown in Figure 6, the operating centre 15 calculates first of all, for the current stretch and all the subsequent stretches of the path of the bus 2, a respective time of coverage $T_{CR,i}$, on the basis of the times $T_{LAST,i}$ and $T_{LAST-1,i}$ of coverage of said stretch of path taken by the two preceding buses, and of the historical mean time $T_{M,i}$ of coverage of said stretch, appropriately weighted by means of the three weights $P_{1,i}$, $P_{2,i}$ and $P_{3,i}$ associated to said stretch of path, according to the following formula (block 400):

$$T_{CR,i} = (P_{1,i} \cdot T_{LAST,i}) + (P_{2,i} \cdot T_{LAST-1,i}) + (P_{3,i} \cdot T_{M,i})$$

[0032] Next, the operating centre 15 calculates the time T_{RM} necessary for the bus 2 to conclude the current stretch of its path (block 410), on the basis of the current time h , of the length L of the current stretch of path, of the length L_{THRG} of the part already covered of the current stretch of path, and of the time of coverage T_{CR} of the current stretch of path, according to the following formula:

$$T_{RM} = h + [(L - L_{THRG}) \cdot T_{CR}] / L$$

[0033] At this point, the operating centre 15 calculates, for each of the characteristic points of the path of the bus 2 subsequent to its current position, the arrival time ETA_i in said characteristic point as sum of the time T_{RM} necessary for the bus 2 to conclude the current stretch of path and of the times T_{CR} of coverage of the subsequent stretches of path up to the characteristic point in question, according to the following formula:

$$ETA_i = T_{RM} + \sum_{x=0}^n T_{CR,x}$$

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where n denotes the stretches of path subsequent to the current one up to the characteristic point in question, and obviously assumes the value zero for the characteristic point of the path of the bus 2 subsequent to its current position (block 420).

10 **[0034]** Finally, as regards the updating of the arrival times displayed on the display units 14 present at the stops, according to what is shown in Figure 7, the operating centre 15 first of all evaluates the reliability of the estimate of the times of passage, which, as may be appreciated, decreases as the distance of the estimate increases; i.e., arrival times at the stops closer to the current position of the bus 2 will have a very low uncertainty, whilst the arrival times at the stops more distant from the current position of the bus 2 will have a high uncertainty.

15 **[0035]** In particular, the reliability of the estimate of the arrival times is established as the contribution of a number of components:

- the historical variability of the times of coverage of the stretches of the path of the bus 2;
- possible significant deviations, with respect to the historical mean times, of the times of coverage of the stretches of path preceding the current one and taken by the last bus that has run the service along the line; and
- possible significant deviations, with respect to the historical mean times, of the times of coverage of the stretches of path preceding the current one and taken by the next-to-last bus that has run the service along the line.

25 **[0036]** In detail, to do this the operating centre 15 first of all calculates the standard deviation for each stretch of the path, according to the following formula (block 500):

$$D_{ATT,i} = \sqrt{\frac{Dev_Std_i^2 \cdot n_i \cdot P_{3,i} + (T_{LAST,i} - T_{LAST-1,i})^2 \cdot P_{1,i} + (T_{LAST-1,i} - T_m)^2 \cdot P_{2,i}}{n \cdot (P_3 + P_1 + P_2)}}$$

35 where n is the number of records of effective times of passage in each characteristic point present in the historical data base. There is then calculated the uncertainty of the estimate of arrival times on the basis of the standard deviations calculated previously, according to the following formula (block 510) :

$$INC_ETA_i = \sqrt{\sum_{x=0}^n (D_{ATT,i})^2}$$

45 **[0037]** Next, the operating centre 15 determines the type of message to display on the display units 14 present at the stops on the basis of arrival times ETA_i and of the uncertainty INC_ETA_i calculated, and in particular makes the verifications indicated in the flowchart of Figure 7, displaying, for example, the following messages:

- "No buses are expected in the next T_1 minutes" if the arrival time ETA_i is shorter than a pre-set time interval T_1 (block 530);
- "Bus arriving in approximately ETA_i " if the uncertainty INC_ETA_i of the arrival time ETA_i is longer than a pre-set time interval T_2 (block 550); and
- "Bus arriving in ETA_i " if the uncertainty INC_ETA_i of the arrival time ETA_i is shorter than a pre-set time interval T_2 (block 560)".

55 **[0038]** The advantages of the system and of the method of the invention described are evident.

[0039] The forecast of arrival times of the vehicles in the characteristic points of the lines, such as, for example, stops, terminals, crossroads, and checkpoints, is in fact extremely useful in so far as it enables the company that manages the public-transport network to identify in due time possible delays of the vehicles with respect to the programmed timetables, to intervene with corrective manoeuvres in the case of events that cause a variation of the table of running times, and

to inform the users waiting at the stops constantly on the expected times of passage of the vehicles.

[0040] It is clear that modifications and variations can be made to the method and to the system described and illustrated herein, without thereby departing from the scope of protection of the present invention, as defined in the annexed claims.

[0041] The historical mean time of coverage of the stretches of the path can, for example, be calculated in a way different from the one described, for example on the basis of a weighted mean time or of any other function.

[0042] Furthermore, the calculation of the time of coverage of the stretches of the path could be made also only on the basis of the time of coverage of the last or of the next-to-last bus, or of any other preceding bus that will be sufficiently close in time to the current one so as to provide reliable indications regarding the time of coverage of the stretch. For example, if the trips are sufficiently close in time, the times of coverage of the third-from-last bus and/or of the fourth-from-last bus, etc. could also be used; if instead they are distant in time, just the times of coverage of the last and/or of the next-to-last bus could be used.

Claims

1. A method for estimating the arrival time(ETA_i) of a vehicle (2) in a given point of its path, **characterized in that** it comprises:

- determining the time taken by said vehicle (2) to cover the distance between the current position of the vehicle and said point of passage on the basis of a historical mean time of coverage of said distance, and of a time taken by at least one preceding vehicle to cover said distance.

2. The estimating method according to Claim 1, in which said time taken by said vehicle (2) to cover the distance between the current position of the vehicle and said point of passage is determined on the basis of a historical weighted mean time of coverage of said distance and of a weighted time taken by a last ($T_{LAST,i}$) and/or by a next-to-last ($T_{LAST-1,i}$) vehicle to cover said distance.

3. The estimating method according to Claims 1 and 2, in which said time taken by said vehicle (2) to cover the distance between the current position of the vehicle and said point of passage is determined on the basis of the sum of said historical weighted mean time of coverage of said distance with said weighted time taken by a last ($T_{LAST,i}$) and/or by a next-to-last ($T_{LAST-1,i}$) vehicle to cover said distance.

4. The estimating method according to Claims 1-3, in which determining said time taken by said vehicle to cover the distance between said current position of said vehicle and said point of passage comprises:

- determining a time of coverage ($T_{CR,i}$) of a stretch of said path, said stretch being comprised between two points of passage of said vehicle in two given points of said path; and
- determining a time (T_{RM}) taken by said vehicle to finish covering a current stretch of said path, said current stretch being comprised between said current position of said vehicle and a subsequent point of passage of said vehicle.

5. The method according to Claims 1-4, in which said time taken by said vehicle to cover the distance between said current position of said vehicle and said point of passage is determined on the basis of said time of coverage ($T_{CR,i}$) of said stretch and of said time (T_{RM}) taken by said vehicle to finish covering said current stretch.

6. The method according to Claim 5, in which said time taken by said vehicle to cover the distance between said current position of said vehicle and said point of passage is calculated on the basis of the sum of said time of coverage ($T_{CR,i}$) of said stretch with said time (T_{RM}) taken by said public means of transport to finish covering said current stretch.

7. The estimating method according to Claims 4-6, in which determining said time of coverage ($T_{CR,i}$) of said stretch comprises:

- determining a time taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch; and
- determining a historical mean time ($T_{M,i}$) of coverage of said stretch.

8. The method according to Claims 4-7, in which determining said time of coverage ($T_{CR,i}$) of said stretch moreover

comprises the step of weighting said time taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch and said historical mean time ($T_{M,i}$) of coverage of said stretch.

9. The method according to Claims 4-8, in which said time of coverage ($T_{CR,i}$) of said stretch is calculated on the basis of said times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch and of said historical mean time ($T_{M,i}$) of coverage of said stretch.

10. The method according to Claims 4-9, in which said time of coverage ($T_{CR,i}$) of said stretch is calculated on the basis of said weighted times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch and of said historical weighted mean time ($T_{M,i}$) of coverage of said stretch.

11. The method according to Claim 9, in which said time of coverage ($T_{CR,i}$) of said stretch is calculated on the basis of the sum of said times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch with said historical mean time ($T_{M,i}$) of coverage of said stretch.

12. The method according to Claim 10, in which said time of coverage ($T_{CR,i}$) of said stretch is calculated on the basis of the sum of said weighted times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch with said historical weighted mean time ($T_{M,i}$) of coverage of said stretch.

13. The estimating method according to Claims 7-12, in which determining said historical mean time ($T_{M,i}$) of coverage of said stretch comprises:

- determining a plurality of times of coverage of said stretch by vehicles that have previously covered said stretch;
- creating a data base containing said plurality of times of coverage;
- extracting from said data base times of coverage of said stretch determined in conditions similar to the current ones, in which said stretch is currently covered by said vehicle; and
- determining said historical mean time ($T_{M,i}$) of coverage of said stretch on the basis of said times of coverage of said stretch determined in conditions similar to the current ones.

14. The estimating method according to Claims 7-13, in which determining said historical mean time ($T_{M,i}$) of coverage of said stretch comprises calculating the arithmetic mean of said times of coverage of said stretch determined in conditions similar to the current ones extracted from said data base.

15. The method according to Claims 4-14, in which said time (T_{RM}) taken by said vehicle to finish covering said current stretch is determined on the basis of a time of coverage (T_{CR}) of said current stretch, of a current time (h), of a length (L) of said current stretch and of a length (L_{THR}) of a part of said current stretch already covered by said vehicle.

16. The estimating method according to Claims 8-14, in which said weighting times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch and said historical mean time of coverage of said stretch comprises:

- determining a standard deviation of said historical mean time of coverage of said stretch;
- determining a reference time ($T_{H,i}$) on the basis of said historical mean time of coverage of said stretch and of said standard deviation of said historical mean time of coverage; and
- determining said weights on the basis of said reference time ($T_{H,i}$) and of said times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch.

17. The estimating method according to any one of the preceding claims, moreover comprising the steps of:

- estimating an uncertainty (INC_ETA_i) of said arrival time (ETA_i) in said point of passage; and
- signalling said arrival time (ETA_i) on the basis of the outcome of said estimate.

18. The estimating method according to Claim 17, in which estimating said uncertainty (INC_ETA_i) of said arrival time (ETA_i) comprises:

- determining a standard deviation ($D_{ATT,i}$) of said time ($T_{CR,i}$) of coverage of said stretch; and
- calculating said uncertainty (INC_ETA_i) on the basis of said standard deviation.

19. The estimating method according to Claim 18, in which signalling said arrival time (ETA_i) comprises:

- verifying whether said arrival time(ETA_i) and said uncertainty (INC ETA_i) of said arrival time satisfy certain conditions with respect to pre-set threshold values; and
- signalling said arrival time(ETA_i) if said arrival time(ETA_i) and/or said uncertainty (INC ETA_i) of said arrival time satisfy said conditions.

20. The estimating method according to any one of the preceding claims, in which said vehicle is a public means of transport and said point of passage is a stop of said public means of transport.

21. A system for estimating the arrival time of a vehicle (2) in a given point of its path comprising:

- a mobile locating unit (13) installed on board said vehicle;
- a fixed display unit (14) set in a position corresponding to a point of passage (4-8) of said vehicle configured for supplying users with information regarding times of passage of said vehicle (2) at said point of passage;
- a portable display unit configured for supplying users with information regarding times of passage of said vehicle (2) at said point of passage; and
- a remote operating centre (15) designed to communicate with said mobile location unit (13) and with said fixed and portable display units (14), said operating centre (15) being configured for implementing the method for estimating arrival times according to any one of the preceding claims.

22. The system for estimating the arrival time of a vehicle (2) according to Claim 21, in which said mobile location unit (13) installed on board said vehicle comprises:

- satellite location means (16) designed to determine the position of said vehicle;
- transceiver means (17) designed to receive and transmit radio signals from and to said operating centre (15); and
- a data-processing unit (18).

23. The system for estimating the arrival time of a vehicle (2) according to Claims 21 and 22, in which said remote operating centre (15) comprises at least one data base.

24. A computer-program product that can be loaded into the memory of a digital processor, said computer-program product comprising portions of software code that can implement the method according to any one of Claims 1 to 20 when said computer-program product is run on said digital processor.

Amended claims in accordance with Rule 86(2) EPC.

1. A method for estimating the arrival time (ETA_i) of a vehicle (2) in a given point of its path, comprising:

- determining the time taken by said vehicle (2) to cover the distance between the current position of the vehicle and said point of passage on the basis of a historical mean time of coverage of said distance, and of a time taken by at least one preceding vehicle to cover said distance;

characterized in that determining the time taken by said vehicle (2) to cover the distance between the current position of the vehicle and said point of passage it comprises:

- determining a time of coverage ($T_{CR,i}$) of a stretch of said path, said stretch being comprised between two points of passage of said vehicle in two given points of said path, on the basis of times taken by last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch and of an historical mean time ($T_{M,i}$) of coverage of said stretch;
- determining a time (T_{RM}) taken by said vehicle to finish covering a current stretch of said path, said current stretch being comprised between said current position of said vehicle and a subsequent point of passage of said vehicle;

wherein said time taken by said vehicle to cover the distance between said current position of said vehicle and said point of passage is calculated on the basis of said time of coverage ($T_{CR,i}$) of said stretch and of said time (T_{RM}) taken by said vehicle to finish covering said current stretch.

2. The estimating method according to Claim 1, in which said time taken by said vehicle (2) to cover the distance

between the current position of the vehicle and said point of passage is determined on the basis of a historical weighted mean time of coverage of said distance and of a weighted time taken by a last ($T_{LAST,i}$) and/or by a next-to-last ($T_{LAST-1,i}$) vehicle to cover said distance.

3. The estimating method according to Claims 1 and 2, in which said time taken by said vehicle (2) to cover the distance between the current position of the vehicle and said point of passage is determined on the basis of the sum of said historical weighted mean time of coverage of said distance with said weighted time taken by a last ($T_{LAST,i}$) and/or by a next-to-last ($T_{LAST-1,i}$) vehicle to cover said distance.

4. The method according to Claims 1-3, in which said time taken by said vehicle to cover the distance between said current position of said vehicle and said point of passage is calculated on the basis of the sum of said time of coverage ($T_{CR,i}$) of said stretch with said time (T_{RM}) taken by said public means of transport to finish covering said current stretch.

5. The estimating method according to Claims 1-4, in which determining said time of coverage ($T_{CR,i}$) of said stretch comprises:

- determining a time taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch; and
- determining a historical mean time ($T_{M,i}$) of coverage of said stretch.

6. The method according to Claims 1-5, in which determining said time of coverage ($T_{CR,i}$) of said stretch moreover comprises the step of weighting said time taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch and said historical mean time ($T_{M,i}$) of coverage of said stretch.

7. The method according to Claims 1-6, in which said time of coverage ($T_{CR,i}$) of said stretch is calculated on the basis of said weighted times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch and of said historical weighted mean time ($T_{M,i}$) of coverage of said stretch.

8. The method according to Claim 1-7, in which said time of coverage ($T_{CR,i}$) of said stretch is calculated on the basis of the sum of said times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch with said historical mean time ($T_{M,i}$) of coverage of said stretch.

9. The method according to Claim 8, in which said time of coverage ($T_{CR,i}$) of said stretch is calculated on the basis of the sum of said weighted times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch with said historical weighted mean time ($T_{M,i}$) of coverage of said stretch.

10. The estimating method according to Claims 5-9, in which determining said historical mean time ($T_{M,i}$) of coverage of said stretch comprises:

- determining a plurality of times of coverage of said stretch by vehicles that have previously covered said stretch;
- creating a data base containing said plurality of times of coverage;
- extracting from said data base times of coverage of said stretch determined in conditions similar to the current ones, in which said stretch is currently covered by said vehicle; and
- determining said historical mean time ($T_{M,i}$) of coverage of said stretch on the basis of said times of coverage of said stretch determined in conditions similar to the current ones.

11. The estimating method according to Claims 5-10, in which determining said historical mean time ($T_{M,i}$) of coverage of said stretch comprises calculating the arithmetic mean of said times of coverage of said stretch determined in conditions similar to the current ones extracted from said data base.

12. The method according to Claims 1-11, in which said time (T_{RM}) taken by said vehicle to finish covering said current stretch is determined on the basis of a time of coverage (T_{CR}) of said current stretch, of a current time (h), of a length (L) of said current stretch and of a length (L_{THRG}) of a part of said current stretch already covered by said vehicle.

13. The estimating method according to Claims 6-11, in which said weighting times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch and said historical mean time of coverage of said stretch comprises:

- determining a standard deviation of said historical mean time of coverage of said stretch;
- determining a reference time ($T_{H,i}$) on the basis of said historical mean time of coverage of said stretch and of said standard deviation of said historical mean time of coverage; and
- determining said weights on the basis of said reference time ($T_{H,i}$) and of said times taken by said last ($T_{LAST,i}$) and next-to-last ($T_{LAST-1,i}$) vehicles to cover said stretch.

14. The estimating method according to any one of the preceding claims, moreover comprising the steps of:

- estimating an uncertainty (INC_ETA_i) of said arrival time (ETA_i) in said point of passage; and
- signalling said arrival time (ETA_i) on the basis of the outcome of said estimate.

15. The estimating method according to Claim 14, in which estimating said uncertainty (INC_ETA_i) of said arrival time (ETA_i) comprises:

- determining a standard deviation ($D_{ATT,i}$) of said time ($T_{CR,i}$) of coverage of said stretch; and
- calculating said uncertainty (INC_ETA_i) on the basis of said standard deviation.

16. The estimating method according to Claim 15, in which signalling said arrival time (ETA_i) comprises:

- verifying whether said arrival time (ETA_i) and said uncertainty (INC_ETA_i) of said arrival time satisfy certain conditions with respect to pre-set threshold values; and
- signalling said arrival time (ETA_i) if said arrival time (ETA_i) and/or said uncertainty (TNC_ETA_i) of said arrival time satisfy said conditions.

17. The estimating method according to any one of the preceding claims, in which said vehicle is a public means of transport and said point of passage is a stop of said public means of transport.

18. A system for estimating the arrival time of a vehicle (2) in a given point of its path comprising:

- a mobile locating unit (13) installed on board said vehicle;
- a fixed display unit (14) set in a position corresponding to a point of passage (4-8) of said vehicle configured for supplying users with information regarding times of passage of said vehicle (2) at said point of passage;
- a portable display unit configured for supplying users with information regarding times of passage of said vehicle (2) at said point of passage; and
- a remote operating centre (15) designed to communicate with said mobile location unit (13) and with said fixed and portable display units (14), said operating centre (15) being configured for implementing the method for estimating arrival times according to any one of the preceding claims.

19. The system for estimating the arrival time of a vehicle (2) according to Claim 18, in which said mobile location unit (13) installed on board said vehicle comprises:

- satellite location means (16) designed to determine the position of said vehicle;
- transceiver means (17) designed to receive and transmit radio signals from and to said operating centre (15); and
- transceiver means (17) designed to receive and transmit radio signals from and to said operating centre (15); and a data-processing unit (18).

20. The system for estimating the arrival time of a vehicle (2) according to Claims 18 and 19, in which said remote operating centre (15) comprises at least one data base.

21. A computer-program product that can be loaded into the memory of a digital processor, said computer-program product comprising portions of software code that can implement the method according to any one of Claims 1 to 17 when said computer-program product is run on said digital processor.

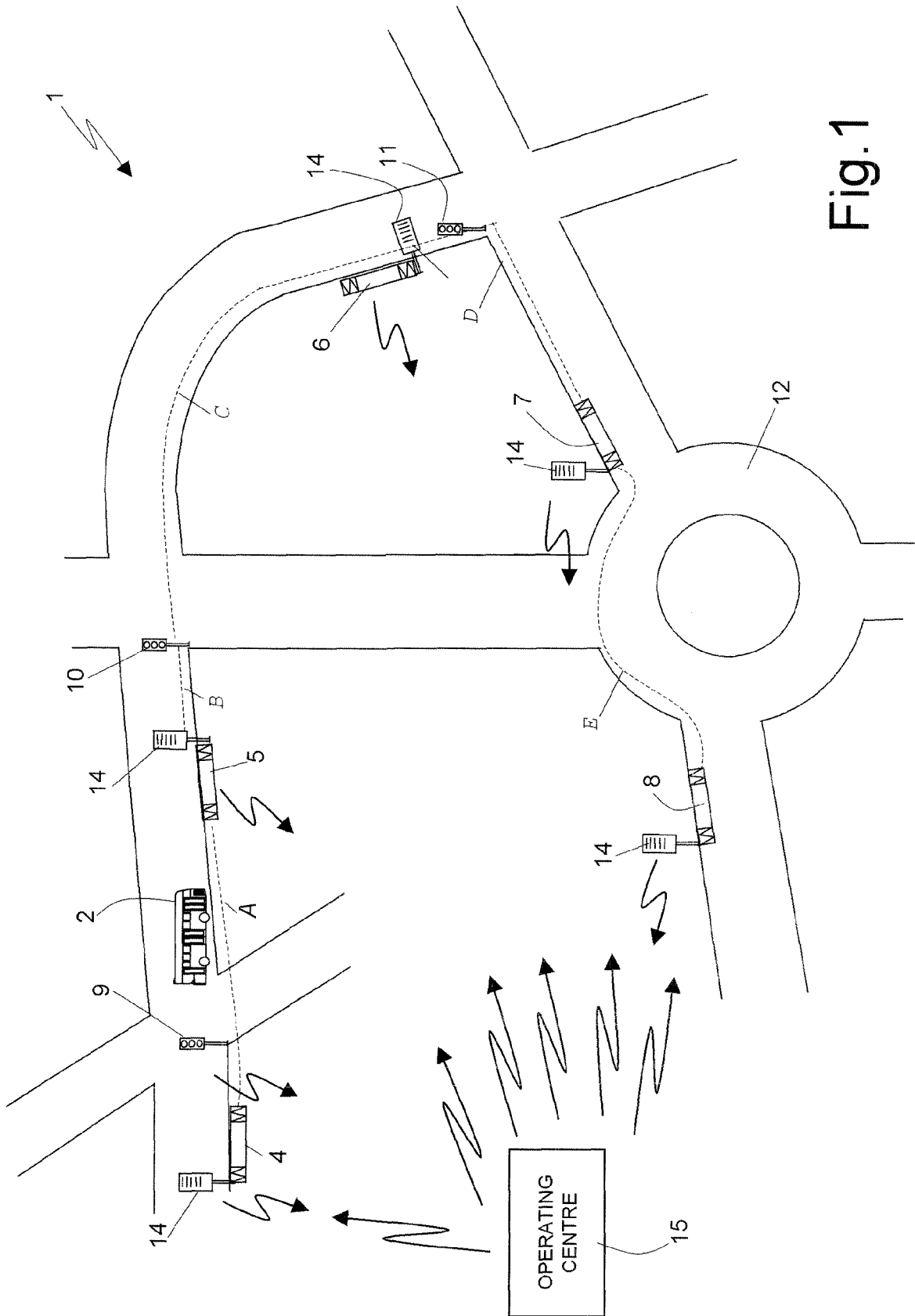


Fig. 1

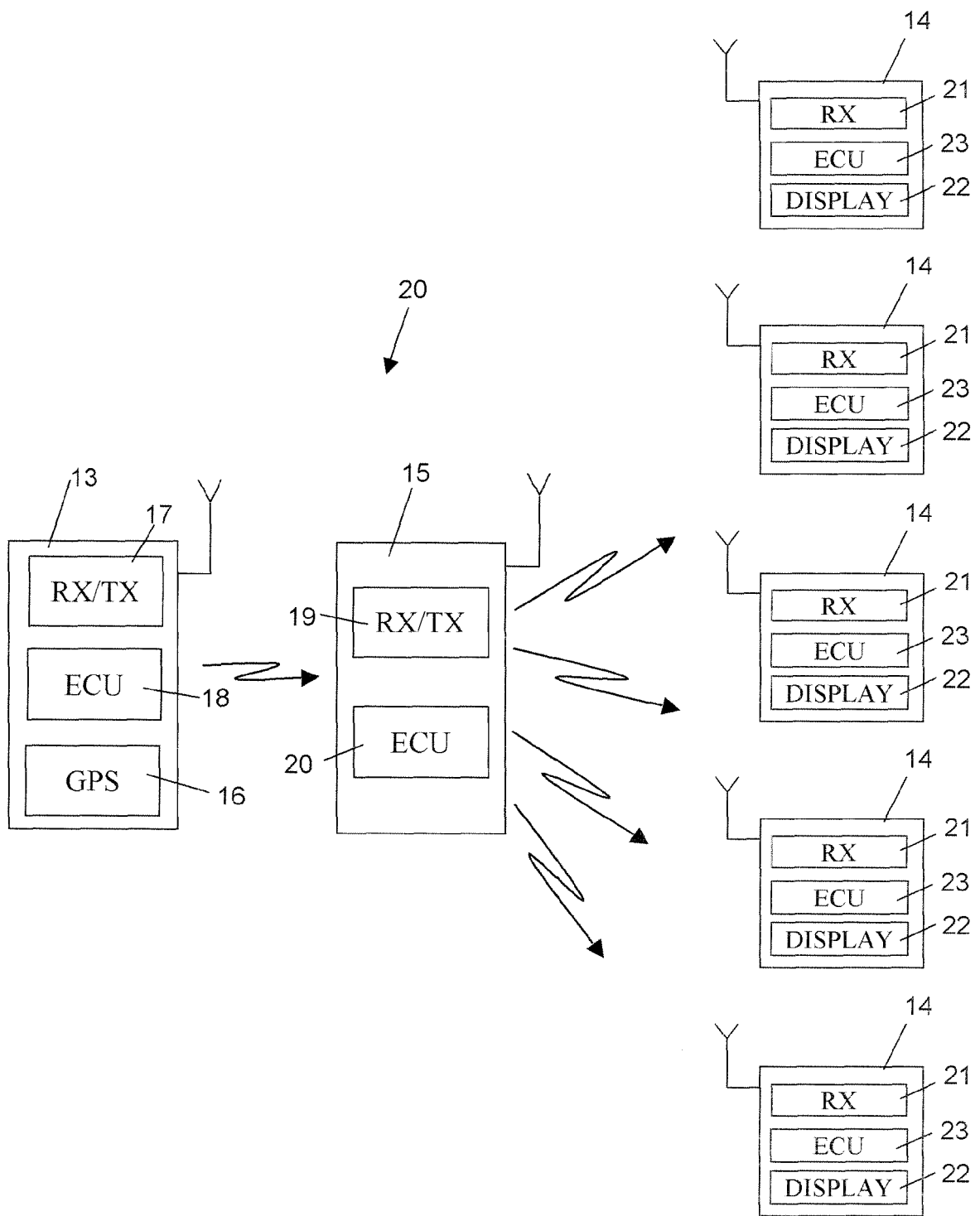


Fig.2

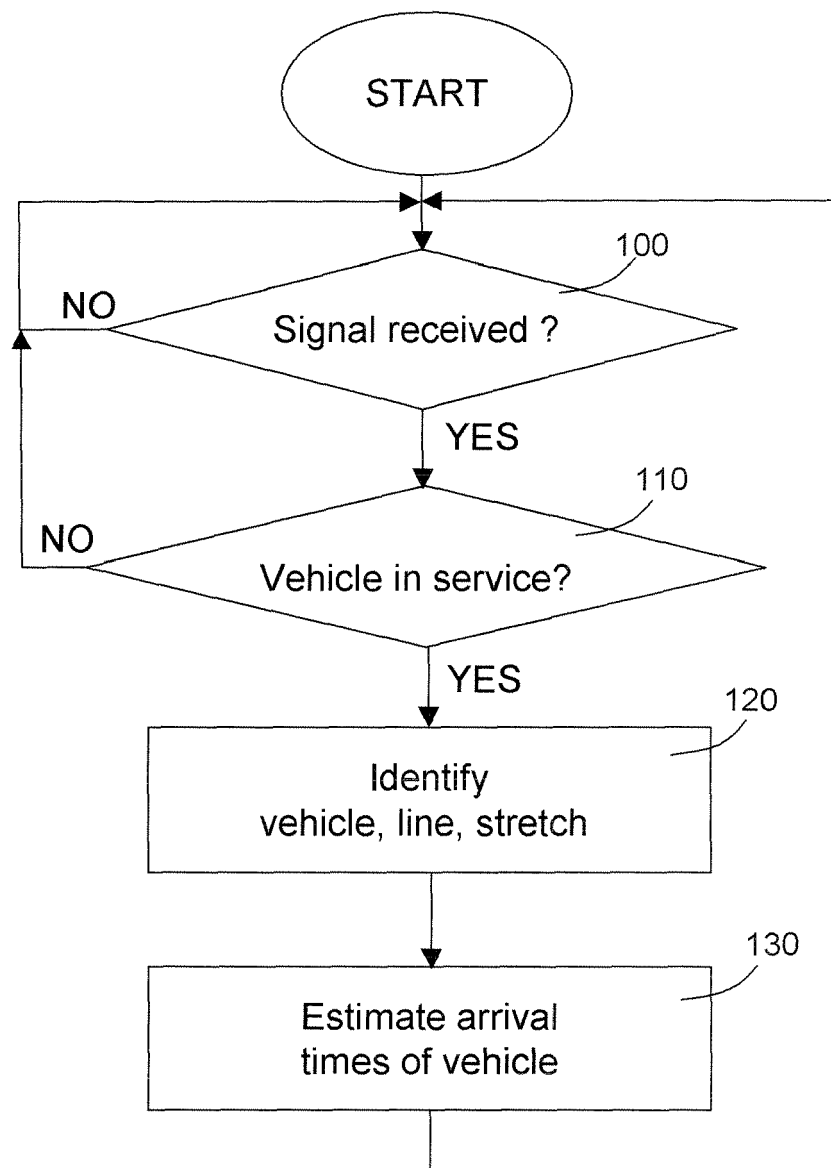


Fig.3

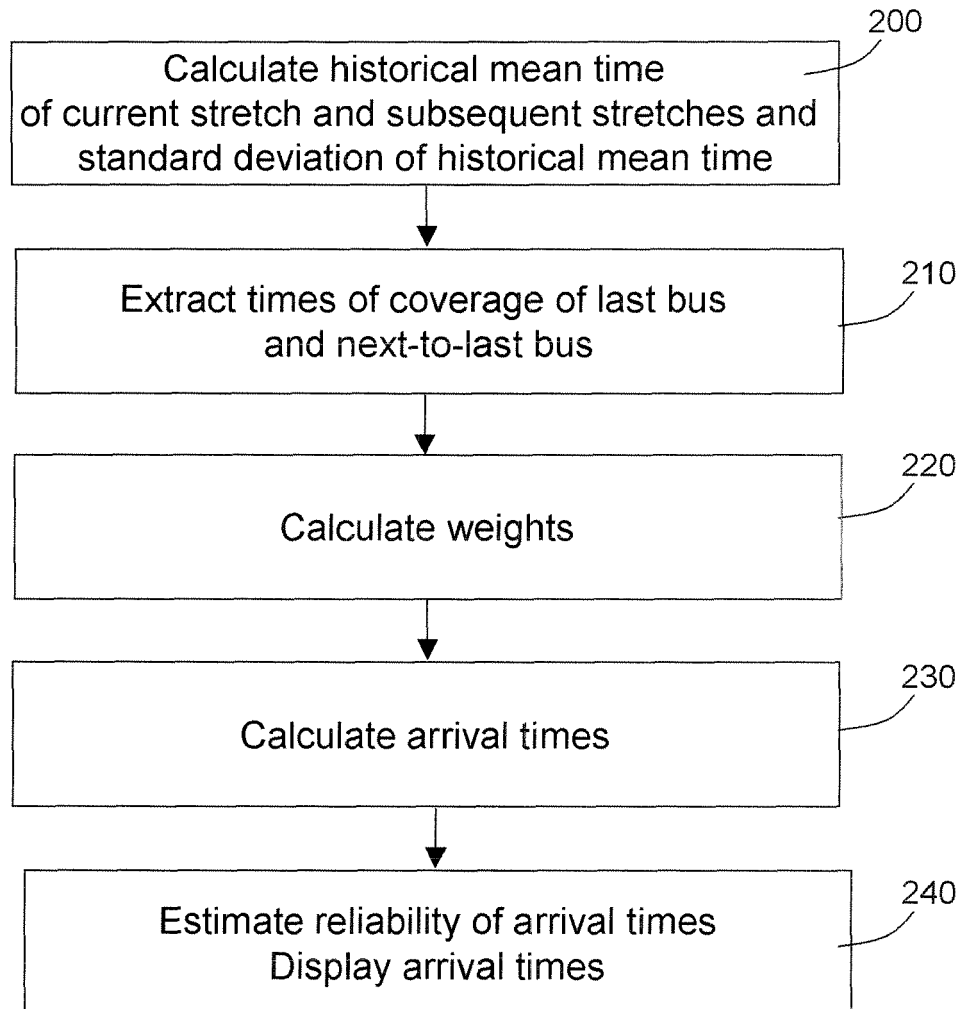


Fig.4

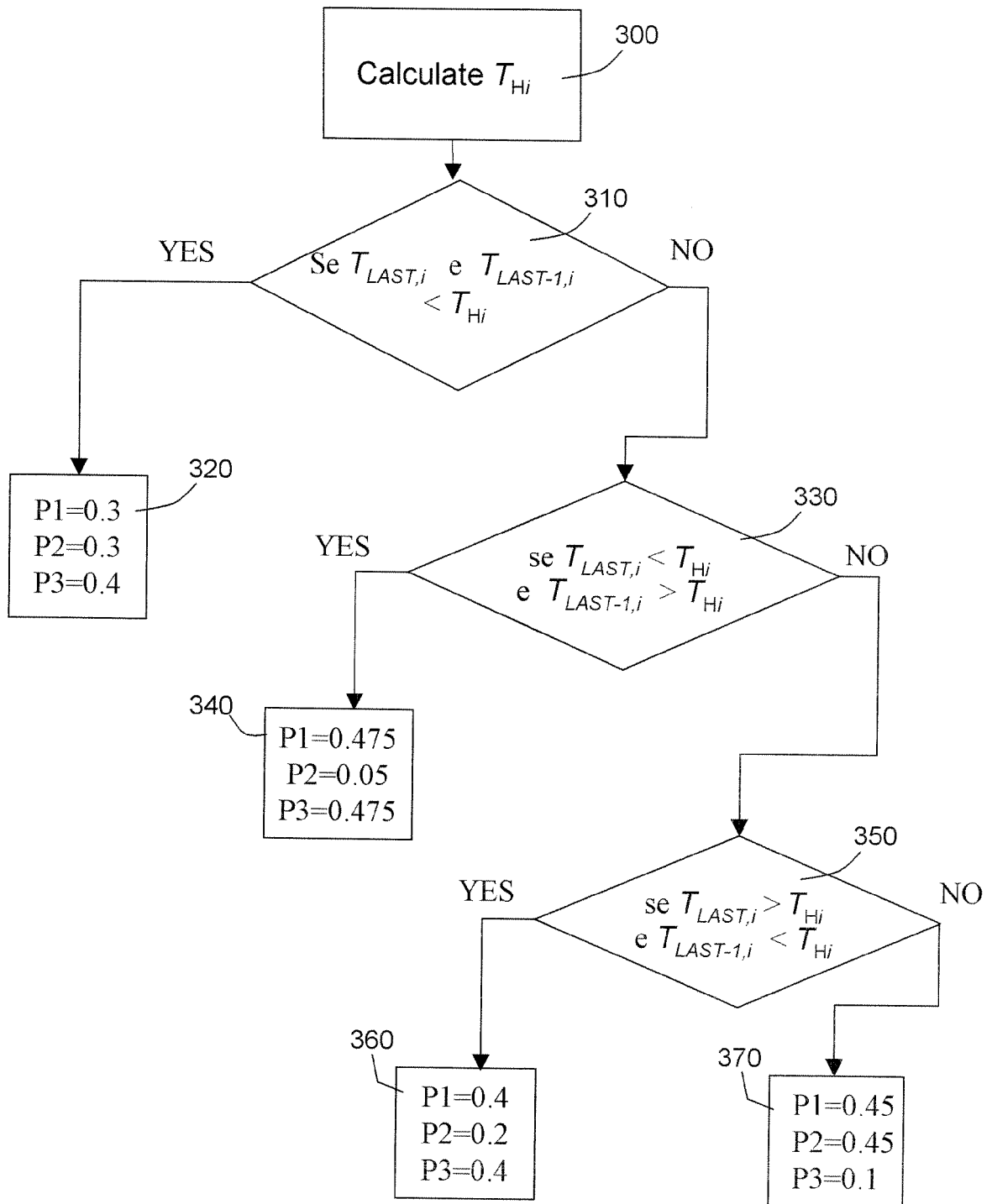


Fig.5

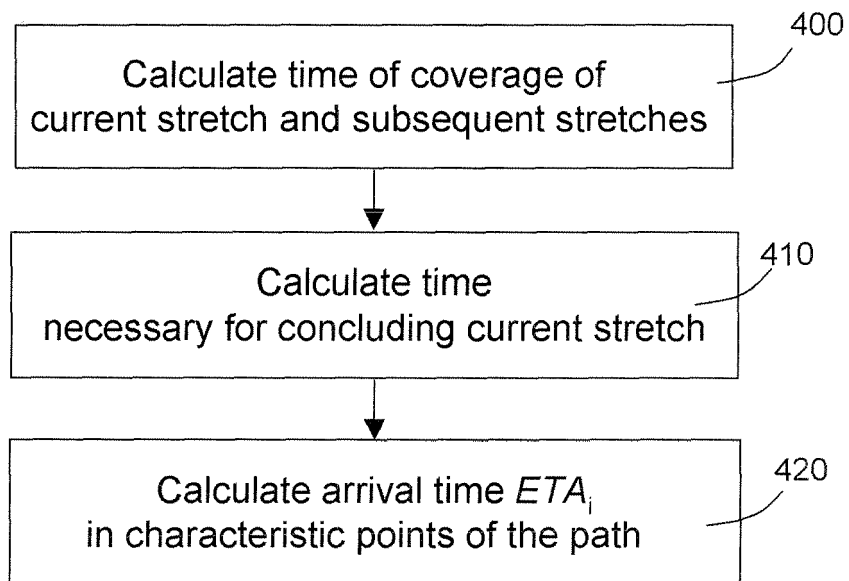


Fig.6

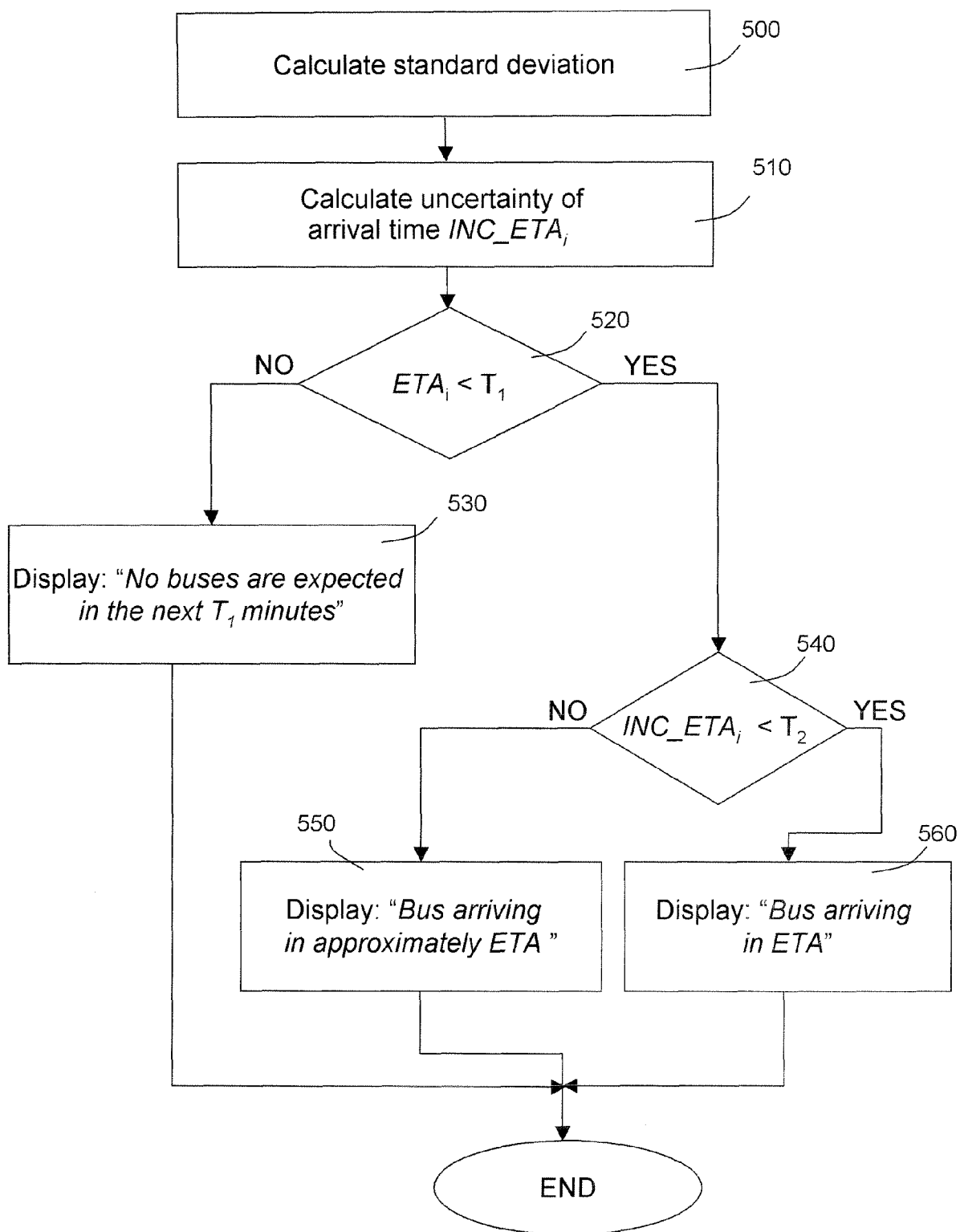


Fig.7



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 42 5880

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Y	* figures 1-6 *	2-20, 22-24	ADD. G08G1/01
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	* page 3, paragraph 36 *		
	* page 4, paragraph 47-49 *		
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 May 2006	Examiner Coffa, A
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
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3
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