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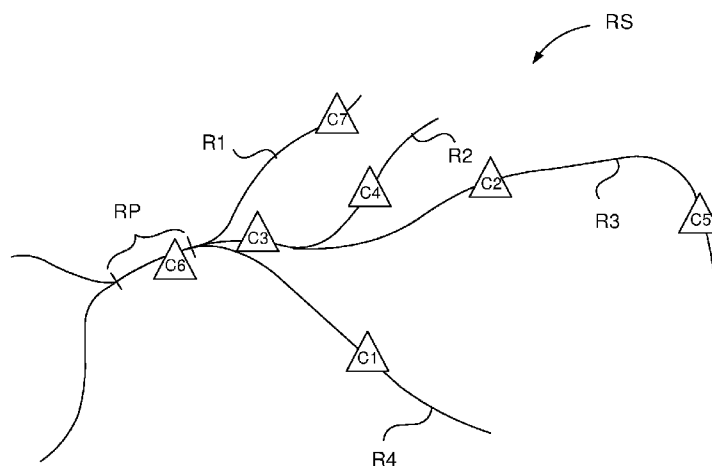


Fig. 1

(57) Abstract: The present invention relates to a method for diagnosing component malfunction of vehicles. The method comprises the steps of: determining malfunction (C1, C2, C3, C4, C5, C6, C7) of vehicle components of vehicles by means of component malfunction determining means; and determining position of vehicles in connection to determined component malfunctions by means of position determining means comprising determining routes (R1, R2, R3, R4) of vehicles for said determined component malfunction (C1, C2, C3, C4, C5, C6, C7). The method further comprises the steps of: comparing routes for vehicles associated with said determined component malfunction; and determining (S4) one or more common route portions (RP) for vehicles associated with said determined component malfunction (C1, C2, C3, C4, C5, C6, C7). The present invention also relates to a system for diagnosing component malfunction of vehicles. The present invention also relates to a computer program and a computer program product.





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METHOD AND SYSTEM FOR DIAGNOSING COMPONENT MALFUNCTION OF VEHICLES

TECHNICAL FIELD

- 5 The invention relates to a method for diagnosing component malfunction of vehicles according to the preamble of claim 1. The invention also relates to a system for diagnosing component malfunction of vehicles. The invention also relates to a vehicle. The invention in addition relates to a computer program and a computer readable medium.

10

BACKGROUND ART

- Component wear of vehicles cannot be avoided as vehicle components are exposed to tough environments and usage. This holds especially for heavy-duty vehicles that are used frequently and/or are in operation for long time periods. However, unexpected actions or events, such as hitting a pot hole, can hasten the process of component wear and cause component malfunction/failure earlier than expected. This can lead to unplanned vehicle unavailability through additional service time and/or breakdowns in operation, which causes disruption in logistics planning, resulting in additional costs for the vehicle owner.

- US2009271066 discloses a diagnostic sequence in a vehicle for detecting a failed component. The failure is logged together with geographical location and vehicle identity. These data may be sent to a database with similar information from other vehicles, wherein relevant statistical information may be retrieved.

There is however a need for further improving diagnosing of component malfunction of vehicles.

OBJECTS OF THE INVENTION

An object of the present invention is to provide a method for diagnosing component malfunction of vehicles which provides relevant information for
5 determining reason for component malfunction so as to facilitate reducing component malfunction.

Another object of the present invention is to provide a system for diagnosing component malfunction of vehicles which provides relevant information for
10 determining reason for component malfunction so as to facilitate reducing component malfunction.

SUMMARY OF THE INVENTION

These and other objects, apparent from the following description, are achieved by a method, a system, a vehicle, a computer program and a
15 computer readable medium, as set out in the appended independent claims. Preferred embodiments of the method and the system are defined in appended dependent claims.

Specifically an object of the invention is achieved by a method for diagnosing component malfunction of vehicles. The method comprises the steps of:
20 determining malfunction of vehicle components of vehicles by means of component malfunction determining means; and determining position of vehicles in connection to determined component malfunctions by means of position determining means. The step of determining position of vehicles in connection to determined component malfunctions comprises the step of
25 determining routes of vehicles for said determined component malfunction. Said method further comprises the steps of: comparing routes for vehicles associated with said determined component malfunction; and determining

one or more common route portions for vehicles associated with said determined component malfunction.

Hereby relevant information for determining reason for component malfunction is obtained in an easy and efficient way, which information may
5 be used for facilitating reducing such component malfunctions. Hereby component failures due to driving at a certain road portion is efficiently determined even if the actual component failure did not occur when the vehicle was driving at that road portion but a certain time afterwards.

The step of determining malfunction of vehicle components of vehicles by
10 means of component malfunction determining means comprises according to an embodiment collecting information regarding detected component malfunction of different vehicles. Component malfunction determining means may comprise means for collecting information of component malfunction of vehicles.

15 Thus, according to an embodiment the method comprises the step of collecting information regarding detected component malfunction of different vehicles.

Component malfunction determining means may comprise any suitable means for determining component malfunction. Component malfunction
20 determining means may comprise any suitable detector arranged on board vehicles in connection to such a component for detecting component malfunction. Component malfunction determining means may comprise any suitable external means such as any suitable detector or the like for determining component malfunction of a component of a vehicle, such
25 external component malfunction detection means e.g. being situated in a workshop for diagnosing/repairing vehicles. Component malfunction determining means may depend on kind of component malfunction and kind of component.

The step of determining position of vehicles in connection to determined component malfunctions comprising determining routes of vehicles for said determined component malfunction comprises according to an embodiment collecting information regarding determined routes of vehicles for said
5 determined component malfunction. Position determining means may comprise means for collecting information of determined routes of vehicles for said determined component malfunction. The position determining means for determining position of vehicles in connection to determined component malfunctions comprises according to an embodiment a Global Navigation
10 Satellite System, GNSS, e.g. a global positioning system, GPS, for determining the position and routes of said vehicles.

Thus, according to an embodiment the method comprises the step of collecting information regarding determined routes of vehicles for said determined component malfunction.

15 The method comprises according to an embodiment the step of storing, by means of storage means, information of determined malfunction of vehicle components of vehicles and information of determined routes of vehicles for said determined component malfunction. Said storage means may be any suitable storage means , for example a central server unit, a computer of any
20 suitable kind, the so called cloud or any other storage means suitable for receiving and storing said information.

The step of comparing routes for vehicles associated with said determined component malfunction comprises the step of retrieving thus stored information from said storage means. The step of comparing routes for
25 vehicles associated with said determined component malfunction comprises utilizing any suitable comparison means for comparing routes for vehicles associated with said determined component malfunction. Said comparison means may comprise any suitable processor unit, control unit, computer or the like. Thus, the method comprises the step of comparing routes for

vehicles associated with said determined component malfunction by means of comparison means.

The step of determining one or more common route portions for vehicles associated with said determined component malfunction comprises utilizing
5 any suitable determining means for determining one or more common route portions for vehicles associated with said determined component malfunction. Said determining means may comprise any suitable processor unit, control unit, computer or the like. Thus, the method comprises the step of determining one or more common route portions for vehicles associated
10 with said determined component malfunction determining means.

According to an embodiment the method further comprises the step of recommending taking action based on said determined one or more common route portions for vehicles associated with said determined component malfunction so as to facilitate reducing such component malfunctions. Hereby
15 component malfunctions may be efficiently reduced by taking relevant action based on the information of route portions for vehicles associated with determined component malfunctions.

According to an embodiment of the method the step of recommending taking action based on said determined one or more common route portions
20 comprises the step of providing recommendations regarding vehicle operation by means of vehicle operation recommendation means.

Said vehicle operation recommendation means may comprise any suitable means for providing recommendation regarding vehicle operation based on said determined one or more common route portions.

25 Said vehicle operation recommendation means may comprise on board vehicle operation recommendation means arranged on board vehicles travelling/intended to travel on routes comprising said one or more common route portions. Said on board vehicle operation recommendation means comprises according to an embodiment visual means for providing a visual

recommendation and/or sound means for providing audible recommendation. The visual means for visual recommendation comprises according to an embodiment one or more display units on board said vehicles on e.g. the instrument panel, a head-up-display on the windshield or the like, for
5 displaying said recommendation regarding vehicle operation based on said determined one or more common route portions.

Said vehicle operation recommendation means may comprise external operation recommendation means arranged external to vehicles travelling/intended to travel on routes comprising said one or more common
10 route portions. Said external operation recommendation means may comprise any suitable means for providing recommendations regarding vehicle operation such as any suitable server unit, computer or the like configured to present such recommendations e.g. by means of visual presentation via a display unit as e.g. a text message, an image or the like,
15 and/or by means of sound, e.g. a sound message or the like.

Said vehicle operation recommendation means for providing recommendation regarding vehicle operation based on said determined one or more common route portions may thus be arranged to provide a recommendation to vehicle operators and/or externally, e.g. to owner of a
20 vehicle fleet, as a basis for route planning.

According to an embodiment of the method the step of providing recommendations regarding vehicle operation depends on one or more of: kind of component, type of component malfunction, type of vehicle. By thus providing recommendations regarding vehicle operation depending on one or
25 more of: kind of component, type of component malfunction, type of vehicle, vehicle operation will be optimized with regard to reducing component malfunctions.

According to an embodiment of the method the step of providing recommendations regarding vehicle operation comprises the steps of:

determining one or more of: kind of component having had said malfunction, type of component malfunction, and type of vehicle having had said component malfunction, and providing recommendations regarding vehicle operation based on or more of: determined kind of component, type of component malfunction, and type of vehicle.

Kind of component having had said malfunction is determined by means of component determining means. Component determining means may comprise any detection means, e.g. one or more detectors or the like, for identifying said component.

10 Type of component malfunction is determined by means of component malfunction determining means. Component malfunction determining means may comprise any detection means, e.g. one or more detectors or the like, for identifying said component malfunction.

15 Type of vehicle having had said malfunction is determined by means of vehicle determining means. Vehicle determining means may comprise any identification means for identifying said vehicle.

According to an embodiment of the method the step of providing recommendations regarding vehicle operation comprises one or more of: recommending avoiding said one or more common route portions, recommending another type of vehicle, recommending adapting the vehicle, recommending adapting vehicle operation when driving on said one or more common route portions, recommending improving the condition of said one or more common route portions. By applying any of said recommendations regarding vehicle operation component malfunctions will be efficiently reduced.

Thus, according to an embodiment of the method the step of providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises recommending avoiding said one

or more common route portions. Such recommendation may be provided if there is an alternative route available.

Thus, according to an embodiment of the method the step of providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises recommending another type of vehicle. Another type of vehicle may e.g. be a more robust vehicle, a vehicle more likely to handle said route portions without having any such component malfunction. Such recommendation may be provided if there is no suitable alternative route.

Thus, according to an embodiment of the method the step of providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises recommending adapting the vehicle. Adapting the vehicle may comprise adapting the vehicle to be more robust to better handle said route portions without having any such component malfunction. Such recommendation may be provided if there is no suitable alternative route.

Thus, according to an embodiment of the method the step of providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises recommending adapting vehicle operation when driving on said one or more common route portions.

Thus, according to an embodiment of the method the step of providing recommendations regarding vehicle operation based on said determined one or more common route portions recommending improving the condition of said one or more common route portions.

According to an embodiment of the method said components may comprise any of the following: suspension arrangements, vehicle axles, vehicle underside, vehicle filters, vehicle engine, vehicle transmission, vehicle tires.

Suspension arrangements may comprise any suspension of the vehicle comprising any wheel suspension comprising spring members or the like. Vehicle axles may comprise any vehicle axles comprising any wheel axles comprising drive axles. Vehicle underside may comprise any part of the
5 vehicle underside comprising underside of cab of vehicle when applicable. Vehicle filters may comprise any vehicle filters such as particle filters, fuel filters, air pressure filters etc.

Conditions on road portions causing component malfunctions may be bad road conditions such as potholes, stones, gravel, bumps, or conditions such
10 as road construction work, speed bumps or the like. Such conditions may e.g. cause flat tires, affect suspension arrangements, wheel axles, underside of vehicle.

The air condition on a particular road portion, caused e.g. by road conditions such as gravel and/or dust, may affect vehicle filters. If e.g. the fuel filter
15 becomes clogged the engine may be affected so that malfunctions/fails.

Specifically an object of the invention is achieved by a system for diagnosing component malfunction of vehicles, comprising component malfunction determining means for determining malfunction of vehicle components of vehicles; position determining means for determining position of vehicles in
20 connection to determined component malfunctions, characterized in that the position determining means for determining position of vehicles in connection to determined component malfunctions comprises means for determining routes of vehicles for said determined component malfunction; said system further comprising means for comparing routes for vehicles associated with
25 said determined component malfunction; and means for determining one or more common route portions for vehicles associated with said determined component malfunction.

According to an embodiment the system further comprises means for recommending taking action based on said determined one or more common

route portions for vehicles associated with said determined component malfunction so as to facilitate reducing such component malfunctions.

According to an embodiment of the system the means for recommending taking action based on said determined one or more common route portions
5 comprises vehicle operation recommendation means for providing recommendations regarding vehicle operation.

According to an embodiment of the system the means for providing recommendations regarding vehicle operation comprises means for considering one or more of: kind of component, type of component
10 malfunction, type of vehicle, as a basis for provided recommendation.

According to an embodiment of the system the means for providing recommendations regarding vehicle operation comprises recommending avoiding said one or more common route portions, recommending another type of vehicle, recommending adapting vehicle operation when driving on
15 said one or more common route portions, recommending improving the condition of said one or more common route portions.

A system according to claim 1, wherein said components may comprise any of the following:

The system for diagnosing component malfunction of vehicles is adapted to
20 perform the methods as set out herein.

The system according to the invention has the advantages according to the corresponding method claims.

Specifically an object of the invention is achieved by a computer program for diagnosing component malfunction of vehicles, said computer program
25 comprising program code which, when run on an electronic control unit or another computer connected to the electronic control unit, causes the electronic control unit to perform methods as set out herein.

Specifically an object of the invention is achieved by a computer readable medium comprising instructions which, when executed by a computer, cause the computer to carry out the method as set out herein.

5 BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention reference is made to the following detailed description when read in conjunction with the accompanying drawings, wherein like reference characters refer to like parts throughout the several views, and in which:

- 10 Fig. 1 schematically illustrates a plan view of a network of roads and determined component malfunctions of vehicles that have been travelling on said network of roads according to an embodiment of the present invention;

Fig. 2 schematically illustrates a block diagram of a system for determining malfunction of vehicle components of vehicles;

- 15 Fig. 3 schematically illustrates a block diagram of a method for determining malfunction of vehicle components of vehicles; and

Fig. 4 schematically illustrates a computer according to an embodiment of the present invention.

20 DETAILED DESCRIPTION

Hereinafter the term “link” refers to a communication link which may be a physical connector, such as an optoelectronic communication wire, or a non-physical connector such as a wireless connection, for example a radio or microwave link.

Hereinafter the term “component malfunction” refers to any suitable component of a vehicle and any relevant malfunction which may be caused due to travelling along a certain route portion. Component malfunction may comprise component failure.

- 5 Fig. 1 schematically illustrates a plan view of a network of roads RS and determined component malfunctions of vehicles that have been travelling on said network of roads according to an embodiment of the present invention.

The network or roads RS comprises a set of roads R1, R2, R3, R4, each road R1, R2, R3, R4 constituting a route along which vehicles travel. The
10 network or roads R1, R2, R3, R4 thus constitutes routes The network or roads R1, R2, R3, R4 along which vehicles are travelling, e.g. distribution vehicles from a fleet of vehicles. The network or roads R1, R2, R3, R4 comprises a first route R1, a second route R2, a third route R3 and a fourth route R4. All routes R1, R2, R3, R4 have a common route portion RP.

- 15 A number of vehicles have been travelling on said routes R1, R2, R3, R4 having said common route portion RP. For a number of those vehicles component malfunctions C1, C2, C3, C4, C5, C6, C7 have been determined by means of component malfunction determining means.

A first vehicle has had a component malfunction C1 which has been detected
20 along the route R4 after having left the common route portion RP. A second vehicle has had a component malfunction C2 which has been detected along the route R3 after having left the common route portion RP. A third vehicle has had a component malfunction C3 which has been detected at a route portion common for routes R2 and R3 after having left the common route
25 portion RP. A fourth vehicle has had a component malfunction C4 which has been detected along the route R2 after having left the common route portion RP. A fifth vehicle has had a component malfunction C5 which has been detected along the route R3 after having left the common route portion RP. A sixth vehicle has had a component malfunction C6 which has been detected

at the common route portion RP. A seventh vehicle has had a component malfunction C7 which has been detected along the route R1 after having left the common route portion RP.

5 Routes R1, R2, R3, R4 of vehicles for said determined component malfunctions C1, C2, C3, C4, C5, C6, C7 are determined by means of position determining means such as Global Navigation Satellite Systems, GNSS, e.g. global positioning systems, GPS, for determining the position and routes of said vehicles.

10 Determined component malfunctions C1, C2, C3, C4, C5, C6, C7 and routes R1, R2, R3, R4 for vehicles associated with said component malfunctions C1, C2, C3, C4, C5, C6, C7 may be stored in any suitable storage means from which said information may be retrieved and processed.

15 According to the invention routes for vehicles associated with said determined component malfunction C1, C2, C3, C4, C5, C6, C7 are compared. One or more common route portions for vehicles associated with said determined component malfunction is determined. In this example the common route portion RP is determined for vehicles associated with said determined component malfunctions C1, C2, C3, C4, C5, C6, C7. Thus, those vehicles having had component malfunctions C1, C2, C3, C4, C5, C6, 20 C7 have all passed said common route portion RP which may be the reason for said component malfunctions C1, C2, C3, C4, C5, C6, C7. Said comparison and determination of common route portion may be performed by means of any suitable processor unit, control unit, computer or the like. By performing such comparisons and identifying one or more common route 25 portions for vehicles associated with determined component malfunctions for a large number of vehicles a good basis for taking proper action in order to reduce such component failures is obtained.

Thus, suitable actions to be taken based on said determined common route portion for vehicles associated with said determined component malfunction

C1, C2, C3, C4, C5, C6, C7 may be recommended so as to facilitate reducing such component malfunctions.

Said recommended actions may comprise recommendations regarding vehicle operation, which may comprise recommending avoiding said one or more common route portions, recommending another type of vehicle, recommending adapting vehicle operation when driving on said one or more common route portions, or recommending improving the condition of said one or more common route portions. Such recommendations may depend on kind of component having had said component malfunction, type of component and/or type of vehicle.

Fig. 2 schematically illustrates a block diagram of a system I for diagnosing component malfunction of vehicles.

The system comprises a control arrangement 100 for said diagnosing of component malfunction of vehicles. Said control arrangement 100 may comprise any suitable control unit, processing unit, computer, server unit or the like for said diagnosing of component malfunction of vehicles.

The system I comprises component malfunction determining means 110 for determining malfunction of vehicle components of vehicles.

The component malfunction determining means 110 comprises according to an embodiment means 110a for collecting information regarding detected component malfunction of different vehicles.

Said component malfunction determining means 110 may comprise any suitable means for determining component malfunction. Said component malfunction determining means 110 may comprise any suitable on board detector $O_1, O_2, O_3, \dots, O_n$ arranged on board vehicles in connection to such components for detecting component malfunction.

Said component malfunction determining means 110 may comprise any suitable external means for determining component malfunction of a

component of a vehicle such as any suitable external detector E_1 , E_2 , E_3 , ... E_n for determining component malfunction of a component of a vehicle. Such external detector e.g. may be situated in a workshop for diagnosing/repairing vehicles, wherein component malfunction is detected at the workshop by
5 means of an external detector. Component malfunction determining means 110, e.g. type of on board detector/external detector, may depend on kind of component malfunction and kind of component.

The system I comprises position determining means 120 for determining position of vehicles in connection to determined component malfunctions.

10 Said position determining means 120 for determining position of vehicles in connection to determined component malfunctions comprises means 122 for determining routes of vehicles for said determined component malfunction. Said position determining means 120 for determining position of vehicles in connection to determined component malfunctions is arranged to determine
15 routes of vehicles for said determined component malfunction.

Said means 122 for determining routes of vehicles for said determined component malfunction comprises according to an embodiment means 122a for extracting map data for information about said routes.

The position determining means 120 for determining position of vehicles in
20 connection to determined component malfunctions comprises according to an embodiment a Global Navigation Satellite System, GNSS, e.g. a global positioning system, GPS, for determining the position and routes of said vehicles. The respective vehicle thus comprises a Global Navigation Satellite System P_1 , P_2 , P_3 , ..., P_n for determining position of vehicles in connection to
25 determined component malfunctions comprising routes of vehicles for said determined component malfunction.

The position determining means 120 comprises according to an embodiment means 120a for collecting information regarding determined routes of vehicles for said determined component malfunction.

According to an embodiment the system I comprises storage means 130 for storing information of determined malfunction of vehicle components of vehicles and information of determined routes of vehicles for said determined component malfunction.

- 5 Said storage means 130 may be any suitable storage means such as any suitable external storage means, for example a central server unit, a computer of any suitable kind, the so called cloud or any other storage means suitable for receiving and storing said information.

- Said system I further comprises means 140 for comparing routes for vehicles
10 associated with said determined component malfunction.

- The means 140 for comparing routes for vehicles associated with said determined component malfunction comprises any suitable comparison means for comparing routes for vehicles associated with said determined component malfunction. Said comparison means 140 may comprise any
15 suitable processor unit, control unit, computer or the like. Said comparison means 140 may according to an embodiment be comprised in said control arrangement 100.

- The system I further comprises means 150 for determining one or more common route portions for vehicles associated with said determined
20 component malfunction.

- The means 150 for determining one or more common route portions for vehicles associated with said determined component malfunction may comprise any suitable determining means for determining one or more common route portions for vehicles associated with said determined
25 component malfunction. Said determining means 150 may comprise any suitable processor unit, control unit, computer or the like. Said determining means 150 may according to an embodiment be comprised in said control arrangement 100.

The system I further comprises means 160 for recommending taking action based on said determined one or more common route portions for vehicles associated with said determined component malfunction so as to facilitate reducing such component malfunctions.

- 5 Said means 160 for recommending taking action based on said determined one or more common route portions comprises vehicle operation recommendation means 162 for providing recommendations regarding vehicle operation.

- 10 Said vehicle operation recommendation means 162 may comprise any suitable means for providing recommendation regarding vehicle operation based on said determined one or more common route portions.

- 15 Said vehicle operation recommendation means 162 may comprise on board vehicle operation recommendation means arranged on board vehicles travelling/intended to travel on routes comprising said one or more common route portions. Said on board vehicle operation recommendation means comprises according to an embodiment visual means for providing a visual recommendation and/or sound means for providing audible recommendation. The visual means for visual recommendation comprises according to an embodiment one or more display units on board said vehicles on e.g. the instrument panel, a head-up-display on the windshield or the like, for
20 displaying said recommendation regarding vehicle operation based on said determined one or more common route portions.

- 25 Said vehicle operation recommendation means 162 may comprise external operation recommendation means arranged external to vehicles travelling/intended to travel on routes comprising said one or more common route portions. Said external operation recommendation means may comprise any suitable means for providing recommendations regarding vehicle operation such as any suitable server unit, computer or the like configured to present such recommendations e.g. by means of visual

presentation via a display unit as e.g. a text message, an image or the like, and/or by means of sound, e.g. a sound message or the like.

Said vehicle operation recommendation means 162 for providing recommendation regarding vehicle operation based on said determined one or more common route portions may thus be arranged to provide a recommendation to vehicle operators and/or externally, e.g. to owner of a vehicle fleet, as a basis for route planning.

The means 162 for providing recommendations regarding vehicle operation comprises means 162a for considering one or more of: kind of component, type of component malfunction, type of vehicle, as a basis for provided recommendation.

According to an embodiment the system I comprises means 170 for determining one or more of: kind of component having had said malfunction, type of component malfunction, and type of vehicle having had said component malfunction.

The means 170 comprises component determining means 172 for determining kind of component having had said malfunction. Component determining means may comprise any detection means, e.g. one or more detectors or the like, for identifying said component.

The means 170 comprises component malfunction determining means 174 for determining type of component malfunction. Component malfunction determining means 174 may comprise any detection means, e.g. one or more detectors or the like, for identifying said component malfunction.

The means 170 comprises component vehicle determining means 176 for determining type of vehicle having had said malfunction. Vehicle determining means 176 may comprise any identification means for identifying said vehicle.

According to an embodiment said means 162 is arranged to provide recommendations regarding vehicle operation based on or more of: determined kind of component, type of component malfunction, and type of vehicle.

- 5 Said means 162 for providing recommendations regarding vehicle operation comprises one or more of: recommending avoiding said one or more common route portions, recommending another type of vehicle, recommending adapting vehicle, recommending adapting vehicle operation when driving on said one or more common route portions, recommending
10 improving the condition of said one or more common route portions.

Thus, according to an embodiment of the system I said means 162 for providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises means 162a for recommending avoiding said one or more common route portions. Such
15 recommendation may be provided if there is an alternative route available which may be determined by means of map data or the like.

Thus, according to an embodiment of the system I said means 162 for providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises means 162b for
20 recommending another type of vehicle. Another type of vehicle may e.g. be a more robust vehicle, a vehicle more likely to handle said route portions without having any such component malfunction. Such recommendation may be provided if there is no suitable alternative route which may be determined by means of e.g. map data.

25 Thus, according to an embodiment of the system I said means 162 for providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises means 162c for recommending adapting the vehicle. Adapting the vehicle may comprise adapting the vehicle to be more robust to better handle said route portions

without having any such component malfunction. Such recommendation may be provided if there is no suitable alternative route.

Thus, according to an embodiment of the system I said means 162 for providing recommendations regarding vehicle operation based on said
5 determined one or more common route portions comprises means 162d for recommending adapting vehicle operation when driving on said one or more common route portions.

Thus, according to an embodiment of the system I said means 162 for providing recommendations regarding vehicle operation based on said
10 determined one or more common route portions comprises means 162e for recommending improving the condition of said one or more common route portions.

Said components may comprise any of the following: suspension arrangements, vehicle axles, vehicle underside, vehicle filters, vehicle
15 engine, vehicle transmission, vehicle tires.

Suspension arrangements may comprise any suspension of the vehicle comprising any wheel suspension comprising spring members or the like. Vehicle axles may comprise any vehicle axles comprising any wheel axles comprising drive axles. Vehicle underside may comprise any part of the
20 vehicle underside comprising underside of cab of vehicle when applicable. Vehicle filters may comprise any vehicle filters such as particle filters, fuel filters, air pressure filters etc.

The control arrangement 100 is operably connected to the means 110 for determining malfunction of vehicle components of vehicles via a link 10. The
25 control arrangement 100 is via the link 10 arranged to receive signals from said means 110 representing data about determined malfunctions of vehicle components of vehicles.

The control arrangement 100 is operably connected to the means 110 for determining malfunction of vehicle components of vehicles via a link 10. The control arrangement 100 is via the link 10 arranged to receive signals from said means 110 representing data about determined malfunctions of vehicle components of vehicles.

The control arrangement 100 is operably connected to the means 110a for collecting information regarding detected component malfunction of different vehicles via a link 10o. The control arrangement 100 is via the link 10o arranged to receive signals from said means 110a representing data about determined malfunctions of vehicle components of vehicles detected by means of on board detectors $O_1, O_2, O_3, \dots, O_n$ arranged on board vehicles in connection to such components for detecting component malfunction.

The control arrangement 100 is operably connected to the means 110a for collecting information regarding detected component malfunction of different vehicles via a link 10e. The control arrangement 100 is via the link 10e arranged to receive signals from said means 110a representing data about determined malfunctions of vehicle components of vehicles determined by means of external means for determining component malfunction of components of vehicles such.

The control arrangement 100 is operably connected to the means 120 for determining position of vehicles in connection to determined component malfunctions via a link 20. The control arrangement 100 is via the link 20 arranged to receive signals from said means 120 representing data about determined positions of vehicles in connection to determined component malfunctions comprising data about determined routes of vehicles for said determined component malfunction.

The control arrangement 100 is operably connected to the means 120a for collecting information regarding determined routes of vehicles for said determined component malfunction via a link 20p. The control arrangement

100 is via the link 20p arranged to receive signals from said means 120a representing data about determined positions of vehicles in connection to determined component malfunctions comprising data about determined routes of vehicles for said determined component malfunction determined by
5 means of Global Navigation Satellite Systems P_1 , P_2 , P_3 , ..., P_n of said vehicles.

The control arrangement 100 is operably connected to the storage means 130 for storing information of determined malfunction of vehicle components of vehicles and information of determined routes of vehicles for said
10 determined component malfunction via a link 30a. The control arrangement 100 is via the link 30a arranged to receive signals from said storage means 130 representing data about determined malfunctions of vehicle components of vehicles.

The control arrangement 100 is operably connected to the storage means
15 130 for storing information of determined malfunction of vehicle components of vehicles and information of determined routes of vehicles for said determined component malfunction via a link 30b. The control arrangement 100 is via the link 30b arranged to receive signals from said storage means 130 representing data about determined positions of vehicles in connection
20 to determined component malfunctions comprising data about determined routes of vehicles for said determined component malfunction.

The control arrangement 100 is operably connected to the means 140 for comparing routes for vehicles associated with said determined component malfunction via a link 40a. The control arrangement 100 is via the link 40a
25 arranged to send signals to said means 140 representing data about determined malfunctions of vehicle components of vehicles.

The control arrangement 100 is operably connected to the means 140 for comparing routes for vehicles associated with said determined component malfunction via a link 40b. The control arrangement 100 is via the link 40b

arranged to send signals to said means 140 representing data about determined positions of vehicles in connection to determined component malfunctions comprising data about determined routes of vehicles for said determined component malfunction.

- 5 The control arrangement 100 is operably connected to the means 140 for comparing routes for vehicles associated with said determined component malfunction via a link 40c. The control arrangement 100 is via the link 40c arranged to receive signals to from means 140 representing data about compared routes for vehicles associated with said determined component
10 malfunction.

- The control arrangement 100 is operably connected to the means 150 for determining one or more common route portions for vehicles associated with said determined component malfunction via a link 50a. The control arrangement 100 is via the link 50a arranged to send signals to said means
15 150 representing data about compared routes for vehicles associated with said determined component malfunction.

- The control arrangement 100 is operably connected to the means 150 for determining one or more common route portions for vehicles associated with said determined component malfunction via a link 50b. The control
20 arrangement 100 is via the link 50b arranged to receive signals to from means 150 representing data about one or more common route portions for vehicles associated with said determined component malfunction.

- The control arrangement 100 is operably connected to the means 160 for recommending taking action based on said determined one or more common
25 route portions for vehicles associated with said determined component malfunction so as to facilitate reducing such component malfunctions via a link 60. The control arrangement 100 is via the link 60 arranged to send signals to said means 160 representing data about determining one or more

common route portions for vehicles associated with said determined component malfunction.

The control arrangement 100 is operably connected to the means 162 for providing recommendations regarding vehicle operation via a link 62a. The
5 control arrangement 100 is via the link 62a arranged to send signals to said means 162 representing data about determining one or more common route portions for vehicles associated with said determined component malfunction.

The control arrangement 100 is operably connected to the means 162 for
10 providing recommendations regarding vehicle operation via a link 62b. The control arrangement 100 is via the link 62b arranged to receive signals from said means 162 representing data about recommendations regarding vehicle operation. Said data about recommendations regarding vehicle operation may comprise data about recommending avoiding said one or more common
15 route portions. Said data about recommendations regarding vehicle operation may comprise data about recommending another type of vehicle when driving on said one or more common route portions. Said data about recommendations regarding vehicle operation may comprise data about recommending adapting the vehicle when driving on said one or more
20 common route portions. Said data about recommendations regarding vehicle operation may comprise data about recommending adapting vehicle operation when driving on said one or more common route portions. Said data about recommendations regarding vehicle operation may comprise data about recommending improving the condition of said one or more common
25 route portions.

Fig. 3 schematically illustrates a block diagram of a method for determining malfunction of vehicle components of vehicles. Malfunction of vehicle components is determined by means of component malfunction determining means.

According to the embodiment the method for diagnosing malfunction of vehicle components of vehicles comprises a step S1. In this step malfunction of vehicle components of vehicles are determined by means of component malfunction determining means.

- 5 According to the embodiment the method for diagnosing malfunction of vehicle components of vehicles comprises a step S2. In this step position of vehicles in connection to determined component malfunctions comprising routes of vehicles for said determined component malfunction are determined by means of position determining means.

- 10 According to the embodiment the method for diagnosing malfunction of vehicle components of vehicles comprises a step S3. In this step routes for vehicles associated with said determined component malfunction are compared.

- 15 According to the embodiment the method for diagnosing malfunction of vehicle components of vehicles comprises a step S4. In this step routes for vehicles associated with said determined component malfunction are compared.

- 20 The step of determining malfunction of vehicle components of vehicles by means of component malfunction determining means comprises according to an embodiment collecting information regarding detected component malfunction of different vehicles. Component malfunction determining means may comprise means for collecting information of component malfunction of vehicles.

- 25 Thus, according to an embodiment the method comprises the step of collecting information regarding detected component malfunction of different vehicles.

Component malfunction determining means may comprise any suitable means for determining component malfunction. Component malfunction

determining means may comprise any suitable detector arranged on board vehicles in connection to such a component for detecting component malfunction. Component malfunction determining means may comprise any suitable external means such as any suitable detector or the like for
5 determining component malfunction of a component of a vehicle, such external component malfunction detection means e.g. being situated in a workshop for diagnosing/repairing vehicles. Component malfunction determining means may depend on kind of component malfunction and kind of component.

10 The step of determining position of vehicles in connection to determined component malfunctions comprising determining routes of vehicles for said determined component malfunction comprises according to an embodiment collecting information regarding determined routes of vehicles for said determined component malfunction. Position determining means may
15 comprise means for collecting information of determined routes of vehicles for said determined component malfunction. The position determining means for determining position of vehicles in connection to determined component malfunctions comprises according to an embodiment a Global Navigation Satellite System, GNSS, e.g. a global positioning system, GPS, for
20 determining the position and routes of said vehicles.

Thus, according to an embodiment the method comprises the step of collecting information regarding determined routes of vehicles for said determined component malfunction.

The method comprises according to an embodiment the step of storing, by
25 means of storage means, information of determined malfunction of vehicle components of vehicles and information of determined routes of vehicles for said determined component malfunction. Said storage means may be any suitable storage means such as any suitable external storage means, for example a central server unit, a computer of any suitable kind, the so called

cloud or any other storage means suitable for receiving and storing said information.

The step of comparing routes for vehicles associated with said determined component malfunction comprises the step of retrieving thus stored
5 information from said storage means. The step of comparing routes for vehicles associated with said determined component malfunction comprises utilizing any suitable comparison means for comparing routes for vehicles associated with said determined component malfunction. Said comparison means may comprise any suitable processor unit, control unit, computer or
10 the like. Thus, the method comprises the step of comparing routes for vehicles associated with said determined component malfunction by means of comparison means.

The step of determining one or more common route portions for vehicles associated with said determined component malfunction comprises utilizing
15 any suitable determining means for determining one or more common route portions for vehicles associated with said determined component malfunction. Said determining means may comprise any suitable processor unit, control unit, computer or the like. Thus, the method comprises the step of determining one or more common route portions for vehicles associated
20 with said determined component malfunction determining means.

According to an embodiment the method further comprises the step of recommending taking action based on said determined one or more common route portions for vehicles associated with said determined component malfunction so as to facilitate reducing such component malfunctions.

25 According to an embodiment of the method the step of recommending taking action based on said determined one or more common route portions comprises the step of providing recommendations regarding vehicle operation by means of vehicle operation recommendation means.

Said vehicle operation recommendation means may comprise any suitable means for providing recommendation regarding vehicle operation based on said determined one or more common route portions.

- Said vehicle operation recommendation means may comprise on board
- 5 vehicle operation recommendation means arranged on board vehicles travelling/intended to travel on routes comprising said one or more common route portions. Said on board vehicle operation recommendation means comprises according to an embodiment visual means for providing a visual recommendation and/or sound means for providing audible recommendation.
- 10 The visual means for visual recommendation comprises according to an embodiment one or more display units on board said vehicles on e.g. the instrument panel, a head-up-display on the windshield or the like, for displaying said recommendation regarding vehicle operation based on said determined one or more common route portions.
- 15 Said vehicle operation recommendation means may comprise external operation recommendation means arranged external to vehicles travelling/intended to travel on routes comprising said one or more common route portions. Said external operation recommendation means may comprise any suitable means for providing recommendations regarding
- 20 vehicle operation such as any suitable server unit, computer or the like configured to present such recommendations e.g. by means of visual presentation via a display unit as e.g. a text message, an image or the like, and/or by means of sound, e.g. a sound message or the like.

- Said vehicle operation recommendation means for providing
- 25 recommendation regarding vehicle operation based on said determined one or more common route portions may thus be arranged to provide a recommendation to vehicle operators and/or externally, e.g. to owner of a vehicle fleet, as a basis for route planning.

According to an embodiment of the method the step of providing recommendations regarding vehicle operation depends on one or more of: kind of component, type of component malfunction, type of vehicle.

- According to an embodiment of the method the step of providing
- 5 recommendations regarding vehicle operation comprises the steps of: determining one or more of: kind of component having had said malfunction, type of component malfunction, and type of vehicle having had said component malfunction, and providing recommendations regarding vehicle operation based on or more of: determined kind of component, type of
- 10 component malfunction, and type of vehicle.

Kind of component having had said malfunction is determined by means of component determining means. Component determining means may comprise any detection means, e.g. one or more detectors or the like, for identifying said component.

- 15 Type of component malfunction is determined by means of component malfunction determining means. Component malfunction determining means may comprise any detection means, e.g. one or more detectors or the like, for identifying said component malfunction.

- Type of vehicle having had said malfunction is determined by means of
- 20 vehicle determining means. Vehicle determining means may comprise any identification means for identifying said vehicle.

- According to an embodiment of the method the step of providing recommendations regarding vehicle operation comprises one or more of: recommending avoiding said one or more common route portions,
- 25 recommending another type of vehicle, recommending adapting the vehicle, recommending adapting vehicle operation when driving on said one or more common route portions, recommending improving the condition of said one or more common route portions.

Thus, according to an embodiment of the method the step of providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises recommending avoiding said one or more common route portions. Such recommendation may be provided if
5 there is an alternative route available.

Thus, according to an embodiment of the method the step of providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises recommending another type of vehicle. Another type of vehicle may e.g. be a more robust vehicle, a vehicle
10 more likely to handle said route portions without having any such component malfunction. Such recommendation may be provided if there is no suitable alternative route.

Thus, according to an embodiment of the method the step of providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises recommending adapting the
15 vehicle. Adapting the vehicle may comprise adapting the vehicle to be more robust to better handle said route portions without having any such component malfunction. Such recommendation may be provided if there is no suitable alternative route.

20 Thus, according to an embodiment of the method the step of providing recommendations regarding vehicle operation based on said determined one or more common route portions comprises recommending adapting vehicle operation when driving on said one or more common route portions.

Thus, according to an embodiment of the method the step of providing
25 recommendations regarding vehicle operation based on said determined one or more common route portions recommending improving the condition of said one or more common route portions.

According to an embodiment of the method said components may comprise any of the following: suspension arrangements, vehicle axles, vehicle underside, vehicle filters, vehicle engine, vehicle transmission, vehicle tires.

Suspension arrangements may comprise any suspension of the vehicle
5 comprising any wheel suspension comprising spring members or the like. Vehicle axles may comprise any vehicle axles comprising any wheel axles comprising drive axles. Vehicle underside may comprise any part of the vehicle underside comprising underside of cab of vehicle when applicable. Vehicle filters may comprise any vehicle filters such as particle filters, fuel
10 filters, air pressure filters etc.

Conditions on road portions causing component malfunctions may be bad road conditions such as potholes, stones, gravel, bumps, or conditions such as road construction work, speed bumps or the like. Such conditions may e.g. cause flat tires, affect suspension arrangements, wheel axles, underside
15 of vehicle.

The air condition on a particular road portion, caused e.g. by road conditions such as gravel and/or dust, may affect vehicle filters. If e.g. the fuel filter becomes clogged the engine may be affected so that malfunctions/fails.

With reference to figure 4, a diagram of an apparatus 500 is shown. The
20 control arrangement 100 described with reference to fig. 2 may according to an embodiment comprise apparatus 500. The system I described with reference to fig. 2 may according to an embodiment comprise apparatus 500. Apparatus 500 comprises a non-volatile memory 520, a data processing device 510 and a read/write memory 550. Non-volatile memory 520 has a
25 first memory portion 530 wherein a computer program, such as an operating system, is stored for controlling the function of apparatus 500. Further, apparatus 500 comprises a bus controller, a serial communication port, I/O-means, an A/D-converter, a time date entry and transmission unit, an event

counter and an interrupt controller (not shown). Non-volatile memory 520 also has a second memory portion 540.

A computer program P is provided comprising routines for diagnosing component malfunction of vehicles. The program P comprises routines for
5 determining malfunction of vehicle components. The program P comprises routines for determining position of vehicles in connection to determined component malfunctions comprising determining routes of vehicles for said determined component malfunction. The program P comprises routines for
10 comparing routes for vehicles associated with said determined component malfunction. The program P comprises routines for determining one or more common route portions for vehicles associated with said determined component malfunction. The program P comprises routines for recommending taking action based on said determined one or more common route portions for vehicles associated with said determined component
15 malfunction so as to facilitate reducing such component malfunctions. The program P comprises routines for providing recommendations regarding vehicle operation by means of vehicle operation recommendation means based on said determined one or more common route portions for vehicles associated with said determined component malfunction so as to facilitate
20 reducing such component malfunctions. The program P comprises routines for recommending avoiding said one or more common route portions, recommending another type of vehicle, recommending adapting the vehicle, recommending adapting vehicle operation when driving on said one or more common route portions, recommending improving the condition of said one
25 or more common route portions, based on said determined one or more common route portions for vehicles associated with said determined component malfunction so as to facilitate reducing such component malfunctions. The computer program P may be stored in an executable manner or in a compressed condition in a separate memory 560 and/or in
30 read/write memory 550.

When it is stated that data processing device 510 performs a certain function it should be understood that data processing device 510 performs a certain part of the program which is stored in separate memory 560, or a certain part of the program which is stored in read/write memory 550.

- 5 Data processing device 510 may communicate with a data communications port 599 by means of a data bus 515. Non-volatile memory 520 is adapted for communication with data processing device 510 via a data bus 512. Separate memory 560 is adapted for communication with data processing device 510 via a data bus 511. Read/write memory 550 is adapted for
- 10 communication with data processing device 510 via a data bus 514. To the data communications port 599 e.g. the links connected to the control units 100 may be connected.

- When data is received on data port 599 it is temporarily stored in second memory portion 540. When the received input data has been temporarily
- 15 stored, data processing device 510 is set up to perform execution of code in a manner described above. The signals received on data port 599 can be used by apparatus 500 for determining malfunction of vehicle components. The signals received on data port 599 can be used by apparatus 500 for determining position of vehicles in connection to determined component
- 20 malfunctions comprising determining routes of vehicles for said determined component malfunction. The signals received on data port 599 can be used by apparatus 500 for comparing routes for vehicles associated with said determined component malfunction. The signals received on data port 599 can be used by apparatus 500 for determining one or more common route
- 25 portions for vehicles associated with said determined component malfunction. The signals received on data port 599 can be used by apparatus 500 for recommending taking action based on said determined one or more common route portions for vehicles associated with said determined component malfunction so as to facilitate reducing such component
- 30 malfunctions. The signals received on data port 599 can be used by

apparatus 500 for providing recommendations regarding vehicle operation by means of vehicle operation recommendation means based on said determined one or more common route portions for vehicles associated with said determined component malfunction so as to facilitate reducing such component malfunctions. The signals received on data port 599 can be used by apparatus 500 for comprises recommending avoiding said one or more common route portions, recommending another type of vehicle, recommending adapting the vehicle, recommending adapting vehicle operation when driving on said one or more common route portions, recommending improving the condition of said one or more common route portions, based on said determined one or more common route portions for vehicles associated with said determined component malfunction so as to facilitate reducing such component malfunctions.

Parts of the methods described herein can be performed by apparatus 500 by means of data processing device 510 running the program stored in separate memory 560 or read/write memory 550. When apparatus 500 runs the program, parts of the methods described herein are executed.

The foregoing description of the preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated.

CLAIMS

1. A method for diagnosing component malfunction of vehicles, comprising the steps of: determining (S1) malfunction (C1, C2, C3, C4, C5, C6, C7) of vehicle components of vehicles by means of component malfunction
5 determining means; determining (S2) position of vehicles in connection to determined component malfunctions by means of position determining means, **characterized in that** the step of determining (S2) position of vehicles in connection to determined component malfunctions (C1, C2, C3, C4, C5, C6, C7) comprises the step of determining routes (R1, R2, R3, R4)
10 of vehicles for said determined component malfunction; said method further comprising the steps of: comparing (S3) routes for vehicles associated with said determined component malfunction; and determining (S4) one or more common route portions (RP) for vehicles associated with said determined component malfunction (C1, C2, C3, C4, C5, C6, C7).
- 15 2. A method according to claim 1, further comprising the step of recommending taking action based on said determined one or more common route portions (RP) for vehicles associated with said determined component malfunction (C1, C2, C3, C4, C5, C6, C7) so as to facilitate reducing such component malfunctions.
- 20 3. A method according to claim 2, wherein the step of recommending taking action based on said determined one or more common route portions (RP) comprises the step of providing recommendations regarding vehicle operation by means of vehicle operation recommendation.
4. A method according to claim 3, wherein the step of providing
25 recommendations regarding vehicle operation depends on one or more of: kind of component, type of component malfunction, type of vehicle.
5. A method according to claim 3 or 4, wherein the step of providing recommendations regarding vehicle operation comprises one or more of: recommending avoiding said one or more common route portions;

recommending another type of vehicle; recommending adapting vehicle; recommending adapting vehicle operation when driving on said one or more common route portions; recommending improving the condition of said one or more common route portions.

- 5 6. A method according to any of claims 1-5, wherein said components may comprise any of the following: suspension arrangements, vehicle axles, vehicle underside, vehicle filters, vehicle engine, vehicle transmission, vehicle tires.
- 10 7. A system (I) for diagnosing component malfunction of vehicles, comprising component malfunction determining means (110) for determining malfunction (C1, C2, C3, C4, C5, C6, C7) of vehicle components of vehicles; position determining means (120) for determining position of vehicles in connection to determined component malfunctions, **characterized in that** the position determining means (120) for determining position of vehicles in connection to determined component malfunctions (C1, C2, C3, C4, C5, C6, C7) comprises means (122) for determining routes (R1, R2, R3, R4) of vehicles for said determined component malfunction; said system further comprising means (140) for comparing routes for vehicles associated with said determined component malfunction (C1, C2, C3, C4, C5, C6, C7); and
- 15 20 means (150) for determining one or more common route portions (RP) for vehicles associated with said determined component malfunction.
- 25 8. A system according to claim 7, further comprising means (160) for recommending taking action based on said determined one or more common route portions (RP) for vehicles associated with said determined component malfunction so as to facilitate reducing such component malfunctions.
9. A system according to claim 7 or 8, wherein the means (160) for recommending taking action based on said determined one or more common route portions comprises vehicle operation recommendation means (162) for providing recommendations regarding vehicle operation.

10. A system according to any of claims 7-9, wherein the means (162) for providing recommendations regarding vehicle operation comprises means (162a) for considering one or more of: kind of component, type of component malfunction, type of vehicle, as a basis for provided recommendation.

- 5 11. A system according to any of claims 7-10, wherein the means (162) for providing recommendations regarding vehicle operation comprises one or more of: recommending avoiding said one or more common route portions; recommending another type of vehicle; recommending adapting the vehicle; recommending adapting vehicle operation when driving on said one or more
10 common route portions; recommending improving the condition of said one or more common route portions.

12. A system according to any of claims 7-11, wherein said components may comprise any of the following: suspension arrangements, vehicle axles, vehicle underside, vehicle filters, vehicle engine, vehicle transmission,
15 vehicle tires.

13. A computer program (P) for diagnosing component malfunction of vehicles, said computer program (P) comprising program code which, when run on an electronic control unit (100) or another computer (500) connected to the electronic control unit (100), causes the electronic control unit to
20 perform the steps according to claim 1-6.

14. A computer readable medium comprising instructions which, when executed by a computer, cause the computer to carry out the method according to any of claim 1-6.

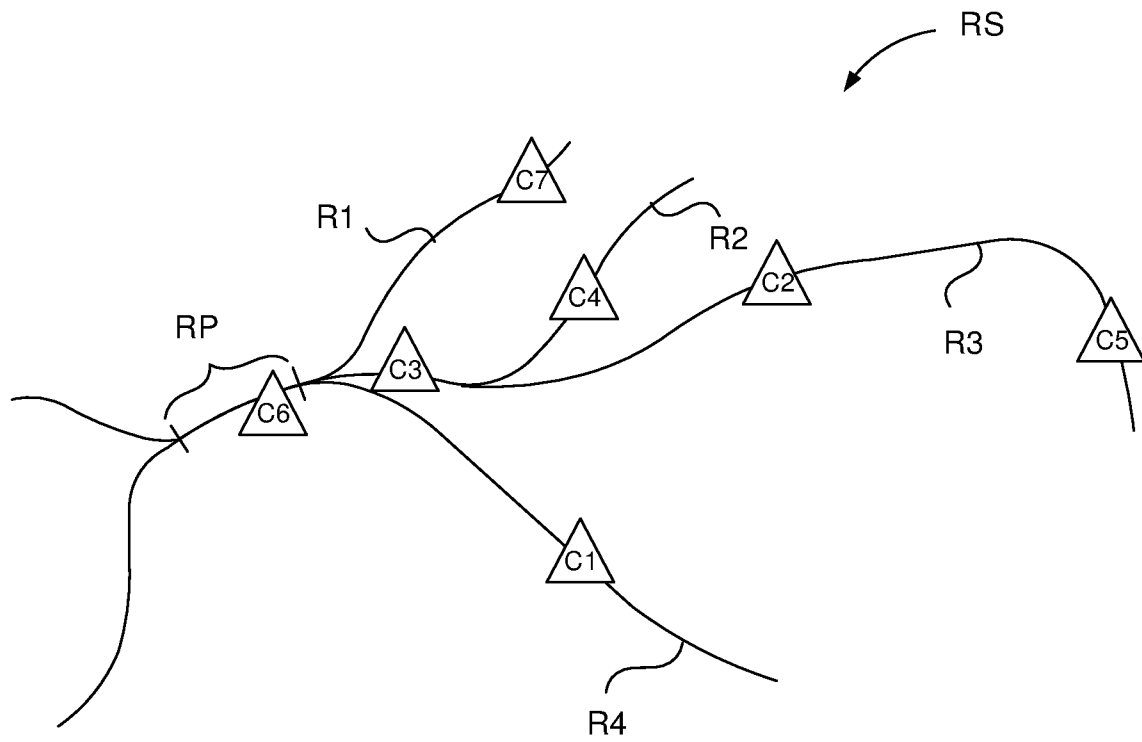


Fig. 1

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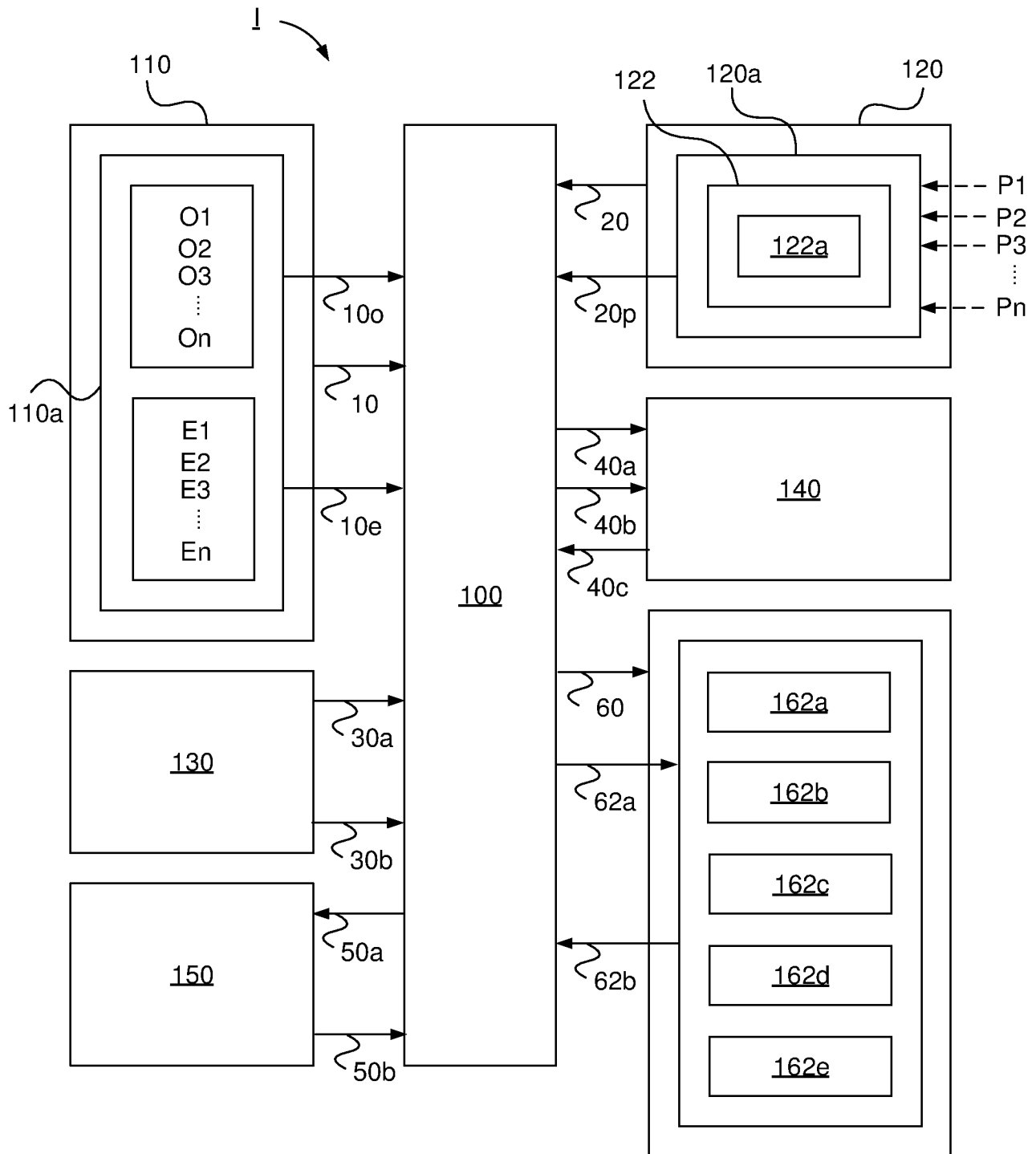


Fig. 2

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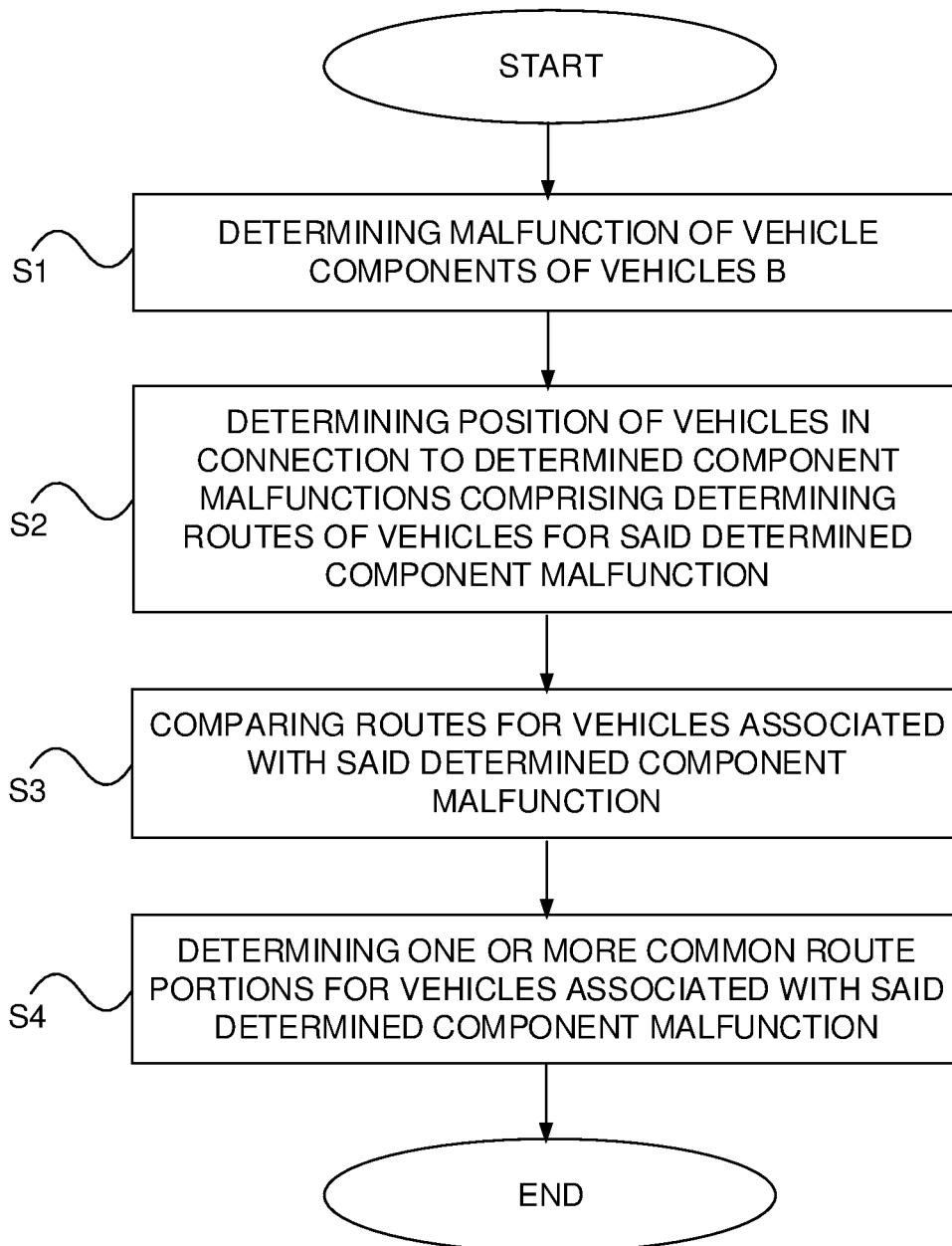


Fig. 3

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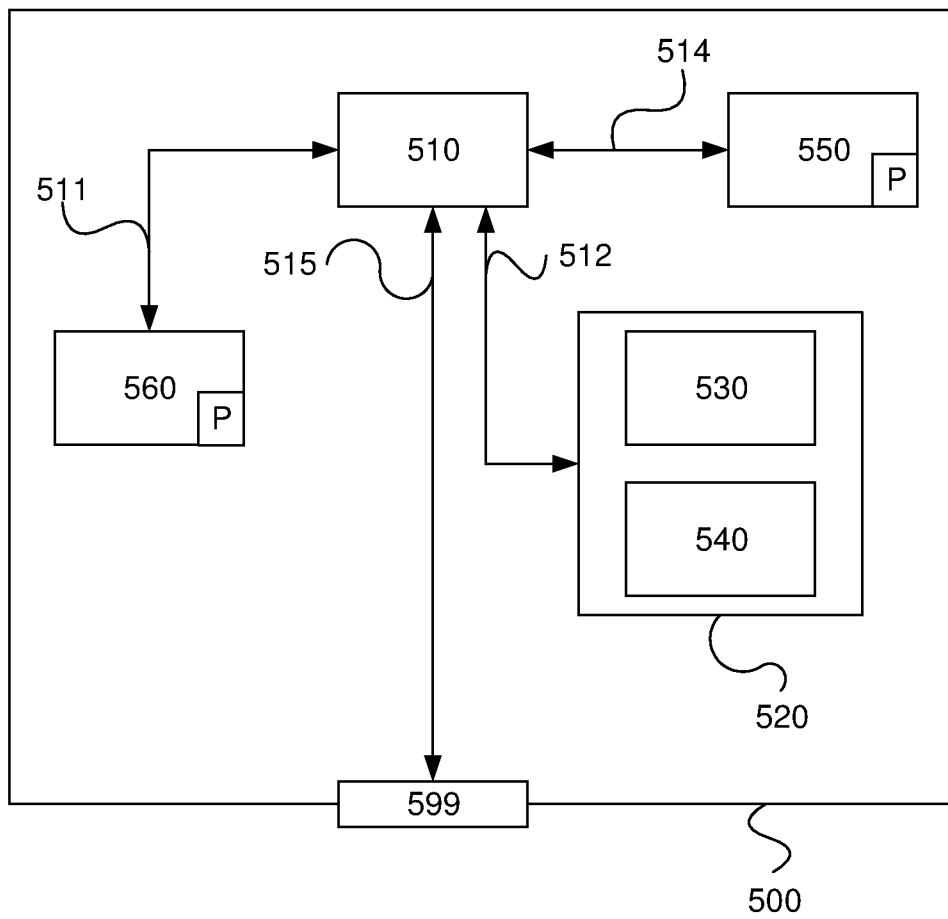


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2018/050436

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G01M, G07C

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6505106 B1 (LAWRENCE KELVIN RODERICK ET AL), 7 January 2003 (2003-01-07); column 1, line 7 - line 13; column 2, line 18 - line 27; column 2, line 36 - line 39; column 3, line 34 - line 36; column 6, line 45 - line 54; figure 6; claim 1 --	1-14
A	US 20170123428 A1 (LEVINSON JESSE SOL ET AL), 4 May 2017 (2017-05-04); abstract; paragraphs [0154], [0162] --	1-14
A	US 20150046582 A1 (GELVIN DAVID C ET AL), 12 February 2015 (2015-02-12); abstract; paragraphs [0217], [0249] --	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

15-06-2018

Date of mailing of the international search report

18-06-2018

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2018/050436

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	US 8260537 B2 (BREED DAVID S), 10 September 2009 (2009-09-10); abstract --	1-14
A	US 20160003621 A1 (KOENIG DAVID J ET AL), 7 January 2016 (2016-01-07); abstract --	1-14
A	AU 2015201894 A1 (GEN ELECTRIC), 12 November 2015 (2015-11-12); abstract -- -----	1-14

Continuation of: second sheet

International Patent Classification (IPC)

G01M 17/00 (2006.01)

G07C 5/00 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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